Packaging

User Guide for Temperature Control M221 Project Template

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The information provided in this documentation contains general descriptions and/or technical characteristics of the performance of the products contained herein. This documentation is not intended as a substitute for and is not to be used for determining suitability or reliability of these products for specific user applications. It is the duty of any such user or integrator to perform the appropriate and complete risk analysis, evaluation and testing of the products with respect to the relevant specific application or use thereof. Neither Schneider Electric nor any of its affiliates or subsidiaries shall be responsible or liable for misuse of the information contained herein. If you have any suggestions for improvements or amendments or have found errors in this publication, please notify us.

All pertinent state, regional, and local safety regulations must be observed when installing and using this product. For reasons of safety and to help ensure compliance with documented system data, only the manufacturer should perform repairs to components.

When devices are used for applications with technical safety requirements, the relevant instructions must be followed.

Failure to use Schneider Electric software or approved software with our hardware products may result in injury, harm, or improper operating results.

Failure to observe this information can result in injury or equipment damage.

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Safety Information

Important Information

NOTICE

Read these instructions carefully, and look at the equipment to become familiar with the device before trying to install, operate, or maintain it. The following special messages may appear throughout this documentation or on the equipment to warn of potential hazards or to call attention to information that clarifies or simplifies a procedure.

The addition of this symbol to a Danger safety label indicates that an electrical hazard exists, which will result in personal injury if the instructions are not followed.

This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

⚠ DANGER

DANGER indicates an imminently hazardous situation which, if not avoided, **will result in** death or serious injury.

⚠ WARNING

WARNING indicates a potentially hazardous situation which, if not avoided, **can result in** death or serious injury.

⚠ CAUTION

CAUTION indicates a potentially hazardous situation which, if not avoided, **can result in** minor or moderate injury.

NOTICE

NOTICE is used to address practices not related to physical injury.

PLEASE NOTE

Electrical equipment should be installed, operated, serviced, and maintained only by qualified personnel. No responsibility is assumed by Schneider Electric for any consequences arising out of the use of this material.

A qualified person is one who has skills and knowledge related to the construction and operation of electrical equipment and its installation, and has received safety training to recognize and avoid the hazards involved.

BEFORE YOU BEGIN

Do not use this product on machinery lacking effective point-of-operation guarding. Lack of effective point-of-operation guarding on a machine can result in serious injury to the operator of that machine.

⚠ WARNING

UNGUARDED EQUIPMENT

- Do not use this software and related automation equipment on equipment which does not have point-of-operation protection.
- Do not reach into machinery during operation.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

This automation equipment and related software is used to control a variety of industrial processes. The type or model of automation equipment suitable for each application will vary depending on factors such as the control function required, degree of protection required, production methods, unusual conditions, government regulations, etc. In some applications, more than one processor may be required, as when backup redundancy is needed.

Only you, the user, machine builder or system integrator can be aware of all the conditions and factors present during setup, operation, and maintenance of the machine and, therefore, can determine the automation equipment and the related safeties and interlocks which can be properly used. When selecting automation and control equipment and related software for a particular application, you should refer to the applicable local and national standards and regulations. The National Safety Council's Accident Prevention Manual (nationally recognized in the United States of America) also provides much useful information.

In some applications, such as packaging machinery, additional operator protection such as point-of-operation guarding must be provided. This is necessary if the operator's hands and other parts of the body are free to enter the pinch points or other hazardous areas and serious injury can occur. Software products alone cannot protect an operator from injury. For this reason the software cannot be substituted for or take the place of point-of-operation protection.

Ensure that appropriate safeties and mechanical/electrical interlocks related to point-of-operation protection have been installed and are operational before placing the equipment into service. All interlocks and safeties related to point-of-operation protection must be coordinated with the related automation equipment and software programming.

NOTE: Coordination of safeties and mechanical/electrical interlocks for point-of-operation protection is outside the scope of the Function Block Library, System User Guide, or other implementation referenced in this documentation.

START-UP AND TEST

Before using electrical control and automation equipment for regular operation after installation, the system should be given a start-up test by qualified personnel to verify correct operation of the equipment. It is important that arrangements for such a check be made and that enough time is allowed to perform complete and satisfactory testing.

⚠ CAUTION

EQUIPMENT OPERATION HAZARD

- Verify that all installation and set up procedures have been completed.
- Before operational tests are performed, remove all blocks or other temporary holding means used for shipment from all component devices.
- Remove tools, meters, and debris from equipment.

Failure to follow these instructions can result in injury or equipment damage.

Follow all start-up tests recommended in the equipment documentation. Store all equipment documentation for future references.

Software testing must be done in both simulated and real environments.

Verify that the completed system is free from all short circuits and temporary grounds that are not installed according to local regulations (according to the National Electrical Code in the U.S.A, for instance). If high-potential voltage testing is necessary, follow recommendations in equipment documentation to prevent accidental equipment damage.

Before energizing equipment:

- Remove tools, meters, and debris from equipment.
- Close the equipment enclosure door.
- Remove all temporary grounds from incoming power lines.
- Perform all start-up tests recommended by the manufacturer.

OPERATION AND ADJUSTMENTS

The following precautions are from the NEMA Standards Publication ICS 7.1-1995 (English version prevails):

- Regardless of the care exercised in the design and manufacture of equipment or in the selection and ratings of components, there are hazards that can be encountered if such equipment is improperly operated.
- It is sometimes possible to misadjust the equipment and thus produce unsatisfactory or unsafe operation. Always use the manufacturer's instructions as a guide for functional adjustments. Personnel who have access to these adjustments should be familiar with the equipment manufacturer's instructions and the machinery used with the electrical equipment.
- Only those operational adjustments actually required by the operator should be accessible to the operator. Access to other controls should be restricted to prevent unauthorized changes in operating characteristics.

About the Book

At a Glance

Document Scope

This document describes a project template to be used with a Modicon M221 Logic Controller and an Magelis HMI display for temperature control application.

The following basic knowledge is required:

- Basic information on functionality, configuration of the controllers, and HMI displays.
- Programming in the ladder diagram (LD) language.

Validity Note

This document has been created with the release of SoMachine 4.1.

This document has been created with the release of SoMachine Basic 1.1.

Related Documents

Title of Document	Reference Number
SoMachine Basic - Generic Functions Library Guide	EIO0000001474

You can download these technical publications and other technical information from our website at www.schneider-electric.com

Product Related Information

⚠ WARNING

LOSS OF CONTROL

- The designer of any control scheme must consider the potential failure modes of control paths and, for certain critical control functions, provide a means to achieve a safe state during and after a path failure. Examples of critical control functions are emergency stop and overtravel stop, power outage and restart.
- Separate or redundant control paths must be provided for critical control functions.
- System control paths may include communication links. Consideration must be given to the implications of unanticipated transmission delays or failures of the link.
- Observe all accident prevention regulations and local safety guidelines.[1]
- Each implementation of this equipment must be individually and thoroughly tested for proper operation before being placed into service.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

[1] For additional information, refer to NEMA ICS 1.1 (latest edition), "Safety Guidelines for the Application, Installation, and Maintenance of Solid State Control" and to NEMA ICS 7.1 (latest edition), "Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable-Speed Drive Systems" or their equivalent governing your particular location.

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

- Only use software approved by Schneider Electric for use with this equipment.
- Update your application program every time you change the physical hardware configuration.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Chapter 1
Temperature Control Application Template

Introduction

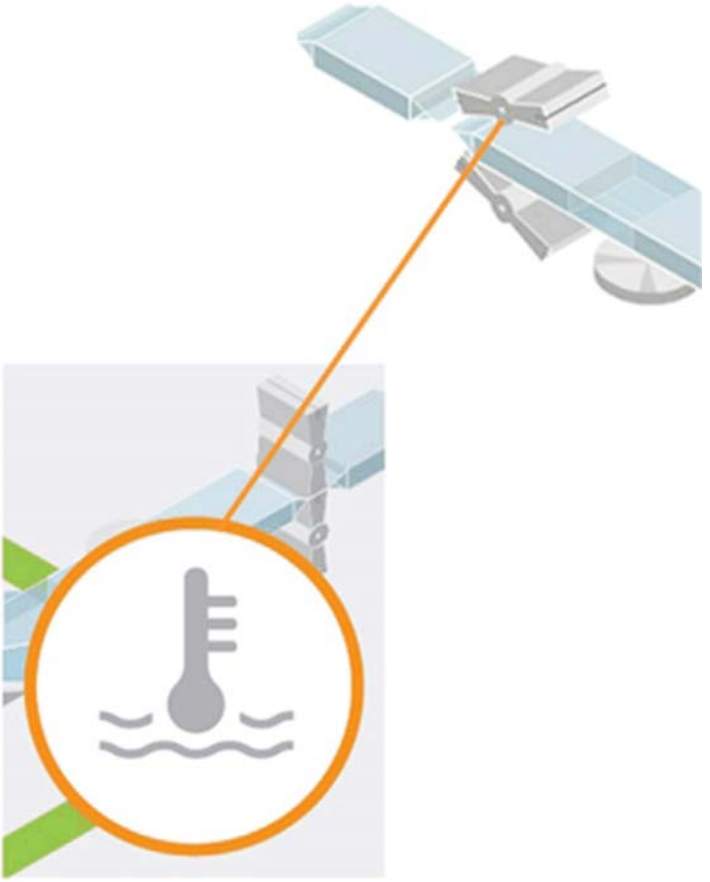
The project template is an example of an application used to control temperature in a packaging machine. It contains a hardware configuration for a temperature control application. It can be a part of vertical or horizontal bagging machine, for example, bag sealing.

For downloading this project template to a M221 Logic Controller, a PC with the following software installation is necessary:

- SoMachine which integrates SoMachine Basic and Vijeo-Designer, or
- SoMachine Basic and Vijeo-Designer as standalone applications.

This project template is based on the M221 Logic Controller with a Magelis HMI.

The following figure is an example for sealing in a horizontal bagging machine:



Chapter 2
Temperature Control Architecture

Overview

This chapter describes the temperature control architecture.

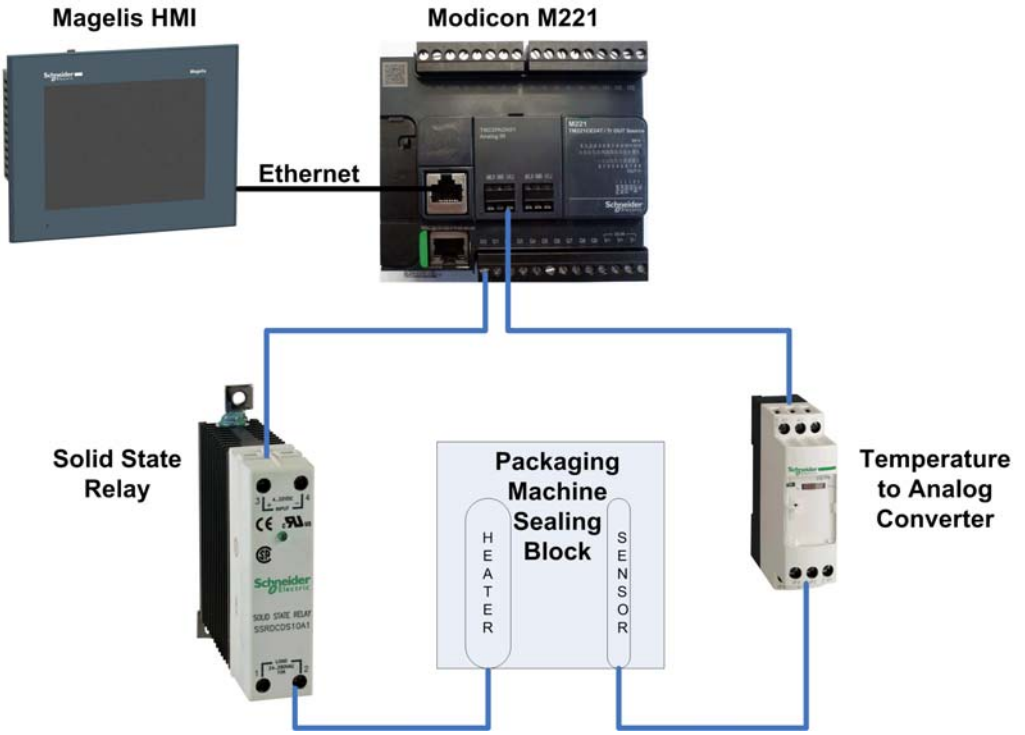
What Is in This Chapter?

This chapter contains the following topics:

Hardware Architecture

Used Architecture

The following figure shows an example and can adapt to your application:



Packaging Application System Requirements

System Requirements

Requirements	Description
M221CE••T	Schneider Electric Programmable Logic Controller (brick format with cartridge option) is connected to the HMI through an Ethernet cable.
TMC2PACK01	Schneider Electric Packaging Cartridge will add 2 analog inputs on the front side of the controller.
RMPT••BD or RMT•••BD	Schneider Electric Analog Interface is used to convert the temperature, coming from the sensor, to an analog value (4...20 mA). The controller reads the analog value and scales back to a temperature value.
Temperature sensor	PT100 or Thermocouple is required to take feedback of the temperature value.
SSRDCDS••A1	Schneider Electric Solid State Relay (SSR) for heater control.
HMIGTO4310	Schneider Electric HMI is used to monitor and control the process.

NOTE: Alternatively to the Packaging cartridge, you can extend the controller with a temperature input expansion module on the right side, requiring a modification to the application.

Chapter 3
Hardware Configuration

Embedded IOs

Input/Output Variables

This table describes the input/output variables:

Input/Output	Variable	Description
%IW1.0	IW_TC1PT100	Temperature value from PT100 sensor through the Packaging Cartridge.
%Q0.0	QXTC1_Heater	Digital output for Solid State Relay (SSR) control.

Chapter 4
Communication

Overview

This chapter describes the communication.

What Is in This Chapter?

This chapter contains the following topics:

Communication

Overview

The Modicon M221 Logic Controller and the Magelis HMI communicate through Modbus TCP.

You can download the application to the Modicon M221 Logic Controller using Ethernet or the SoMachine Mini USB Programming Cable.

You can download the HMI program using Ethernet or a USB memory stick or a dedicated cable XBTZG935.

Ethernet

Overview

IP addresses are configured as below:

Device	IP Address	Subnet Mask
Modicon M221 Logic Controller	192.168.100.20	255.255.255.0
Magelis HMI	192.168.100.10	

Chapter 5
Application Software

Overview

This chapter describes the application software.

What Is in This Chapter?

This chapter contains the following topics:

Task Configuration

Overview

This table shows the tasks configuration of the packaging application project template:

Task	POU	Type	Description
`Master Task`	`Application_Temperature`	Periodic	Contains packaging temperature control ladder logic rungs. The task is configured with a defined cycle time of 20 ms.

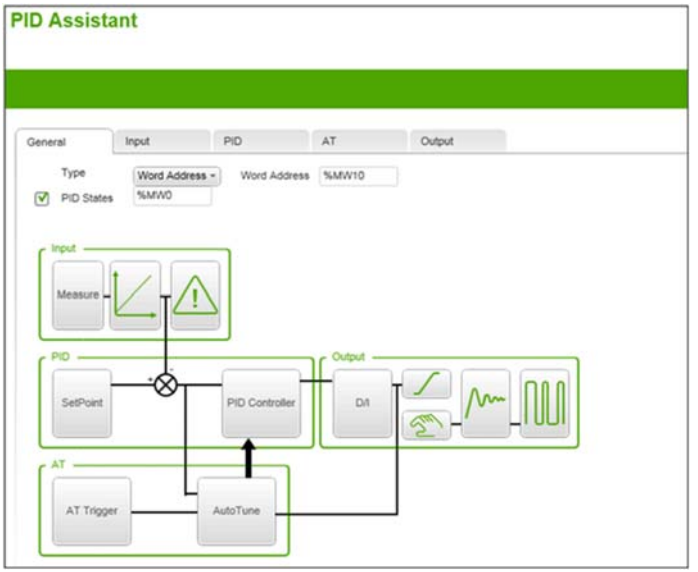
Temperature Control

Overview

The project template is based on PID 0 Software Object of SoMachine Basic. PID consists of AutoTuning, PID, and PWM function.

Application_Temperature

The project template reads the converted temperature value (4..20 mA) through the Packaging cartridge. The Packaging cartridge has 2 analog inputs. One analog input is used in the project template. You can read the temperature using a dedicated controller module or a Temperature to Analog current/voltage converter.



By using the PID Assistant, the PID 0 is configured and memory words are mapped to different functions. This table describes the memory addresses used in the PID Assistant:

Memory Address	Variable Name	Description
MW0	WTC1_PIDSTATUS	PID function block status Id
MW1	WTC1_ACTVALUE	Actual temperature (deg)
MW2	WTC1_SETPOINT	Setpoint temperature (deg)
MW3	WTC1_KP	KP (x100)
MW4	WTC1_TI	Ti (x0.1 s)
MW5	WTC1_TD	Td (x0.1 s)

Memory Address	Variable Name	Description
MW6	WTC1_ANALOGOP	PID analog output (0...5000)
MW7	WTC1_MANUALOPVAL	PID manual mode output value
MW8	WTC1_SETTEMPLOWALARM	Temperature low alarm setpoint
MW9	WTC1_SETTEMPHIGHALARM	Temperature high alarm setpoint
MW10	WTC1_PIDMODE	PID mode
M0	XTC1_ATTRIGGER	Auto start trigger
M1	XTC1_ACTIONTYPE	PID action type
M2	XTC1_MANUALMODE	PID manual mode enable
M3	XTC1_PWMOUTPUT	PWM output bit
M4	XTC1_ENPID	PID enable (Use in Project)
M5	XTC1_TEMPLOWALARM	Temperature low alarm bit
M6	XTC1_TEMPHIGHALARM	Temperature high alarm bit

The different PID mode is managed in the project template. After AutoTuning, the PID mode is 4. This logic is part of the project template and not managed by a function block.

This table describes the PID mode:

PID Mode (WTC1_PIDMODE)	The controller...
0	is disabled.
1	operates in simple PID mode.
2	operates in AutoTuning + PID mode.
3	operates in AutoTuning mode only.
4	operates in simple PID mode, with PI corrector only.

This table describes the AutoTuning state codes (WTC1_PIDSTATUS):

AutoTuning State (Hex Code)	AutoTuning State (Decimal Code)	AutoTuning Phase...
0100	256	1 in progress
0200	512	
0400	1024	
0800	2048	
1000	4096	complete

The following default values are automatically loaded if the Kp value is 0:

- Kp = 527
- Ti = 3447
- Td = 0

The PID is used as PI mode only.

The default value of the high temperature alarm (`WTC1_SETTEMPHIGHALARM`) is 150 and automatically loaded if the user value is 0.

The temperature high alarm bit (`XTEMPHIGHALARM`) is used as an interlock to turn off the heater control by PID. You can set the temperature high alarm setpoint according to the requirements of your machine application. While AutoTuning is executing, the `XTEMPHIGHALARM` bit is ignored and allows the control of the heater by the AutoTuning function.

The PWM period is set to 5 s in the **Output** tab of the PID Assistant and provides a good starting point for regulation of temperature.

The PID output limit is fixed as 1...5000 in the **Output** tab of the PID Assistant.

The PID sampling time is set to 20 ms (base is 10 ms) in the **PID** tab of the PID Assistant.

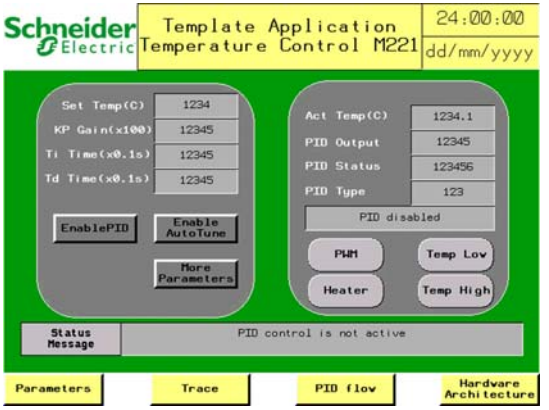
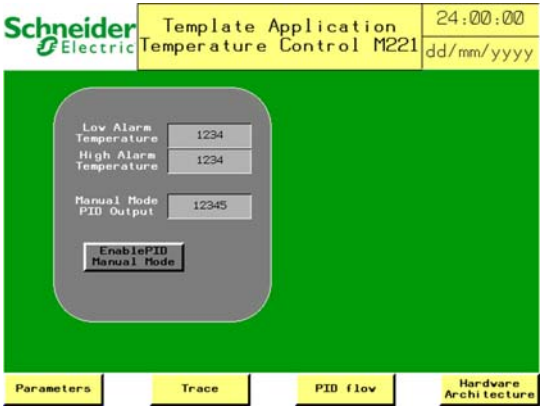
You can configure the PWM period, PID output limit, and sampling time as memory address in the PID Assistant.

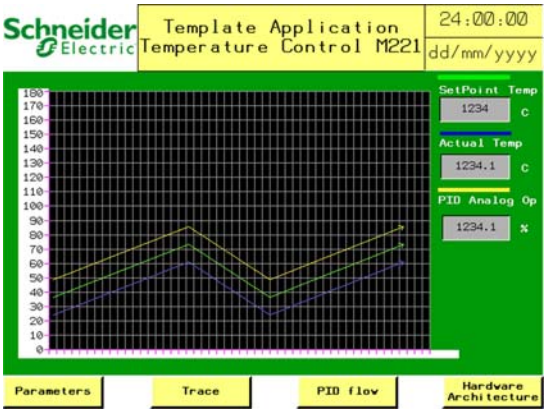
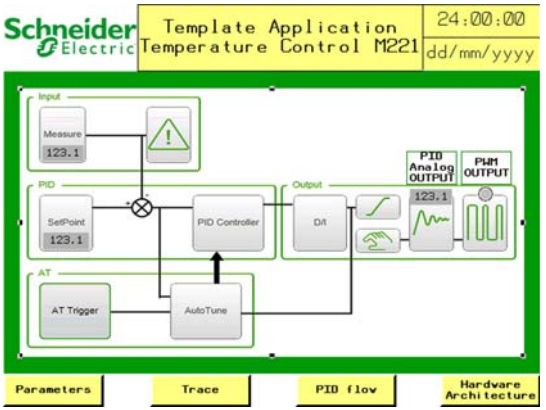
HMI Display

Overview

The project template uses Magelis HMI. You can parameterize, start AutoTuning, monitor, and control the temperature process.

This table describes different tabs of the panel with description:

Tab	Panel	Description
Parameters		Here, you can set the actual temperature, PID output, PID function block status number, PID type, and the alarm status. To activate any of the PID function, click the **EnablePID** button from the HMI.
Parameters		Here, you can set the Low and High temperature alarm, and you can enable the manual mode of the PID.

Tab	Panel	Description
Trace		The panel shows the trace of the actual temperature, setpoint, and the PID output. The PID analog output is a percentage value (100% = 5000). This is converted to percentage for HMI display purpose only.
PID flow		The panel shows a data flow diagram in the PID function block. For detailed information, refer to the General Tab *(see SoMachine Basic, Generic Functions Library Guide)*. The **Hardware Architecture** window shows the example architecture used in the project template.

Application Control

Overview

You have to ensure that the parameters Kp, Ti, Td, and alarm setpoints are configured on HMI.

Click the **EnablePID** button in the **Parameters** window for PID, and AutoTuning operation. The PID type Id changes to 4, indicating that PI control is activated.

By default, PID status message displays the text **PID Control is in progress** or **PID SetPoint has been reached**.

Click the **EnableAutoTune** button in the **Parameters** window to perform the AutoTuning. The PID type Id changes to 2, indicating that the controller operates in AutoTuning + PID mode. The PID status message changes to **Auto-Tuning phase 1 in progress**. The AutoTuning has 5 main states *(see page 25)*.

This table shows the settings used for the template reference architecture. These settings should be adapted to the requirements of your machine and application.

Parameter	Value
Controller scan time	20 ms
PID sampling time	20 ms
PWM time period	5 s
Dynamic AT corrector	Slow
Kp (x100)	527
Kp (x100)	3447
Td (x0.1s)	0

With the above parameters steady state temperature variation is less and ± 2 ºC.

For detailed information on PID operating modes, PID states and detected error codes, refer to the PID Programming *(see SoMachine Basic, Generic Functions Library Guide)*.