

2022

Start up procedure SV660N



INOVANCE TECHNOLOGY EUROPE

V1.4

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1 GENERAL DATA

Authors:	RSR
Date:	26.08.2022
Hardware:	SV660N
Software:	InoDriverShop v3.2.1.1
Info:	SV660N Start up procedure guide

2 PURPOSE OF THIS DOCUMENT

The purpose of this document is to facilitate the start-up and diagnosis of the SV660 servo drive. The SV660N series high-performance AC servo drive covers a power range from 50 W to 7.5 kW. It supports EtherCAT communication protocol to work with the host controller for a networked operation of multiple servo drives.

The document is divided into different sections to explain the basic wiring, communication with the diagnostic PC and the operation of the InoDriverShop program, which is used to perform the configuration and diagnostic functions of the servo drive.

In order to use the InoProShop software, you need the serial communication cable S6-L-T00-3.0, described in the section 5. Serial Communication cable.

3 REVISION HISTORY

Revision	Date	Author	Description	
1.2	4 February 21	RSR	First release	
1.3	5 March 21	RSR	The following sections have been added:	
			6.5.4 Comparison	
			6.8.1 EtherCAT position interpolation	
			7 Axis Scaling	
			8 Absolute encoder system	
			9.4 CiA402 Object Dictionary	
1.4	26 August 21	RSR	The following sections have been added:	
			8.2 Data range in the absolute position linear mode	
			6.6.4 Inertia ratio calculation	
			The following sections have been modified:	
			6.4.4 Motor parameters	
			6.6.2 STUNE	

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4 WIRING & COMMUNICATION



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4.1 CONNECTION OF STO TERMINALS

This section describes the definition and functions of the I/O terminal (CN6) for the safe torque off (STO) functional safety function.

Two isolated inputs are configured to dual-channel inputs of STO function: STO1/STO2.

To make it more convenient and safe for installation, an additional pin with supply voltage (+24V) is integrated. The bridging of the 24 volts is needed in case the safety circuit is installed but no STO function is needed.

NOTE The servo drive can operate normally only if the input status of STO1 and STO2 are both "1" or "H". If the input status of either STO1 or STO2 (or both) is "0" or "L", the servo **drive cannot run**.



Terminal	Pin No.	Name	Value	Description
	1	СОМ	0 V	STO reference ground
CNG	2	24V	24 V	24 V power supply
CINO	3	STO1	-	Control input for STO1
	4	STO2	-	Control input for STO2



Figure 1. Example of external 24 V connection

Figure 2. Example of internal 24 V connection



5 SERIAL COMMUNICATION CABLE

The cable used to connect the SV660N with the computer is S6-L-T00-3.0. It is a DB9 (PC side) to RJ45 (drive side) cable. The physical layer is according to RS232 communication.

Model Number: S6-L-T00-3.0

Material Code: 15041243



Figure 1. Connection relation between the servo drive and PC communication cable pins

RJ45 on Servo	Drive Side (A)	DB9 on PC Side (B)				
Signal Name	Pin No.	Signal Name	Pin No.			
RS232-TXD	6	PC-RXD	2			
RS232-RXD	7	PC-TXD	3			
GND	8	GND	5			
PE (shield)	Enclosure	PE (shield)	Enclosure			

Figure 2. Pin definition of DB9 ("B" in the preceding figure) on the PC side

Pin No.	Definition	Description	Terminal Pin Layout
2	PC-RXD	PC receiving end	
3	PC-TXD	PC transmitting end	
5	GND	Ground	
Enclosure	PE	Shield	

A female USB / RS232 converter will be needed if your computer is not equipped with a RS232 serial port.



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6 INODRIVERSHOP

InoDriverShop is the commissioning and diagnostic tool for SV660N drives series. This document explain the InoDriverShop version v3.2.1.1

6.1 INSTALL AND EXECUTE INODRIVERSHOP

This program does not need to be installed. Unzipping the file in a folder on your computer is enough to run it. Once the file has been decompressed in the resulting folder, the executable InoDriveShop appears. Executing this file opens the user environment.

📕 🛃 ਵ InoDriveWorkshop_3.2.1.2_Overse	as			_	\times
File Home Share View					~ ?
← → · ↑ 🖡 « InoDriv > InoDriveWork	shop_3.2.1.2_Overseas	・ ひ 🔎 Search In	noDriveWorkshop_3.2.1	.2_Overseas	
Name	Date modified	Туре	Size		^
InoCommunication.dll	31-Dec-19 8:43	Application extension	30 KB		
InoContinuousOscWrapper.dll	20-Mar-20 2:02	Application extension	81 KB		
100DriverShop	02-Mar-20 3:30	Application	383 KB		
InoFFTAlgorithm.dll	27-Feb-20 4:53	Application extension	17 KB		
InoFFTChannelControl.dll	27-Feb-20 4:48	Application extension	17 KB		
InoFFTChannelControlWrapper.dll	27-Feb-20 4:53	Application extension	82 KB		~
211 items					

6.2 CREATE A NEW PROJECT

To create a new project, click on the new project icon or the command from the start screen:

	InoDriverShop - Home Page	- 🗆 ×
General Project	1. Start Sta	UI Style 🔻
New Open Close Save Connect Disconnect Loc device	el Remote grassistant account	
Project Network communciation De	bug mode User management	
Work Space 4	🔁 Home Page 🔳	
	File operation Open Project Recent project V Close home page after opening p	
Param Monitor	oursectual Unit	4 🖬
No Produer name runcion C Description		Sustem Time 2020.11.09 16-FE-2E
		system nine 2020-11-09 16:55:25

The corresponding dialog to select the type of drive is show. It is possible to create a new project online or offline. The offline project allows you to create a project without being connected to the computer.

If you connect with the drive, select the appropriate communication parameters. Connect the servo drive and the PC by using the PC communications cable.

The default parameters of the SV660N are:



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- Communication: Serial port
- Baud Rate: 115200
- Data bit:8
- Check bit: none
- Stop bit: 1



Select the corresponding drive model (in this case SV660N) and click "Next Page" button.

The next image shows the dialog for scanning drives:

- 1. When the dialog opens, the scan of the devices starts automatically. But using this buttons it is possible to start and stop the scanning procedure.
- 2. In this text box there is the range node Id to search devices. Usually the drive uses no Id 1
- 3. When a device is detected it is shown in this list.
- 4. This message shows when the search ends
- 5. Name of the project
- 6. Folder where project is stored

Select the SV660N Drive which connected on the serial port communication and define the project name then press the button "Finish"

Device	List					2			~		
egin s	canning S	top scanning	Slave	ld 1		- 15					
Ro 7 01	Object name SV660N	Object type SV660N	Slave Id 1	Baud rage 115200	Version 13.26	3					
Object	1		Scan finis	hed. 🕢							
Project	dir										
Projec	name:	NewProject202	0-11-09				5				
Storag	e path:	C:\Documents	Software\InoL)riveShop\Inc	DriveWorks	hop_3.2	.1.2_Overs	eas	6		٩



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6.3 USER INTERFACE

The main screen is divided into three sections:

- 1. Buttons to access the most common functions
- 2. Project tree, where it is possible to access all the program options
- 3. This section shows the different screens of the program
- 4. Parameter monitor.

	InoDriverShop - [SV660N]Position JOG	- D X
eneral Project SV660N ergency Cancel stop ermergency stop Control	er to Rotation value direction General	UI Syle Fault Mechanical Peram Continuous Multi-machine Z Signal Function Function
rk space 2 2 Project 2 rvs60cn 2 Continuous 0sc Continuous 0sc Continuous 0sc Continuous 0sc Param Monitor Param Monitor Param List - Usability adjustment 0 10 Sotting HSpeed JOG - Postiton JOG - Russhort parameters - Ruscharical analysis Dedicated parameters - Ruscharical analysis Device Information - Fault Management - Reset to zero	SV660N(1)Paramilist (* ISV660N)Position JOG (* Choose axis Axis) (* STEP1-Enable Rotating (* Constraint) (* Con	Solution tracking
am Monitor Module Name Function c Descrip 1 SY6000[11][1] H08-46 Feedfor 2 SY6000[11][1] H08-76 Model 3 SY6600[11][1] H08-70 Spred 4 SY6600[11][1] H08-70 Spred 5 SY6600[11][1] H09-70 Stiffn 6 SY6600[11][1] H09-70 Gain a 7 SY6600[11][1] H09-70 Spred 5 Sy6600[11][1] Spred 5 Sy6600[11][1] H09-70 Spred 5 Sy6600[11][1] Spred 5 Sy6600[11][1] H09-70 Spred 5 Sy6600[11][1] Spred 5 Sy6600[1] Spred 5 Sy6600[1] Spred 5 Sy6600[1] Spred 5 Sy6600[1] Spred	i Bon Yward value 20in Toop gwin te position counter ess level ute-tuning mode Feedfaymawd eain	Qurent value 95,0 40,0 40,0 115,0 207240015 200 3[Interpolation mode+Inertia suto-tuning] 0 0 0 System Time 2021-01-26 09:17:30

By dragging the tabs it is possible to organize the different windows or sections of the program as shown in the following image:

imergency Cancel stop emergency stop Program Re reset defe Control	Cover to Rotation ult value direction	Anical Peram Confinuous Multi-machine Inertia Network ysis List Occ	
bot Space 2 Project Project 2000-11-00 Control of the second	Operation Dependencies Dependencies Dependencies		Choose and Asia Speed 300 Conse and Asia Speed 300 Conse and Asia Speed 300 JOG acceleration Soft
: >	Var count: 329 Current var: 329	Operating Taxene and ever a working of the second s	***
o Module Name Function c Des	orption ourrent val Unit		Section Time 2020-11-09 20:43-14



6.4 COMMISIONING AND OPERATION



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The following figure shows the general procedure for axis commissioning:

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6.4.1 POWER SUPPLY

Switching on the input power supply

The input terminals for single-phase 220 V power supplies are L1 and L2.

The input terminals for **three-phase power supplies** are L1C/L2C (control circuit power input terminals) and R/S/T (main circuit power input terminals)

After switching on the input power supply, if the bus voltage indicator is in normal status and the keypad displays "reset" \rightarrow "ry" in sequence, it indicates the servo drive is ready to run and waits for the S-ON signal to be sent from the host controller.

First status after power up. After initialization or reset is done, the servo drive automatically switches to other status.
The servo drive is ready to run and waits for the S-ON signal to be sent from the host controller.
STO enabled. Connect the STO1 and STO2 to the 24 V input voltage signal to switch to "Ready" state

6.4.2 FACTORY DEFAULT

The factory default parameters of the drive can be restored through the software InoDriverShop or with parameter "H02-31 System parameter initialization" changing the value from 0 to 1.

General	Project	SV660	N														
	0		6	P,	5	S	8	Ø	[III]	ı← →I	\oplus	\wedge	-2	=	<u> </u>	P	×
Emergency stop	Cance emergency	el / stop	Program reset	Recover to default value	Rotation direction▼	Connet I	Disconnect N	Nodify station number	Inertia identification	Tuning	IO Setting	Fault Management	Mechanical analysis	Param List	Continuous Osc	Multi-machine recipe	e Z Signal Search
		C	Control				General						Function				
						Inc	oDriverSl	hop Restore d	efault sett	ings?	×						
								<u>Y</u> es	1	<u>l</u> o							

Some parameters need to be effective after powered on again. The parameters can be validated by software reset. So, it is recommended to do a software reset after restore factory default parameters

General	Project SV6	50N														
		6	0	•	S	8	Ø	- (H)	ı← →I	\oplus	\wedge	-2		<u> </u>	P	×
Emergency	Cancel	Program	Recover to	Rotation	Connet D	Disconnect	Modify station	Inertia	Tuning	10 Setting	Fault	Mechanical	Param	Continuou	s Multi-machin	e Z Signal
stop	emergency stop	Teset	leiault value	direction.			number	identification		setting	wanagement	analysis	LISU	OSC	recipe	Search
		Control				Gener	al					Function				

6.4.3 JOGGING

The jog function can be started using the keypad (jogging in the speed mode/jogging in the position mode) or Inovance software tool (jogging in the speed mode).

1. Open Jog screen





- 2,3. Change speed and acceleration values
- 4. Enable drive (S-ON signal)
- 5,6. Move forward and reverse in jog mode

	InoDriverShop - [SV660N]Speed JOG	-		~
General Project SV660N	79		UI Styl	/le •
General Project Stefon Finite Cancel stop emergency stop Program Project	Recover to Retation Funing Fault ID Management Setting Fault ID Management Fa		UI Style	×
	Param Monitor		4	
	Ro Module Name Function c Description current val Unit			
< >				
	System Ti	me 2020-11-	-09 21:14:41	



6.4.4 MOTOR PARAMETERS

If the motor belongs to INOVANCE MS1 Series Servo Motor, the parameters are stored in the encoder. Therefore, it is not necessary to configure the motor parameters, but it is important to verify that the parameter "H00-00 Motor Code" corresponds to the motor code indicated on the nameplate.

6.4.4.1 NAMEPLATE AND MODEL





Parram.	Name	Range												
H00-00	Motor code	14000 Inovance n Encoder resolutio 14101 Inovance n Encoder resolutio	 14000 Inovance motor with incremental encoder. Encoder resolution: 1048576 (2²⁰) 14101 Inovance motor with absolute encoder. Encoder resolution: 8388608 (2²³) 											
H00-05	Serial- type motor code	The definition of I For example, 114 11101 means 100	he definition of H00-05 shown as below table. or example, 11408 means 750W MS1 H4 series motor with serial bus encoder without PTC. 1101 means 100W MS1 H1 series motor with serial bus encoder without PTC.											
		Ten thousands digit	Thousands digit	Hundreds digit	Tens digit	Units digit								
		Platform version	Encoder type	Motor series	Power rat the rc prin	ting (follow ounding ciple)								
		1-first generation	1-serial bus without PTC 2-serial bus with PTC	1-H1 series 220V 2-H2 series 380V 3-H3 series 380V 4-H4 series 220V 8-H2 series 220V 9-H3 series 220V	Power rat power For exam is 01, 75	ting digits = (W)/100 iple, 100W 50W is 08								
		product 2-second generation product	5-non serial bus without PTC 6-non serial bus with PTC 7-resolver without PTC 8-resolver with PTC	5-G1 series	power rat power	ing digits = (kW)/1								
				6-G2 series	power rat power for exam is	ing digits = (kW)/10 ple, 31 kW 03								

6.4.4.2 MOTOR SAMPLE

INOVANCE AC Servo Motor	
Model: MS1H1-40B30CB-A334Z-INT Pn (kW) 0.4 Un (V) 220 In (A) 2.8 Nn (r/min) 3000 Tn (N m) 1.27 Duty S1 fn (Hz) 250 IP67 3PH AC Motor Code: 14101 Mass: 1.48 kg	
SN: 011115374M300001 Made in P.R.C. Suzhou Inovance Technology Co., Ltd Address NO.16, Youxiang Road, Yuexi Towri, Wuzhong District, Suzhou 215104, P.R. China	

	Eramo Sizo	Rated	Rated	Rated Maximum		Maximum
Model	(mama)	Output	Torque	Torque	Current	Current
	(mm)	(kW) ^[1]	(N · m)	(N · m)	(Arms)	(Arms)
MS1H1-40B30CB	60	0.4	1.27	4.46	2.8	10.10

Encoder Type A3: 23 bit Multi-turn absolute encoder

Rated Voltage H00-09 = 220 V

Rated Power H00-10 = 0.4 kW

Rated Current H00-11 = 2.8 A

Rated Torque H00-12 = 1.27 Nm

Max. Torque H00-13 = 4.46 Nm

Motor Code H00-00 = 14101

Parameter Group Customized System	Upload and save (Current page all)	Upload and save (All tick options) Open recip	e Save setting (All tick option	IS (Except g H00 and	all Write all to roups options (cur H01) page)	ck rent Ca	ompare	elect all (curre	∽ General user ∽
[3] Arisi Arisi S. 1980 [Servo motor parameters] ** Aris 1.900 [Servo drive parameters] ** Aris 1.900 [Servo drive parameters] ** Aris 1.900 [Servinia] nutry parameters] ** Aris 1.906 [Sevinia notrol parameters] ** Aris 1.906 [Sevinia notrol parameters] ** Aris 1.906 [Sevinia notrol parameters] ** Aris 1.906 [Sevinia notrotic parameters] ** Aris 1.906 [Daviliar] contection parameters] ** Aris 1.906 [Laxillar] renotice parameters] ** Aris 1.910 [Laxillar] renotice parameters]	Axis Id Function Axis I H00-00 Axis I H00-02 Axis I H00-04 Axis I H00-06 Axis I H00-07 Axis I H00-07 Axis I H00-08	c. Description Motor SN Customized No. Encoder version Serial encoder motor SN FPGA customized No. STO version Serial encoder type	Setting value 14101 14101 14101 14101 14101 14101 14101 1410	current value 14101 0,00 2312,7 111104 0,00 90,10 14100	Default Value 14101 0.00 0.0 0.00 0.00 0.00 0 0	Minimu. 0 0.00 0.0 0 0.00 0.00 0 0	Maximum value 65535 4294967295.00 6553.5 65535 655.35 655.35 655.35 65535	Unit Modified type Downtime modifi No modificatic No modificatic No modificatic No modificatic No modificatic	Effective ication Power on m m m m

rk Space 4	SV660N]	Motor Parameters 🔟										
Project	Choose axis:	Axis1	~	Open files	Save files	Upload all paramete	Write cl	heck param	e Motor a	ingle initial	iz	
> Open Param File	Row Index	Parameter Id	Parameter Name			Parameter Value	Default	Minimu	Maximum v	Unit	Modified Type	Show
-CalContinuous Osc	001	H00-09	Rated voltage			0[220 V]	0	0	1		Downtime modification	Decir
- Charles - Char	002	H00-10	Rated power			0.40	0.75	0.01	655, 35	kw	Downtime modification	Decir
🕘 Trigger Setting	003	H00-11	Rated current			2,80	4,70	0.01	655, 35	A	Downtime modification	Deci
- Param Monitor	004	H00-12	Rated torque			1.27	2.39	0.10	655, 35	Nm	Downtime modification	Deci
SV660N[1]	005	H00-13	Max, torque			4.46	7.16	0,10	655, 35	Nm	Downtime modification	Deci
- Param List	006	H00-14	Rated speed			3000	3000	100	6000	rpm	Downtime modification	Deci
-≒ Usability adjustment	007	H00-15	Max. speed			6000	6000	100	6000	rpm	Downtime modification	Deci
- IO Setting	00S	H00-16	Moment of inert	ia		0.38	1.30	0.01	655, 35	kg c m'	Downtime modification	Deci
- Speed JOG	009	H00-17	Number of pole	pairs of PMSM		5	5	2	65535		Downtime modification	Deci
- Position JOC	010	H00-18	Stator resistan	ce		1.970	0.500	0.001	65.535	Ω	Downtime modification	Deci
Bus motor parameters	011	H00-19	Stator inductan	ce Lq		8.71	3.27	0.01	655, 35	mH	Downtime modification	Deci
& Mechanical analysis	012	H00-20	Stator inductan	ce Ld		8.71	3.87	0.01	655.35	mH	Downtime modification	Deci
-12 Dedicated parameter list	013	H00-21	Linear back EMF	coefficient		32.00	33.30	0.01	655, 35	mV/rpm	Downtime modification	Deci
Contrast output	014	H00-22	Torque coeffici	ent Kt		0.45	0.51	0.01	655.35	Nm/Arms	Downtime modification	Deci
- 🜍 BlackBox	015	H00-24	Mechanical cons	tant Tm		0.50	0.24	0.01	655, 35	ms	Downtime modification	Deci
Device Information	016	H00-28	Absolute encode	r position offset		11814	8192	0	4294967295		Downtime modification	Dec:
-A Fault Management	017	H00-30	Encoder selecti	on (Hex)		0x0013[0x13: I	19	0	4095		Downtime modification	Hexi
+ Reset to zero	018	H00-31	Encoder PPR			8388608	8388608	1	1073741824	p/Rev	Downtime modification	Dec:
	019	H00-37	Absolute encode	r function setting	bit	0x0000	0	0	65535		Downtime modification	Hexa
	020	H00-60	Rated motor cur	rent		65535	0	0	65535		Downtime modification	Dec
	021	H00-61	Brake close tim	ie		65535	0	0	65535	ms	Downtime modification	Dec
	022	H00-63	Max. motor curr	ent		42949672.95	16.95	0.00	65535.00	A	Downtime modification	Dec
	023	H00-73	Bit01 of motor	SN code		OxFFFF	0	0	65535		Downtime modification	Hexa
	024	H00-74	Bit23 of motor	SN code		0xFFFF	0	0	65535		Downtime modification	Hexa
	025	H00-75	Bit45 of motor	SN code		OxFFFF	0	0	65535		Downtime modification	Hex
	026	H00-76	Bit67 of motor	SN code		OxFFFF	0	0	65535		Downtime modification	Hexa
	027	H00-77	Bit89 of motor	SN code		0xFFFF	0	0	65535		Downtime modification	Hex
	028	H00-78	Bit11 of motor	SN code		0xFFFF	0	0	65535		Downtime modification	Hexa
	029	H00-79	Bit13 of motor	SN code		0xFFFF	0	0	65535		Downtime modification	Hexi
	030	H00-80	Bit15 of motor	SN code		OxFFFF	0	0	65535		Downtime modification	Hexa
	031	H00-98	Motor attribute	check		0x0000	0	0	65535		Downtime modification	Hex
	032	H01-22	D-axis coupling	voltage compensatio	on coefficient	100.0	50.0	0.0	1000.0	5	Any modification	Dec
	033	H01-23	Q-axis back EMF	compensation coeff.	icient	100.0	50.0	0.0	1000.0	%	Any modification	Dec
	034	H01-24	D-axis current	loop gain		700	500	0	20000	HZ	Any modification	Dec:
	035	H01-25	D-axis current	loop integral compen	nsation factor	2.00	1.00	0.01	100.00		Any modification	Dec
	036	H01-27	Q-axis current	loop gain		400	500	0	20000	HZ	Any modification	Dec
	037	H01-28	Q-axis current	loop integral compet	nsation factor	2.00	1.00	0.01	100.00		Any modification	Dec
	038	H01-39	Current loop ve	rsion No.		0x0000	0	0	65535		Downtime modification	Hex
	039	H01-52	D-axis proporti	onal gain in perform	mance priority mode	900	2000	0	20000	HZ	Any modification	Dec
	040	H01-53	D-axis integral	gain in performance	e priority mode	2,00	1.00	0,01	100,00		Any modification	Deci
	041	H01-54	Q-axis proporti	onal gain in perform	mance priority mode	900	2000	0	20000	HZ	Any modification	Deci
	1.042	1001-55	Quarie interral	min in performance	and and the mode	2.00	1.00	0.01	100.00		Ann medification	Deed





6.5 PARAMETER MANAGEMENT

6.5.1 BACKUP

Following this procedure we can make a backup copy of the drive parameters.

- 1. Click on "Param List"
- 2. Select the axis group
- 3. Click on "Upload and save (Current page all)"
- 4. The following message appears. Select whether the parameters H00, H01 should be saved in the parameter file.



5. Select the file to save the parameters

General Project SV660N				UI Style
Cancel Cancel Program Recover to R Restriction of the status of the stat	otation Connet Disconnect Modify static	Intria Tuning O Fault Mechanical Param Cor Identification	tinuous Multi-machine Z Sigr	nal
Control	General	Function	ose recipe seure	
		(UILIO)		_
		3		
Project Pare sv660n Cu b Open Param File	umeter Group Istomized Up Gain adjustment (Cu	load and save Upload and save or call tick options) Open recipe Save settings (All tick options)	Write all Write (Except groups options H00 and H01) pa	all tick VS (current Compare ge)
- Continuous Osc	Gain adjustment ALL	Ax Func Description	Setting value current value	Defa Minimu
Trigger Setting	ystem	A., HO Motor SN	14101	14101 0
Param Monitor	Axisl	A. HO Customized No.	0.00	0.00 0.00
= SV660N[1]	Axis 1/H00 [Servo motor para	A. HO Encoder version	2312.7	0.0 0.0
- Param List	Axis 1/H02 [Basic control par	 nu perial encoder motor by H0 EPCA sustamized No. 	0.00	0 00 0 00
→ Usability adjustment	Axis 1/H03 [Terminal input pa	A. HO STO version	90, 10	0,00 0,00
w IU Setting	Axis 1/H04 [Terminal output]	A., H0 Serial encoder type	14100	0 0
⇒ Position IOG	Axis 1/H06 [Speed control parts	A HO MCU software version	902.3	0.0 0.0
Bus motor parameters	Axis 1/H07 [Torque control p	A HO FPGA software version	902.7	0.0 0.0
-@ Mechanical analysis	🖶 Axis 1/H08 [Gain parameters]	A HO Servo drive series No.	3[S2R8]	3 0
- Dedicated parameter list	Axis 1/H09 Gain auto-tuning	A., HO Voltage class of the drive unit	220	220 0
Contrast output	Axis 1/HOB Monitoring parame	A. HU Kated power of the servo drive	0.40	0.40 0.00
BlackBox	Axis 1/HOD [Auxiliary function]	HO Rated output current of the servo drive	2.80	2 80 0.00
Device Information	Axis 1/HOE [Communication fu	A. HO Max. output current of the servo drive	10.10	10.10 0.00
+ Reset to zero	Axis 1/H18 [Position compari]	A., HO DC bus overvoltage protection threshold	420	420 0
These to serv	CARIS I/HIS CHArger position	A HO Control mode selection	9[EtherC	9 0
		A. HO Absolute system selection	0[Increm	0 0
		A. HO Rotation direction selection	0L CCW di	0 0
		A. HO Stop mode at No. 2 foult	UL Coast	0 -3
		HO Stop mode at overtravel	1[Stop a	1 0
		A. HO Stop mode at No.1 fault	2[DB Sto	2 0
		A. HO Delay from brake output ON to command received	250	250 0
		A HO Delay from brake output OFF to motor de-ener	150	150 50
		A HO Motor speed threshold at brake output OFF in	30	30 20
		A. HO Delay from S-ON OFF to brake output OFF in r	500	500 1
		A. HU Warning display on the keypad	01 Output	0 0
		 Ho Power of huilt-in regenerative resistor 	50	0 0
		A. HO Resistance of built-in regenerative resistor	50	0 0
		A. HO Resistor heat dissipation coefficient	30	30 10
		A HO Regenerative resistor type	3[No res	3 0
		A. HO Power of external regenerative resistor	40	40 1
		A. HO Resistance of external regenerative resistor	50	50 15
		A. HU User password	0 0[No	0 0
		A. HO Selection of parameters in group HOR	50	50 0
		A., HO Keypad data refresh frequency	0	0 0
		A., HO Factory password	0	0 0
		A HO DI1 function selection	14[Posit	14 0
<	, []	A. HO DI1 logic selection	0[Normal	0 0
If y	ou need to operate, please enter the factory password (fi	anction code H0241)! No	Update Differe	nt with
			Dillelei	n mut



6.5.2 RESTORE

This procedure shows us the steps to restore the drive parameters from a backup file:

- 1. Click on "Param List"
- 2. Click on "Open recipe". The parameter file values are showed in the "Setting value" field
- 3. Click on "Write all (Except groups H00 and H01)". A progress bar show the downloading process status



The following message appears. It is recommended to reset the drive after downloading parameters. Click on Yes to reset the drive software.

Yes No a fight Yes No Organization of the state o		InoE	Some param again. The pa Click 'Yes' to Note: Groups please modify	eters need to be rameters can be reset the softwar H00 and H01 a r them carefully,	effective after validated by s re; otherwise, c re manufacture	being pow oftware res lick 'No' er paramete	ered on set: ers,	×				
Project VARN Varnet			-		⊻es		No					
Mail Projet S4600 USA Statest Second Statest Statest Second Statest Statest Second Statest Statest Second Statest Statest Statest Second Statest States			InoDriverShop - SV660	N[1]Param List							- □	
Prove Carlo Prove Research Laboration Prove Research Laboration Provide Carlo Prove Research Laboration Prove Research Laboration Provide Carlo Pro	neral Project SV660N			Fat 7 14		-	c1-13	_	-	•7		UI Style
Control Central Function Project ************************************	rgency Cancel stop emergency stop	r to Rotation value direction	isconnect Modify station number	Inertia Identification	g IO Fault Setting Managen	Mechanie nent analysis	cal Param	Continuous Mul Osc	ti-mach recipe	nine Z Sigr Searc	al h	
Project Stronger Decide and saw Decide and saw <thdecide and="" saw<="" th=""> Decide and saw</thdecide>	Space 4	SV660N[1]Param List	General			Functio	n					
Open rate in File Descentions Parameters Percentions Descentions Descentions <thdescentions< th=""></thdescentions<>	Project ▶ sv660n	Parameter Group	Upload and sa (Current nace	ve Upload and sav	e Open recipe	Save se	ttings	Write all 3 Except groups	Wroptio	ite all tick ns (current	VS Compa	re - /
Trigger Setting ## Aris 1/B01 [Servo friv X. H0. Speed loop gain 135.9 115.0 40.0 0.1 2000.0 His Arr Imm Paras Booltor ** A. H0. Speed loop gain 135.9 105.0 10.5 115.00 10.0 His Arr Imm ** Stability adjustment ** A. H0. Fostion loo. 135.9 106.1 10.61 0.1 2000.0 His Arr Imm ** Aris 1/B01 [Gain parts ** A. H0. Fostion loo. 135.9 105.0 40.0 0.1 2000.0 His Arr Imm ** Aris 1/B01 [Gain parts ** A. H0. Fostion loo. 10.0 10.1 10.1 10.1 10.1 10.1 10.1 10.1 10.0 10.0 0.0 10.0 0.0 10.0 0.0 10.0 0.0 10.0 0.0 10.0 0.0 10.0 0.0 10.0 0.0 10.0 0.0 10.0 0.0 10.0 0.0 10.0 0.0 10.0 0.0 10.0 0.0 10.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	- Continuous Osc - Open wave data file	Axis 1/H00 [Se	rvo mote _ Ax Func	Description	Setting value cu	rrent value	Defa Mir	H00 and H01) himu Maximu	Unit	page) Modifi I	Effecti	
SPECON11 Transit J Mos 1 (Franki J VL. HD., 2nd speed 10 10.5, 9 106.8 64.0 0.1 2000.0 HE Arry Imm Utability adjuttent VL. HD., 2nd speed 10 10.6 10.5 0.5.0 0.1 2000.0 HE Arry Imm Within J Mos 1 (Franki J VL. HD., 2nd speed 10 10.6 10.61 10.61 10.61 0.15 512.00 ms Arry Imm Prosition JOC Within J Mos 1 (Franki J VL. HD., 2nd speed 10 10.6 10.61 10.61 0.01 10 Arry Imm Prosition JOC Within J MOS 1 (Franki J VL. HD., 2nd speed 10 10.6 10.61 10.61 0.01 10 Arry Imm Prosition JOC Within J MOS 10000 Contrast 1000 Contrast 1000 10 Arry Imm Within J MOS 10000 Ma Arry Imm Backnoin Jandysis Within J MOS 10000 Contrast 1000 Contrast 1000 Contrast 1000 Contrast 1000 Arry Imm Backnoin Jandysis Within J MOS 100000 Within J MOS 100000 Within J MOS 100000 Arry	Trigger Setting	Axis 1/H01 [Se Axis 1/H02 [Be	ervo driv 🗹 A HO asic cont 🔽 A HO	Speed loop gain Speed loop i	135.9 11 5.85 10	15. 0). 50	40.0 0. 19.89 0.	1 2000.0 15 512.00	Hz ms	Any	1mm 1mm	
The limit of adjustment of the limit	SV660N[1]	Axis 1/H03 LT	erminal i A. HO erminal c A. HO	Position loo 2nd speed lo	135.9 10 75.0 75)6. 8 5. 0	64.0 0. 75.0 0.	1 2000. 0 1 2000. 0	Hz Hz	Any	Imm Imm	
• D adding • A. BD • A	- Usability adjustment	Axis 1/H05 [Po Axis 1/H06 [Sp	peed cont	2nd speed lo 2nd position	10.61 10 120.0 11	0.61 20.0	10.61 0. 120.0 0.	15 512.00 1 2000.0	ms Hz	Any	Emm Emm	
The point of the second secon	- Speed JOG	Axis 1/H07 [10	ain param A. HO	2nd gain mode Gain switcho	1[Switch 1] 0[Fixed 0]	Switch	1 0	1		Any	Imm	
- Mechanical analysis - Mechanical anal	- Ma Bus motor parameters	Axis 1/H09 [G	ault and	Gain switcho	5.0 5.	0	5.0 0.0	0 1000.0	ms	Any	[mm	
Cottrast output ■ Main J Phe Lomminical ↓ h. B 0.0 3.0 3.0 0.0 100.0 m m m. ● BlackBox ■ Device Information ↓ h. B Device Information ↓ h Device Information ↓ h Device Information ↓ h Device Information	-® Mechanical analysis - Dedicated parameter list	Axis 1/HOD [A	axiliary A. HO	Gain switcho	30 30	,	30 0	20000		Any	Lium	
• Device Information • Fault Management • Reset to zero • Reset to zero • Asis 1/H19 (larget pol V.A. Bb Speed feedfor 0. 50 0.50 0.50 0.00 4.0 mm Any Imm V.A. Bb Speed feedfor 0. 50 0.50 0.00 6.0 mm mm • Asis 1/H19 (larget pol V.A. Bb Speed feedfor 0.0 0.0	Contrast output BlackBox	Axis 1/H0E LCG	osition c A. HO	Position gai Load moment	3.0 3. 9.15 11	0 2.34	3.0 0.1 1.00 0.1	0 1000.0 00 120.00	ms	Any	l mm I mm	
* Reset to zero V.A. BD Speed feedf	Device Information Fault Management	AXIS 1/HI9 [14	A. HO	Zero phase d Speed feedfo	0.0 0. 0.50 0.	0 50	0.0 0.0	0 4.0 00 64.00	ms ms	Any	lmm lmm	
4. BD Torque feedf 0.0 0.0	+ Reset to zero		A., H0	Speed feedfo Torque feedf	0.0 0. 0.50 0.	0 50	0.0 0.0	0 100.0 00 64.00	% ms	Any	Emm Emm	
C.A., HD, Curdf frag, S000 8000 100 9000 HZ Arr Imm C.A., HD, DPDF control 100 100 0100 0.0 0.0 0.0 HA C.A., HD, PDFF control 100 170 170 170 50 600 HZ Arr Imm C.A., HD, Dirtitomen 100 100 100 100 HA Arr Imm C.A., HD, Speed observ 0.0 0.80 0.80 0.80 100 HA Arr Imm C.A., HD, Disturbance 600 600 600 100 HA Arr Imm C.A., HD, Disturbance 00 0 0 100 HA Arr Imm C.A., HD, Speed observ 0.0 0 0 0 1000 HA Arr Imm C.A., HD, Incritia corr 100 100 0 1000 HA Arr Imm C.A., HD, Speed observ 0.0 0 0 0 1000 HA Arr Imm C.A., HD, Speed observ 0.0 0.0 0.0			A. HO	Torque feedf Speed feedba	0.0 0.	0 Moving.	0.0 0.0	0 300.0	*	Any	Imm	
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K. BD Intertia corr 100 100 100 100 % Ary Imm K. BD Phote modula 0 0 0 0 90 90 M. Ary Imm K. BD Prequency of 0 0 0 0 0 000 H. Ary Imm K. BD Comparation 0 0 0 0 0 0 Ary Imm K. BD Comparation 0 0 0 0 1 Ary Imm K. BD Soled observ 1[Enable] 0 1 Ary Imm K. BD Model sain 375.8 40.0 40.0 0.1 Ary Imm K. BD Model main 375.8 40.0 0.0 300.0 HZ Ary Imm K. BD Modum and 0 0 0 0 300.0 HZ Ary Imm K. BD Modum and 0.0 0.0 0.0 0.0 4 <t< td=""><td></td><td> </td><td>A H0</td><td>Disturbance</td><td>600 60 0 0</td><td>0</td><td>0 0</td><td>4000 100</td><td>Hz %</td><td>Any</td><td>Imm Imm</td><td></td></t<>			A H0	Disturbance	600 60 0 0	0	0 0	4000 100	Hz %	Any	Imm Imm	
X. B0 Frequency of 0 0 0 0000 Hz Any Imm X. B0 Comparation 0 0 0 0 0 8 Any Imm X. B0 Comparation 0 0 100 Hz Any Imm X. B0 Model pair 375. 95. 0 1 Any Imm X. B0 Model pair 375. 95. 90. 0.0 1.000.0 Any Imm X. B0 Model pair 375. 95. 90. 0.0 0.00.0 Any Imm X. B0 Modular and 0.0 0.0 0.0 0.00.0 8 Any Imm X. B0 Modular and 0.0 0.0 0.0 0.00.0 8 Any Imm X. B0 Modular and 0.0 0.0 0.0 0.00.0 8 Any Imm X. B0 Modular and 0.0 0.0 0.0 0.00.0 8			✓ A H0 ✓ A H0	Inertia corr Phase modula	100 10 0 0	00	100 0 0 -9	1600 0 90	り度	Any	Emm Emm	
			A., H0	Frequency of Compensation	0 0 0		0 0	1000	Hz %	Any	[mm [mm	
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Construction Construction<			A. H0	Model gain	375.8 40	0.0	40.0 0.	1 2000.0		Any	Emm	
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			✓ A H0	POSICION 100								
If you need to operate, please enter the factory password (function code H0241)1" No Different from Undate Different with		<	➤ A H0 ➤ A H0	2nd position	512.00 51 0[Disabla] 0]	12.00 Disablal	51 0. 0 0	15 512.00		Any	Imm	



6.5.3 OFFLINE EDIT

To edit the values of a parameter file without being connected to the drive, follow these steps:

- 4. Click on "Open parameter file"
- 5. Select the corresponding parameter file in the open file dialog box
- 6. Select the corresponding parameter section
- 7. Edit the "current value" of the parameter

Changes made to the parameter values are automatically saved in the corresponding parameter file





6.5.4 COMPARISON

The InoDRiverShop software has two options for comparing the project parameters.

The first option allows you to compare the current values of the project with a parameter file. The second option allows you to compare the values of a file with the factory values.

6.5.4.1 COMPARE WITH CURRENT VALUES

To compare parameter file with actual values follow the next procedure:

1. Open parameter file. Click on "Open Recipe" button and select the corresponding parameter file. After opening the parameter file the values of this file are loaded in the column "Setting value".



2. Click "Compare" button and select "The set value is different from the current value"

Write all t options (cu page)	ick rrent Co	VS ompare	Axis copie	ed II (curre	Find	General	use
urrent value	Defa.	The set v	alue is differ/	ent from	the curre	ent value	
29.8	40.0	The set v	alue is differ/	ent from	the facto	ory value	
. 07	19.89 0	. 10 0	12.00 ms	Any	Immeai	ate	

3. This is the comparison result:



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6.5.4.2 COMPARE WITH FACTORY VALUES

To compare parameter file with factory values follow the next procedure:

1. Open parameter file. Click on "Open Recipe" button and select the corresponding parameter file. After opening the parameter file the values of this file are loaded in the column "Setting value".



2. Click "Compare" button and select "The set value is different from the factory value"

Write all t options (cu page)	tick Irrent	VS Compare	Axis	copie	d I (curre	Find	Gei	neral	user
urrent value	Defa.	The s	et value is	differe	ent from	the cu	rrent v	alue	
29.8	40.0	The set value is different from the factory value							
. 07	19.89	0.10	012.00	ms	Any	Immed	llate		

3. This is the comparison result:

Central Project SWARN Imagency incompany king Program Recover to Rendon unterference filter time constant Imagency incompany king <	ı ×	
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Control Control Function WebS Space 3 00000011200000000000000000000000000000		
With Sale Image: Sale of Sale		
Property Parameter Group Upload and saw Upload and saw Upload and saw Open reform Saw subtry Utilize (structure) Saw subtry Saw subtry Saw subtry <th< td=""><td></td></th<>		
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Wyow need to speake pleake either by password thireditor code HB2412 * No Different from Update Different with SVV00N Gains Linoparam		
Param Monitor		



6.6 GAIN TUNING

Set the gain parameters of the servo drive to proper values so that the servo drive can drive the motor as fast and accurate as possible based on internal references or commands sent from the host controller.

The gain is defined by the combination of multiple mutually-affected parameters (including position loop gain, speed loop gain, filter and inertia ratio). Set these parameters to proper values to keep a balanced performance.

NOTE Before gain tuning, perform a trial run through jogging to ensure the motor operates properly.

The following figure shows the general procedure for gain tuning.





6.6.1 INERTIA AUTO-TUNING

The load inertia ratio (H08-15) is calculated by using the following formula.

load inertia ratio $(H08 - 15) = \frac{Total moment of inertia of the mechanical load}{Moment of inertia of the motor (H00 - 16)}$

Click on "Inertia Identification" icon to access to the inertia identification dialog.



- 1. Parameter H09-09 Number of motor revolutions per inertia auto-tuning
 - a. Displacement of one revolution
 - b. Displacement of five revolution
 - c. Customized
- 2. Parameter H09-06 Max. speed of inertia auto-tuning
- 3. Parameter H09-07- Time constant for accelerating to the maximum speed during inertia auto-tuning
- 4. Parameter H09-09 Customized number of motor revolutions per inertia auto-tuning
- 5. Parameter H09-05 Offline inertia auto-tuning mode
 - a. Unidireccional
 - b. Bidireccional
- 6. Button to go to the next step. Click this button when the inertia settings are ok.



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Inertia identification		\times
– Servo ON / OFF operatio	n Run executior	ı ———
	-	8
Servo ON 9	Forward	Reverse
Hint: The data changes small, and the function i	, and the range o is completed.	of multiple changes is
Ratio of moment of	0.13	[100%]
Estimated moment of	0. 13	[100%] Downlo

- 7. Enable drive
- Start Inertia autotuning. When either of these two buttons is pressed the inertia auto tune starts. The motor moves as configured in the previous screen. The calculated inertia value appears in the "estimated moment of inertia" box. Continue with the test until this value is stable.
- 9. Disable the drive
- 10. Save the inertia value in the parameter H08-15

6.6.1.1 ONLINE AUTO-TUNING

This method automatically calculates the inertia from the movements sent by the host controller. The servo drive calculates the inertia ratio in real time and stores the result to H08-15 every 30 minutes

Different H09-03h values indicating different updating speeds of the inertia ratio in H08-15

- H09-03h = 1: Applicable to the scenario where the actual inertia ratio rarely changes, such as machine tool and wood carving machine.
- H09-03h = 2: Applicable to the scenario where the inertia ratio changes slowly.
- H09-03h = 3: Applicable to the scenario where the actual inertia ratio changes rapidly, such as transportation manipulator.

NOTE Do not use online inertia auto-tuning in applications involving hitting against limit switches and press fitting.



6.6.2 STUNE

The servo tuning requirements are completed through a single parameter setting, the load inertia ratio is adaptively identified, and the resonance suppression parameters are automatically set, which greatly reduces the difficulty of debugging and improves the tuning

STune performs gain auto-tuning based on the set stiffness level H09-01. It aims to fulfill the requirements of rapidity and stability.

The servo tuning requirements are completed through a single parameter setting, the load inertia ratio is adaptively identified, and the resonance suppression parameters are automatically set, which greatly reduces the difficulty of debugging and improves the tuning

The STune function is enabled by default with H09-00 (Gain auto-tuning mode) being set to 4 (Normal mode+Inertia auto-tuning). The servo drive is turned off automatically 10 min after command input.

The STune function is intended to be used in applications featuring slight load inertia changes. For applications featuring dramatic inertia changes or where inertia auto-tuning is unavailable (due to operating speed too low or acceleration rate too small), disable the STune function after initial power-on.



🖆 [SV660N]Usability adjustment 🗵					
Select the corresponding tuning mode based on different scenarios.					
STune	STune Applicable to manual gain tuning when servo drive receives instructions. Easy and flexible tuning But				
ETune					





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ajustment-stone	~
Self-adjustment mode (STEP1)	Vibration suppression control
It is recommended to change the mode in the static state or in the stop state!	Vibration % Setting
OInterpolation mode + inertia automatic i	Vibration suppression switch
ONormal mode + inertia automatic identifi	Open Clear resonance su
◯ Fast positioning mode + inertia automati	Close
Manual mode	Default (10 minutes)
Load inertia ratio setting (STEP2)	Rigidity setting (STEP3)
Inertia 0 Setting	The higher the rigidity level, the stronger the gain and the faster the response, but the
Inertia 0 Setting Online inertia 0	The higher the rigidity level, the stronger the gain and the faster the response, but the
Inertia 0 Setting Online inertia 0	The higher the rigidity level, the stronger the gain and the faster the response, but the
Inertia 0 Setting Online inertia 0 Manual inertia ident Turn off online inerti	The higher the rigidity level, the stronger the gain and the faster the response, but the
Inertia 0 Setting Online inertia 0 Manual inertia ident Turn off online inerti	The higher the rigidity level, the stronger the gain and the faster the response, but the
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Inertia 0 Online inertia 0 Manual inertia ident Turn off online inerti	 The higher the rigidity level, the stronger the gain and the faster the response, but the ¹⁸ ²⁴ ³⁰ ³⁶ ³⁶ ³⁶ ³⁶ ³⁶ ³⁶ ³⁶ ¹⁵ [⊕]
Inertia Inertia 0 Setting Online inertia 0 Image: Comparison of the ima	 The higher the rigidity level, the stronger the gain and the faster the response, but the ¹⁸ ²⁴ ³⁰ ³⁶ ³⁶ ³⁶ ³⁶ ³⁶ ¹⁵ ¹⁵



	H09-00	Application	Affected parameters	Speed Feedforward	Gain switchover	Inertia auto- tuning	Resonance suppression	Model Tracking Function	Disturbance Observer	Notch Filter	PDFF
0	Manual mode	Manual gain tuning is needed.	None	Can be configured	NO		NO	NO	NO	NO	NO
1	Standard stiffness level mode	Gain auto-tuning is performed based on the set stiffness level. Allows the feedforward gains manual modification.	H07-05 H08-00 H08-01 H08-02	Can be configured	NO	NO	NO	NO	NO	NO	NO
2	Positioning mode	Gain auto-tuning is performed based on the set stiffness level. This mode is applicable to occasions requiring quick positioning. Allows the feedforward gains manual modification.	H07-05 H07-06 H08-00 H08-01 H08-02 H08-03 H08-04 H08-05	Can be configured	ҮЕЅ H08-10	NO	NO	NO	NO	NO	NO
3	Interpolation mode	 Applied in trajectory control, such as CNC, gantry synchronization, electronic cam / gear. high stability requirements medium response requirements low overshoot 		Can be configured	NO	YES (10 min.) H09-03 = 2	YES (10 min.) H09-11 H09-37	NO	NO	YES H09- 02=3	NO
4	Normal mode	 General positioning (default value). Applied to general positioning control, automatic identification of load inertia. high stability requirements low response requirements no overshoot 		Can be configured	NO	YES (10 min.) H09-03 = 2	YES (10 min.) H09-11 H09-37	NO	NO	YES H09- 02=3	NO
6	Fast positioning mode	Applied to short travel and high speed positioning control. Model- Tracking algorithm is added to realize positioning within 10ms, with small inertia adaptation range. • medium stability requirements • fast response requirements • some overshoot	H07-05 H08-00 H08-01 H08-02 H08-43 H08-46	CANNOT be configured	NO	YES (10 min.) H09-03 = 2	YES (10 min.) H09-11 H09-37	YES H08-42=1	NO	YES H09- 02=3	NO

STEP 1 - Self-Adjustment mode (Firmware version H01-00<903.0 H02-00=0):

STEP 1 - Self-Adjustment mode (Firmware version H01-00>903.0 or H02-00>118.00):

	H09-00	Application	Affected parameters	Speed Feedforward	Gain switch over	Inertia auto- tuning	Resonance suppression	Model Tracking Function	Disturbanc e Observer	Notch Filter	PDFF
0	Manual mode	Manual gain tuning is needed.	None	Can be configured	NO		NO	NO	NO	NO	NO
1	Standard stiffness level mode	Gain auto-tuning is performed based on the set stiffness level.	H07-05 H08-00 H08-01 H08-02	Can be configured	NO	NO	NO	NO	NO	NO	NO
2	Positioning mode	Gain auto-tuning is performed based on the set stiffness level. This mode is applicable to occasions requiring quick positioning.	H07-05 H07-06 H08-00 H08-01 H08-02 H08-03 H08-04 H08-05	Can be configured	ҮЕЅ H08-10	NO	NO	NO	NO	NO	NO
3	Interpolation mode	 Applied in trajectory control, such as CNC, gantry synchronization, electronic cam / gear. high stability requirements medium response requirements low overshoot 		H08-19 18.1% Cannot be configured	NO	YES (10 min.) H09-03 = 2	YES	NO	NO	YES H09- 02=3	H08-24 81.9% Cannot be configured
4	Normal mode	 General positioning (default value). Applied to general positioning control, automatic identification of load inertia. high stability requirements low response requirements no overshoot 		Cannot be configured	NO	YES (10 min.) H09-03 = 2	YES	NO	NO	YES H09- 02=3	NO
6	Fast positioning mode	 Applied to short travel and high speed positioning control. Model- Tracking algorithm is added to realize positioning within 10ms, with small inertia adaptation range. medium stability requirements fast response requirements some overshoot 	H07-05 H08-00 H08-01 H08-02 H08-43 H08-46	Cannot be configured	NO	YES (10 min.) H09-03 = 2	YES	YES H08-42=1	YES H08-31 H08-32	YES H09- 02=3	NO

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STEP 2 - Load inertia ratio setting

Please, refer to the section 6.6.1 Inertia Auto-tuning

STEP 3 - Rigidity Setting

The value range of H09-01 (Stiffness level selection) is 0 to 41. The level 0 indicates the weakest stiffness and lowest gain and level 41 indicates the strongest stiffness and highest gain.

Please, refer to the section 6.6.5 Rigidity level calculation

Recommended Stiffness Level	Type of Load Mechanism
Level 4 to level 8	Large-scale machineries
Level 8 to level 15	Applications with low stiffness such as a conveyor
Level 15 to level 20	Applications with high stiffness such as a ball screw and direct-
	coupled motor

Vibration suppression control

Vibration suppre	ssion control		
Vibration	5	%	Setting
Vibration supp Open Close Default (10	ression switch	Clear	resonance su

Vibration: Parameter H09-11-Vibration threshold. When the torque ripple detected by the servo drive exceeds the setpoint of H09-11 and becomes uncontrollable, the stiffness level will be reduced automatically until reaching level 10 where ER661 is reported.

Vibration suppression switch:

Parameter H09-37 - Vibration monitoring time

- Open →H09-37 = 65536
- Close →H09-37 = 0
- Default (10 minutes) \rightarrow H09-37 = 600

If H09-00 (Gain auto-tuning mode) is set to 3, 4, or 6, the servo drive suppresses vibration by performing inertia auto-tuning automatically within 10 min (or other time interval defined by H09-37) after power-on or stiffness level setting, and then it exits from inertia auto-tuning. The inertia auto-tuning function, once deactivated, cannot be activated again by setting H09-09 to 3, 4, or 6.

6.6.3 ETUNE

ETune is a wizard-type function designed to guide users to perform auto-tuning by setting the motion profile and the desired response level. After the motion profile and the response level are set, the servo drive will perform the auto-tuning to obtain the optimal gain parameters. The auto-tuned parameters can be saved and exported as a recipe for use in other devices of the same model.

The ETune function is intended to be used in applications featuring slight load inertia changes.









6.6.4 INERTIA RATIO CALCULATION

In some systems it is not possible to calculate the system inertia ratio with the InoDriverShop tool because the axis cannot be moved manually or the axis is coupled to another axis.

In this type of systems, the "Online Inertia identification" tool can be used or the inertia can be calculated manually with the following procedure.

In this example the inertia ratio of the Inovance's motor MS1H1-40B30CB and a 400g and 95mm diameter pulley is calculated. In this case we can know the inertia of the load, but normally this data is not known exactly. Therefore, we will calculate the inertial ratio without taking into account the pulley data.

To calculate the ratio of inertia we need to perform a step movement of the axis with load, and trace this movement using the InoDriverShop Oscilloscope:





From these graphs we can obtain the maximum speed of the movement at the end of the ramp, the acceleration time and the current feedback during the acceleration:

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Max.Speed = $2000rpm = \frac{2000rpm \cdot 2 \cdot \pi}{60s} = 209.43 \ rad/s$

Acceleration time = 0.1s

$$Acceleration = \frac{209.43 \ rad/s}{0.1s} = 2094.3 \ rad/s^2$$

The current during the acceleration region is more or less 80% of nominal torque

$$Torque = 1.27Nm \cdot 0.8 = 1.016Nm$$

According the MS1 motor specifications the nominal torque is 1.27Nm and inertia of motor is $0.376Kg \cdot cm^2 = 0.376 \cdot 10^{-4}Kg \cdot m^2$

Torque of a body in an angular motion:

$$T = J_t \cdot \alpha \to \alpha = \frac{T}{J_t} = \frac{T}{J_l + J_m} \to J_l = \frac{1.016 \text{Nm}}{2094.3 \ rad/s^2} - 0.376 \cdot 10^{-4} Kg \cdot m^2 = 4.475 \cdot 10^{-4} Kg \cdot m^2$$

where

 \sum Inertia=moment of inertia(Kgm²)

 α =angular acceleration (rad/s²)

The inertia ratio is as follow:

Inertia ratio (H08 - 15) =
$$\frac{J_l}{J_m} = \frac{4.475 \cdot 10^{-4} Kg \cdot m^2}{0.376 \cdot 10^{-4} Kg \cdot m^2} = 11.9$$

where

 J_l load inertia

 J_m motor inertia

The theoretical calculation of the inertia of the pulley is:

Disk Inertia
$$=$$
 $\frac{m \cdot r^2}{2} = \frac{0.4Kg \cdot 0.0475^2m}{2} = 4.51 \cdot 10^{-4}Kg \cdot m^2$

The theoretical result is almost the same as that calculated with the motor graphs.



6.6.5 RIGIDITY LEVEL CALCULATION

The value range of H09-01 (Stiffness level selection) is 0 to 41. The level 0 indicates the weakest stiffness and lowest gain and level 41 indicates the strongest stiffness and highest gain. The following table lists the stiffness levels for different load types.

Recommended Stiffness Level	Type of Load Mechanism
Level 4 to level 8	Large-scale machineries
Level 8 to level 15	Applications with low stiffness such as a conveyor
Level 15 to level 20	Applications with high stiffness such as a ball screw and direct-
	coupled motor

To get this Rigidity level value, there is some relation between different parameters:

- Motor Inertia **J**_m
- Load inertia J
- Motor torque Nt
- Nominal current In

In this example the following motor MS1H1-40B30CB-A331Z is used with the following data:

Drive Parameter	Description	Value
H00-11	Rated current In	2.8A
H00-12	Rated torque T _n	
H00-22	Torque Coefficient K _t	0.53 Nm/A _{rms}
H00-16	Moment of Inertia	0.376·10 ⁻⁴ kgm ²

Inertia ratio H08-15=1

 $J_{\text{I}} = ratio^*J_{\text{m}}$

Inertia ratio (H08 – 15) =
$$\frac{J_l}{J_m} \rightarrow J_l = I_{ratio} \cdot J_l = 0.376 \cdot 10^{-4} Kg \cdot m^2$$

Torque of a body in angular motion:

$$T = J_t \cdot \alpha \to \alpha = \frac{T}{J_t} = \frac{T}{J_l + J_m} = \frac{0.53 \frac{\text{Nm}}{A_{rms}} \cdot 2.8A}{0.376 \cdot 10^{-4} Kg \cdot m^2 + 0.376 \cdot 10^{-4} Kg \cdot m^2} = 19734 \frac{rad}{s^2}$$

where

 \sum Inertia=moment of inertia(Kgm²)

 α =angular acceleration (rad/s²)

From the following table it can be calculated the rigidity level around 24. Then H09-01 = 24






6.6.5.1 STIFFNESS LEVEL

This section shows the gain values depending on the value of stiffness level: H09-00: Gain auto-tunning mode H09-01: Stiffness level H08-00: Speed loop proportional gain H08-01: Speed loop integral gain H08-02: Position loop proportional gain

H08-43: Tracking function model gain

H08-46: Tracking function feedforward gain

H07-05:Torque reference filter time constant

	H09-00=4				H09-00=3			H09-00=6								
H09-01 Stiffness level		H08- 00	H08- 01	H08- 02	H07- 05	H08- 00	H08- 01	H08- 02	H07- 05		H08- 00	H08- 01	H08- 02	H08-43	H08- 46	H07- 05
15		39	28	36.2	0.2	40	27.43	37.1	0.2		39	28.13	36.2	72.4	99	0.2
16		43.7	25.11	40.6	0.2	50	21.95	46.4	0.2		43.7	25.11	40.6	81.2	99	0.2
17		49	22.38	45.5	0.2	60	18.28	55.7	0.2		49	22.38	45.5	91	99	0.2
18		54.9	19.98	51	0.2	75	14.62	69.7	0.2		54.9	19.98	51	102	99	0.2
19		61.5	17.83	57.1	0.2	90	12.18	83.6	0.2		61.5	17.83	57.1	114.2	99	0.2
20		68.9	15.92	64	0.2	115	9.53	106.8	0.2		68.9	15.92	64	128	99	0.2
21		77.1	14.22	71.6	0.2	140	7.83	130.1	0.2		77.1	14.22	71.6	143.2	99	0.2
22		86.4	12.69	80.2	0.2	170	6.44	157.9	0.2		86.4	12.69	80.2	160.4	99	0.2
23		96.8	11.33	89.9	0.2	210	5.22	195.1	0.18		96.4	11.33	89.9	179.8	99	0.2
24		108.4	10.11	100.7	0.2	250	4.38	232.3	0.15		108.4	10.11	100.7	201.4	99	0.2
25		121.4	9.03	112.8	0.2	280	3.91	260.2	0.14		121.4	9.03	112.8	225.6	99	0.2
26		136	8.06	126.3	0.2	310	3.53	288.1	0.12		136	8.06	126.3	252.6	99	0.2
27		152.3	7.2	141.5	0.2	340	3.22	315.9	0.11		152.3	7.2	141.5	283	99	0.2
28		170.5	6.43	158.4	0.2	370	2.95	343.8	0.1		170.5	6.43	158.4	316.8	99	0.2
29		191	5.74	177.5	0.2	400	2.74	371.7	0.09		191	5.74	177.5	355	99	0.2
30		213.9	5.13	198.7	0.18	450	2.43	418.2	0.08		213.9	5.13	198.7	397.4	99	0.18
31		239.6	4.57	222.6	0.16	500	2.19	464.6	0.07		239.6	4.57	222.6	445.2	99	0.16
32		268.4	4.08	249.4	0.14	500	2.19	464.6	0.07		268.4	4.08	249.4	498.8	99	0.14
33		300.6	3.64	279.3	0.13	500	2.19	464.6	0.07		300.6	3.64	279.3	558.6	99	0.13
34		336.7	3.25	312.9	0.11	500	2.19	464.6	0.07		336.7	3.25	312.9	625.8	99	0.11
35		377.1	2.9	350.4	0.1	500	2.19	464.6	0.07		377.1	2.9	350.4	700.8	99	0.1
36		422.3	2.59	392.4	0.09	500	2.19	464.6	0.07		422.3	2.59	392.4	784.8	99	0.09
37		473	2.31	439.5	0.08	500	2.19	464.6	0.07		473	2.31	439.5	879	99	0.08
38		529.8	2.07	492.3	0.07	500	2.19	464.6	0.07		529.8	2.07	492.3	984.6	99	0.07
39		593.4	1.84	551.4	0.06	500	2.19	464.6	0.07		593.4	1.84	551.4	1102.8	99	0.06
40		664.6	1.64	617.6	0.05	500	2.19	464.6	0.07		664.6	1.64	617.6	1235.2	99	0.05









6.6.6 MECHANICAL ANALYSIS

As shown in the preceding figure, the mechanical analysis function tests the speed response of the entire system under different frequencies and generates the baud rate diagram, which helps you to find the resonance frequency and set notches. For example, the resonance frequency shown in the preceding figure is 2195 Hz.



- **Closed Loop** directly measures the closed loop frequency response of the servo. Used to determine the axis response bandwidth.
- **Mechanical Analysis** This trace shows the frequency response of the mechanics of the drive and motor. Directly measures the mechanical and electrical properties of the motor, drive and any mechanical bodies attached to the axis. Used to determine the mechanical resonance point.

The closed control loop is uses for the determination of the bandwidth, while the open control loop is regarded for calculating the amplitude response. The bandwidth is read where the phase response first crosses the -3 dB or the -90° line. The higher the bandwidth of a system, the more stable it is and the higher the control loop gain can be set. This result in high dynamics.

Incentive adjustment: when selecting this check box, if the vibration is excessive the current excitation will reduced automatically. If the current excitation set a reasonable value the 'incentive adjustment' function will not work. Usually this function is not used.

Smooth: Increasing the smoothing percentage, the Bode plot traces become cleaner and easier to read. Will not affect to test, but when there are a lot wave noise in the displayed wave, it can adjust the value to find the Resonance frequency.

Current Excitation: Percentage of torque used to realize the test. To avoid strong vibration, the excitation level usually set as 10% at the beginning, it can adjust the value according to the wave feedback.



6.6.6.1 BODE PLOT

The Bode diagram is a representation of a system in the frequency range. The Bode diagram consists of a graph for the amplitude (gain response) and a graph for the phase shift (phase response). It describes the stationary reaction of the system to a harmonic excitation (sinus oscillation). The frequency is displayed logarithmically on the X-axes.

To determine the frequency response of a system, the following procedure is carried out. A sinusoidal signal of a certain amplitude and frequency is applied to the input of the system. As the frequency of the input signal is increased, it is compared with the output signal. At first the output is aligned in amplitude and frequency with the input, but when increasing the input frequency, without increasing the amplitude, the output signal has a different amplitude and phase.

In an ideal system the output follows the input in amplitude and phase. In other words, the gain is OdB and the phase is 0°. But in a real application there is a specific frequency where the output signal cannot follow the input signal and is increased by the amplitude and the phase shift.



6.6.6.2 AXIS BANDWIDTH

With the "Speed close loop" bode diagram you can determine the bandwidth of the system. Bandwidth is related to the response of the system. The higher the bandwidth, the better the response and the higher the control loop gain can be set. This result in high dynamics.

The bandwidth in the Bode plot is determined by the point at which the gain plot crosses -3dB or the phase reach -90 degrees.





6.6.6.3 INERTIA RATIO

The Bode diagram also shows the inertia ratio of the system. The greater the distance between the antiresonance point and the resonance point, the greater the inertia ratio between the motor and the load.



Example 1: Pulley 32T 0.095 kg

Example 2: Pulley 60T 0.480 kg







6.6.6.4 RESONANCE POINT

The elements of any mechanical system are what cause the different resonance frequencies. Each mechanical element in a system will have its own natural resonant frequency that shows both an antiresonance [] and a resonance [] point, where the mechanical element decouples from the system or is excited at its resonance point. Each pair of nodes is related to a coupled element in the system. While a system can have multiple resonant nodes, the first set of nodes (lowest frequency) is the most critical, as a bandwidth greater than the frequency of the first antiresonance node cannot be achieved.

Example 1: Two pulleys with a belt. In this case it can be seen how the mechanical analysis shows two resonance points due to the two pulleys coupled by a belt.



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Example 2: One pulley. Mechanical analysis shows only one resonance point because the load coupled to the motor is made up of a single element.







6.6.7 FILTER ADJUSTMENT

In all mechanical systems there are resonances that can be classified as high, medium or low frequency, depending on where they are within the bandwidth of the control loop.

To eliminate these resonances, two types of filters are usually used, damping filters for low frequency alterations and notch filter for high frequency ones.



Low frequency – Vibration Suppression

If the mechanical load end is long and heavy, vibration may easily occur on this part during fast ramps, affecting the settling time. Such vibration is called low frequency resonance as its frequency is generally within 100 Hz









Use the low frequency resonance suppression function to suppress such vibration. Trace the position following error waveform using the oscilloscope function in INOVANCE software tool and calculate the position following error fluctuation frequency, which is the low-frequency resonance frequency. Next, input H09-38 (or H09-44) and H09-49 manually, and keep the values of other parameters to their default values. Observe the suppression effect after using the low frequency resonance suppression filter.



Example: position following error frequency 74.7ms = 13.38Hz

Vibration suppression ON \rightarrow H09-38=13.4Hz and H09-49=13.4Hz



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High Frequency – Notch filter

Notch filters attenuate the response of a narrow, specific range of frequencies around a center frequency (notch). Frequencies above or below the specified range pass unchanged. Signals close to the notch (center) frequency are heavily attenuated, but attenuation drops off at the ends of the specified range.

The notch reduces the gain at certain frequencies to suppress the mechanical resonance. After the vibration is suppressed by the notch, you can continue to increase the gain. The operating principle of the notch is shown in the following figure:



• Width level The width level indicates the ratio of the notch width to the center frequency of the notch.

$$Width \ level = \frac{f_H - f_L}{f_T}$$

In which:

 f_T : Center frequency of the notch, which is also the mechanical resonance frequency f_H - f_L : Notch width, indicating the frequency width whose amplitude attenuation rate is -3 dB in relative to the notch center frequency

The default value 2 applies to general applications.

Depth Level

The notch depth level indicates the ratio of the input to the output at the center frequency. When the depth level is 0, the input is completely suppressed at the center frequency. When the depth level is 100, the input can be fully received at the center frequency. Therefore, the smaller the depth level is, the larger the notch depth is, and the stronger the suppression effect will be. Note that a too small depth level may lead to system oscillation.

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A total of four notches can be used, and each is defined by three parameters: frequency, width level, and depth level. Parameters of the 1st and 2nd manual notches are set manually by the user using 6.6.6 Mechanical analysis. Parameters of the 3rd and 4th notches can be either set manually or set automatically after being configured as an adaptive notch (H09-02 = 1 or 2).

	Manua	l Notch	Manual / Adaptative Notch			
	1 st Notch	2 nd Notch	3 rd Notch	4th Notch		
Frequency	H09-12	H09-15	H09-18	H09-21		
Width level	H09-13	H09-16	H09-19	H09-22		
Depth level	H09-14	H09-17	H09-20	H09-23		

NOTE When the "frequency" is the default value (4000 Hz), the notch is disabled.

NOTE The adaptive notch (H09-02 = 1 or 2) is preferred for resonance suppression. The manual notch can be used in cases where the adaptive notch cannot deliver desired performance.

Procedure for using the adaptive notch:







6.6.8 MODEL TRACKING FUNCTION

The model tracking function, which is only available in the position control mode, can be used to improve the responsiveness and shorten the positioning time.

Parameters used by model tracking are normally set automatically through STune or ETune along with the gain parameters.

However, manual tuning could be needed. Model tracking function is based on system ideal mathematical model, it is as a "Feed-forward Controller+ Filter".

Normally, this function is applied to point-to-point quick positioning mode (H09-00=6).

The effect of relevant parameters:



H08-43: Model Gain (as below curves, increasing H08-43 from 75 to 175, the speed response becomes more close to reference)



H08-46: Model feedforward (as below curves, increasing H08-46 from 1% to 90%, it can effectively shorten the positioning time)





H08-51: Model filter time 2 (as below curves, increasing H08-51 from 0 to 0.5ms, it can effectively reduce overshoot caused by too strong feedforward)





Drive Parameter	Description	Unit	Range	Default
H08-42	Model control selection		0 to 1	0
H08-43	Model Gain		0.1 to 2000	40
H08-46	Model feedforward	%	0 to 102.4	95

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H08-51	Model filter time 2	0 to 2000	0

6.6.9 GAIN ADJUSTMENT PARAMETERS

This section collect all the parameters related with gains and filters adjustment of the different loops of the drive. The first section is a table with all the parameters. The second section is a diagram with the most important parameters of the drive loops.

MENU 8

	Function		Current		Minimum	Maximum	Default
	code ID	Description	var value	Unit	value	value	Value
٩	H08-00	Speed loop gain	40	Hz	0.1	2000	40
00	H08-01	Speed loop integral time constant	19.89	ms	0.15	512	19.89
uo	H08-02	Position loop gain	64	Hz	0.1	2000	64
siti	H08-03	2nd speed loop gain	75	Hz	0.1	2000	75
ga ga		2nd speed loop integral time					
s pa	H08-04	constant	10.61	ms	0.15	512	10.61
bee	H08-05	2nd position loop gain	120	Hz	0.1	2000	120
S	H08-08	2nd gain mode	1		0	1	1
ver	H08-09	Gain switchover condition	0		0	10	0
cho	H08-10	Gain switchover delay	5	ms	0	1000	5
wite	H08-11	Gain switchover level	50		0	20000	50
n S	H08-12	Gain switchover hysteresis	30		0	20000	30
Gai	H08-13	Position gain switchover time	3	ms	0	1000	3
	H08-15	Load moment of inertia ratio	1		0	120	1
	H08-17	Zero phase delay	0	ms	0	4	0
		Speed feedforward filter time					
	H08-18	constant	0.5	ms	0	64	0.5
	H08-19	Speed feedforward gain	0	%	0	100	0
		Torque feedforward filter time					
	H08-20	constant	0.5	ms	0	64	0.5
	H08-21	Torque feedforward gain	0	%	0	300	0
	H08-22	Speed feedback filter selection	0		0	4	0
		Cutoff frequency of speed					
	H08-23	feedback low-pass filter	8000	HZ	100	8000	8000
	H08-24	PDFF control coefficient	100	%	0	200	100
		Cutoff frequency of speed					
Speed	H08-27	observer	170	HZ	50	600	170
Observer	1100.20	Inertia correction coefficient of	100	04	1	1000	100
	HU8-28	Speed observer	100	%	1	1000	100
	H08-29	Speed observer filter time	0.8	ms	0	10	0.8
Disturbance	H08-31	Disturbance cutoff frequency	600	HZ	10	4000	600
Observer	H08-32	Disturbance compensation gain	0	%	0	100	0
Observer		disturbance observer	100	0/	0	1600	100
	100-55	Phase modulation of medium-	100	70	0	1000	100
	H08-37	frequency jitter suppression 2	0	?	-90	90	0
Mechanical		Frequency of medium-frequency			50	50	
Resonance	H08-38	iitter suppression 2	0	Hz	0	1000	0

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	Function		Current		Minimum	Maximum	Default
	code ID	Description	var value	Unit	value	value	Value
		Compensation gain of medium-					
	H08-39	frequency jitter suppression 2	0	%	0	300	0
	H08-40	Speed observer selection	0		0	1	0
	H08-42	Model control selection	0		0	1	0
	H08-43	Model gain	40		0.1	2000	40
	H08-46	Feedforward value	95		0	102.4	95
		Medium- and low-frequency jitter					
	H08-53	suppression frequency 3	0	HZ	0	300	0
E		Medium- and low-frequency jitter					
ssic	H08-54	suppression compensation 3	0	%	0	200	0
pre		Medium- and low-frequency jitter					
dng	H08-56	suppression phase modulation 3	100	%	0	600	100
u 6		Medium- and low-frequency jitter					
atic	H08-59	suppression frequency 4	0	HZ	0	300	0
ibra		Medium- and low-frequency jitter					
>	H08-60	suppression compensation 4	0	%	0	200	0
		Medium- and low-frequency jitter					
	H08-61	suppression phase modulation 4	100	%	0	600	100
		Position loop integral time					
	H08-62	constant	512		0.15	512	512
		2nd position loop integral time					
	H08-63	constant	512		0.15	512	512
		Speed observation feedback					
	H08-64	source	0		0	1	0

MENU 9

	Function code ID	Description	Current var value	Unit	Minimum value	Maximum value	Default Value
	H09-00	Gain auto-tuning mode	4		0	7	4
	H09-01	Stiffness level	15		0	41	15
	H09-02	Adaptive notch mode	3		0	4	3
	H09-03	Online inertia auto-tuning mode	2		0	3	2
	H09-05	Offline inertia auto-tuning mode	1		0	1	1
	H09-06	Max. speed of inertia auto-tuning	500	rpm	100	1000	500
ertia		Time constant for accelerating to the maximum speed during inertia					
L L	H09-07	auto-tuning	125	ms	20	800	125
	H09-08	Inertia auto-tuning interval	800	ms	50	10000	800
		Number of motor revolutions per					
	H09-09	inertia auto-tuning	1		0	100	1
	H09-11	Vibration threshold	5	%	0	100	5
ce al	H09-12	Frequency of the 1st notch	8000	HZ	50	8000	8000
ani	H09-13	Width level of the 1st notch	2		0	20	2
ech	H09-14	Depth level of the 1st notch	0		0	99	0
Re	H09-15	Frequency of the 2nd notch	8000	HZ	50	8000	8000

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			Current				
	Function		var		Minimum	Maximum	Default
	code ID	Description	value	Unit	value	value	Value
	H09-16	Width level of the 2nd notch	2		0	20	2
	H09-17	Depth level of the 2nd notch	0		0	99	0
	H09-18	Frequency of the 3rd notch	8000	HZ	50	8000	8000
	H09-19	Width level of the 3rd notch	2		0	20	2
	H09-20	Depth level of the 3rd notch	0		0	99	0
	H09-21	Frequency of the 4th notch	8000	HZ	50	8000	8000
	H09-22	Width level of the 4th notch	2		0	20	2
	H09-23	Depth level of the 4th notch	0		0	99	0
	H09-24	Auto-tuned resonance frequency	0	HZ	0	5000	0
	H09-32	Gravity compensation value	0	%	0	100	0
		Forward friction compensation					
	H09-33	value	0	%	0	100	0
		Reverse friction compensation					
	H09-34	value	0	%	-100	0	0
	H09-35	Friction compensation speed	2		0	20	2
		Friction compensation speed					
	H09-36	selection	0		0	19	0
	H09-37	Vibration monitoring time	600		0	65535	600
		Frequency of low-frequency					
	1100.20	resonance suppression 1 at the	100	117	1	100	100
	HU9-38	Setting of low frequency reconcises	100	HZ	1	100	100
		suppression 1 at the mechanical					
	H09-39	end	2		0	3	2
	H09-41	Frequency of the 5th notch	8000	H7	50	8000	8000
	H09-42	Width level of the 5th notch	2	112	0	20	2
	H09-43	Depth level of the 5th notch	0		0	99	0
e	1105 45	Frequency of low-frequency	U				U U
anc		resonance suppression 2 at the					
le nos	H09-44	mechanical end	0		0	200	0
y re		Response of low-frequency					
cha		resonance suppression 2 at the					
Me	H09-45	mechanical end	1		0.01	10	1
-fre		Width of low-frequency resonance					
ŇO		suppression 2 at the mechanical					
_	H09-47	end	1		0	2	1
		Frequency of low-frequency					
	H09-49	mechanical end	0		0	200	0
	1105 45	Response of low-frequency	0		U	200	U
		resonance suppression 3 at the					
	H09-50	mechanical end	1		0.01	10	1
		Width of low-frequency resonance					
		suppression 3 at the mechanical					
	H09-52	end	1		0	2	1



		Current				
Function		var		Minimum	Maximum	Default
code ID	Description	value	Unit	value	value	Value
H09-56	STune mode setting	4		0	4	4
	STune resonance suppression					
H09-57	switchover frequency	900	Hz	0	4000	900
	STune resonance suppression reset					
H09-58	selection	0		0	1	0



GAIN ADJUSTMENT PARAMETERS DIAGRAM 6.6.9.1



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6.7 CONTINUOS OSCILLOSCOPE

Continuous sampling supports long-term acquisition. During long-term acquisition, the waveform data will be automatically saved under the current project directory "WaveData". Therefore, if you need to sample continuously for a long time, you can run for a long time without data loss as long as you ensure enough hard disk space.



[1] Sample time. Minimum sample time is 3ms

[2]Time Axis

	Save sampling data to a file
1	Auto adjust the data to fit the screen
%	Active the multi channel mode. If it is active, each channel is shown in a different graph. Otherwise all channels are shown on the same graph
+ † +	Enable pan mode. When hold the mouse right cursor over the graph the graph move along mouse movement
Ø	Zoom in
	Enable cursors
Ş	Displays sampling points
8 2 2 3	Change to full screen mode
D	It takes a screenshot of current data sampling
	Button to start sampling
	Button to stop sampling. After clicking the data is stored under the current project directory "WaveData"
	Button to pause sampling, and the button becomes \square .At this time, the data is still being
	collected, but the interface data is not refreshed. After clicking the 🛄, the sampling resumes, and the collected data can still be displayed normally during the pause

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sampling resumes

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6.8 TRIGGER OSCILLOSCOPE

Trigger sampling supports event acquisition. The scope monitors the incoming signal and waits for the value to rise above (or fall below) a set threshold, then causes the scope to capture and display the waveform.



Ordinary Channel:

ID	Description	Parameter	Update Rate
17	Position reference absolute value	CiA402 position demand	250µs
		value 6062h	
		(encoder unit)	
27	Real-time target absolute position: CiA402 target	CiA402 target position	EtherCAT
	position 607Ah + 60B0h	607Ah + 60B0h	cycle
28	Real-time target speed: CiA402 target speed 60FFh	CiA402 target speed 60FFh	EtherCAT
	+ 60B1h	+ 60B1h	cycle
29	Real-time target torque: CiA402 target torque	CiA402 target torque	EtherCAT
	6071h + 60B2h	6071h + 60B2h	cycle
30	Control Word: CiA402 Control Word 6040h	CiA402 Control Word	EtherCAT
		6040h	cycle
31	Status Word: CiA402 Control Word 6041h	CiA402 Status Word 6041h	1ms
2	Position reference: position increment		250µs
32	Position reference unfiltered: position increment		250µs
3	Position feedback: position increment		250µs
20	Position feedback absolute value: absolute position	CiA402 position actual	62.5µs
		value* 6063h	
		(encoder unit) H0B-17	
4	Position following error	H0B-15	62.5µs
25	Position following deviation-reference unit	H0B-53	250µs
		Following Error Actual	
		Value 60F4h	
5	Speed reference (rpm)	H0B-01	62.5µs
6	Speed feedback (rpm)	606Ch (instruction unit/s)	62.5µs



7	Speed feedback filter	H0B-00	1ms
8	Torque reference	H0B-02	62.5µs
9	Current Feedback	6077h	62.5µs

6.8.1 ETHERCAT POSITION INTERPOLATION

In CSP mode, the servo drive operates as a position-follower with current/velocity/position loops closed in the drive. The EtherCAT master does all of the calculations to produce motion profiles that move the motor to desired positions.

The servo drive only sees increments of position with every PDO (CiA402 object 607Ah) and has no knowledge of the final target position or velocities. And the rate at which the updates arrive depends on the time-base of the master (EtherCAT cycle time).

General	Autoconfig Master/Slave	5		EtherCAT.			
Function Code	EtherCAT NIC Setting						
Update	Destination Address (MAC)	FF-FF-FF-FF-FF	Broadcast	Enable Redundancy			
Sync Unit Assignment	Source Address (MAC)	00-00-00-00-00	Browse				
EtherCAT I/O Mapping	Network Name	Network Name eth1 O Select network by MAC • Select network by Name					
Status	A Distributed Clock		J Options				
Information	Cycletime 4000	🗢 µs	Use LRW inst	ead of LWR/LRD			
	Sync Offset 12	\$ %	Auto restart s	aves			
	Sync window 1	‡ μs					

The next two graphs show the difference between a 4ms and an 8ms EtherCAT cycle. The waveform signal shows the position sent by the EtherCAT master each cycle and the orange waveform is the **position interpolated between two points** received each cycle from EtherCAT. The drive uses the value of the orange waveform to introduce it as a reference in the position loop.

ID	Description	Parameter	Update Rate
27	Real-time target absolute position	CiA402 target position 607Ah + 60B0h	EtherCAT cycle
17	Position reference absolute value	CiA402 position demand value 6062h (encoder unit)	250µs
32	Position reference unfiltered: position increment		250µs

Trigger configuration:

Trigger Setting 🔲									
Setting Show									
Device SV660N[1] ~	Trigger sampling	Continuous trigg.							
Communication setting				Sampling int	erval				
🕞 Channel		Move up	Move down	Sampling int	orval	1 62	5 us		
⊕ Ordinary channel ⊞ Bit channel	27:R 17:P 32:P	eal-time target osition referen osition referen	absolute position ce absolute value ce unfiltered	Pre-trigger s	etting				
				10		%			
	>>			Condition		A	Ŷ		
				Condition A			Condition	В	
				Trigger	Speed	reference	~ Trigger	(Null)	~
	<<			Trigger	Rising	s edge	~ Trigger	Rising edge	~
				Trigger level	1	×1.00	Trigger le	vel 0	
				Value range	-32768	0~32767.0	Value rar	ige	

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Example 1: EtherCAT cycle time 4ms



Example 2: EtherCAT cycle time 8ms



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6.8.2 SYNC AND IRQ PHASE POSITION (μ S) [49]

SV660N uses the Distributed Clock mode to maintain an exact synchronization with the master.

[Source EtherCAT.org]

The method of Distributed Clocks provides highly precise time synchronization between slaves in an EtherCAT network. Since DC refers to the ESC-internal clocks, synchronization time between slaves can be guaranteed to much better than 1 μ s. The requirement of DC depends on the necessity of synchronization precision of the developing slave device. For instance, in machines in which multiple servo drives are functionally coupled, the axes need to be precisely synchronized to perform coherent movement. For this reason, many slaves for servo drive adopt DC in order to achieve high synchronization precision with other slaves. Thus the DC functionality should be implemented in cases of servo drive systems or I/O slaves being synchronized with servo drives.

Using the trigger tool it is possible to see the synchronization between master and slave. The value of [49] "SYNC and IRQ phase position" shows the offset between slave microprocessor interrupt and SYNC signal interruption.

SV660N[1]	Triager compline Continuous triag		
SV000N[1] V	ringger sampling Conundous uigg		
mmunication setting		Sampling interval	
-FUNC test 1 -FUNC test 2 -FUNC test 3 -FUNC test 4	Move up Move down 49:SYNC and IRQ phase position (us)	Sampling interval 1 62.5 us	
-FUNC test 5 (floating point t -FUNC test 6 (floating point t -FUNC test 7 (floating point t	>>	10 %	
-FUNC test 8 (floating point t -Main cyclic program execution -Interrupt program execution t		Condition A	Condition B
-Interrupt program execution t -Scheduling time of main cycli -Torque interrupt scheduling t	<<	Trigger (Null) ~ Trigger Falling edge ~	Trigger (Null) ~ Trigger Rising edge ~
-Soft interrupt scheduling tim -SYNC signal cycle detection v		Trigger level	Trigger level 0
Performance test variable 1 Performance test variable 2		Value range	Value range
-Performance test variable 3 -Performance test variable 4 -FUNC test 9 (floating point t			
FUNC test 10 (floating point ¥			



Example 1: This trace show the value of [49] "SYNC and IRQ phase position" when the jitter from EtherCAT master is acceptable. The EtherCAT master cycle time is 4 ms.



Example 2: This trace show the value of [49] "SYNC and IRQ phase position" when the jitter from EtherCAT master is NOT acceptable. The EtherCAT master cycle time is 4 ms. In this case it can observe that in some cycles the [49] value is too high. This is because EtherCAT SYNC signal is very close to Master IRQ interruption and these two signals are overlapping. In this example, the "Time Shift" parameter of the master has been modified from 12% to 30% to cause this effect





The following image shows the InoProShop EtherCAT Master configuration. The EtherCAT setting allows you to change the "Sync Offset" value to change the position of IRQ with respect to the SYNC signal.

General	Autoconfig Master/Slaves			Ether CAT
Function Code	EtherCAT NIC Setting			
Update	Destination Address (MAC) FF	-FF-FF-FF-FF-FF	Broadcast	Enable Redundancy
Sync Unit Assignment	Source Address (MAC) 00	00-00-00-00-00 Browse		
EtherCAT I/O Mapping	Select network by MAC	Select netwo		
Status	J Distributed Clock		Options	
Information	Cycletime 4000 Sync Offset 12 Sync Window Monitoring Sync window 1	↓ µs ↓ %	Use LRW inst	ead of LWR/LRD ges pertask laves

The distributed clock is used in applications that require very high synchronization between slaves. All slave clocks are aligned with the same time reference and generate synchronous events within each slave. The interruption

For good synchronization, the SYNC signal that triggers a process data update must always follow the receipt of the frame carrying new data values. However, the transmission time of the frame may fluctuate depending on the implementation of the master, and therefore the frame carrying new output data may overlap with the SYNC signal.



The following image show the EtherCAT slave timing:



- EoF: End of Frame
- SoF: Start of Frame. Ethernet SOF delimiter at the end of the preamble of Ethernet frames
- PDI: Process Data Interface or Physical Device Interface: an interface that allows access to ESC from the process side
- IRQ: Master application cycle time
- SYNC: Signal generated by the Distributed Clocks unit
- Offset [2]: value related with "Sync Offset" from the EtherCAT Master configuration



6.9 BLACKBOX

The black box is used for data collection when a fault occurs, which is convenient for analyzing the cause of the fault.

	1	Condition Setting		
Read Blackb. 10 Clear Blackb		Sampling	0-Fast	~
hannel Selection		BlackBox Mode	0-Not open	~
Interrupt time	<u>^</u>			
Bus voltage DI status		Specify Error Code:	101.0(Abnormal parameters in	a group ∨
DO status		Time Oracities		
Current feedback		Ingger Condition		
Torque reference HOB28	>>	Triager Source:	Interrupt time	
D-axis instruction			0	
H0B29		Irigger Level:	•	
HOB30 Phase II feedback current	<<		0.01(0-65535)	
Phase V feedback current		Trigger Level	O-Rising edge	
Speed feedback		Tridder Fever		
Speed reference		Trigger	0	
Control word				

[01] Condition setting: enable the black box function, please set the condition parameters correctly, otherwise the data will not be captured normally

[02] Sampling frequency: 0-fast (sampling frequency: 16 kHz, sampling interval 62.5us), 1-medium (4 kHz, sampling interval 250us), 2-slow (1 kHz, sampling interval 1ms).

[03] Trigger mode: 0-not open, 1-arbitrary failure, 2-specified failure, 3-specified condition trigger; When the trigger mode is 2-specified fault, you can select the corresponding specified fault code through the drop-down menu [4]. At this time, you can also configure the trigger position. The trigger position refers to the data collected before and after the trigger condition

When the trigger mode is 3-specified condition trigger, the trigger source selects the corresponding observation channel variable through the drop-down menu [5], and sets the trigger level. When you want to view the value of the observation variable crossing the trigger level [6] from small to large, the trigger level selection [7] can select 0-rise Edge, if it crosses the trigger level from large to small, select 2-falling edge, etc.

Click the "Set" button [1] to send the black box trigger condition to the driver

In addition, users can click "Read last configuration" [9] to get the trigger condition information set last time; 3. Black box data acquisition

Select the channels to be observed, up to 4 channels: click the button >> and << to delete the channels

Click "Read Black Box Data" [10] to start reading the black box data. After reading, it will jump to the oscilloscope interface to display the channel data



6.11 CHANGE INTERFACE LANGUAGE

To change the language of the user interface, access the main tab of the program and click on the button "Language Settings". Select the desired language on the dialog that appears.

							Inc	DriverShop	Home Page						\Box ×
General Pro	oject														UI Style 🔻
Work Space		Help		Check upgrading											,
Full scroop	1	About		check upgroung											
U rui screen	Language	About													
	Setting	- Home	Page												
Window	Setting		Hel	р											
Work Space				4 💶 🐔	Home Pa	ige 🔳									•
- <u>-</u> Project						_							~		
				Language Di	tionary										
				Dictionary	2	Dictionant	ath	InoDrive	Shop\InoDrive	orkshop 3, 2, 1, 2	Overseas\Dict	tionary\Dictionary.dat			
				System D	ictiona	Dictionary P	aur								
						Version Nur	mber	1. 0. 0. 0		Enable Mul	i-Language				
						System Def	fault Lang	English	3	Enable For	t i i i i i i i i i i i i i i i i i i i				
										_					
						Row In	Langua	Language	Region name	Native language n.	Font	^			
						001	0x0436	ar-2A	Albania	shoin	米林				
						003	0x3801	ar-AE	United Ar	العربية	宋体				
						004	0x042b	hy-AM	Armenia	Հայերեն	宗体				
						005	0x042c	az-Lat	Azerbaijan	azərbaycan	宋体				
						006	0x042d	eu-ES	Spain	euskara	宋体				
						007	0x0423	be-BY	Belarus	балгару	米体				
						000	0x0402	ca-ES	Snain	català	未 件 実体				
						✓ = 010	0x0804	zh-CN	China	中文(简体)	宋体				
						011	0x0404	zh-TW	Taiwan	中文(繁體)	宗体				
						012	0x041a	hr-HR	Croatia	hrvatski	宗体				
						013	0x0405	cs-CZ	Czechia	čeština	宗体			IN	IOVANCE
Daram Monitor			-			014	0X0406	da-DK	Denmark	dansk	木 体	~			N a 📰
Param Monitor						Add		Delete	Edit						13° 🕈 📫
Ro Module Na	ame F	-unction c	Descriptio												
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94	45x563 16	5:37:19 - Exp	orted to:	Copy to clipboar	ł										



7 AXIS SCALING

There are two methods for modifying the axis scaling or application units: modify scaling on the SV660N or on the EtherCAT master. These two methods are described in the following sections.

7.1 SV660N SCALING CONFIGURATION

The following figure shows the relationship between the position reference (reference unit), load displacement, and electronic gear ratio.



Scaling factor -	6091 - 1h	H05 - 07	Encoder resolution	🦯 Gear input turns	Load turns
scaling factor =	6091 - 2h	$\frac{1}{H05 - 09}$	Motor turns	Gear output turns	Application units

Step	Item		Mechanism	
		Ball Screw	Belt Pulley	Rotary actuator
1	Mechanical parameters	Reduction ratio R: 2/1 Lead: 0.01 m	Reduction ratio R: 5/1 Diameter of belt pulley: 0.2 m (circumference: 0.628 m)	Reduction ratio R: 10/1 Load rotating angle for one load shaft revolution: 360°
2	Encoder resolution	23 bit 8388608 pulses/revolution	23 bit 8388608 pulses/revolution	23 bit 8388608 pulses/rev.
3	Application units	1µm=0.00001 m	0.1mm=0.001m	0.01°
4	Calculation	$\frac{8388608}{1} \times \frac{2}{1} \times \frac{1}{0.01/0.00001}$	$\frac{8388608}{1} \times \frac{5}{1} \times \frac{1}{0.628/0.001}$	$\frac{8388608}{1} \times \frac{2}{1} \times \frac{1}{360/0.01}$
5	Setting	H05-07=16777216 H05-09=1000	H05-07=41943040 H05-09=628	H05-07=83886080 H05-09=36000



7.2 INOPROSHOP SCALING CONFIGURATION

The axis scaling can also be modified from the EtherCAT Master. This section describes the scaling configuration using the InoProShop software.

Follow this procedure to change the axis scaling:

- 1. Open axis configuration
- 2. Select Scaling
- 3. Select "Do not use gearbox" if so is
- 4. Select the corresponding units. This does not affect to the axis behavior, it is only for information purpose.
- 5. Define the encoder pulse/revolution.
 - a. 23 bit encoder: set 16#800000 or 8388608
 - b. 20 bit encoder: set 16#100000 or 1048576
 - c. Another kind of encoder set the corresponding value
- 6. Define travel distance for motor rotation

Devices 👻 🕈 🛪	ite SlaveAxis 🗙							
Training 2 Test Training 2 Test Device (AM600-CPU 1608TP/TN)	General Setting	Unit in application						
Device Diagnosis	Scaling 2	🔿 pulse 🔿 mm 🔿 um 🔿 nm 💿 degree 🔿 inch 🔮						
Network Configuration		Travel Distance						
PLC Logic SoftMotion General Axis Pool	Homing Setting	Invert Direction						
HIGH_SPEED_IO (High Speed IO Mod	Mapping/Other Setting	Command pulse count per motor rotation 5 16#800000 pulse/rev						
MODBUS_TCP (ModbusTCP Device)		Do not use gearbox						
😑 📃 ETHERCAT (EtherCAT Master SoftMotio	Commissioning							
AM600_RTU_ECTA (AM600-RTU-EC	SM Drive ETC GenericDSP402: I/O	Work travel distance per motor rotation 6 360 degree/rev						
■ IS810N (IS810_2Axis_V2.02)	Mapping	Reference: Unit conversion formula						
InoSV660N_2 (SV660_1Axis_V0.08)	Status	Command pulse count per motor rotation [DINT]						
SlaveAxis (Axis)	Information	Number of pulses [pulse] = * Travel distance [Unit in application] Work travel distance per motor rotation [LREAL]						

Follow the next procedure if there is a mechanical transmission ratio:

- 7. Enable gearbox option
- 8. Define travel distance for load rotation
- 9. Set numerator of the gear ratio
- 10. Set denominator of the gear ratio

Use gearbox				
Work travel distance per work	<pre>c rotation</pre>	8	360 degree/rev	
(Please refer to the Modulo v	alue in General Setting if the Axis type is Modulo m	ode)		
Numerator of the gear ratio (the number of teeth (5) in the following picture)	9	1	
Denominator of the gear ratio	o (the number of teeth (4) in the following picture)	10	1	
The Axis type is Linear mode				
Reference: Unit conversion formu	la			
Number of pulses [pulse] =	Command pulse count per motor rotation [DINT]	*	Numerator of the gear ratio [DINT]	* Travel distance [] Init in application]
interior puises (puise) = .	Work travel distance per work rotation [LREAL]		Denominator of the gear ratio [DINT]	have distance [onit in application]

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Item		Mechanism			
	Ball Screw	w Belt Pulley			
Mechanical parameters	Reduction ratio R: 2/1 Lead: 0.01 m	Reduction ratio R: 5/1 Diameter of belt pulley: 0.2 m (circumference: 0.6283185 m)	Reduction ratio R: 10/1 Load rotating angle for one load shaft revolution: 360°		
Encoder	23 bit	23 bit	23 bit		
resolution	8388608 pulses/revolution	8388608 pulses/revolution	8388608 pulses/rev.		
Application units	μm	millimetres	Degrees		
Setting	 Encoder count/rev: 16#800000 Enable Gear box Load displacement: 0.01m=10000 μm Gear numerator: 1 Gear denominator: 2 	 Encoder count/rev: 16#800000 Enable Gear box Load displacement: 628.3185 mm Gear numerator: 1 Gear denominator: 5 	 Encoder count/rev: 16#800000 Enable Gear box Load displacement: 360° Gear numerator: 1 Gear denominator: 10 		

Ball screw:

Unit in application			
Travel Distance			
Invert Direction			
Command pulse count per motor rotation	16#800000 pulse/rev		
O Do not use gearbox	L		
Work travel distance per motor rotation	360 um/rev		
Reference: Unit conversion formula			
Command pulse count per motor rotation [DINT]	* Travel distance [] Init in application]		
Work travel distance per motor rotation [LREAL]	- maver distance [onit in application]		
Use gearbox			
Work travel distance per work rotation	10000 um/rev		
(Please refer to the Modulo value in General Setting if the Axis type is Modulo mo	ide)		
Numerator of the gear ratio (the number of teeth (5) in the following picture)	2		
Denominator of the gear ratio (the number of teeth (4) in the following picture)	1		
The Axis type is Linear mode			
Reference: Unit conversion formula			
Command pulse count per motor rotation [DINT]	Numerator of the gear ratio [DINT] * * Travel distance [Unit in application]		
Work travel distance per work rotation [LREAL]	Denominator of the gear ratio [DINT]		



Belt Pulley:

Unit in application O pulse mm O) um 🔿 nm 🔿 degree 🔿 inch	
Travel Distance		
Invert Direction		
Command pulse count per moto	or rotation	16#800000 pulse/rev
○ Do not use gearbox		
Work travel distance per motor r	rotation	360 mm/rev
Reference: Unit conversion formula		
	Command pulse count per motor rotation [DINT]	
Number of pulses [pulse] =	Work travel distance per motor rotation [LREAL]	 Travel distance [Unit in application]
Use gearbox		
Work travel distance per work ro	otation	628.3185 mm/rev
(Please refer to the Modulo valu	e in General Setting if the Axis type is Modulo mo	de)
Numerator of the gear ratio (the Denominator of the gear ratio (t	e number of teeth (5) in the following picture) the number of teeth (4) in the following picture)	5
The Axis type is Linear mode		
Reference: Unit conversion formula		
C Number of pulses [pulse] =	Command pulse count per motor rotation [DINT]	Numerator of the gear ratio [DINT]
Number of pulses [pulse] =	Work travel distance per work rotation [LREAL]	Denominator of the gear ratio [DINT]

Rotary Actuator:

Unit in application O pulse O mm	⊖um ⊖nm					
Travel Distance						
Invert Direction						
Command pulse count per mo	ator rotation	16#800000 pulse/rev				
O Do not use gearbox						
Work travel distance per moto	or rotation	360 degree/rev				
Reference: Unit conversion formu	la					
Number of subset for loss	Command pulse count per motor rotation [DINT]	t Tourist distance film in configuration				
Number of pulses [pulse] =	Work travel distance per motor rotation [LREAL]	ERAL] Travel distance [Unit in application]				
Use gearbox						
Work travel distance per work	rotation	360 degree/rev				
(Please refer to the Modulo v	alue in General Setting if the Axis type is Modulo mo	de)				
Numerator of the gear ratio (the number of teeth (5) in the following picture)	10				
Description of the second						
Denominator of the gear ratio	(the number of teeth (4) in the following picture)					
The Axis type is Linear mode						
Reference: Unit conversion formu	la					
Number of pulses [pulse] =	Command pulse count per motor rotation [DINT]	Numerator of the gear ratio [DINT]				
	Work travel distance per work rotation [I PEAL]	 Travel distance [Unit in application] 				

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7.2.1 VELOCITY CALCULATION

The default speed of PLCOpen FBs is "application units / second". The following formula is used to calculate the axis velocity from the motor revolutions per minute (RPM):

Axis velocity
$$\left(\frac{application\ units}{s}\right) = \frac{(RPM)}{60\ s} \cdot Load\ displacement\ per\ rev. \cdot \frac{gear\ ratio\ numerator}{gear\ ratio\ denominator}$$

Ball screw:

Use this formula to fix the motor speed to 300 RPM

Axis velocity
$$\left(\frac{application units}{s}\right) = \frac{300 \text{ RPM}}{60 \text{ s}} \cdot 10000 \mu \text{m} \cdot \frac{1}{2} = 1500000 \frac{\mu \text{m}}{\text{s}}$$

Belt Pulley:

Use this formula to fix the motor speed to 200 RPM

Axis velocity
$$\left(\frac{application units}{s}\right) = \frac{200 RPM}{60 s} \cdot 360^{\circ} \cdot \frac{1}{10} = 120 \frac{\text{degree}}{s}$$

Rotary Actuator:

Use this formula to fix the motor speed to 200 RPM

Axis velocity
$$\left(\frac{application units}{s}\right) = \frac{200 RPM}{60 s} \cdot 360^{\circ} \cdot \frac{1}{10} = 120 \frac{\text{degree}}{s}$$



8 ABSOLUTE ENCODER SYSTEM

8.1 LINEAR MODE



To configure the absolute position with its limits of a linear axis it may be necessary to access the following objects of the CiA402. To access these objects, follow the steps in the section 9.4 CiA402 Object Dictionary

CiA402 Object	Description	Unit	Range	Default
607C-00h	Home offset	Application units	-2 ³¹ to +(2 ³¹ - 1)	0
6098-00h	Homing method	-	1-35	26
60E6-00h	Actual position calculation method	-	 0-Absolute position homing After homing is done, the following formula applies: 6064h (Position actual value) = 607Ch (Home offset) 1-Relative position homing After homing is done, the following formula applies: 6064h (Position actual value) = Present position feedback value + 607Ch (Home offset) 	0
607D-01h	Negative software limit	Application units	-2 ³¹ to +(2 ³¹ - 1)	-2 ³¹
607D-02h	Positive software limit	Application units	-2 ³¹ to +(2 ³¹ - 1)	2 ³¹ - 1

Drive parameters:

Drive Parameter	Description	Unit	Range	Default
H02-01	Absolute system selection	-	0-Incremental position mode 1-Absolute position linear mode 2-Absolute position rotation mode 3-Absolute position linear mode 2 4-Single-turn absolute mode	0
H05-46 (2005-2Fh)	Position offset in absolute position linear mode (low 32 bits)	encoder counts	-2 ³¹ to +(2 ³¹ - 1)	0
H05-48 (2005-31h)	Position offset in absolute position linear mode (high 32 bits)	encoder counts	-2 ³¹ to +(2 ³¹ - 1)	0
H05-30 (2005-1Fh)	Local homing	-	0-No operation 6-Current position as home	0

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H05-36	Local home offset		-2 ³¹ to	
(2005-25h)		-	+(2 ³¹ - 1)	0

These two parameters (H05-46, H05-48) define the offset of the mechanical absolute position (H0B-58, H0B-60 encoder unit) relative to the motor absolute position (H0B-77, H0B-79 encoder unit) when the absolute encoder system works in the linear mode (H02-01 = 1).

Position offset in the absolute position linear mode = Motor absolute position - Mechanical absolute position

(H05-46, H05-48) = (H0B-77, H0B-79) - (H0B-58, H0B-60)

NOTE Default values of these two parameters are 0 in the absolute position linear mode. After homing is done, the servo drive automatically calculates the deviation between the absolute position feedback by the encoder and the mechanical absolute position, assigns the deviation value to H05-46 and H05-48, and saves the deviation in EEPROM.



8.1.1 MASTER CONTROLLER HOME

The following figure shows the general procedure for absolute linear mode configuration using the PLCOpen FB MC_Home:




8.1.2 LOCAL HOME

The following figure shows the general procedure for absolute linear mode configuration using the drive local home:



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8.2 DATA RANGE IN THE ABSOLUTE POSITION LINEAR MODE

The absolute encoder records the single-turn position (H0B-71) and the number of revolutions (H0B-70). With a single-turn resolution up to 8388608 (2^{23}) pulses, the encoder can record 16-bit multi-turn data.

The multi-turn data range in the absolute position linear mode is **-32768 to +32767**. If the number of forward revolutions is larger than 32767 or the number of reverse revolutions is smaller than -32768, E735.0 (Encoder multi-turn counting overflow) will occur. In this case, set H0D-20 (200D-15h - Absolute encoder reset selection) to 2 (Reset the encoder fault and multi-turn data) to reset the multi-turn data and perform homing again.

In special occasions, you can set H0A-36 (200A-25h - Multi-turn overflow fault of absolute encoder) to 1 (Hide) to hide E735.0 or use absolute position linear mode 2.

Parameter H0B-07 shows the absolute position of the axis. With the default values of the drive, this parameter has a range between 2 ^ 31 to 2 ^ 31. With this configuration the **axis range is 512 turns**. It can make 256 turns in the positive direction and 256 turns in the negative direction before exceeding the limit of the parameter.

To increase the number of absolute encoder turns stored in parameter H0B-07, it is necessary to modify the scaling of the axis (H05-07 and H05-09). The absolute multi-turn information is stored in the parameters H0B-77 and H0B-79. The parameter H0B-07 is calculated from parameters H0B-77 and H0B-79. The multi-turn information for these parameters is in the range of -32768 to +32767. Therefore, by modifying the scaling of the axis, we can increase the multi-turn information stored in parameter H0B-07.

$$HB_07 = \frac{H05_09}{H05_07} \times H0B_79 \times 2^{32} + H0B_77 - (H0B_40 \times 2^{32} + H0B_48)$$

Absolute Gear Ratio Encoder Multi-turn Home Offset position

The below image shows the absolute position parameters range.



HOB-71 Position of the absolute encoder within one turn









8.3 ABSOLUTE ENCODER SYSTEM PARAMETERS DIAGRAM





9 APPENDIX

PHASE ANGLE TUNING 9.1

INOVANCE motors are already phased out of the box. The phase value is stored in the encoder parameter H00-28. If for some reason the value of the phase angle is not correct, a phase angle tune can be carried out with the following procedure:

- 1. Open "Bus motor parameters" screen
- 2. Select the corresponding axis
- 3. Upload all parameters from encoder
- 4. See the value of H00-28, it should be close to 0 (below 15000, the range is 0 2^32)
- 5. Open the angle initialization dialog WARNING When the angle initialization starts the motor will move around 60 degrees. It can be connected to the load, but better if it is free
- 6. Click the "Start" button, the motor move around 60 degrees and stops
- 7. Doing angle tune
- 8. Angle tune finish
- 9. Close the dialog.
- 10. Probably the parameter H00-28 has changed. Check if the value it is close to 0. If the procedure is repeated a few times the value should be similar
- 11. Restart the drive. Changes in the parameter H00-28 have no effect until the computer is restarted

NOTE During the angle initialization process could appears the error E941.0 "Parameter modifications activated at next power on. That is because the parameter H00-28 value has changed.







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9.2 DRIVE LOOPS CYCLE TIME

By default the drive loops cycles are:

- Position command: refresh frequency of position command, related to the par H01-61 command scheduling frequency, 1 kHz/2 kHz /4 kHz /8 kHz, sample cycle up to 125μs, default 4 kHz, 250 μs.
- Position loop cycle: related to the par H01-60 FPGA scheduling frequency, 8KHz/16Khz, sample cycle up to 62.5μs, default 16 kHz, 62.5 μs.
- Velocity loop cycle: related to the par H01-60 FPGA scheduling frequency, 8 kHz /16 kHz, sample cycle up to 62.5μs, default 16 kHz, 62.5 μs.
- Current loop cycle: 1.6 µs, 625 kHz, cannot be modified.

To change the cycle of the position or speed loop, it is necessary to activate the super user mode with the password: "SuperAdmin" or H02-41 = 1430 (factory password)

Upload and save	Upload and save		Save settings	Write all	Write	all tick	V5		Axis copied	Find		× _			
(Current page all)	(All tick options)	Open recipe	(All tick options)	(Except group H00 and H01	s options) pa	(current ige)	Compare	-	Select all (curre	5	Super adm	inis ~ 🛡)		
Ax Function co	Description				Setting value	current	value			Defa.	. Minimu	Maximu	Unit	Modifi	Effecti
A H01-00	MCU software	version				902.3				0.0	0.0	6553.5		No	
A H01-01	FPGA softwar	e version				902. 9				0.0	0.0	6553.5		No	
A H01-07	Software tes	t version				0.00				0.00	0.00	655.35		No	
A H01-08	Model parame	ter version				2.00				0.00	0.00	655.35		No	
A H01-10	Servo drive	series No.			3[S2R8]	3[S2F	18]			3	0	65535		Dow	Pow
A H01-11	Voltage clas	s of the drive u	nit			220				220	0	65535	V	No	
A H01-12	Rated power	of the servo dri	ve			0.40				0.40	0.00	1073	kw	No	
A H01-14	Max. output	power of the ser	vo drive			0.40				0.40	0.00	1073	kw	No	
A H01-16	Rated output	current of the	servo drive			2.80				2.80	0.00	1073	Α	No	
A H01-18	Max. output	current of the s	ervo drive			10.10				10.10	0.00	1073	Α	No	
A H01-20	Carrier freq	uency				8000				8000	4000	20000	HZ	Dow	Pow
A H01-21	Dead zone ti	me				2.00				2.00	0.01	20.00	us	Dow	Pow
A H01-22	D-axis coupl	ing voltage comp	ensation coeffic:	ient		100.0				50.0	0.0	1000.0	96	Any	Imm
A H01-23	Q-axis back	EMF compensation	coefficient			100.0				50.0	0.0	1000.0	%	Any	Imm
A H01-24	D-axis curre	nt loop gain				700				500	0	20000	HZ	Any	Imm
A H01-25	D-axis curre	nt loop integral	compensation fac	ctor		2.00				1.00	0.01	100.00		Any	Imm
A H01-26	Current samp	ling Sinc3 filte	r data extraction	n rate		0[Ext	raction r	ate 3	32]	0	0	3		Dow	Pow
A H01-27	Q-axis curre	nt loop gain				400				500	0	20000	HZ	Any	Imm
A H01-28	Q-axis curre	nt loop integral	compensation fac	ctor		2.00				1.00	0.01	100.00		Any	Imm
A H01-29	Q-axis coupl	ing voltage comp	ensation coeffic:	ient		6553. 5	5			50.0	0.0	1000.0	%	Any	Imm
A H01-30	Bus voltage	gain adjustment			101.7				100.0	50.0	150.0	96	Dow	Pow	
A H01-32	Relative gai	lative gain of UV sampling				32768				32768	3 1	65535		Dow	Pow
A H01-34	Servo drive	over-temperature			90				90	0	150	°C	Any	Pow	
A H01-36	Current sens	Current sensor range				20.83				62.50	0.00	9999.99	A	Dow	Pow
A H01-38	FPGA phase c	urrent protectio	n threshold			90.0				90.0	0.0	100.0	%	Dow	Pow
A H01-39	Current loop	version No.				0x0000)			0x0	0x0	0xFFFF		Dow	Pow
A H01-40	DC bus overv	DC bus overvoltage protection threshold								420	0	2000	V	No	
A H01-41	DC bus volta	ge discharge thr	eshold			380				380	0	2000	V	Dow	Imm
A H01-42	DC bus under	voltage threshol	d			200				200	0	2000	V	Any	Imm
A H01-52	D-axis propo	rtional gain in	performance prio	rity mode		900				2000	0	20000	HZ	Any	Imm
A H01-53	D-axis integ	ral gain in perf	ormance priority	mode		2.00				1.00	0.01	100.00		Any	Imm
A H01-54	Q-axis propo	rtional gain in	performance prior	rity mode		900				2000	0	20000	HZ	Any	Imm
A., H01-55	Q-axis integ	ral gain in perf	ormance priority	mode		2.00				1.00	0.01	100.00		Any	Imm
A H01-56	Current loop	low-pass cutoff	frequency			11000				11000	0 (65535	HZ	Dow	Pow
A H01-59	Serial encod	ler data transmis	sion compensation	n time		0.000				0.000	0.000	2.000	us	Dow	Pow
A H01-60	FPGA schedul	ing frequency se	lection			1[16	kHz]	2		1	1	2		Dow	Pow
A H01-61	Command sche	duling frequency	selection			0[4]	Hz]	•		3	0	3		Dow	Pow
A H01-62	Auto-tuning	of servo drive m	odel			3				0	0	65535		No	
A H01-66	Current loop	configuration				12				12	0	31	KHZ	Any	Imm
A H01-67	Dead zone co	mpensation coeff	icient			1.00				1.00	0.00	2.00		Any	Imm
A H01-68	Current obse	rver cutoff free	uency			2000				2000	200	5000		Any	Imm
A., H01-69	Current obse	rver correction	coefficient			1.00				1.00	0.00	9.00		Any	Imm
A., H01-72	Servo drive	model auto-tunin	g selection			0[Not	hide]			0	0	1		Any	Pow
A., H01-73	电流采样延迟	时间	-			1				1	0	7		Any	Pow



9.3 POSITION REFERENCE FILTER

This function filters the position references divided or multiplied by the electronic gear ratio. It involves the first-order filter and moving average filter.

The next two parameters explain the reference position filter:

H05-04 First-order low-past filter time constant

It sets the time constant of first-order low-pass filter for position reference (encoder unit).

If position reference P is rectangular wave or trapezoidal wave, the position reference after first-order low-pass filter is as follows:



This function has no effect on displacement (position reference sum).

Too large setting of this parameter will cause an increase in response delay. Set this parameter correctly according to actual condition.

H05-05 Moving average filter time constant 1

It sets the time constant of moving average filter for position references (encoder unit). If position reference

P is rectangular wave or trapezoidal wave, the position reference after filter of average value is as follows:



This function has no effect on displacement (position reference sum). Too large setting of this parameter will

cause an increase in response delay. Set this parameter correctly according to actual conditions.



9.4 CIA402 OBJECT DICTIONARY

Using the InoProShop software it is possible to access the CiA402 object dictionary list. Access to these objects is through the "Dedicated parameter list" option. This option shows us a list with some of the objects already configured:

																			- C	
General	Project	SV660N_1	SV660	0N_2																UI Style 📍
	6			ച	6		Co		0	562	I← (0		a 6	. ·	1			
	U	/ 🛛 💟			ి	•	्र	> (լեր	\rightarrow \checkmark	7 <u>/</u>	∆ ~≪	= 2	<u> </u>	<u>.</u>	.			
Emergency	Cano	el Prog	ram Red	cover to	Rotati	on	Conn	et Disc	onnect Modify static	n Inertia	Tuning I	D Fau	lt Mechanica	al Param Conti	nuous Multi-n	nachine Z	Signal			
stop	emergenc	y stop res	set defa	ault value d	irectio	n▼			number	identificati	on Set	ting Manage	ment analysis	List O	sc rec	ipe S	Search			
		Contro	bl						General				Function							
Work Space				4 ×	۲	SV6	60N_2]Dedic	ated parameter list									 		•
🖃 🛄 Projec	ct				Set	nrival	te ad		Select avis Axis1		~	Download f	th Unload a	Inar Save	recipe	nen recine				
= = sv66	60n_dual_a	axes Eile			-	pinto			Sereet and				opiodala	- participation	- oopo	porrioup				
	ontinuous	P11e Osc			ID	1	Index	Sub I	Parameter Name	Setting valu	e curren	it value	Minimum value	Maximum value	e Data Type	Input	Read			
-B 0r	Den wave	data file				1 (605A	0	Quick stop option .	. 2	2[Ran	np to stop a	. 0	7	short	Drop	Read			
- 🔍 Tı	rigger Se	tting				2 (605C	0	Stop mode at S-O	. 0	0[Coa	st to stop,	-3	1	short	Drop	Read			
- 🖆 Pa	aram Moni	tor				3 (605D	0	Stop option code	1	1[Ran	np to stop a	. 1	3	short	Drop	Read			
🖨 🖛 SI	V660N_1[1]]				4 (605E	0	Stop mode at No	2	2[Ran	np to stop a	5	3	short	Drop	Read			
-0	Param Li	st				5 (6060	0	Modes of operation	8	8[Cyc	ic Synchro	0	10	char	Drop	Read			
	Usabilit	y adjustmen	it			6 (6061	0	Modes of operatio	. 0	8[Cyc	ic Synchro	0	10	char	Drop	只读			
-0	→ IO Setti	ng			Ne l	7 (6065	0	Following error wi.	. 27486951	27486	/951	0	4294967295	unsigned int	General	Read			
- 🗖	Speed J0	G			No.	8 (6066	0	Following error ti	0	0		0	65535	unsigned	General	Read			
R	Position	JUG			No.	9 1	6067	0	Position window	5872	5872		0	4294967295	unsigned int	General	Read			
	Machanic	al analysis	5		¥.	10	6000	0	Position window u.		0	nund hemi	0	00000	unsigned	General	Read			
	Dedicate	d parameter	list		H١.	12 4	6001	2	Forming mode	20	20[F0	ward nomi	. 0	33	unsigned int	Coporal	Read			
· •	Contrast	output	1150		١Ľ	12 1	6001	1	Gear ratio (numor	1	1		1	4294907293	unsigned int	General	Read			
-0	BlackBox		× 1		H.	14	60091	0	Velocity threshold		0		0	65525	unsigned inc	General	Read			
	Device I	nformation			H.	15	AF.	0	Velocity threshold	10	10		0	65535	unsigned	General	Read			
-4	Fault Ma	nagement			H.		606E	0	Velocity window ti	0	0		0	65535	unsigned	General	Read			
	Reset to	zero			1	17	606D	0	Velocity window	10	10		0	65535	unsigned	General	Read			
🕀 🧒 SV	V660N_2[2]	1				18	6502	0	Supported drive m.	. 0	941		0	4294967295	unsigned int	General	只读			
					H	19	2000	1	Model filter time 2	0	941		0	65535	unsigned int	General	口读			
						20 (607D	1	Negative software .	-214748364	8 -2147	483648	-2147483648	2147483647	int	General	Read			
						21	607D	2	Positive software li.	0	21474	183647	-2147483648	2147483647	int	General	Read			
					<u> </u>															
					1	4	Δdd		Modify	Dele	te									
									mouny	2010										
																		System Tir	me 2021-02	-07 17:15:06

Through the "Add" and "Modify" buttons we can modify this list to access the different objects of the CiA402 object dictionary. The next image shows dialog box with values to add the CiA402 object 607D-01h "Negative software limit":

etting parametersSe	etting parameters			\times
General Parame	ter option			
	Parameter		Negative software limit	
	Index	0x	607D	
	Sub Index	0x	1	
	Minimum value		-2147483648	
	Maximum value		2147483647	
	Parameter value		int 🗸	
	只读		Read and write	
			OK Conc	
			UK Calice	51

