

EcoStruxure Machine Expert - Basic Example Guide

Using Pulse Train Output and Motion
Task Tables

xSample_PTO_Motion_Table.smbe

12/2018

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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, service, 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” or “Warning” 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 a hazardous situation which, if not avoided, **will result in** death or serious injury.

⚠ WARNING

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

⚠ CAUTION

CAUTION indicates a hazardous situation which, if not avoided, **could 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.

WARNING

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 death, serious 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 how to configure the Pulse Train Output of M221 Logic Controller and use the Motion and Administrative function blocks. It also demonstrates the advantages of using Motion tables.

The example described in this document is intended for learning purposes only. It must not be used directly on products that are part of a machine or process.

WARNING

UNINTENDED EQUIPMENT OPERATION

Do not include any wiring information, programming or configuration logic, or parameter values from any of the examples in your machine or process without thoroughly testing your entire application.

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

This document and its related EcoStruxure Machine Expert - Basic project file focus on specific instructions and function blocks provided with EcoStruxure Machine Expert - Basic, and on specific features available in EcoStruxure Machine Expert - Basic. They are intended to help you understand how to develop, test, commission, and integrate applicative software of your own design in your control systems.

The example is intended for new EcoStruxure Machine Expert - Basic users who already have some degree of expertise in the design and programming of control systems.

Validity Note

This document has been updated for the release of EcoStruxureTM Machine Expert - Basic V1.0.

Related Documents

Title of Documentation	Reference Number
LXM32M AC Servo Drive Product Manual	0198441113767

Title of Documentation	Reference Number
EcoStruxure Machine Expert - Basic - Operating Guide	<u>EIO0000003281 (ENG)</u> <u>EIO0000003282 (FRA)</u> <u>EIO0000003283 (GER)</u> <u>EIO0000003284 (SPA)</u> <u>EIO0000003285 (ITA)</u> <u>EIO0000003286 (CHS)</u> <u>EIO0000003287 (POR)</u> <u>EIO0000003288 (TUR)</u>
EcoStruxure Machine Expert - Basic Generic Functions - Library Guide	<u>EIO0000003289 (ENG)</u> <u>EIO0000003290 (FRE)</u> <u>EIO0000003291 (GER)</u> <u>EIO0000003292 (SPA)</u> <u>EIO0000003293 (ITA)</u> <u>EIO0000003294 (CHS)</u> <u>EIO0000003295 (POR)</u> <u>EIO0000003296 (TUR)</u>
Modicon M221 Logic Controller Advanced Functions - Library Guide	<u>EIO0000003305 (ENG)</u> <u>EIO0000003306 (FRE)</u> <u>EIO0000003307 (GER)</u> <u>EIO0000003308 (SPA)</u> <u>EIO0000003309 (ITA)</u> <u>EIO0000003310 (CHS)</u> <u>EIO0000003311 (POR)</u> <u>EIO0000003312 (TUR)</u>

You can download these technical publications and other technical information from our website at <https://www.schneider-electric.com/en/download>

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.

WARNING

UNINTENDED EQUIPMENT OPERATION

Do not include any wiring information, programming or configuration logic, or parameter values from any of the examples in your machine or process without thoroughly testing your entire application.

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Chapter 1

Example Description

What Is in This Chapter?

This chapter contains the following topics:

Topic	Page
Overview	14
Configuring the Pulse Train Output Generator	15
Motion and Administrative Function Blocks	17
Example Description	19
Project Template Description	27

Overview

General

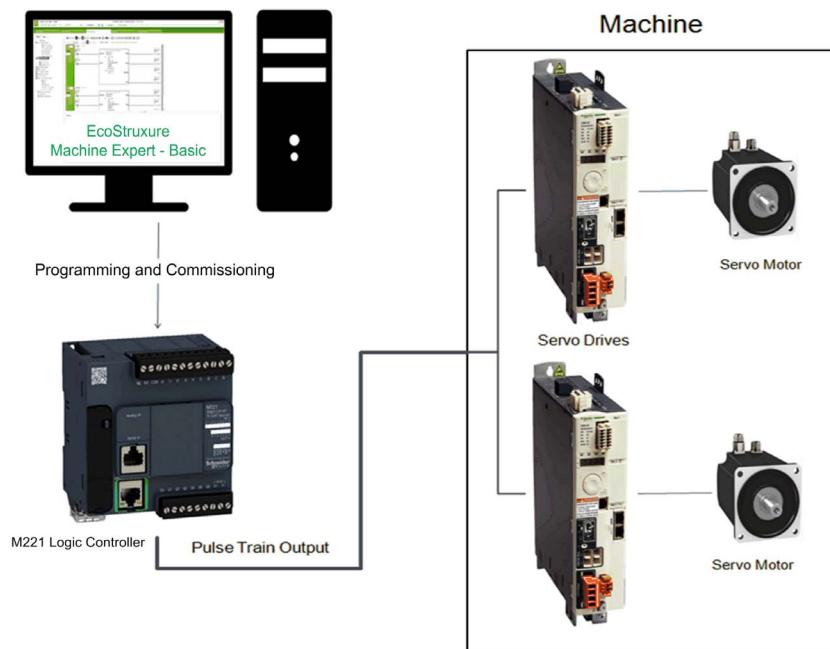
This example guide and its corresponding project template, included with EcoStruxure Machine Expert - Basic, help you to implement the Pulse Train Output (PTO) functionality of the M221 Logic Controller in your application. This guide helps you to:

- Configure the PTO output with EcoStruxure Machine Expert - Basic.
- Implement the PTO function blocks.
- Use Motion tables to simplify the use of multiple Motion function blocks.

This example guide also describes an application that uses the PTO function blocks.

The EcoStruxure Machine Expert - Basic project template is associated with the `xSample_PTO_Motion_Table.smbe` project file. This template is compatible with EcoStruxure Machine Expert - Basic V1.0.

This graphic illustrates a PTO setup:

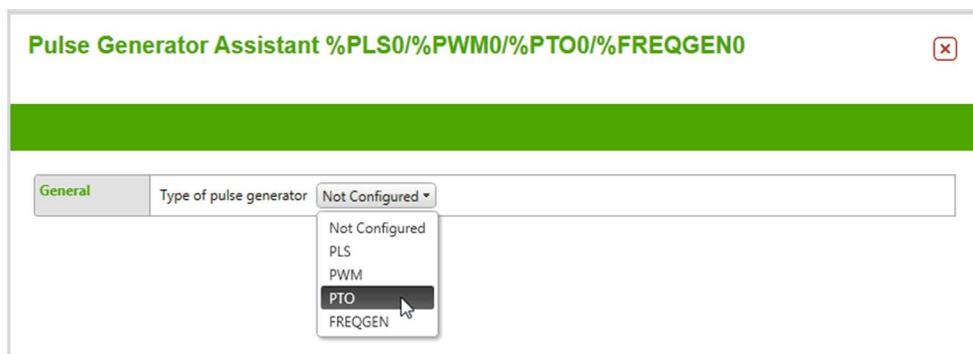


Configuring the Pulse Train Output Generator

To use the Pulse Train Output, first configure the corresponding **Pulse Generators** in EcoStruxure Machine Expert - Basic.

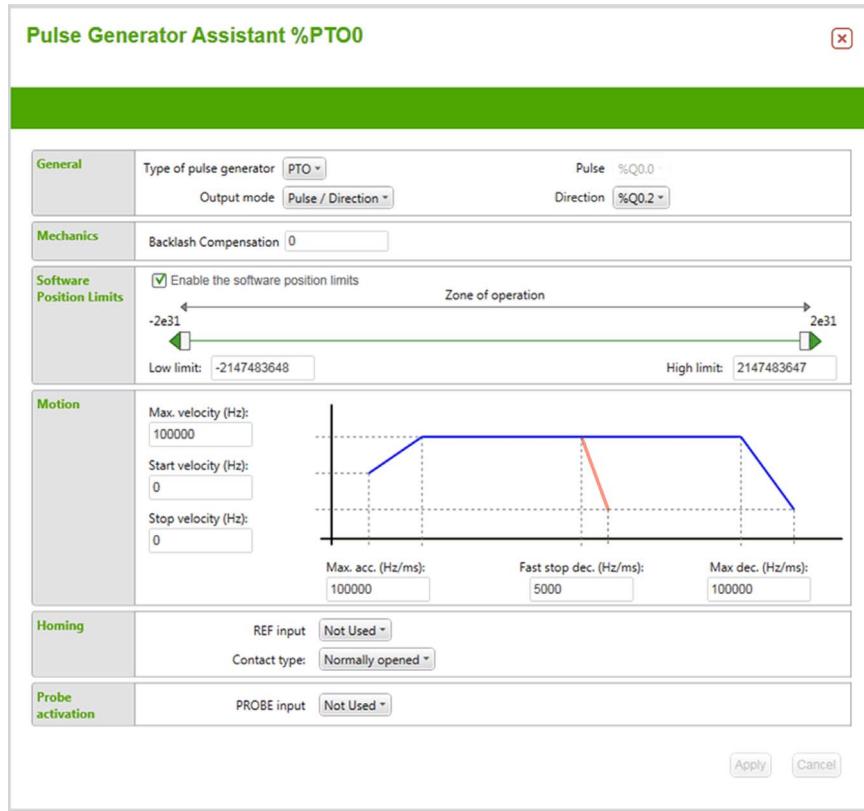


Except for the controller references with relay outputs, there are two **Pulse Generators** in the M221 Logic Controller that you can configure for various applications. You can configure both of them as PTOs and each output is called an axis in EcoStruxure Machine Expert - Basic.



The **Pulse Generator Assistant %PTOx** enables you to configure the software parameters. A servo drive must be configured separately, refer to Configuring a Servo Drive with SoMove ([see page 20](#)). You must adapt the software parameters according to the parameters of your servo drive and motor.

Example Description



Each axis uses two outputs of the M221 Logic Controller. For the **Pulse/Direction** configuration, Q0.0 and Q0.2 are the pulses sent by each axis. Q0.1 and Q0.3 are the directional signals sent by each axis. To use the PTO, follow the diagram shown in M221 Output Wiring Diagram ([see page 19](#)).

Configuration of the **Homing** and **Probe activation** areas of the assistant window is only necessary if you are using MC_Home_PTO and MC_TouchProbe_PTO function blocks, respectively.

Motion and Administrative Function Blocks

Overview

There are two types of PTO function blocks in EcoStruxure Machine Expert - Basic:

- Administrative
- Motion

PTO is managed in an open loop configuration in the M221 Logic Controller. This means that the M221 Logic Controller does not receive feedback signals directly from the servo drive. Instead, Motion function blocks send the appropriate signals, and the Administrative function blocks provide information on the state of the motor by reading the history of the signals sent by the Motion function blocks. The precision of PTO makes it possible to use an open loop configuration.

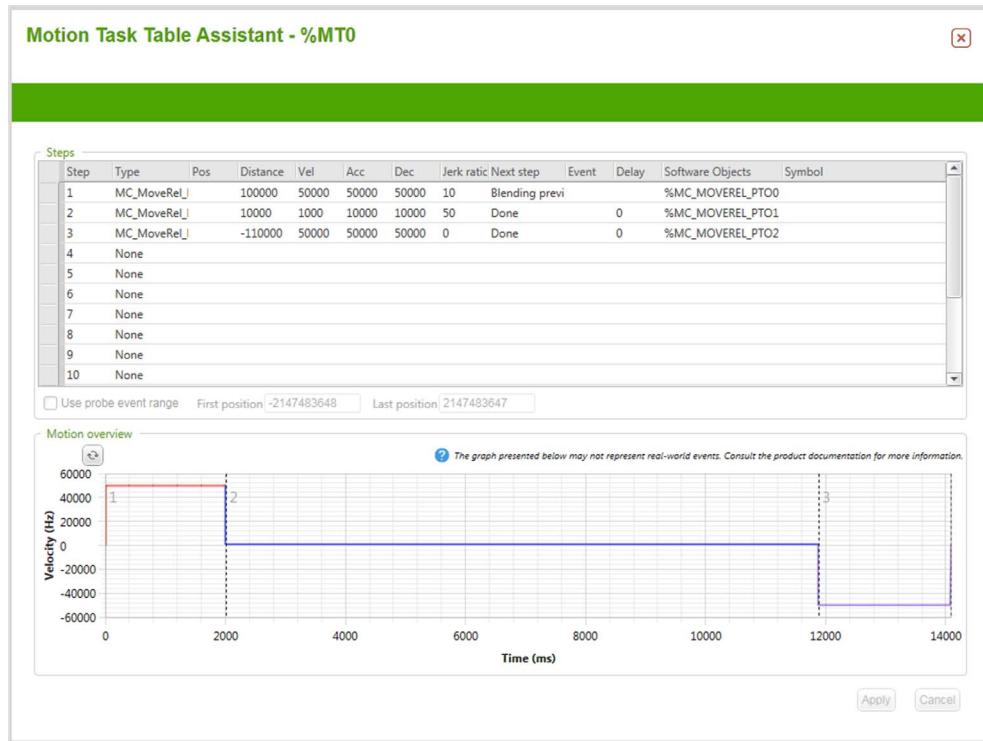
The `MotionTask` function block is a Motion function block that is used to manage the other Motion function blocks. You can find the information on how to use the `MotionTask` function block in [Using MotionTask Function Block and Motion Task Tables](#) ([see page 18](#)).

Although there are many `PTO` function blocks, it is not necessary to use all of them in your application. It is mandatory to use `MC_Power_PTO` to enable the other function blocks. It is also convenient to use `MC_Reset_PTO` to reset errors detected during execution of the function blocks.

In this template, not all Administrative and Motion function blocks are implemented. For more details on each of these function blocks, refer to the M221 Logic Controller - Advanced Functions Library Guide ([see page 9](#)).

Using the MotionTask Function Block and Motion Task Tables

The MotionTask function block is used in Ladder diagrams. This function block calls Motion Task Table, a table used to regroup Motion function blocks, sequence them, and display the velocity of the motor. For example, in the following example three function blocks are regrouped in a Motion Task Table:



As shown in the graphic above, you can put Motion function blocks (maximum 16) to be executed inside the Motion Task Table. You do not need to program these function blocks as they are managed completely by the Motion Task Table.

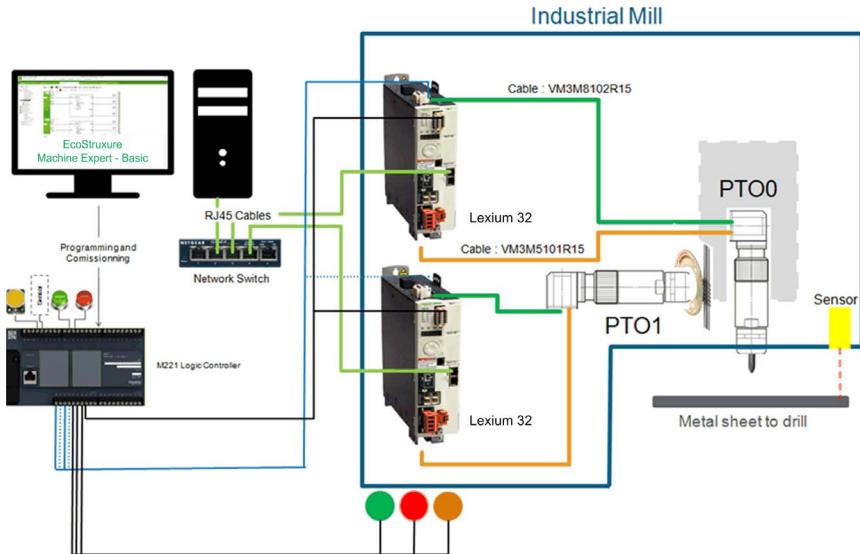
Use a Motion Task Table for a visual representation of the evolution of the velocity of the motor.

You can have up to four Motion Task Tables, each associated with a different axis. Inside a Motion Task Table, you can also assign inputs, called events, which can be used to trigger the next step.

Example Description

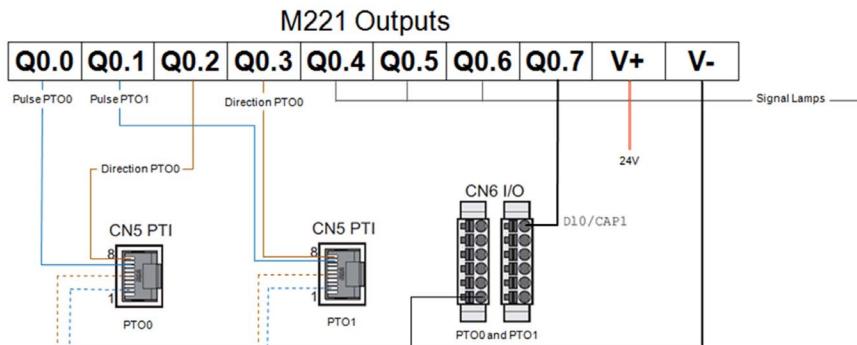
Overview

The example used with the EcoStruxure Machine Expert - Basic project template is illustrated in the following graphic:

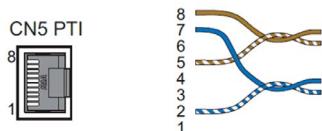


This shows an industrial mill used for drilling thin metal sheets.

This graphic presents the wiring of the outputs of the controller:

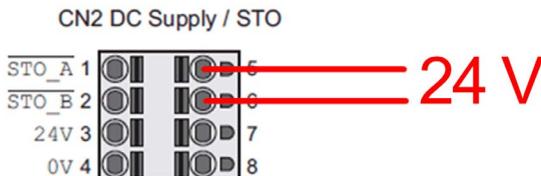


CN5 and **CN6** correspond to the inputs of the Lexium 32 ([see page 9](#)). The wiring of the **CN5 Pulse Train Input** of the Lexium needs to be done as explained in the LXM32M AC Servo Drive Product Manual ([see page 9](#)) and presented in the following graphic:



Pin	Signal	Pair	Meaning	I/O
7	PULSE (24)	A	Pulse 24 V	I (24 V)
2	PULSE	A	Pulse, inverted	I (24 V)
8	DIR (24)	B	Direction 24 V	I (24 V)
5	DIR	B	Direction, inverted	I (24 V)

You also need to connect the **STO** inputs (**CN2**) to a 24 V power supply:



One output of the M221 Logic Controller is connected to one input of the Lexium 32. This input is used for enabling the power stage of the drive and allows the drive to pass from **RDY** state to **RUN** state.

Configuring Servo Drives with SoMove

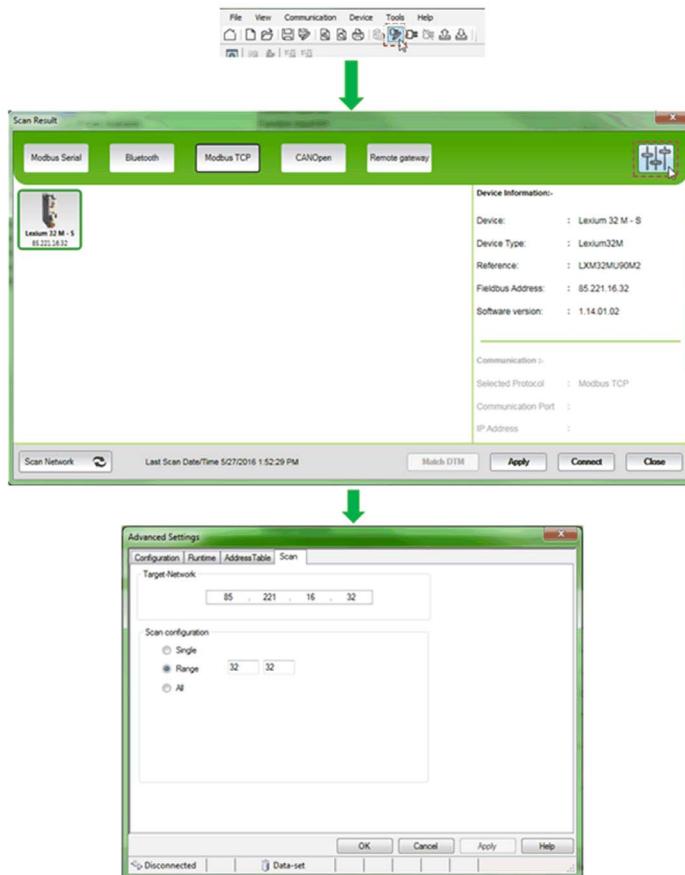
The initial configuration of the Lexium 32 drives is done using a SoMove application. SoMove is a Schneider Electric software that can be used to configure and monitor Schneider Electric variable frequency and servo drives. For Lexium drives, you need to [download the correct library](#) from the Schneider Electric website and install it.

You can connect your PC to the drives through their respective Ethernet ports. To do so, you need to specify the IP address of the drive in SoMove. The IP address configuration of the Lexium can be found through the human machine interface integrated in the drive:

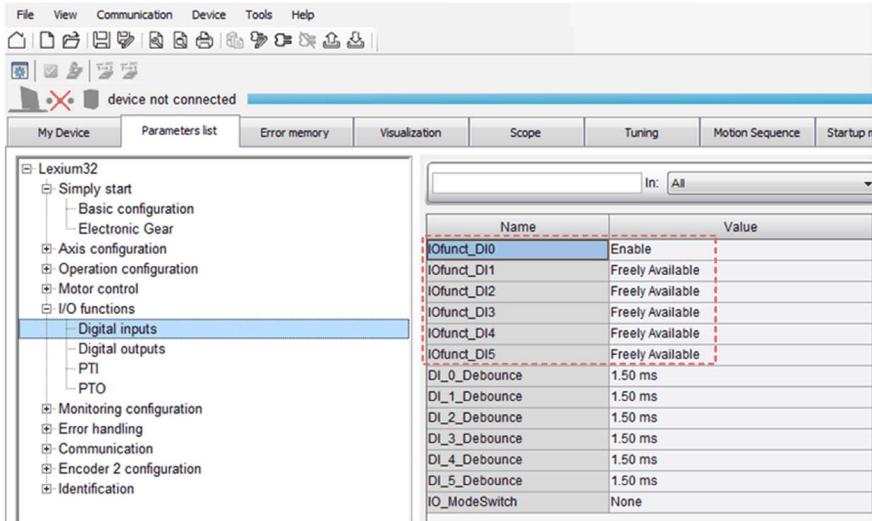
,Pn1	Type of obtaining IP address	→NAnu
,Pc1	IP address Ethernet module, byte 1	
,Pc2	IP address Ethernet module, byte 2	
,Pc3	IP address Ethernet module, byte 3	
,Pc4	IP address Ethernet module, byte 4	
,Pn1	IP address subnet mask, byte 1	
,Pn2	IP address subnet mask, byte 2	
,Pn3	IP address subnet mask, byte 3	
,Pn4	IP address subnet mask, byte 4	
,Pg1	IP address gateway, byte 1	
,Pg2	IP address gateway, byte 2	
,Pg3	IP address gateway, byte 3	
,Pg4	IP address gateway, byte 4	

Example Description

After configuring the IP address of the drive, the same IP address must be entered in the following fields in SoMove:



After the connection is established, you need to configure the following parameters (disable inputs DI1, DI2, DI3, DI4, and DI5):



To use the PTI input of the drive, choose the electronic gear mode.

The remaining information given hereafter about SoMove is optional. Once the initial configuration is done, you no longer need to be connected to your drive.

In SoMove, you can find the memory address of the parameters and read them with the M221 Logic Controller using the Modbus protocol. Most of the parameters are under the **Simply start → Basic Configuration** menu which is presented in the following graphic:

Example Description

Name	Value
_Imax_system	5.40 Arms
DEVCmdInterf	Local Control Mode
IOdefaultMode	Electronic Gear
PTI_signal_type	P/D Signals
PTO_mode	PTI Signal
ESIM_sscale	4096 Encinc
CTRL_v_max	13200 [1usr_v]
CTRL_l_max	9.00 Arms
LIM_l_maxQSTP	9.00 Arms
LIM_l_maxHalt	9.00 Arms
MOD_Enable	Modulo Off
InvertDirOffMove	Inversion Off
SimAbsolutePos	Simulation Off
ENC_abs_source	Encoder 1
Mains_reactor	No
ShiftEncWorkRang	Off
MOD_Min	0 [1usr_p]
MOD_Max	3600 [1usr_p]
MOD_AbsDirection	Shortest Distance
MOD_AbsMultiRng	Multiple Ranges Off
LIM_QstopReact	Deceleration ramp (Quick Stop)
LIM_HaltReaction	Deceleration Ramp

You can take the control of the drive and monitor its states by using the executive control option:

WARNING

UNINTENDED EQUIPMENT OPERATION

Incorrect use of the commissioning software may cause unexpected triggering or blocking of movements and signals.

- Only use this commissioning software if you have fully read and understood the corresponding manuals.
- Run initial tests without coupled loads.
- Verify that a functioning emergency stop push-button is within reach of all persons involved in performing work on the system.
- Do not operate the drive system with unknown settings or data.
- Anticipate movements in the incorrect direction or oscillation of the motor.
- Only start the system if there are no persons or obstructions in the zone of operation.
- Do not leave the activated system unattended.
- Verify that connection monitoring is on.

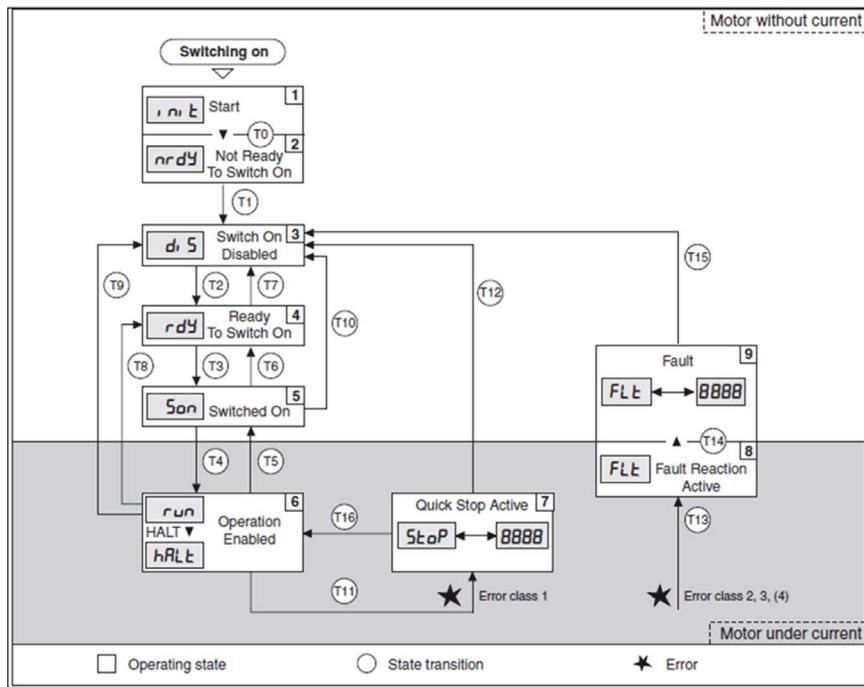
Failure to follow these instructions can result in death, serious injury, or equipment damage.

If you agree to follow these instructions, press 'Alt-F'.

↓

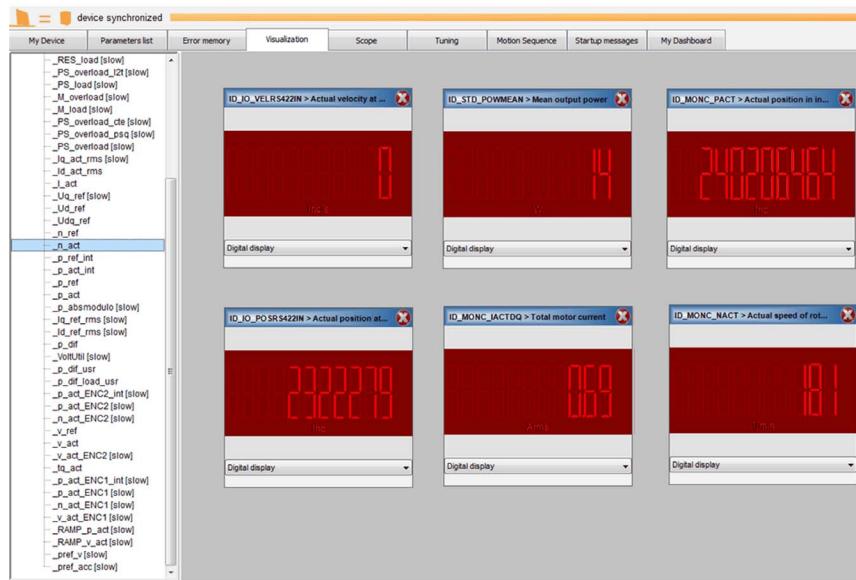
Exd.	Operating state POWER ENABLED [6] Operation Enabled On Off	Power On Off	Operating modes Electronic Gear Position Synchronization Immediate Position Synchronization Compensated Velocity Synchronization	Gear numerator 1 Start	Gear denominator 1 Stop	Proceed Set Halt
------	--	--------------------	--	---------------------------	----------------------------	---------------------

The Lexium 32 implements the following state machine diagram, which is shown under **Operation state** in SoMove:



Example Description

In SoMove, you can visualize certain parameters (**Velocity**, **Position**, **Errors** and so on) in the **Visualization** tab:



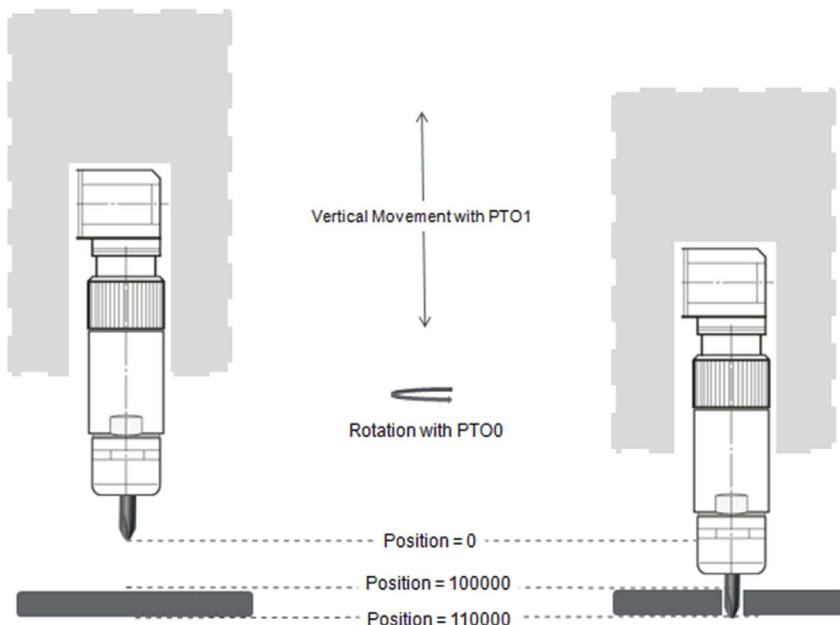
Project Template Description

Overview

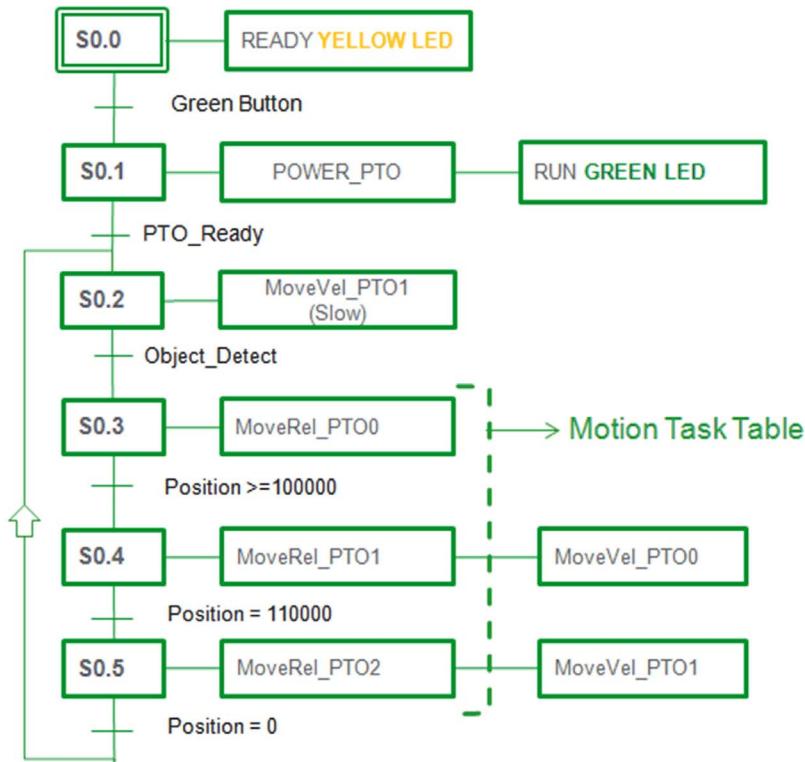
This section describes the operating principles of the project template `xSample_PTO_Motion_Table.smbe`.

This project template is based on the industrial mill described in the Example Description ([see page 19](#)).

This graphic illustrates the movement of the drill:



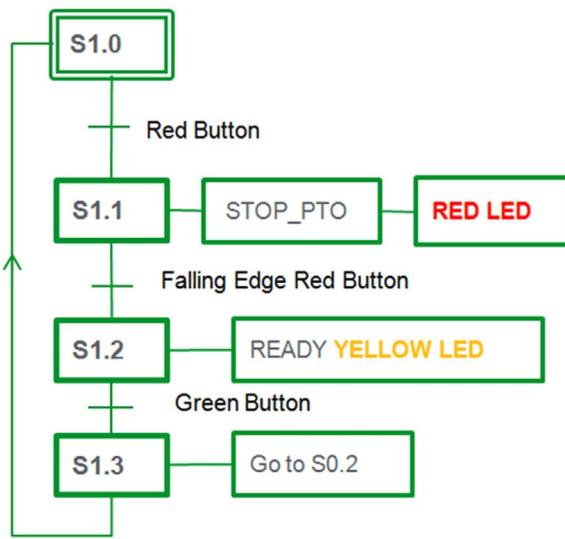
The drill waits for a metal sheet at position 0 while rotating at a low speed. Upon the detection of a sheet, it translates towards the sheet very fast and increases its rotational speed before touching the sheet. Just before touching the sheet (position 100000), it decreases its translation speed and starts drilling. Once the drilling is completed (position 110000), it returns to its initial position with a fast translation speed and decreases its rotational speed. This operation is illustrated with the following Grafcet (SFC) state chart.



The machine is controlled by an operator. The operator can start the machine with the start button %IO.7 (green button) or stop it with %IO.8 (red button). It is possible to monitor the state of the machine with the LEDs associated with the outputs %QO.4, %QO.5, and %QO.6.

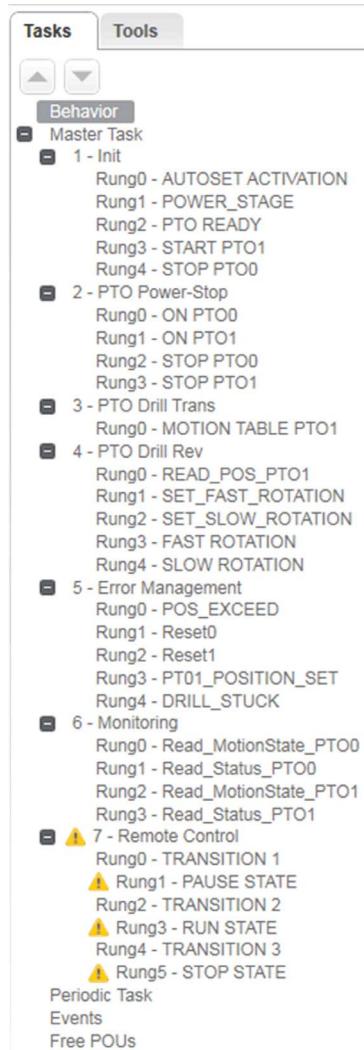
A description of the program is:

- Pushing the green button twice starts the machine (the second time releases the button). The green LED (**Run**) is illuminated when both MC_Power_PTO function blocks are activated. The drill waits to detect an object and then proceeds with the steps given in the Motion Task Table (**S0.3** in the Grafcet (SFC) state chart above).
 - Pushing the red button stops the machine. When the button is pushed (first push), the red LED (**Stop**) is illuminated. If the green button is pressed at the same time, the machine will not start.
 - When the red button is released, the yellow LED (**Ready**) is illuminated. At this state, the operator can reset the position of the machine by pushing the Set_Position button I0.0. Pushing the green button again restarts the machine. This is illustrated in the following Grafcet (SFC) state chart:



Structure of the EcoStruxure Machine Expert - Basic Project Template

The EcoStruxure Machine Expert - Basic project template is composed of various rungs and POU's as shown in the following graphic:



The first four POU_s and POU7 of this template implement the operating principles of the machine and are identical to the Grafset (SFC) state charts (*see page 27*). POU5 and POU6 are for error management and monitoring, which are implemented to demonstrate the advantages of using the Administrative function blocks.

1 - Init

This POU initializes the machine when the **Start** button is pressed. MC_Power_PTO function blocks are enabled through the variables (%M1 and %M5) of this POU, and this allows the first servo motor to start turning.

2 - PTO Power-Stop

This POU is composed of the MC_Power_PTO and MC_Stop_PTO function blocks of both axes.

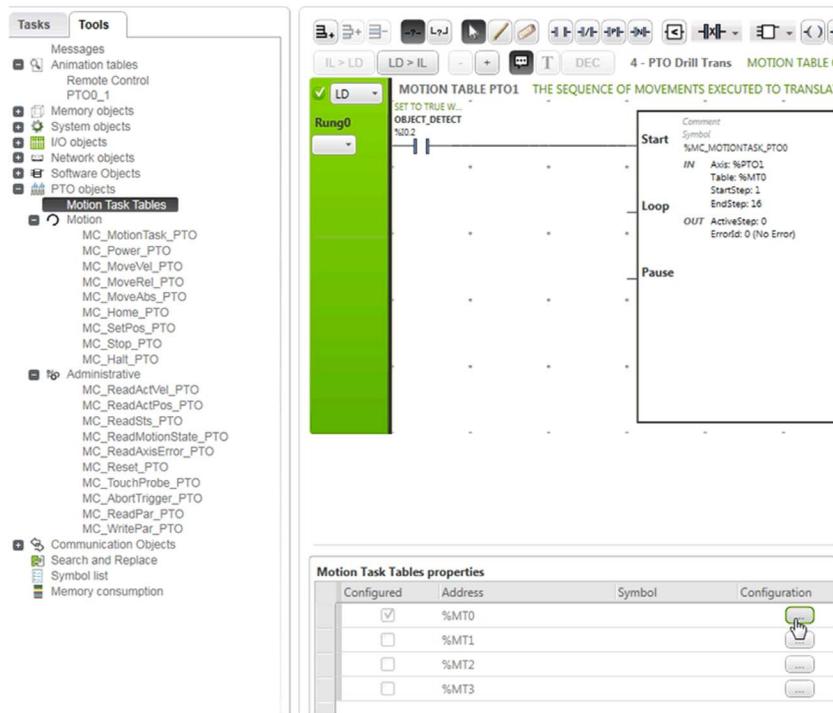
When %M5 is set in POU1, MC_Power_PTO0 and MC_Power_PTO1 are enabled, which in turn enables the other Motion function blocks.

If the operator presses the **Stop** button, or if an error is detected in POU5, both axes are disabled.

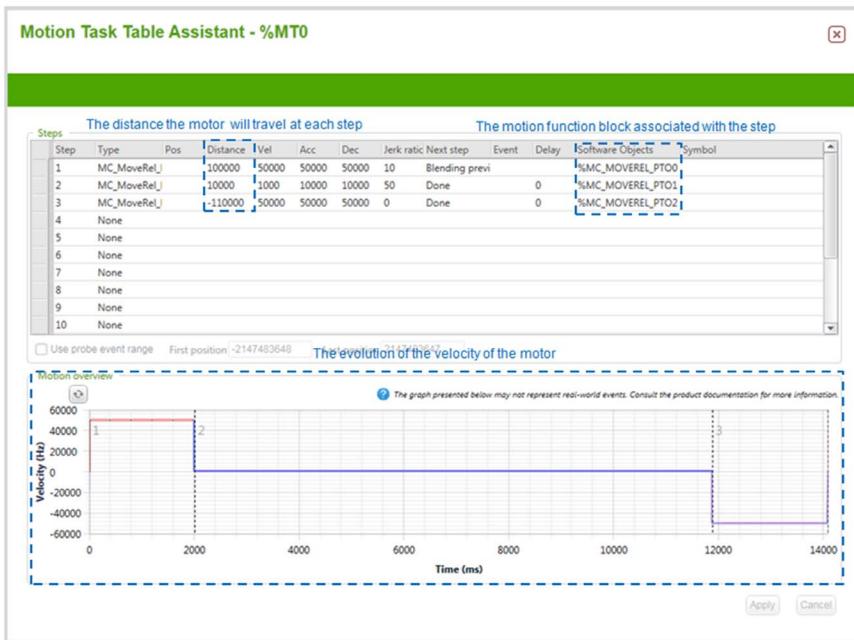
3 - PTO Drill Trans

This POU is composed of MC_MotionTask_PTO0. This function block needs to be configured in Tools → PTO objects → Motion Task Tables before using it.

Example Description



This function block executes the steps **S0.3**, **S0.4**, and **S0.5** of the first Grafset (SFC) state chart ([see page 27](#)). Each step is configured within this function block, which implicitly calls the corresponding Motion function block.



When configuring this block, the time required for each step is calculated by EcoStruxure Machine Expert - Basic, allowing you to set the speed and distance independently from each other.

4 - PTO Drill Rev

This POU controls the rotational speed of the servo motor wired to PTO0. The position of PTO0 is read from the MC_ReadActPos_PTO function block. PTO0 adjusts its velocity based on its position. When the drill is in between position 0 and position 100000, it rotates slowly. When the drill is between position 100000 and position 110000, it rotates fast and drills through the metal sheet.

5 - Error Management

This POU manages three error cases:

- Rung0: If the position limits are exceeded due to external interruptions, %M200 is set to TRUE and the motors stop.
- Rung2 and Rung3: These rungs reset the error when the **Stop** button is released.
- Rung3: If the position of the drill is not correct, the operator can bring the machine to the pause state and, after adjusting the position of the drill to 0, the **Set_Position** button can be pressed to set the position to 0 in the program.
- Rung4: If the drill is not advancing even though it should be drilling, the program waits for five seconds then stops the machine by setting %M201 to TRUE.

6 - Monitoring

This POU gives information on the state of both PTOs. The output bits of the function blocks found in this POU can be used with an external HMI or can be used while commissioning the machine with EcoStruxure Machine Expert - Basic.

The outputs of Rung2 are used to determine whether the drill is advancing and for error management.

7 - Remote Control

This POU is an exact translation of the second Grafset (SFC) state chart (*see page 27*) to the Ladder diagram.