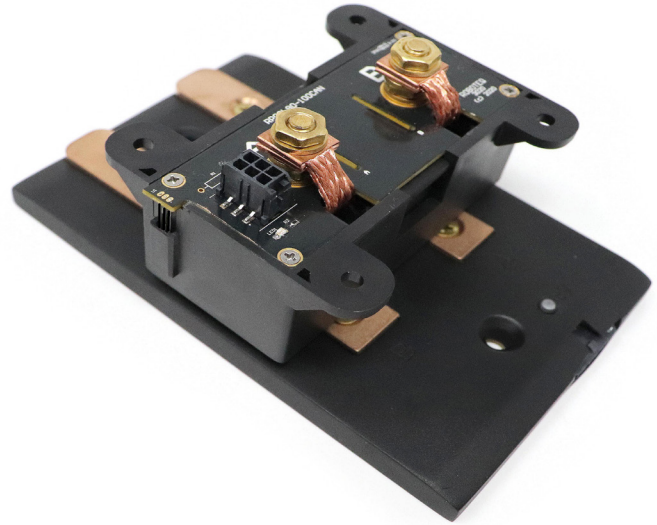


Magnetically Activated Charger Contacts for Mobile Robots with Optional CAN Transceiver



The RoboPad charging contact system offers a precision, high current charging solution for mobile robots and Automated Guided Vehicles (AGV). It is composed of a charge contacts base that is typically affixed on the floor, and a collector unit with extendable contacts, mounted on the robot. Unlike conventional spring-loaded contact products commercially available, RoboPad utilizes high energy magnets to control the connection and disconnection action automatically, while using no additional power from the mobile systems batteries. The magnet's strong attractive action result in a high pressure, high quality electrical contact. The magnet's repelling function actively forces the pads retractions as the robot moves away. The base's ultra-low profile, and the collector's extension range, allows for far more compact charging configurations over any other charge system, in permanent factory and business environments.

Sensors on the collector and in the base signal to the battery charger and the robot's BMS when the contacts are aligned and extended. The pads are available with an optional wireless CAN bus transceiver, allowing the Charger and the BMS to optimize the power delivery by exchanging commands and monitoring data during charging.

Applications

- Automatic Guided Vehicles
- Mobile robots
- Warehouse shuttles
- Cleaning Robots
- Personal mobility system
- Amusement rides
- Electric forklifts
- Autonomous Lawn and Garden Maintenance Robots

Features List

- Two-part system made of retractable collector and fixed base
- Fully passive – No power required
- High contact pressure
- Excellent low resistance electrical contacts
- Ultra-low-profile charge base
- Floor, or wall mounting
- Very low footprint
- Ultra-fast connect/disconnect. Minimizes or eliminates accidental arcing
- Built-in solid-state Hall switches in Collector and Base to indicate retracted/extended state
- Optional wireless CANbus transceiver for communication between Charger and Battery Management System
- Ultra low-wear copper beryllium contacts.
- Guaranteed over 250K cycles
- High Current Capacity – 100A Typical
- Low cost

Ordering References

Part Number	Description	CAN Transceiver
RPBAS90-100	RoboPad Charging Base, 90mm wide, 100A	No
RPCOL90-100	RoboPad Extendable Collector, 90mm wide, 100A	No
RPKIT90-100	RoboPad Kit including Base and Collector, 90mm wide, 100A	No
RPBAS90C-100	RoboPad Charging Base, 90mm wide, 100A	Yes
RPCOL90C-100	RoboPad Extendable Collector, 90mm wide, 100A	Yes
RPKIT90C-100	RoboPad Kit including Base and Collector, 90mm wide, 100A	Yes

Description

There are few commercially available options available today for performing the charging function of a mobile robot or AGV. The majority of them use weak spring loaded copper or brass contacts which use the shape of the contact to ride over the charging pad, creating considerable wear and tear on the system. What is needed is a rapidly connecting, low wear contactor that can supply high current for extended periods and disconnect without creating damaging electrical arcs. The RoboPad meets this challenge head on, and uniquely solves problem using a high technology and precision system. In addition, the low-profile design allows for mounting the charging pads almost anywhere – including walls, poles, under platforms and even overhead.

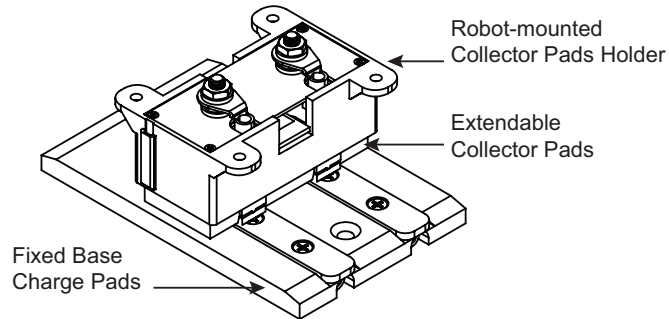


FIGURE 1. RoboPads Charge System composition

The RoboPad charging contact system operates on the principles of magnetic attraction and repulsion. Most commonly, the floor mounted charging pads are placed in a location either along the route, or at specific waypoints in the path of the robot. The robot will then stop at this specific location and connect to the charger for the required time. Another encountered arrangement is to place the charging pads in a protected parking location that is off the main path to allow other robots to travel unimpeded.

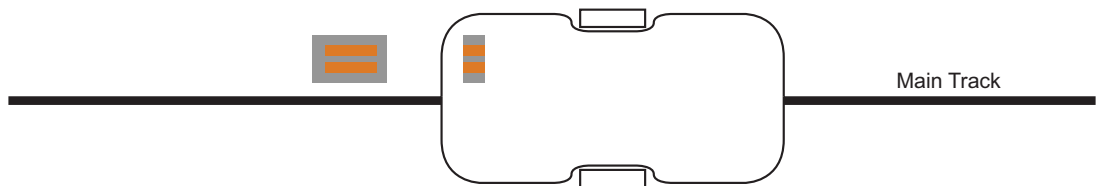


FIGURE 2. Charge pads at stop points along the robot's main track

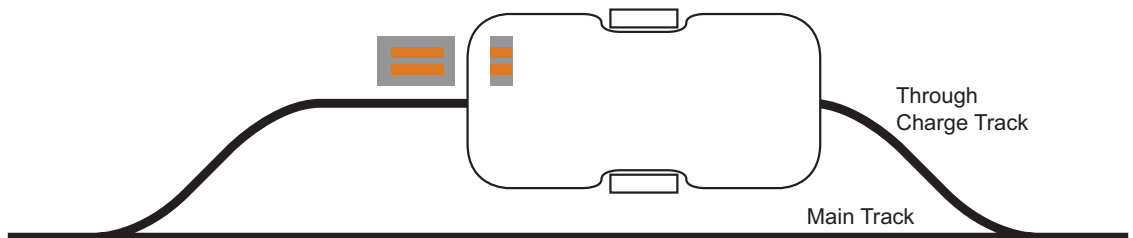


FIGURE 3. Charge pads located at diverted track

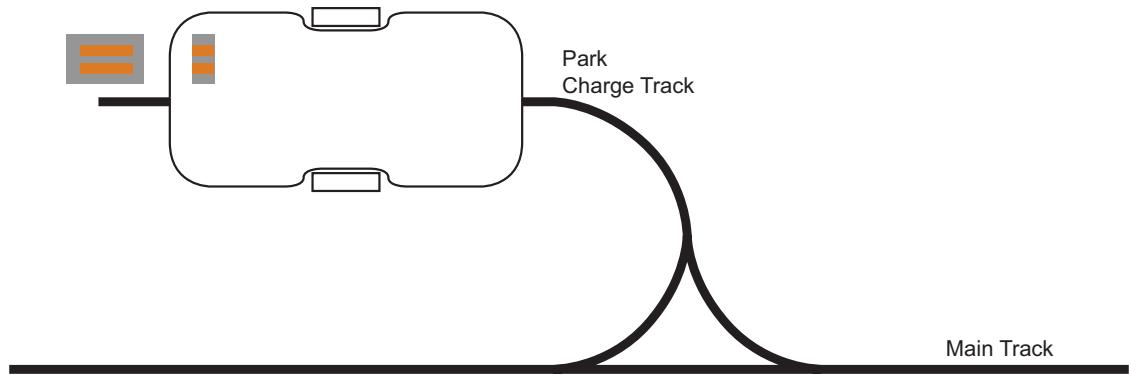
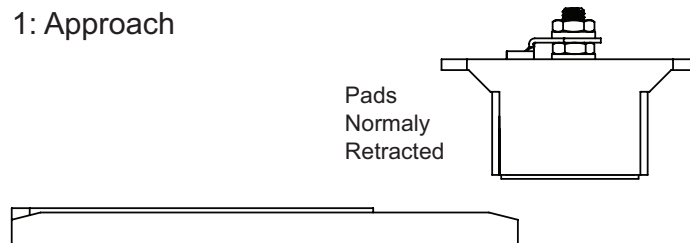


FIGURE 4. Charge pads located at charge parking

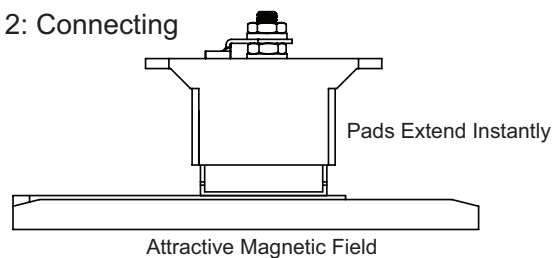
To charge, the robot or AGV simply drives over the charging pads on the floor. When the robot's collector pads are aligned with the base, they instantly extend. By detecting the charge voltage directly, or monitoring the built-in sensor in the charging contacts, the robot can determine when to stop. Current can then flow to the battery to charge it.

How it works

1: Approach



2: Connecting



3: Departing

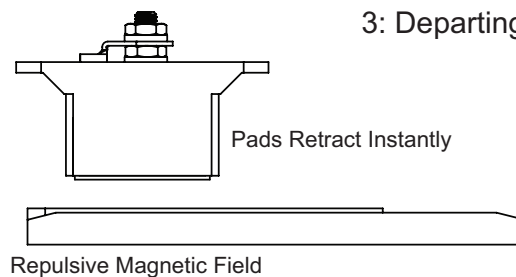


FIGURE 5. Collector pads extension and retraction depending on position over base

High force magnets are staggered with opposing polarities in the charging base and charging contacts such that a strong force of repulsion occurs during entry and exiting the floor mounted charging pad. Only during the center most electrically active area of the base pad does the strong attractive action appear, allowing for a solid electrical connection between charger pad and base pads to be achieved. This locks in the high current charging so the AGV batteries acquire full charge at the maximum rate possible. When the charge cycle is completed, the robot simply pulls forward or reverse off the pad and the contacts automatically retract into the underside of the AGV.

Benefits over brush/springs

Conventional charging contacts use spring loaded collector contacts which drag or hang underneath the mobile robot in use. These units have a low floor clearance and tight height tolerance as they must physically slide up a ramp on the base: if they are mounted too low, they will touch the floor or hit the side of the base. If they are mounted too high, they will have weak spring pressure or not make contact at all.

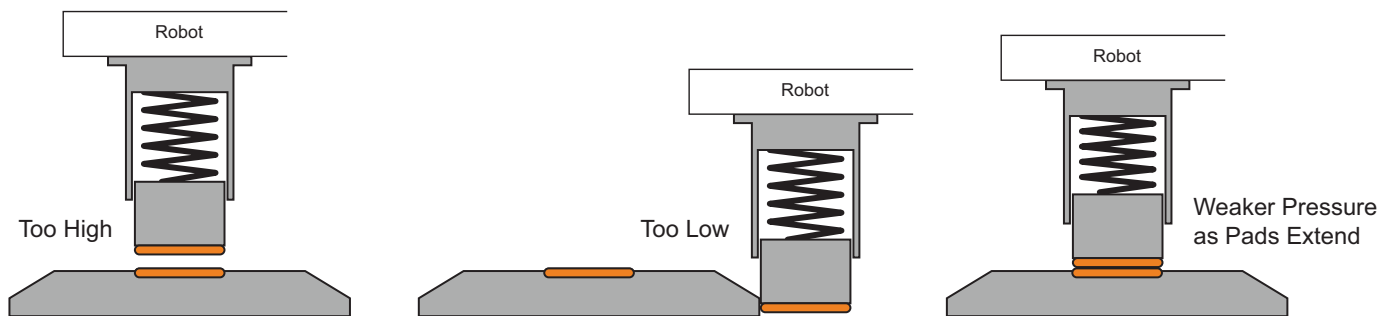


FIGURE 6. Spring loaded pads have lower ground clearance and must be adjusted tight height tolerance

Spring contacts have a high wear rate over time because the constant sliding action of the contacts over the charging pads, and the weakening of the springs behind the contacts which push the contact against the pad when compressed. Ideally, the charging contacts on the Robot should connect rapidly – almost instantaneously to the pads without sliding and pull away rapidly to avoid being dragged over the charging pad as the robot exits the charger.

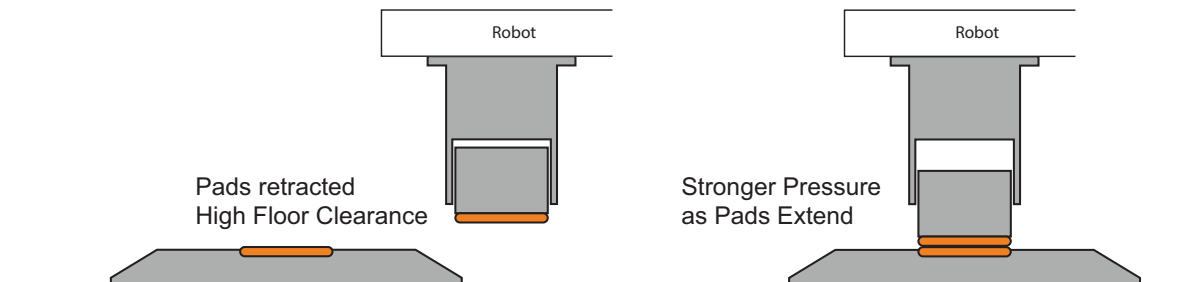


FIGURE 7. RoboPads have higher floor clearance and much stronger contact pressure

The magnetic action of the RoboPad is almost instantaneous as it takes around 20ms for the pads to fully extend or retract. Another major advantage of the RoboPad is the constant strong pressure the contacts push against the charging pads due to magnetic attraction. Unlike spring loaded contacts, the RoboPad systems pressure increases as the pad extend. Extension force remains constant over the life of the pads and will always provide the maximum charging current and less residual heating effects than conventional spring-loaded systems.

Construction

Highly durable ABS plastic with flame retardant is used in the construction of the RoboPad charging system. Integral ceramic rare-earth magnets are securely mounted internally providing a smooth and accurate extension and retraction. All components are precision injection molded and have a high-quality finish.

Mounting and Wiring

Mounting the charging system underneath the AGV/Mobile Robot is the most commonly used option. For this application, the charging pad is secured to the floor itself. Mounting the collector contacts on the robot can be done in several locations.

Mounting the charging plates directly under the robot can now be a real possibility with the RoboPad. The low profile allows sufficient clearance in most applications to centrally mount the pads. This may be more convenient for parking the robot over charging pads that are along its route.

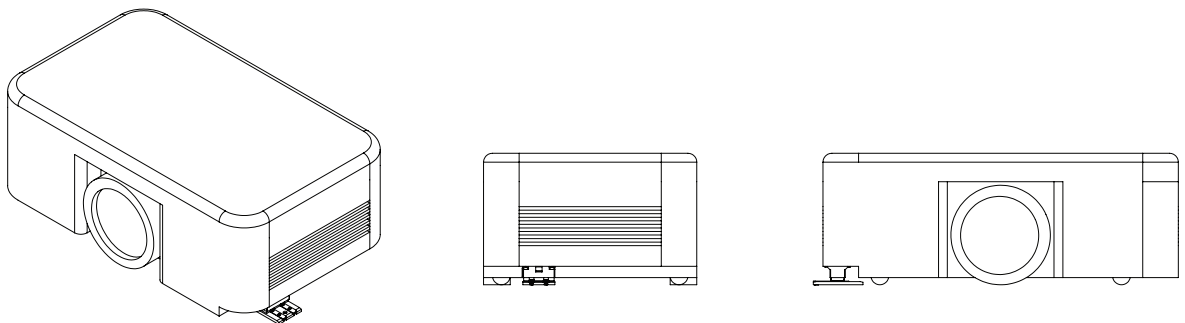


FIGURE 8. Base charge pads on floor and collector pads under robot

An alternative location of the charging system is on the sides of the robot. If mounted on the right or left side, the robot would drive up against the charging pads mounted vertically on a post or wall to connect. The retracted pads can be flush with the chassis surface and will extend only when aligned with the base charge pads.

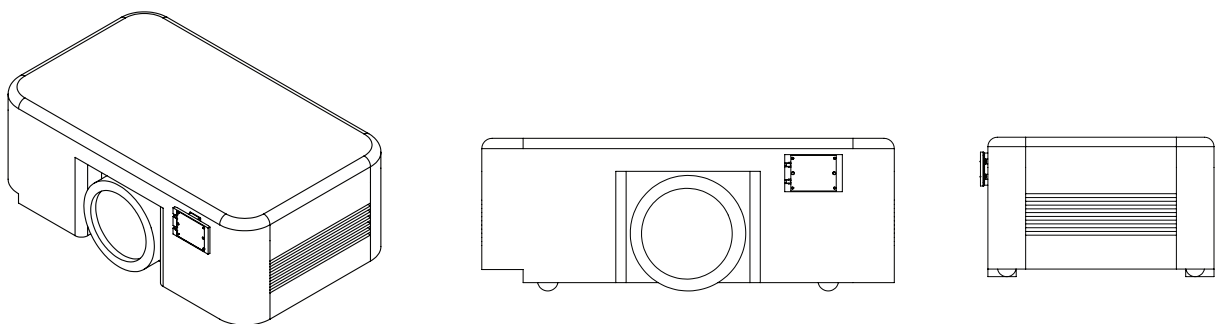


FIGURE 9. Base charge pads on wall and collector pads on robot's side

The base assembly can be mounted on any non conductive surface such as wood, concrete, tile, or plastic. The base assembly is fastened to the floor or mounting surface by use of either two 6mm or 1/4 inch screws. To avoid damage to the surface, double side adhesive tape can be used in some conditions to affix the charge base on the floor.

Wires connected to internal ring lugs exit on one end of the housing and allow connection with red and black

(recommended colors) 8-10 AWG wire to the charging power supply.

On the robot side, the collector contacts unit attaches to the AGV or Mobile Robot with four 4mm screws. Connection to the collector contacts is made with ring lugs and 8-10 AWG wires to the robot's battery system. For best results, the user's ring lug must be placed directly over the ring lug that connect to the copper braid on the charging contacts.

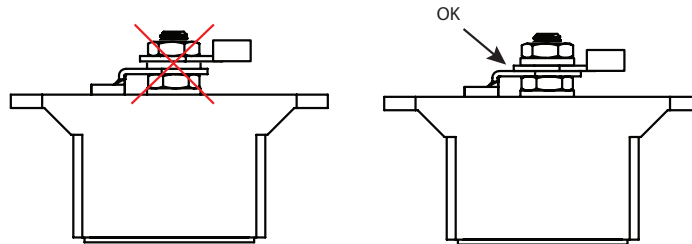


FIGURE 10. Attach user lug directly over the braid lug

Copper ring lugs are recommended to connect to the charging base and the collector pads. Additionally, adding solder to the lug and wire will strengthen the connection and make it highly wear resistant.

Hall switch

Located on the side of the charging contact housing is a Hall Magnetic Sensor. This solid-state device is located near one of the retractable collector magnets and changes state when the pads extend or retract, providing the robot's Battery Management System and/or supervisory computer with this important information.

Connecting to the hall sensor to Non-CAN Collector and Base

A hall sensor is fitted inside the collector and another one in the base to detect when the pads are making physical contact. The signal can then be used the charger to turn on and off the power only when a robot is correctly docked

The sensor has an open collector output and will pull the output to ground when the pads are extended. The sensor output is off (floated) when the pads are retracted. When connecting to a PLC or computer, a 1K to 10K pull up resistor must be inserted between the output and a 5-24V source.

Collector Sensor

On the original Version 1 collectors, three wires connect to the collector pad's hall sensor: a Ground wire (Black), a +5V to +24V power wire (Red), and an output wire (White).

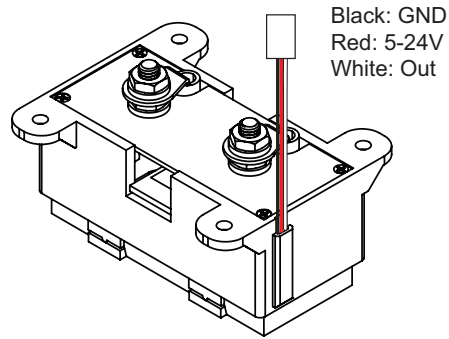


FIGURE 11. Version 1 Non-CAN Collector with Sensor cable output

On the newer V2 of the collector, the hall sensor signals are accessible from a 2x3 pins Molex connector.

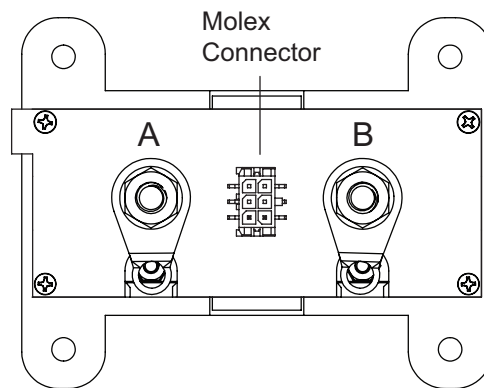


FIGURE 12. Version 2 Non-CAN Collector Layout

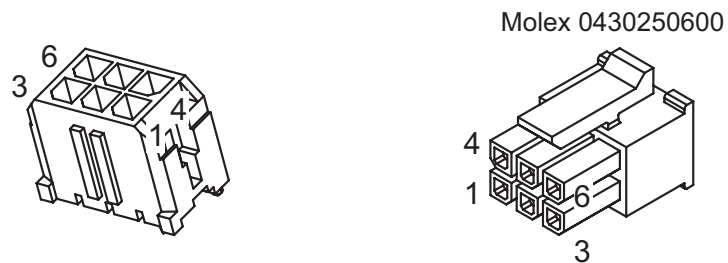


FIGURE 13. CAN and Hall Connector on Collector

TABLE 1. Collector Header Pins Identification

Connector Pin	Signal	Description
1	Hall_Out	Collector Extended Hall Sensor Output
2	NC	Reserved
3	NC	Reserved
4	NC	Reserved
5	Vin	6V to 30V Power Supply Input
6	GND	Ground

Base Sensor

A similar hall sensor is located in the base and will activate when the collector are extended onto the base.

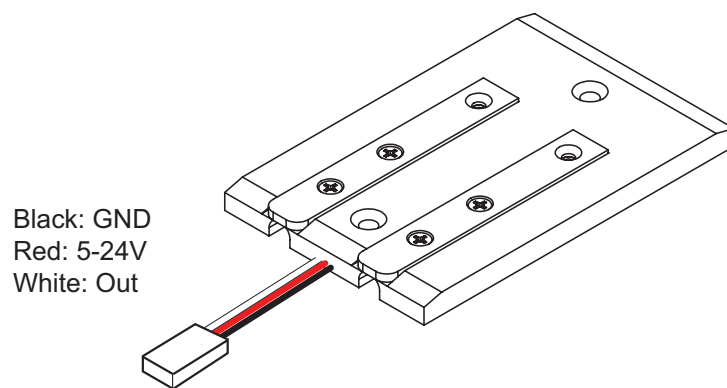


FIGURE 14. Non-CAN Base with Sensor cable output

Optional CANbus Transceiver

This version of the Robopad Charging Contact System has the addition of a bi-directional optical transceiver for the exchange of CAN data from the robot to charging base. When the collector pads are lined up with the base, CANbus signals on the collector and the base are joined wirelessly, as if they were electrically joined.

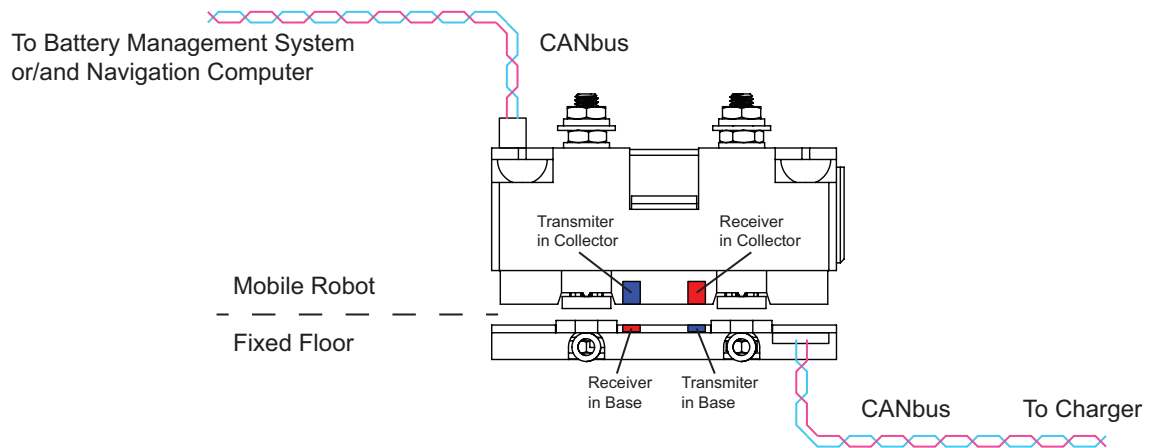


FIGURE 15. CANbus Transceiver for BMS to Charger Communication

The Robopads only act as a transceiver on the bus: they don't interface to the bus and don't accept or respond to CAN commands. CAN signals are carried through the transceivers at their native bit rate, up to 250 kbit/s and a transmission range of 20mm.

An application example would be communication between the BMS (Battery Management System) and the Base charger to have the current throttled in function of the battery's State of Charge and/or temperature.

For charge-only applications, the CAN version is completely compatible with existing basic model Robopads. Durable polycarbonate optical windows seal the optical sensors on both Charging Base and Extensible Collectors to help keep out dust and oil. Electrical connections are implemented with industry standard Molex Microfit connectors.

Beware that for proper operation the transmitter of the collector must be aligned over the receiver of the base, and the receiver of the collector must be aligned over the transmitter of the base. Align the AB marking on the collector with the AB marking on the base.

CAN-Enabled Collectors

The CAN-Enabled Collector uses a 6-pin connector located on the top side. An LED indicates the presence of supply voltage for the internal electronics. The infrared receivers and transmitter are on the bottom side next to the electrical contacts.

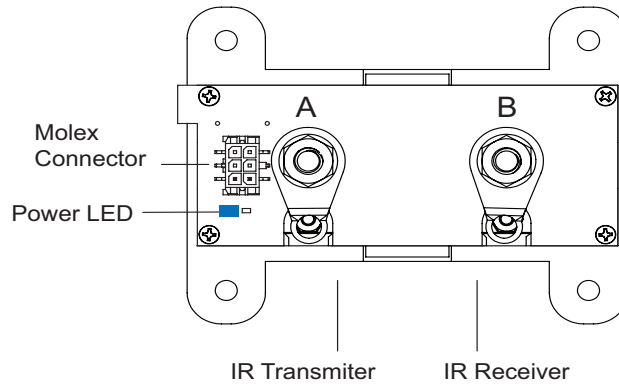


FIGURE 16. CAN-Enabled Collector Layout

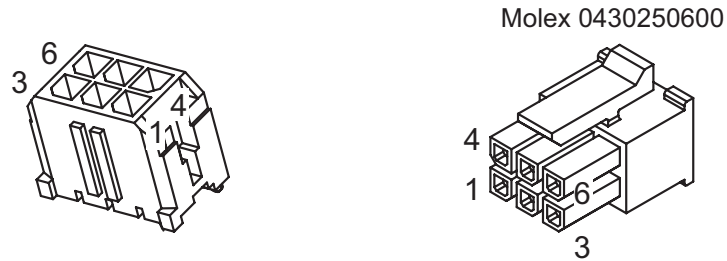


FIGURE 17. CAN-Enabled Collector Connector pins identification

TABLE 2. CAN-Enabled Collector Header Pins Identification

Connector Pin	Signal	Description
1	Hall_Out	Collector Extended Hall Sensor Output
2	NC	Reserved
3	CAN_H	CAN high bus line
4	CAN_L	CAN low bus line
5	Vin	6V to 30V Power Supply Input
6	GND	Ground

CAN-Enabled Base Layout and Connections

The CAN-Enabled Base use a single-row, 6 pin connector built into the base. An LED indicates the presence of supply voltage for the internal electronics. The infrared receivers and transmitter are behind clear windows.

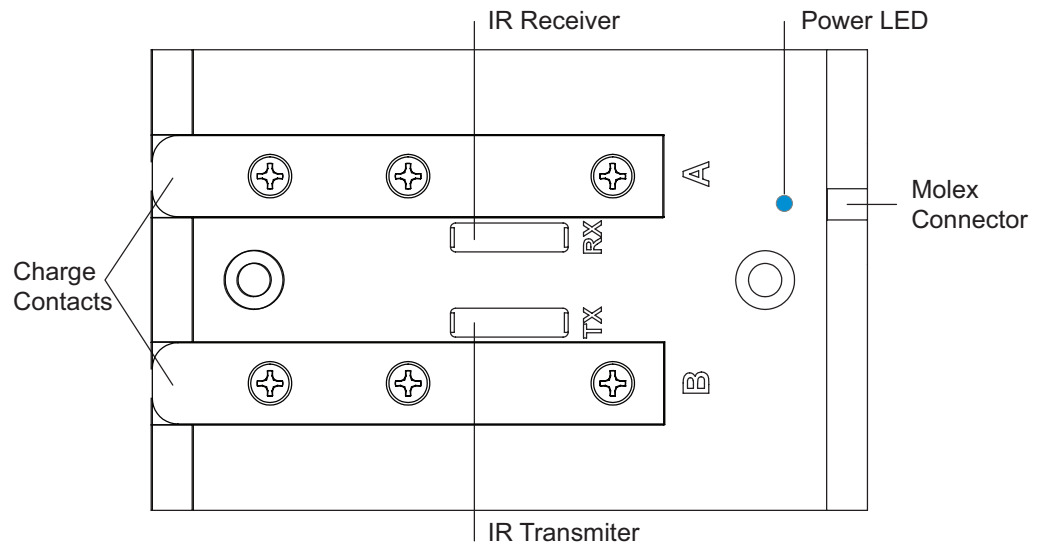


FIGURE 18. CAN-Enabled Base Layout

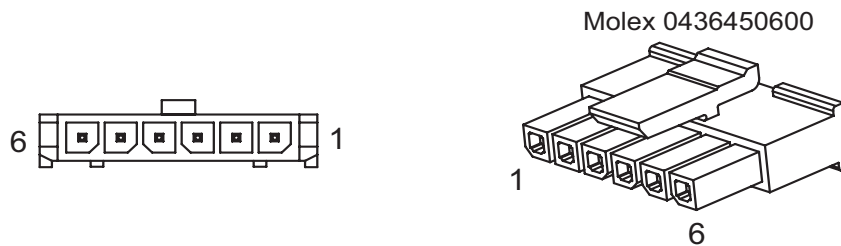


FIGURE 19. CAN and Hall Connector on Base

TABLE 3. Base Header Pins Identification

Connector Pin	Signal	Description
1	Vin	6V to 36V Power Supply Input
2	CAN_H	CAN high bus line
3	CAN_L	CAN low bus line
4	Hall_Out	Collector Present Hall Sensor Output
5	NC	Reserved
6	GND	Ground

Part of Roboteq's Integrated Solution for Mobile Robots

The RoboPad charging connection is part of a complete system of AGV or Mobile Robot components available from RoboteQ. From a line of single and dual channel motor controllers, to complete power management

solutions, RoboteQ can provide additional solutions for your project.

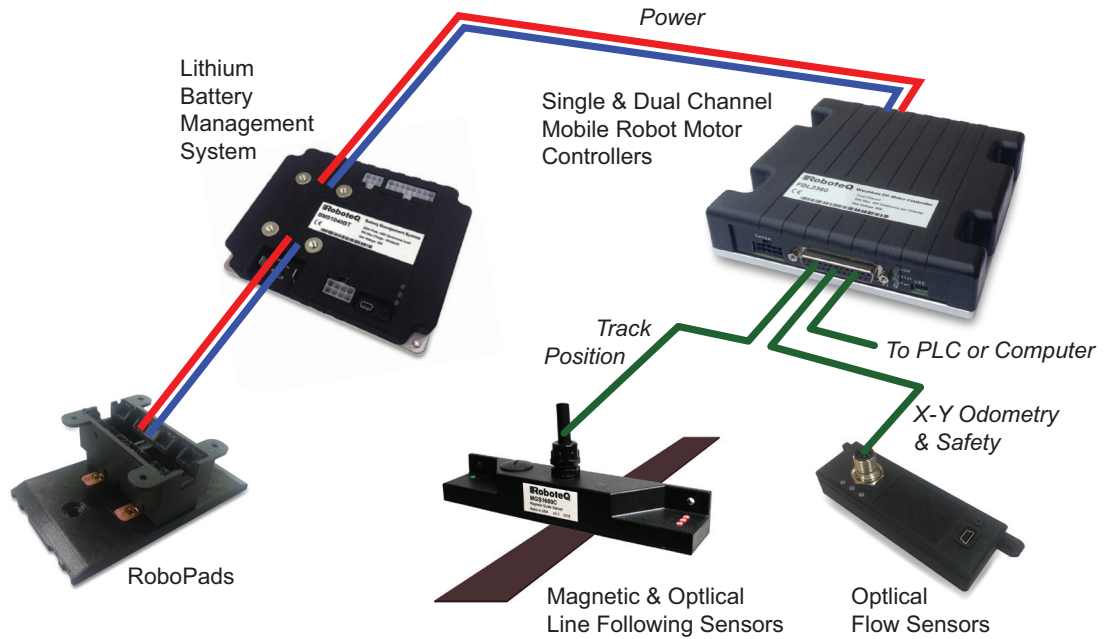


FIGURE 20. Roboteq’s integrated product solution for Mobile Robots

Specifications

Dimensions Base	140 x 90 x 10mm
Dimensions Collector Extended	90 x 56 x 42mm
Dimensions Collector Retracted	90 x 56 x 32mm
Extension range	10mm
Current	100A max, 75A continuous
Voltage	200V max
Extension/Retraction speed	20ms typical
Contact Pressure	1.5kg typical
Left/Right alignment tolerance	+/-5mm
Hall sensor voltage	4.5 to 24V, open collector output
Max up/down cycles	>250,000
Collector Sensor Activation Distance	4mm min / 5mm max
CANBus bit rate	250kbit/s max

Mechanical Drawing

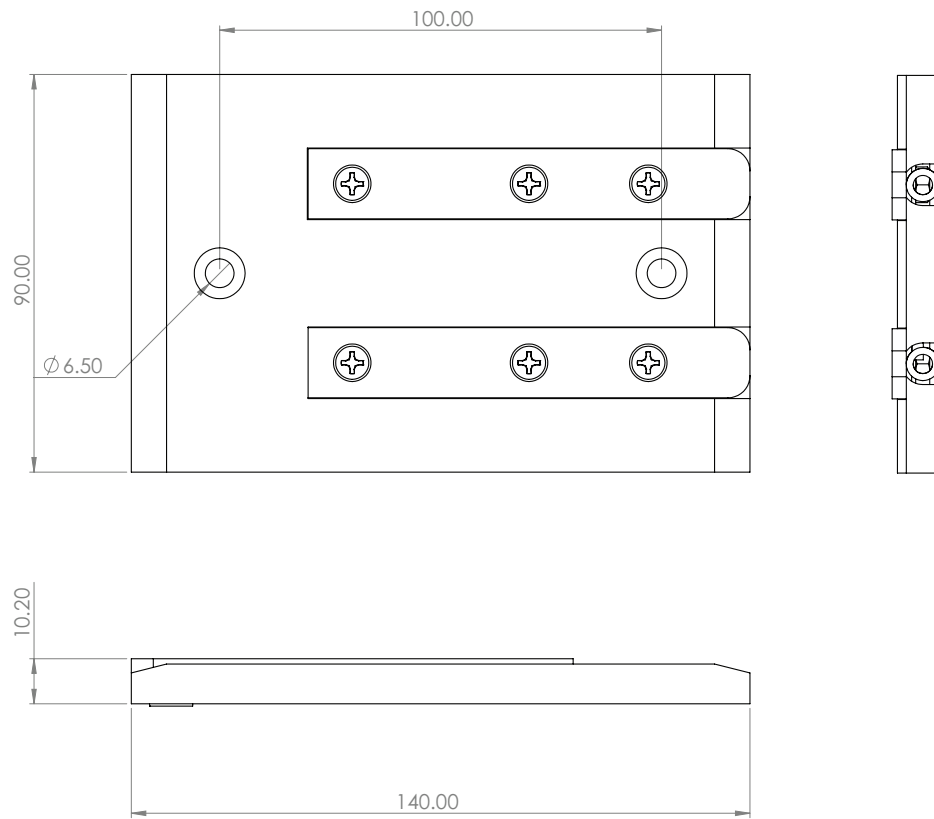


FIGURE 21. Base charge pads mechanical dimensions

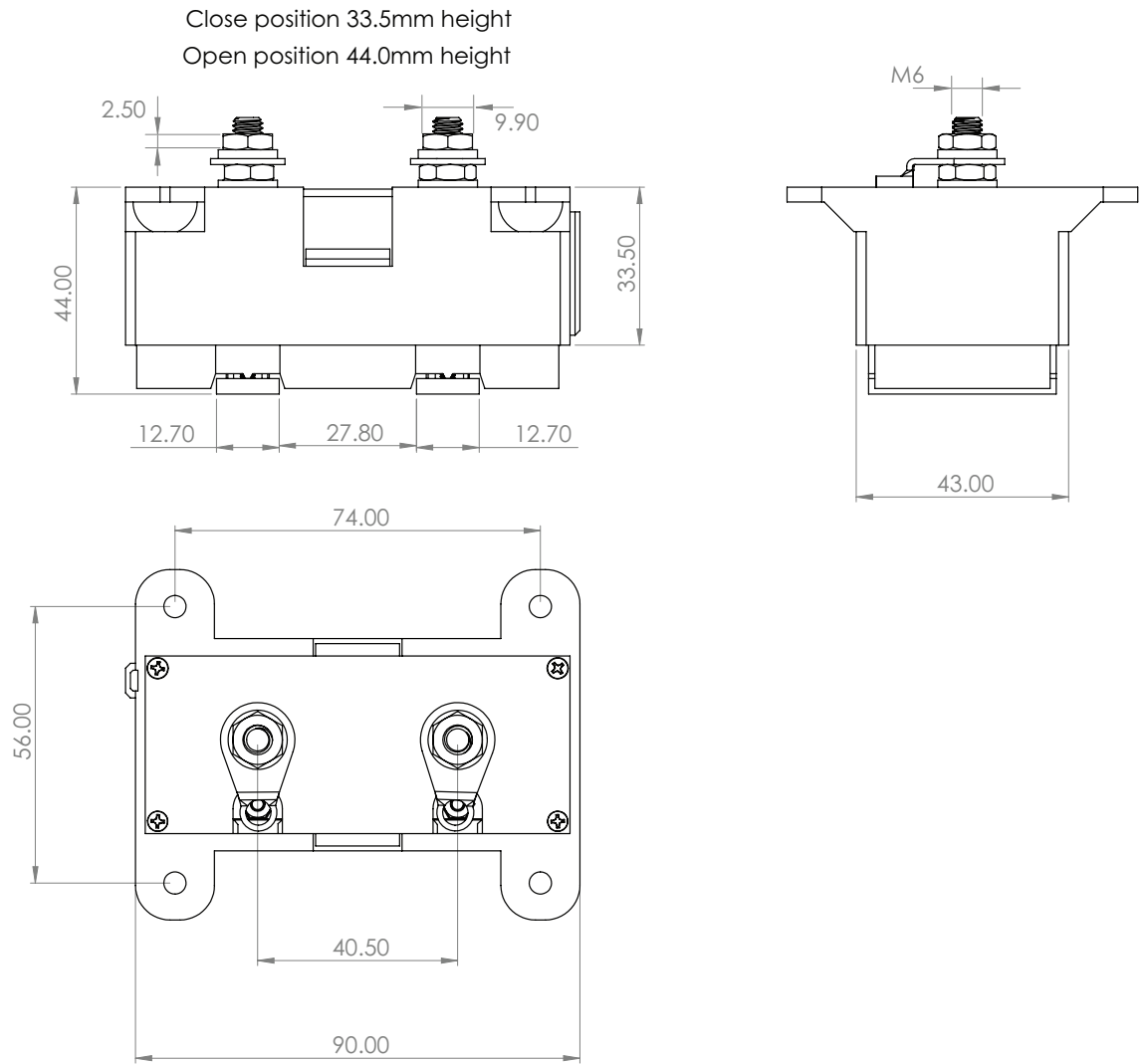


FIGURE 22. Collector charge pads mechanical dimensions