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A Model-based approach to Motion Control design

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THE TRADE-OFF

Maintainability

- Broad range of Applications, Stages, Motors, Platforms
- EPICS dependencies
- Standardized solutions
- Less engineering effort
- Easy to deploy

Performance/Capabilities

- Encoder/step resolution
- Ripple/vibrations
- Heat dissipation
- Obtainable speed ranges
- Tracking performance
- Reliability/Robustness
- Protections
- Synchronized

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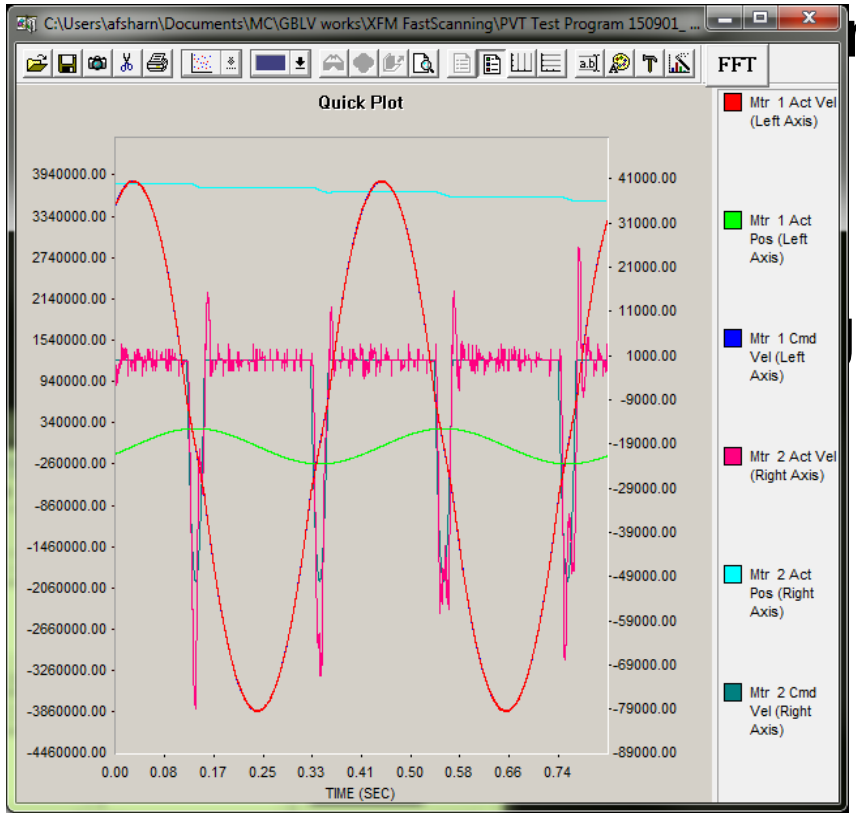
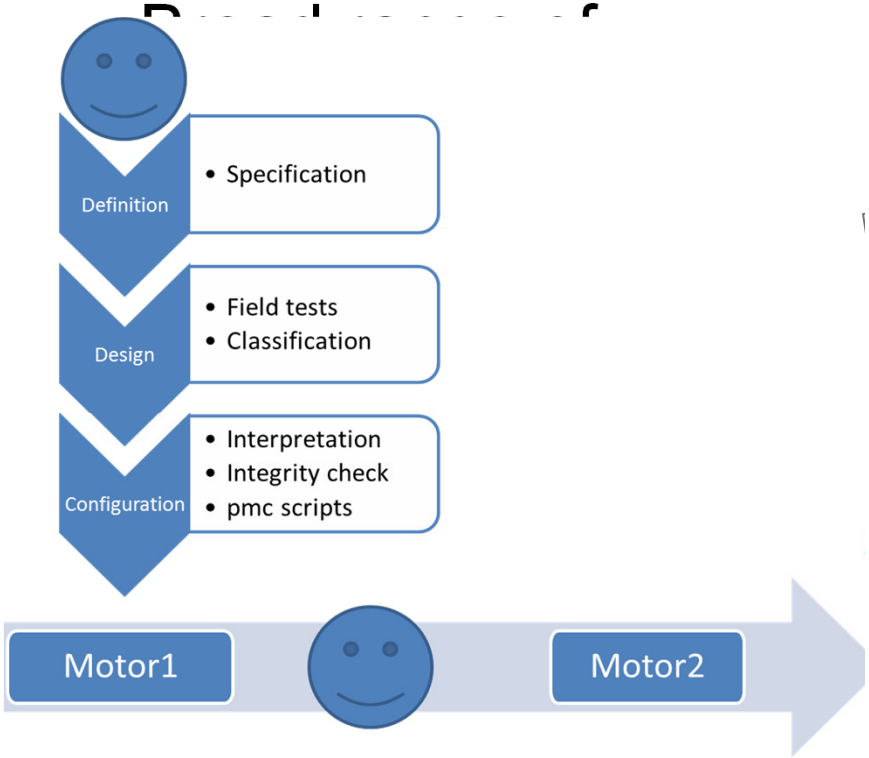
Performance/Capabilities

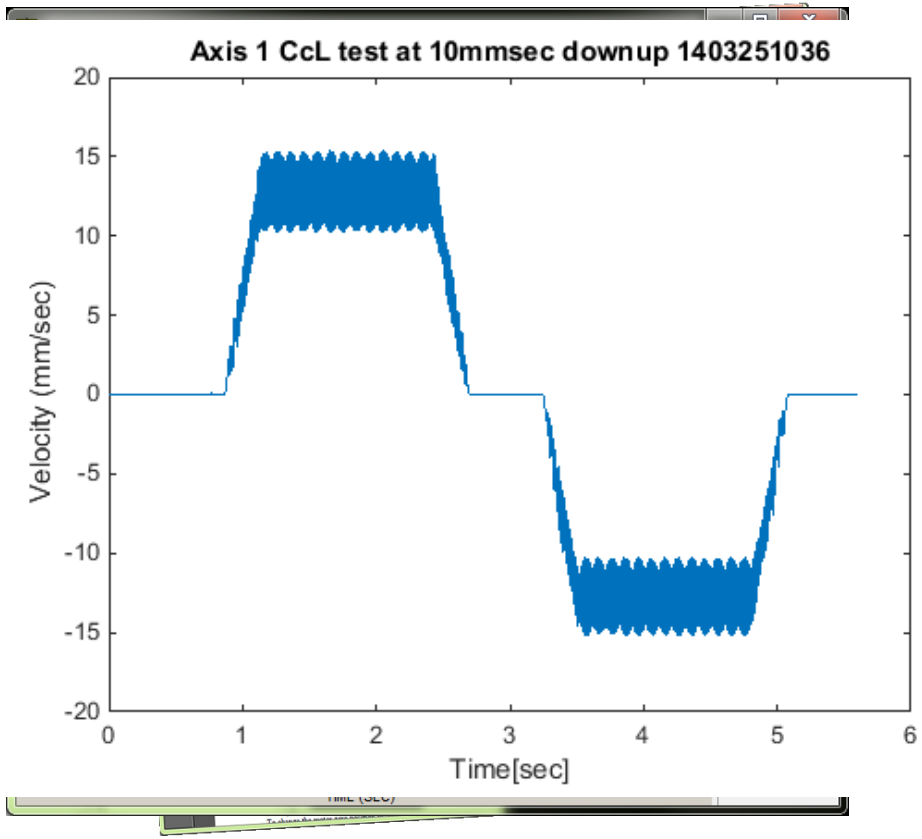


THE TRADE-OFF

Maintainability



Performance/Capabilities



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Add Motor | AddCat | Auto Edit | Step | Servo PID | VLim | CurrPID | Set Ratio

Specifications

Requirements

Design

XModel outputs

Hardware configuration

*Not Saved

Engineer Dev> 2 10

SR05ID01HW513:Z(Holder Axis 3)

Description	FullName	Value	Unit	Recommended	Deviatio	Strong	Weak	Min	Max	Pre
					1				Config Dev>	
Commutation Algorithm	a_Commutation_D	BrushlessDC	Text		-		DirectMicroStepping			
MaxPhase/PWM Frequency	b_PWMFreq_D	20	kHz		-		20			
Motor type	s_MotType_S	SM231AE-KFON		SM231AE-KFON	0.00%	SM231AE-	USR00			
Motor holding torque (Torque constant	s_MotHoldingTorque_S	0.43	Nm	0.43	0.00%	0.43				
Motor rotor inertia (best estimate)	s_MotRotorInertia_S	5.20E-05	kg.m2	0.000052	0.00%	0.000052				
Motor voltage (bipolar) at maximum	s_MotVMax_E	41.444177	volts	<64!	######		64	64		1
Design velocity precision	a_VelPrecision_U	0.4	EGU/sec		-		?			
Requiremen	a_VelHi_U	5	EGU/sec		-		10	0.4	10	
Requiremen	a_VelLo_U	5	EGU/sec		-		10	0.4	5	
Homing position and direction	a_HomingLimDir_E	MLIM_Plus			-		MLIM_Plus			
Encoder index used for homing	a_IsEncIndexHoming_E	1	Bool		-		0			
Index mark at the edge of operational	a_IsIndexOnlyHoming_E	0	Bool	0	0.00%	0	0			
Design homing velocity (absolute)	a_HomingVel_E	2	EGU/sec		-		2		2	
Current loo	a_CurrKpf_E	0.8467	mA/mA		-		0.45078	0	2	6
Servo PID P	a_ServoKp_E	4.8828125	DAC/ct		-		!			##
Instantaneous current limit	a_CurrLimInstant_E	7600	mA peak		-		7600	2	7600	0
Full stroke counts between hard limits	s_FullStrokeCts_F	104160	ct		-					1
Stage type	s_StageClass_X	Holder			-					
Actual position resolution (EPICS motor	e_MRES_X	0.001	EGU/ct		-					
Soft limit high, estimated for 2.5%	e_DHLM_X	96.962	EGU		-					
Expected maximum escape distance at	a_LimEscapeMax_X	4	EGU	>0.1!	######				0.1	
Motor Phase frequency to resonance	a_MotPhaseFreqRatioMax_X	0.3922	ratio	0.4	1.39%	0.4				4
Motor phase frequency at max	a_MotPhaseFreqMax_X	4	Hz	4.08	1.40%	4.08				
Minimum required PWM Frequency	a_PWMFreqMin_X	5.1	kHz		-				10	1
Hardware Clock Control	a_I7m03_E	2258		2258	0.00%	2258		0	4095	0
PWM Deadtime/PFM Pulse Width Control	a_I7m04_E	3		3	0.00%	3		0	255	0
Servo IC m Channel n Capture Control	a_I7mn2_E	11	bits	11	0.00%	11		0	15	0
Command Output Address	a_Ixx02_E	78012	hex	78012	0.00%	78012				
Position Loop Feedback Address	a_Ixx03_E	3503	hex	3503	0.00%	3503				
Positive Software Position Limit	a_Ixx13_E	96962	ct	96962	0.00%	96962		-1000	3.44E+10	0
Jog Speed	a_Ixx22_E	5	ct/msec	5	0.00%	5		0.001		3
Servo PID Proportional Gain	a_Ixx30_E	80000		80000	0.00%	80000		-8388608	8388607	0
Current loop Ki (x1/4)	a_Ixx61_E	0.10017		0.10017	0.00%	0.10017		0	1	8
Servo PID Friction Feedforward	a_Ixx68_E	300	ct/16	300	0.00%	300		0	32,767	0
Fault protection control bits	a_P400_x_E	291	bits	291	0.00%	291		0	32,767	0
Hold strategy PLC: Brake engage time lead	a_P716_x_E	50	msec	50	0.00%	50		0	32,767	0
Hold strategy PLC: Holding (idle) current as	a_P748_x_E	67	%	67	0.00%	66.66667		0	100	0
Actual Micro steps per motor revolution	a_MicroStepsPerRevActual_X	156.25	step/rev		-					
Xmodel output date	e_ConfigDateTime_X	14/10/2015 10:06:55	date		-					2

22	s_MotType_S	P21NRXD			-				
23	s_MotNphases_S	2	#	2	0.00%	10			
24	s_MotStepsPerRev_S	200	#		-				
25	s_MotWiring_S	BiPar			-			Config Dev>	
26	s_MotCurrRate_S	760	mA		-	pping	Max	Pre	
27	s_MotResistance_S	10.4	Ohms		-				
28	s_MotInductance_S	4.12E-02	H		-				
29	s_MotHoldingTorque_S	7.70E-01	Nm		-	64		1	
30	s_MotRotorInertia_S	1.20E-05	kg.m2		-	0.4	10		
31	s_MotDetentTorque_S	2.80E-02	Nm		-	0.4	5		
32	s_MotTorqueConst_X	1.013	Nm/Amp		-				
33	s_MotVMax_E	39.52	volts	39.52	0.00%		2		
34	s_EffectiveGearing_S	40.00	ratio		-	0	2	6	
35	s_EGU_S	mm	text		-	2	7600	## 0	
36	e_MRES_U	0.00003125?	EGU/ct		-			1	
37	e_REVERSED_U	0?	Bool		-				
38	s_EffectivePitch_S	25.4	EGU/rev		-		0.1		
64	a_PositionPrecision_U	3.18E-03	EGU		-			4	
65	a_IsEncReadbackSet_E	0	Bool		-		10	1	
66	s_IsEncDirReversed_S	0	Bool		-	0	4095	0	
67	s_IsMotDirReversed_D	0	Bool	0	0.00%	0	255	0	
68	a_IsPositionCL_E	0	Bool	0	0.00%	0	15	0	
69	a_StepDesiredRatio_E	20	ratio		-	1000	3.44E+10	0	
70	a_DesiredStepRes_E	0.00015875	EGU/step	0.00015875	0.00%	0.001		3	
71	a_MicroStepsN_E	20	#	20	0.00%	8608	8388607	0	
72	a_IsAxisScaleSpecd_X	1	Bool		-	0	1	8	
73	a_IsEncoderUsed_X	0	Bool	0	0.00%	0	32,767	0	
						0	32,767	0	
						0	32,767	0	
						0	100	0	
								2	

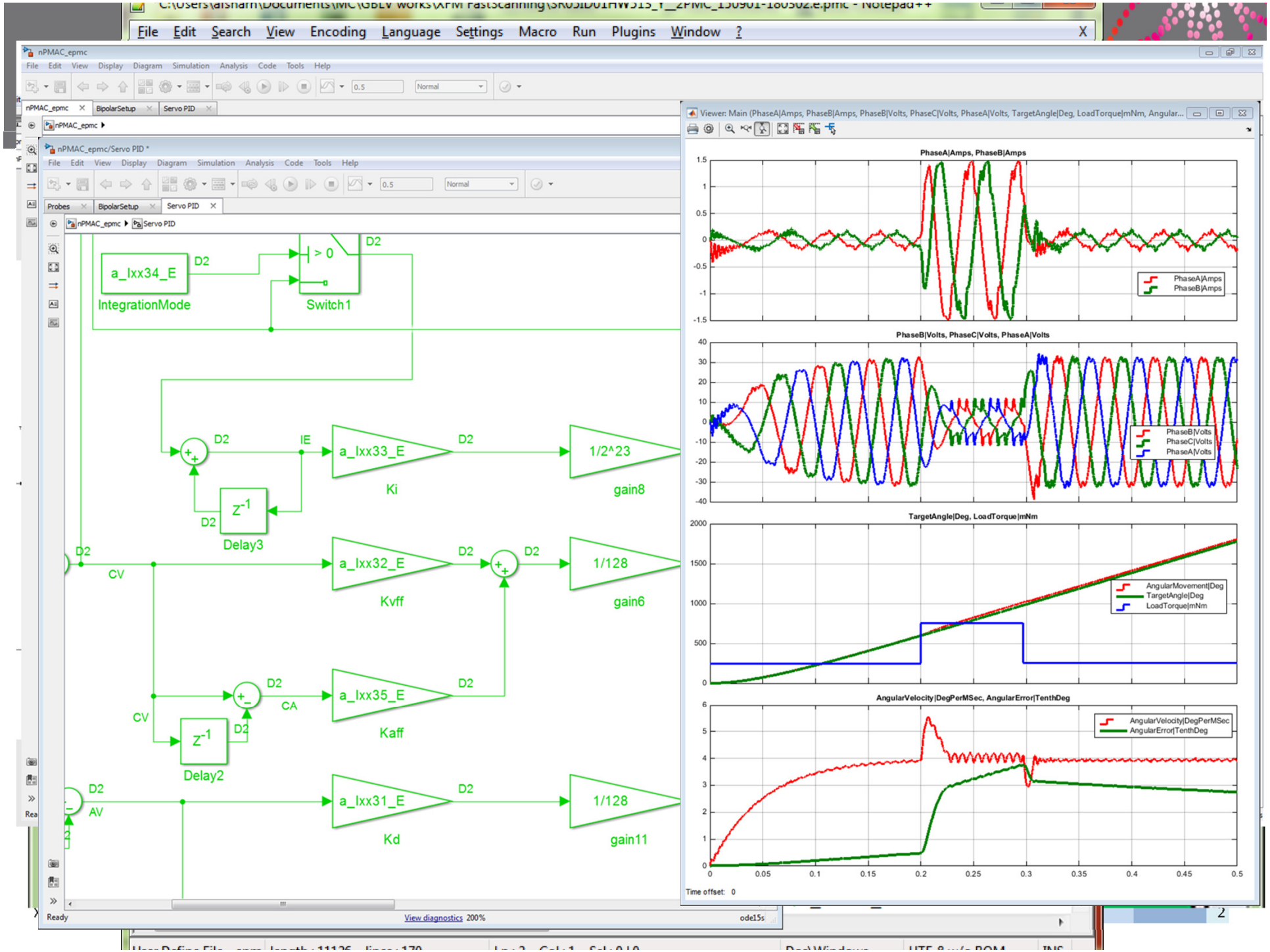
69	a_StepDesiredRatio_E	20	ratio		-
70	a_DesiredStepRes_E	0.00015875	EGU/step	0.00015875	0.00%
71	a_MicroStepsN_E	20	#	20	0.00%
72	a_IsAxisScaleSpecd_X	1	Bool		-
219	a_Ixx41_E	0	ct		-
220	a_Ixx57_E	2904	~mA	2904	0.00%
221	a_Ixx58_E	0?	~mA	0?	-
222	a_Ixx60_E	0		0	0.00%
223	a_Ixx61_E	0.1			-
224	a_Ixx62_E	2			-
225	a_Ixx76_E	0			-
226	a_Ixx64_E	0		0	0.00%
227	a_Ixx65_E	160	ct/16	160	0.00%
228	a_Ixx66_E	1453	/I7m00	1453	0.00%
229	a_Ixx70_E	1	#	1	0.00%
230	a_Ixx71_E	2560		2560	0.00%
231	a_Ixx72_E	512		512	0.00%
232	a_Ixx77_E	736	~mA	736	0.00%

C:\Users\afshar\Documents\MC\GBLV works\XPM FastScanning\SR05ID01HW513_Y__2PMC_150901-180302.e.pmc - Notepad++

File Edit Search View Encoding Language Settings Macro Run Plugins Window ?

PLC2_homing.pmc | new 1 | CS_2jack.pmc | SR00ID01USR00_MOT7__7pmC.e.pmc | SR05ID01HW513_Y__2PMC_150901-180302.e.pmc

```
;;;; SLSA MC Development & Configuration tool for TurboPMAC by Nader.Afshar@synchrotrc
;;;; Auto generated ExtendedPMAC script from X-model at 01-Sep-15 18:03 by afsharn
;>e_SBSID_P = 'SR05ID01';{SBS Prefix }
;>b_ServoClock_D = 5;kHz{Servo Clock Frequency }
;>s_EffectivePitch_S = 2;EGU/rev{Stage displacement per stage shaft turn}
;>a_HomingLimDir_E = 'NOLIM_Plus';{Homing position and direction}
;>a_IsEncIndexHoming_E = 1;Bool{Encoder index used for homing}
;>a_MicroStepsN_E = 625;#{Number of microsteps per full step (equivalent for non-step
;>a_PowerDownStgy_E = 'RunHold';text{Idle strategy}
;>a_CurrLoopNF_E = 297;Hz{Current loop tuning natural frequency}
;>a_CurrKi_E = 0.06;mA/mA/sec{Current loop tuning Ki}
;>a_ServoKd_E = 0.035095214844;DAC/(ct/Ts){Servo PID Derivative Gain}
;>s_RefPhasePosOffset_F = 0;ct/16{Offset to reference position (Ixx26) where phase pos
;>s_Ixx91_F = $EB0000;hex{Power-On Phase Position Format (Hall effect sequence)}
;>s_FullStrokeCts_F = 1014243;ct{Full stroke counts between hard limits}
;>s_StageClass_X = 'Scanner';{Stage type}
;>e_MRES_X = 0.0001;EGU/ct{Actual position resolution (EPICS motor record MRES)}
;>e_DHLM_X = 47.6948;EGU{Soft limit high` estimated for 2.5% clearance at each end}
;>a_EncPulsFreq_X = 100;kHz{Encoder pulse frequency at Max velocity}
;>a_VelPrecision_X = 0.5;EGU/sec{Best continuous controllable velocity precision}
;>a_MotResonanceFreq_X = 18.5;Hz{Motor resonance most significant harmonic frequency F
I10 = 1677653;{Servo Interrupt Time}b_I10_E
;;I30 = 1;bool{Compensation Table Wrap Enable}b_I30_E
I51 = 0;bool{Compensation Table  Enable}b_I51_E
I35 = 0;{Brick LV & Controller E-Stop Enable}b_I35_E
I65 = $50001;hex{Brick identifier}b_I65_E
I7000 = 1473;{MaxPhase/PWM Frequency Control}a_I7m00_E
I7001 = 3;{Phase Clock Frequency Control}a_I7m01_E
I7003 = 2256;{Hardware Clock Control }a_I7m03_E
I260 = 0;{Servo Cycle Period Extension Period}a_Ixx60_E
I200 = 1;{Axis enabled/disabled}a_Ixx00_E
I1000 = 1;{Companion axis enabled/disabled}a_Icc00_E
I201 = 1;2bits{Commutation enabled}a_Ixx01_E
I202 = $7800A;hex{Command Output Address}a_Ixx02_E
I203 = $3502;hex{Position Loop Feedback Address}a_Ixx03_E
I1003 = $3502;hex{Companion axis position readback address}a_Icc03_E
```


File Edit Search View Encoding Language Settings Macro Run Plugins Window ?
nPMAC_epmc
nPMAC_epmc/Servo PID *
Servo PID
a_Ixx34_E
IntegrationMode
Switch1
a_Ixx33_E
Ki
1/2^23
gain8
Delay3
a_Ixx32_E
Kvff
1/128
gain6
a_Ixx35_E
Kaff
Delay2
a_Ixx31_E
Kd
1/128
gain11
CV
CA
AV
IE
D2
Viewer: Main (PhaseA|Amps, PhaseB|Amps, PhaseB|Volts, PhaseC|Volts, PhaseA|Volts, TargetAngle|Deg, LoadTorque|mNm, Angular...
PhaseA|Amps, PhaseB|Amps
PhaseB|Volts, PhaseC|Volts, PhaseA|Volts
TargetAngle|Deg, LoadTorque|mNm
AngularMovement|Deg
TargetAngle|Deg
LoadTorque|mNm
AngularVelocity|DegPerMSec, AngularError|TenthDeg
AngularVelocity|DegPerMSec
AngularError|TenthDeg
Time offset: 0
Ready
View diagnostics 200%
ode15s

OUTCOMES