



7165L Single axis joystick
**Owner's Operation, Installation &
Maintenance Manual**



January 2024

Kobel Manufacturing Co. Ltd.

NOTES:

[illegible]

RECORD DATA BEFORE INSTALLATION FOR FUTURE REFERENCE

Model #:	
Serial #:	
Date of Purchase:	
Date of Installation:	

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1 INTRODUCTION

1.1 CONTACT

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This document is intended to clearly present comprehensive product data and provide technical information to assist the end user in design applications. Kobelt reserves the right, without notice, to change the design, or construction, of any products and to discontinue or limit distribution of any products. Kobelt also reserves the right to change, or update, without notice, any technical information contained within this document.

Kobelt recommends that customers visit our website to check for updates to this Manual. Once a product has been selected for use, it should be tested by the user to ensure proper function in all possible applications. For further instructions, please contact our distributors or visit our website.

1.2 SAFETY

1.2.1 Safety Alerts

Throughout this manual, the following symbols, and their accompanying explanation, are used to alert the user to special instructions concerning a service or operation that may be hazardous if performed incorrectly or carelessly. The associated risk levels are stated below.

 DANGER	This symbol indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.
 WARNING	This symbol indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.
 CAUTION	This symbol indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.
NOTICE	This symbol informs the reader of events not related to personal injury but which there is a risk of damage to property or equipment.
SAFETY INSTRUCTIONS	This symbol informs the reader of safety-related instructions or procedures.

1.2.2 Notice to Installer

Disregarding the following safety measures can result in an accident causing severe injury to personnel and damage to material assets.

- Only use the product as directed in this manual.
- Never put the product into service if there is evidence of visible damage.
- Never put the product into service before fully completing installation and commissioning.
- Do not carry out any modifications to the product.
- Only use authentic Kobelt spare parts.
- Observe all local regulations, directives and laws during the installation of this product.
- All installation, commissioning, and maintenance work must only be conducted by qualified personnel. (For the purpose of this manual, qualified personnel are persons who are familiar with the assembly, installation, commissioning, and operation of the product and who have the qualifications necessary for their occupation.)
- Observe all specifications in this manual. If these guidelines are not followed and damage occurs, the warranty will be voided.

1.2.3 Product Hazards



Disconnect Power: Turn off power at distribution panel before beginning installation to protect installer from electrical hazards.



Voltage and Current Compatibility: Confirm that the power source is compatible with the maximum voltage and current ratings of is product variant. Failure to do so could result in damage or fire.

2 PRODUCT DESCRIPTION

The Kobelt 7165L joystick is a single axis control module that can be configured as on on/off output device, or as an analog style output device. This allows for simple use as a jog unit, capable of control in two directions, or as an infinitely variable positioning device. Its small size allows for installation in tight areas where space constraints are paramount.

In addition to the variation on the controller outputs, controller handling is also a configurable feature provided in the 7165L product line. The joystick handle can be configured to be spring return to neutral, a detent neutral, or a friction drag.

The 7165L is designed for indoor and outdoor installation with a robust die cast bronze and stainless-steel construction. The joystick is protected with a UV and water-resistant rubber boot that prevents ingress into the electronic components. These features provide a long service life in a harsh marine or industrial environment.

2.1 MODEL CODE KEY

7165L joysticks can be ordered from the model code key shown in Figure 1. Most combinations are compatible with each other, except for the electrical output options. One must decide on either a ‘-D’ a ‘-G’ or a ‘-H’. For example, a 7165L-DG or 7165L-DH cannot be ordered. A valid model code key for a joystick with spring return, friction drag and jog switches with prewired terminal strip would be 7165L-BEGW. See section 5 for a more detailed description of the control behavior each model possesses.

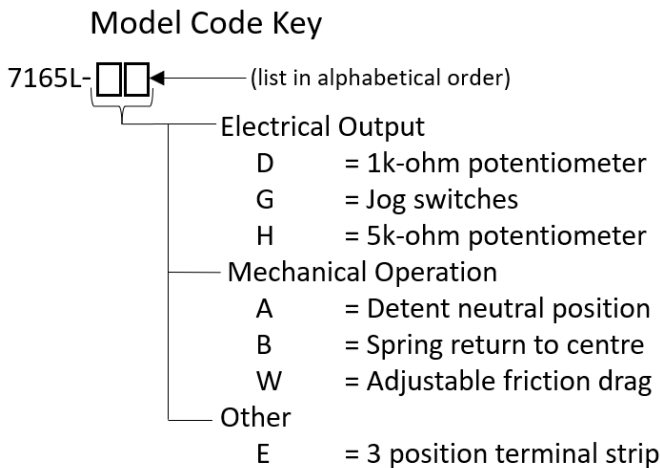


Figure 1: 7165L Model configuration key

2.2 TECHNICAL DATA

Table 1: 7165L Electrical Data

MODEL		7165L-	
MODEL	7165L-G	7165L-D	7165L-H
OUTPUT	Discrete (Low/High)		Analog(variable)
SWITCH ELECTRICAL CONTACTS	Form A, N.O or N.C (per direction) ¹	-	-
MAX SWITCH VOLTAGE	250 VAC	-	-
MAX SWITCH CURRENT	10 A (per switch)	-	-
MAX POTENTIOMETER RESISTANCE	-	1kΩ	5kΩ
MAX POTENTIOMETER POWER	-	1.0W	1.0W

1. 7165L-EG models factory wired as N.O. 7165L-G can be wired in either N.O or N.C circuit.

Table 2: 7165L Physical data

MODEL		7165L-	
Model	7165L-A	7165L-B	7165L-W
JOYSTICK BEHAVIOR	DETENT NEUTRAL	SPRING RETURN TO NEUTRAL	FRICTION INHIBITED MOTION
HANDLE TRAVEL	24° (per direction)		
OPERATING FORCE	N/A	1.0 lbf [4.5 N]	ADJUSTABLE
PRODUCT FINISH	Painted texture black body		
OPERATING TEMPERATURE	-13°F ... 158°F [-25°C ... 70°C]		
PRODUCT WEIGHT	1.0 lbs [0.45kg]		

3 INSTALLATION

3.1 MECHANICAL



WARNING

In spring return models, do not operate the joystick if the internal spring has broken. Unexpected operation could result.

Ideally, the joystick should be mounted in a central location at each station on-board the vessel to control steering operation.

- Within 6 feet [1.8 m] of electrical junction box.
- Placed on horizontal or angled dash surface.
- Placed as to protect the external electrical cable from damage.

The joystick is equipped with (4) four clearance holes for #10 (or M5) screws or bolts through the top surface for direct mounting to the dash. Refer to Appendix E for a cutout dash template. Ensure the unit is securely fastened to a suitable surface.

3.2 ELECTRICAL

The joystick units come with two arrangements for electrical connections. On ‘-E’ models, the control has a terminal strip supplied attached to the central frame. Switches and potentiometers come pre-wired to the terminal strip. Customers can then use standard fork-style connections to wire in the joystick at the terminal strip.

Models without the ‘-E’ suffix come with no wiring. Customers will need their electrical cables to be directly wired to the terminals of the switches or potentiometers via soldering.

3.2.1 On/off switch controlled joysticks

3.2.1.1 Pre wired ‘EG’ Joysticks

For joysticks that have a ‘EG’ option, it will operate as a on/off, Normally Open(N.O) output device. When the joystick is pushed off centre approximately 24° the switch corresponding to that particular direction will be moved to a closed-circuit position. The default wiring provided by the Kobelt factory is shown in Figure 2. Customers can connect their electrical cables to the terminal strip as desired to achieve the joystick directionality suited for your application.

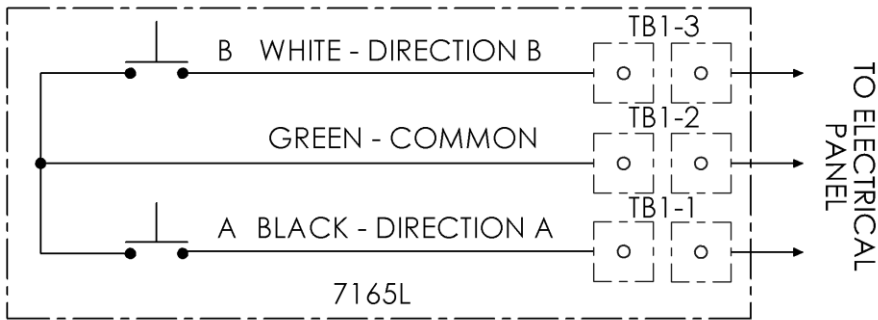


Figure 2: 7165L Internal Wiring Diagram, ‘EG’ models only

Figure 3 shows the controller and what side direction “A” and “B” in Figure 2 refer too. The electrical terminal strip is also shown for convenience with the terminals labelled in Figure 3. For operation and expected outputs of joysticks with microswitches, refer to section 5.2.2.

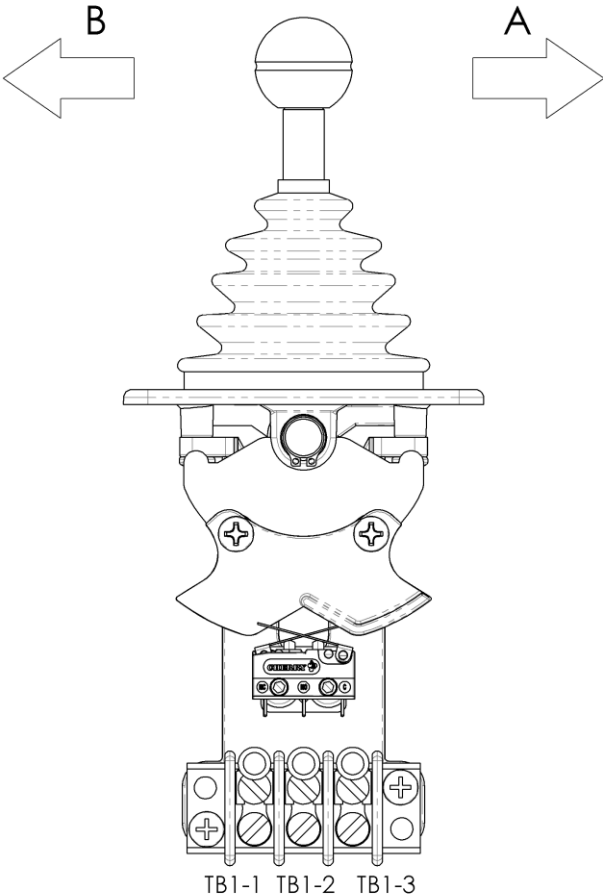


Figure 3: 7165L Switch Direction Diagram, Terminal reference shown.

3.2.1.2 Non-wired joysticks ‘G’ models

Customers who order a ‘G’ joystick without the ‘E’ combination will not have a terminal strip or have the microswitches prewired. They therefore have the option of customizing their electrical circuit functionality. These customers will be required to solder their connection wires to the microswitches and can choose either a N.O or normally closed (N.C) circuit functionality.

For choosing the switches and terminals to connect to, refer to Figure 4. The joystick direction that corresponds to a particular switch is shown. Also shown is which terminals on the switches correspond to which circuit functionality.

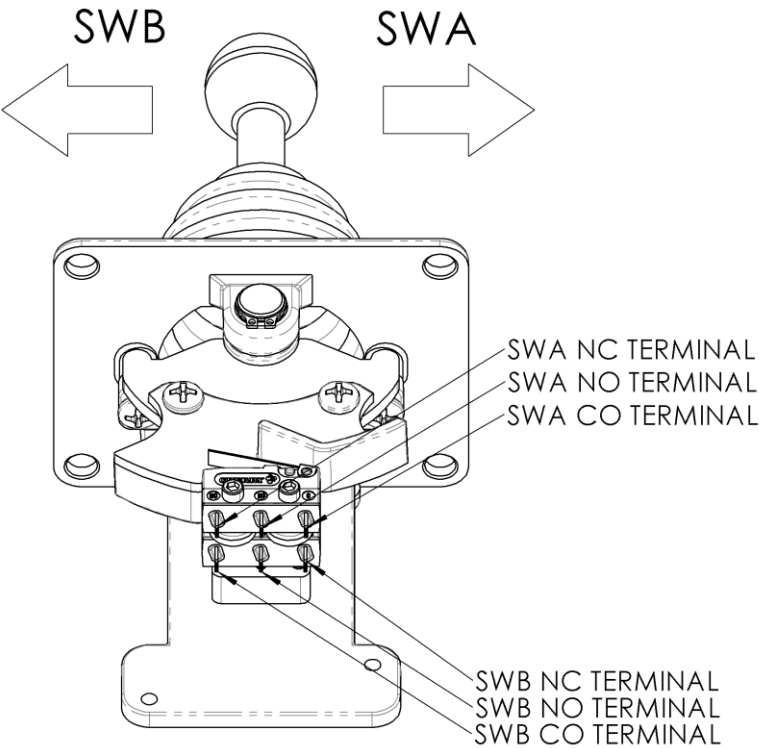


Figure 4: 7165L-G shown, terminals and switch directions shown.

3.2.2 ‘D’ or ‘H’ Analog output Potentiometer controlled joysticks

For customers that select a ‘D’ or ‘H’ joystick, it comes with a 1k-ohm or 5k-ohm rotary potentiometer respectively. This configuration will give the joystick the ability to behave like an analog output device, capable of a variable voltage output within the range of the potentiometer.

The pinout and wiring schematic for the potentiometer is given in Figure 5. A typical wiring arrangement is given in Table 3. This wiring is typical for both the 1k-ohm and 5k-ohm potentiometers. Refer to section 5.2 for operation of the joystick with the potentiometers and expected outputs.

Ensure wire gauge sizes meet local regulatory requirements for your particular electrical system.

Table 3: Suggested Potentiometer connection, default wiring ‘-E’ models

7165L-D/7165L-H				
Terminal #	Wire Name	Colour	Gauge	Function
1	POT+	White	18AWG	Potentiometer power supply connection.
2	POT WIPER	Red	18AWG	Potentiometer signal connection.
3	POT-	Black	18AWG	Potentiometer ground connection.

- 1. Terminals 1 & 3 may be swapped to reverse potentiometer output.

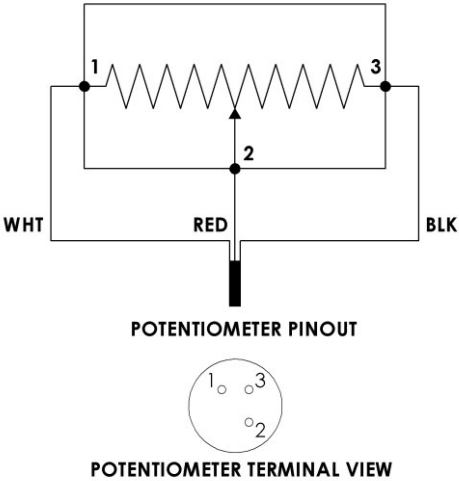


Figure 5: Potentiometer wiring schematic.

4 COMMISSIONING

4.1 ELECTRICAL CHECK



CAUTION

Ensure that the joystick base is properly secured and installed before powering up the unit.

Confirm that the electrical connection to the 7165L have been made and correspond to the requirements of your system. Refer to section 3.2 for specifications of the electrical connections.

4.2 FUNCTIONAL TEST



CAUTION

The Functional Test should be carried out while the vessel is still at dock and before it is taken out to sea after installation has been completed.

A complete functional test should be performed on the system to confirm that the joystick has been installed correctly before entering operational use.

5 OPERATION

The Kobelt 7165L operates on one axis of rotation. As shown in Figure 6, the joystick can be pushed either left, direction B, or right, direction A.

Depending on the manner in which the joystick is configured, the outputs will be varied. A brief description of the expected joystick operational behavior is given in section 5.1 and 5.2. Models ordered with more than one configuration will have behavior that is a combination of the selected configurations.

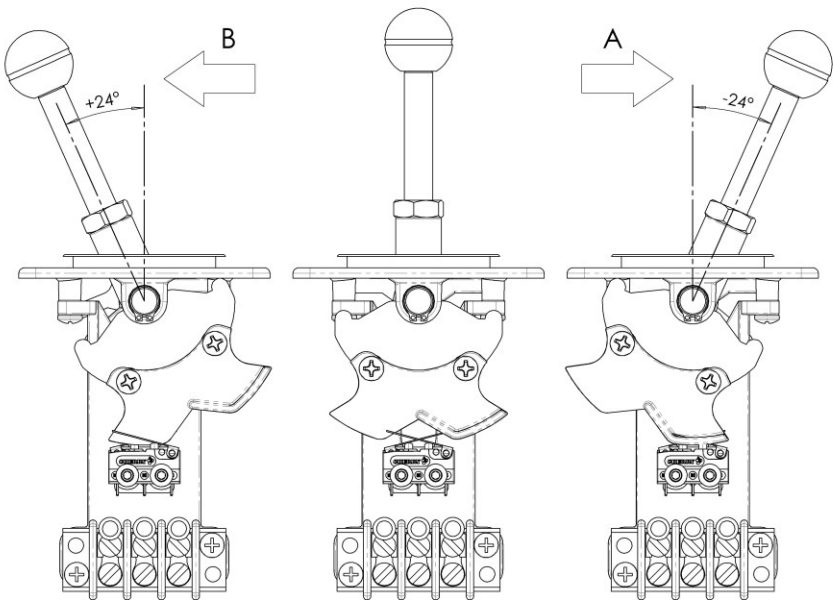


Figure 6: 7165L-BE Positions of Operation, LEFT - CENTRE - RIGHT

5.1 MECHANICAL CONFIGURATIONS

5.1.1 7165L-A, Neutral detent

For models selected with a neutral detent, the operator can push the joystick between position 'A' or 'B' freely when not in the centre position. In the centre position, a small, spring loaded detent will engage and hold the joystick in the neutral position. The operator must overcome the force of the detent before the joystick will begin moving again.

5.1.2 7165L-B, Spring return to neutral

For models selected with a spring return, there is a tension spring inside the joystick that holds it in the neutral position. When the joystick is moved to either position ‘A’ or ‘B’, the spring will provide a resistance force that tries to pull the joystick back to neutral. If the operator releases the joystick at any arbitrary position, the spring will pull the joystick back to its neutral position.

5.1.3 7165L-W Adjustable friction drag

Models selected with friction drag contain a friction drag element that provided resistance to moving the joystick in either direction. This works well in applications where it is desired to position the joystick at any arbitrary position between ‘A’ and ‘B’ and parking it there. The frictional resistance will help to prevent the joystick from drifting due to vibration.

5.2 ELECTRICAL CONFIGURATIONS

5.2.1 7165L-D & 7165L-H, analog output

For models selected with the potentiometers as output devices, the operator can move the joystick between ‘A’ and ‘B’ and get a varying output signal. The joysticks come set from the factory with the midrange of the potentiometer lined up with the neutral position of the joystick. When the operator moves the joystick to position ‘A’ or ‘B’ the potentiometer will vary its output from its midrange position. The expected relationship between potentiometer output and handle position is shown in Figure 7 and Figure 8 for the 7165L-DE and 7165L-EH respectively. Refer to Figure 6 for handle throw sign convention.

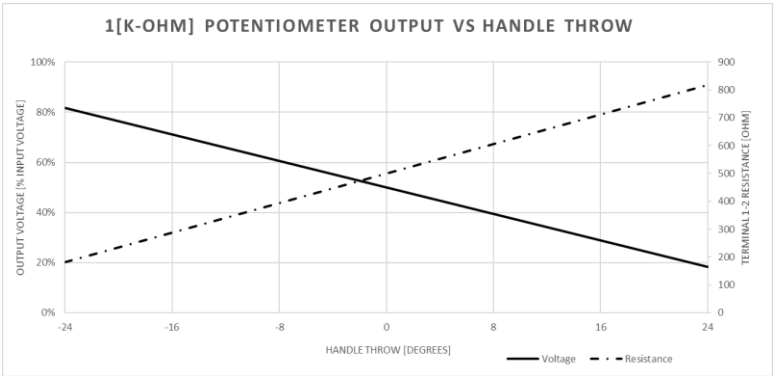


Figure 7: 7165L-DE expected joystick output vs handle throw.

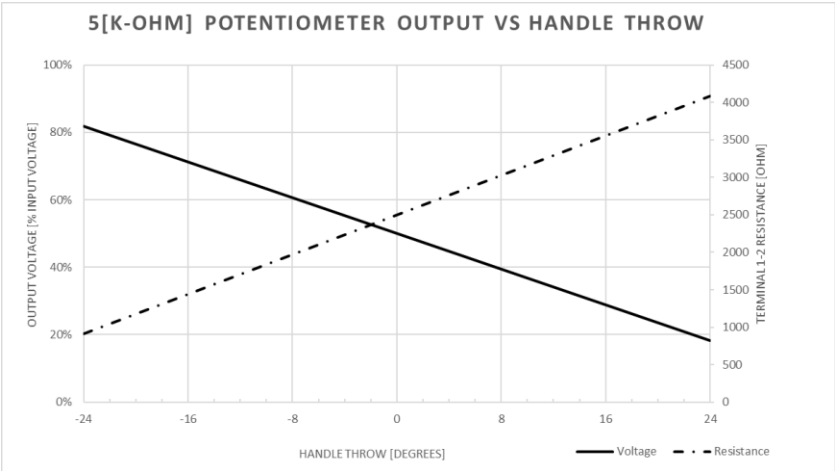


Figure 8: 7165L-EH expected joystick output vs handle throw.

5.2.2 7165L-G, binary output

Models selected with a -G suffix, will contain two microswitches that behave as a binary, on/off output devices. Joysticks with this output selected will behave like a jog device. When the joystick is pushed to either position ‘A’ or ‘B’, the microswitch of that particular direction will activate. The circuit of that microswitch will then change state. When the joystick is in the centre position, both microswitches are in the same state.

Microswitches can be wired in either a normally closed or normally open circuit configuration. Pending on which circuit is selected by installation personnel, the expected circuit state at neutral and positions ‘A’ and ‘B’ will differ. Section 3.2.1 should be reviewed with installation personnel to ensure intended operation is maintained. The expected relation between the microswitch output and handle throw is shown in Figure 9 for a 7165L-EG.

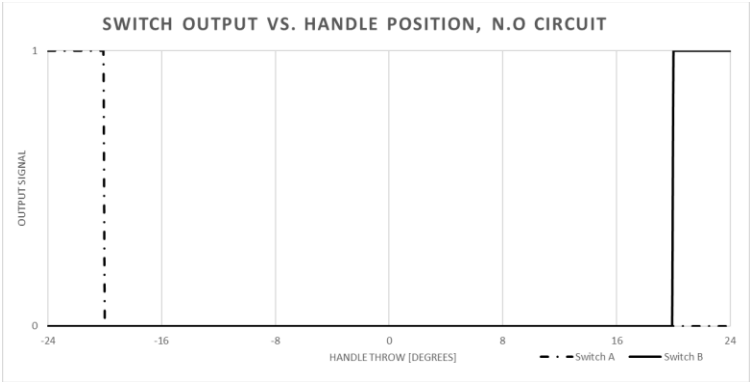


Figure 9: 7165L-EG expected joystick output vs handle throw.

6 MAINTENANCE

6.1 PREVENTATIVE MAINTENANCE

- Quarterly (4 times per year)
 - Visually inspect wire and cable insulation for splits or damage.
 - Ensure there is no visible corrosion on the unit.
 - Ensure that the friction drag is adequate so joystick does not freely move (-W models only), see section 6.1.1.
 - Lubricate the detent track (-A models).
- Every 2 years
 - Confirm cable glands are secured to cables.
 - Replace seals.
 - Replace tension spring(for -B models only).

6.1.1 Adjusting friction drag

1. Remove the joystick from its mounting position, take care to protect electrical wires connected to the joystick.
2. Locate the set screw in the left most position when viewed from the head of the screw, refer to Figure 10
3. Using a 3/16" hex key, adjust the setscrew, clockwise rotation will provide more friction drag, counterclockwise will slacken the friction drag. The drag should be set so that the joystick cannot move freely from vibrations experienced by the vessel it is mounted to.
4. Reinstall the joystick to its mounting position.

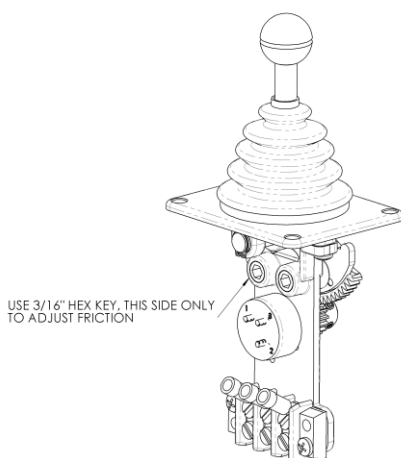


Figure 10: Adjusting friction lock, '-W' models.

7 TROUBLESHOOTING

If you encounter problems with the operation of your product, please refer to the trouble-shooting suggestions before contacting Kobelc for assistance. If the steps below do not resolve your issue, please reach out either Kobelc directly or our Dealers in your area.

Table 4: Common Solutions

Problem (Issue encountered)	Cause (What it means)	Corrective Action (What to do)
Joystick action is reversed.	Wiring is backwards.	<ol style="list-style-type: none">1. ('-G' models)Swap the Switch A and Switch B output wires to their respective system connections.2. ('-D' & '-H' models). Swap potentiometer terminal 1 and 3 connections.
Joystick does not move equipment at all.	Wiring is wrong.	<ol style="list-style-type: none">1. Check wiring.2. Refer to system design drawing for proper wiring.
	The rest of the system isn't hooked up correctly.	<ol style="list-style-type: none">1. Check system wiring.2. Confirm wiring to joystick.
	Broken switch or contact(''-G' models only)	<ol style="list-style-type: none">1. Use a multi-meter to monitor the resistance of the wiring between switch contacts.2. Check for normal operation of each switch by measuring the connection while moving the joystick handle.3. Check both Switch A and Switch B directions. Replace any damaged switches.
	Broken potentiometer(-D & -H models only).	<ol style="list-style-type: none">1. Use a multi-meter to monitor the resistance between terminals 1&2 on the potentiometer. To get an accurate measurement, the potentiometer should be disconnected from all other circuitries.2. Check the resistance for a range of values and compare to the expected outputs in Figure 7 and Figure 8 for the '-D' and '-H' models respectively.3. If the outputs do not agree reasonably well with the expected outputs, the potentiometer should be replaced

8 WARRANTY

Kobelt Manufacturing Co. Ltd. ("Kobelt") warrants the Products and Parts manufactured by Kobelt to be free from defects in workmanship or material and that said products are designed mechanically and functionally to perform to specifications.

This warranty is effective providing:

- The equipment is used within the intended operating conditions and in accordance with Kobelt recommendations
- The equipment is installed according to equipment diagrams, specifications and recommendations which Kobelt has provided

This warranty becomes invalid if the factory supplied serial number has been removed or altered on the product. This warranty does not cover cosmetic damage or damage caused by an act of God, accident, misuse, abuse, negligence or modification of any part of the product. This warranty does not cover damage due to improper operation or maintenance, connection to inappropriate equipment or attempted repair by anyone other than an authorized Kobelt representative.

Upon identification of a potential issue or defect with a Kobelt Product or Part, the Warranty Applicant ("Applicant") must immediately contact Kobelt and describe the issue in writing, by letter, fax, email or other electronic conveyance. Kobelt will then assess the cause of the defect and determine warranty applicability and appropriate remediation.

If any part is found to be defective, Kobelt will replace said part FOB the Kobelt factory provided that any such defective part is returned by the Buyer with freight and applicable forwarding charges prepaid by the Buyer. Kobelt's sole obligation to the Applicant will be to repair or replace the defective part with same or similar product, to a maximum value of the list price of the product or part. The Kobelt warranty does not cover labour charges, travel or any other associated expenses.

All Products and Parts manufactured by Kobelt, are subject to a warranty against manufacturer's defects in materials or workmanship for a period of two (2) years from the date of purchase.

Kobelt will be responsible for all Products or Parts sold by Kobelt but manufactured by 3rd party manufacturing companies. However, these products and parts are subject to applicable 3rd party warranties and may not be the same as the Kobelt warranty.

9 APPENDIX A: INSTALLATION DIMENSIONS

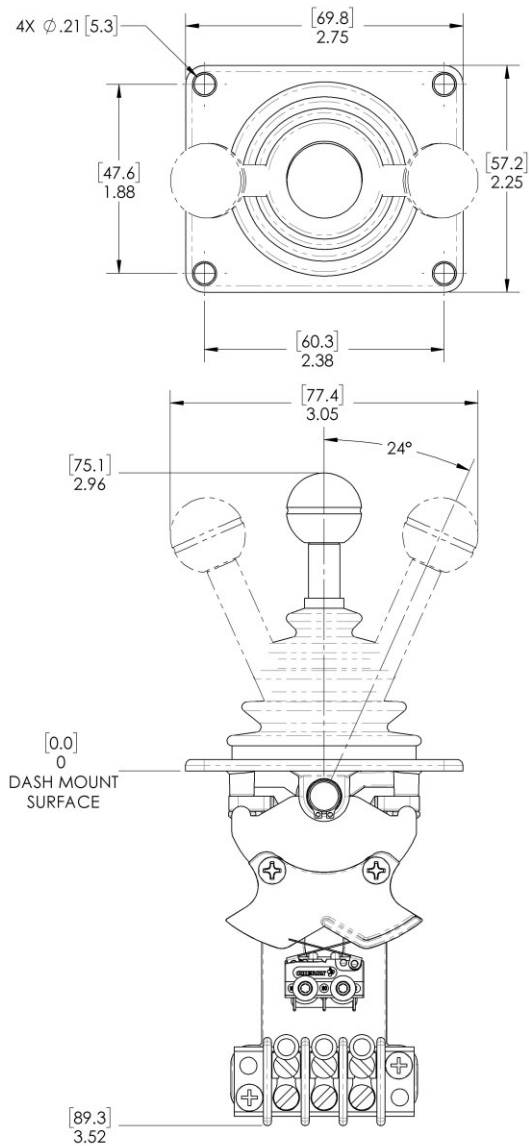


Figure 11: 7165L installation dimensions, front and top view

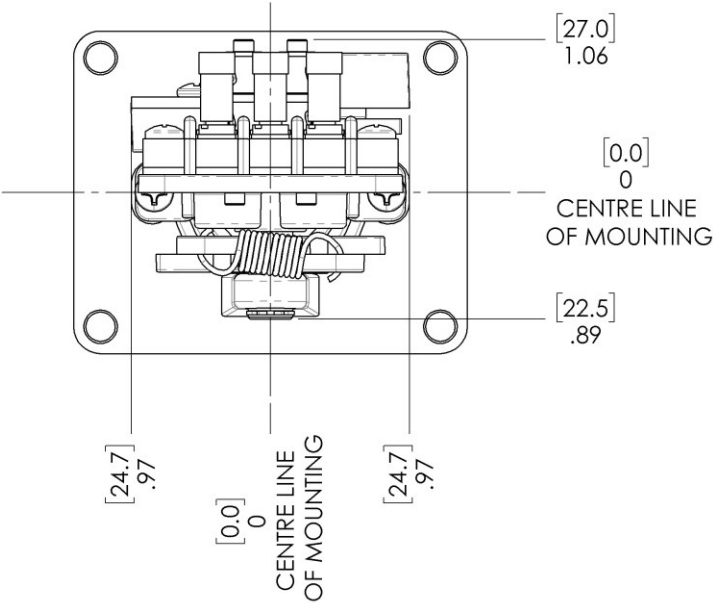


Figure 12: 7165L mounting dimensions bottom view.

10 APPENDIX B: PARTS LIST

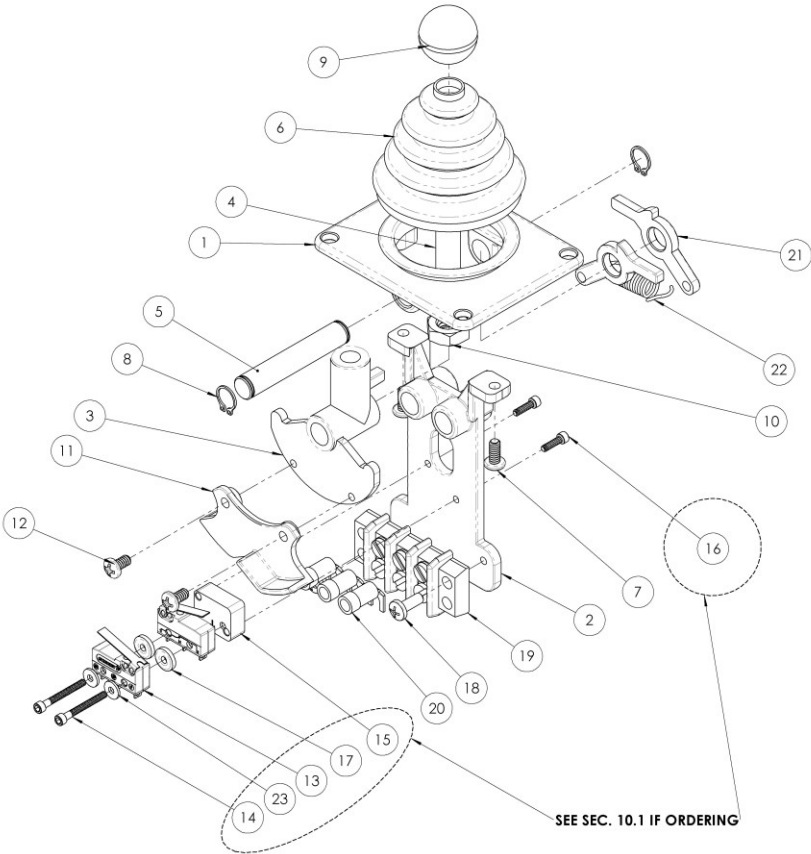


Figure 13: 7165L Parts Diagram, 7165L-BEG.

Table 5: Bill of materials for 7165L-BEG

7165L-BEG				
ITEM	QTY.	PART NUMBER	DESCRIPTION	NOTES(SEC. 10.1)
1	1	7165-1001-B	FRAME (BLACK)	-
2	1	7165-0002	SUPPORT	-
3	1	7165-1003	CAM FRICTION-DETENT	-
4	3	7165-0008	HANDLE SHAFT	-
5	1	7165-0009	HINGE PIN	-
6	1	7165-0010	BOOT	-
7	2	1012-0605	MACHINE SCREW - PAN HD PHL; #6 UNC X 5/16 / 18-8	-
8	2	1029-1031	RETAINING RING, 5/16 SHAFT	-
9	3	6654-0036	KNOB	-
10	1	1022-0211	NUT, JAM, 5/16-18 UNC, 18-8	-
11	1	7165-0004	SWITCH CAM	-
12	2	1012-0604	MACHINE SCREW - PAN HD PHIL.; 6-32 X 1/4, 18-8	-
13	2	6001-0112	MICRO SWITCH, SUBMINIATURE, STRAIGHT LEVER, SPDT 10A	1
14	2	1002-0212	SCREW, SKT HD CAP, 2-56 X 3/4, 18-8	1
15	1	7165-0011	BRACKET; MICROSWITCH; 7165	1
16	2	1002-0205	SCREW; SKT HD CAP; 2-56 X 5/16; 18-8	1
17	2	1023-0202	WASHER; FLAT; #2 X 5/16 OD; 18-8	1
18	2	1012-0606	SCREW, PAN HD, PHL DRIVE, 6-32 x 3/8IN, 18-8 SS	-
19	1	6009-0003	TERMINAL BLOCK, PANEL MOUNT, 3 POS, 15A, 250V	-
20	3	6009-6461	FORK TERMINAL, 16-14 AWG, #6 STUD	-
21	2	7165-0006	SPRING LEVER	-
22	1	1202-1013	EXTENSION SPRING 7165	-
23	2	1023-0102	WASHER; FLAT; #2 X 1/4 OD; 18-8	1

10.1 PARTS LIST NOTES:

1. Contained in Microswitch retrofit kit: 7165L-RF-01. See section 11.1 to determine if a retrofit kit is required or can purchase standalone part.

11 APPENDIX C: DETERMINATION OF JOYSTICK GENERATION


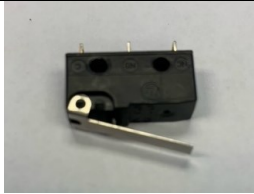
The original microswitches in the 7165L joystick were phased out in mid 2023; The change is not backwards compatible. Customers with old microswitches who require replacements will not be able to order the old microswitch. They must perform a retrofit to allow the new microswitch to become compatible with their units. Joysticks with the old microswitch are referred to as ‘Generation 1’, and joysticks with the new microswitch are referred to as ‘Generation 2’.

This change to the joystick only applies to models with the jog switches, ‘-G’ models. All other joysticks that use potentiometers still remain as a ‘Generation 1’ joystick and replacement parts can be ordered as normal.

11.1 MICROSWITCH DETERMINATION AND REPLACEMENT ORDERING

Customers can identify which generation of joystick they have by examining their joystick microswitch and comparing to the microswitches pictured in Table 6. The generation 1 style microswitch was a larger, plunger style microswitch. The generation 2, was slightly smaller and has an actuation lever.


Table 6: Joystick generation determination via microswitch identification

Key Features	Generation 1	Generation 2
Microswitch part number	6001-0104	6001-0112
Picture		
Replacement part number	Retrofit kit, 7165-RF-01	Microswitch only, 6001-0112

If you identify that you have a generation 1 microswitch and require a replacement, then you must order the retrofit kit, 7165-RF-01 to utilize the new microswitches. The retrofit will need to be installed following the instructions given in Appendix D. If you identify that you already have a Generation 2 microswitch, then you may simply order the microswitch and replace it exactly as it was taken out of the joystick.

12 APPENDIX D: 7165-RF-01 MICROSWITCH RETROFIT KIT

INSTALLATION

 WARNING	Replacing the microswitches requires soldering as well as correct placement of the microswitches. This should only be done by Kobelco factory authorized service representatives. Failure to do so could result in a failure of the limit switch and a loss of control.
NOTICE	Please read through and review steps 1-20 and all figures in section 12 before starting the removal of the old microswitch and installation of the new microswitch.

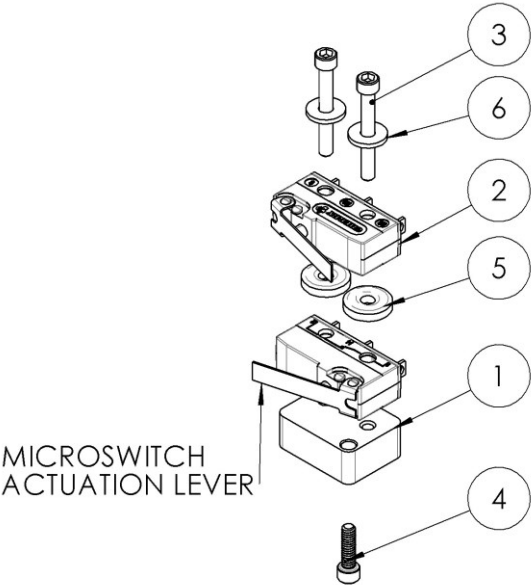


Figure 14: Microswitch retrofit kit, 7165-RF-01.

Table 7: Bill of materials for Microswitch retrofit kit, 7165-RF-01

ITEM	QTY.	PART NUMBER	DESCRIPTION
1	1	7165-0011	BRACKET; MICROSWITCH; 7165
2	2	6001-0112	MICRO SWITCH, SUBMINIATURE, STRAIGHT LEVER, SPDT 10A
3	2	1002-0212	SCREW, SKT HD CAP, 2-56 X 3/4, 18-8
4	2	1002-0205	SCREW; SKT HD CAP; 2-56 X 5/16; 18-8
5	2	1023-0202	WASHER; FLAT; #2 X 5/16 OD; 18-8
6	2	1023-0102	WASHER; FLAT; #2 X 1/4 OD; 18-8

The following tools are required for installing the retrofit kit:

1. No.41 (.096") or 3/32(0.09375") drill bit
2. Electric powered hand drill or drill press
3. Loctite 242
4. Solder
5. Soldering iron
6. 5/64" Hex key

Installation instructions:

1. Note, both old microswitches must be replaced with the new style if the retrofit is being performed.
2. Note the connections of all wires going to the old microswitches prior to disconnecting. It will be imperative to ensure the wires go to the same microswitch as before so that the joystick will behave in the same manner as prior to the retrofit.

For convenience a diagram is provided in Figure 15, fill it out with the color of wire that is routed to which terminal. Additionally, it will be required to identify if the wired circuit is normally open, or normally closed.

On the old microswitch:

Terminals 1&2 complete a normally closed circuit.

Terminals 3&4 complete a normally open circuit.

This can be confirmed by checking for continuity across the wired terminals:

If the circuit has continuity when the switch is **not** depressed, the circuit is normally closed (N.C). The opposite will be true for a normally opened circuit (N.O).

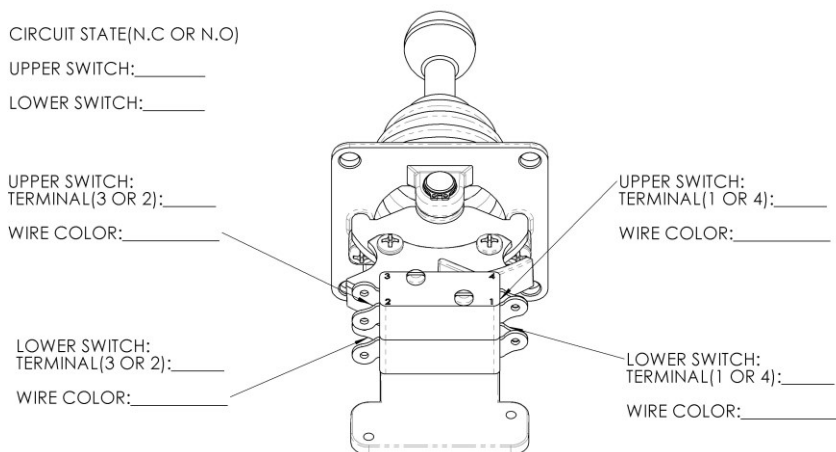


Figure 15: Wire terminal colour fill out diagram, old microswitch.

3. Desolder the wire connections on the old microswitches.
4. Remove and discard the old microswitches.
5. Refer to Figure 16, drill out the two threaded holes that were used to secure the old microswitches with a No.41(.096") or 3/32(0.0937") drill bit.

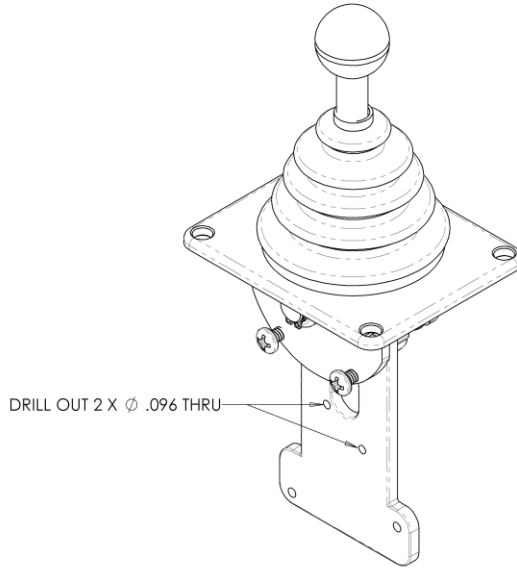


Figure 16: Diagram showing holes to be drilled out for new microswitch bracket.

6. Figure 17 for the next three steps. Note the engraved arrow on the microswitch bracket ① is pointed downwards on the joystick support.

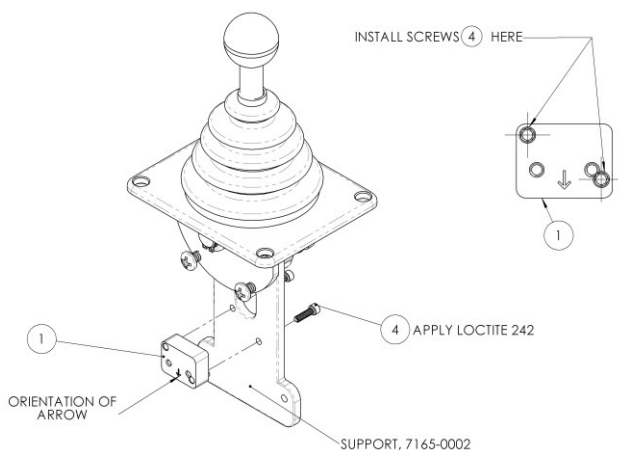


Figure 17: Installation of microswitch bracket, 7165-0011

7. Apply Loctite 242(Blue) to the X2 socket head cap screws ④.
8. Install bracket ① with screws ④ onto the joystick support 7165-0002, ensuring the engraved arrow is correctly orientated and the correct holes are used.
9. Refer to Figure 18 for the next several steps. Note the orientation of the lower and upper microswitches ② shown in Figure 18.

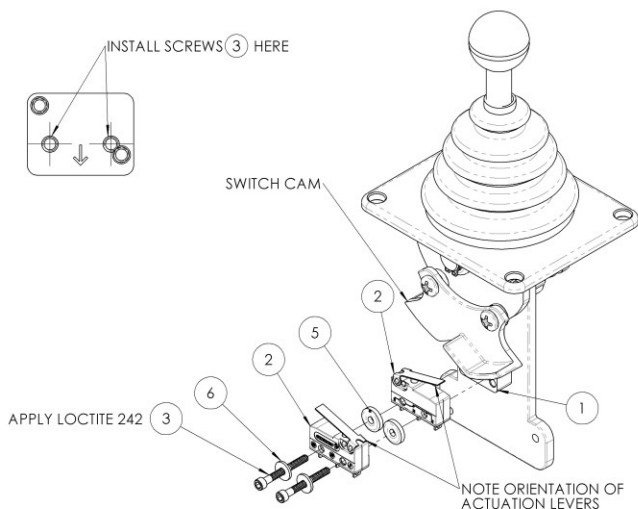


Figure 18: Placement of microswitches in the joystick assembly.

10. Arrange the microswitches ②, washers ⑤ ⑥, and screws ③ as shown Figure 18 to make a micro switch subassembly.

Ensure the orientation of the actuation levers on the microswitches are as shown in Figure 18.

11. Place Loctite 242(blue) on the exposed threads of the screws ③.
12. Keeping the microswitch sub-assembly together, place it on top of the mounting bracket ①, keeping everything orientated as shown in Figure 18.
13. Tighten the screws ③ to secure the new microswitches to the joystick.
14. Check correct operation of the switches by rotating the joystick through its full travel carefully, ensure:
 - a. The actuation levers of microswitches ② are clear of any obstructions through its range of motion. If the switch cam(see Figure 18) grabs or gets stuck on one of the microswitch actuation levers check the switches are orientated correctly.
 - b. The microswitch ② lever is depressed enough to actuate the switch contacts when the joystick is pushed to its end of travel. This can be done by checking for continuity across the Normally Open(N.O) terminal 4 and the Common(C.O)

terminal 1. See Figure 19 for clarity on terminals being checked. When the switch is depressed, terminal 1 and 4 should have continuity.

- c. The microswitch ② lever is raised enough to open the switch contacts when the joystick is in its neutral position. This can be done by checking for an open circuit(no continuity) across the N.O and C.O terminals. When the joystick is in its neutral position, there should be no continuity across terminal 1 and 4.
- d. Check these conditions on both microswitches.

If conditions 'a', 'b' or 'c' are not met, loosen the screws ③ and adjust the microswitch positions until the conditions are satisfied. Loctite should be reapplied to the microswitch screws if allowed to dry beyond the recommended setup time.

- 15. Prepare the wires for connecting to the new microswitch. The wires must be positioned so that they are clear from any moving parts in the joystick.
- 16. Refer to the filled out Figure 15 to ensure the correct wiring of the new switches. The new microswitch terminals are shown in Figure 19. Solder the power supply (most likely green) leads to the Common (CO) on the upper and lower switches.
- 17. The signal return wires must be wired to the correct N.C or N.O terminals on each of the microswitches. Ensure the same signal wires go to the upper and lower switches respectively as was written down in Figure 17.

Refer to Figure 17 to check what circuit state was wired in the old microswitches. Connect the signal wires to the correct terminal given in Figure 19. If the circuit had a N.O state before the retrofit, then the signal wires must be soldered to the N.O terminals(No.4). NC circuits must have the signal lead soldered to the N.C terminals(No.2).

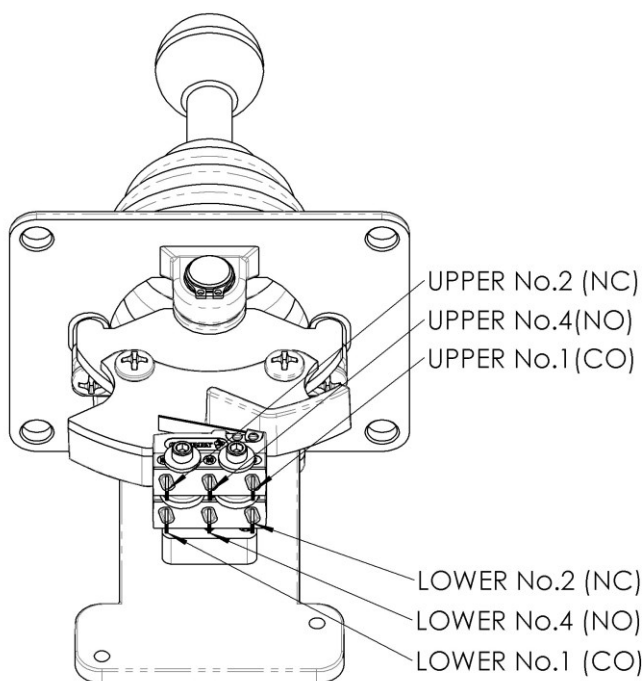


Figure 19: New microswitch terminal diagram

18. Ensure any cable ties that were removed during the process are replaced in a similar manner to ensure that the electrical wires remain secured.
19. Check the continuity on the wired terminals when the joystick is in the neutral and extended position, checking both directions. Compare the circuit state to what was written down in Figure 15 and ensure the same circuit functionality as before the retrofit. If it is not correct, the wire soldered to the NC or NO terminal must be moved to the other terminal.
20. Refer to section 3.2.2 for recommissioning the joystick.

13 APPENDIX E: INSTALLATION CUT-OUT TEMPLATE

NOTICE

Scale may not be exactly 1:1 due to PDF and printer scaling. Verify primary dimension with a ruler after printing and before using to cut.

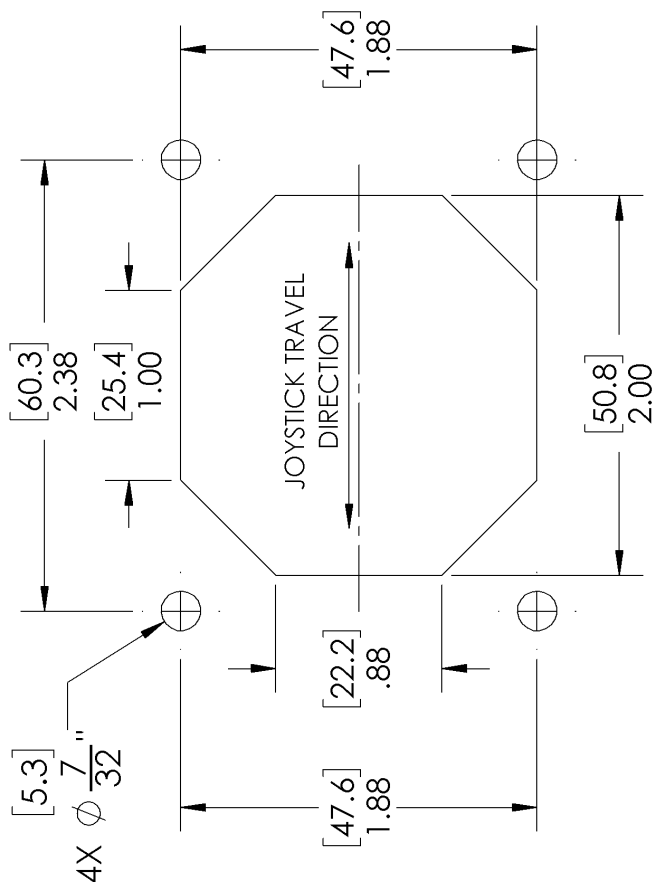


Figure 20: Installation Cut-out Template

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