## TB295 – Yaskawa Sigma I and II with Centroid CNC11 based CNC controls

**Overview:** Excellent cnc machine tool motion can be achieved with the Centroid OAK CNC control board or MPU11/GPIO4/Opticdirect based systems running older Yaskawa Sigma I or Sigma II servo drives and motors. Centroid CNC11 Version 3.14+ supports Yaskawa Sigma I and II drives and motors in Position mode. With Autotuning in the Yaskawa drive and Auto delay calculation in CNC11 this configuration yields excellent results while being simple to setup and get running well in a short period of time. Running the Yaskawas in position mode as described in this Tech Bulletin is highly recommended over velocity mode setup. (if you have Yaskawa <u>Sigma V drives, please refer to TB267</u>)

### **CNC11** with Sigma I and II Setup Procedure

- 1.) Connect to Yaskawa drive using SigmaWin software and a serial cable with USB to serial adapter.
- 2.) Program the Drive parameters for Position Mode.
- 3.) Configure CNC11 parameters for Yaskawa Sigma I or II position mode.
- 4.) Use Yaskawa Autotune to tune the axes.
- 5.) Set Timing Delay using Centroid Autotune.

#### Wire system according to the Oak or MPU11/GPIO4 system yaskawa schematics.

Here is a photo of an Oak board installed in a 15 year old control cabinet with Yaskawa Sigma I drives. Ready to for the drives and CNC11 to be configured. The Centroid Yaskawa cable, (Centroid part number #13134 works with Sigma,I,II,V drives) directly connects the Oak board to the Yaskawa Servo drives with two way digital drive communication with encoder feed back and drive load output (load meters). No extra encoder cables going back to the cnc cpu are necessary.



Items needed for the steps in this Tech Bulletin are: Laptop running SigmaWin+ software, Serial Cable and USB to serial converter, USB stick, Centroid system schematic, Latest Centroid CNC11 software, and for Sigma I only, a Yaskawa JUSP-OP02A1-E programming/operator module

#### 1.) Connect to Yaskawa drive using SigmaWin software and a serial cable with USB to serial adapter.

a.) Build or buy a yaskawa serial cable communication cable. Buy: Yaskawa part #YS-11(A) Build: Follow instructions in Appendix A of this Tech Bulletin to build your own cable.

b.) Buy a Serial to USB converter. We used a <u>Manhattan USB to Serial Converter</u> with success. Many other brands are available, reports have come in that some other brands work and some do not.

c.) Install <u>Yaskawa SigmaWinplus 5.70A</u> (which was the latest version as of this writing) on your laptop.

d.) Connect cable to Yaskawa and PC with drive power on and Estop depressed.

e.) Connect to the servo drive thru the SigmaWin software, make sure the "online tab" is selected and click on the "search" box, select the drive type you are connected to and the USB tab and the little Search box is checked and then click on Search at the bottom of the window.

	Search Condition Setting
Portela Ria - Diversiona 5	Check off the target that is not needed to search
	Target Servopack Series Setting
Online Offline	
A USB	USB Controller & Ethernet you may have a rs422 tab appear here
Axis Seronack Seronmotor Option Axis name	Search 5
Servo drive name will appear here when search is successful	When exampling for a UICP communications interface a batch example in
	executed and information on all the USB connection axes of the selected
	series will be searched for.
Connect Cancel	
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Mastercam X3	6
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f.) If the search was successful, the servo drive name will appear, highlight it and click the "Connect" Box.

If the servo drive does not appear, you may have to try a different tab in step #4 in figure 2 above. Sometimes depending on your computer even though you are connected thru a USB port a Tab will appear in the SigmaWin software labeled RS232 or RS422, select this new tab and run the search again.

g.) Once connected it is advisable to make a backup of the servo drives existing parameters. Click "Parameters(U)" and select "Edit Parameters" from the drop down menu. Click on the Floppy disk icon and save the .USR file to your laptop. (.USR file is the extension given to the yaskawa servo drive parameter backup file) Note: Give the .USR file a name that indicates that it is the initial/original backup of that particular drive and axis.

save .l	USR file Contro	y Setting er Level sta I Mode All	andard (all para) Control Mode	meters)			Cha	nge
No	Name	Value	Unit	Min	Max	Default		l
Cn-01	Memory switch setting 1	0100H	-	-	-	0080H		✓ Edit
Cn-02	Memory switch setting ?	0000H		-	-	0000H		
Cn-11	Number of encoder pulses	8192	P/R	513	32768	8192		
Cn-2B	Control method selection	2		0	11	0	Ξ	
Cn-2A	Motor selection	143	-	0	254	143		
Cn-03	Speed reference adjustment	250	(min-1)/V	10	2000	250		
Cn-04	Speed loop gain	80	Hz	1	2000	80		
Cn-05	Speed loop integration time c	2000	0.01ms	200	51200	2000		
Cn-1A	Position loop gain	40	1/s	1	1000	40		
Cn-1C	Bias	0	min-1	0	450	0		
Cn-1D	Feed-forward	0	%	0	100	0		
Cn-17	Torque reference filter time co	0	0.1ms	0	250	4		
Cn-28	Speed loop compensation co	0	-	0	100	0		
Cn-0C	Mode switch(torque reference)	200	%	0	800	200		
Cn-0D	Mode switch(speed reference)	0	min-1	0	10000	0		
Cn-0E	Mode switch(acceleration refe	0	10(min-1	0	3000	0		
Cn-0F	Mode switch(error pulse)	0	referenc	0	10000	0		Comment
Cn-0A	PG dividing ratio	2048	P/R	16	32768	8192	-	
•		III				•		Timport
Select A	\II(Include those not displayed)							

2.) Program the Servo Drive parameters for Position Mode.a.) In SigmWin use the "Edit Parameters" menu and check the box beside the parameter you need to edit and click the Edit box. Edit the parameter value and click OK. Do this for all parameters in the chart below.

User Leve Control Mode 2 000 Ises 819 ion 0 143	I standard (all para All Control Mode Unit CH - 2 P/R -	Min - 513	Max -	Default 0080H 0000H	Chang	e <b>2</b> ✓ Edit	Cn-01 [Memory switch setting 1 Category Input signal enable/disable	Bit No.	Setting
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2 000 Ises 819 ion 0 143	0H - 2 P/R -	- 513	•	0000H				~	0 : Uses servo ON input (/S-ON).
lses 819 ion 0 143	2 P/R	513						1	0 : Uses SEN signal input (SEN) when absolute encoder is use
ion 0 143			32768	8192	-			2	1 : Does not use forward rotation prohibited input (P-OT). For
143		0	11	0	-			3	1 : Does not use reverse rotation prohibited input (N-OT). Rev
A	•	0	254	143			Reserved (Do not change )	4	0 : Reserved (Do not change )
tment 250	(min-1)/V	10	2000	250			Operation performed at recovery fr		0 : Reset each alarm status at nower recovery from its more
80	Hz	1	2000	80			Operation perioritied at recovery in	in a C	0 . Nesets serve alarm status at power recovery norm is mone
time c 200	0 0.01ms	200	51200	2000			Sequence selection at alarm condit	IOF 6	0 Stop the motor by applying dynamic brake (DB) at base bid
40	1/s	1	1000	40				7	0 At base block, stops the motor by applying dynamic brake i
0	min-1	0	450	0				8	0 : Stops the motor according to bit 6 setting when overtravel
0	%	0	100	0				9	0 : When overtravel is detected, decelerates the motor to a str
time co 0	0.1ms	0	250	4			Process selection for Servo OFF	A	0 : Clears error pulse at Servo OFF.
tion co 0		0	100	0			Mode switch selection	в	0 : Uses mode switch function. Follows Cn-01 bits D,C.
terence) 200	76	0	008	200				D.C	00 : Uses internal torque reference as a condition (Level settin
terence) U	min-1	0	10000	0			Encoder selection	E	0 : Uses incremental encoder.
tion rete 0	TU(min-1.		10000	0		Comment	Reserved (Do not change )	F	0 : Reserved (Do not change )
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Yaskawa <u>Sigma I</u> Param #	<u>Sigma I</u> Change	Sigma L parameter description	Yaskawa <u>Sigma II</u> Param #	Sigma II Change	Sigma II paramotor description
		Position Mode			Position control
Cn-02	0020	Position Mode	Pn002	0100H	Absolute encoder as incremental
Cn-11	8192	Number of encoder pulses	Pn102	80-120	Gain, adjust by trial and error. Start with 90, machine dependent
Cn-2B	1	Control Method Selection Position Mode	Pn110	0	Autotuning 1=ON, 0=OFF
Cn-1A	50 to 70 are typical values*	Gain, adjust by trial and error. Start with 60. Value is machine dependent	Pn200	0004H	Input signal A phase B phase X4
Cn-0A	8192	PG dividing ration	Pn201	8192	PG divider (Needed if Pn207 is 16 bit)
Cn-24	1	Electronic Gear Ratio Numerator	Pn202	4	Electronic gear ratio Numerator
Cn-25	1	Electronic gear ratio Denominator	Pn203	1	Electronic gear ratio Denominator
Cn-1B	7	Positioning completion range	Pn207	0100H	17 bit output (Not on Early sigma 2)
			Pn212	8192	Divider
			Pn500	7	7 Position completed width
			Pn50A	8100H	Over travel off
			Pn50B	6548H	Over travel off
			Pn50E	3200H	Servo ready

Once editing is complete click on "Write" to write the new values to the servo drive. Once written the servo drive will need to be rebooted, power off the servo drive power, wait 30 seconds and power back up. At this point its a good idea to double check the parameter values. Using SigmaWin reconnect to the servo drive and click edit parameters and review that the proper values are being displayed.

#### 3.) Configure CNC11 parameters for Yaskawa Sigma I or II position mode.

a.) Follow the CNC11 configuration instructions in its entirety using the Installation manual for the system you are using. <u>OAK</u> board installation manual or the <u>MPU11/GPI04/Optic Direct manuals as usual</u>. Then proceed...

b.) In CNC11 set the Encoder Counts per Rev to 32768.

(<u>Review TB267</u> on the limits of encoder count maximums for MPU11 based systems)

c.) In CNC11 Set PID values as follows

Кр	Ki	Kd	Limit	Kg	Kv1	Ka	Accel
0	0	0	2560000	0	0	0	.375

c.) Set parameter 256 = 2 which enables Precision/Position Mode

d.) Release estop with machine in middle of travels, slow jog axes to test basic control of motion.

#### 4.) Use Yaskawa Autotune to tune the axes.

**Sigma I:** Follow Sigma I Autotune procedure found in the <u>Yaskawa Sigma I users manual</u>. A plug in programming module is required to Autotune a Sigma I drive. We have successfully used the Yaskawa JUSP-OP02A1-E ( also known as a DAPSX3000) operator module to Autotune Sigma I drives. These are available new and used (ebay). Unlike other yaskawa drives you can not use the SigmaWin+ software to Autotune a Sigma I, the plug-in module JUSP-OP02A1-E is required for this step.

a.) Using a JUSP-OP02A1-E follow the Sigma I User's Manual section 4.2.3 and Autotune the drive.

b.) Move the machine at all the speeds and listen for noise or bad characteristics. Adjust GAIN (CN-1a) as necessary to achieve smooth sounding nice action motion and then re-Autotune once you have the gain set for satisfactory motion.

**Sigma II:** Follow Yaskawa Sigma II User's Manual and follow the Autotune instructions in Chapter 6 starting on page 24. You can use SigmaWin+ software to Auotune a Sigma II drive.

a.) Start the tuning process by setting the Moment of Inertia using the instructions for the Sigma I drives above.

b.) Once the Moment of Inertia has been determined use the Yaskawa Sigma II User's Manual Section 6.3. Adjust the "Rigidity" setting (Fn0001) using the keypad on the drive face. A good starting point is to set Fn0001 to 6 for a mill.

c.) Set the Autotuning Parameter Pn110 to 1 (1= Autotune ON). Move (with CNC11) the axis at rapids, typical cutting feedrates and at slow speeds to see how it responds if the axis is noisy or sluggish use Fn0001 to adjust the rigidity.

d.) After the drive is tuned set Parameter Pn110 to 0. (Pn110=0 Autotune OFF, Pn110=1 Autotune ON)

#### 5.) Measure and Set Timing Delay Parameter Automatically with Centroid's Autotune.

Position each axis in middle of travel and run "Autotune" in the Centroid PID menu. Centroid's Autotune will automatically calculate and set the delay timing parameter for that axis. Perform the Centroid Autotune procedure on each axis, one axis at a time.

Typically Timing Delays are: Sigma I 10 - 20 milliseconds and Sigma II 5-10 milliseconds. If the Delay times are longer than these typical values then the gain is set too low, increase gain, check for good axis motion at various speeds, reautotune on servo drive and then reset the Delay Timing using the Centroid Autotune. (Note: Each time you adjust the Gain settings in the Yaskawa drive or Run Autotune in the Yaskawa, be sure to re-autotune on the Centroid side to calculate a new Timing Delay.)

f.) Once satisfied with the motion, backup good the good .USR files for each drive. Backup CNC11 parameters by making a "report" file. Email the files to <u>support@centroidcnc.com</u> and they will be filed with the Centroid cnc system folder for safe keeping and future reference.

Notes:

- 1.) Useful links
- Oak board Installation Manual
- Yaskawa Sigma II User's Manual
- Yaskawa Sigma I User's Manual
- MPU11/GPIO4D with Opticdirect and Yaskawa User's manual
- Latest Schematics, Oak Sigma I and II, MPU11/GPIO4D/OpticDirect Sigma I and II
- Latest CNC11 Software download
- Yaskawa SigmaWinplus 5.70A download
- TB267 Yaskawa Sigma 5 setup with CNC11 (for reference, First and Last page applys to Sigma I and II as well)
- Manhattan USB to Serial Converter

- Example Position Mode Yaskawa ".USR" files. <u>Download this Zip file which contains both a sigma I and sigma II working</u> <u>Position Mode .USR files for your reference.</u>

Note: These can be opened in SigmaWin+ in the Offline Mode and reviewed without being connected to a servo drive.

**2.) The Yaskawa JUSP-OP02A1-E programming/operator module** required for Autotuning a Sigma I drive can be purchased new from Yaskawa for around \$220 and on ebay used for around \$75-\$100. It plugs into the same 3CN connector on the drive as the serial cable.



**3.) DRO Flicker and Load Meter Bounce control.** Sometimes on a light load axis (like a Z axis on a knee mill) the DRO and Load Meters will flicker or bounce around since there is not a lot of mechanical damping on that axis and the servo motor is hunting around trying to hold .0001". With CNC11 Version 3.14+ the Load Meters and DRO Flicker can be dampened in the CNC11 software with Parameters 137 (load meter) and 138 (DRO). Typical value for P137 is 2 or 4, Typical value for P138 2 or 4. (Leave both set to 0 for an axis that is not flickering)

**4.) Load Meters.** CNC11 Load meters receive a low voltage signal feedback from the 5CN connector on the Yaskawa servo drive. The Centroid Yaskawa interface cable has a small two wire connector pig tail that comes off the Servo drive end of the Cable. Simply plug this small 4 lug (two wire) connector into the 5CN connector on the Yaskawa (see image below) and configure CNC11 for Load Meter display. Set Parameter # 143 to 1 (Load meters ON) or 3 (Load meters ON with outline) or 11 for all on with mini DRO. See <u>Centroid Operator Manual for details page 14-31</u>



# Yaskawa Sigma I or II RS 232 to USB serial cable

Build your own Yaskawa serial communication cable.

#### Serial Cable pin out connections from the Yaskawa Sigma I manual



#### Notes:

- We used a <u>Manhattan USB to Serial converter</u> with success. Many other brands are available, reports have come in that some others work and some do not.

- We used 22 awg shileded cable from west penn wire.

- We tested our cable and sigmawin software connection before going out to the job site with a spare sigma 1 drive on the bench. You can connect single 220 vac phase power to the sigma one and it will boot up and communicate thru the 3CN connection without a motor connected (or anything else).

- Rather than build your own, you can purchase the serial cable from Yaskawa part #YS-11(A)