PRODUCT NOTE

MOTION PRODUCT ENGINEERING GROUP

Subject: Motion Systems using Yaskawa Servo Amplifiers with Exlar Actuators

Product: Sigma amplifiers (Sigma II SGDH, Sigma III SGDS, Sigma-5 SGDV) with Exlar SR and GSX series actuators

Product Line Description:

Exlar, Inc. (Chanhassen, MN) is a leading manufacturer of electric roller screw actuators. For specifications and sizing on Exlar actuators, visit their website at http://www.exlar.com. Customers specifying and purchasing actuators from Exlar will find this document useful in selecting the appropriate amplifier and accessory components for your system. For new applications, the Sigma-5 SGDV amplifiers should be used. Contact your local Yaskawa sales representative or distributor for price and availability on the Sigma-5 amplifiers.

The combination of Exlar actuators with Yaskawa Sigma amplifiers offers the following advantages to the user:

- 2 to 18 inch travel lengths
- 100 to over 12,000 pounds of thrust
- Travel speeds up to 33 in/sec
- Available for incremental and absolute positioning requirements*
- Simplified amplifier set-up ("plug and play" with no motor parameter setup files needed for amplifier configuration)
- Choice of 110, 230, or 460 Volt systems (depending on actuator size)
- The Sigma series amplifiers are compatible with most PLC and PC-based general purpose motion controllers and indexers, as seen at Yaskawa's website   (http://www.yaskawa.com).

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Document Scope:

The purpose of this document is to provide supplemental selection and application information when EXLAR roller screw actuators are specified with Yaskawa feedback options. It may be possible for an EXLAR actuator with their standard encoder output to be sinusoidally commutated using a Yaskawa Sigma-5 amplifier with an optional encoder interface module. Please contact your local Yaskawa sales representative or distributor for information.
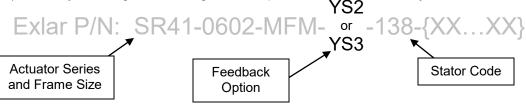
*Exlar actuators with Yaskawa encoders will have absolute positioning data throughout the travel length and can be used with compatible controllers from Yaskawa, Delta Tau, Galil, and Ormec (consult Yaskawa sales representative for compatibility with other controllers).

Actuator Part Numbering:

EXLAR Actuators for use with Sigma amplifiers are designated by using the code **YS2** in the "Feedback Option" part of the Exlar actuator part number for four-inch frame actuators (17-bit absolute encoders).

For two- and three-inch actuators (16-bit absolute), use encoder designation **YS3**.

The actuator series and frame size are identified by the first set of numbers in the actuator part number. The stator code is the three digit code toward the end of the actuator part number (it may be followed by other characters designating options on the actuator). In the combination tables that follow, this series/size designator will be used to determine the appropriate Yaskawa Sigma-5 amplifier (rotary style, not linear) for the system. Sigma II and Sigma III are provided for reference only.

Exlar P/N: SR41-0602-MFM- (YS2 or YS3) -138-{XX…XX}

- Actuator Series and Frame Size
- Feedback Option
- Stator Code

Amplifier Combinations – GSX60 (using YS2 amplifier designation):

Actuator Series	Stator	Stroke Lengths [in]	System Voltage	Sigma II	Sigma III [4]	Sigma-5
GSX60	138	6, 10	230	SGDH-50AE	SGDS-50A12A	SGDV-330A□1
GSX60	168	6, 10	460	SGDH-50DE	Not Available	SGDV-170D□1
GSX60	238	10	230	SGDH-75AE [1]	SGDS-75A12A	SGDV-550A□1[1]
GSX60	268	10	460	SGDH-75DE [2]	Not Available	SGDV-260D□1[2]
GSX60	368	10	460	SGDH-1ADE [3]		SGDV-280D□1[3]

[1] This amplifier also requires the purchase of JUSP-RA05 regenerative unit.
[2] This amplifier also requires the purchase of JUSP-RA18 regenerative unit.
[3] This amplifier also requires the purchase of JUSP-RA19 regenerative unit.
[4] These Sigma III amplifiers include integrated digital network (Yaskawa MechatroLink) capabilities for use with compatible controllers (ie. Yaskawa MP2000 controllers)

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Amplifier Combinations – GSX40 and SR41 (using YS2 amplifier designation)**:**

Actuator Series	Stator	Stroke Lengths [in]	System Voltage	Sigma II Amplifier*	Sigma III Amplifiers	Sigma-5 Amplifiers
GSX40	138	6, 8, 12, 18	230 (1-phase)	SGDH-15AE-S	N/A	SGDV-120A☐1A0080000
			230 (3-phase)	SGDH-10AE	SGDS-10A12A	SGDV-7R6A☐1
GSX40	168	6, 8, 12, 18	460	SGDH-10DE	N/A	SGDV-3R5D☐1
GSX40	238	6, 8, 12, 18	230 (1-phase)	SGDH-15AE-S	N/A	SGDV-120A☐1A0080000
			230 (3-phase)	SGDH-15AE	SGDS-15A12A	SGDV-120A☐1
GSX40	268	6, 8, 12, 18	460	SGDH-15DE	N/A	SGDV-5R4D☐1
GSX40	338	8, 12, 18	230	SGDH-20AE	SGDS-20A12A	SGDV-180A☐1
GSX40	368	8, 12, 18	460	SGDH-20DE	N/A	SGDV-8R4D☐1
SR41	138	6, 12	230 (1-phase)	SGDH-15AE-S	N/A	SGDV-120A☐1A0080000
			230 (3-phase)	SGDH-10AE	SGDS-10A12A	SGDV-7R6A☐1
SR41	168	6, 12	460	SGDH-10DE	N/A	SGDV-3R5D☐1
SR41	238	6, 12	230 (1-phase)	SGDH-15AE-S	N/A	SGDV-120A☐1A0080000
			230 (3-phase)	SGDH-15AE	SGDS-15A12A	SGDV-120A☐1
SR41	268	6, 12	460	SGDH-15DE	N/A	SGDV-5R4D☐1

> * Actuators compatible with the Yaskawa Legend (SGDG) amplifiers are not available.

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Amplifier Combinations – GSX30 and SR31 (using YS3 amplifier designation):

Actuator Series	Stator	Stroke Lengths [in]	System Voltage	Sigma II Amplifier*	Sigma III Amplifiers	Sigma-5 Amplifiers
GSX30	138	3, 6, 10, 14, 18	230 (1-phase)	SGDH-08AE-S	SGDS-08A12A	SGDV-5R5A☐1
			230 (3-phase)	SGDH-05AE	SGDS-10A12A	SGDV-3R8A☐1
GSX30	168	3, 6, 10, 14, 18	460	SGDH-05DE	N/A	SGDV-1R9D☐1
GSX30	238	3, 6, 10, 14, 18	230 (1-phase)	SGDH-08AE-S	SGDS-08A12A	SGDV-5R5A☐1
			230 (3-phase)	SGDH-08AE	SGDS-10A12A	SGDV-5R5A☐1
GSX30	268	3, 6, 10, 14, 18	460	SGDH-10DE	N/A	SGDV-3R5D☐1
GSX30	338	6, 10, 14, 18	230 (1-phase)	SGDH-15AE-S	N/A	SGDV-120A☐1A0080000
			230 (3-phase)	SGDH-10AE	SGDS-10A12A	SGDV-7R6A☐1
GSX30	368	6, 10, 14, 18	460	SGDH-10DE	N/A	SGDV-3R5D☐1
SR31	138	6, 12	230 (1-phase)	SGDH-08AE-S	SGDS-08A12A	SGDV-5R5A☐1
			230 (3-phase)	SGDH-05AE	SGDS-10A12A	SGDV-3R8A☐1
SR31	168	6, 12	460	SGDH-05DE	N/A	SGDV-1R9D☐1
SR31	238	6, 12	230 (1-phase)	SGDH-08AE-S	SGDS-08A12A	SGDV-5R5A☐1
			230 (3-phase)	SGDH-08AE	SGDS-10A12A	SGDV-5R5A☐1
SR31	268	6, 12	460	SGDH-10DE	N/A	SGDV-3R5D☐1

> * Actuators compatible with the Yaskawa Legend (SGDG) amplifiers are not available.

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Amplifier Combinations – GSX20 and SR21 (using YS3 amplifier designation):

Actuator Series	Stator	Stroke Lengths [in]	System Voltage	Sigma II Amplifier*	Sigma III Amps	Sigma-5 Amps
GSX20	118	3, 6, 12	115 (1-phase)	SGDH-02BE	N/A	N/A
GSX20	138	3, 6, 12	230 (1-phase)	SGDH-02AE	SGDS-02A12A	SGDV-1R6A□1
GSX20	168	3, 6, 12	460	SGDH-05DE	N/A	SGDV-1R9D□1
GSX20	238	3, 6, 12	230 (1-phase)	SGDH-08AE-S	SGDS-08A12A	SGDV-5R5A□1
			230 (3-phase)	SGDH-05AE	SGDS-10A12A	SGDV-3R8A□1
GSX20	268	3, 6, 12	460	SGDH-05DE	N/A	SGDV-1R9D□1
GSX20	338	6, 12	230 (1-phase)	SGDH-08AE-S	SGDS-08A12A	SGDV-5R5A□1
			230 (3-phase)	SGDH-08AE	SGDS-10A12A	SGDV-5R5A□1
GSX20	368	6, 12	460	SGDH-10DE	N/A	SGDV-3R5D□1
SR21	118	6,12	115 (1-phase)	SGDH-02BE	N/A	N/A
SR21	138	6, 12	230 (1-phase)	SGDH-02AE	SGDS-02A12A	SGDV-1R6A□1
SR21	168	6, 12	460	SGDH-05DE	N/A	SGDV-1R9D□1
SR21	218	6,12	115 (1-phase)	SGDH-04FE	N/A	SGDV-2R8F□1
SR21	238	6, 12	230 (1-phase)	SGDH-04AE	SGDS-04A12A	SGDV-2R8A□1
SR21	268	6, 12	460	SGDH-05DE	N/A	SGDV-1R9D□1

* Actuators compatible with the Yaskawa Legend (SGDG) amplifiers are not available.

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Cable Selection:

The motor power and encoder cables for Exlar actuators are shown in the table below. For the six-inch actuator series, the power cable must be ordered from Exlar, but the standard Yaskawa Encoder cable is still used. For actuators with holding brakes, the brake cable is a separate item and can be ordered from Exlar.

	100/200V Power Cable	400V Power Cable	Encoder Cable (200V or 400V) *1
2-, 3-, and 4-inch actuators (all but GSX60)	B1E-□□ (A)	BAE-□□(A)	JZSP-CMP02-□□(B)
6-inch actuators (GSX60 series)	(Purchase power cables from Exlar)		

*1: Replace the □□ in the above part numbers with the desired length in meters: **-03**, **-05**, **-10** (standard), **-15**, and **-20** are available cable lengths for all of the listed cables.

The larger wire gauge of the listed cable does not interface correctly with the terminal blocks for U, V, and W on 400W and smaller SGDH amplifiers. If the SGDH-02 or –04 amplifiers are to be used, it is strongly recommended that connector **231-105/026-000** (the UVW connector on the amplifier) also be ordered to allow a better compatibility with the larger wire gauge.

Encoder Resolution:

The following table provides the counts per inch of the Exlar actuator units. Note that the resolution varies depending on the size of the actuator as well as its lead length. Not all lead lengths are available in all frame sizes.

Lead (inches)	YS2 Encoder option (17-bit absolute per rev)	YS3 Encoder option (16-bit absolute per rev)
0.1	1,310,720 cts/in	655,360 cts/in
0.2	655,360 cts/in	327,680 cts/in
0.25	524,288 cts/in	N/A
0.4	N/A	163,840 cts/in
0.5	262,144 cts/in	131,072 cts/in
0.75	174,763 cts/in	N/A
1.0	131,072 cts/in	N/A

Wiring:

Follow standard wiring practices as described in the *Sigma III and Sigma II Series Servo System User's Manual* (YEA-SIA-S800-11 and YEA-SIA-S800-32.2 respectively), and Sigma-5 User's Manual (SIEP S800000 45x) are available on the Yaskawa website. Wiring is discussed in chapter 3 of the Sigma II User's Manual and chapter 5 of the Sigma III and Sigma-5 manual. Recommended Fuse/circuit breaker sizes are listed in the same manual or the Sigma-5 Catalog.

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Amplifier Setup Requirement:

Because the Exlar actuators utilize Yaskawa serial encoders, there is no special set-up to be done with the Yaskawa amplifiers. When the motor is powered up, the serial encoder will send the actuator speed/torque parameters to the amplifier.

> **Important:** Many applications do not require the absolute position data that the absolute encoder provides. The Sigma amplifiers can be configured to provide incremental encoder output to the upper controller by setting parameter Pn002. See *Sigma II Servo System User's Manual* section 5.7.2, Sigma III User's manual section 7.7.3, and Sigma-5 users manual section 5.9.1.

There are several methods for setting Sigma parameters:

- The built-in keypad[*1] on the front of the amplifier or the optional handheld operator.
- SigmaWin+, a full-featured PC-based software package available from Yaskawa as a download at www.yaskawa.com

Application Considerations:

The overload curve for the Sigma amplifiers is reduced when used with Exlar actuators. The maximum amount of time that the actuator can apply full torque is reduced to one second (instead of more than three seconds with a standard Yaskawa motor-amplifier combination). This is based on Exlar recommendation.

As with all linear applications, it is important to prevent the load from reaching the end of its linear travel by implementing hardware limit switches or software limits. If position limiting (either hardware or software) is neglected and the rod reaches its linear end of travel, the Exlar actuator rod will begin to apply *rotational torque* to whatever device to which it is coupled. This can cause unexpected machine operation:

- The rod may provide torque to the machine or coupling, causing a torque overload or, in some situations, mechanical failure.
- There may be movement of the encoder without corresponding linear movement of the actuator rod, resulting in incorrect position data.

Regeneration Energy:

Regeneration energy should be calculated by Exlar when the application is sized. Many Yaskawa amplifiers have regeneration resistors built-in, as listed in the chart on the following page. If extra regeneration capacity is needed, external regeneration resistors can be added to the application, just as they can with a rotary application.

Regenerative resistors for servo amplifiers are internally mounted as shown in the following table. They can be mounted externally on all servo amplifiers, but are especially effective when regenerative energy exceeds the servo amplifiers capacity.

When mounted externally, be sure to remove the jumper between B2 and B3 (SGDH-05 to SGDH-50 only) which deactivates the internal regenerative resistor. Also be sure to set parameter Pn600 correctly.
Important: External regeneration resistor sizing and amplifier set-up will be important for proper operation.

Use Yaskawa's Sigma II Series Servo System User's Manual (YEA-SIA-S800-32.2) section 5.6.
Use Yaskawa's Sigma III Series User's Manual (YEA-SIA-S800-11)
Use Yaskawa's Sigma-5 Series Servo System User's Manual (SIEP S800000 45) section 3.6.

(See chart on next page for specific information on regeneration for each amplifier.)

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Sigma II

Voltage	Applicable Servo Amplifier	Resistance of built-in resistor (Ω)	Nominal wattage of built-in resistor *1 (W)	Effective Capacity of Internal Resistor (W)	Minimum Allowable Resistance (Ω)
115	SGDH-02BE	-	-	-	40
115	SGDH-04FE	-	-	-	40
230	SGDH-02AE	-	-	-	40
230	SGDH-04AE	-	-	-	40
230	SGDH-05AE	50	60	12	40
230	SGDH-08AE	50	60	12	40
230	SGDH-08AE-S	50	60	12	40
230	SGDH-10AE	50	60	12	40
230	SGDH-15AE	30	70	14	20
230	SGDH-15AE-S	25	140	28	20
230	SGDH-20AE	25	140	28	12
230	SGDH-50AE	8	280	56	8
230	SGDH-75AE	3.13 *2	1760 *2	350 *2	2.9
460	SGDH-05DE	108	70	14	73
460	SGDH-10DE	108	70	14	73
460	SGDH-15DE	108	70	14	73
460	SGDH-20DE	45	140	28	44
460	SGDH-50DE	32	180	36	28
460	SGDH-75DE	18 *3	880 *3	180 *3	18
460	SGDH-1ADE	14.25 *4	1760 *4	350 *4	14.2

*1   Capacity prior to de-rating. If regeneration power requirements exceed internal capacity of amp, install an external regeneration resistor (reference "Minimum Allowable Resistance"). Be sure to de-rate wattage of external resistor to 20% or less (natural convection) and to 50% or less with forced air-cooling.

*2   Capacity when used with the required JUSP-RA05 regenerative unit.

*3   Capacity when used with the required JUSP-RA18 regenerative unit.

*4   Capacity when used with the required JUSP-RA19 regenerative unit.

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Sigma III

Use Yaskawa's SigmaSize and the Sigma III Series
Servo System Use's Manual: YEA-SIA-S800-11

Applicable Servo Amplifier		Regenerative Resistor Mounted in a Servo Amplifier		Internal Regeneration Power Capacity (W)	Minimum Allowable Resistance (Ω)
		Resistance (Ω)	Wattage* (W)		
200V Single-phase	SGDS-A5A1□A	—	—	—	40
	SGDS-01A1□A				
	SGDS-02A1□A				
	SGDS-04A1□A				
	SGDS-08A1□A	50	60	12	
200V Three-phase	SGDS-05A1□A	50	40	8	40
	SGDS-10A1□A				
	SGDS-15A1□A	30	70	14	20
	SGDS-20A1□A	25	140	28	12
	SGDS-30A1□A	12.5			
	SGDS-50A1□A	8	280	56	8
	SGDS-60A1□A	6.25**	880**	180	5.8
	SGDS-75A1□A	3.13***	1760***	350	2.9

* Capacity prior to derating. If regeneration power requirements exceed internal capacity of the amp, install an external regeneration resistor (reference "Minimum Allowable Resistance"). Be sure to derate wattage of external resistor to 20% or less (natural convection) and to 50% or less with forced air-cooling.

** Provided externally by JUSP-RA04

*** Provided externally by JUSP-RA05

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Sigma-5

● Specifications of Built-in Regenerative Resistor

The following table shows the specifications of the SERVOPACK's built-in resistor and the amount of regenerative power (average values) that it can process.

Applicable SERVOPACK SGDV-		Specifications of Built-in Resistor		Regenerative Power Processed by Built-in Resistor[1]	Minimum Allowable Resistance
		Resistance Ω	Capacity W	W	Ω
Single-phase 100 V	□□□F	–	–	–	40
Three-phase 200 V	R70A,R90A, 1R6A,2R8A	–	–	–	40
	3R8A, 5R5A, 7R6A	50	40	8	40
	120A	20	50	10	20
	180A, 200A	12	80	16	12
	330A	8	180	36	8
	470A	(6.25)[2]	(880)[2]	(180)[2]	5.8
	550A, 590A, 780A	(3.13)[3]	(1760)[3]	(350)[3]	2.9
Three-phase 400 V	1R9D, 3R5D, 5R4D	108	70	14	73
	8R4D, 120D	45	140	28	44
	170D	32	180	36	28
	210D,260D	(18)[4]	(880)[4]	(180)[4]	18
	280D,370D	(14.25)[5]	(1760)[5]	(350)[5]	14.25

*1: The average regenerative power that can be handled is 20% of the rated capacity of the regenerative resistor built into the SERVOPACK.
*2: For the optional JUSP-RA04-E regenerative resistor unit.
*3: For the optional JUSP-RA05-E regenerative resistor unit.
*4: For the optional JUSP-RA18-E regenerative resistor unit.
*5: For the optional JUSP-RA19-E regenerative resistor unit.