TECHNICAL NOTE
MOTION PRODUCT AND ENGINEERING GROUP

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Subject: Configuring user units with MotionWorks+

Product: MP940, MotionWorks+ v2.82 or later

Who should read this document?

Anyone is who is attempting to program an MP940 Machine Controller, using MotionWorks+ programming environment. This document illustrates the configuration of user units when using MotionWorks+. There are three main areas of interest:

　　　1) System Properties
　　　2) System Variables
　　　3) System Parameters

This document is intended to be a quick reference tool for configuration of user units. For more in depth information regarding the parameters discussed in this document, refer to the MotionWorks+ User's Manual YEA-SIA-C887-1.5x. Where x indicates revision level.
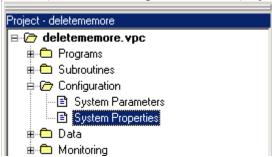
The appendix for this document depicts several application examples:
　　　1) Ball Screw
　　　2) Conveyor
　　　3) Rotary Table
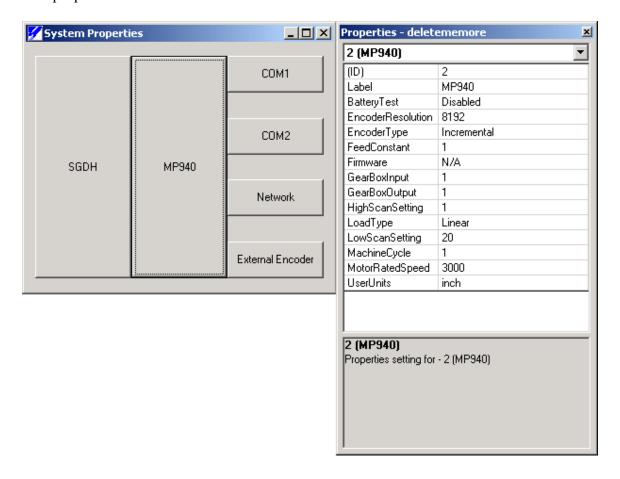　　　4) Multi-head rotary placer (cutter)

System Properties

Select (from the Configuration folder) System Properties:

Click on the MP940 element of the block diagram, and note the elements that appear in the "properties" window.

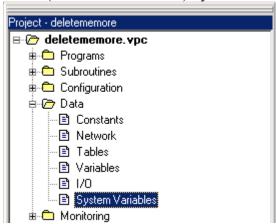| Encoder Resolution	Post-Quadrature encoder counts per revolution (see below)
Encoder Type	Match the motor part number SGMxH-##y__z__abc A: 13-bit Incremental (8192 PPR-Post Quad) B: 16-bit Incremental (16384 PPR-Post Quad) C: 17-bit Incremental (131072 PPR-Post Quad) 1: 16-bit Absolute (16384 PPR-Post Quad) 2: 17-bit Absolute (131072 PPR-Post Quad) 3: 20-bit Absolute (1048576 PPR-Post Quad)
Feed Constant	Number of user units per revolution or cycle of the machine. This is where the pitch of a ball screw would be entered if used. Or for example, if the application is a rotary table with user units of degrees, this would be set to 360. [There are 360 degrees of motion per revolution of the output shaft]
Gear Box Input	The number of times the input shaft rotates (motor) for the number of output shaft revolutions. Multiple drive train components may compiled together and their effective ratio entered here.
Gear Box Output	The number of times the output shaft rotates for the number of input (motor) shaft revolutions. Multiple drive train components may compiled together and their effective ratio entered here.
Load Type	**Linear**: Position counts up (or down) forever, until hardware limitation is reached, then wraps automatically and continues counting. The long register that contains position counts up to 2 billion, when $(2^{32}/2)-1$ is reached the next value will be $-(2^{32}/2)$. The count will then continue up through zero and beyond. Extended math functions are used to keep errors from occurring. **Rotary**: Position is automatically modularized to roll over at the machine cycle setting. All position related registers are modularized as well (e.g. mPositonActual, and mPositionLatch_Main).
Machine Cycle	Only useful when rotary load type is selected. This is the point where the position automatically wraps over back to zero. For example a standard rotary table with user units of degrees, this would be set to 360. [Actual position will display between 0 and 360 degrees]. An example of rotary application where this value is not the same as Feed Constant is included below.

Motor Rated Speed	This setting should match the motor parameters. SGMAH – 3000 RPM SGMGH – 1500 RPM* SGMPH – 3000 RPM SGMSH – 3000 RPM SGMUH – 6000 RPM * Note: Some SGMGH are available with 1000 RPM rated speed.
User Units	Select the user units desired from the drop down or enter a user-defined type.

When configuring the parameters of the External Encoder all of the above items have the same meaning, except; Encoder Type and Motor Rated Speed. One additional parameter is to be configured; Pulse Type. The choices are Quadrature (Forward or Reverse), or Pulse and Direction (Forward or Reverse).

System Variables

Select (from the Data folder) System Variables:

The System Variables pop-up window:

All of the System Variables that are preceded by an "s" are user configurable (settable), These variables may adjusted by one of three methods. 1) Include them some where in the program; 2) Modify them by monitoring them online; 3) Setting them in the System Variables pop-up screen. If the second or third method is chosen, after changing them online they take immediate effect. However, a compile and download is required for the values to be maintained during a power cycle. Consider changing the value while online or through the System Variables a temporary change.

The other System Variables are preceded by an "m" and they are not settable, they can only be monitored. They can be used within a program, be monitored online, or viewed by opening the System Variables.
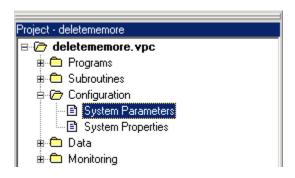
sLimit_Speed_Negative	The maximum speed limit that the axis may travel in the reverse (negative) direction in user units. The default of 10000-user units/sec may not be appropriate for the application. For example a rotary table with a feed constant and machine cycle of 360 degrees, assuming a SGMPH motor has the capability of traveling at 30000 degrees/sec.
sLimit_Speed_Positive	The maximum speed limit that the axis may travel in the forward (positive) direction in user units.

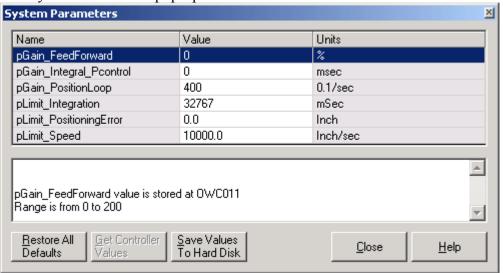| sLimit_Torque	The maximum amount of torque that may be applied in 0.01% of rated torque. Applies in both directions and should be entered as a negative value. For example a value of –28000 equates to 280.00% torque limit. Applicable value varies for each application, but it is limited by the capabilities of the motor. To determine the maximum possible value divide the Instantaneous Peak Torque by the Rated Torque found in the Sigma II User's Manual or Product Selection Guide. Entering a value larger than the system is capable of will cause the system to generate an A9F error.
sPosition_CompletionWindow	This is the tolerance for the system to indicate that the positioning movement is complete. It is set in user units. If left at the default of zero, the position achieved must be exactly requested. In an untuned system this may result in widely varying positioning times.

System Parameters

Select (from the Configuration folder) System Parameters:

The System Parameters pop-up window:

All of the System Parameters are preceded by a "p," they are user configurable parameters. The parameters may adjusted by one of three methods. 1) Include them some where in the program; 2) Modify them by monitoring them online; 3) Setting them in the System Parameters pop-up screen. If the second or third method is chosen, after changing them online they take immediate effect. However, a compile and download is required for the values to be maintained during a power cycle. Consider changing the value while online or through the System Parameters a temporary change

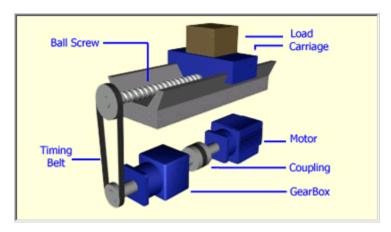| pGain_FeedForward	Position loop feed forward gain. (%)
pGain_Integral_Pcontrol	Position loop integration time constant. (msec) Default of zero disables the integral component of position loop. Modification usually only required for very high performance applications. This gain is time based, so a higher number will result in a lower effective gain.
pgain_PositionLoop	Position loop gain. (0.1 Hz) Typically a good starting point for this gain is = to the value of the Speed Loop gain (* 10) the in the SGDH (PN100). Be careful with regard to units, the SGDH parameter is set Hz, the gain the MP940 is set in 0.1 Hz. Setting this value any higher than the value of PN100 will result in instability.
pLimit_Integration	Position loop integration limit. (msec) This parameter limits the amount of integration "wind-up" that can take place in the integration component of the Position loop. Default of 32767 allows maximum "wind-up." Modification usually only required for very high performance applications.

plimit_PositioningError	Position loop following error limit. (user units) Leaving the value at the default (zero), tells the system to ignore following error. Even though the variable is set in user units, the system converts the value to pulses, therefore when the value is read back from the controller it may be slightly different that the value that was set. Furthermore, the current version of MotionWorks+ (2.82) only allows for a maximum of 65535 pulses of following error.
pLimit_Speed	Speed limit while in Torque mode. (user units/sec) Using the "Torque" block automatically sets this user parameter.

Application # 1 Ball Screw:

Pitch of Ball Screw:
10 mm/rev
In Position tolerance:
.1 mm
Following error limit:
1 mm
Gearbox ratio:
5:1
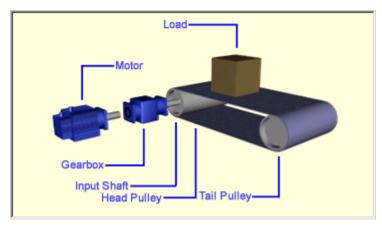Pulley diameters:
50 mm, 100 mm
Servomotor:
SGMGH-05D2A6C

System Properties		
EncoderResolution	131072 (determined by motor part number)	
EncoderType	Absolute (determined by motor part number)	
FeedConstant	10 (pitch of ball screw)	
GearBoxInput	10	5:1 of gearbox and 100:50 (2:1) belt pulley ratio, yields
GearBoxOutput	1	this result
LoadType	Linear	
MachineCycle	1	
MotorRatedSpeed	1500 (determined by motor part number)	
UserUnits	mm (customer supplied data)	

System Variables	
sLimit_Speed_Negative	50 mm/sec (theoretical max. based on top motor rpm)
sLimit_Speed_Positive	50 mm/sec (theoretical max. based on top motor rpm)
sPosition_CompletionWindow	0.1 mm (customer supplied data)
sLimit_Torque	-31400 (314% based on motor data)

System Parameters	
plimit_PositioningError	1 mm (customer supplied data)

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Application # 2 Conveyor:

Gearbox ratio:
10:1
Head pulley diameter:
5"
In position limit:
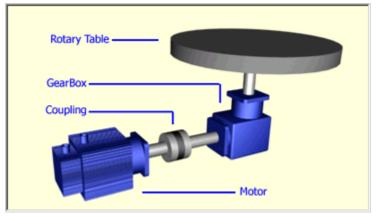.5"
Following error limit:
2.5"
Servomotor:
SGMGH-1AACA61

System Properties		
EncoderResolution	131072 (determined by motor part number)	
EncoderType	Incremental (determined by motor part number)	
FeedConstant	31.41593 (circumference of head pulley)	
GearBoxInput	10	10:1 gearbox (customer supplied data)
GearBoxOutput	1	
LoadType	Linear	
MachineCycle	1	
MotorRatedSpeed	1500 (determined by motor part number)	
UserUnits	Inch (customer supplied data)	

System Variables	
sLimit_Speed_Negative	104.7 in/sec (theoretical max. based on top motor rpm)
sLimit_Speed_Positive	104.7 in/sec (theoretical max. based on top motor rpm)
sPosition_CompletionWindow	0.5 inch (customer supplied data)
sLimit_Torque	-25000 (250% based on motor data)

System Parameters	
plimit_PositioningError	2.5 inch (customer supplied data)

Application #3 Rotary Table:

Gearbox ratio:
50:1
In position limit:
.5 degrees
Following error limit:
5 degrees
Servomotor:
SGMPH-15A1E4CD

System Properties		
EncoderResolution	65536 (determined by motor part number)	
EncoderType	Absolute (determined by motor part number)	
FeedConstant	360 (rotary table)	
GearBoxInput	50	50:1 gearbox (customer supplied data)
GearBoxOutput	1	
LoadType	Rotary	
MachineCycle	360 (position display rolls over at this point)	
MotorRatedSpeed	3000 (determined by motor part number)	
UserUnits	Degrees (customer supplied data)	

System Variables	
sLimit_Speed_Negative	600 deg/sec (theoretical max. based on top motor rpm)
sLimit_Speed_Positive	600 deg/sec (theoretical max. based on top motor rpm)
sPosition_CompletionWindow	0.5 degrees (customer supplied data)
sLimit_Torque	-30000 (300% based on motor data)

System Parameters	
plimit_PositioningError	5 degrees (customer supplied data)

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Application # 4 Rotary Placer (4 head):

Gearbox ratio:
4:1
In position limit:
1 degree
Following error limit:
2 degrees
Servomotor:
SGMUH-30DCA61

System Properties	
EncoderResolution	131072 (determined by motor part number)
EncoderType	Incremental (determined by motor part number)
FeedConstant	360 (1 revolution of output shaft rotates head 360 degrees)
GearBoxInput	4 4:1 gearbox (customer supplied data)
GearBoxOutput	1
LoadType	Rotary
MachineCycle	90 (machine has 4 placing heads, spaced @ 90 degrees apart)
MotorRatedSpeed	6000 (determined by motor part number)
UserUnits	Degrees (customer supplied data)

System Variables	
sLimit_Speed_Negative	9000 deg/sec (theoretical max. based on top motor rpm)
sLimit_Speed_Positive	9000 deg/sec (theoretical max. based on top motor rpm)
sPosition_CompletionWindow	1 degree (customer supplied data)
sLimit_Torque	-32768 (327.68% largest number possible for integer)

System Parameters	
plimit_PositioningError	2 degrees (customer supplied data)