**PEAK**ROBOTICS
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# User's Manual

# KX-2 Linear Rail - User's Manual

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## Disclaimer

Peak Robotics, Inc. makes no warranty with regards to information contained within this manual.

It is the general policy of Peak Robotics, Inc. to improve our products. We reserve the right to make changes to specifications and to this manual at any time and without notification.
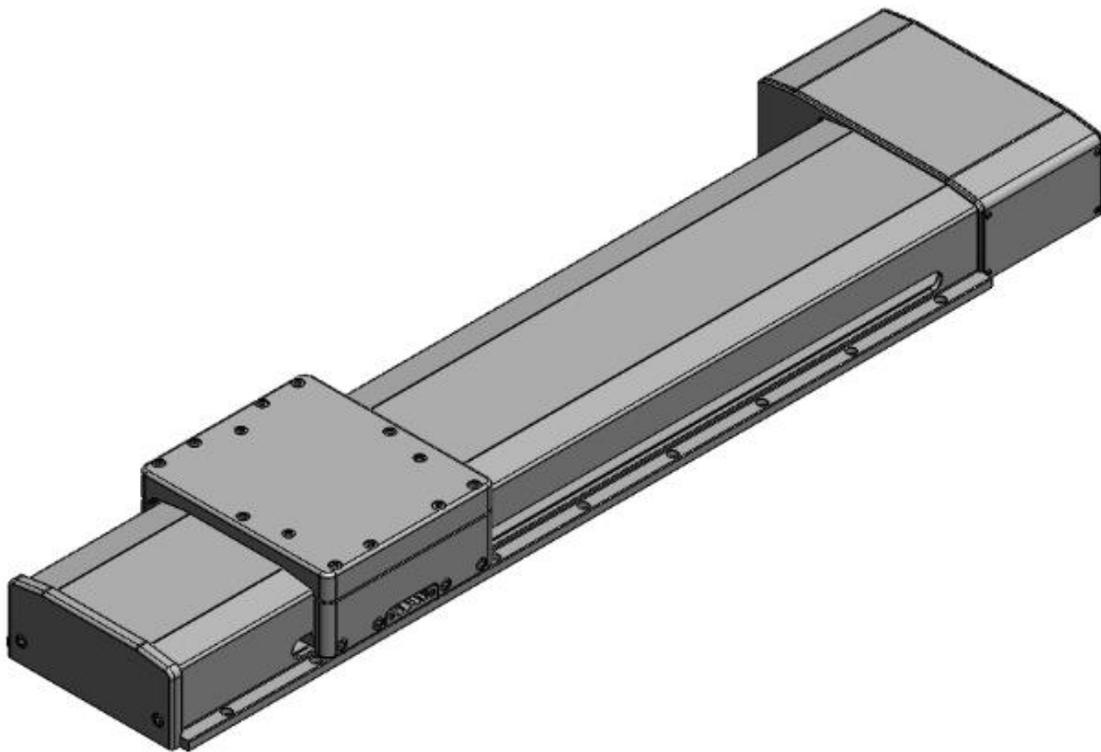
## Contact Info

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## 1.0 Introduction

1.1 Thank you for purchasing a KX-2 Laboratory Linear Rail. This rail was developed specifically for challenging laboratory environments. It incorporates proven technology that was developed for the demanding semiconductor industry.

1.2 Reference Guide: This manual is intended to be a reference guide for the engineer and maintenance technician responsible for installation and maintenance of the KX-2 Linear Rail.

1.3 Setup Guidelines: This manual includes information on how to install the rail, how to bring it online, teach it, and then diagnose and rectify any problems. These steps are critical to ensure a successful installation and long-term reliability. Peak Robotics suggests keeping a written history of all settings, changes, and results.

1.4 Experienced Personnel: Although this rail can be run by non-technical personnel, installation and troubleshooting should be performed by technicians with good electrical, mechanical, and computer skills.

1.5 Software Instructions: Please refer to the KX-2 Software Instructions manual for detailed information on software and PC control of the rail.



*LRKX2-500 Linear Rail*

## 2.0 Warnings

2.1 Symbols: The following symbols are used in this manual.

| ⚠ Warning | This icon accompanies text and/or other international symbols dealing with hazards to personnel. When present, it indicates that a potential hazard to personal safety exists if information stated within the **"WARNING"** paragraph is not adhered to or procedures are executed incorrectly. |
|---|---|
| ⚠ Caution | This icon accompanies text and/or other international symbols dealing with potential damage to equipment. When present, it indicates that there is a potential danger of equipment damage, software program failure or that a loss of data may occur if information stated within the **"CAUTION"** paragraph is not adhered to or procedures are executed incorrectly. |
| ⚡ Warning | **HIGH VOLTAGE**<br><br>This icon accompanies text and/or other international symbols indicating that a potential hazard to personal safety exists from a high voltage source. In this document, the **"WARNING"** icon will accompany this symbol. To reduce risk of electrical shock, all high-voltage devices employ a three-wire electrical cable and plug to connect the equipment to earth ground.<br><br>Ensure that the wall outlet receptacle is wired properly, and **earth grounded.**<br><br>**DO NOT use a three-to-two wire plug adapter.**<br><br>**DO NOT use a two-wire extension cord or a two-wire multiple-outlet power strip.**<br><br>**Disconnect power to the system before performing maintenance.**<br><br>**DO NOT remove any panels; panels should be removed only by qualified service personnel.** |
| ⚠ Warning | **SHARP OBJECTS/MOVING PARTS**<br><br>This icon accompanies text and/or other international symbols dealing with hazards to personnel from unblunted corners or other appendages on the outside or inside of the equipment. In this document, the **"WARNING"** icon will accompany this symbol.<br><br>To avoid injury due to moving parts, observe the following:<br>**Keep loose clothing and hair away from moving parts.**<br>**Never attempt to physically restrict movement of moving parts.** |

2.2 Installation: This product is sold as a component to be installed in a complete system using good engineering practices. Care must be taken by the system integrator to ensure that this product, as well as the other products in the system, are installed and used in a safe manner according to local and international safety laws and regulations, as well as any safety standards required by the end-user.

2.3 Component Selection: This document and other information from Peak Robotics, Inc. and authorized distributors provide product information for users having technical expertise. The user is solely responsible for making the final selection of the system components and ensuring that all performance, safety, and warning requirements are satisfied.

2.4 High Speed: This high-performance product can produce rapid movement and high forces. Unexpected motion may occur, especially during the development of control sequences. Never enter the working envelope of the rail and never touch any part of the equipment while it is in operation.

2.5 Protection: If the equipment is used in any manner that does not conform to the instructions given in this user's manual, then the protection provided by the equipment may be impaired.

## 3.0 Safety Precautions

3.1 General Precaution: The KX-2 linear rail operates under computer control. As with most computer-controlled and robotic devices, there is always the potential for injury or damage from moving components whenever the device is in motion.

Warning: Never reach into the robot's working envelope when the unit is moving.

3.2 High Force: The KX-2 linear rail can generate enough force to cause injury to a person who obstructs the motion of the rail. Peak Robotics recommends that the rail be mounted inside an enclosure with safety-interlocked doors or light curtains that do not allow the robot to run when open or interrupted. Alternatively, the integrator can perform a risk assessment per ISO 10218-2:2011 to determine whether the application is suitable for collaborative operation of the rail. Furthermore, the following conditions must be met:

- When the linear rail is in motion, the robot axes must be stationary. If the robot axes were to be moved at the same time as the rail, then the end-of-arm speed would be amplified, and the speed limits for collaborative operation would be exceeded.
- When the linear rail is in motion, the robot gripper fingers must not be oriented in a way that causes the tips of the fingers to move forward. The gripper fingers must be perpendicular to or facing away from the direction of rail motion.

Important: Ensure that no extraneous objects can inadvertently enter the rail's working envelope when powered up.

**Safety Glasses Required**

Safety Glasses Required: All personnel who are working within close proximity of an unguarded rail shall wear safety glasses at all times that meet or exceed ANSI Z87.1–2015.

3.3 Emergency Stop: The rail is equipped with an emergency stop button which, when pressed, will decelerate the rail to a controlled stop, after which power to the motor will be disabled. This allows the operator to stop the rail in an emergency. If the emergency stop button is pressed while the rail is motion, the rail will continue moving a short distance as the motor decelerates to a stop. If the rail is integrated with other moving devices, a *master* emergency stop button should be installed that disables all equipment simultaneously. Consult the factory for E-Stop wiring options.

Important: Avoid having multiple emergency stop buttons that serve varying purposes, as this can lead to confusion in a panic situation.

3.4   Rail Damage: The rail can be damaged if made to collide with external equipment, especially if the rail is moving at a high rate of speed. The rail is also capable of damaging other equipment if made to collide with it.

Recommendation: When testing new sequences, run the rail slowly the first time through. If a collision occurs, the position error tracking feature of the rail motor drives may stop the rail. If this happens, move the rail away from the obstruction by hand and then re-initialize.

3.5   Teaching the Rail: The robot/rail software has no provisions for avoiding surrounding equipment automatically. The robot/rail merely executes the commands sent to it.

Note: It is the responsibility of the teaching operator/programmer to create sequences that avoid obstacles.

3.6   Electrical Hazard: Do not disassemble any portion of the rail or power supply box when the power supply box is connected to an AC power source.  Note: All voltage internal to the rail is 57VDC or less; however, 57 volts is hazardous, and the voltage potential can damage sensitive components inside the rail. High-voltage AC power (115 or 230VAC) is present inside the rail power supply box.

3.7   Collaborative Applications: The KX-2 linear rail has been designed for use in collaborative applications, in accordance with ISO 10218-1:2011 and ISO/TS 15066. This does not, however, automatically ensure that the rail will be safe for collaborative use in all applications. It is the responsibility of the system integrator and the end user to verify that the application meets the requirements of ISO 10218-2:2011, Robots and Robotic Devices—Safety Requirements for Industrial Robots—Part 2: Robot Systems and Integration. It is also the responsibility of the system integrator and the end user to verify that the application meets all internal company safety policies and applicable international and local laws and regulations.

## 4.0 Compliance with Standards

4.1 The KX-2 linear rail complies with the following standards:

| Standard | Description |
|---|---|
| CISPR11/FCC Class A | Emission Standard for Industrial Environments (EMC) |
| EMC Directive 2014/30/EU | IEC 61326-1:2012, Electrical Equipment for Measurement, Control and Laboratory Use (EMC) |
| IEC 61010-1:2016 | Safety Requirements for Laboratory Equipment |
| ISO 10218-1:2011 | Robots and Robotic Devices—Safety Requirements for Industrial Robots, Part 1: Robots |
| ISO/TS 15066 | Robots and Robotic Devices—Collaborative Robots |
| ISO 13849-1:2015 | Safety of Machinery—Safety-related Parts of Control Systems, Part 1: General Principles for Design |
| ISO 13849-2:2012 | Safety of Machinery—Safety-related Parts of Control Systems, Part 2: Validation |
| EU 2015/863 | RoHS3—Restriction of Hazardous Substances |
| 2006/42/EC | Machinery Directive (CE) |

4.2 Clause 5.8.4 of ISO 10218:1-2011 states that the pendant or teaching control device shall have an emergency stop function. A PC application or a game controller can be used to teach the KX-2 robot/rail. These controls do not have an integrated emergency stop function. Peak Robotics has made the determination that an integrated emergency stop function is not necessary, due to compliance of the robot/rail with ISO/TS 15066.

4.3 Clause 5.7.1 of ISO 10218:1-2011 states that operational modes shall be selectable with a mode selector. The KX-2 robot does not have a mode selector. Peak Robotics has made the determination that a mode selector is not necessary, due to compliance with ISO/TS 15066.

4.4 Clause 5.6 of ISO 10218:1-2011 describes the requirements for speed control. Peak Robotics has made the determination that speed control, as described in ISO 10218:1-2011 is not necessary due to compliance with ISO/TS 15066. The speed of the KX-2 robot/rail is controlled in the following ways:

- Each individual motor drive is programmed with a maximum speed limit for the attached motor. The motor drive will disable the motor if the speed limit is exceeded.
- The software is configured with individual motor speed limits as well as speed limits for linear motion.
- The power supply and motors are sized such that they are not physically capable of attaining speeds that are significantly higher than the limits imposed by the motor drives and software.

# KX-2 Rail – User's Manual

## 5.0 Contents and Packaging Instructions

### 5.1 Package Contents

- Rail in plastic bag
- Mounting Fasteners
- USB drive with software & documentation
- Printed card with software & documentation download links

### 5.2 Use the following procedure when unpacking the rail:

Step 1) Remove the screws from the top of the crate.
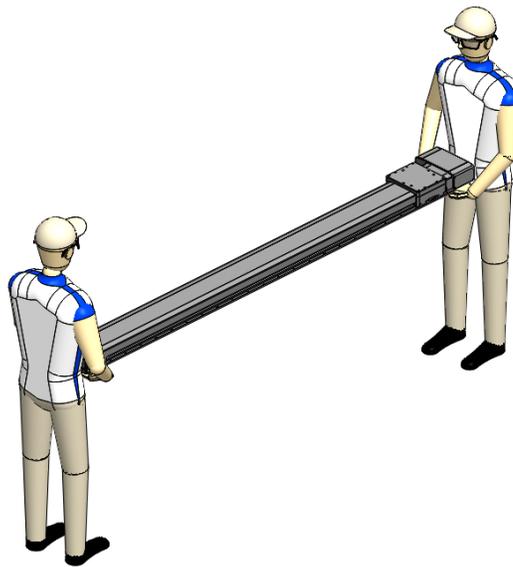


Step 2) Lift the cover off the crate.

Step 3) Remove the screws securing the straps to the crate. It is necessary to detach only one end of each strap.



Step 4) With the help of an assistant, lift the rail out of the box. Lift via the two ends of the rail.



Step 5) Lay the rail right side up on a piece of foam or bubble wrap to protect the finish.

Step 6) Remove the plastic bag from the rail.

## 6.0 Product Description

6.1   Description: The KX2 Linear Rail is a tabletop horizontal linear actuator designed for use with the KX2 robot in laboratory and light industrial applications.

6.2   Technology: The rail has a single axis of motion and incorporates a planetary gearbox and belt drive powered by a DC servomotor. Motion control is accomplished via a true absolute encoder and distributed motor drive.

6.3   Partially Enclosed: The rail housing shields the internal mechanism from objects that may be dropped inadvertently from above.

6.4   Standard Models: There are three standard strokes available: 0.5m, 1.0m and 2.0m.
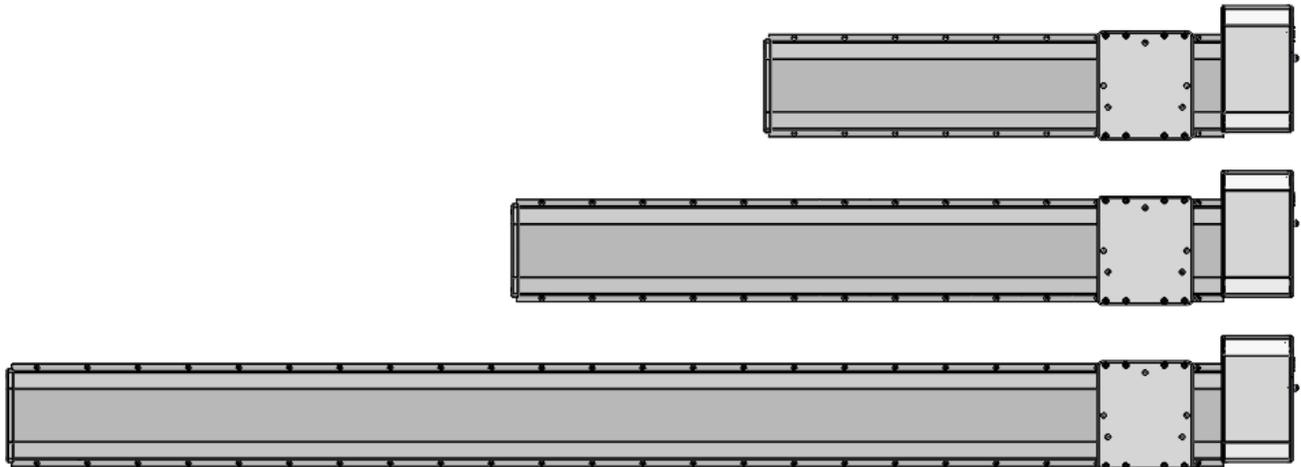
6.5   User Inputs/Outputs: The robot Inputs/Outputs are passed through the rail to the 15-pin HD d-sub connector on the rail. Refer to the KX2 Robot User's Manual for more information.

6.6   Internal Motor Drive: The rail is servo-driven by a drive mounted inside the rail next to the motor. A USB/CANOpen adapter is mounted inside the rail and provides a USB interface between the rail/robot and PC.

6.7   User-Supplied PC: A standard PC with Windows 7 or newer is required to control the rail/robot. The rail connects to the PC via a USB 2.0 port. An RS232 serial port is required for the barcode reader (a serial/USB adapter is provided with the robot).

6.8   Power: The rail/robot uses 57 VDC for motor power, and 24VDC for logic power. The two DC power supplies are mounted inside the power supply box included with the robot. A power supply is not included with the rail.

6.9   Universal DLL: A universal .NET 4.0 DLL (provided with rail) is to be used by the top-level sequencing program, which typically is written in VB, C++, C#, etc. The rail is designed to be used with a robot. The DLL can control the rail only if a robot is present.

6.10  Scheduling Software: As an option, PAA Overlord can be used for synchronizing the rail/robot with other equipment. Please see www.paa-automation.com for more information.

6.11  Serial Number Tag: A serial number tag is located on the end of the rail housing.
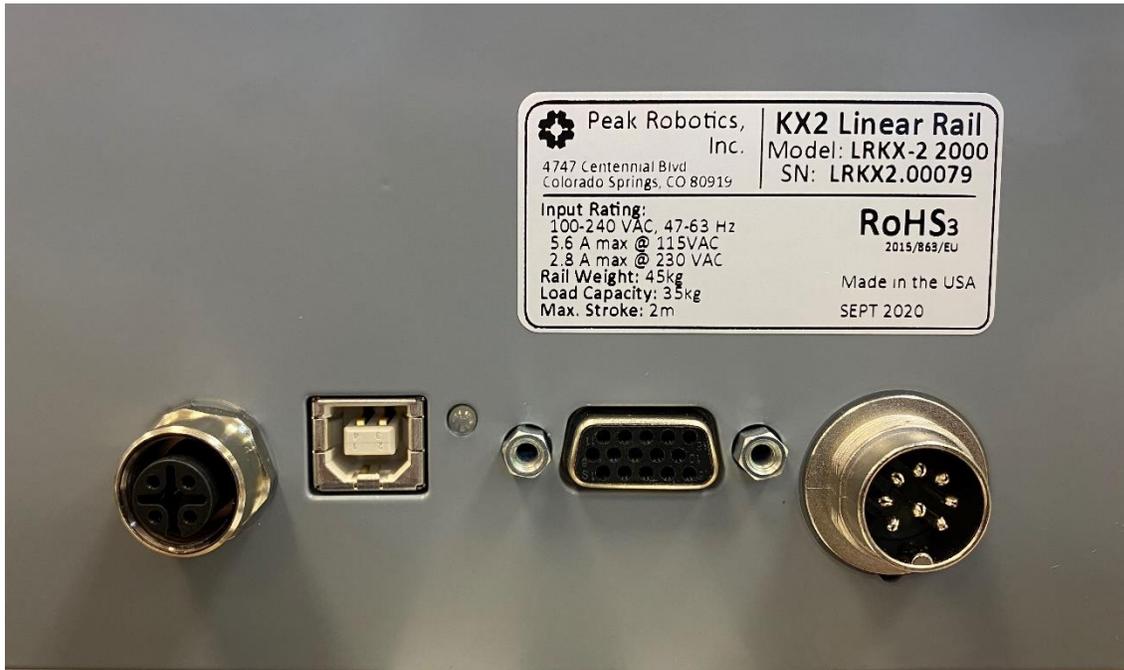
*Serial Number Tag*

## 7.0 Specifications

### 7.1 General Specifications

| Max Payload | 35kg (77lb) |
|---|---|
| Linear Travel | 0.5m (19.69in), 1.0m (39.37in), 2.0m (78.74in) |
| Speed (Max) | 750 mm/s (29.5 in/s), 410 mm/s (16.1 in/s) collaborative application limit |
| Acceleration (Max) | 1200 mm/s$^2$ (47.2 in/s$^2$) |
| Thrust (Max) | 116N (26lb) |
| Encoder Resolution | 8192 counts/mm |
| Repeatability | +/- 0.1mm (.004in) |
| Weight | **LRKX-2 500:** 23kg (51lb), **1000:** 31kg (68lb), **2000:** 47kg (104lb) |
| Length | **LRKX-2 500:** 1047mm (41.22in), **1000:** 1547mm (60.91in), **2000:** 2547mm (100.28in) |
| Power: | |
| Input Power: | 100-240 VAC), 1Φ, 47-63Hz, 5.6A Max @ 115VAC (2.8A Max @ 230VAC) |
| Output to Rail: | 57VDC/5.3A/300W Max, 24VDC/3A/80W Max |
| Power Supply Dims: | 240mm x 160mm x 90mm (9.5in x 6.3in x 3.5in) |
| Safety | Current & Position Error Sensing, Emergency Stop Button (Stop Cat. 1) |
| User I/O | 3 Digital Inputs, 2 Analog Inputs, 3 Digital Outputs |
| Encoder | Magnetic Absolute |
| Teaching | Drag-to-teach-point, one-touch teach button on robot |
| PC Interface | USB 2.0 |

### 7.2 Environmental Conditions

| Condition | Limits |
|---|---|
| Operating Ambient Temperature | 5° to 40°C (41° to 104°F) |
| Storage Temperature | -20° to 49°C (-4° to 120°F) |
| Maximum Non-condensing Humidity | 90% |
| Maximum Operating Altitude | 2,000m (6,562 feet) |

7.3 Ventilation, Cleaning and Decontamination

 7.3.1 Ventilation of the space containing the rail should be adequate to maintain the environmental conditions listed above.

 7.3.2 The rail should not be sprayed with any liquid. Inadvertent contact with the occasional droplet of non-corrosive liquid is acceptable but should be minimized.

 7.3.3 The rail should be cleaned by wiping with a microfiber cloth or paper towel partially saturated in isopropyl alcohol. Power should be disconnected from the rail prior to cleaning, and the rail should be left to dry for at least 15 minutes prior to reconnecting power.

 7.3.4 The rail should not be decontaminated with any type of gas that may cause corrosion of metal or deterioration of plastic.

7.4   Rail Overall Dimensions:
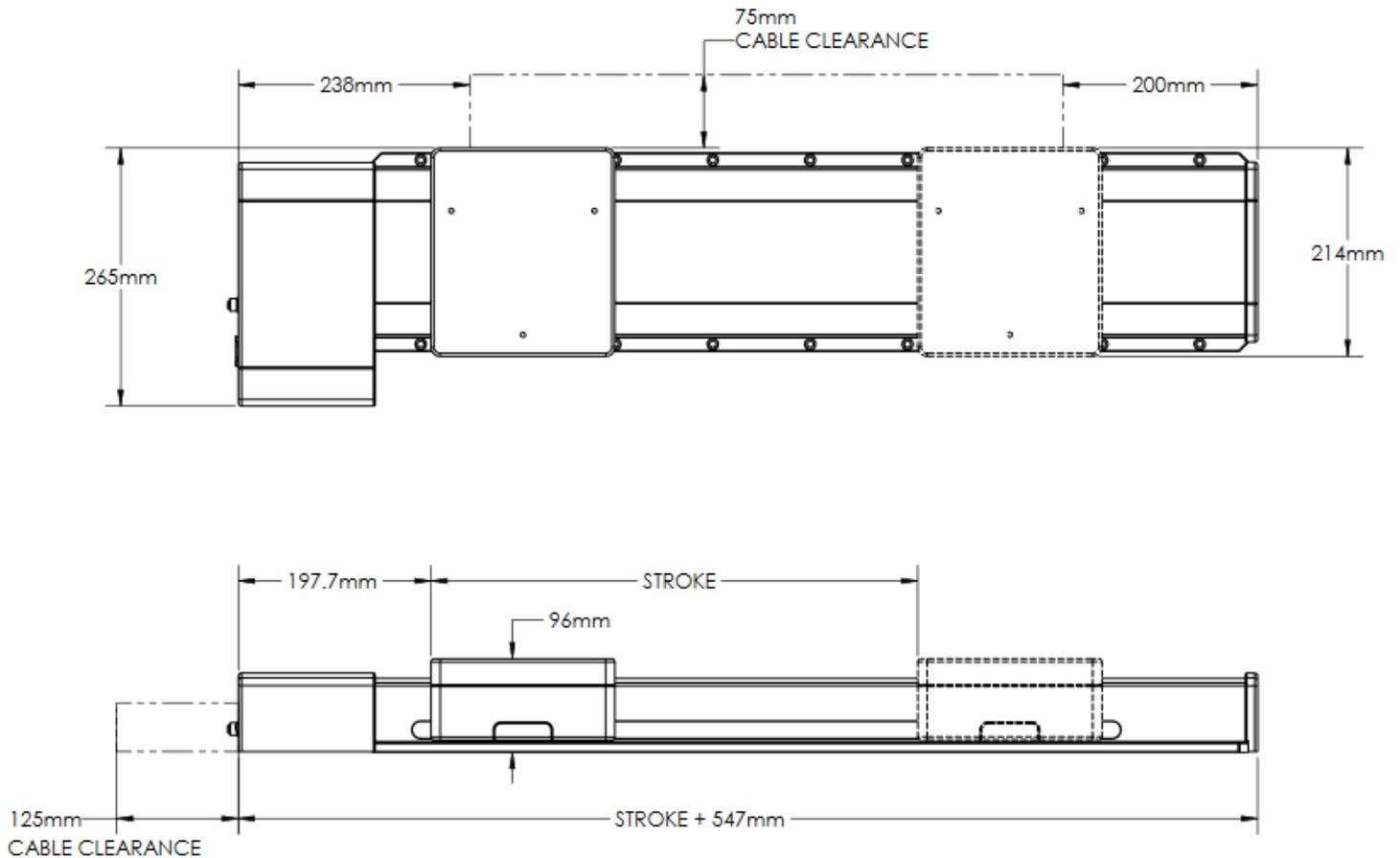


| KX-2 RAIL SIZE | STROKE |
|---|---|
| 0.5 m | 500 mm |
| 1 m | 1000 mm |
| 2 m | 2000 mm |

7.5   Rail Mounting Dimensions:



THRU HOLE                              TAPPED HOLE
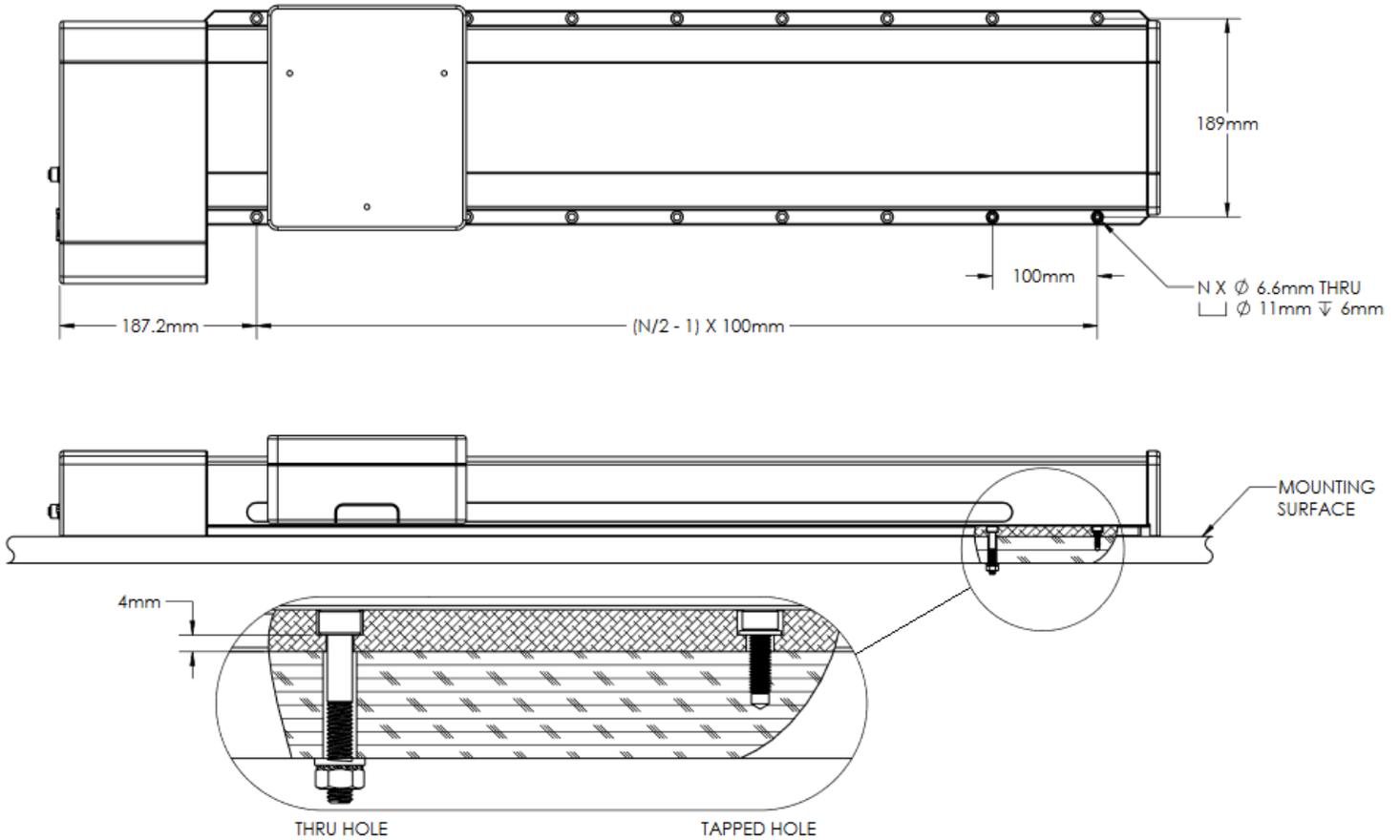
| MOUNTING HOLE | MANUFACTURING METHOD | RECOMMENDED FASTENERS |
|---|---|---|
| THRU HOLE | MACHINE DRILL | M6 SHCS, WASHER, LOCKNUT |
| THRU HOLE | TRANSFER PUNCH AND HAND DRILL | M6 SHCS, WASHER, LOCKNUT |
| TAPPED | MACHINE DRILL AND TAP | M6 SHCS, 12 mm LENGTH MINIMUM |
| TAPPED | TRANSFER PUNCH, HAND DRILL AND TAP | M5 SHCS, 10 mm LENGTH MIN., WASHER |

| KX-2 RAIL SIZE | N |
|---|---|
| 0.5 m | 18 |
| 1 m | 28 |
| 2 m | 48 |

7.6   Power Supply Dimensions:
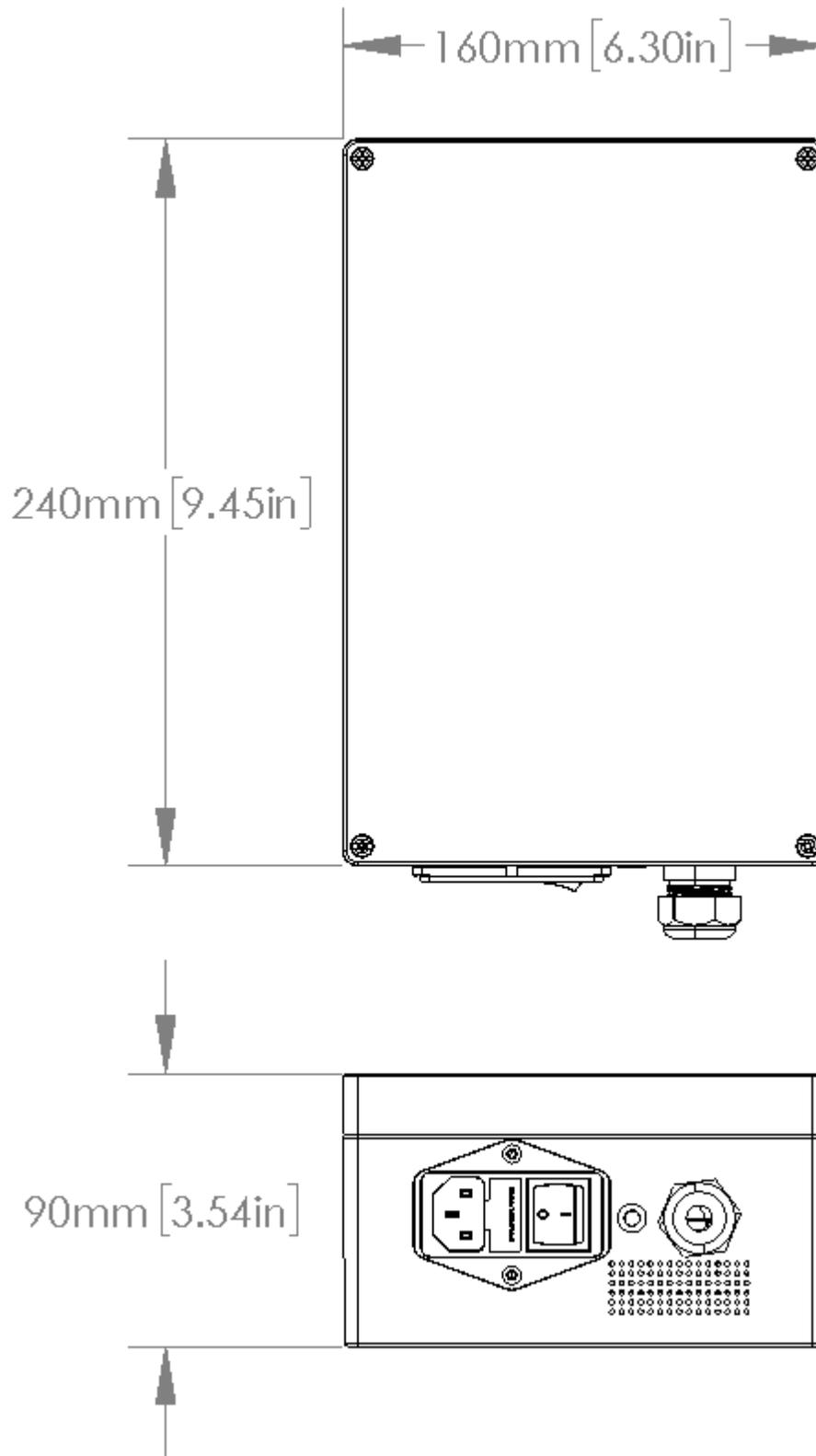
## 8.0 Electrical Description

8.1 Power: The rail is powered by standard residential single-phase AC power (see Specifications section). The AC power cord plugs into the power supply box. The power supply box contains a 57VDC power supply and a 24VDC power supply. A cable with an 8-pin mini-DIN connector connects the power supply box to the rail and supplies the rail with DC power used by the motor drives, sensors, and indicator lights in the rail and robot.

8.2 CANOpen Network: A USB/CANOpen adapter is located inside the robot shoulder. It connects the PC to the robot via the provided 6ft USB cable. The adapter uses CANOpen protocol to communicate with the five motor drives mounted inside the robot.



*Rail Cable Connections*

8.3 Emergency Stop Wiring: A button for stopping the rail/robot in emergency situations is plugged into the rail. Actuating the Intelligent E-Stop circuitry by pressing the E-Stop button stops the robot but keeps the motor drive logic circuits powered. Restarting the robot after an E-Stop requires a deliberate input by the operator on the controlling computer. Note: Shutting off AC power to the robot will require re-homing of the gripper.



*E-Stop Button*

8.4 Auxiliary Connector:  A 15-pin female high-density d-sub connector is located on the rail. This connector provides the user with access to digital inputs, analog inputs, digital outputs, and the RS232 communication lines for the barcode reader that is integrated into the gripper.

8.5 Status LED: If the E-Stop button is popped up, power is applied to the rail/robot, and no rail drive errors are present, then the Drive Status LED located on the rail should be green. If the LED is red, then either the E-Stop button is pressed or disconnected, or a rail drive error is present. If the LED is off, then either the power is disconnected or the fuse inside the robot Shoulder is blown.
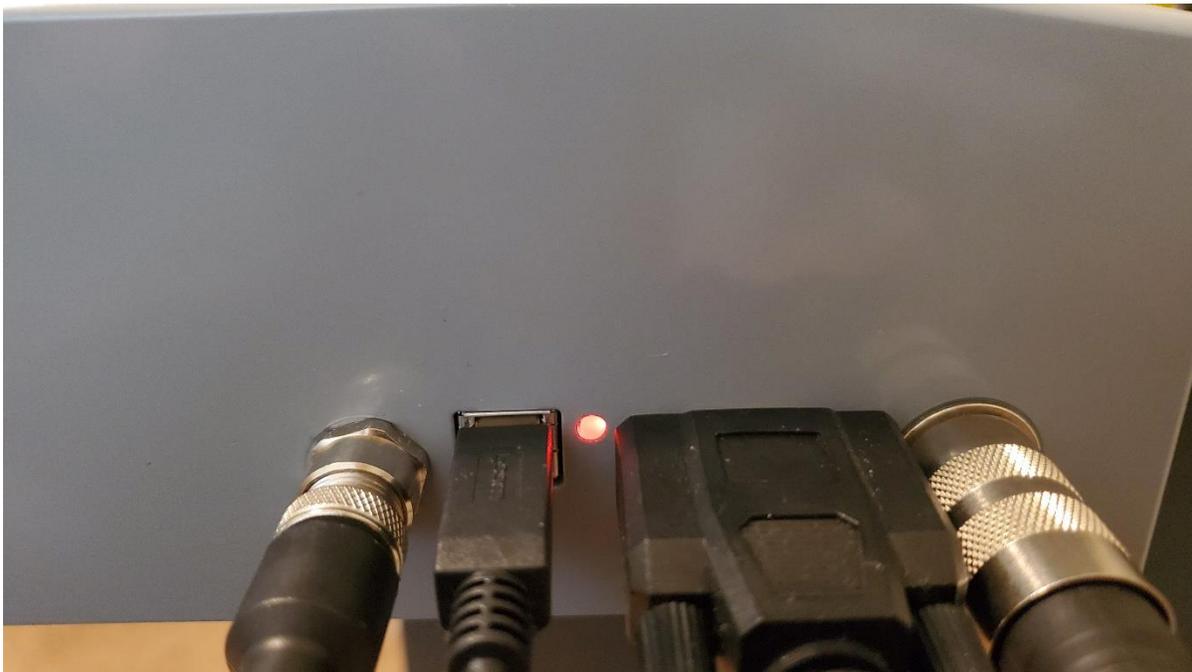




*Rail Drive Status LED*

8.6 Power LED: If AC power is connected to the power supply box and the AC power switch is in the "on" position, the blue LED powered by 24V should be on. If this LED is not on, then the fuses inside the power entry module may be blown.

Unplug the AC power cord from the power supply box before removing the fuse cover!

8.7 Controlling PC: A standard PC must be supplied to control the rail/robot. The PC must be equipped with Windows 7 or higher and must have two USB 2.0 ports available for main PC communication as well as the supplied USB/Serial adapter for the barcode reader.

8.8 DLL: The robot control software is a universal .NET 4.0 DLL. For debugging and teaching the robot, a graphical user interface is provided (KX-2 Teach Pendant) and is described later in this document.

8.9 Robot I/O: Each of the five motor drives inside the robot is equipped with digital inputs, digital outputs, and analog inputs, some of which are available to the user at the Auxiliary connector on the rail connector panel. Refer to the User I/O & Circuit Boards section for more information.

8.10 Rail Zero Position: The rail motor uses a magnetic absolute encoder that does not require homing upon power-up. The encoder is not battery powered. A rotating magnet induces enough electrical current to power the encoder circuits when main power is disconnected. The zero position of the rail is calibrated at the factory. If the rail is disassembled or replaced, the zero position will most likely be changed and will require recalibration.

8.11 Motion Alert:  If desired, the robot software can be configured to flash the indicator lights and beep the buzzer before motion begins after an extended time period with no motion (see Teach Pendant/Options/Miscellaneous – Warning Before Move).

## 9.0 Installation and Setup

9.1 Setup: The procedures described in this section are used to install and configure the rail/robot. These procedures, or a portion of them, may need to be followed whenever any of the following occur:

- When the rail is first installed into the system
- After disassembly or service of the rail
- After moving the system
- When equipment that interfaces with the rail/robot is serviced, moved, or replaced
- When the rail base mounting bolts are loosened & retightened
- After a severe robot collision

9.2 Installing and Anchoring the rail:

9.2.1 Sub-Frame: Because of the high speed and center of mass of the robot, the rail must be anchored to ensure stability and repeatability. This requires providing a flat, stable, and rigid mounting surface for the rail as well as for all devices that the robot will be accessing. The mounting surface must be continuous and attached to a highly rigid metal frame such as the system shown below.



*Rigid Metal Table*

⚠️ **Caution**

Important Note: Most problems with the robot such as non-repeatability can be traced to either a non-rigid installation or improper teaching methods! All equipment that is accessed by the robot must be mounted rigidly to the same mounting surface as the robot to ensure the position of the equipment (relative to the robot) is stable!

9.2.2     Mounting Surface: The recommended mounting surface for the rail and all devices is 10mm (3/8") thick (minimum) aluminum tooling plate. The aluminum can be powder coated or epoxy coated to resist most chemicals. If plastic must be used, a minimum thickness of 25mm (1") is highly recommended; ensure that it is fully supported by and fastened to a rigid metal frame underneath. Braces should be positioned strategically directly under the rail and the devices so that flexing of the mounting surface is minimized.

9.2.3     Flatness: There should be no more than a 2mm gap at any location between the bottom of the rail and the mounting surface prior to installing mounting screws. A large gap will cause the rail to warp when the mounting screws are tightened. A selection of plastic shims is provided with the rail and should be used to minimize any gaps. Shims should be located underneath mounting screw holes (cut a hole or slot for the screw).

9.2.4     Attachment: The rail is attached to the table via a series of holes located along the two long edges of the rail. Use M6 or ¼" SHCS in a linear pattern, as shown in the drawings in the specifications section. It is recommended to use every mounting hole. If the table is highly rigid, then it may be acceptable to skip every other mounting hole.

9.2.5     Mounting Screws: There is only a small amount of clearance in the screw holes, so it is critical that the anchoring threaded holes be drilled and tapped accurately and perpendicular to the mounting surface. If a milling machine is *not* available for this purpose, it is recommended that the rail be used as a jig for marking the mounting-hole locations with a transfer punch. The holes should then be drilled using a drill guide to ensure the holes are perpendicular to the mounting surface.

9.2.6     Detach the Robot Mount Plate from the bottom of the robot by removing the three screws and flat washers securing it to the Shoulder (robot purchased separately).

Note: If the robot and rail were not ordered as a set, then a communication jumper cable will need to be installed inside the robot shoulder prior to mounting the robot on the rail. Refer to the *KX-2 Rail & First-Generation KX-2 Robot Installation Instructions.pdf* document for more information.
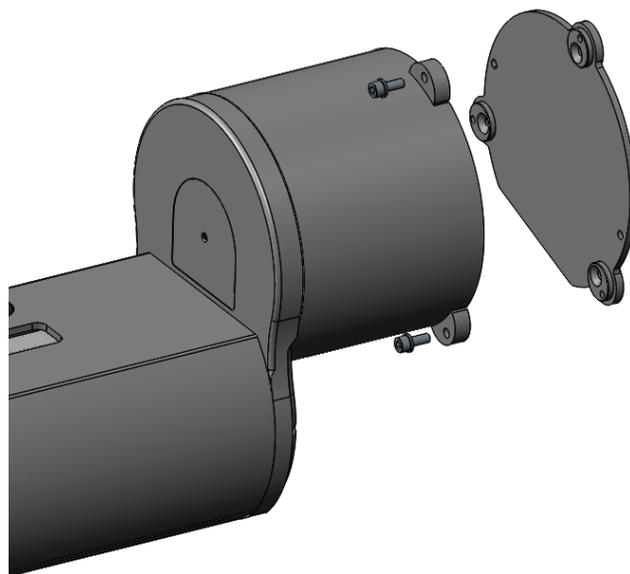
9.2.7    Attach the Robot Mount Plate to the rail carriage with the included dowel pins and M6 flat head screws. Orient the flat edge of the plate toward the carriage cables.
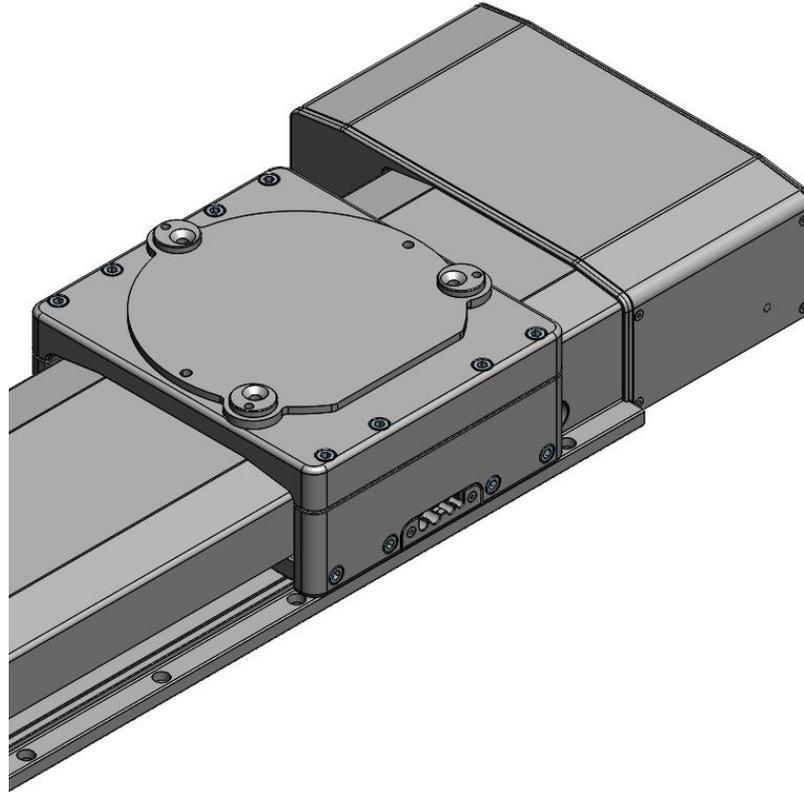


9.2.8    With the help of an assistant, lift the robot and set it on top of the Robot Mount Plate. Reinstall the three screws and flat washers while the assistant is holding the robot to ensure it does not topple over. Refer to the KX-2 Robot User's Manual for more information.

CAUTION: The robot is not stable on its own and may tip over. Do not stand it up and leave it unattended without attaching it to a table. The robot should be left lying on its back on a soft surface if provisions for mounting it are not yet available.

9.3   Cable Connections:

      9.3.1    Plug the rail carriage e-stop, barcode reader communication, USB and power cables into the base of the robot.

9.3.2 The power supply box must be positioned within 2.75m (9ft) of the rail due to cable length limitations (EMC).

⚠ **Warning**

Make sure AC power is <u>not</u> connected to the power supply box before proceeding.

9.3.3 Plug the DC power cable into the larger round connector on the rail connector panel with the notches lined up. Turn the metal portion of the plug clockwise until it is threaded firmly onto the connector.

9.3.4 Plug the USB cable into the Type B (square) socket on the rail connector panel. Plug the other end (Type A) into an available USB 2.0 port on the PC.

9.3.5 Plug the Emergency Stop button into the rail connector panel. Twist the metal portion of the plug clockwise until it is threaded firmly into the connector. Twist the red e-stop button clockwise to make sure it is popped out in the 'Run' position.

9.3.6 Plug the male 15-pin end of the Barcode Reader cable into the 15-pin D-Sub connector on the rail connector panel. Tighten the two thumb screws lightly.
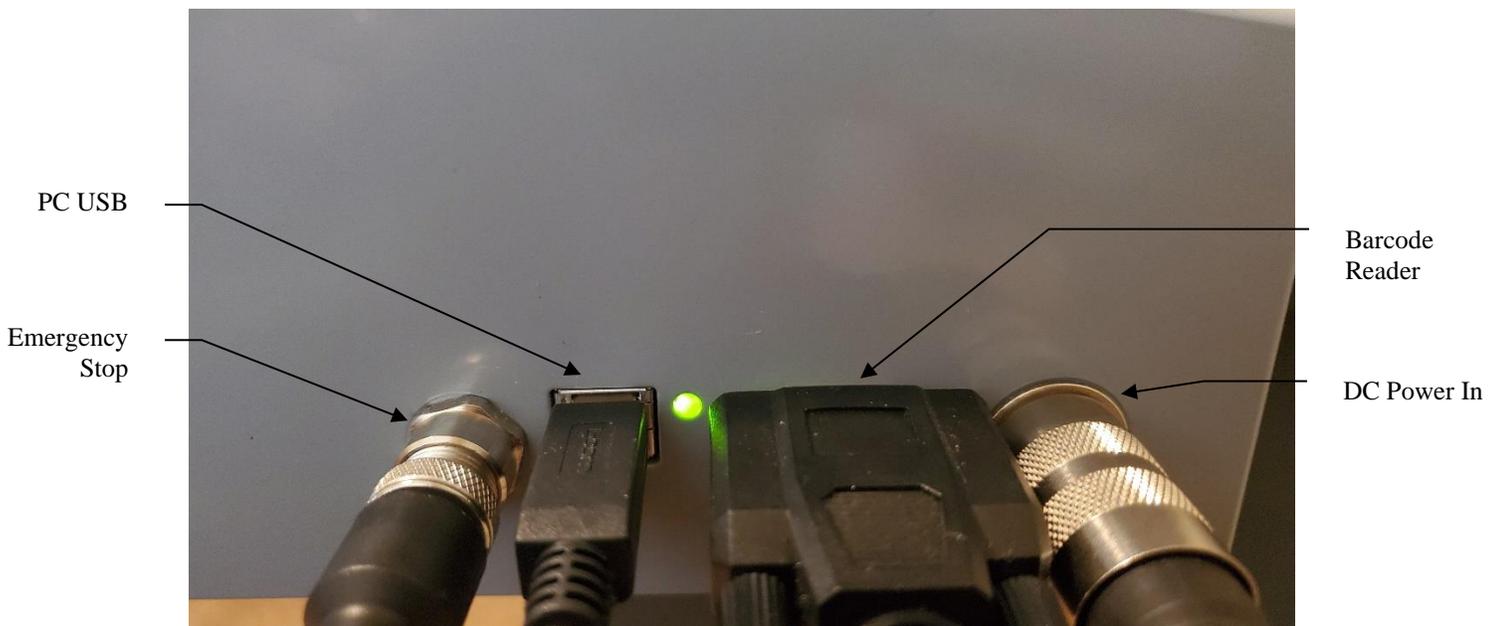
9.3.7 Connect the other end of the Barcode Reader cable to the supplied USB/Serial adapter. Tighten thumb screws lightly. Plug the adapter into an available USB 2.0 port on the PC.



9.3.8 Plug the AC power cord (Volex 17661) into the power supply box.

9.3.9 Plug the other end of the AC power cord into a standard grounded North American residential 110V outlet. If this type of outlet is not available, refer to the specifications section to ensure an appropriate AC power source is used. The supplied Volex 17661 cord can be replaced with a suitable grounded power cord that has a 10A minimum rating, shielding, and an IEC 60320 C13 plug on the end that connects to the power supply box.

9.3.10   Apply AC power to the power supply box by flipping the switch on the AC power entry module to the 'I' position. The blue power indicator LED on the box should light up. The rail drive status LED should also light up. It should be red initially and should then change to green after a few seconds. If it stays red, verify the emergency stop button is popped up.



Drive Status LED

9.4 Software Installation:

9.4.1 Refer to the PSM-126 KX-2 Robot User's Manual for information on installing and using the KX-2 software.

9.4.2 The software will determine the presence of a rail and robot, and will display additional rail-specific controls, as follows.

Rail Jog Buttons

Note: Commands in the sequence editor that refer to axis numbers will have an axis 5 listed for the rail.

## 10.0   User I/O & Emergency Stop

10.1 The robot contains digital inputs, analog inputs, and digital outputs that are available to the user, and are controlled through the robot control software (DLL). They can be monitored and toggled using the Teach Pendant Inputs/Outputs tab described in the previous sections.

10.2 All User I/O are accessed via the female high-density 15-pin d-sub Auxiliary connector on the rail connector panel. The Barcode Reader uses this connector, so it will be necessary to build a splitter cable that plugs into the Auxiliary connector on one end (Norcomp 180-015-103L001 or equivalent) and into the Barcode Reader cable on the other end (Norcomp 180-015-203L001 or equivalent). This splitter cable will need to pass through the three lines specific to the Barcode Reader (BCR, listed below).

10.3 The following I/O are available on the Auxiliary connector:

- 3 digital inputs (non-opto-isolated and sinking, each has a 10k inline resistor, and can be used with 24VDC PNP sensors)
- 2 analog inputs, 12-bit resolution
- 3 digital outputs (non-opto-isolated, sourcing)
- +24VDC source (1A max. with servo gripper, 2A without)

| AUX PIN | FUNCTION |
| --- | --- |
| 1 | Shoulder AN1+, +/-10V |
| 2 | Shoulder OUT2, 5V/10mA MAX |
| 3 | Shoulder IN3 |
| 4 | Shoulder IN1 |
| 5 | +24VDC OUT, 1A MAX |
| 6 | Shoulder AN1- (Use with AN1+) |
| 7 | Shoulder OUT3, 3.3V/8mA MAX |
| 8 | Shoulder OUT1, 5V/10mA MAX |
| 9 | Shoulder IN2 |
| 10 | 0VDC (used by BCR) |
| 11 | BCR Tx |
| 12 | BCR Rx |
| 13 | Shoulder AN2, 0-3V |
| 14 | Reserved (Shoulder OUT4) |
| 15 | Reserved (Decel) |

10.4 Emergency Stop

  10.4.1 The robot is equipped with an emergency stop button that, when pressed, will cause the robot & rail to decelerate to a controlled stop. Power is then removed from the motors after a 750ms delay. Power will not be restored to the motors until after the emergency stop button is popped back up by twisting it clockwise, and an Initialize command has been sent via the software.



  10.4.2 The emergency stop function is Stop Category 1, per IEC 60204-1.

  10.4.3 The emergency stop function is designed and built to meet PL=d (Performance Level), as required by ISO 10218-1:2011 and defined by ISO 13849-1:2015. PL=d is defined as having a probability of dangerous failure of less than $10^{-6}$ failures per hour.

  10.4.4 The emergency stop function is designed and built to meet fault resistance Category 3, as required by ISO 10218:1-2011 and defined by ISO 13849-1:2015. Category 3 specifies that a single fault will not lead to loss of safety function, and the fault is detected. No fault exclusions have been made.

  10.4.5 If modifications are made to the emergency stop function and its associated hardware, The PL=d and Category 3 ratings may be compromised, leading to a condition where the robot or rail may not stop when the emergency stop function is activated. Refer to ISO 13849-1:2015 for more information.

  10.4.6 The operating limits of the emergency stop function are the same as defined in the Specifications/Environmental Conditions section. The emergency stop function must not be modified to perform functions other than the functions described in this section.

  10.4.7 The emergency stop function, as provided by the emergency stop button, must not be muted at any time.

  10.4.8 The emergency stop function has only one control mode.

  10.4.9 Consult Peak Robotics if any internal parts of the emergency stop function must be replaced.

10.4.10 The rail connector panel should be oriented in a location that allows its drive status LED to be viewed easily, and without having to enter the robot/rail workspace.

10.4.11 When the emergency stop button is pressed, a signal is sent to the rail and robot via digital inputs 5 and 6 on the rail motor drive, which initiates a controlled deceleration of the motor. The safety rated STO1 and STO2 motor drive inputs receive a delayed signal 750 milliseconds later, and power is removed from the motors. The following table lists the maximum distance the rail may travel during controlled deceleration, assuming the rail is at its peak velocity when the emergency stop button is pressed. The rail may continue to coast a short distance past the stated distance at a very low velocity.

| Axis | Velocity | Deceleration | Time | Distance |
|------|----------|--------------|------|----------|
| Rail | 750mm/s | 1200mm/s^2 | 0.63s | 234mm |

10.4.12 The emergency stop button plugs into the E-Stop connector on the rail connector panel.

| J4 Pin | Wire | Function |
|--------|-------|-----------|
| 1 | Brown | +5VDC OUT |
| 2 | White | E-Stop1 |
| 3 | Blue | +5VDC OUT |
| 4 | Black | E-Stop2 |

10.4.13 The emergency stop button contains two sets of normally closed contacts that open when the button is pressed. The robot & rail are permitted to operate when E-Stop1 and E-Stop2 are connected to fuse-protected +5VDC supplied by the Shoulder motor drive via the closed contacts.

10.4.14 The state of the emergency stop function is displayed via a bicolor LED located on the rail connector panel. The LED reports the following states based on its color:

Green—Emergency stop button is popped up, and the robot is permitted to operate.

Red—Emergency stop button is pushed down, and robot/rail motion is inhibited.  If the LED remains red after the emergency stop button is popped up, and will only return to green if power is cycled, then this indicates a fault in the emergency stop function, which must be investigated before the robot is returned to service. See Periodic Maintenance section for more information.

Off—The 1/10A fuse inside the Shoulder may be blown.

## 11.0   Periodic Maintenance

11.1 Periodic maintenance should be performed every time the rail has completed the equivalent of 5000 kilometers linear travel. Maintenance should be performed at least every two years even if 5000 kilometers of linear travel has not been reached.

11.1.1   The software logs the total accumulated travel of the rail. The cycle data can be found on the Teach Pendant window.

11.1.2   If the controlling software is written to monitor the "maintenance required" event, it is recommended that a window be made to pop up when the event is received, indicating maintenance is required.

11.1.3   If the controlling software does not monitor this event, then the Teach Pendant should be checked every few months, depending on use. Check for Maintenance Required = true or false.  If true, perform the maintenance and then change to "false" by double-clicking on "true".

Grease, adjust, or replace as necessary:

11.1.4   Check the rail for bearing wear. The output carriage should feel firm with little to no discernable play.  A bad collision can damage the bearings and cause mechanical looseness.

11.1.5   Check the timing belt tension. The belt should not droop. It should feel firm and should vibrate if plucked.

11.1.6   Check tightness of rail mounting screws. If loose, then re-tighten. Teach points may need to be re-taught.

11.1.7   A grease gun with a standard grease zerk fitting is required for greasing the rail bearing blocks.



*Grease Gun (GreaseTek 910101 Shown)*

11.1.8 Use Castrol Tribol GR 100-2 PD grease (14-oz. cartridge is part number 157C88-14OZ).

11.1.9   Grease the rail bearing blocks, as follows:

- Remove the black plastic cover from the side of the rail carriage to expose the two grease zerks.





Zerks

- Attach the grease pump to one of the zerks. Each of the two bearing blocks need 2.0 cubic centimeters (0.07oz) of grease added to it at each maintenance interval. The GreaseTek gun shown above pumps a volume of 0.025oz per pump, so just shy of three full pumps of the handle will deliver the correct volume. Pump in half of the grease, then move the rail through its full range of travel once before pumping in the second half of the grease. Do not pump more grease than is required, as excess grease will escape past the bearing seals and will make a mess. Repeat for the second zerk.

Note: Pump slowly to prevent swelling of the hoses that attach the zerks to the bearing blocks.

- Reinstall the cover.

11.1.10 After both bearing blocks have been greased, move the rail slowly through its full range of travel a few times to distribute the grease within the bearing blocks.

11.1.11 Open the Teach Pendant, reset the robot, and double-click on the 'Rail Maint. Req'd" box to set it to 'True'. Close the Teach Pendant to save the setting to the rail.

11.2 Emergency Stop Maintenance

11.2.1 To maintain the rated safety level of the emergency stop function, the user shall perform a diagnostic test periodically, as follows:

1) With the emergency stop button popped up in its normal position, the Drive Status LED located on the rail connector panel must be green.

2) The emergency stop button should then be pressed down, and the Drive Status LED must transition to red.

3) The emergency stop button should then be popped back up, and the Drive Status LED must transition back to green.

11.2.2 For SIL 2 the diagnostic test must be performed at least once per year.

11.2.3 For SIL 3 the diagnostic test must be performed at least once every 24 hours.

**Revision History**

| Revision | Date | Line | Description |
|----------|------|------|-------------|
| 1 | 10/27/2020 | All | Initial Release |
| 2 | 2/5/2021 | 3.2 | Collaborative application guidance |
| | | 7.1 | Collaborative max. speed of 410 mm/s |

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