Super Agilis Series

CONEX-SAG Controller
with SAG-xxxx Stages

Newport™

User's Manual

V1.1.x

Warranty

Newport Corporation warrants that this product will be free from defects in material and workmanship and will comply with Newport's published specifications at the time of sale for a period of one year from date of shipment. If found to be defective during the warranty period, the product will either be repaired or replaced at Newport's option.

To exercise this warranty, write or call your local Newport office or representative, or contact Newport headquarters in Irvine, California. You will be given prompt assistance and return instructions. Send the product, freight prepaid, to the indicated service facility. Repairs will be made and the instrument returned freight prepaid. Repaired products are warranted for the remainder of the original warranty period or 90 days, whichever occurs last.

Limitation of Warranty

The above warranties do not apply to products which have been repaired or modified without Newport's written approval, or products subjected to unusual physical, thermal or electrical stress, improper installation, misuse, abuse, accident or negligence in use, storage, transportation or handling.

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Original instructions.

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EU Declaration of Conformity

2 Tech Drive
Andover, MA 01810
www.mksinst.com

EU27 Declaration of Conformity

Application of Council Directive(s):
☒ Electromagnetic Compatibility Directive (EMCD) – 2014/30/EU
☒ Machinery Directive – 2006/42/EC
☒ Restriction of Hazardous Substances Directive (RoHS3) – (EU) 2015/863(7)
☒ Waste Electrical and Electronic Equipment – Directive 2012/19/EU

Standard(s) to which conformity is declared:
☒EN 61326-1:2013 – (EMC)
☒EN ISO 12100:2010 Safety of Machinery – General Principles of Design – Risk Assessment and Risk Reduction

Emissions:
☒EN 55011: 2016 +A1:2017 (4) Industrial, scientific and medical equipment - Radio-frequency disturbance characteristics - Limits and methods of measurement
☒IEC 61000-6-4: 2018 Emission standard for industrial environments

Immunity:
☒EN 61000-4-2:2009 EMC/Electrostatic Discharge Immunity Test
☒EN 61000-4-3:2006+A2:2010 EMC/Radiated Radio Frequency Electromagnetic Field Immunity Test
☒EN 61000-4-4:2012 EMC/Electrical Fast Transient/Burst Immunity Test
☒EN 61000-4-6:2014 EMC/Conducted Disturbances induced by Radio Frequency Fields Immunity Test
☒IEC 61000-6-2:2016 Immunity standard for industrial environments

Manufacturers Name: MKS Instruments, Inc., 2 Tech Drive, Andover, MA 01810 USA

Authorized Representatives Name & Location: _____

Equipment Type/Description: **CONTROLLER CONEX SUPER AGILIS**

Model Number(s) (6): CONEX-SAG-LS16, CONEX-SAG-LS32, CONEX-SAG-LS48
CONEX-SAG-LS16P, CONEX-SAG-LS32P, CONEX-SAG-LS48P

The object of the declaration described above is in conformity with the relevant Community harmonization legislation. MKS product conforms to the above Directive(s) and Standard(s) only when installed in accordance with manufacturer's specifications. This declaration has been issued under the sole responsibility of the manufacturer.

Date: 3/15/2022

Signature:

Full Name: **Le Cointe Hervé**

Title: **Quality Director**

4) Class A, Group 2
6) Compliance of the above model numbers requires the use of a braided shielded cable properly terminated at both ends – if so noted in the MKS Instruction Manual.
7) RoHS Directive has to be checked for in scope products; cannot CE mark without compliance to RoHS. RoHS Directive can be unchecked only for systems which MKS sells which qualify for "Large Scale Industrial Tool" exclusion.

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Andover, MA USA

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Document Number: MKS-GPC-TM-20062

UK Declaration of Conformity

2 Tech Drive
Andover, MA 01810
www.mksinst.com

UK Declaration of Conformity

Application of Council Directive(s):

☒ Electromagnetic Compatibility Directive (EMCD) – 2014/30/EU
☒ Machinery Directive – 2006/42/EC
☒ Restriction of Hazardous Substances Directive (RoHS3) – (EU) 2015/863(7)
☒ Waste Electrical and Electronic Equipment – Directive 2012/19/EU

Standard(s) to which conformity is declared:

☒BS EN 61326-1:2013 – (EMC)
☒BS EN ISO 12100:2010 Safety of Machinery – General Principles of Design – Risk Assessment and Risk Reduction

Emissions:

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☒IEC 61000-6-4: 2018 Emission standard for industrial environments

Immunity:

☒IEC 61000-4-2:2008 EMC/Electrostatic Discharge Immunity Test
☒IEC 61000-4-3:2006 2006+AMD1:2007+AMD2:2010 EMC/Radiated Radio - Frequency Electromagnetic Field Immunity Test
☒IEC 61000-4-4:2012 EMC/Electrical Fast Transient/Burst Immunity Test
☒IEC 61000-4-6:2013 EMC/Conducted Disturbances induced by Radio Frequency Fields Immunity Test
☒IEC 61000-6-2:2016 Immunity standard for industrial environments

Manufacturers Name: MKS Instruments, Inc., 2 Tech Drive, Andover, MA 01810 USA

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Equipment Type/Description: **CONTROLLER CONEX SUPER AGILIS**

Model Number(s) (6): CONEX-SAG-LS16, CONEX-SAG-LS32, CONEX-SAG-LS48
CONEX-SAG-LS16P, CONEX-SAG-LS32P, CONEX-SAG-LS48P

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Title: **Quality Director**

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7) RoHS Directive has to be checked for in scope products; cannot CE mark without compliance to RoHS. RoHS Directive can be unchecked only for systems which MKS sells which qualify for "Large Scale Industrial Tool" exclusion.

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Preface

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Service Information

The user should not attempt any maintenance or service of the Super Agilis Controller/Driver and its accessories beyond the procedures outlined in this manual. Any problem that cannot be resolved should be referred to Newport Corporation. When calling Newport regarding a problem, please provide the Tech Support representative with the following information:

- Your contact information.
- System serial number or original order number.
- Description of problem.
- Environment in which the system is used.
- State of the system before the problem.
- Frequency and repeatability of problem.
- Can the product continue to operate with this problem?
- Can you identify anything that may have caused the problem?

Newport Corporation RMA Procedures

Any Super Agilis Controller being returned to Newport must have been assigned an RMA number by Newport. Assignment of the RMA requires the item serial number.

Packaging

The Super Agilis Controller being returned under an RMA must be securely packaged for shipment. If possible, reuse the original factory packaging.

CONEX-SAG Controller with SAG-xxxx Stages Super Agilis Series

1.0 Introduction

1.1 Definitions and Symbols

The following terms and symbols are used in this documentation and also appear on the Super Agilis Controller/Driver where safety-related issues occur.

1.1.1 General Warning or Caution

Figure 1: General Warning or Caution Symbol.

The Exclamation Symbol in Figure 1 may appear in Warning and Caution tables in this document. This symbol designates an area where personal injury or damage to the equipment is possible.

1.1.2 Electric Shock

Figure 2: Electrical Shock Symbol.

The Electrical Shock Symbol in Figure 2 may appear on labels affixed to the Super Agilis Controller/Driver. This symbol indicates a hazard arising from dangerous voltage. Any mishandling could result in irreparable damage to the equipment, in personal injury, or death.

1.1.3 European Union CE Mark

Figure 3: CE Mark.

The presence of the CE Mark on Newport Corporation equipment means that it has been designed, tested and certified as complying with all applicable European Union (CE) regulations and recommendations.

1.2 Warnings and Cautions

The following are definitions of the Warnings, Cautions and Notes that may be used in this manual to call attention to important information regarding personal safety, safety and preservation of the equipment, or important tips.

WARNING

Situation has the potential to cause bodily harm or death.

CAUTION

Situation has the potential to cause damage to property or equipment.

NOTE

Additional information the user or operator should consider.

1.3 General Warnings and Cautions

The following general safety precautions must be observed during all phases of operation of this equipment.

Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the equipment.

- Heed all warnings on the unit and in the operating instructions.
- To prevent damage to the equipment, read the instructions in this manual.
- Only plug the power supply to a grounded power outlet.
- Assure that the power supply is properly grounded to earth ground through the grounding lead of the AC power connector
- Route power cords and cables where they are not likely to be damaged.
- Disconnect or do not plug in the AC power cord in the following circumstances:
  - If the AC power cord or any other attached cables are frayed or damaged.
  - If the power plug or receptacle is damaged.
  - If the unit is exposed to rain or excessive moisture, or liquids are spilled on it.
  - If the unit has been dropped or the case is damaged.
  - If the user suspects service or repair is required.
- Keep air vents free of dirt and dust.
- Keep liquids away from unit.
- Do not expose equipment to excessive moisture (>85% humidity).
- Do not operate this equipment in an explosive atmosphere.
- Disconnect power before cleaning the Controller/Driver unit. Do not use liquid or aerosol cleaners.
- Do not open the CONEX-SAG controller. There are no user-serviceable parts inside.
- Return equipment to Newport Corporation for service and repair.
- Dangerous voltages associated with the 100-240 VAC power supply are present inside the power supply. To avoid injury, do not touch exposed connections or components while power is on.
- Follow precautions for static-sensitive devices when handling electronic circuits.

2.0 System Overview

2.1 General Description

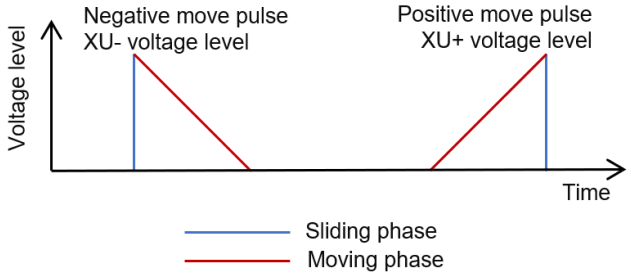
The CONEX-SAG is a single axis motion controller/driver for piezo actuator with encoder feedback. It provides a very compact and low-cost solution for driving a variety of Newport Agilis-type piezo stages from a PC. The SAG-LSxxP stages are closed loop versions with encoder feedback when SAG-LSxx stages are open loop versions.

Communication with the CONEX-SAG is achieved via an USB port (requires Windows™ operating system). A Windows™ based software enables basic motion. Advanced application programming is simplified by an ASCII command interface and a set of two letter mnemonic commands.

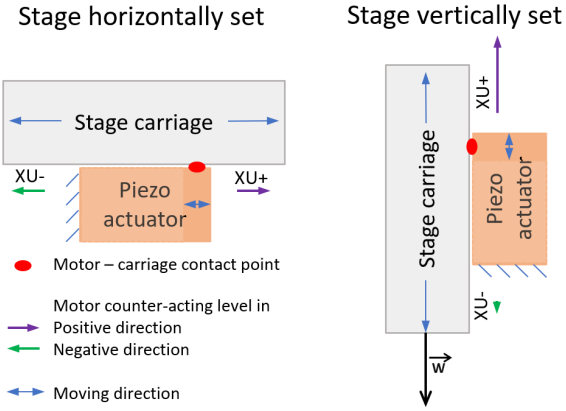
2.1.1 Piezo motion operation

The Piezo motion is obtained using the reverse piezoelectric effect: by powering the piezo it expends and the carriage contact point slides and sticks on the carriage bottom to move it by steps in Jogging phase, or with great sensivity and without sliding in the range of less than a full extension in Shifting and Scanning phases (refer to Closed Loop technology).

The succession of sliding and moving phases generates the moves. The direction of individual moves (steps) are determined by the signal shape and voltage applied to the piezo motor:



The step's size is determined by the pulse's voltage applied to the piezo motor relative to each setup conditions (stage orientation, loading, ...).



Velocity and acceleration parameters are respectively determining the frequency and change in frequency of the pulses applied to the piezo motor.

2.1.2 Encoder Theory of Operation

The SAG-LSxxP stages use a Sine/Cosine encoder which is interpolated to give high resolution position information with low noise. It also presents high positioning repeatability.

2.1.3 Closed Loop technology

The Conex closed loop algorithm for SAG-LSxxP stages is a simplified version of the typical DC servo loop algorithm.

For firmware versions inferior to v.0.17.0, although a motion profile is not generated in the algorithm, the Conex controller still closes a loop based on the error.

For further firmware versions, a motion profiler is used to enhance the displacement's acceleration and velocity control.

The closed loop motions are divided into 3 phases: jogging, shifting and scanning.

The parameters of the different phases, transitions and motion profile are configurable, refer to relevant commands (Command Set) and section Configuring the Controller.

2.1.3.1 Closed Loop Jogging phase

When a new target is requested or when the position error is larger than the output deadband (DB and DDS commands), the motion enters in the jogging phase to move the stage to a shifted target position (SSD command).

- For firmware version inferior to v.0.17.0:

The larger the error, the faster the stage is commanded to move to reduce the error. The stage could start at the full system speed of 10KHz if the stage is far from the desired position.

- For firmware version superior or equal to v.0.17.0:

The stage follows a trapezoid motion profile according to VA (velocity) and AC (acceleration) commands.

The Jogging phase ends when the stage is within a specified range around the shifted target position. This range is called the shift deadband and is set by SSP and SSN commands.

When the position in within the shift deadband for SST×10 ms, the closed-loop motion enters in shifting phase.

2.1.3.2 Closed Loop Shifting phase

During this phase, the stage moves towards the commanded target position by increasing and adjusting the piezo voltage.

The Shifting phase ends when the stage position remains within a specified range around the commanded target position. This range is called the deadband and is set by DBP and DBN commands.

If the stage position remains inside the deadband within DDT×10 ms, the closed-loop motion enters in scanning phase and the controller state is set to ready-closed-loop.

2.1.3.3 Closed Loop Scanning phase

In this phase the motion is considered as ended but the position error is continuously corrected by adjusting the piezo voltage with an integral servo coefficient (SSK).

If a position error superior to output deadband (DB and DDS commands) is detected, the controller switches back to the jogging phase.

2.1.3.4 Closed Loop Deadband

As described in the different motion phases, deadbands are either set directly or calculated by the profiler according to parameters stored in the controller nonvolatile memory.

The different phase's deadbands input and output conditions are determined by the parameter's values described in the following tables:

- With scanning mode enabled (SSK > 0)

	JOGGING	SHIFTING	SCANNING
Entry Deadband +	= SSD + SSP	= DBp	= DBp
Entry Deadband -	= SSD + SSN	= DBn	= DBn
Exit Deadband +	N/A	= DBp × DDSp	= DBp × DDSp
Exit Deadband -		= SSD – (SSN × DDSn)	= DBn × DDSn

(p = positive value, n = negative value, refer to relevant command description)

- With scanning mode disabled (SSK = 0)

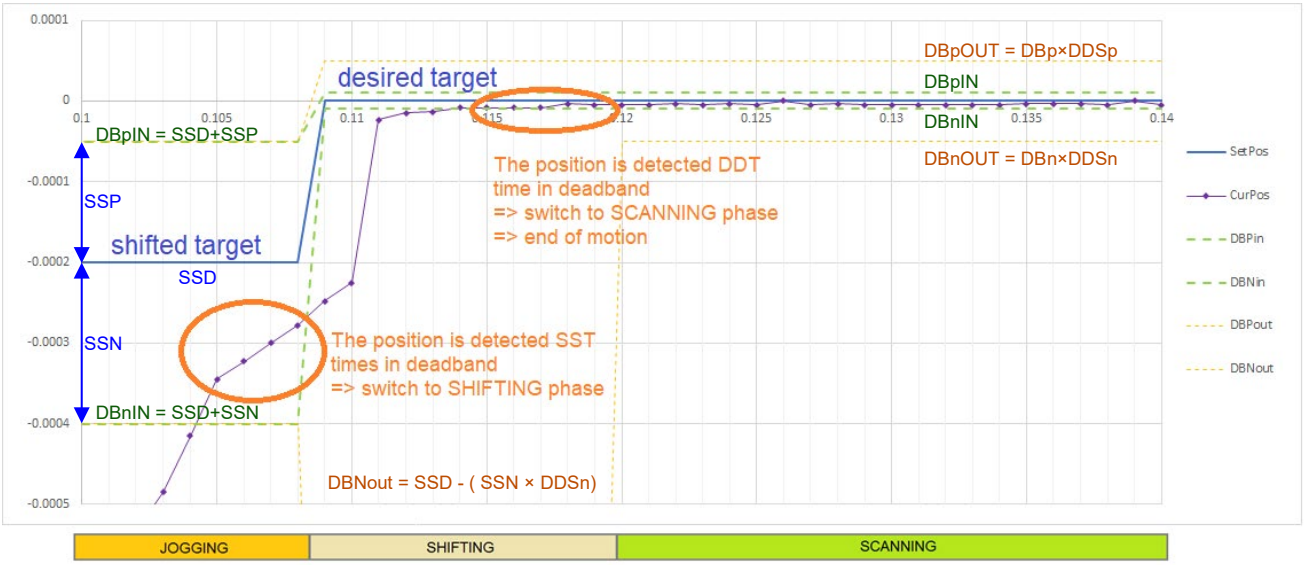
	JOGGING	SHIFTING	SCANNING
Entry Deadband +	= DBp	N/A	N/A
Entry Deadband -	= DBn		
Exit Deadband +	= DBp × DDSp	N/A	N/A
Exit Deadband -	= DBn × DDSn		

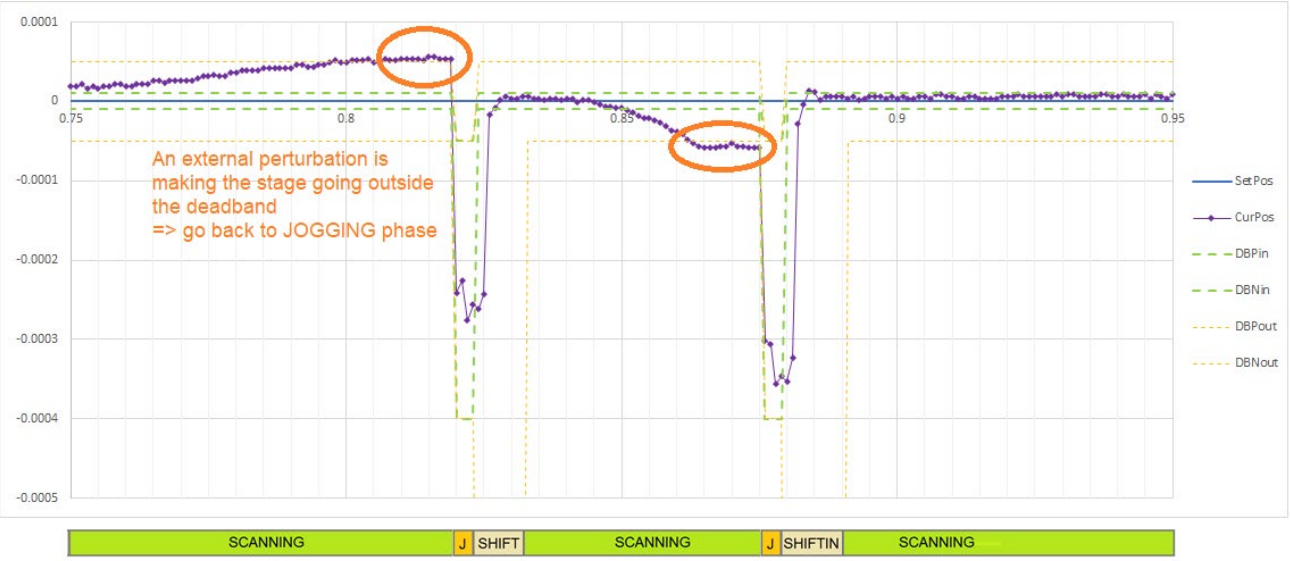
2.1.3.5 Example

The motion in this example responds to the following:

Command: PA0

Parameters: DB-1e-05, 1e-05
DDT5
DDS-5,5
SSD-0.000200
SSP0.000150
SSN-0.000200
SST4





2.1.3.6 Holding state

For firmware versions starting from v1.1.4, a holding state is implemented allowing to open the control loop after a move and keep the piezo voltage as it was during the scanning phase.

In this way it is guaranteed that no motion will be generated by the controller.

For more detail refers to HD command description.

2.2 Security features

2.2.1 Temperature sensor

The controller has an embedded sensor to monitor the temperature.

If the temperature exceeds 85°C, the motion is stopped and an error flag is set.

All motion requests will be refused by the controller until the temperature falls below 85°C.

The current temperature of the controller can be read with the RT command.

2.2.2 Motion Timeout

If a motion lasts more than the motion timeout set with the MT command, it is stopped and an error flag is set.

All motion requests will be refused by the controller until the error flag is read with the TS command.

An update of the velocity (JA) or target position (PA/PR) during the motion will reset the timeout counter.

2.2.3 Hard stop detection

This security feature is available only for closed loop stages.

During a motion, if an obstacle is blocking the stage, the controller will detect it by monitoring the current stage velocity.

If the velocity is below the minimum velocity (configured with TOD command) during more than the motor stall timeout (configured with TOT command), the motion is stopped and an error flag is set.

All motion requests will be refused by the controller until the error flag is read with the TS command.

During the referencing the same logic is used to detect the hard stop, but TOR is used instead of TOD.

2.3 Part Numbers

Product	Description
CONEX-SAG	Super Agilis Motion Controller/Driver for SAG-LSxx and SAG-LSxxP stages.
CONEX-PS	40 W power supply for SA Controller.
CONEX-USB	USB cable, 1.8 m length
CONEX-BP	Base plate to attach up to 6 CONEX controllers

2.4 Contents of Delivery

- Super Agilis Controller box integrated with piezo motor linear stage.

2.5 Super Agilis CONEX-SAG Controller

2.5.1 Specifications

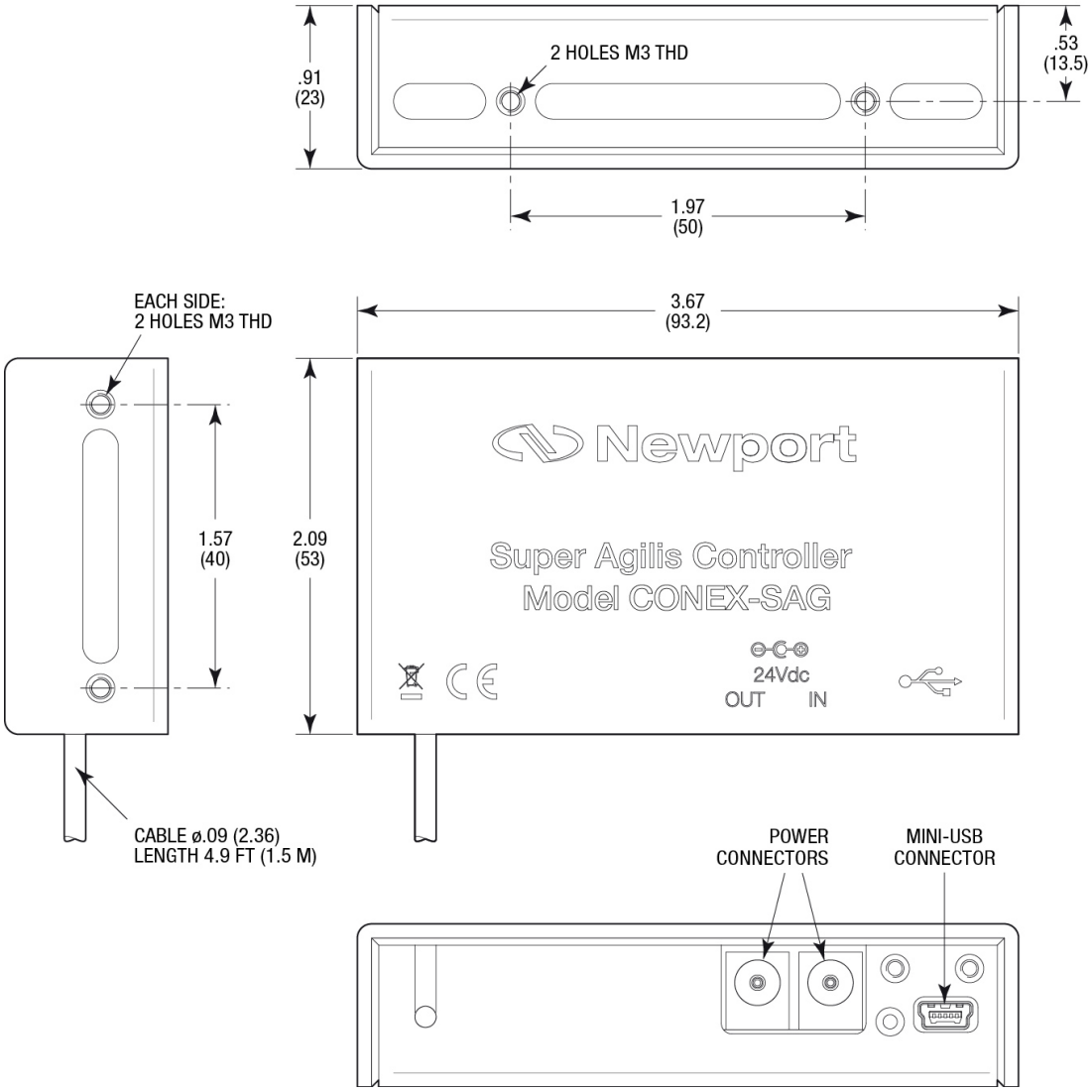
General Description	Super Agilis controller
Control Capability	Piezo motors, closed loop
Piezo Output	48Vpeak 10 kHz max
Control loop	Digital PI loop 100 Hz servo rate for firmware versions inferior to v0.17.0 1 kHz servo rate for firmware versions superior to v0.17.0
Motion	Absolute and relative motion
Computer interface	USB Virtual COM port
Programming	25+ intuitive, 2 or 3 letter ASCII commands
Communication rate	50 Hz Max. (USB)
Status display	Two color LED
Power Supply	+5V (USB): Consumption : < 0.3 Arms Operating voltage : 4.75V to 5.25V +24V (DRIVE POWER) : Consumption : < 1.5 Arms Operating voltage : 23V to 25V Both power (+5V and +24V need to be supplied. It is mandatory to keep the +5V and +24V power supplies independent one to the other to insure the voltages are kept into the recommended operating values during hot plugging phases.

2.5.2 USB Communication Settings

Communication parameters are preset in the CONEX-SAG controller and do not require any configuration:

Bits per second	57,600
Data bits	8
Parity	None
Stop bits	1
Flow control	None
Terminator	C_RL_F

2.5.3 Dimensions



CAUTION

DO NOT EXCEED M3 THD depth 4mm for the screws fixing the CONEX plastic body

2.6 SAG-LSxx and SAG-LSxxP Stages

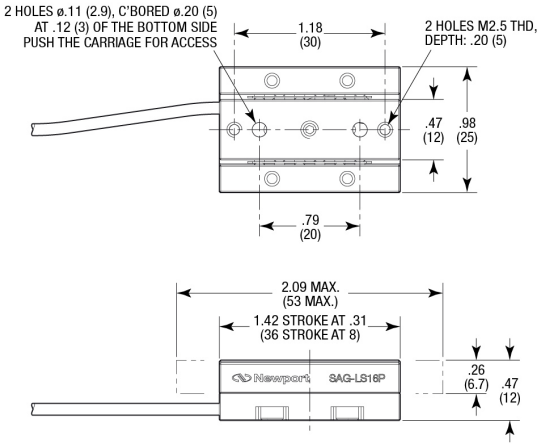
2.6.1 Mechanical specifications

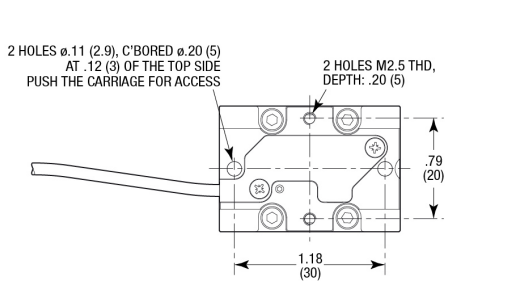
Open loop stage (without encoder) + controller	CONEX-SAG-LS16	CONEX-SAG-LS32	CONEX-SAG-LS48
Travel range (mm)	16	32	48
Maximum speed (mm/s)	10		
Material	Stainless Steel		
Centered Load Capacity (N)	20	30	30
Maximum axial force (N)	2		
Holding Force (N)	3		
Minimum Incremental Motion (nm)	100		
Pitch/Yaw (µrad)	150		
Cable Length (m)	1.5		
Limit Switches	Not Available		
Operating Temperature (°C)	10 to 35		
Weight, Without Cable (g)	65	93	127

Closed loop stage (with encoder) + controller	CONEX-SAG-LS16P	CONEX-SAG-LS32P	CONEX-SAG-LS48P
Travel range (mm)	16	32	48
Maximum speed (mm/s)	10		
Material	Stainless Steel		
Centered Load Capacity (N)	20	30	30
Maximum axial force (N)	2		
Holding Force (N)	3		
Bi-directional Repeatability (nm)	120 (full stroke) / 25 (scanning mode)*		
Minimum Incremental Motion (nm)	25		
Pitch/Yaw (µrad)	150		
Cable Length (m)	1.5		
Limit Switches	Not Available		
Operating Temperature (°C)	10 to 35		
Weight, Without Cable (g)	65	93	127

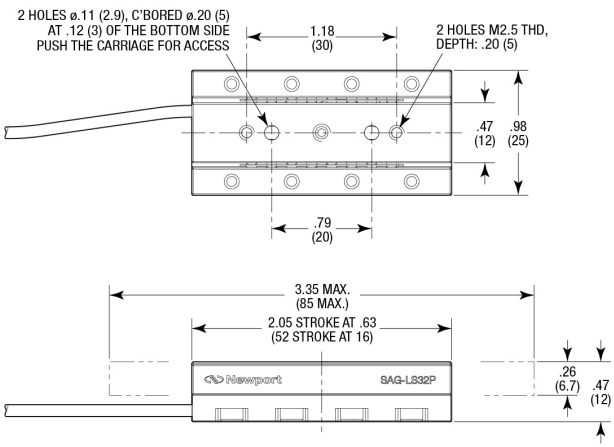
2.6.2 Dimensions (same for LSxx and LSxxP stages)

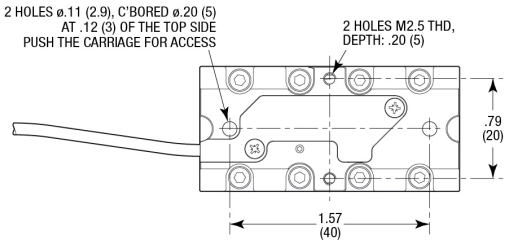
CONEX-SAG-LS16P (Stage)



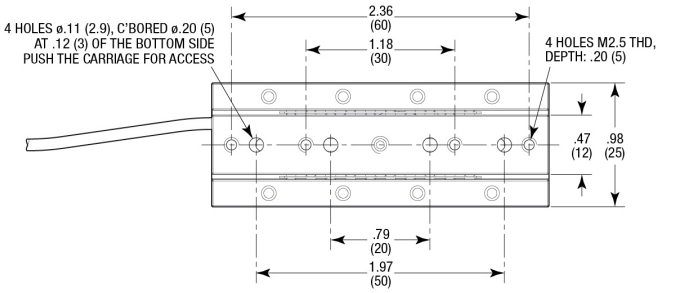


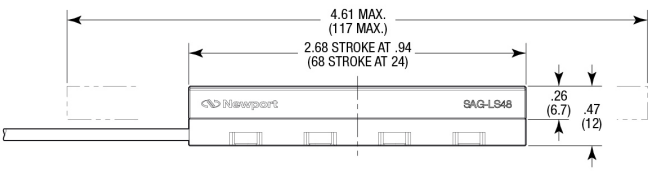
CONEX-SAG-LS32P (Stage)

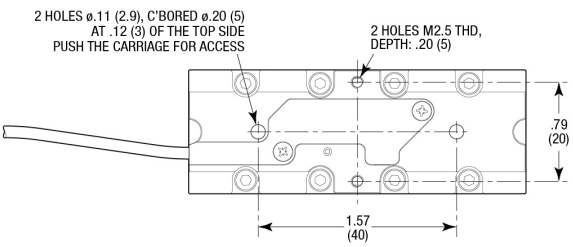




CONEX-SAG-LS48P (Stage)





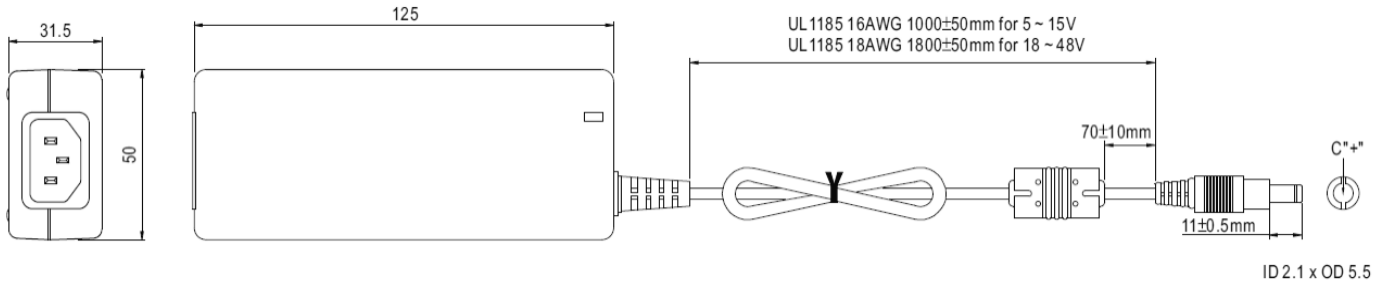


2.7 CONEX-PS

2.7.1 Specifications

AC Input	100–240 VAC, 47–63 Hz, 1.9 A
DC Output	24 V, 40 W max
Connector	Male: Ø 2.1 x Ø 5.5 x 11 mm

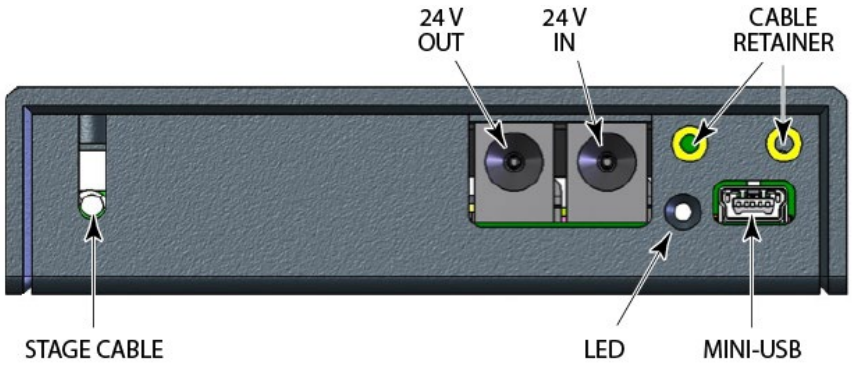
2.7.2 Dimensions



2.8 Environmental Specifications

Operating temperature	5 °C to 40 °C
Operating humidity	<85% relative humidity, non-condensing
Storage temperature	0 °C to 60 °C RH <85% relative humidity, non-condensing
Installation category	II
Pollution degree	2
Use location	Indoor use only

2.9 Connector Identification



USB	mini USB connector
LED	Status LED
POWER IN	24V supply input
POWER OUT	24V supply out
STAGE	Stage entry cable
Cable retainer	2 x M3 threaded hole (4 mm max inner length) to attach cable retainer (not provided)

3.0 Getting Started

This section guides the user through the proper set-up of the Super Agilis Controller motion control system.

Carefully unpack and visually inspect the Agilis Stage, Super Agilis Controller and CONEX-PS power supply for any damage. Place all components on a flat and clean surface.

3.1 Connections

To power the system, follow the sequence below:

1. Connect the CONEX-PS to the Super Agilis Controller (DC IN connector).
2. Connect the CONEX-PS to power.
3. Connect the CONEX-USB to the Super Agilis Controller.
4. Connect the CONEX-USB to a PC.

The Super Agilis Controller is automatically powered on. Wait for the boot time (few seconds). Super Agilis Controller LED should turn solid orange

3.2 Communication Settings

3.2.1 Requirements

CONEX-SAG GUI and Dll are designed for Personal Computers running Windows 7, 8.1 and 10 platforms (32 bit & 64 bit).

3.2.2 PC USB Communication

Use the provided USB cable to connect the Super Agilis Controller (USB connector) to your PC.

If not already installed Windows will ask for the compatible driver. Follow the procedure below to install it.

NOTE

To install the USB driver, consult the USB Driver Installation Manual of our DL Controller on our website and proceed in the same way.

3.3 Configuring the Controller

All Super Agilis Controller parameters have been set in the factory for most current usage and can be adjusted for single use.

Consult the **Super Agilis Controller GUI Manual** for general description and exploitation of the GUI.

NOTE

Beware to make a backup of the factory settings before making any changes. The ZT command lists the current settings which can then be printed.

3.3.1 Standard procedure

The standard parameters of the Super Agilis Controller can be modified with the Newport CONEX-SAG Applet or in a Terminal window.

NOTE

Use PW1/PW0 commands to save new parameters in the nonvolatile memory of the controller if permanent changes have to be made, or changes will be reset to factory settings on the next reboot of the controller.

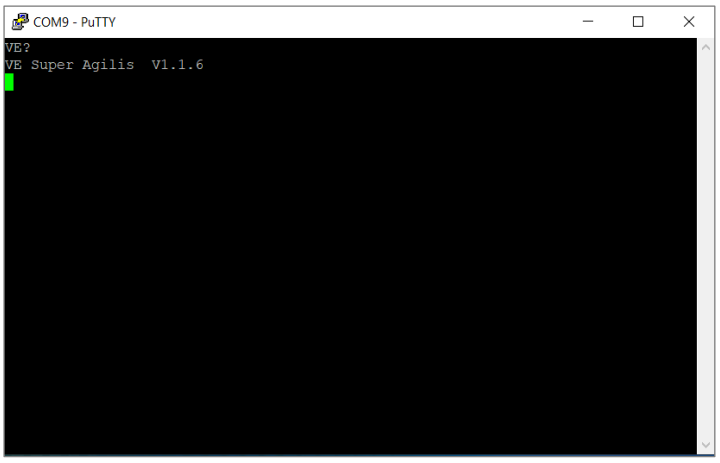
Newport CONEX-SAG Applet

1. Install the stage in desired condition of use.
2. Connect the controller to the Newport CONEX-SAG Applet and power on.
3. Perform tests of parameters values in the Open Loop or Closed Loop window if adjustments are needed.
4. In the Diagnostic window of the Newport CONEX-SAG Applet enter new parameters values with relevant commands (see Command Set table and Command Syntax section).

Terminal window

Connect the controller to the USB port and power on.

Open a Terminal window and enter directly new parameters values with relevant commands (see Command Set table and Command Syntax section)



3.3.2 Modified payload or Z axis utilization

All Super Agilis Controller parameters have been set in the factory per the associated stage without any payload or Z axis utilization.

In case of significant load added to the stage or Z axis use, parameters must be adjusted.

Velocity and acceleration could influence the motion process by inducing unwanted sliding due to the piezo motion and, in some cases, generate closed loop system instability, they both should be adjusted with the load or angle of inclination.

NOTE

Z axis utilization is possible but not recommended.
In case of z axis use, it is mandatory to:
- set the stage with its positive motion upward (direction of cable output).

- limit the load to 0.1 kg.
- perform specific calibration and configuration using the Newport CONEX-SAG Applet.

For open loop operations

The Parameters to be adjusted are:

- The XU parameters to set the appropriate voltage values to generate the desired step's length
- The XF parameter to limit the possible sliding due to a too high steps frequency relative to the loading.

For closed loop operations

The Parameters to be adjusted and configured in order of priority are:

- The KO parameters to set the minimum voltage values to generate motion.
- The KP parameter to set the proportional gain of the PI control loop.
- The KI parameter to set the integral gain of the PI control loop.
- The VA parameter to set the velocity used by the profiler during closed loop motion.
- The AC parameter to set the acceleration used by the profiler during closed loop motion
- The RA parameter to set the velocity used by the profiler during referencing jogging mode.
- The SSK parameters to set the Shifting and the Scanning integral coefficients.
- The SST parameter to set the Scanning shift deadband timer.

3.3.2.1 KO parameters configuration

The KO parameters are the most effective parameters to be adjusted as they determine the minimum voltage value to generate the lower in length carriage negative and positive steps for closed loop motions. This is particularly important to adjust KO in case a constant force is applied on the carriage (for example with a Z axis mounting).

They must be tested and adjusted manually in real condition of use with the open loop mode of the Newport CONEX-SAG Applet.

Procedure

1. Install the stage in desired condition of use.
2. Connect the controller to the Newport CONEX-SAG Applet and power on.
3. In the **Open Loop** of Main X window:
   - Set the XF value to 1 Hz by sliding the XF bar to the left.
   - Set the step number to 1.
   - Set the left XU- value to the minimum value for generating a constant negative motion:
     - Decrease progressively the left XU- value and command a simple motion using left arrow.
     - Repeat until each individual displacement becomes at least 4 times lower than the shifted target deadband size. Use the indication of the encoder feedback to measure each individual moves.
     - Once determined, verify the behavior on different used portions of the stage range. Adapt it if required.
   - Set the right XU+ value to the minimum value for generating a constant positive motion.
     - Decrease progressively the right XU+ value and command a simple motion using right arrow.
     - Repeat until each individual displacement becomes, at least 4 times lower than the shifted target deadband size. Use the indication of the encoder feedback to measure each individual moves.
     - Once determined, verify the behavior on different used portions of the stage range. Adapt it if required.
4. When left and right XU values are determined, set the KO parameters with these new XU values (KO command) and save them in the Controller's nonvolatile memory:

   In the terminal window, or in the Diagnostic window of the Newport CONEX-SAG Applet, enter :

   PW1

   KOnn,pp

   PW0

   Where nn = new left (negative) XU- value,
   pp = new right (positive) XU+ value

   Example:

   PW1

   KO-15, 30

   PW0

The KO parameters for the working range of the stage are now configured and saved in the Controller's nonvolatile memory.

3.3.2.2 KP and KI parameters configuration

The KP and KI parameters set the proportional and integral gains of the PI control loop and define the closed loop counter action reactivity during closed loop jogging phases. Both could be adjusted to improve the motion stability and dynamic.

Excessive dynamic may generate instability and oscillations, too weak dynamic may affect the settling time.

Decrease KP and KI parameters from the standard factory set should help to improve motion stability in case of modified payload or Z axis use.

Procedure

1. Install the stage in desired condition of use.
2. Connect the controller to the Newport CONEX-SAG Applet and power on.
3. Enter the new KP and/or KI values in the Terminal window, or in the Diagnostic window of the Newport CONEX-SAG Applet, using KP and/or KI commands.
4. Test changes by commanding displacement in **Closed loop** window.
5. Repeat changes until correct displacements are established.
6. Once KI and KP values are determined, verify the behavior on different used portions of the stage range. Adapt it if required.
7. When KI and KP values are correctly adjusted to generate stable displacements, set the KI and KP parameters with these new values and save them in the Controller's nonvolatile memory:

   In the command window, or in the Diagnostic window of the Newport CONEX-SAG Applet, enter :

   PW1

   KInn

   KPnn

   PW0

   Where nn = new values of KI/KP parameters

   Example:

   PW1

   KI4000

   KP150

   PW0

The KI/KP parameters for stable motions of the stage are now configured and saved in the Controller's nonvolatile memory.

3.3.2.3 VA parameter configuration

The VA parameter sets the velocity used by the profiler during closed loop motion.

Excessive velocity may generate unwanted slides due to system inertia, too weak velocity may affect the displacement time.

VA acts as a motor pulses frequency limiter.

Decrease VA parameter from the standard factory set should help to improve motion efficiency in case of modified payload or Z axis use.

Procedure

1. Install the stage in desired condition of use.
2. Connect the controller to the Newport CONEX-SAG Applet and power on.
3. Enter the new VA value in the Terminal window, or in the Diagnostic window of the Newport CONEX-SAG Applet, using VA command.
4. Test changes by commanding motion in **Closed loop** window.
5. Once correct value is determined, verify the behavior on different used portions of the stage range. Adapt it if required.
6. When VA value is correctly adjusted to generate stable motions, set the VA parameter with this new value and save it in the Controller's nonvolatile memory:

   In the command window, or in the Diagnostic window of the Newport CONEX-SAG Applet, enter :

   PW1

   VAnn

   PW0

   Where nn = new value of VA parameter

   Example:

   PW1

   VA5.000000

   PW0

The VA parameter for stable motions of the stage is now configured and saved in the Controller's nonvolatile memory.

3.3.2.4 AC parameter configuration

The AC parameter sets the acceleration used by the profiler during closed loop motion.

Excessive acceleration may generate unwanted slides due to system inertia, too weak acceleration may affect the displacement time.

Decrease AC parameter from the standard factory set should help to improve motion efficiency in case of modified payload or Z axis use.

Procedure

7. Install the stage in desired condition of use.
8. Connect the controller to the Newport CONEX-SAG Applet and power on.
9. Enter the new AC value in the Terminal window, or in the Diagnostic window of the Newport CONEX-SAG Applet, using AC command.
10. Test changes by commanding motion in **Closed loop** window.
11. Once correct value is determined, verify the behavior on different used portions of the stage range. Adapt it if required.
12. When AC value is correctly adjusted to generate stable motions, set the AC parameter with this new value, save it in the Controller's nonvolatile memory:

    In the command window, or in the Diagnostic window of the Newport CONEX-SAG Applet, enter :

    PW1

    ACnn

    PW0

    Where nn = new value of AC parameter

    Example:

    PW1

    AC1

    PW0

The AC parameter for stable motions of the stage is now configured and saved in the Controller's nonvolatile memory.

3.3.2.5 RA parameter configuration

The RA parameter sets the velocity used by the profiler during referencing jogging phases.

Excessive velocity may generate unwanted slides due to system inertia, too weak velocity may affect the stage referencing moves efficiency .

Decrease RA parameter from the standard factory set should help to improve referencing efficiency in case of modified payload or Z axis use.

Procedure

1. Install the stage in desired condition of use.
2. Connect the controller to the Newport CONEX-SAG Applet and power on.
3. Enter the new RA value in the Terminal window, or in the Diagnostic window of the Newport CONEX-SAG Applet, using RA command.
4. Test changes by executing referencing in **Closed loop** mode.
5. Repeat changes until correct referencing is established.
6. Once correct values are determined, verify the behavior on different used portions of the stage range. Adapt it if required.
7. When RA value is correctly adjusted to generate stable referencing, set the RA parameter with this new value and save it in the Controller's nonvolatile memory:

   In the command window, or the Diagnostic window of the Newport CONEX-SAG Applet, enter :

   PW1

   RAnn

   PW0

   Where nn = new value of RA parameter

   Example:

   PW1

   RA1

   PW0

The RA parameter for stable referencing of the stage is now configured and saved in the Controller's nonvolatile memory.

3.3.2.6 SSK parameters configuration

The SSK parameters set the Shifting and the Scanning integral coefficients during shifting and scanning phases, they define the sensitivity of the control loop, both could be adjusted to improve motion stability.

Excessive sensitivity may generate instability and oscillation, too weak sensitivity may affect settling time and accuracy.

Decrease SSK parameters from the standard factory set should help to improve motion stability in case of modified payload or Z axis use, during shifting and scanning phases.

Procedure

1. Install the stage in desired condition of use.
2. Connect the controller to the Newport CONEX-SAG Applet and power on.
3. Enter the new SSK values in the Terminal window, or in the Diagnostic window of the Newport CONEX-SAG Applet, using SSK command.
4. Test changes by commanding motion in **Closed loop** mode.
5. Repeat changes until correct displacements are established.
6. Once correct values are determined, verify the behavior on different used portions of the stage range. Adapt it if required.
7. When SSK values are correctly adjusted to generate stable motions, set the SSK parameters with these new values and save them in the Controller's nonvolatile memory:

   In the command window, or in the Diagnostic window of the Newport CONEX-SAG Applet, enter :

   PW1

   SSKnn,mm

   PW0

   Where nn = new value of shifting integral coefficient parameter
   mm = new value of scanning integral coefficient parameter

   Example:

   PW1

   SSK100000,50000

   PW0

The SSK parameters for stable motions of the stage in shifting and scanning phases are now configured and saved in the Controller's nonvolatile memory.

3.3.2.7 SST parameter configuration

The SST parameter sets the shift deadband timer used by the profiler during scanning phases.

Excessive Shift deadband timer may affect the settling time.

Decrease SST parameter from the standard factory set should help to improve motion efficiency in case of modified payload or Z axis use during scanning phases.

Procedure

1. Install the stage in desired condition of use.
2. Connect the controller to the Newport CONEX-SAG Applet and power on.
3. Enter the new SST value in the Terminal window, or in the Diagnostic window of the Newport CONEX-SAG Applet, using SST command.
4. Test changes by commanding motion in **Closed loop** mode.
5. Repeat changes until correct displacement is established.
6. Once correct values are determined, verify the behavior on different used portions of the stage range. Adapt it if required.
7. When SST value is correctly adjusted to generate stable displacements, set the SST parameter with this new value and save it in the Controller's nonvolatile memory:

   In the command window, or in the Diagnostic window of the Newport CONEX-SAG Applet, enter :

   PW1

   SSTnn

   PW0

   Where nn = new value of SST parameter

   Example:

   PW1

   SST1

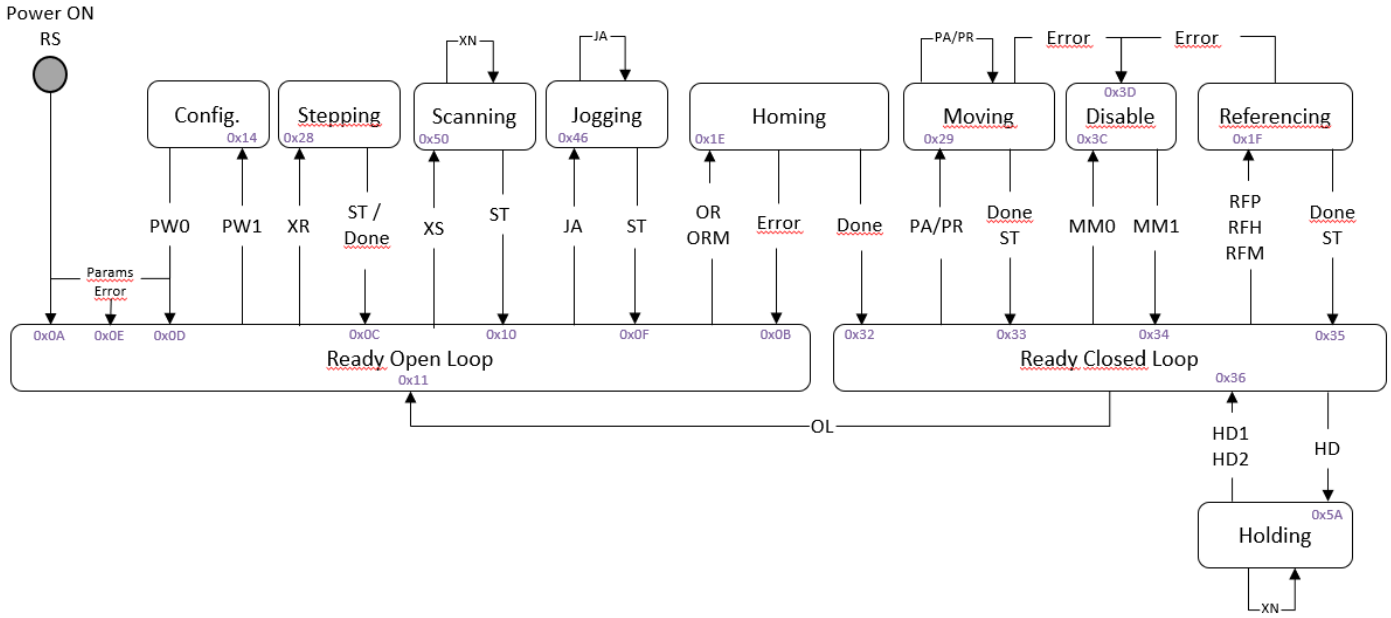
   PW0

The SST parameter for stable motions of the stage is now configured and saved in the Controller's nonvolatile memory.

4.0 Programming

4.1 State Diagram

For a safe and consistent operation, the Agilis Controller uses 10 different operation states: Configuration, Ready Open Loop, Stepping, Scanning, Jogging, Homing, Ready Closed Loop, Disable, Moving and Referencing. In each state, only specific commands are accepted by the Agilis Controller. Therefore, it is important to understand the state diagram below and which commands and actions cause transition between the different states. Also see section 4.4 for command/state information.



LED display:

	RED	ORANGE	GREEN
SOLID	READY OPEN LOOP with FAULT or ERROR CONFIG	READY OPEN LOOP	READY CLOSED LOOP
SLOW BLINK	CONFIG	HOMING	DISABLE HOLDING
FAST BLINK	-	STEPPING JOGGING SCANNING	MOVING REFERENCING

READY OPEN LOOP	: If hardware faults or wrong parameters then SOLID RED.
READY OPEN LOOP	: If everything is OK then SOLID ORANGE.
CONFIGURATION	: SLOW BLINK RED.
READY CLOSED LOOP	: SOLID GREEN.
DISABLE	: SLOW BLINK GREEN.
HOLDING	: SLOW BLINK GREEN.
HOMING	: SLOW BLINK ORANGE.
MOVING	: FAST BLINK GREEN.
STEPPING	: FAST BLINK ORANGE.
SCANNING	: FAST BLINK ORANGE.
JOGGING	: FAST BLINK ORANGE.

When connecting the Super Agilis Controller to power, it starts in READY OPEN LOOP state. From this state, the Controller can go to the CONFIGURATION state with the PW1 command.

In CONFIGURATION state, the Super Agilis Controller allows changing all stage configuration parameters like proportional gain of the closed loop (for SAGxx-P only).

The PW0 command saves all changes to the Controller's memory and returns the Controller back to the READY OPEN LOOP state.

In READY OPEN LOOP state, the controller can make open loop motion. The motions are executed with the commands (XR, JA, XS).

To execute move commands (PA, PR) in closed loop, the Controller must be in READY CLOSED LOOP state. To get from the READY OPEN LOOP state to the READY CLOSED LOOP state, the positioner must homed with the OR command. During homing (OR command execution), the Controller is in HOMING state. When the homing is successful, the Controller automatically gets to the READY CLOSED LOOP state. The position after homing is either the position related to the current phase angle of the encoder signal when the OR0 is used, or, if the ORMxx is used, the current position is given by xx (xx in mm). The stage adjusts its position, if necessary, by making a motion to match the phase of the encoder.

The process for referencing, and which mechanical ends of runs are looked for during referencing, can be defined with the HT command.

The referencing can either go to a mechanical limit (RFH), measure the current position by going to a limit and returning to the original position (RFP). This is useful if the power was removed and the current position information was lost. The command RFMnn moves to a hard stop and goes to the position indicated by the parameter nn.

To get from READY CLOSED LOOP state to READY OPEN LOOP state, for instance to make some further parameter change in CONFIGURATION state, you can either reboot the Controller with the RS command (working parameters are restore to default) or use the OL command (working parameters are maintained).

4.2 Command Syntax

The Super Agilis Controller is a command driven Controller. The general format of a command is a two letter ASCII character preceded and followed by parameters specific to the command:

Command format:

nn	AA or AAA	xx

nn — Axis number (optional).

AA or AAA — Command name.

xx — Optional or required value or "**?**" to query current value.

Both, upper and lower case characters are accepted.

Most commands can be used to set a value (in that case the command name is followed by the value "**xx**") or to query the current value (in that case the command name is followed by a "**?**"). When querying a value, the Controller responds with the command it received followed by the queried value. For example, 1KP300 sets the proportional gain of the axis #1 to 300 units. 1KP? sends the response 1KP300.

Not every command can be executed in all states of the Agilis Controller and some commands have different meaning in different states. It is therefore important to understand the State Diagram of the Controller.

Blank spaces

Blanks are allowed and ignored in any position, including inside a numerical value. The following two commands are equivalent, but the first example might be confusing and uses more memory:

PA1.43 6

PA1.436

Decimal separator

A dot (".") is used as decimal separator for all numerical values.

Command terminator

Commands are executed as the command terminator C_R or L_F (carriage-return line-feed, ASCII 13 and ASCII 10) is received. The Controller will analyze the received string. If the command is valid and its parameters are in the specified range, it will be executed. Otherwise it will memorize an error.

After the execution of the command, all remaining characters in the input string, if any, will be ignored. In particular, it is not possible to concatenate several commands on a single string from the PC to the Super Agilis Controller.

Each command will handle properly the memorization of related errors that can be accessed with the TE command. Please refer to the section Command Set for details.

4.3 Command Execution Time

The Agilis Controller interprets commands continuously as received. The typical execution time for a "tell position command" (TP?) is inferior to 10 ms. Here, command execution time means the time from sending the command until receive of the answer.

It is important to note that a move command, which may last for several seconds, will not suspend the Controller from further command execution. So, for an efficient process flow with many move commands it is to query the Controller status (TS command) or the current position (TP command) before any further motion command is sent.

4.4 Command Set

This section describes the supported two-letter ASCII commands used to configure and operate the Agilis Controller.

	CONF	RDY OL	RDY CL	STEP.	JOG	SCAN	MOV.	REF.	HOLD.	DIS.	OL/CL	Description
AC	●	●	●	●	●	●	●	●	●	●	BOTH	Set/Get Acceleration
DB	○	□								□	CL	Set/Get deadband
DD	○	□								□	CL	Set/Get deadband entry/exit conditions
ID	●	●	●	●	●	●	●	●	●	●	BOTH	Get stage identifier
IF	●	●	●	●	●	●	●	●	●	●	CL	Get interpolation factor
FS	○										BOTH	Restore/Set factory setting
HD			●						●		CL	Enter/Exit Holding state
HT	○	□								□	CL	Set/Get referencing config
JA		●			●						BOTH	Move jogging
KF	○	□								□	CL	Set/Get feedforward gain
KI	○	□								□	CL	Set/Get integral gain
KP	○	□								□	CL	Set/Get proportional gain
KS	○	□								□	CL	Set/Get integral saturation
KO	○	□								□	CL	Set/Get offset friction
MM			●							●	CL	Enter/leave DISABLE state
MS	●	●	●	●	●	●	●	●	●	●	BOTH	Get motion status
MT	○	□								□	BOTH	Set/Get motion timeout
OL			●								CL	Go to READY OL state
OR		●									CL	Go to READY CL state
PA			●				●				CL	Move absolute
PR			●				●				CL	Move relative
PW	●	●									BOTH	Enter /Leave CONFIG state
RA	○	□	□							□	CL	Set/Get Referencing jogging velocity
RF			●								CL	Execute REFERENCING
RS	●	●	●	●	●	●	●	●	●	●	BOTH	Reset Controller
RT	●	●	●	●	●	●	●	●	●	●	BOTH	Read controller temperature
SA	○										BOTH	Set/Get axis number
SL	○	□								□	CL	Set/Get stage left travel range
SR	○	□								□	CL	Set/Get stage right travel range
SS	○	□								□	CL	Set/Get scanning setting
ST				●	●	●	●	●			BOTH	Stop motion
SU	○										CL	Set/Get encoder pitch
TB	●	●	●	●	●	●	●	●	●	●	BOTH	Get error string
TE	●	●	●	●	●	●	●	●	●	●	BOTH	Get last error
TH	●	●	●	●	●	●	●	●	●	●	CL	Get target position
TO	○	□								□	CL	Set/Get motor stall timeout
TP	●	●	●	●	●	●	●	●	●	●	BOTH	Get current position
TS	●	●	●	●	●	●	●	●	●	●	BOTH	Get Controller status
VA	●	●	●	●	●	●	●	●	●	●	BOTH	Set/Get Velocity
VE	●	●	●	●	●	●	●	●	●	●	BOTH	Get Controller version
XF	○	□									BOTH	Set/Get OL step frequency
XN						●			●		BOTH	Set/Get scanning command
XR		●									BOTH	Move stepping
XS		●									BOTH	Go to SCANNING state
XU	○	□									BOTH	Set/Get OL step amplitude
ZT	●	●								●	BOTH	Get all axis parameters

○:	Changes configuration parameters. Those changes will be stored in the Controller's memory with the PW1 command and remain available after switching off the Controller.
□:	Changes working parameters only. Those changes will get lost when switching off the Controller.
●:	Accepted command.
Blank:	Not accepted command (will return an error).

NOTE

Use ZT command to get all actual parameters value.

Command read is accepted in all states.

AC — Set/Get Acceleration

Usage
■ Config ■ Ready OL ■ Ready CL ■ Holding ■ Stepping ■ Referencing ■ Jogging ■ Moving ■ Scanning ■ Disable

Compatibility
☐ Open-Loop
■ Closed-Loop

Syntax **AC**nn or **AC**?

Parameters

Description **nn** [float] — Acceleration.

Range **nn** — ≥ 1.5 and ≤ 1500

Units **nn** — mm/s²

Defaults **nn** Missing: Error.
Out of range: Error.

Description The AC command set the acceleration used by the profiler during closed loop motion.
This command is not available for firmware version inferior to v0.17.0.

Returns If the sign "?" takes place of nn, this command returns the current programmed value.

Errors — Unknown message code.
— Execution not allowed.

Rel. Commands VA — Set/Get Velocity.
PA — Move absolute.
PR — Move relative.

Example
AC500 | set acceleration to 500mm/s²
AC? | Get acceleration.
| Controller returns : AC500

DB — Set deadband

Usage
■ Config ■ Ready OL ☐ Stepping ☐ Jogging ☐ Scanning
☐ Ready CL ☐ Referencing ☐ Moving ■ Disable
☐ Holding

Compatibility
☐ Open-Loop
■ Closed-Loop

Syntax **DB**nn,pp or **DB**?

Parameters

Description
nn [float] — Negative deadband.
pp [float] — Positive deadband.

Range
nn — ≥ -0.05 and <0
pp — >0 and ≤+0.05

Units
nn — Preset unit.
pp — Preset unit.

Defaults
nn Missing: Error.
pp Missing: Error.
Out of range: Error.

Description
In CONFIGURATION state, this command sets deadband of the PI control loop which can be saved in the controller's nonvolatile memory using the PW command. It is also the default value that will be used unless a different value is set in DISABLE or READY OPEN LOOP states.

In DISABLE or READY OPEN LOOP states, this command allows setting a new working parameter for deadband. This value is not saved in the controller's memory and will be lost after reboot.

Returns
If the sign "?" takes place of nn, this command returns the current programmed value.

Errors
— Unknown message code.
— Parameter missing or out of range.
— Execution not allowed.
— Execution not allowed in XXXX state.

Rel. Commands
DD — Set deadband entry/exit conditions.
KI — Set integral gain.
KP — Set proportional gain.

Example

DB-0.000015, 0.00001	Set negative deadband to 15e-6 units.
	Set positive deadband to 10e-6 units.
DB?	Get deadband.
	Controller returns "DB-1.5e-5, 1e-5"

DD — Set deadband entry/exit conditions

Usage
■ Config ■ Ready OL ☐ Stepping ☐ Jogging ☐ Scanning
☐ Ready CL ☐ Referencing ☐ Moving ■ Disable
☐ Holding

Compatibility
☐ Open-Loop
■ Closed-Loop

Syntax
DDSnn,pp or **DDS**?
DDTqq or **DDT**?
DDXrr or **DDX**?

Parameters

Description
nn [int] — Deadband exit negative coefficient.
pp [int] — Deadband exit positive coefficient.
qq [int] — Deadband entry timer.
rr [int] — Deadband exit timer.

Range
nn-rr — >0 and ≤100

Units
nn-rr — Preset unit.

Defaults
nn-rr Missing: Error.
Out of range: Error.

Description
In CONFIGURATION state, this command sets deadband entry/exit conditions which can be saved in the controller's nonvolatile memory using the PW command. It is also the default value that will be used unless a different value is set in DISABLE or READY OPEN LOOP states.

The entry timer value defines how many successive positions have to be detected in the deadband before validating the end of motion.

The exit coefficients define how much the position error has to be superior to deadband to trig a motion.

The exit timer value defines how many successive positions have to be detected outside the deadband to trig a motion (available from firmware version v0.17.0).

In DISABLE or READY OPEN LOOP states, this command allows setting a new working parameter for deadband entry/exit conditions. This value is not saved in the controller's memory and will be lost after reboot.

Returns
If the sign "?" takes place of nn, this command returns the current programmed value.

Errors
— Unknown message code.
— Parameter missing or out of range.
— Execution not allowed.
— Execution not allowed in XXXX state.

Rel. Commands
DB — Set deadband.
KI — Set integral gain.
KP — Set proportional gain.

Example
DDT4 | position has to be in deadband during 4 corrector period to validate motion.
DDS-3, 4 | position error superior to 4×deadband+ generates a move.
| position error inferior to 3×deadband- generates a move.

ID —Get stage identifier

Usage
- ■ Config
- ■ Ready OL
- ■ Ready CL
- ■ Holding
- ■ Stepping
- ■ Referencing
- ■ Jogging
- ■ Moving
- ■ Scanning
- ■ Disable

Compatibility
- ■ Open-Loop
- ■ Closed-Loop

Syntax **ID**?

Parameters

Description **nn** [string] — Stage identifier.

Range **nn** — 1 to 31 ASCII characters.

Defaults **nn** Missing: Error.
Out of range: Error.

Description The ID? command return the stage identifier. This is the Newport product name.

Returns If the sign "?" takes place of nn, this command returns the current programmed value.

Errors
— Unknown message code.
— Parameter missing or out of range.
— Execution not allowed.
— Execution not allowed in XXXX state.

Rel. Commands ZT — Get memory configuration.

Example ID? | Get stage identifier.
| Controller returns “Super Agilis V1.0.0”

IF — Get interpolation factor

Usage
■ Config ■ Ready OL ■ Stepping ■ Jogging ■ Scanning
■ Ready CL ■ Referencing ■ Moving ■ Disable
■ Holding

Compatibility
☐ Open-Loop
■ Closed-Loop

Syntax
IF?

Description
The IF? command return the interpolation factor.

The encoder position resolution is : 0.25 × SU ÷ IF

Errors
— Unknown message code.
— Parameter missing or out of range.
— Execution not allowed.
— Execution not allowed in XXXX state.

Rel. Commands
ZT — Get memory configuration.
SU — Set/Get encoder pitch.

Example

```
IF?      | Get interpolation factor.
         | Controller returns 7987
SU?      | Get encoder pitch.
         | Controller returns 0.0798742
         | encoder resolution = 0.25 × 0.0798742 ÷ 7987 = 2.5nm
```

FS — Factory settings modification/restoration

Usage
■ Config ☐ Ready OL ☐ Stepping ☐ Jogging ☐ Scanning
☐ Ready CL ☐ Referencing ☐ Moving ☐ Disable
☐ Holding

Compatibility
■ Open-Loop
■ Closed-Loop

Syntax **FSM**nn, or **FSM**?
FSR

Parameters

Description **nn** [string] — Password for factory settings modification.

Range **nn** — Unique password.

Units **nn** — None.

Defaults **nn** Missing: Error.
Out of range: Error.

Description **FSM**: This command sends the password to allow factory settings modifications. If the password is correct, all parameters modification in CONFIGURATION state changes the factory settings of the Controller. The factory settings modifications rights are lost after leaving the CONFIGURATION state.

FSR: This command restores all parameters to factory settings.

Returns If the sign "?" takes place of nn, this command returns 1 if the Controller have the factory settings modifications rights, else it returns 0.

Errors — Unknown message code.
— Parameter missing or out of range.
— Execution not allowed.
— Execution not allowed in XXXX state.

Rel. Commands PW — Enter/Leave CONFIGURATION state.

Example FSR | Restore all parameters to factory settings.

HD — Enter/Exit Holding state

Usage
☐ Config ☐ Ready OL ☐ Stepping ☐ Jogging ☐ Scanning
■ Ready CL ☐ Referencing ☐ Moving ☐ Disable
■ Holding

Compatibility
☐ Open-Loop
■ Closed-Loop

Syntax **HD**, or **HD**nn

Parameters

Description **nn** [int] — Exit mode.

Range **nn** — 1 exit holding state and return to previous target position.

2 exit holding state with target set to current position (no motion).

Units **nn** — None.

Defaults **nn** Missing: Error.

Out of range: Error.

Description In ready closed loop state, the HD command can be used to enter to HOLDING state.

In HOLDING state the piezo voltage is fixed at the current scanning command and the control loop is opened.

The XN Command can be used to query the piezo command and adjust it for manual position adjustment.

The HOLDING state can be exited with HD1 or HD2 commands.

HD1 will return to ready closed loop and set the setpoint position to its value before entering the state. This can produce motion in case of position derivation during the HOLDING state.

HD2 will return to ready closed loop and set the setpoint position to the current position without any motion. But the control loop is now closed and perturbations can now produce a motion.

This command is not available for firmware version inferior to v1.1.4

Returns If the sign "?" takes place of nn, this command returns the current programmed value.

Errors
— Unknown message code.
— Parameter missing or out of range.
— Execution not allowed.
— Execution not allowed in XXXX state.

Rel. Commands XN — Set scanning command.

Example

```
HD      | Enter Holding state.
XN?     | Get scanning command.
        | Controller returns 22.3
XN22.4  | Set scanning command to 22.4%
HD2     | return to ready closed loop and keep current position as target.
```

HT — Set/Get referencing configuration

Usage
■ Config ■ Ready OL ☐ Stepping ☐ Jogging ☐ Scanning
☐ Ready CL ☐ Referencing ☐ Moving ■ Disable
☐ Holding

Compatibility
☐ Open-Loop
■ Closed-Loop

Syntax **HT**nn, or **HT**?

Parameters

Description **nn** [int] — Home type value.

Range **nn** — 3 use positive mechanical end of run.
4 use negative mechanical end of run.

Units **nn** — None.

Defaults **nn** Missing: Error.
Out of range: Error.

Description This command sets the HOME type that will be used when RF command will be executed.

Returns If the sign "?" takes place of nn, this command returns the current programmed value.

Errors — Unknown message code.
— Parameter missing or out of range.
— Execution not allowed.
— Execution not allowed in XXXX state.

Rel. Commands RF — Execute referencing.

Example HT3 | Use OR- switch for HOME.

JA — Move jogging

Usage ☐ Config ■ Ready OL ☐ Stepping ■ Jogging ☐ Scanning
☐ Ready CL ☐ Referencing ☐ Moving ☐ Disable
☐ Holding

Compatibility ■ Open-Loop
■ Closed-Loop

Syntax **JA**nn, or **JA**?

Parameters

Description **nn** [int] — Jogging mode.

Range **nn** — ≥-4 and ≤4.

Units **nn** — Mode.

Defaults **nn** Missing: Error.
Out of range: Error.

Description The JA command initiates a motion in Jogging mode.
-4 — Negative direction, 10 000 steps/s at max. step amplitude.
-3 — Negative direction, 5 000 steps/s at max. step amplitude.
-2 — Negative direction, 1 000 step/s at max. step amplitude.
-1 — Negative direction, 50 steps/s at defined step amplitude.
0 — No move, stay in JOGGING state (use ST command to go to READY OL state).
1 — Positive direction, 50 steps/s at defined step amplitude.
2 — Positive direction, 1 000 steps/s at max. step amplitude.
3 — Positive direction, 5 000 steps/s at max. step amplitude.
4 — Positive direction, 10 000 steps/s at max. step amplitude.

Returns If the sign "?" takes place of nn, this command returns the current programmed value.

Errors — Unknown message code.
— Parameter missing or out of range.
— Execution not allowed.
— Execution not allowed in XXXX state.

Rel. Commands ST — Stop the current motion.

Example JA4 | Set jogging mode to 4.

KF — Set feed-forward gain

Usage
■ Config ■ Ready OL ☐ Stepping ☐ Jogging ☐ Scanning
☐ Ready CL ☐ Referencing ☐ Moving ■ Disable
☐ Holding

Compatibility
☐ Open-Loop
■ Closed-Loop

Syntax **KF**nn1,nn2,nn3,nn4 or **KF**?

Parameters

Description
nn1 [float] — Feedforward gain value for -12mm/s velocity.
nn2 [float] — Feedforward gain value for -6mm/s velocity.
nn3 [float] — Feedforward gain value for +6mm/s velocity.
nn4 [float] — Feedforward gain value for +12mm/s velocity.

Range **nn** — ≥0 and <10.

Units **nn** — None.

Defaults
nn Missing: Error.
Out of range: Error.

Description
In CONFIGURATION state, this command sets the integral gain of the feedforward control loop which can be saved in the Controller's nonvolatile memory using the PW command. It is also the default value that will be used unless a different value is set in DISABLE or READY OPEN LOOP states.

In DISABLE or READY OPEN LOOP states, this command allows setting a new working parameter for the feedforward gain. This value is not saved in the Controller's memory and will be lost after reboot.

This command is not available for firmware version inferior to v0.17.0

The Feedforward KF gain is variable and can be set with 4 points (-12, -6, 6 and 12 mm/s)

- KF is constant at nn1 for setpoint velocity from -15 to -12mm/s
- KF is interpolated between nn1 and nn2 for setpoint velocity from -12 to -6mm/s
- KF is constant at nn2 for setpoint velocity from -6 to 0mm/s
- KF is constant at nn3 for setpoint velocity from 0 to 6mm/s
- KF is interpolated between nn3 and nn4 for setpoint velocity from 6 to 12mm/s
- KF is constant at nn4 for setpoint velocity from 12 to 15mm/s

Returns If the sign "?" takes place of nn, this command returns the current programmed value.

Errors
— Unknown message code.
— Parameter missing or out of range.
— Execution not allowed.
— Execution not allowed in XXXX state.

Rel. Commands
DB — Set/Get deadband.
KP — Set/Get proportional gain.

Example

KF1,1,1,1	Set feedforward gain to 1 (constant).
KF 0.7,1.4,1.0,0.7	Set feedforward gain to be attenuated at 0.7 at high velocity boosted at 1.4 at low negative velocity.

KI — Set integral gain

Usage
■ Config ■ Ready OL ☐ Stepping ☐ Jogging ☐ Scanning
☐ Ready CL ☐ Referencing ☐ Moving ■ Disable
☐ Holding

Compatibility
☐ Open-Loop
■ Closed-Loop

Syntax **KI**nn, or **KI**?

Parameters

Description **nn** [float] — Integral gain value.

Range **nn** — ≥0 and <10^{12}.

Units **nn** — None.

Defaults **nn** Missing: Error.
Out of range: Error.

Description In CONFIGURATION state, this command sets the integral gain of the PI control loop which can be saved in the Controller's nonvolatile memory using the PW command. It is also the default value that will be used unless a different value is set in DISABLE or READY OPEN LOOP states.

In DISABLE or READY OPEN LOOP states, this command allows setting a new working parameter for the integral gain. This value is not saved in the Controller's memory and will be lost after reboot.

Returns If the sign "?" takes place of nn, this command returns the current programmed value.

Errors
— Unknown message code.
— Parameter missing or out of range.
— Execution not allowed.
— Execution not allowed in XXXX state.

Rel. Commands
DB — Set/Get deadband.
KP — Set/Get proportional gain.

Example KI7800 | Set integral gain to 7800.

KP — Set proportional gain

Usage
■ Config ■ Ready OL ☐ Stepping ☐ Jogging ☐ Scanning
☐ Ready CL ☐ Referencing ☐ Moving ■ Disable
☐ Holding

Compatibility
☐ Open-Loop
■ Closed-Loop

Syntax **KP**nn, or **KP**?

Parameters

Description **nn** [float] — Proportional gain value.

Range **nn** — ≥0 and <10^{12}.

Units **nn** — None.

Defaults **nn** Missing: Error.
Out of range: Error.

Description In CONFIGURATION state, this command sets the proportional gain of the PI control loop which can then be saved in the Controller's nonvolatile memory using the PW command. It is also the default value that will be used unless a different value is set in DISABLE or READY OPEN LOOP states.

In DISABLE or READY OPEN LOOP states, this command allows setting a new working parameter for the proportional gain. This value is not saved in the Controller's memory and will be lost after reboot.

Returns If the sign "?" takes place of nn, this command returns the current programmed value.

Errors
— Unknown message code.
— Parameter missing or out of range.
— Execution not allowed.
— Execution not allowed in XXXX state.

Rel. Commands
DB — Set/Get deadband.
KI — Set/Get integral gain.

Example KP356 | Set proportional gain to 356.

KS — Set integral saturation

Usage
■ Config ■ Ready OL ☐ Stepping ☐ Jogging ☐ Scanning
☐ Ready CL ☐ Referencing ☐ Moving ■ Disable
☐ Holding

Compatibility
☐ Open-Loop
■ Closed-Loop

Syntax **KS**nn, or **KS**?

Parameters

Description **nn** [float] — Integral saturation value.

Range **nn** — ≥0 and <14.7.

Units **nn** — mm/s.

Defaults **nn** Missing: Error.
Out of range: Error.

Description In CONFIGURATION state, this command sets the integral saturation of the PI control loop which can then be saved in the Controller's nonvolatile memory using the PW command. It is also the default value that will be used unless a different value is set in DISABLE or READY OPEN LOOP states.

In DISABLE or READY OPEN LOOP states, this command allows setting a new working parameter for the saturation value. This value is not saved in the Controller's memory and will be lost after reboot.

This command is not available for firmware version inferior to v0.17.0

Returns If the sign "?" takes place of nn, this command returns the current programmed value.

Errors
— Unknown message code.
— Parameter missing or out of range.
— Execution not allowed.
— Execution not allowed in XXXX state.

Rel. Commands
DB — Set/Get deadband.
KI — Set/Get integral gain.

Example KS1.5 | Set integral saturation to 1.5mm/s

KO — Set/Get offset friction

Usage
■ Config ■ Ready OL ☐ Stepping ☐ Jogging ☐ Scanning
☐ Ready CL ☐ Referencing ☐ Moving ■ Disable
☐ Holding

Compatibility
☐ Open-Loop
■ Closed-Loop

Syntax **KO**nn,pp or **KO**?

Parameters

Description
nn [int] — Offset negative friction.
pp [int] — Offset positive friction.

Range
nn — >-100 and <0
pp — >0 and <100

Units
nn — %
pp — %

Defaults
nn Missing: Error.
pp Missing: Error.
Out of range: Error.

Description
The Agilis controller produces pulses on the piezo, to generate motion, which scale from 0V to maximum pulse voltage as defined in the specification table. The KO command is used to configure the offset of the pulse generated in closed loop motion: i.e.: the minimum voltage of the pulse to be generated.

In CONFIGURATION state, this command sets the offset of the output pulse which can then be saved in the Controller's nonvolatile memory using the PW command. It is also the default value that will be used unless a different value is set in DISABLE or READY OPEN LOOP states.

In DISABLE or READY OPEN LOOP states, this command allows setting a new working parameter for the offset. This value is not saved in the Controller's memory and will be lost after reboot.

Returns
If the sign "?" takes place of nn, this command returns the current programmed value in the form KO negative value, positive value.

Errors
— Unknown message code.
— Parameter missing or out of range.
— Execution not allowed.
— Execution not allowed in XXXX state.

Rel. Commands
KI — Set integral gain.
KP — Set proportional gain.

Example
KO-5,10 | Set the positive offset friction to 10% of full scale pulse.
| Set the negative offset friction to 5% of full scale pulse.
KO? | Get offset friction.
Controller returns "KO-5, 10".

MM — Enter/Leave DISABLE state

Usage
☐ Config ☐ Ready OL ☐ Stepping ☐ Jogging ☐ Scanning
■ Ready CL ☐ Referencing ☐ Moving ■ Disable
☐ Holding

Compatibility
☐ Open-Loop
■ Closed-Loop

Syntax **MM**nn, or **MM**?

Parameters

Description **nn** [int] — Direction.

Range **nn** — 0 change from READY CLOSED LOOP to DISABLE state.
1 change from DISABLE to READY CLOSED LOOP state.

Units **nn** — None.

Defaults **nn** Missing: Error.
Out of range: Error.

Description MM0 changes the Controller's state from READY to DISABLE. In DISABLE state the control loop is open. The encoder, though, is still read and the current position gets updated.

MM1 changes the Controller's state from DISABLE to READY CLOSED LOOP. The Controller's set point position is set equal to its current position and the control loop gets closed. The residual following error gets cleared from the buffer.

Returns If the sign "?" takes place of nn, this command returns the current state.

Errors — Unknown message code.
— Parameter missing or out of range.
— Execution not allowed.
— Execution not allowed in XXXX state.

Rel. Commands PW — Enter/leave CONFIGURATION state.

Example MM0 | Controllers goes to DISABLE state.

MS — Get motion status

Usage
- ■ Config
- ■ Ready OL
- ■ Ready CL
- ■ Holding
- ■ Stepping
- ■ Referencing
- ■ Jogging
- ■ Moving
- ■ Scanning
- ■ Disable

Compatibility
- ■ Open-Loop
- ■ Closed-Loop

Syntax **MS**?

Description The MS? command returns 1 if the stage is moving, else it returns 0.

Errors

	—	Unknown message code.
	—	Execution not allowed.

Rel. Commands

JA	—	Move jogging**.**
PA	—	Move absolute.
PR	—	Move relative.
XR	—	Move stepping.

Example

JA4	| start jogging.
MS?	| Get motion status.
	| Controller returns : MS1
JA0	| Stop jogging.
MS?	| Get motion status.
	| Controller returns : MS0

MT — Set/Get motion timeout

Usage
■ Config ■ Ready OL ☐ Stepping ☐ Jogging ☐ Scanning
☐ Ready CL ☐ Referencing ☐ Moving ■ Disable
☐ Holding

Compatibility
■ Open-Loop
■ Closed-Loop

Syntax **MT**nn or **MT**?

Parameters

Description **nn** [float] — Timeout value.

Range **nn** — >0 and <200

Units **nn** — Seconds.

Defaults **nn** Missing: Error.
Out of range: Error.

Description In CONFIGURATION state, this command sets the motion timeout which can then be saved in the Controller's nonvolatile memory using the PW command. It is also the default value that will be used unless a different value is set in DISABLE or READY OPEN LOOP states.

In DISABLE or READY OPEN LOOP states, this command allows setting a new working parameter for the motion timeout. This value is not saved in the Controller's memory and will be lost after reboot.

Motion timeout is applied in MOVING and JOGGING states.

In JOGGING state the motion timeout is:

- 1 × MT for JA4/JA-4
- 3 × MT for JA3/JA-3
- 10 × MT for JA2/JA-2
- 500 × MT for JA1/JA-1

Returns If the sign "?" takes place of nn, this command returns the current programmed value.

Errors
— Unknown message code.
— Parameter missing or out of range.
— Execution not allowed.
— Execution not allowed in XXXX state.

Rel. Commands
JA — Move jogging.
PA — Move absolute.
PR — Move relative.
XR — Move stepping

Example MT10 | Set the motion timeout to 10 seconds.

OL — Go to READY OPEN LOOP state

Usage

☐ Config	☐ Ready OL	☐ Stepping	☐ Jogging	☐ Scanning
	■ Ready CL	☐ Referencing	☐ Moving	☐ Disable
	☐ Holding			

Compatibility

☐ Open-Loop
■ Closed-Loop

Syntax **OL**.

Parameters None.

Description This command changes the current state from READY CLOSED LOOP to the state READY OPEN LOOP.

Errors

— Unknown message code.
— Parameter missing or out of range.
— Execution not allowed.
— Execution not allowed in XXXX state.

Rel. Commands OR — Execute HOME search sequence.

Example

OL	Go to READY OL state.

OR — Go to READY CLOSED LOOP state

Usage
☐ Config ■ Ready OL ☐ Stepping ☐ Jogging ☐ Scanning
☐ Ready CL ☐ Referencing ☐ Moving ☐ Disable
☐ Holding

Compatibility
☐ Open-Loop
■ Closed-Loop

Syntax **OR**

ORMnn

Description **nn** [float] — Preset position.

Range **nn** — SL to SR.

Units **nn** — Units.

Defaults **nn** Missing: Error.
Out of range: Error.

Description This command goes from READY OPEN LOOP to READY CLOSED LOOP.

The OR command closes the control loop without modification of current position.

The ORM command sets the position specified by nn. If the requested position do not match the current phase of the stage, a motion is initiated so that the current phase of the encoder matches the requested position.

Errors
— Unknown message code.
— Parameter missing or out of range.
— Execution not allowed.
— Execution not allowed in XXXX state.

Rel. Commands OL — Go to READY OL state.

Example OR | Go to READY CLOSED LOOP state.

PA — Move absolute

Usage
☐ Config ☐ Ready OL ☐ Stepping ☐ Jogging ☐ Scanning
■ Ready CL ☐ Referencing ■ Moving ☐ Disable
☐ Holding

Compatibility
☐ Open-Loop
■ Closed-Loop

Syntax **PA**nn, or **PA**?

Parameters

Description **nn** [float] — New target position.

Range **nn** — SL to SR.

Units **nn** — Preset units.

Defaults **nn** Missing: Error.
Out of range: Error.

Description The PA command initiates an absolute move. When received, the positioner will move to the new target position specified by nn.

The PA command is only accepted in READY CLOSED LOOP or MOVING states.

To avoid any mismatch, the Controller always rounds the new target position to the closest encoder position.

Returns If the sign "?" takes place of nn, this command returns the target position value.

Errors
— Unknown message code.
— Parameter missing or out of range.
— Execution not allowed.
— Target position out of limits.
— Execution not allowed in XXXX state.

Rel. Commands
PR — Move relative.
TH — Tell set point position.
TP — Tell current position.

Example PA2.2 | Move to 2.2 units absolute position.

PR — Move relative

Usage

☐ Config	☐ Ready OL	☐ Stepping	☐ Jogging	☐ Scanning
	■ Ready CL	☐ Referencing	■ Moving	☐ Disable
	☐ Holding			

Compatibility

☐ Open-Loop
■ Closed-Loop

Syntax **PR**nn, or **PR**?

Parameters

Description **nn** [float] — Displacement.

Range **nn** — SL to SR

Units **nn** — Preset units.

Defaults **nn** Missing: Error.
Out of range: Error.

Description The PR command initiates a relative move. When received, the positioner will move to a new target position nn units away from the current target position.

The PR command is only accepted in READY CLOSED LOOP or MOVING states.

To avoid any mismatch, the Controller always rounds the new target position to the closest encoder position.

Returns If the sign "?" takes place of nn, this command returns the target position value.

Errors
— Unknown message code.
— Parameter missing or out of range.
— Execution not allowed.
— Target position out of limits.
— Execution not allowed in XXXX state.

Rel. Commands
PA — Move absolute.
TH — Tell set point position.
TP — Tell current position.

Example PR2.2 | Move 2.2 units from target position.

PW — Enter/Leave configuration state

Usage
■ Config ■ Ready OL ☐ Stepping ☐ Jogging ☐ Scanning
☐ Ready CL ☐ Referencing ☐ Moving ☐ Disable
☐ Holding

Compatibility
■ Open-Loop
■ Closed-Loop

Syntax **PW**nn, or **PW**?

Parameters

Description **nn** [int] — Configuration mode.

Range **nn** — 1 change from READY OPEN LOOP to CONFIGURATION.
0 change from CONFIGURATION to READY OPEN LOOP.

Units **nn** — None.

Defaults **nn** Missing: Error.
Out of range: Error.

Description PW1 changes the Controller's state from READY OPEN LOOP to CONFIGURATION. In Configuration state all parameter settings are saved in the Controller's memory and remain available after switching off the Controller. In addition, some settings are only possible in CONFIGURATION state (e.g. set controller address, etc.).

PW0 checks all stage parameters, and if they are acceptable, saves them in the flash memory of the Controller. After that, it changes the Controller's state from CONFIGURATION to READY OPEN LOOP.

The execution of a PW0 command may take up to 10 seconds. During that time the Controller will not respond to any other command.

Returns If the sign "?" takes place of nn, this command returns the current state.

Errors
— Unknown message code.
— Parameter missing or out of range.
— Execution not allowed.
— Execution not allowed in XXXX state.

Rel. Commands MM — Enter/Leave Disable state.

Example PW1 | Enters CONFIGURATION state.

RA — Referencing jogging velocity

Usage
■ Config ■ Ready OL ■ Ready CL ☐ Holding ☐ Stepping ☐ Referencing ☐ Jogging ☐ Moving ☐ Scanning ■ Disable

Compatibility
☐ Open-Loop
■ Closed-Loop

Syntax **RA**nn, or **RA**?

Parameters

Description **nn** [int] — Referencing Jogging mode.

Range **nn** — ≥1 and ≤4.

Units **nn** — Mode.

Defaults **nn** Missing: Error.
Out of range: Error.

Description The RA command change the jogging step configuration used during referencing mode.
1 —50 steps/s at defined step amplitude (SU).
2 —1 000 steps/s at max. step amplitude.
3 —5 000 steps/s at max. step amplitude.
4 —10 000 steps/s at max. step amplitude.
This command is not available for firmware version inferior to v1.1.4

Returns If the sign "?" takes place of nn, this command returns the current programmed value.

Errors
— Unknown message code.
— Parameter missing or out of range.
— Execution not allowed.
— Execution not allowed in XXXX state.

Rel. Commands RF — Execute the referencing sequence.

Example RA2 | Set referencing jogging mode to 2.

RF — Execute the referencing sequence

Usage

☐ Config	☐ Ready OL	☐ Stepping	☐ Jogging	☐ Scanning
	■ Ready CL	☐ Referencing	☐ Moving	☐ Disable
	☐ Holding			

Compatibility

■ Open-Loop
■ Closed-Loop

Syntax

RFH

RFP

RFMnn

RFS?

Parameters

Description **nn** [float] — Reference position.

Range **nn** — SL to SR.

Units **nn** — Preset Unit.

Defaults **nn** Missing: Error.

Out of range: Error.

Description

The RF command executes the referencing sequence:

RFH: Move to mechanical end of run defined by HT, and take this position as reference.

After the sequence current position equals SR or SL according to HT value.

RFP: Move to mechanical end of run defined by HT, take this position as reference, and move back to previous position.

After the physical position is the same than before the sequence, but the current position is referenced to SR or SL according to HT value.

RFM: Move to mechanical end of run defined by HT, take this position as reference, and move to position indicated by the parameter nn.

RFS?: Returns 1 if the stage is referenced and 0 otherwise.

Errors

— Unknown message code.

— Parameter missing or out of range.

— Execution not allowed.

— Execution not allowed in XXXX state.

Example

RFS? | Controller returns 0

RFH | Move to the reference position to the mechanical limit defined by HT.

RFS? | Controller returns 1

RS — Reset controller

Usage
- ■ Config
- ■ Ready OL
- ■ Ready CL
- ■ Holding
- ■ Stepping
- ■ Referencing
- ■ Jogging
- ■ Moving
- ■ Scanning
- ■ Disable

Compatibility
- ■ Open-Loop
- ■ Closed-Loop

Syntax **RS**.

Parameters None.

Description The RS command issues a hardware reset of the Controller, equivalent to a power-up.

Errors
- — Unknown message code.
- — Execution not allowed.

Example

RS | Reset Controller.

RT — Tell temperature

Usage
- ■ Config
- ■ Ready OL
- ■ Ready CL
- ■ Holding
- ■ Stepping
- ■ Referencing
- ■ Jogging
- ■ Moving
- ■ Scanning
- ■ Disable

Compatibility
- ■ Open-Loop
- ■ Closed-Loop

Syntax **RT**

Parameters None.

Description The RT command returns the current temperature of the processor in °C.

Errors
- — Unknown message code.
- — Execution not allowed.

Example

RT	|	Tell temperature
RT50	|	Controller returns 50 °C.

SA — Set/Get axis number

Usage
■ Config ☐ Ready OL ☐ Stepping ☐ Jogging ☐ Scanning
☐ Ready CL ☐ Referencing ☐ Moving ☐ Disable
☐ Holding

Compatibility
■ Open-Loop
■ Closed-Loop

Syntax **SA**nn, or **SA**?

Parameters

Description **nn** [int] — Axis number.

Range **nn** — 1 to 31

Units **nn** — None.

Defaults **nn** Missing: Error.
Out of range: Error.

Description Obsolete command kept for backward compatibility.

For firmware versions inferior to v1.0.0, The controller responds only to commands sent with this address.

For firmware version starting from v1.0.0, this command have no effect, the controller responds to all addresses. SA can still be used to store axis number information even if it has no effect in firmware.

Returns If the sign "?" takes place of nn, this command returns the current programmed value.

Errors
— Unknown message code.
— Parameter missing or out of range.
— Execution not allowed.
— Execution not allowed in XXXX state.

Rel. Commands RF — Execute the referencing sequence.

Example (v0.x.x)

SA2	|	Set the axis number to 2
1TP?	|	Controller doesn't respond
2TP?	|	Controller responds with position

Example (v1.x.x)

SA2	|	Set the axis number to 2
1TP?	|	Controller responds with position
2TP?	|	Controller responds with position

SL — Set/Get stage left travel range

Usage
■ Config ■ Ready OL ☐ Stepping ☐ Jogging ☐ Scanning
☐ Ready CL ☐ Referencing ☐ Moving ■ Disable
☐ Holding

Compatibility
☐ Open-Loop
■ Closed-Loop

Syntax **SL**nn, or **SL**?

Parameters

Description **nn** [float] — Stage left travel range.

Range **nn** — ≤0 and >-10^{12}

Units **nn** — Preset units.

Defaults **nn** Missing: Error.
Out of range: Error.

Description In CONFIGURATION state, this command sets the stage left travel range which can then be saved in the Controller's nonvolatile memory using the PW command.

Returns If the sign "?" takes place of nn, this command returns the current programmed value.

Errors
— Unknown message code.
— Parameter missing or out of range.
— Execution not allowed.
— Execution not allowed in XXXX state.

Rel. Commands
RF — Execute the referencing sequence.
SR — Set/get stage right travel range

Example SL-16 | Set stage left travel range to -16 units.

SR — Set/Get stage right travel range

Usage
■ Config ■ Ready OL ☐ Stepping ☐ Jogging ☐ Scanning
☐ Ready CL ☐ Referencing ☐ Moving ■ Disable
☐ Holding

Compatibility
☐ Open-Loop
■ Closed-Loop

Syntax **SR**nn, or **SR**?

Parameters

Description **nn** [float] — Stage right travel range.

Range **nn** — ≥0 and <10^{12}

Units **nn** — Preset units.

Defaults **nn** Missing: Error.
Out of range: Error.

Description In CONFIGURATION state, this command sets the stage right travel range which can then be saved in the Controller's nonvolatile memory using the PW command.

Returns If the sign "?" takes place of nn, this command returns the current programmed value.

Errors
— Unknown message code.
— Parameter missing or out of range.
— Execution not allowed.
— Execution not allowed in XXXX state.

Rel. Commands
RF — Execute the referencing sequence.
SL — Set/get stage left travel range

Example SR16 | Set stage left travel range to 16 units.

SS — Set/Get scanning settings

Usage
■ Config ■ Ready OL ☐ Stepping ☐ Jogging ☐ Scanning
☐ Ready CL ☐ Referencing ☐ Moving ■ Disable
☐ Holding

Compatibility
☐ Open-Loop
■ Closed-Loop

Syntax

SSDnn1	or **SSD**?
SSInn2	or **SSI**?
SSKnn3,mm3	or **SSK**?
SSPnn4	or **SSP**?
SSNnn5	or **SSN**?
SSTnn6	or **SST**?

Parameters

Description

nn1 [float] — Scanning shift distance.
nn2 [float] — Scanning integral initialization gain.
nn3 [float] — Shifting integral coefficient.
mm3 [float]— Scanning integral coefficient.
nn4 [float] — Scanning shift positive deadband.
nn5 [float] — Scanning shift negative deadband.
nn6 [int] — Scanning shift deadband timer.

Range

nn1 — ≤ 0 and ≥-0.0005
nn2 — ≥ 0 and ≤2
nn3,mm3 — ≥ 0 and <50000
nn4,nn5 — <0 and >-0.0005
nn6 — >0 and <100

Units
nn — Preset units.

Defaults
nn Missing: Error.
Out of range: Error.

Description

In closed-loop, motions are separated in 3 phases:

JOGGING:

The stage move to the target position shifted by SSD distance.

Once the position is detected SST times in the shift deadband defined by SSP/SSN, the controller switch to SHIFTING phase.

SHIFTING:

In this phase the stage moves slowly to the target position by increasing the piezo voltage with SSK integral servo coefficient (1st parameter). The integral is initialized to a value that is multiplied by SSI.

Once the position is detected DDT times in the deadband defined by DB, the controller switch to SCANNING phase, and the motion is ended (go back to ready CL state). The servo integral coefficient is also switched to 2nd SSK parameter.

SCANNING:

In this phase the piezo voltage is continuously controlled with the servo integral coefficient (SSK 2nd parameter).

If the position is detected outside the exit deadband (see DDS) the controller go back to JOGGING state with shifted target.

For firmware version inferior to v0.17.0, SSK have only one parameter and the same integral coefficient is used for SHIFTING and SCANNING.

Returns If the sign "?" takes place of nn, this command returns the current programmed value.

Errors
- — Unknown message code.
- — Parameter missing or out of range.
- — Execution not allowed.
- — Execution not allowed in XXXX state.

Rel. Commands
- DB — Set/Get deadband.
- DD — Set/Get deadband entry/exit conditions.

Example

SSD-0.0002	|	Set shift distance to -0.0002 preset units.
SSP0.00015	|	Set positive shift deadband to 0.00015 preset units.
SSN-0.0002	|	Set negative shift deadband to -0.0002 preset units.
SSK3000	|	Set scanning KI to 3000.
SSI0.9	|	Set scanning integral initialization gain to 0.9.

ST — Stop motion

Usage

☐ Config	☐ Ready OL	■ Stepping	■ Jogging	■ Scanning
	☐ Ready CL	■ Referencing	■ Moving	☐ Disable
	☐ Holding			

Compatibility

■ Open-Loop
■ Closed-Loop

Syntax **ST**.

Parameters None.

Description The ST command is a safety feature. It stops a move in progress by decelerating the positioner immediately with the acceleration defined by the AC command until it stops.

Errors

— Unknown message code.

— Execution not allowed.

— Execution not allowed in XXXX state.

Example

ST | Stop motion.

SU — Set/Get encoder pitch

Usage
■ Config ☐ Ready OL ☐ Stepping ☐ Jogging ☐ Scanning
☐ Ready CL ☐ Referencing ☐ Moving ☐ Disable
☐ Holding

Compatibility
☐ Open-Loop
■ Closed-Loop

Syntax **SU**nn or **SU**?

Parameters

Description **nn** [float] — Encoder scale pitch.

Range **nn** — ≥0 and $<10^{12}$

Units **nn** — Preset units.

Defaults **nn** Missing: Error.
Out of range: Error.

Description In CONFIGURATION state, this command sets the encoder pitch which can then be saved in the Controller's nonvolatile memory using the PW command.

Returns If the sign "?" takes place of nn, this command returns the current programmed value.

Errors
— Unknown message code.
— Parameter missing or out of range.
— Execution not allowed.
— Execution not allowed in XXXX state.

Rel. Commands IF — Get the interpolation factor.

Example SU0.079 | Set encoder scale pitch to 0.079 units.

TB — Tell error string

Usage
- ■ Config
- ■ Ready OL
- ■ Ready CL
- ■ Holding
- ■ Stepping
- ■ Referencing
- ■ Jogging
- ■ Moving
- ■ Scanning
- ■ Disable

Compatibility
- ■ Open-Loop
- ■ Closed-Loop

Syntax **TB**nn.

Parameters

Description **nn** [int] — Error code.

Range **nn** — 0 to ERROR CODE.

Units **nn** — None.

Defaults **nn** Missing: Error.
Out of range: Error.

Description The TB command returns a string that explains the meaning of the error code nn (see TE command for complete list).

Errors
- — Unknown message code.
- — Parameter missing or out of range.
- — Execution not allowed.

Rel. Commands TE — Tell error code.

Example
- TB@ | Tell explanation of error code @.
- TB@ No error | Controller returns No error.

TE — Tell last error

Usage
- ■ Config
- ■ Ready OL
- ■ Ready CL
- ■ Holding
- ■ Stepping
- ■ Referencing
- ■ Jogging
- ■ Moving
- ■ Scanning
- ■ Disable

Compatibility
- ■ Open-Loop
- ■ Closed-Loop

Syntax
TE.

Parameters
None.

Description
The TE command returns the currently memorized error. When a command is not executable, it memorizes an error. This error can be read with the TE command. After the execution of a TE command, the error buffer gets erased and another TE command will return @, means no error. When a new command error is generated before the previous command error is read, the new command error will overwrite the current memorized error.

For a safe program flow it is recommended to always query the command error after each command execution.

Errors
— Unknown message code.
— Execution not allowed.

Example
TE | Tell last error code.
TE@ | Controller returns @.

List of errors codes :.

A : Unknown Message Code.
B : Axis Number not correct.
C : Parameter out of Limits.
D : Function Execution not Allowed.
E : Voltage ERROR.
F : Function Execution not Allowed in SCANNING mode.
G : Function Execution not Allowed in JOGGING mode.
H : Function Execution not Allowed in READY OPEN LOOP mode.
I : Function Execution not Allowed in CONFIGURATION mode.
J : Function Execution not Allowed in DISABLE mode.
K : Function Execution not Allowed in READY CLOSED LOOP mode.
L : Function Execution not Allowed in HOMING/REFERENCING mode.
M : Function Execution not Allowed in MOVING mode.
N : Function Execution not Allowed in STEPPING mode.
O : Function Execution not Allowed in NO ENCODER mode.
P : Function Execution not Allowed in ENCODER mode.
S : Communication ERROR.
U : Error during EEPROM access.

TH — Tell target position

Usage
■ Config ■ Ready OL ■ Stepping ■ Jogging ■ Scanning
■ Ready CL ■ Referencing ■ Moving ■ Disable
■ Holding

Compatibility
☐ Open-Loop
■ Closed-Loop

Syntax **TH**.

Parameters None.

Description The TH command returns the value of the target position.

Errors
— Unknown message code.
— Execution not allowed.

Rel. Commands TP — Tell current position.

Example
TH | Tell target position.
TH0 | Controller returns 0.

TO — Set/Get motor stall timeout

Usage
■ Config ■ Ready OL ☐ Stepping ☐ Jogging ☐ Scanning
☐ Ready CL ☐ Referencing ☐ Moving ■ Disable
☐ Holding

Compatibility
☐ Open-Loop
■ Closed-Loop

Syntax
TOTnn1 or **TOT**?
TODnn2 or **TOD**?
TORnn3 or **TOR**? (not available for firmware version inferior to v1.1.4)

Parameters

Description

nn1 [float]	—	Timeout value.
nn2 [float]	—	Min velocity value for MOVING/JOGGING.
nn3 [float]	—	Min velocity value for REFERENCING.

Range

nn1	—	>0 and <200
nn2	—	0.001 to 0.015
nn3	—	0.001 to 0.015

Units

nn1	—	Seconds.
nn2	—	Preset units / seconds.
nn3	—	Preset units / seconds.

Defaults
nn Missing: Error.
Out of range: Error.

Description
In CONFIGURATION state, this command sets the motor stall timeout which can then be saved in the Controller's nonvolatile memory using the PW command. It is also the default value that will be used unless a different value is set in DISABLE or READY OPEN LOOP states.

In DISABLE or READY OL states, this command allows setting a new working parameter for the motor stall timeout. This value is not saved in the Controller's memory and will be lost after reboot.

For motion during MOVING and JOGGING states (except for JA1/-1), motor stall timeout stops the motion when velocity is under TOD during TOT seconds.

The purpose of this timeout is to stop automatically the motion when end of run is reached.

For referencing, end of run is detected when velocity is under TOR during TOT seconds.

Returns
If the sign "?" takes place of nn, this command returns the current programmed value.

Errors

—	Unknown message code.
—	Parameter missing or out of range.
—	Execution not allowed.
—	Execution not allowed in XXXX state.

Rel. Commands

JA	—	Move jogging.
PA	—	Move absolute.
PR	—	Move relative.
XR	—	Move stepping.

Example

MT1	|	Set the motion timeout to 1 seconds.
TOD0.005	|	Set the velocity threshold to 5µm/s.

TP — Tell current position

Usage
- ■ Config
- ■ Ready OL
- ■ Ready CL
- ■ Holding
- ■ Stepping
- ■ Referencing
- ■ Jogging
- ■ Moving
- ■ Scanning
- ■ Disable

Compatibility
- ■ Open-Loop
- ■ Closed-Loop

Syntax
TP.

Parameters
None.

Description
The TP command returns the value of the current position. This is the position where the positioner is actually according to his encoder value. In MOVING state, this value always changes. In READY CLOSED LOOP state, this value should be equal or very close to the set-point and target position.

Together with the TS command, the TP command helps evaluating whether a motion is completed.

If the stage doesn't have an encoder, TP return a step counter instead of the position.

Errors
— Unknown message code.
— Execution not allowed.

Rel. Commands
TH — Tell set point position.

Example
TP | Tell current position.
TP0 | Controller returns 0.

TS — Get positioner error and controller state

Usage
- ■ Config
- ■ Ready OL
- ■ Ready CL
- ■ Holding
- ■ Stepping
- ■ Referencing
- ■ Jogging
- ■ Moving
- ■ Scanning
- ■ Disable

Compatibility
- ■ Open-Loop
- ■ Closed-Loop

Syntax **TS**.

Parameters None.

Description The TS command returns the error bits and the current Controller state.

Returns The TS command returns 8 characters (1TSabcdef).

The first 4 characters (abcd) represent the error bits in Hexadecimal.

The last two characters (ef) represent the Controller state in Hexadecimal.

Error bits	
0001	Not used
0002	Not used
0004	Not used
0008	Not used
0010	Bit motor stall timeout
0020	Bit time out motion
0040	Bit time out homing
0080	Bit bad memory parameters
0100	Bit supply voltage too low
0200	Bit internal error
0400	Bit memory problem
0800	Bit over temperature

Controller state	
0A	READY OPEN LOOP: after reset
0B	READY OPEN LOOP: after HOMING state
0C	READY OPEN LOOP: after STEPPING state
0D	READY OPEN LOOP: after CONFIGURATION state
0E	READY OPEN LOOP: after with no parameters
0F	READY OPEN LOOP: after JOGGING state
10	READY OPEN LOOP: after SCANNING state
11	READY OPEN LOOP: after READY CLOSED LOOP state
14	CONFIGURATION
1E	HOMING
1F	REFERENCING
28	MOVING OPEN LOOP (OL)
29	MOVING CLOSED LOOP (CL)
32	READY CLOSED LOOP: after HOMING state
33	READY CLOSED LOOP: after MOVING CL state
34	READY CLOSED LOOP: after DISABLE state
35	READY CLOSED LOOP: after REFERENCING state
36	READY CLOSED LOOP: after HOLDING state
3C	DISABLE: after READY CLOSED LOOP state
3D	DISABLE: after MOVING CL state
46	JOGGING
50	SCANNING
5A	HOLDING

Errors — Unknown message code.

Rel. Commands TE — Tell last error.

Example TS | Tell current status & errors.

TS000033 | Controller returns :
READY CLOSED LOOP: after MOVING CL state.

VA — Set/Get Velocity

Usage
■ Config ■ Ready OL ■ Ready CL ■ Holding ■ Stepping ■ Referencing ■ Jogging ■ Moving ■ Scanning ■ Disable

Compatibility
☐ Open-Loop
■ Closed-Loop

Syntax **VA**nn or **VA**?

Parameters

Description **nn** [float] — Velocity.

Range **nn** — ≥ 0.6 and ≤ 15

Units **nn** — mm/s

Defaults **nn** Missing: Error.
Out of range: Error.

Description The VA command set the velocity used by the profiler during closed loop motion.
This command is not available for firmware version inferior to v0.17.0.

Returns If the sign "?" takes place of nn, this command returns the current programmed value.

Errors — Unknown message code.
— Execution not allowed.

Rel. Commands AC — Set/Get Acceleration**.**
PA — Move absolute.
PR — Move relative.

Example
VA5 | Set velocity to 5mm/s.
VA? | Get velocity.
| Controller returns : VA5.

VE — Tell controller revision information

Usage
- ■ Config
- ■ Ready OL
- ■ Ready CL
- ■ Holding
- ■ Stepping
- ■ Referencing
- ■ Jogging
- ■ Moving
- ■ Scanning
- ■ Disable

Compatibility
- ■ Open-Loop
- ■ Closed-Loop

Syntax **VE** or **VE?**.

Parameters None.

Description This command returns the Controller's revision information.

Errors —Unknown message code.

Rel. Commands TP — Tell current position.

Example
VE | Get Controller revision information.
| Controller returns VE Super Agilis Controller version 1.0.

XF — Set/Get stepping frequency

Usage
- ■ Config
- ■ Ready OL
- ☐ Ready CL
- ☐ Holding
- ☐ Stepping
- ☐ Referencing
- ☐ Jogging
- ☐ Moving
- ☐ Scanning
- ☐ Disable

Compatibility
- ■ Open-Loop
- ■ Closed-Loop

Syntax **XF**nn, or **XF**?

Parameters

Description **nn** [float] — Stepping frequency.

Range **nn** — ≥1 and ≤10 000.

Units **nn** — Hertz (Hz).

Defaults **nn** Missing: Error.
Out of range: Error.

Description The XF command is used to read or modify the stepping frequency.

Returns If the sign "?" takes place of nn, this command returns the current frequency value.

Errors
- — Unknown message code.
- — Parameter missing or out of range.
- — Execution not allowed.
- — Execution not allowed in XXXX state.

Rel. Commands
- XR — Move stepping.
- XU — Set/Get Open Loop step size.
- TP — Tell current position.

Example

XF3000	Set the stepping frequency to 3000 Hz.
XU-60,50	Set the stepping negative amplitude to 60%.
	Set the stepping positive amplitude to 50%.
XR1000	Generate 1000 positive pulses.
XR-1000	Generate 1000 negative pulses.

XN — Set/Get scanning command

Usage
☐ Config ☐ Ready OL ☐ Stepping ☐ Jogging ■ Scanning
☐ Ready CL ☐ Referencing ☐ Moving ☐ Disable
■ Holding

Compatibility
■ Open-Loop
■ Closed-Loop

Syntax **XN**nn or **XN**?

Parameters

Description **nn** [float] — Scanning command.

Range **nn** [float] — 0 to 96.

Units **nn** — Percent (%).

Defaults **nn** Missing: Error.
Out of range: Error.

Description The XN command set the piezo voltage command in the SCANNING/HOLDING state.
The XN parameter is a percentage of the maximum voltage (48V).

Returns If the sign "?" takes place of nn, this command returns the target position value.

Errors
— Unknown message code.
— Parameter missing or out of range.
— Execution not allowed.
— Execution not allowed in XXXX state.

Rel. Commands
XS — Go to scanning state.
HD — Go to holding state.
ST — Stop motion.

Example
XS | Go to SCANNING state.
XN20 | Set scanning command to 20%.

XR — Move stepping

Usage
☐ Config ■ Ready OL ☐ Stepping ☐ Jogging ☐ Scanning
☐ Ready CL ☐ Referencing ☐ Moving ☐ Disable
☐ Holding

Compatibility
■ Open-Loop
■ Closed-Loop

Syntax **XR**nn

Parameters

Description **nn** [int] — Step count.

Range **nn** [int] — Int32.

Units **nn** — Preset units.

Defaults **nn** Missing: Error.
Out of range: Error.

Description The XR command initiates a stepping motion. When received, the positioner will generate a number of pulses specified by nn.

The XR command gets only accepted in READY OPEN LOOP state.

Returns If the sign "?" takes place of nn, this command returns the target position value.

Errors
— Unknown message code.
— Parameter missing or out of range.
— Execution not allowed.
— Execution not allowed in XXXX state.

Rel. Commands
XF — Set/Get stepping frequency.
XU — Set/Get Open Loop step size.
TP — Tell current position.

Example
XF3000 | Set the stepping frequency to 3000 Hz.
XU-60,50 | Set the stepping negative amplitude to 60%.
| Set the stepping positive amplitude to 50%.
XR1000 | Generate 1000 positive pulses.
XR-1000 | Generate 1000 negative pulses.

XS — Go to SCANNING state

Usage

☐ Config	■ Ready OL	☐ Stepping	☐ Jogging	☐ Scanning
	☐ Ready CL	☐ Referencing	☐ Moving	☐ Disable
	☐ Holding			

Compatibility

■ Open-Loop
■ Closed-Loop

Syntax **XS**

Parameters None.

Description The XS command changes the Controller's state from READY OPEN LOOP to SCANNING. The scanning command can then be changed with XN command to drive directly the piezo voltage at a constant value between 0V and 48V, allowing fine positioning in the piezo travel range (approx.. 1.5µm).

The XS command is only accepted in READY OPEN LOOP state.

Returns If the sign "?" takes place of nn, this command returns the target position value.

Errors

—	Unknown message code.
—	Execution not allowed.
—	Execution not allowed in XXXX state.

Rel. Commands

XN	—	Set/Get scanning command.
ST	—	Stop motion.

Example

XS	|	Enter scanning mode.
XN15	|	Set the scanning command to 15%.
XN85	|	Set the scanning command to 85%.
ST	|	Leave scanning mode.

XU — Set/Get Open Loop step size

Usage
■ Config ■ Ready OL ☐ Stepping ☐ Jogging ☐ Scanning
☐ Ready CL ☐ Referencing ☐ Moving ☐ Disable
☐ Holding

Compatibility
■ Open-Loop
■ Closed-Loop

Syntax **XU**nn,pp or **XU**?

Parameters

Description
nn [int] — Negative Step size.
pp [int] — Positive Step size.

Range
nn — >-100 and <0 for negative pulses.
pp — >0 and <100 for positive pulses.

Units
nn — %

Defaults
nn Missing: Error.
Out of range: Error.

Description
The XU command enables to change the current open loop step size.

The variable step size is available only for XF frequencies up to 1 kHz. For higher frequencies the step size is always 100%.

Warning: if the step size is too small, the stage may not move or move in the wrong direction.

Returns
If the sign "?" takes place of nn, this command returns the target position value.

Errors
— Unknown message code.
— Parameter missing or out of range.
— Execution not allowed.
— Execution not allowed in XXXX state.

Rel. Commands
XR — Move stepping.
XF — Set/Get stepping frequency.
TP — Tell current position.

Example

XF3000	Set the stepping frequency to 3000 Hz.
XU-60,50	Set the stepping negative amplitude to 60%.
	Set the stepping positive amplitude to 50%.
XR1000	Generate 1000 positive pulses.
XR-1000	Generate 1000 negative pulses.
XU?	Get open loop step size.
	Controller returns "XU-60, 50"

ZT — List all configuration parameters

Usage

■ Config	■ Ready OL	☐ Stepping	☐ Jogging	☐ Scanning
	☐ Ready CL	☐ Referencing	☐ Moving	■ Disable
	☐ Holding			

Compatibility

■ Open-Loop
■ Closed-Loop

Syntax **ZT**.

Parameters None.

Description The ZT command returns the list of all current configuration parameters.

Errors

— Unknown message code.

— Execution not allowed in XXXX state.

Rel. Commands TE — Tell error code.

Example

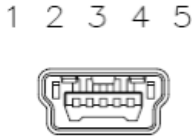
ZT | Tell configuration parameters.
PW1
…
SR32
…
…
PW0.

5.0 Connector Pinout

5.1 Power Connectors (Female Ø 2.1 x Ø 5.5 x 11 mm)

Pin #	Description
Center	+24 VDC
Outer	GND

5.2 USB Connector (USB Mini-B Receptacle)



Pin	Description
1	N.C.
2	USBDM
3	USBDP
4	N.C.
5	Ground
22	Ground
23	N.C.
24	N.C.
25	N.C.

6.0 Troubleshooting

Here is a list of possible errors and the recommended corresponding actions to be taken prior to contact Newport.

"TS" Error	Description	Actions
00001	Not implemented in SAG series stages	
00002		
00004		
00008		
00010	The stage has reached a hard limit	• Check that the stage is referenced • Check software limits (SR/SL) • Increase MO • Restore Factory settings
00020	The requested motion didn't end after MT seconds	• Increase MT • Increase deadband for quicker stabilization (but lower accuracy) • Restore Factory settings
00040	Bit time out homing	• Restore Factory settings
00080	Bit bad memory parameters	• Restore Factory settings
00100	Power supply voltage lower than 24V or defective power supply	• Check power supply
00200	Bit internal error	
00400	Bit memory problem	
00800	Bit over temperature	• Add time between moves

7.0 Maintenance and Service

7.1 Enclosure Cleaning

The Super Agilis Controller/Driver should only be cleaned with a lightly damped cloth or sponge with a soapy water solution. Do not use an acetone or alcohol solution, this will damage the finish of the enclosure.

7.2 Obtaining Service

The Super Agilis Controller/Driver contains no user serviceable parts. To obtain information regarding factory service, contact Newport Corporation or your Newport representative. Please have the following information available:

- Instrument model number.
- Description of the problem.

If the instrument is to be returned to Newport Corporation, you will be given a Return Number, which you should reference in your shipping documents.

Complete a copy of the Service Form as represented on the next page and include it with your shipment.

Service Form

Your Local Representative

Tel.: _____

Fax: _____

Name: _____

Company: _____

Address: _____

Country: _____

P.O. Number: _____

Item(s) Being Returned: _____

Model#: _____

Return authorization #: _____
(Please obtain prior to return of item)

Date: _____

Phone Number: _____

Fax Number: _____

Serial #: _____

Description: _____

Reasons of return of goods (please list any specific problems): _____

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