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Refer to figures on pages 3 to 5.

PURPOSE OF THIS DOCUMENT
This document is intended to supplement the applicable Kollmorgen® AKD® motor drive User Guide and Safety Guide. It provides details to assist with commissioning a Kollmorgen® AKD® motor drive using Kollmorgen® WorkBench interface software. Emphasis is placed on configuring the drive to enhance the operational safety of the gripping system. Note: User Guides, Safety Guide, and WorkBench software can be downloaded from the Kollmorgen® website.

MOTOR PARAMETERS
The AKM38H-4NZDC450 motor supplied with the M1095 gripper option incorporates a plug and play feature which allows the drive to automatically configure motor parameters when the motor is connected to the drive. Note: See the “Motor” section of the Kollmorgen® User Guide for additional information. Below is an abbreviated list of motor performance parameters. Note: See Kollmorgen® website for full listing of motor parameters. Rated Speed = 5500 rpm (w/ 320 VDC buss) Rated Torque = 2.27 Nm [20.09 in-lb] (at rated speed w/ 320 VDC buss) Continuous Stall Torque = 2.87 Nm [25.40 in-lb] (w/ 100 °C rise) Torque Constant = 0.52 Nm / rev [4.6 in-lb / rev] 
Weight = 3.36 kg [7.4 lb] (including motor brake)

GRIPPING ZONE(S)
Operating the drive in position mode provides a precise means of establishing one or more “gripping zones,” based on jaw travel position, with input torque and position following error limited to low values outside of the gripping zone(s). The establishment of gripping zones enhances the operational safety of the gripper system by limiting the grip force and increasing the positional fault sensitivity of the system to detect object collisions in those portions of the jaw travel where the gripper is not expected to encounter an object. Only within the relatively narrow confines of the gripping zone is the gripper allowed to exert full grip force. The gripping zone should bound the jaw travel position where the gripper is expected to grip the gripped part and be no longer in travel than is necessary to compensate for gripped part dimensional variations and tooling deflection. When gripping multiple parts of differing dimensions, establish a separate gripping zone for each anticipated gripping position. Note: To place the controller in position mode, set the “Operations Mode” to “2 - Position” on the “Settings” screen. See the “Settings” section of the Kollmorgen® User Guide for additional information.

JAW TRAVEL MAPPING
The “Limits” screen allows the position of the jaws to be easily mapped to the rotation of the motor so that jaw position, velocity, and acceleration values can be subsequently specified relative to jaw travel, instead of motor revolutions. See figure 1.
1. Set “Type of Mechanics” to “Motor Only”.
2. Set “Position Unit,””Velocity Unit,” and “Acceleration Unit” to “3 - Custom…”.
3. In the “Custom” section, enter “8512 mm = 1000 rev” to establish that each jaw travel 8.512 mm means that each jaw moves ½ of the total travel, or 4.256 mm.

POSITION REFERENCE
Positive rotation of the M1095 option motor causes the jaws to move towards one another (close) while negative motor rotation moves the jaws apart (open). A convenient frame of reference for jaw position is to assign a value of zero to the position of the jaws in the fully opened position so that positive (clockwise) rotation of the motor will cause the measured position of the jaws to increase while negative rotation will decrease the measured jaw position.

INPUT - OUTPUT CONFIGURATION
The input - output configuration of the drive allows the position of the jaws, as reported by the motor feedback device, to control the allowable grip force and positional fault sensitivity of the system. The I/O configuration is established on the “General Purpose I/O’s” tab of the “Digital I/O” screen. Figure 2 illustrates an example configuration. In addition to a “homing” function assigned to Digital Input 1 (DIN 1), “jog open” and “jog closed” functions have been assigned to DIN 5 and DIN 6, respectively, and “start motion” functions have been assigned to DIN 3, DIN 4, and DIN7. Digital Output 1 (DOUT 1) is used to establish the gripping zone(s) via the Programmable Limit Switch (PLS) function of the drive and DIN 2 is used to toggle a command buffer which contains the commands to raise and lower the maximum motor torque and allowed position error in response to the output (DOUT 1) from the programmable limit switches.

To configure the input and the gripping zone command buffer:
4. Set the “Mode” of the desired input to “9 - Command Buffer.”
5. Set the “Buffer” for the input to the desired buffer number.
6. Click the “Edit” button to open the buffer for editing.
7. Follow the instructions in the “COMMAND BUFFER” section below to configure the buffer.

To configure the output and the Programmable Limit Switches:
8. Set the “Mode” of the desired output to “15 - Prog. Limit Switch State.”
9. Click on the “Goto PLS” link which will appear in the “Param” column to open the “Programmable Limit Switches” screen.
10. Follow the instructions in the “PROGRAMMABLE LIMIT SWITCHES” section below to configure the switches.

COMMAND BUFFER
The Command Buffer allows drive parameters to be changed using a digital input. Each digital input that is assigned to control a command buffer is linked to one command buffer set. Each buffer set is divided into a group of commands that are executed when the associated digital input changes to a “high” state and a second group of commands that are executed when the associated digital input changes to a “low” state. The PLERRFTHRESH command is used to define the allowed position following error (positional fault sensitivity) while the IL LIMITP and IL LIMITN commands define the positive and negative motor current limits, respectively. Figure 3 shows an example command buffer configured as follows:
• High Command Buffer (executed when the jaws enter the gripping zone):
(11) PLERRFTHRESH 10 sets the allowed position following error at 10 mm. Note: This value should equal the width of the gripping zone.
(12) IL LIMITP 6.41 limits the maximum current that the controller will apply to the motor to 6.41 Ams. Note: Do not exceed 7.39 Ams to prevent potential damage to the gripper.
(13) IL LIMITP -6.41 limits the maximum current that the controller will apply to the motor to -6.41 Ams. Note: Do not exceed -7.39 Ams to prevent potential damage to the gripper.
• Low Command Buffer (executed when the jaws exit the gripping zone):
(14) PLERRFTHRESH 0.5 sets the allowed position following error at 0.5 mm.
(15) IL LIMITP 1.00 limits the maximum current that the controller will apply to the motor to 1.00 Ams.
(16) IL LIMITN -1.00 limits the maximum current that the controller will apply to the motor to -1.00 Ams.

PROGRAMMABLE LIMIT SWITCHES
Programmable limit switches (PLS) are used to define the gripping zone(s). Up to eight individual gripping zones can be configured using the switches. Figure 4 provides an example showing the switches configured for two gripping zones, with one zone centered at a grip travel of 175 mm and a second zone centered at 250 mm. Each grip zone is 10 mm wide to accommodate gripped part dimensional variations and tooling flexure. Grip zone 1 = 170 mm to 180 mm (centered at 175 mm). Grip zone 2 = 245 mm to 255 mm (centered at 250 mm).

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In this example, for each of the gripping motion tasks: gripper zone about the reported gripping position. See figure 4. The applicable gripping zone can then be adjusted as desired, to re-center at which gripping is actually occurring, as reported by the position feedback device within. Tip: The position "COMMAND BUFFER" Buffer", as previously discussed in the parameter entered into the "Hi Command force is controlled by the value of the position (typically to the end of the gripping zone). Note: for gripping to occur and be sustained, the motion task associated to the end of the zone, even though the jaws have stopped against the gripped object. It is therefore crucial that for gripping to occur and be sustained, the motion task associated with gripping must command the jaws to move to a position beyond the anticipated grip position (typically to the end of the gripping zone). Note: The magnitude of the gripping force is controlled by the value of the IL.LIMITIP parameter entered into the "Hi Command Buffer", as previously discussed in the "COMMAND BUFFER" section. Tip: The position at which gripping is actually occurring, as reported by the position feedback device within the motor, can be easily determined by looking at the "Position Feedback" value listed at the bottom of the "Programmable Limit Switches" screen while the gripper is gripping. See figure 4. The applicable gripping zone can then be adjusted as desired, to re-center the gripping zone about the reported gripping position.

**HARDWARE JUMPER**

An external jumper wire must be added between the applicable digital output (DOUT) pin controlled by the PLS and the digital input (DIN) pin controlling the gripping zone command buffer in order for the output and input to communicate with one another. Figure 5 shows an example of a jumper wire added between pin 7 of I/O connector X7 (DOUT 1+) and pin 9 of connector X7 (DIN 2) to affect the communication path.

**MOTION TASKS**

Figure 6 illustrates three sets of motion tasks as shown on the "MOTION TASKS" screen. The first set (tasks 1 & 2) is associated with a gripping zone 10 mm wide, centered at a total jaw travel position of 175 mm. The second set (tasks 4 & 5) is associated with a gripping zone 10 mm wide, centered at a total jaw travel position of 250 mm. The last task (task 7) moves the jaws in the open direction to travel position of 10 mm. In this example, gripping is accomplished by executing either sequential tasks 1 & 2 or tasks 4 & 5, to close the jaws to the end of the respective gripping zone. Task 7 would then be executed to open the jaws. Each set of sequential gripping tasks consists of a rapid traverse of the jaws in the close (positive) direction until the jaws reach a position 31 mm prior to the beginning of the applicable gripping zone. At this position, the jaws are decelerated at 1 G (9810 mm/s²) to a final gripping velocity of 50 mm/s before the jaws enter the 10 mm wide gripping zone. Figure 7 shows the detail page for Task 1 (accessed by double-clicking on line 1 on the "MOTION TASKS" screen). To link the rapid traverse motion (e.g. task 1) to the gripping motion (e.g. task 2):

1. Check box to enable "Next Task".
2. Enter line number of gripping motion task (e.g. "2").
3. Check the "Blend" radio button.
4. Select "Blend into Velocity" from the pulldown menu to specify that the jaws smoothly decelerate from the rapid traverse velocity to the gripping velocity. It is important to begin the deceleration of the jaws at a position that will allow adequate distance for the jaws to fully decelerate to the desired gripping velocity. The following equation can be used to calculate the required deceleration distance:

\[ s = \frac{V_v^2 - V_g^2}{2a} \]

Where: \( s \) = Deceleration distance  
\( V_v \) = Rapid traverse velocity  
\( V_g \) = Gripping velocity  
\( a \) = Deceleration

In this example, for each of the gripping motion tasks:

\[ V_v = 780 \text{ mm/s} \]  
\[ V_g = 50 \text{ mm/s} \]  
\( a = 1 \text{ G} = 9810 \text{ mm/s}^2 \)

Entering these values into the deceleration distance equation yields: \( s = 30.9 \text{ mm} \), therefore the position for the start of the jaw deceleration is chosen to be 31 mm prior to the beginning of each respective gripping zone.

Having entered the gripping zone, the decelerated jaws can be expected to encounter the extremities of the object to be gripped and be brought to rest by contact with the object. Because the motion task is commanding the jaws to move to the end of the gripping zone, the drive will continue to deliver current to the stalled motor in an attempt to move the jaws to the end of the zone, even though the jaws have stopped against the gripped object. It is therefore crucial that for gripping to occur and be sustained, the motion task associated with gripping must command the jaws to move to a position beyond the anticipated grip position typically to the end of the gripping zone). Note: The magnitude of the gripping force is controlled by the value of the IL.LIMITIP parameter entered into the "Hi Command Buffer" as previously discussed in the "COMMAND BUFFER" section. Tip: The position at which gripping is actually occurring, as reported by the position feedback device within the motor, can be easily determined by looking at the "Position Feedback" value listed at the bottom of the "Programmable Limit Switches" screen while the gripper is gripping. See figure 4. The applicable gripping zone can then be adjusted as desired, to re-center the gripping zone about the reported gripping position.

**OPERATING LIMITS**

The "LIMITS" screen shows all of the drive limits for convenience on a single screen. See figure 8.

29. The "Current Limits" are controlled by the values entered for IL.LIMITIP and IL.LIMITIN in the command buffer (See the "COMMAND BUFFER" section for additional information). As the buffer toggles between high and low states, the values displayed for the "Current Limits" will change accordingly, Tip: View the "Current Limits" at any time to determine if the gripper is allowed to exert full gripping force (i.e. the "Current Limits" match those specified in the High Command Buffer) or is restricted to lower grip force (i.e. the "Current Limits" match those specified in the Low Command Buffer). Note: Do not exceed ± 7.39 A/mm to prevent potential damage to the gripper.

30. The "Positive and Negative Speed Limits" are chosen so as not to exceed the running speed of the motor. Note: Do not exceed ± 780 mm/s to prevent exceeding the 5500 rpm rated running speed of the motor. Tip: Jav speed is equally divided between each jaw. A jaw speed of 780 mm/s means that each jaw moves at ½ of the total speed, or 390 mm/s.

31. The "User Over-Speed Limit" should be kept as low as is practical for reliable operation of the gripper. Too low of a value will typically result in an over-speed drive fault. If over-speed faults occur, progressively raise the over-speed limit and / or reduce the acceleration / deceleration and speed of the motion tasks.

32. The "Overall Over-Speed Limit" is capped by internal motor parameters and should not need to be adjusted.

33. The "Maximum Position Error" is controlled by the value entered for PL.ERRFTHRESH in the command buffer (See the "COMMAND BUFFER" section for additional information). As the buffer toggles between high and low states, the value displayed will change accordingly.

34. The "Positive and Negative Speed Limits" are typically set on the method chosen to home the gripper. If the gripper is homed using a hard mechanical stop (such as allowing the jaws to travel until the jaws physically contact the end plates or center plate of the gripper) then the limits should be chosen to preclude the jaws from reaching the mechanical stops while the gripper is running. In the example shown, the jaws of a 350 mm travel EGRR were homed against the end plates of the gripper. If the gripper is homed using a hard mechanical stop (such as allowing the jaws to travel until the jaws physically contact the end plates or center plate of the gripper) then the limits should be chosen to preclude the jaws from reaching the mechanical stops while the gripper is running. In the example shown, the jaws of a 350 mm travel EGRR were homed against the end plates of the gripper and the resulting home position set to 0 mm. Position limits are set to 5 mm and 345 mm respectively, to prevent each jaw from coming any closer than 2.5 mm to the end and center plates of the gripper.

35. Set the "Acceleration Limits" to prevent the acceleration / deceleration of the jaws from exceeding 1 G (9810 mm/s²). Tip: Jaw acceleration is equally divided between each jaw. A jaw acceleration of 1 G means that each jaw experiences ½ of the total acceleration, or 0.5 G.

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**FIGURE 1** - Units screen

**FIGURE 2** - Digital Inputs and Outputs screen

**FIGURE 3** - Command Buffer number 1 window
FIGURE 4 - Programmable Limit Switches screen

FIGURE 7 - Motion Task number 1 window

FIGURE 5 - External Jumper between PLS Output and Command Buffer Input
FIGURE 6 - Motion Tasks screen

FIGURE 8 - Limits screen