

TB267 (Rev6) - CNC11 Yaskawa Sigma V Precision Mode Setup

Overview:

This document will walk you through the process of configuring and tuning a Yaskawa Sigma V Servopack and Servomotor with a Centroid CNC11 based control, running in Precision Mode. Centroid's Precision Mode can provide very good resolution and high feedrates but the following maximum should not be exceeded:

$$\text{CNC11 Max Counts/min} = 72,000,000$$

This maximum is derived from the maximum counts per interrupt using the following formula:

$$300 \text{ counts/int} * 4000 \text{ int/sec} * 60 \text{ seconds}$$

The maximum commanded counts per second that the Yaskawa drive can accept is 1,200,000/s. The following table shows examples of resolutions resulting from selected encoder counts per rev and ballscrew pitch.

Encoder Counts/Rev Yielding Resolution and Speeds

	Counts/Rev	Resolution ("/Count)	Max RPM	Max Speed ("/Min)	Max Speed (mm/Min)
12mm Pitch	8192	0.000058	8789	4152	49828
	16384	0.000029	4395	2076	24914
See Notes*	24000	0.000020	3000	1417	17008
	32768	0.000014	2197	1038	12457

	Counts/Rev	Resolution ("/Count)	Max RPM	Max Speed ("/Min)	Max Speed (mm/Min)
16mm Pitch	8192	0.000077	8789	5536	88583
	16384	0.000038	4395	2768	44291
See Notes*	24000	0.000026	3000	1890	30236
	32768	0.000019	2197	1384	22146

*Yaskawa Sigma V Series Motors (SG-MGV) Maximum RPM = 3000

The 8192 default value referred to in this tech bulletin and manual refers to 8192 lines which corresponds to 32768 encoder counts per revolution.

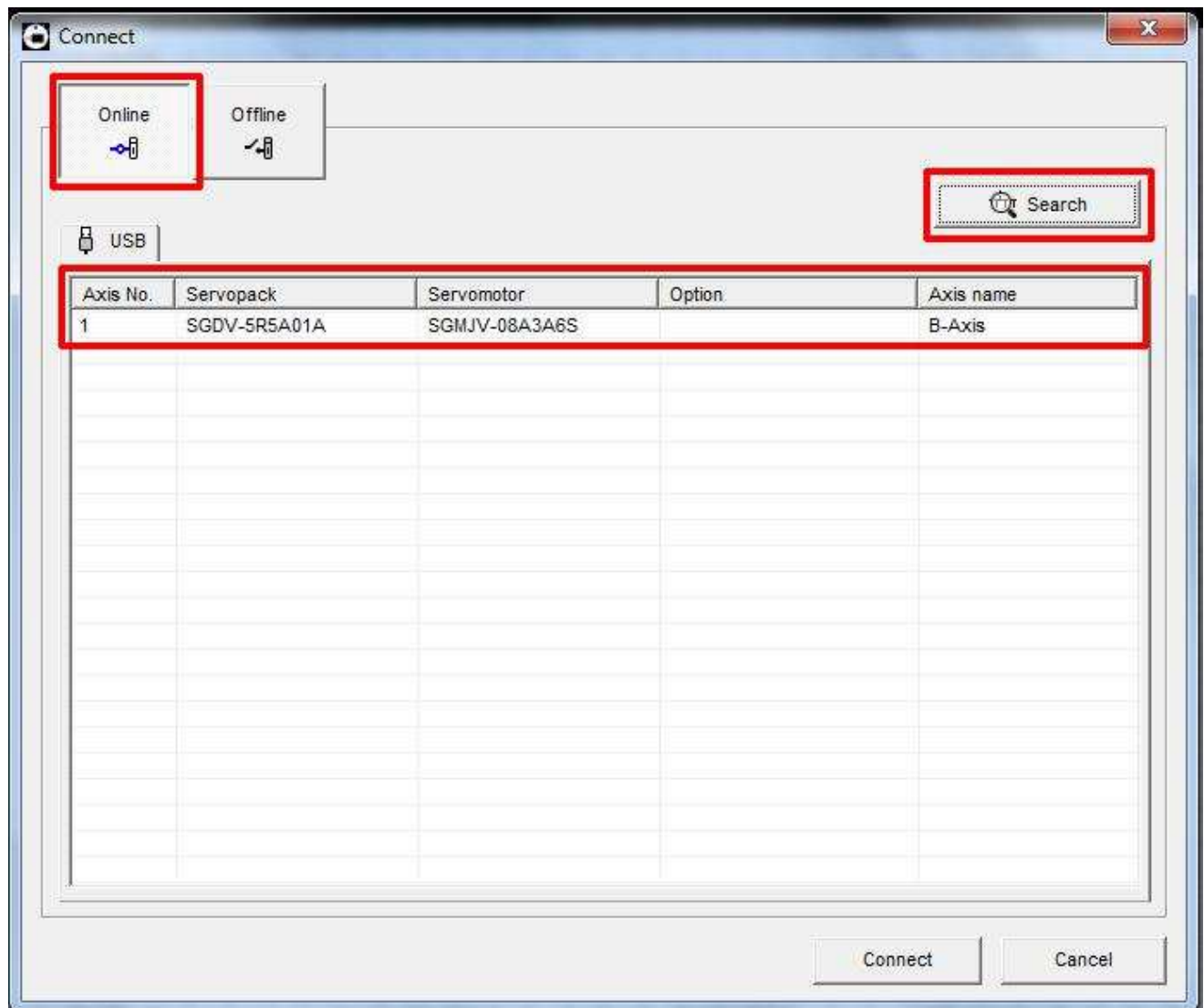
Prerequisites:

The following items are needed:

- Computer with the Yaskawa SigmaWin+ software installed. SigmaWin+ Version 5.54 was used for this document. SigmaWin+ Version 7 has a different look.
- A to Mini-B type USB cable (Yaskawa part number JZSP-CVS06-02-E) – connected between the laptop and the Yaskawa drive you wish to setup.

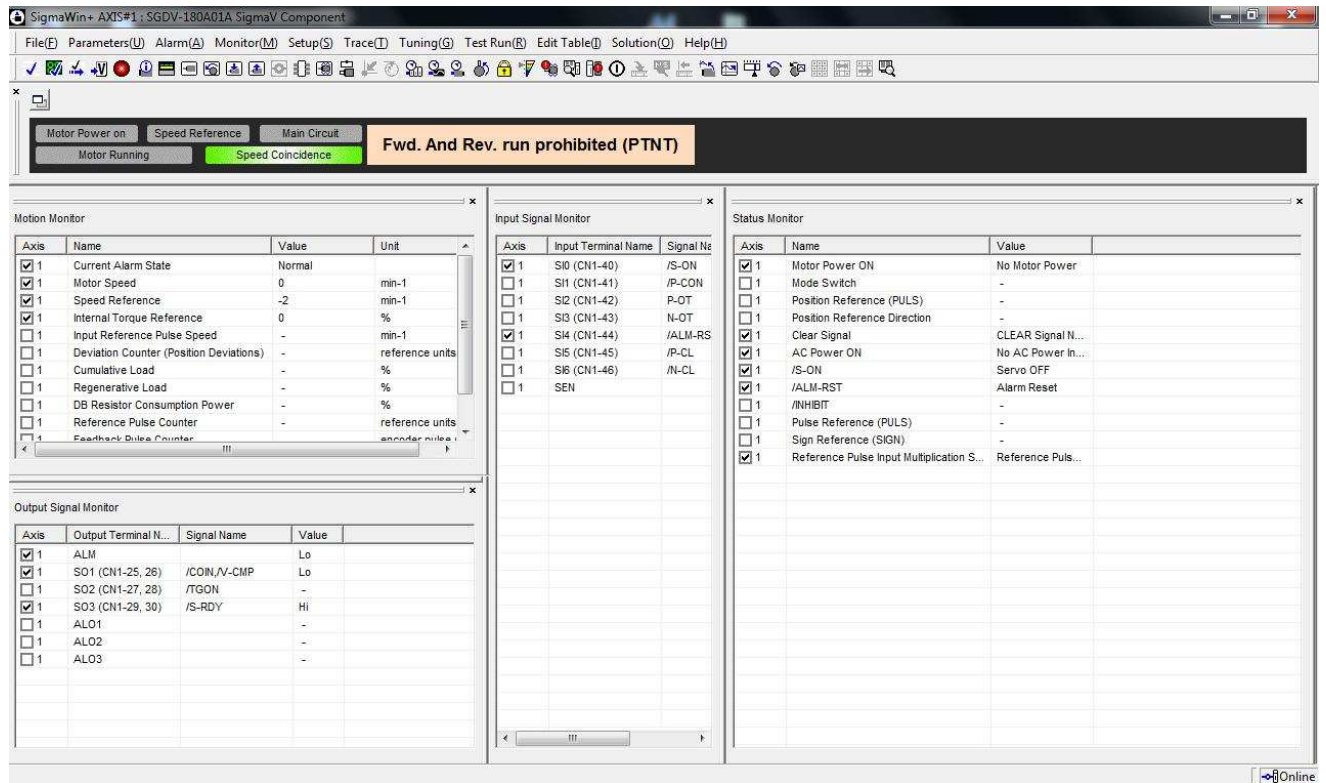
Servopack Configuration Process:

- Launch the Yaskawa SigmaWin+ software.
- You will see the following screen:

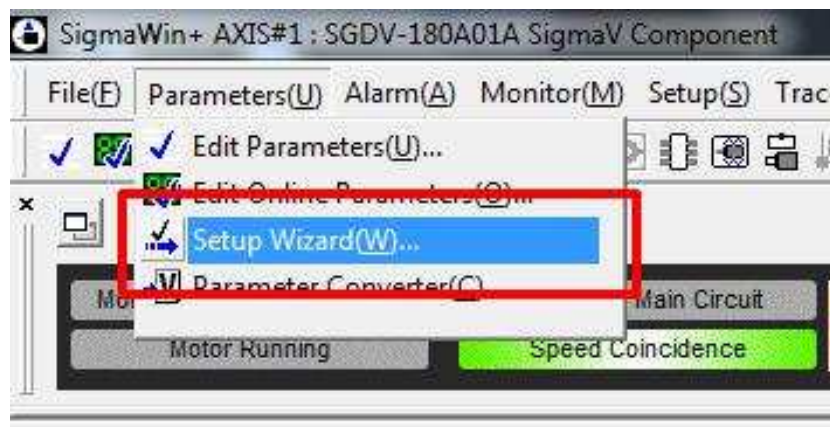


- Ensure "Online" is selected as shown above
- Select "**Search**" and make sure "Σ5 drives" are selected. This search must be done every time you power up the software or connect to a different Servopack because the SigmaWin+ software remembers the last drive that was connected to it and displays that rather than what is currently connected.
- Select the drive that appears and click "**Connect**".

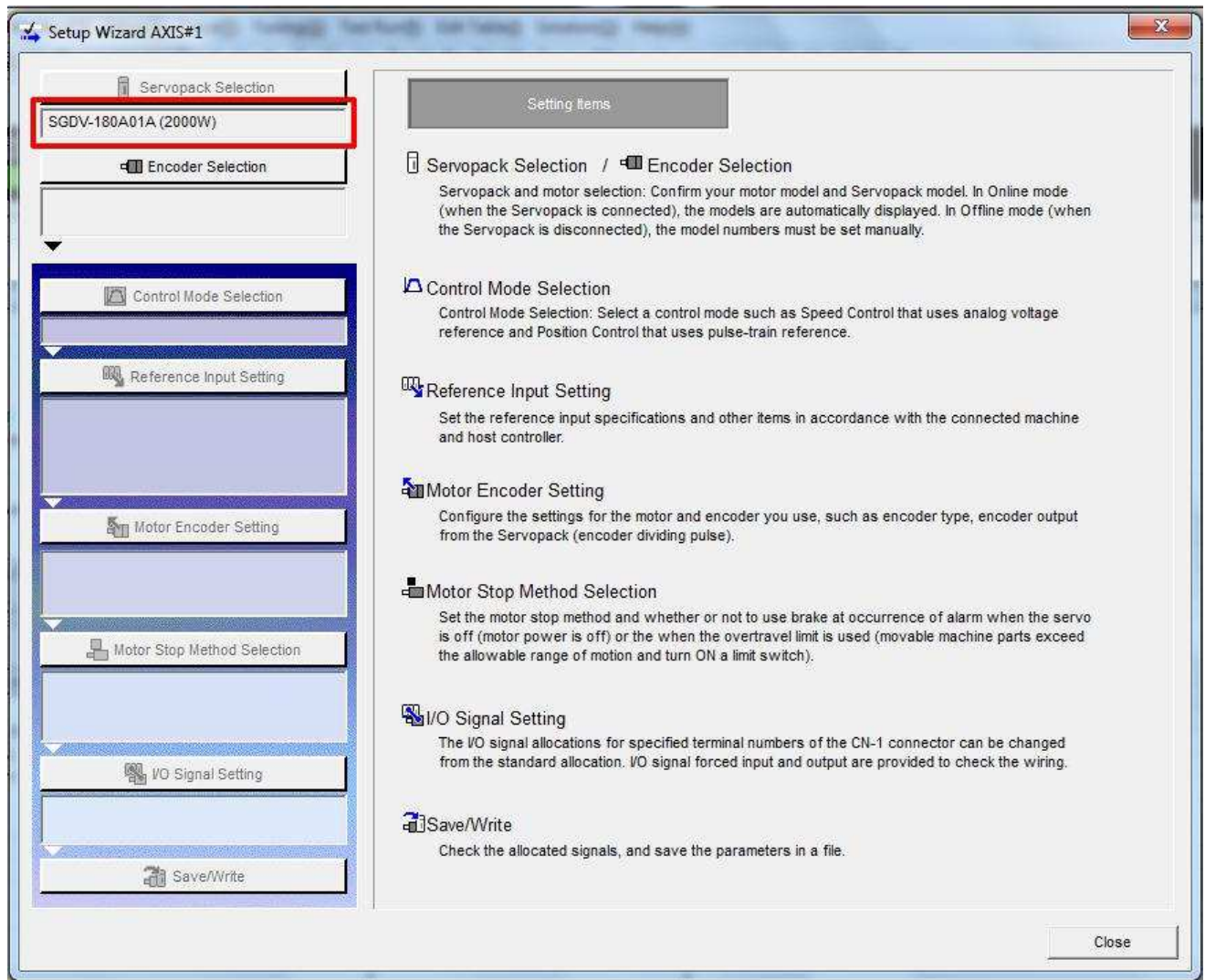
- SigmaWin+ will then open to the main screen as shown below:



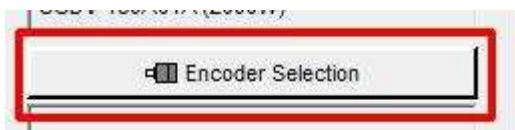
- The best way to configure the Servopack is by using the Setup Wizard which is located under the Parameters menu option as shown below:



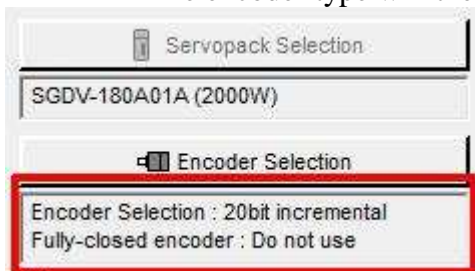
- Select “**Parameters(U)**” then click “**Setup Wizard(W)**” to start the wizard. The “**Setup Wizard(W)**” window is shown below:



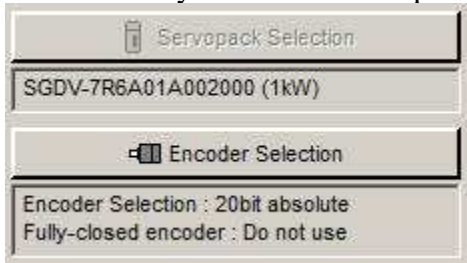
- To run the setup wizard you will click on the buttons at the left of the window. Starting at the top and working down the list.
- Start by clicking the "**Encoder Selection**" button.



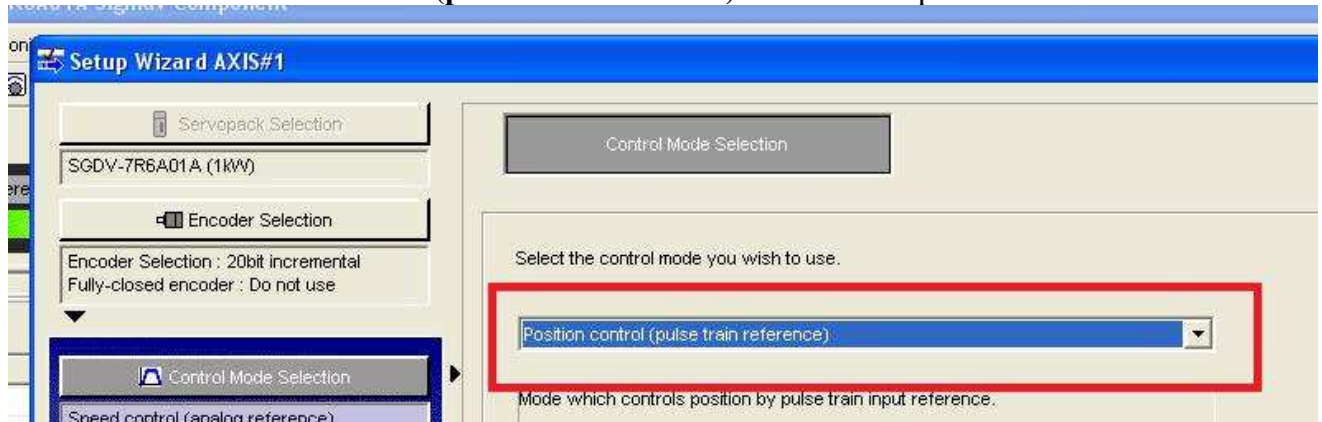
- Nothing is displayed in the window under "**Encoder Selection**" until you click on "**Apply**" at the lower right corner.
- The encoder type will then be shown under the Encoder Selection button.



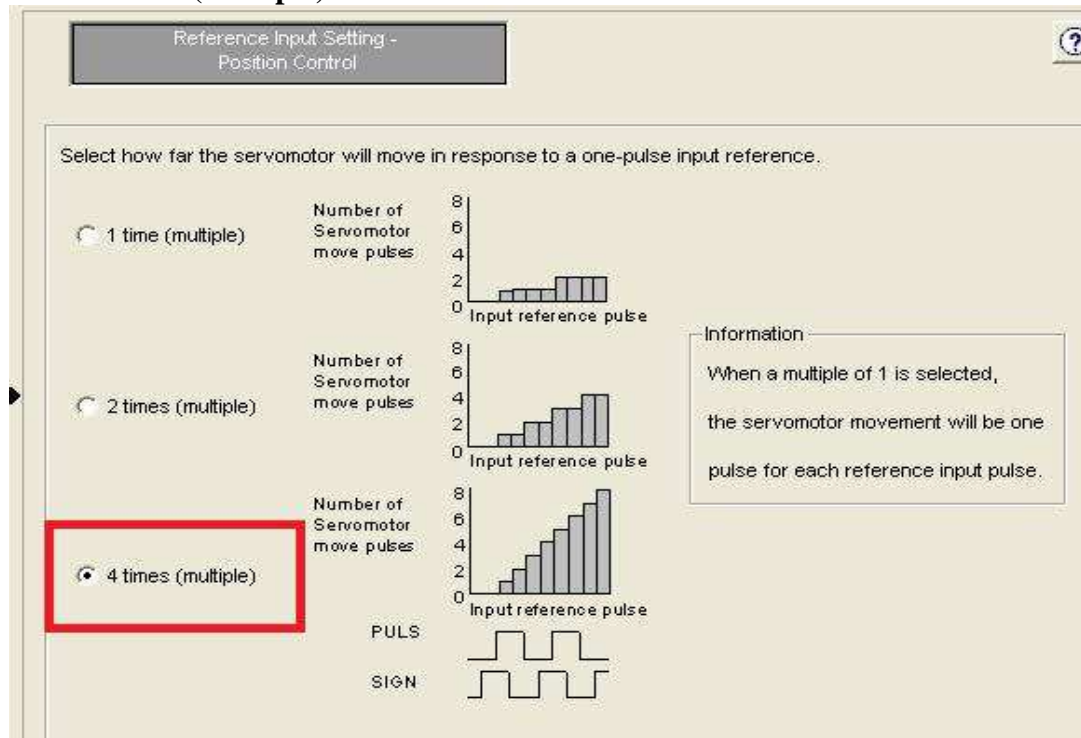
- If you intend to set up the encoder as absolute, make sure an absolute encoder is detected.



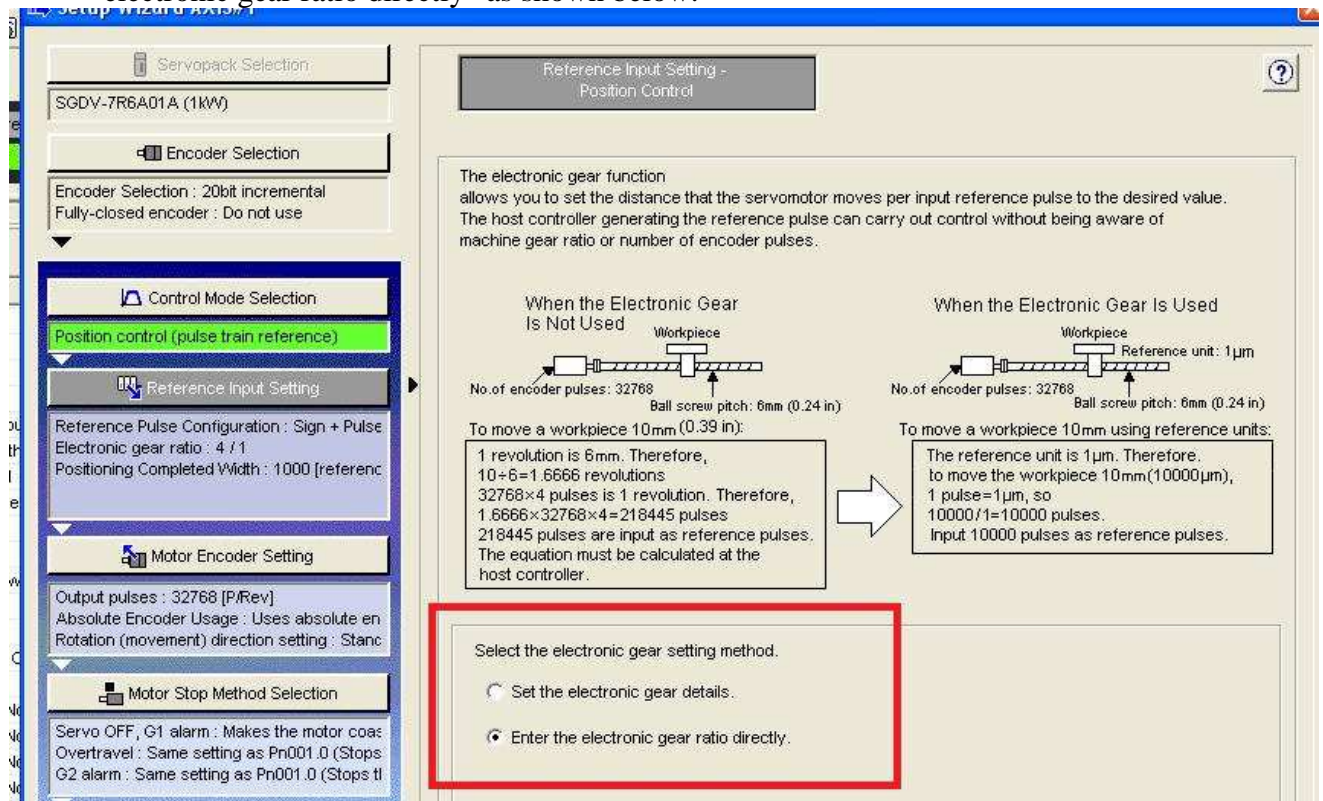
- Click "**Control Mode Selection**".
- Select "**Position Control (pulse train reference)**" from the drop down menu:



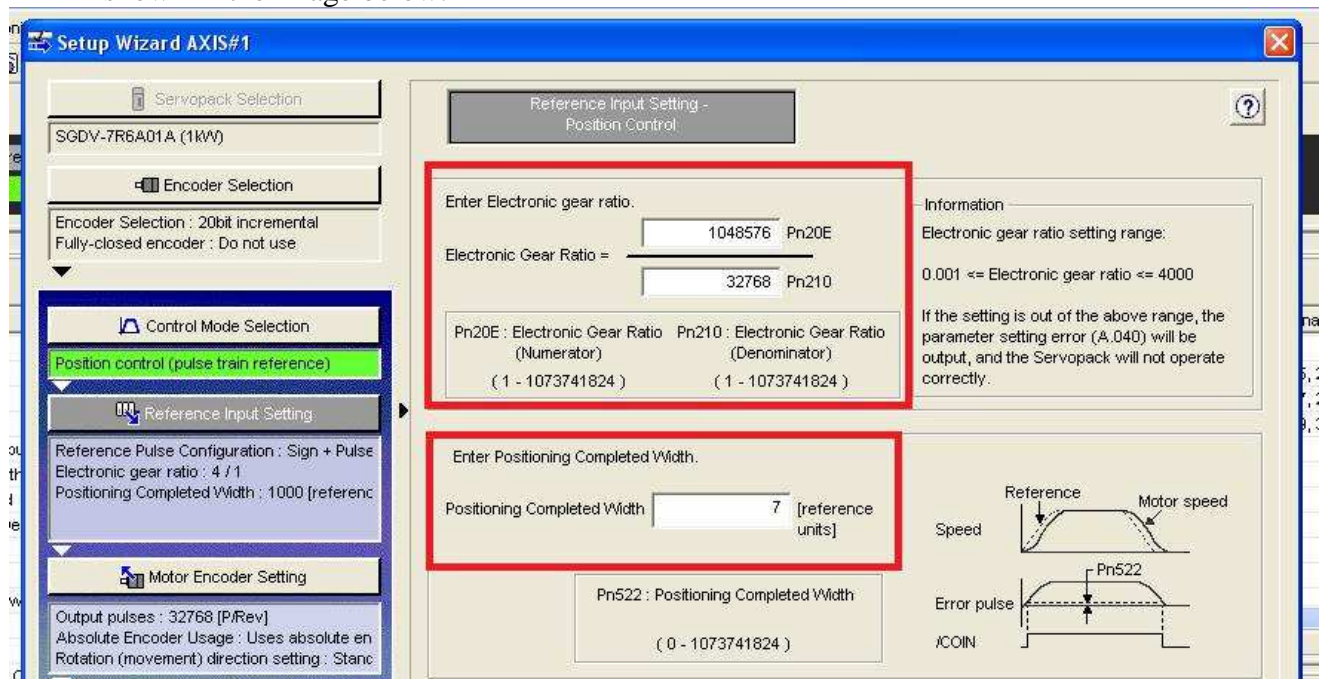
- Click "**Apply**".
- Click "**Reference Input Setting**".
Note: the "**Control Mode Selection**" setting is now highlighted in green, signifying that it has been completed.
- Select "**phase A + phase B**" and click "**Next**".
- You will then need to select how far the servomotor will move in response to a one-pulse input.
- Select "**4 times (multiple)**" as shown below:



- Click "Next".
- You will then be asked to Select the electronic gear setting method. Select "Enter the electronic gear ratio directly" as shown below:

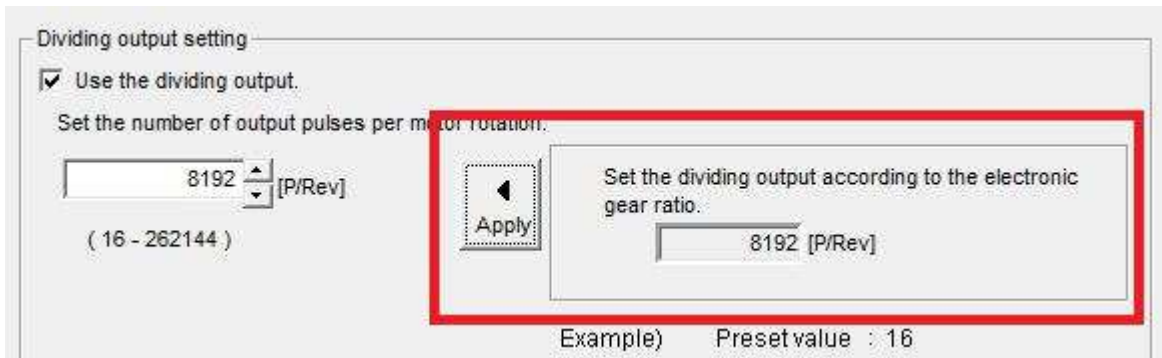


- Click "Next".
- You will then need to enter the gear ratio. Enter **1048576** on top and **32768** on bottom as shown in the image below:

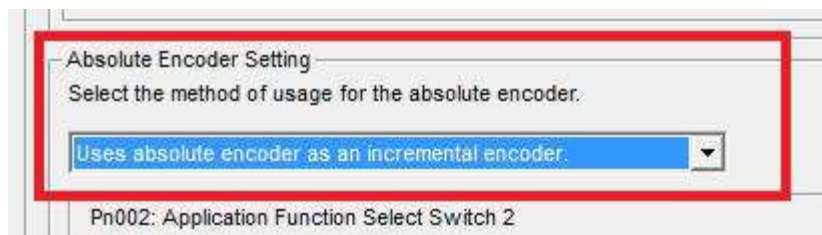


- Verify the "Positioning Completed Width" is set to **7** and click "Apply".
- The "Reference Input Setting" will now be green.
- Click "Motor Encoder Settings".

- On the right side of the screen you will see the option “Set the dividing output according to the electronic gear ratio” as shown below. Click “**Apply**” to set the number of output pulses per motor rotation to **8192**.

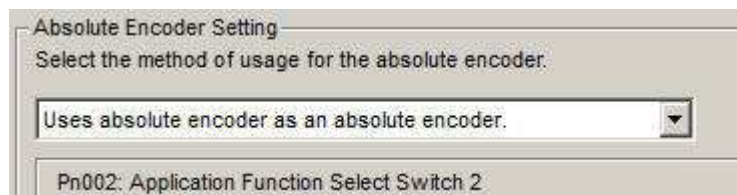


- Absolute encoders are supported with CNC12 v4.06 and newer. DriveComm or OpticDirect drive interface cards support Yaskawa absolute encoders. A battery is needed for absolute encoders, which may be on DriveComm or OpticDirect or in Yaskawa cable JZSP-CSP12-E. If these requirements for software, hardware, and battery are met, the control system supports absolute encoders. *See TB301 for more information on the absolute encoder.*
- Sometimes due to availability, you may receive a servomotor with an absolute encoder instead of an incremental encoder. The wizard will detect this and allows you to set the following option. If the servomotor has an absolute encoder installed, but the control does not support it, the “Absolute Encoder Setting” must be changed to “**Uses absolute encoder as an incremental encoder.**” as shown below:

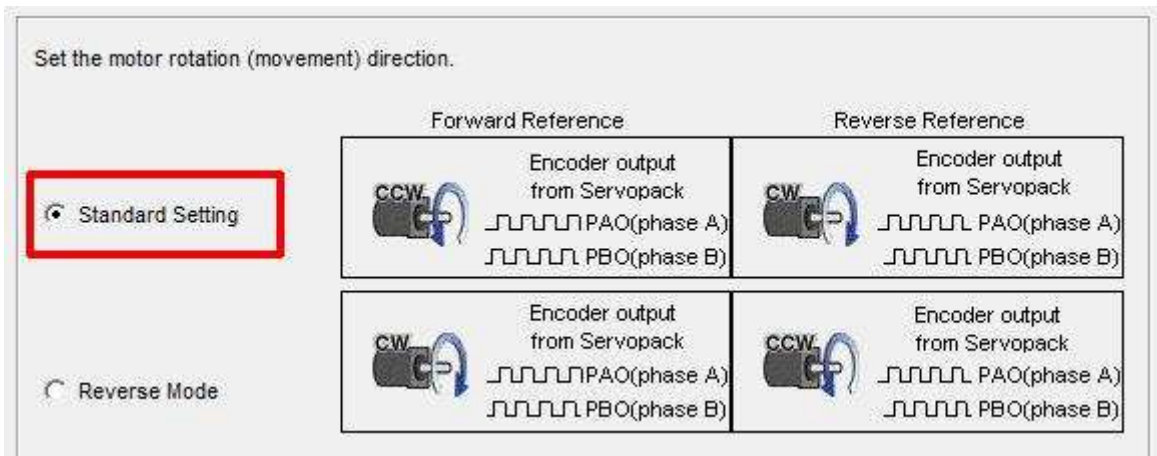


Note: The "Absolute Encoder Setting" option is grayed out if you have an incremental encoder.

- If the control supports absolute encoders and you would like to use the feature, leave the option set to use absolute as shown:

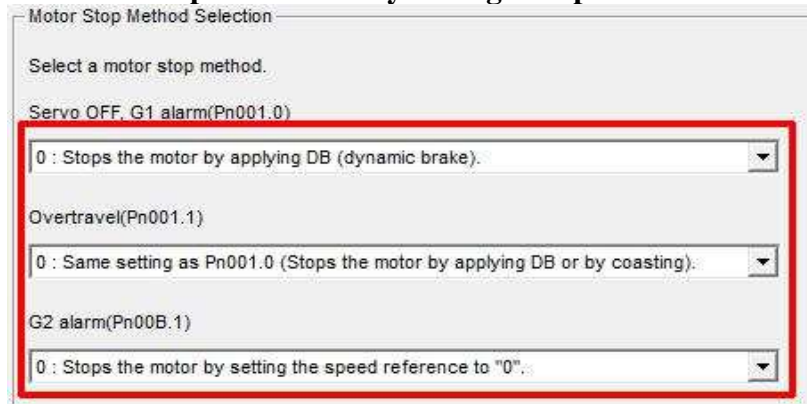


- Click "**Next**".
- Select "**Standard Setting**".

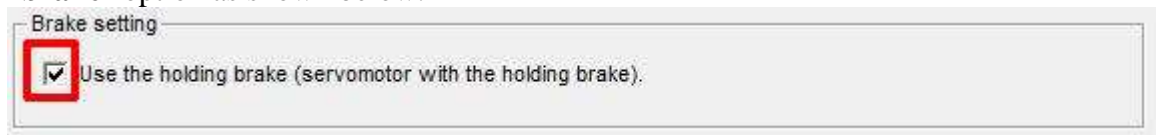


- Click "**Apply**".

- The "Motor Encoder Settings" will now also be green.
- Click "**Motor Stop Method**".
- Pn001.0 should be set by default to the settings in the picture below. If not, make sure they are set accordingly.
- Set "Servo OFF" to "**0 : Stops the motor by applying DB (dynamic brake).**".
- Set "Overtravel" to "**0 : Same setting as Pn001.0 (Stops the motor by applying DB or by coasting).**".
- Set "G2 alarm" to "**0 : Stops the motor by setting the speed reference to "0".**".



- If the Servomotor you are setting up has a brake, you will need to check the "**Use the Holding brake**" option as shown below:



- Click "**Apply**".
- Click "**IO Signal Settings**" then click "**Input Signal Settings**".
- Disable "N-OT" by clicking in the "**Always OFF**" column as shown below.
- Disable "P-OT" by clicking in the "**Always OFF**" column as shown below.

Select the input signal allocation mode.

Standard allocation Customize allocation

Click any cell to allocate an input signal.

	Allocation	SI0 (CN1-40)	SI1 (CN1-41)	SI2 (CN1-42)	SI3 (CN1-43)	SI4 (CN1-44)	SI5 (CN1-45)	SI6 (CN1-46)	Always ON	Always OFF
/S-ON	Required	/S-ON(L)								
/P-CON	Possible		/P-CON(L)							
P-OT	Possible									P-OT
N-OT	Possible									N-OT
/ALM-RST	Possible					/ALM-RST(L)				
/P-CL	Possible						/P-CL(L)			
/N-CL	Possible							/N-CL(L)		
/SPD-D	Not required									/SPD-D
/SPD-A	Not required									/SPD-A
/SPD-B	Not required									/SPD-B
/C-SEL	Not required									/C-SEL
/ZCLAMP	Not required									/ZCLAMP
/INHIBIT	Not required									/INHIBIT
/G-SEL	Possible									/G-SEL
/P-DET	Possible									/P-DET

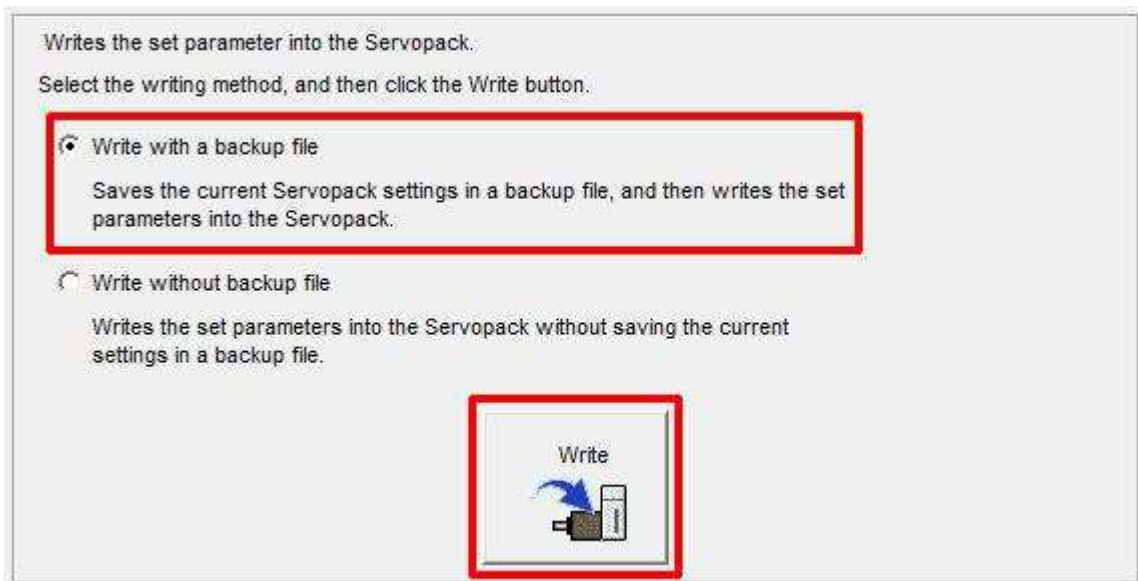
VO name (L) Normal allocation Pn50A: Input Signal Selection 1 Pn50C: Input Signal Selection 3
VO name (H) Reversed allocation Pn50B: Input Signal Selection 2 Pn50D: Input Signal Selection 4

- Click "OK".
- Click "Output Signal Settings".
- You must set "/COIN" and "/V-CMP" to "Disable (Do not use)" as shown below:
- For motors with a brake you must also set "/BK" to "SO1 (CN1-25,26)" as shown below:

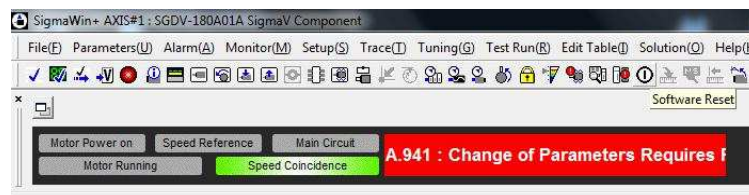
Click any cell to allocate an output signal.

	Allocation	SO1 (CN1-25,26)	SO2 (CN1-27,28)	SO3 (CN1-29,30)	Disable (Do not use)
/COIN	Not require				/COIN
/V-CMP	Possible				/V-CMP
/TGON	Possible		/TGON(L)		
/S-RDY	Possible			/S-RDY(L)	
/CLT	Possible				/CLT
/VLT	Not require				/VLT
/BK	Required	/BK(L)			
/WARN	Possible				/WARN
/NEAR	Not require				

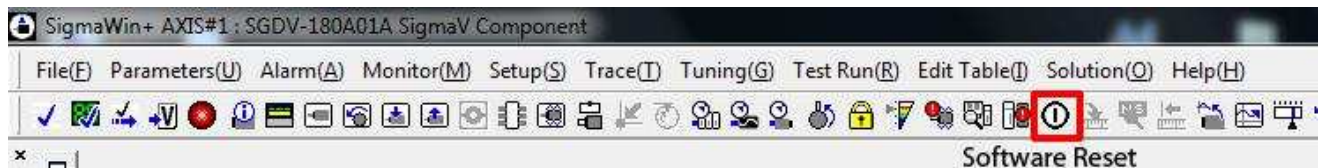
- Click "OK".
- You will then be returned to the IO Signal Settings screen. Hit "Apply" to save the settings and then click "Save/Write".
- Select "Write with a backup file" then press "Write". This will save the current configuration and then write the current configuration to the Servopack:



- Click "**Finish**".
- Click "**Yes**" when prompted to complete the Setup Wizard.
- The ServoPack will now have an A941 error as shown below. This indicates that a reset is required to apply the configuration changes.



- To reset the Servopack you must click the "**Software Reset**" button in SigmaWin or remove power from the Servopack. Before clicking the "**Software Reset**" button push in the E-stop button on the control. This avoids putting the control into an error state when the drive and motor go offline. The Software Reset button is shown below:



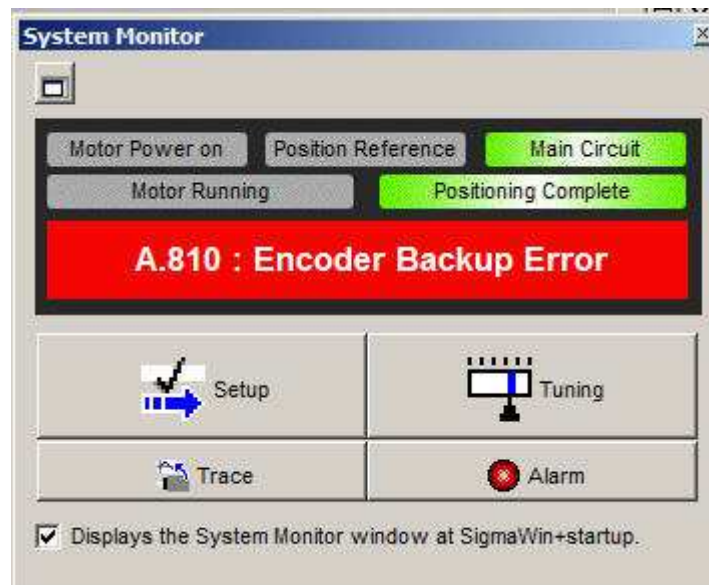
- After pressing the "**Software Reset**" button you will receive a warning. Simply click "**Execute**" to continue as shown below:



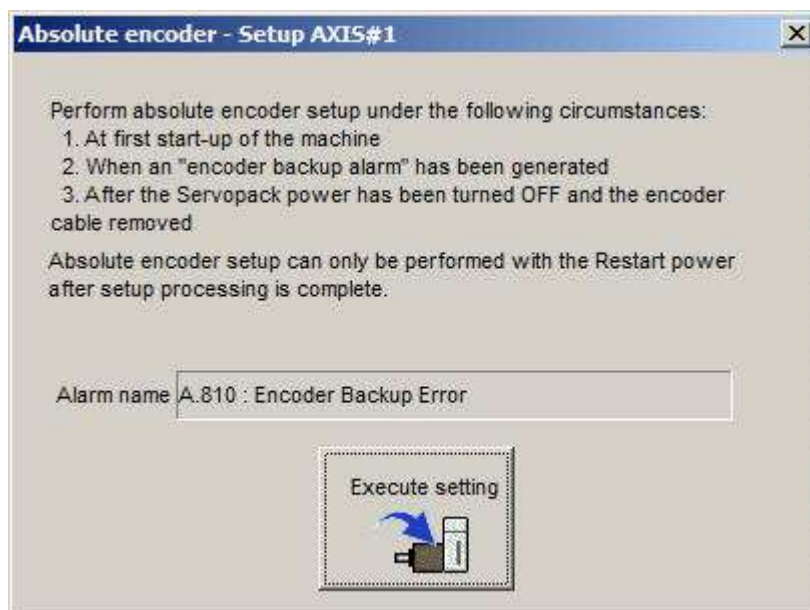
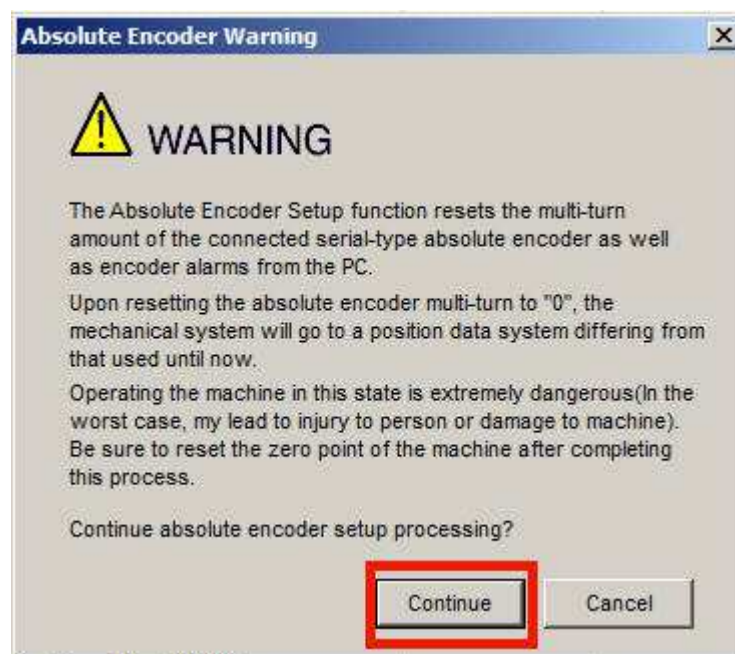
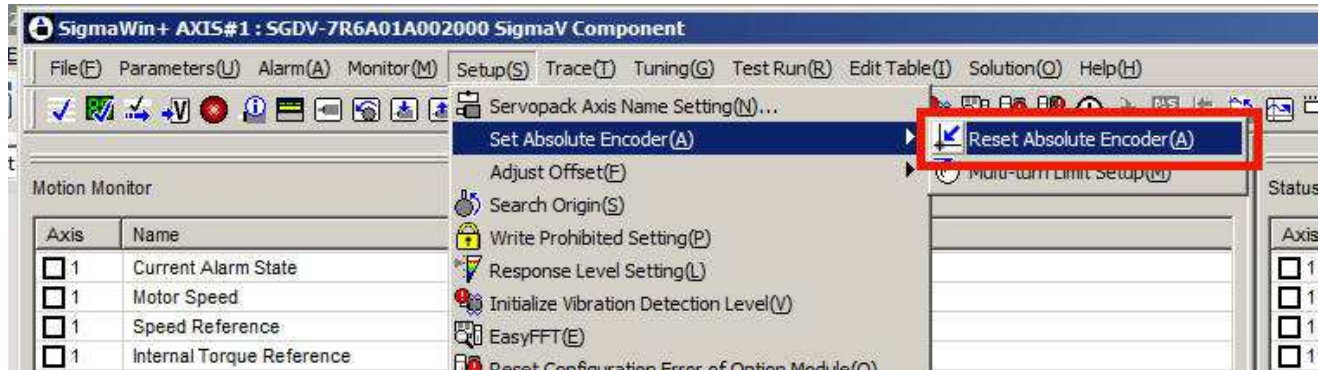
- Click "**Execute**" at the next screen that pops up to confirm reset of the Servopack.
- Every time the Yaskawa Servopack is reset, you will normally get an error on the Centroid control. Having the E-stop button pressed will avoid getting that error message.
- Once the Servopack is reset, you will have a "Motor Base Blocked - bb" message displayed on the Servopack. This message means that everything is OK.

Absolute Encoder Reset:

- If an absolute encoder was enabled, the following error will appear:



- This error will recur any time the backup battery is disconnected. Reset the absolute encoder position as follows:

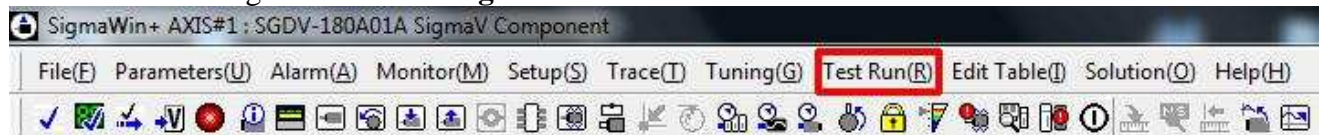




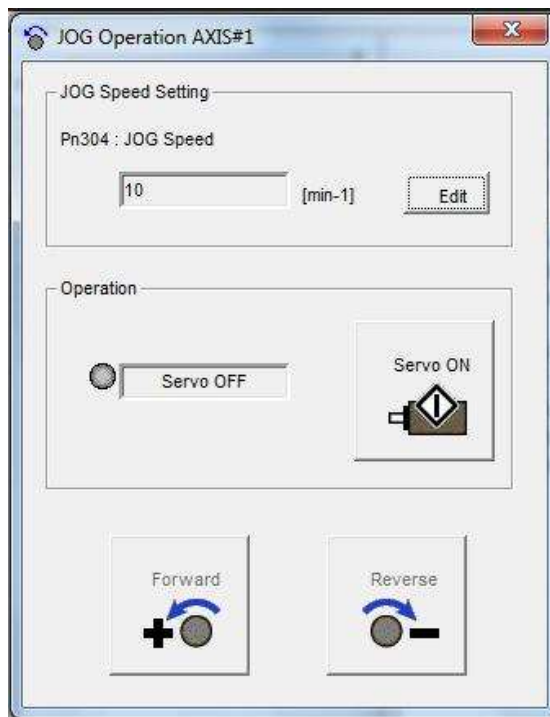
Test Run:

We are now ready to perform a test run of the Servopack and Servomotor. This test run will be performed from the SigmaWin+ software using the Jog Mode.

- To enter Jog Mode select "**Jog**" from the "**Test Run**" menu as shown below:

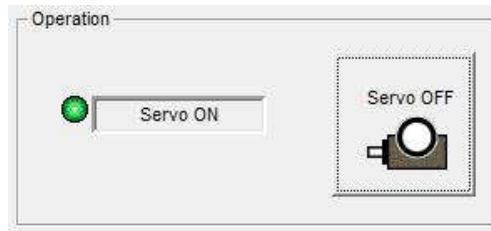


- You will then see the Jog Operation window as shown below:



- Click "**Edit**" to change the "JOG Speed" setting. 50rpm is a good safe starting point.
- Verify that the E-stop button is released.
- Click "**Servo ON**" to enable the Servopack Motor Power.

The screen should then show "Servo ON" as shown below:



- You can now jog the motor by pressing and holding either the Forward or Reverse buttons.
- If everything is working correctly you should have smooth motion of the Servomotor. Simply close the Jog Operation window to exit Jog Mode. Cycle the E-stop button.

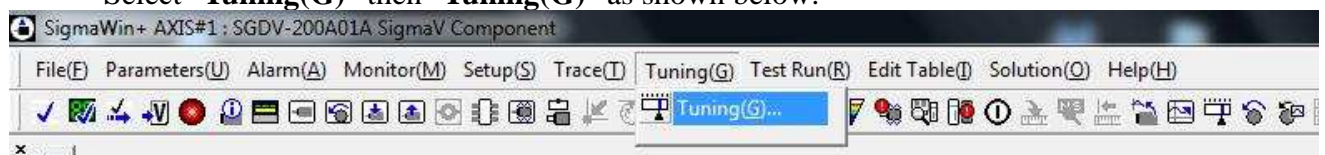
Servopack Tuning:

We are now ready to tune the Yaskawa Servopack. There are two main options for doing this:

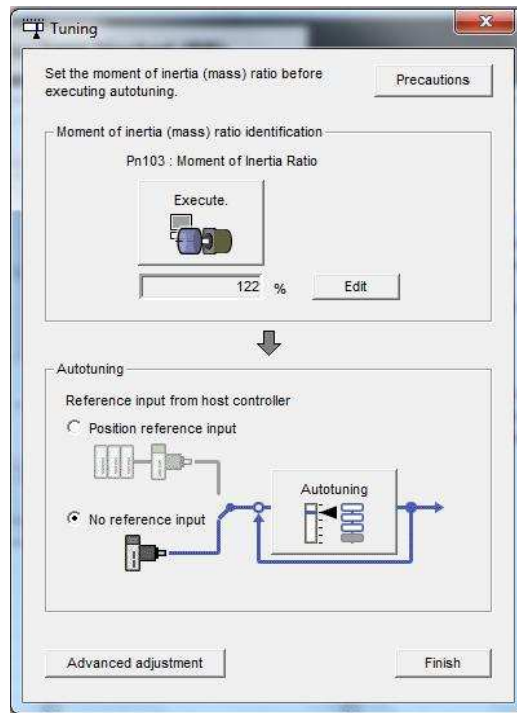
1. "Tune Less Mode" – This is the default mode for the Servopack. It obtains a stable response without adjustment.
2. "Autotuning" – In this mode the Servopack will attempt to tune itself to the dynamics of the system, saving the parameters for use after that.

Note: Most Servopack/Servomotor combinations seem to perform better once they have been Autotuned, so that is the option in which we will proceed.

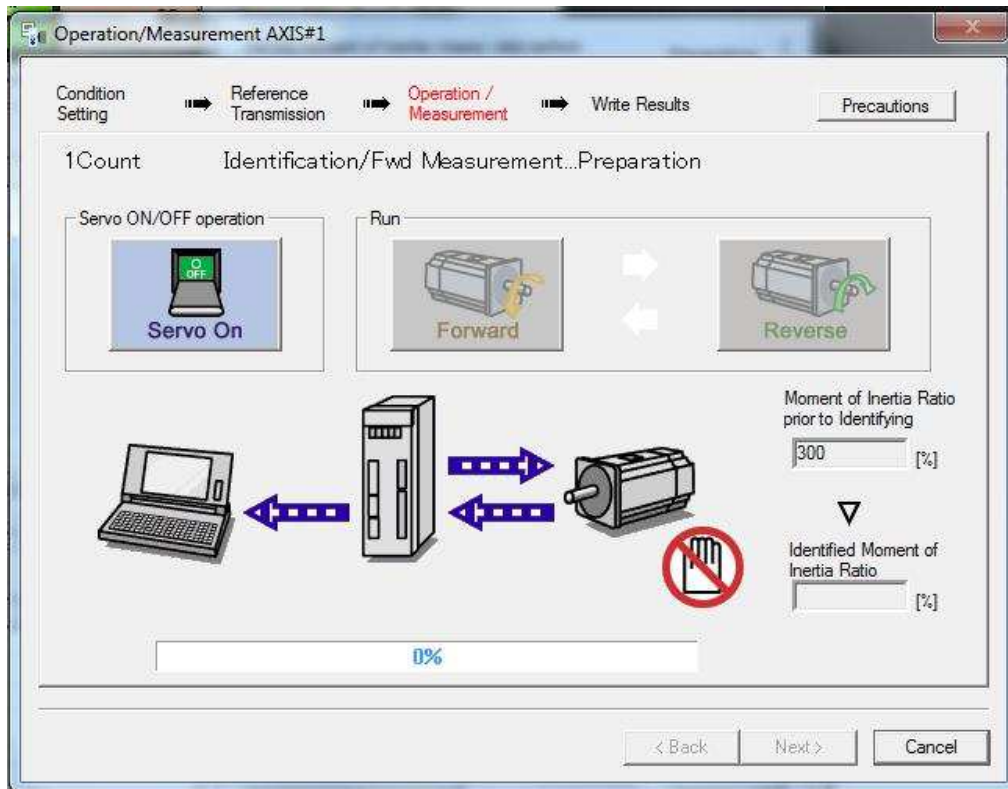
- Select "**Tuning(G)**" then "**Tuning(G)**" as shown below:



- You will then see a safety warning about the use of Tuning. Simply press "**Execute**" to continue.
- You will then see the following Tuning window:

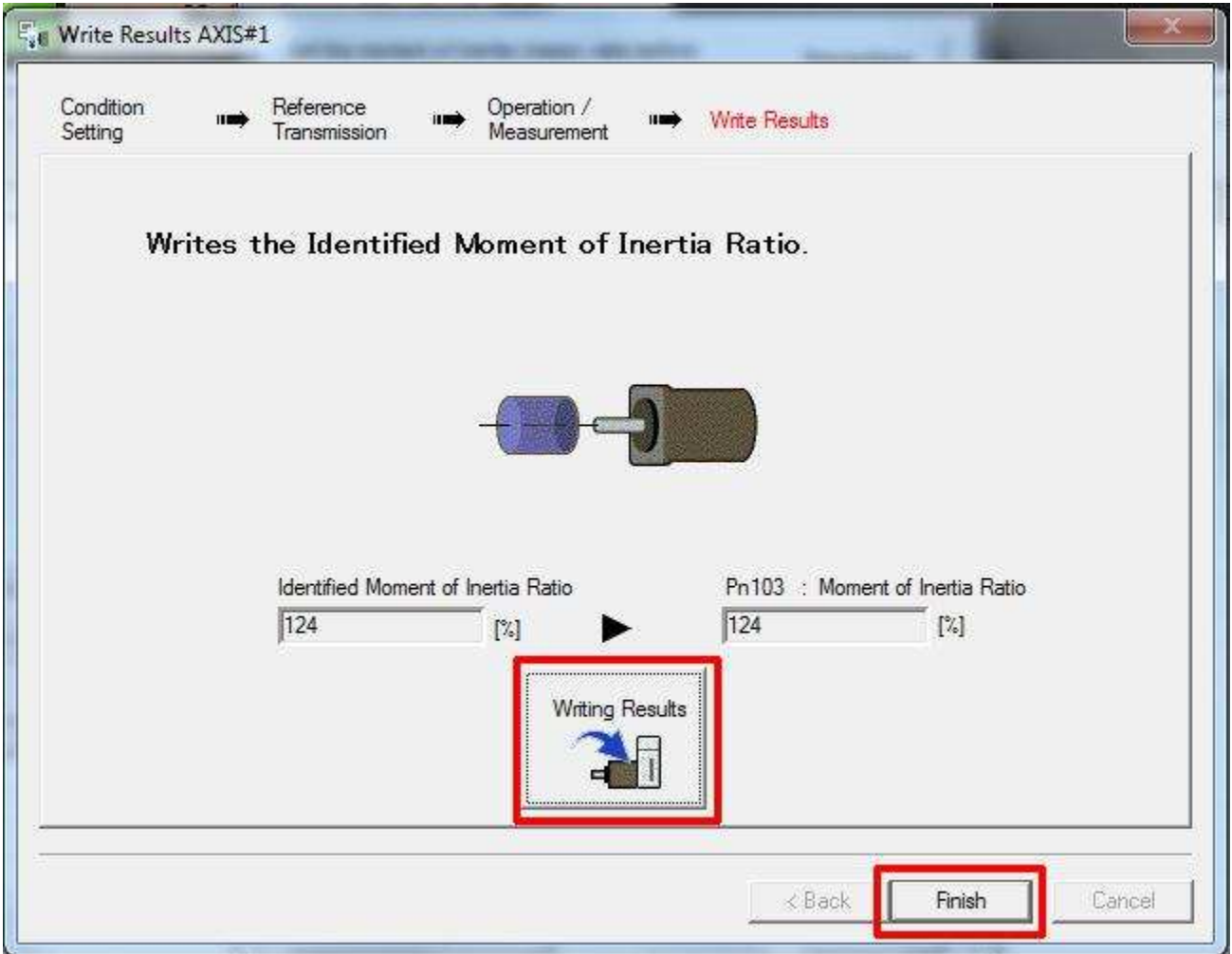


- Click "**Execute**". This will begin the process to calculate the Moment of Inertia for the Servomotor.
- You will then see the Condition Setting window as shown below. Click "**Next**".
- Click "**Start**" to transfer reference conditions to the Servopack and then click "**Next**".
- You will then see the Moment of Inertia calculation as shown below:

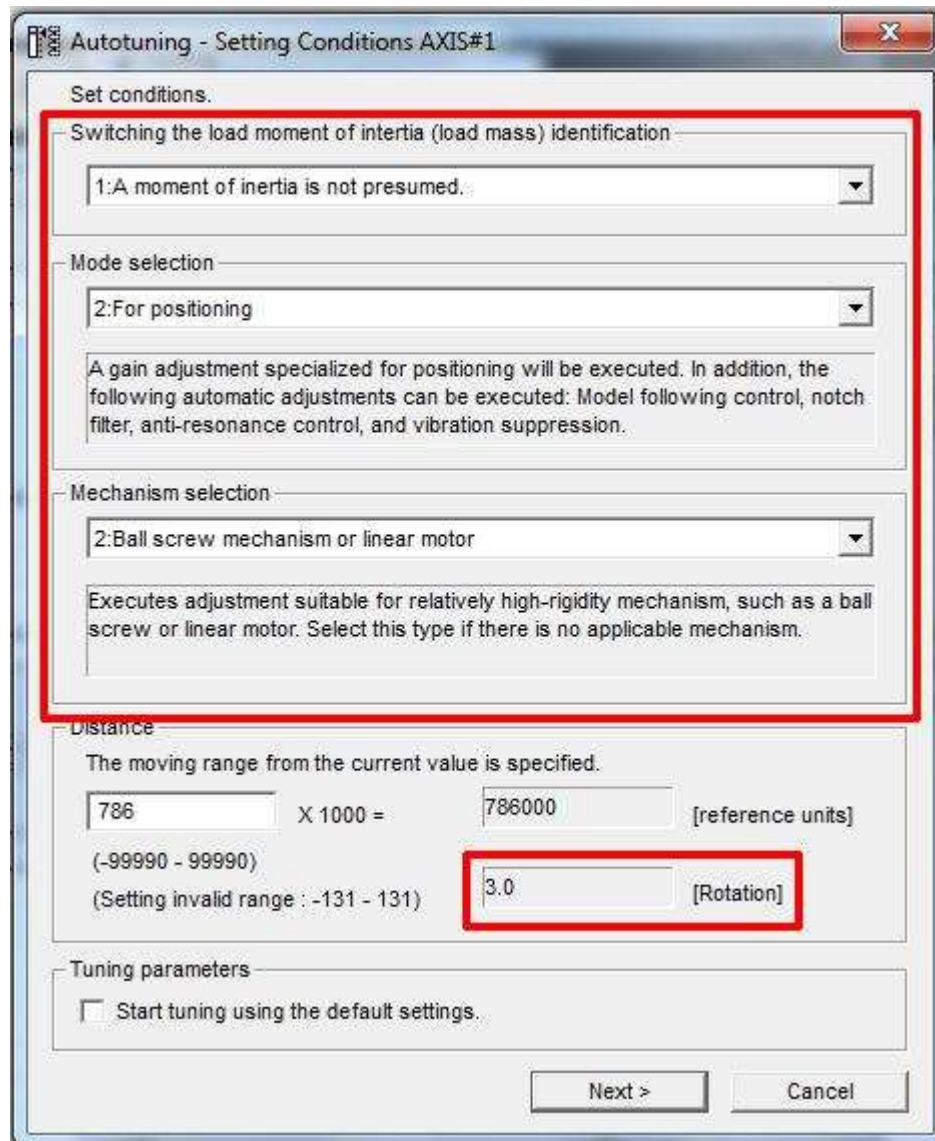


- Verify that the E-stop button is released.
- Click "**Servo On**" to apply power to the Servomotor.
- Alternatingly, click "**Forward**" then "**Reverse**" until the SigmaWin software will no longer allow you to press either one, signifying that the process is complete.
- Push in the E-stop button and click "**Next**".

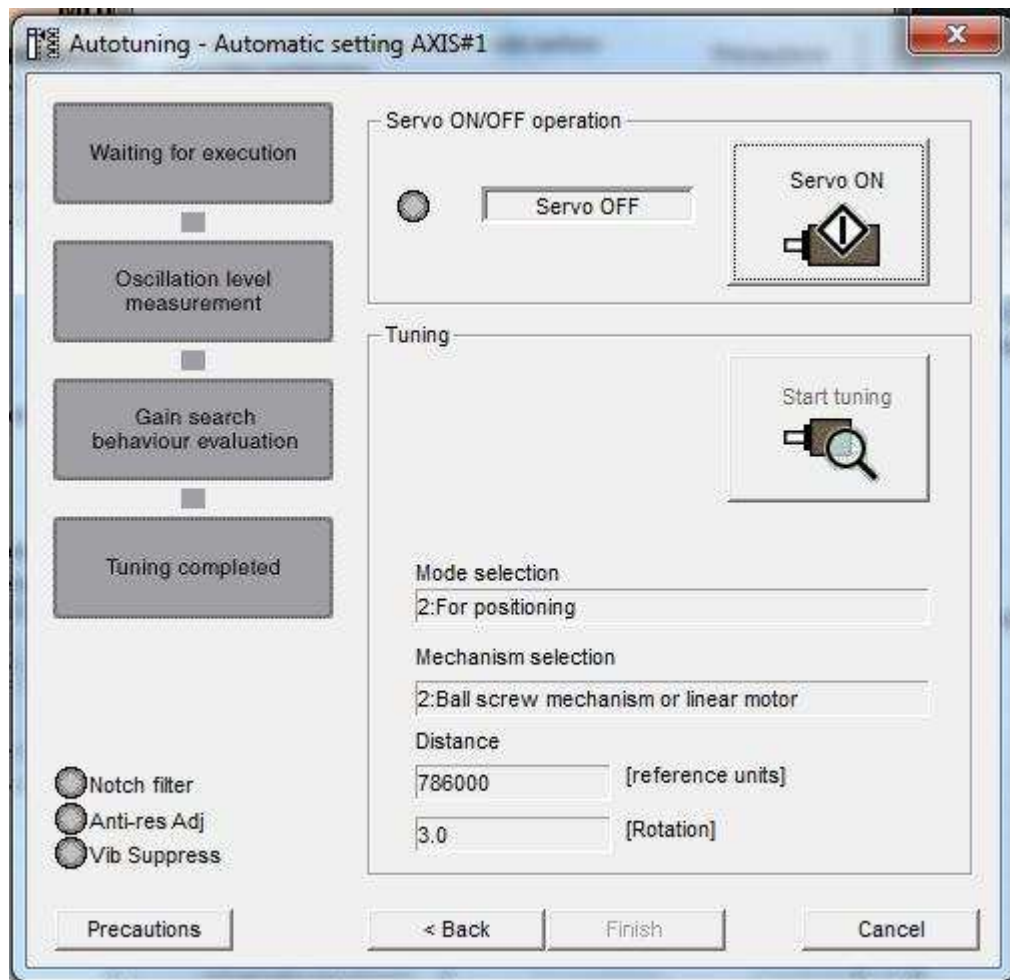
- You will then see the window as shown below:



- Click "**Writing Results**" to send the results to the Servopack.
- Click "**Finish**".
- You will be prompted to execute a **Software Reset** on the Servopack.
- You will then be returned to the Tuning window.
- Under the "**Autotuning**" section, click "**No Reference Input**" to ensure the correct mode during tuning. Click "**Autotuning**".
- You will then see the following Autotuning - Set Conditions window:



- The following settings should be set by default, verify that they match the following settings:
 - Set "Switching the load moment of inertia (load mass identification)" to **"1: A moment of inertia is not presumed."**.
 - Set "Mode selection" to **"2: For positioning"**.
 - Set "Mechanism selection" to **"2:Ball screw mechanism or linear motor"**.
 - Ensure the "Moving Range" is set to **"3.0"** rotations.
- Click **"Next"**.
- You will receive another warning. Click **"Yes"** to send the parameters to the Servopack.
- You will then see the Autotuning – Automatic setting window as shown below:



- Verify that the E-stop button is released.
- Click "**Servo ON**".
- Click "**Start tuning**". The Servopack will then tune itself. Sometimes the autotune will fault. This can usually be fixed by performing a **Software Reset** and re-starting the Autotune.
- Click "**Finish**" when tuning is complete.
- At this point the Servopack and servomotor are tuned. Execute a **Software Reset** to be sure everything is back in good operation

Centroid PID Configuration:

Verify that parameter 256 is set to 2 on the CNC11 software as this parameter tells the control that it's in Position Mode. From the main screen press F1(Setup)->F3(Config)->default password is 137->F3(Params). Press F8(Next Table) until parameters 200-299 are being displayed.

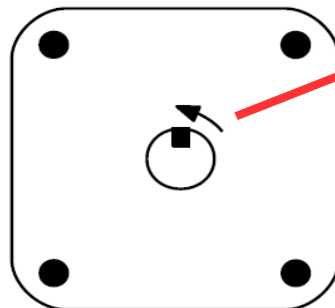
When the CNC11 software is in Precision Mode, the PID values should be set according to the table below. From the main screen press F1(Setup)->F3(Config)->default password is 137->F4(PID)->F4(PID Config).

Kp	Ki	Kd	Limit	Kg	Kv1	Ka	Accel.
0	0	0	2560000	0	0	0	0.500

The "**Encoder counts/rev**" field should be set to the same value that was used on the SigmaWin+ software which is 32768. From the main screen press F1(Setup)->F3(Config)->default password is 137->F2(Mach.)->F2(Motor).

Using the SigmaWin+ software to jog the motors, as done in the **Test Run** section above, confirm that the "**Abs Pos**" field in the PID menu is increasing when the Servomotor shaft is moving counter clockwise. If it is counting backwards or not counting at all, the encoders are wired incorrectly or the encoder mapping on the CNC11 software is not set correctly.

PID Menu							
Axis	Error	Sum	Delta	PID Out	Abs Pos	Max Error	Min Error
X*	0	0	0	OFF	-1	0	0
Y*	0	0	0	OFF	-1	0	0
Z	0	0	0	OFF	0	0	0
N*	0	0	0	OFF	-1	0	0
N*	0	0	0	OFF	-1	0	0
N*	0	0	0	OFF	2	0	0
N	0	0	0	OFF	0	0	0
N	0	0	0	OFF	0	0	0



For a standard 3-axis system, parameters 300-302 should be set to 1, 2, and 3, while parameters 308-310 should be set to 7, 8, and 9. Parameters 357-359 should be set to 3000.

***After the Yaskawa Servopacks have been configured and tuned or any time you have changed any settings on the Servopack(s), an Autotune on the CNC11 software must be performed. This is done by pressing F1(Setup)->F3(Config)->default password is 137->F4(PID)->F5(Tune). Make sure that all axes can move the specified amount without running into any obstacles or a limit switch.

Note: If your axis motors are excessively growling when moving after running the Centroid Auto Tune function, please follow the section below to "fine tune" delay.

Servopack Delay Fine Tuning:

The CNC software Autotune can only adjust delays to the nearest 250us increment. Fine tuning must be completed with Yaskawa SigmaWin+.

See the PID Menu section of chapter 14 (Configuration) in the M-Series Operator's Manual for information on the live tuning procedure if you are not already familiar with it. Run a short back and forth movement test program while observing the output graph.

If there is a consistent error proportional to Vabs as shown below, fine tuning is needed in SigmaWin+.

Axis X (6.741, 110.143)

	Scale	Offset	Value
VExp	1.00	0.00	0.000/0.00 RPM
VAbs	1.00	0.00	0.000/0.00 RPM
ErrAbs	1.00	0.00	2.000/0.00001 in
ErrSum	0.01	0.00	0.000

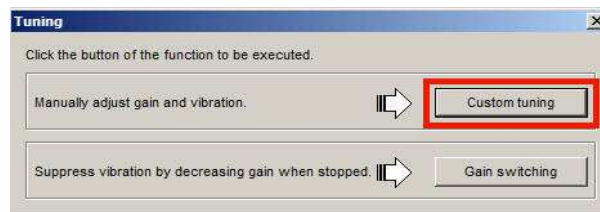
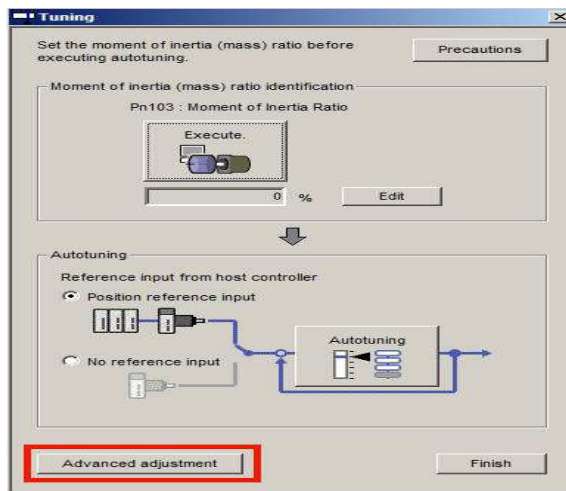
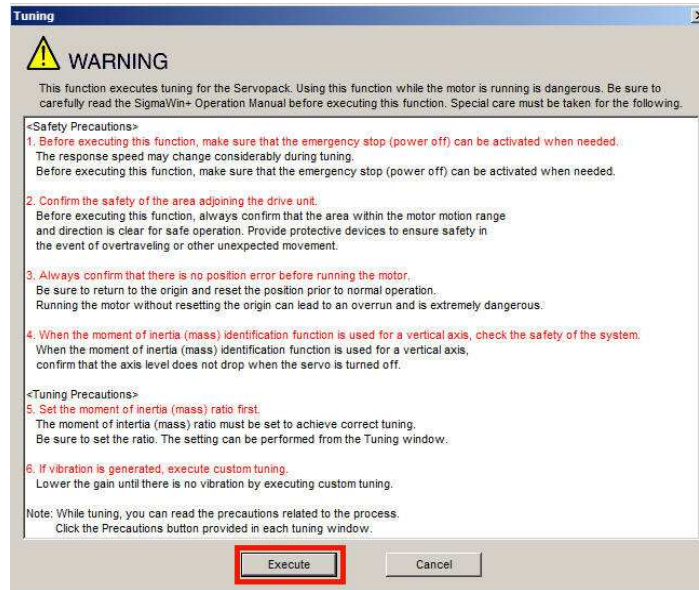
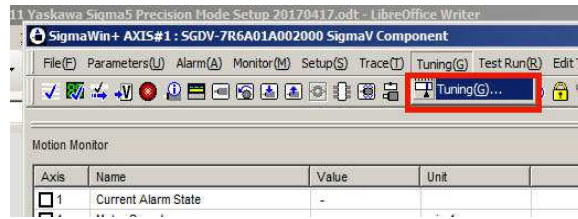
Axis	Kp	Ki	Kd	Limit	Kg	Kv1	Ka	Accel.	Max Rate
X	0.0000	0.000000	0.0000	2560000	0.0000	0.0000	0.0000	2.0000	(439.4)
Y	0.0000	0.000000	0.0000	2560000	0.0000	0.0000	0.0000	0.5000	(200.0)
N	0.0000	0.000000	0.0000	2560000	0.0000	0.0000	0.0000	0.5000	(200.0)
N	0.0000	0.000000	0.0000	2560000	0.0000	0.0000	0.0000	0.5000	(200.0)
N	0.0000	0.000000	0.0000	2560000	0.0000	0.0000	0.0000	0.5000	(200.0)
N	0.0000	0.000000	0.0000	2560000	0.0000	0.0000	0.0000	0.5000	(200.0)
N	0.0000	0.000000	0.0000	2560000	0.0000	0.0000	0.0000	0.5000	(200.0)
N	0.0000	0.000000	0.0000	2560000	0.0000	0.0000	0.0000	0.5000	(200.0)

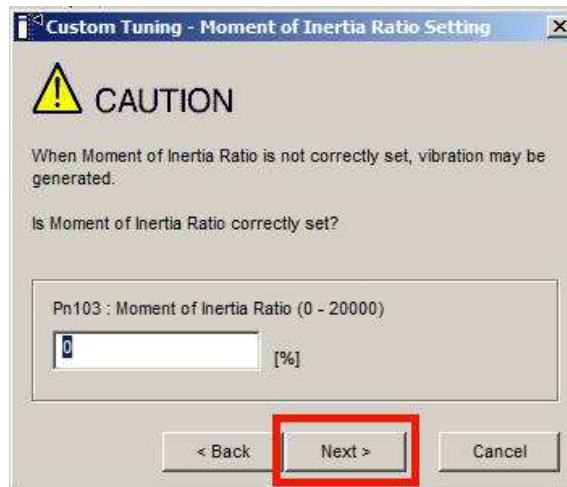
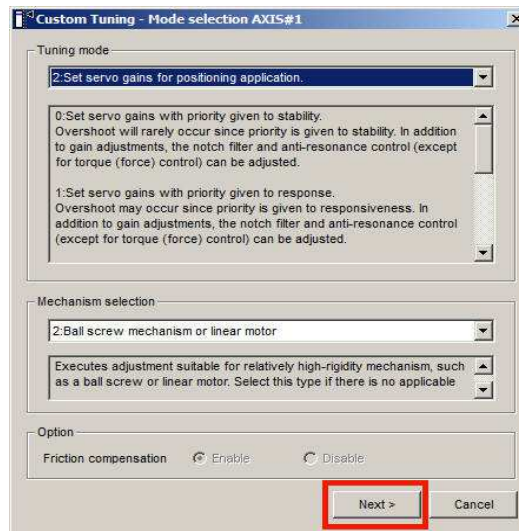
Autotune file not found or invalid data. Run Autotune

Edit Program	Run Program	Ranges	Toggles & Pan	Zoom In	Zoom Out	Zoom All	Change Axis	Save & Apply	Save & Exit
F1	F2	F3	F4	F5	F6	F7	F8	F9	F10

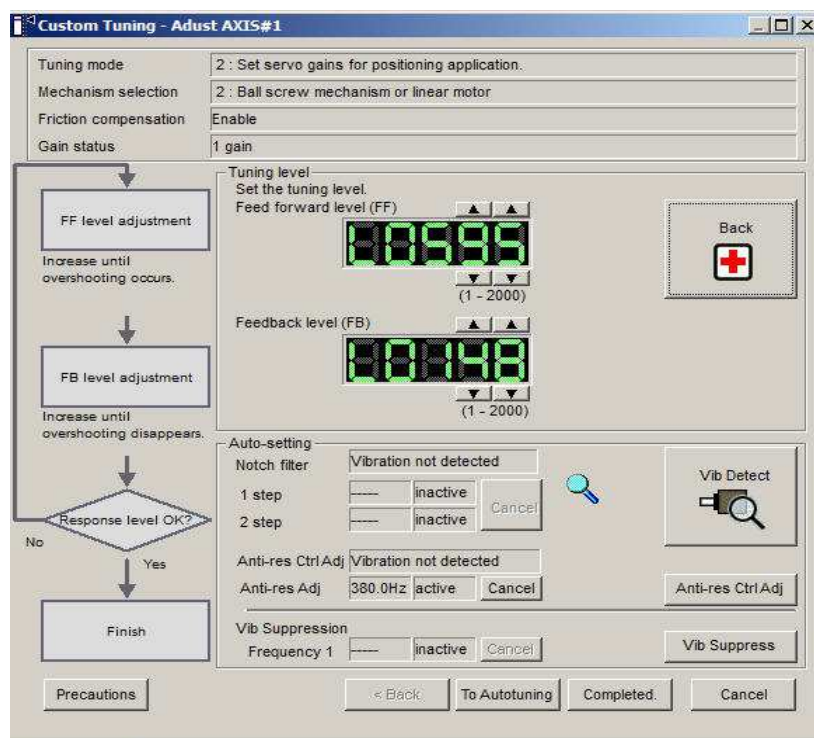
This error is due to a delay time mismatch. Centroid autotune has corrected the delay to the best of its ability, but the smallest correction it can make is 250us. A residual delay mismatch may remain that is between 0 and 250us.

Follow the following steps to get to the SigmaWin+ Custom Tuning menu:





- Do not change the moment of inertia, simply click next.



While the live tuning program is running, adjust the "Feed forward level (FF)" in Sigma Win+. Relatively fine changes will be needed here that will not undo previous tuning efforts. The "Feed forward level (FF)" changes will take effect when the motor stops (at direction changes). The error trace on Centroid's live tuning should get closer to 0. If not, adjust "Feed forward level (FF)" the other way. The error trace will be centered around 0 when the adjustment is correct.

Corrected performance after delay fine tuning:



Press the "Completed." button in Sigma Win+ and disconnect from the drive.

Braking Resistors:

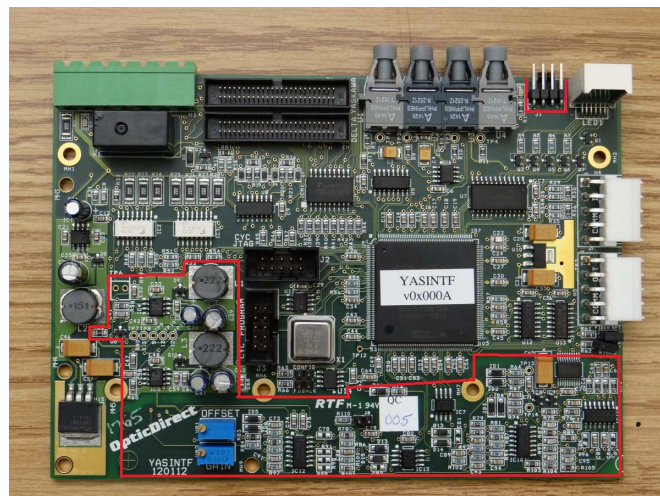
If the Yaskawa Servopack is wired to use an external braking resistor you must set Parameter 600 (Regenerative Resistor Capacity) on the Yaskawa to be equal to 20% of the wattage of the braking resistor.

Load Meter Setup

1. If using the OAK board, all that is needed is the Yaskawa interface cable for the OAK board, Centroid part number 13134. Just connect the analog input connector of the Yaskawa interface cable to the CN5 connector of the Yaskawa drive which is located underneath the display cover as shown in the photo below.



If using the OpticDirect boards, please verify that the OpticDirect board has the analog section populated as shown in the photo below.



2. Verify that the following is defined in the PLC program. **Note** – The input and word definitions may vary depending on the component that is being used to read the analog torque voltage from the Yaskawa drive as well as what is already being defined in the PLC program

Input Definitions

AnalogInput1	IS INP241
AnalogInput2	IS INP257
AnalogInput3	IS INP273
AnalogInput4	IS INP289
AnalogInput5	IS INP305

Word Definitions

XMeterADC_W IS W14
YMeterADC_W IS W15
ZMeterADC_W IS W16
AMeterADC_W IS W17
SpindleMeterADC_W IS W20

Main Stage

IF true THEN BTW XMeterADC_W AnalogInput1 16,
 BTW YMeterADC_W AnalogInput2 16,
 BTW ZMeterADC_W AnalogInput3 16,
 BTW AMeterADC_W AnalogInput4 16,
 BTW SpindleMeterADC_W AnalogInput5 16

IF XMeterADC_W > 32767 THEN XMeterADC_W = XMeterADC_W – 65536
IF YMeterADC_W > 32767 THEN YMeterADC_W = YMeterADC_W – 65536
IF ZMeterADC_W > 32767 THEN ZMeterADC_W = ZMeterADC_W – 65536
IF AMeterADC_W > 32767 THEN AMeterADC_W = AMeterADC_W – 65536
IF SpindleMeterADC_W > 32767 THEN
 SpindleMeterADC_W = SpindleMeterADC_W – 65536

; TODO: Pre-compute constants in initial stage
; The Delta drives put out +/-8V at max torque
; The spindle is +/-10V

IF true THEN XMeterADC_W = (100 * XMeterADC_W) / 1638,
 YMeterADC_W = (100 * YMeterADC_W) / 1638,
 ZMeterADC_W = (100 * ZMeterADC_W) / 1638,
 AMeterADC_W = (100 * AMeterADC_W) / 1638,
 SpindleMeterADC_W = (100 * SpindleMeterADC_W) / 2048

IF true THEN SV_METER_1 = abs(XMeterADC_W),
 SV_METER_2 = abs(YMeterADC_W),
 SV_METER_3 = abs(ZMeterADC_W),
 SV_METER_4 = abs(AMeterADC_W),
 SV_METER_6 = abs(SpindleMeterADC_W)

3. Verify that parameters 35, 57, 137, 143, and 313 are set correctly.

Parameter 35

This is the axis that is assigned as your spindle axis. By default, it should be set to 6.

Parameter 57

This is bit based parameter that tells the CNC11 software which axes to turn the load meters on for.

Axis	1	2	3	4	5	6	7	8
Bit	0	1	2	3	4	5	6	7
Value	1	2	4	8	16	32	64	128

For example, we have a 3-axis system with a spindle in which it is desired to see the load meters of all the axes as well as the spindle. Therefore, bits 0, 1, 2, and 5 would be set. That means that parameter 57 would be a value of $1+2+4+32 = 39$.

Parameter 137

This parameter tells the CNC11 software how many samples to use when calculating the average output for the load meter display. By default it should be set to 0 but if the load meter jumps around a lot with it set to 0, this parameter can be adjusted to minimize the amount of “jumpiness” of the load meter display.

Parameter 143

This is another bit based parameter that controls the display of the axis load meters. By default it should be set to 0 which enables the load meters as well as the Distance to Go DRO and provides an outline for the load meters.

Parameter 313

This parameter tells the CNC11 software which encoder input to look at for the 6th axis, which is the spindle axis that was set by parameter 35. By default it should be 6.

Document History

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