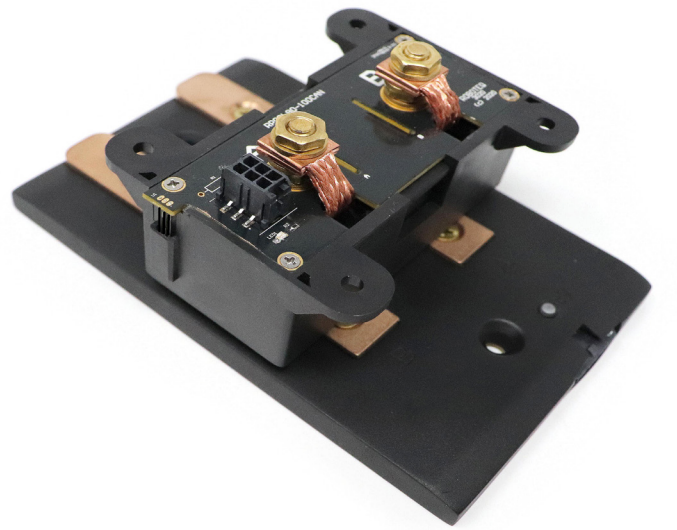
Magnetically Activated Charger Contacts for Mobile Robots with Optional CANTransceiver



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.

Hall sensors located on the collector and base plates, report the contacts state and can be utilized by the BMS or the battery charger. The pads are available with an optional wireless CAN bus transceiver, allowing for data exchange between the charger and the BMS when the pads are in contact. This function enables the charging optimization through real-time data monitoring.

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

In today's market, options for the charging function of a mobile robot or AGV are limited, with the vast majority relying on weak, spring-loaded copper or brass contacts. These contacts can lead to significant wear and tear as they traverse the charging pad. In response to this challenge, RoboPad presents a cutting-edge solution that employs high-energy magnets to establish contact between the base and collector components. Featuring a rapid and low-wear contactor capable of supplying high current for extended periods and disconnecting without generating damaging electrical arcs, RoboPad sets a new standard in charging technology. With its high-precision, high-technology system, it directly addresses these concerns. Additionally, its low-profile design offers versatile mounting options, including walls, poles, under platforms, and even overhead.

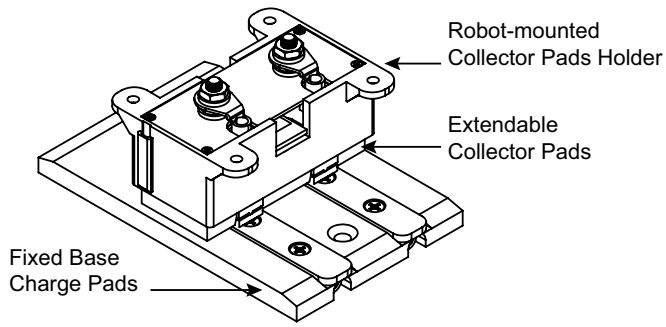


FIGURE 1. RoboPads Charge System composition

Typically, floor-mounted charging pads are strategically placed along the robot's route or at specific waypoints separate from the main path, enabling other robots to move freely while the robot charges.

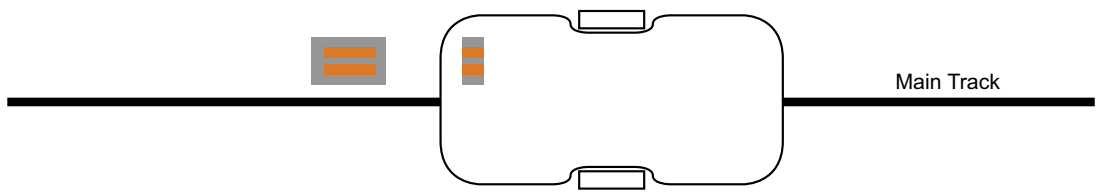


FIGURE 2. Charge pads at stop points along the robot's main track

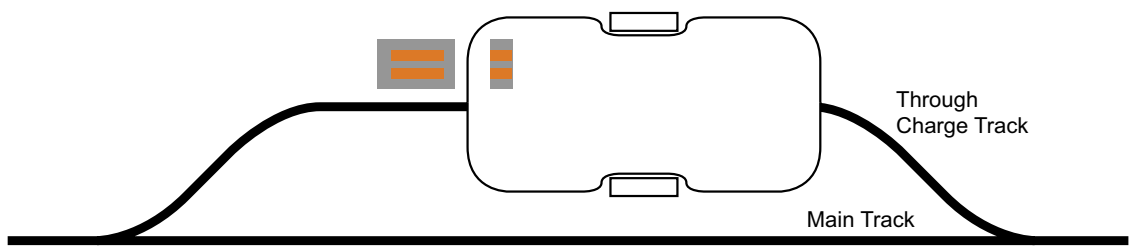


FIGURE 3. Charge pads located at diverted track

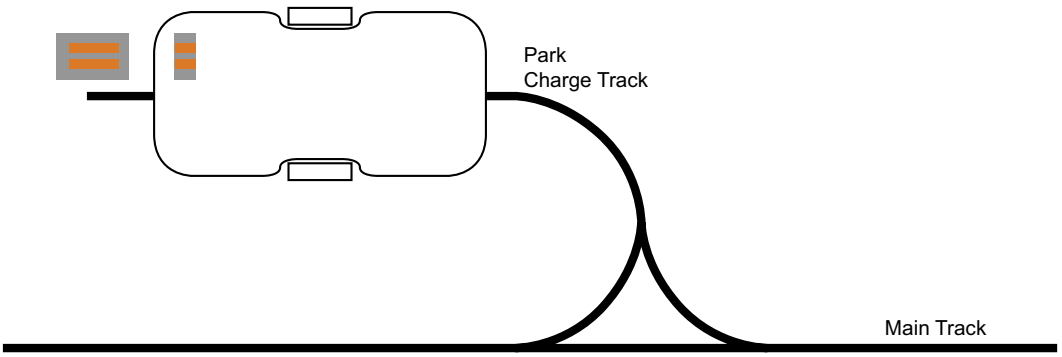


FIGURE 4. Charge pads located at charge parking

To initiate charging, the robot or AGV simply drives over the charging pads on the floor. When the robot's collector pads align with the base, they instantly extend. The robot has several methods to determine when to stop and begin the charging process, including detecting the charging voltage, reading signals from the built-in hall sensors placed on the base and collector plates, or optionally through CAN communication, which is typically conducted between the charger and the BMS.

How it works

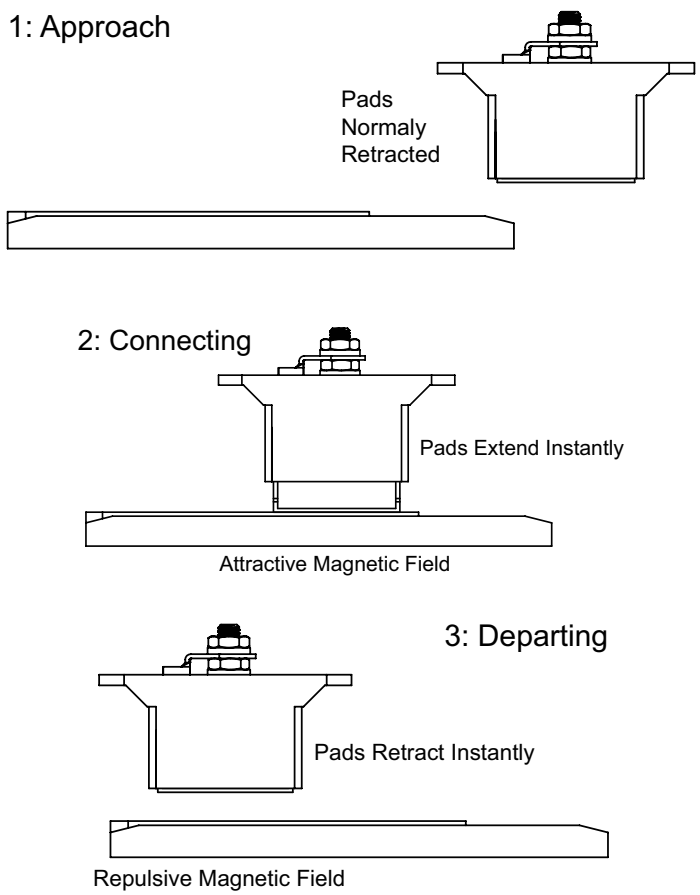


FIGURE 5. Collector pads extension and retraction depending on position over base

RoboPads deploy a configuration of magnets that generate a strong attractive force when both contacts are perfectly aligned and repulsive forces when the two contacts are approaching or moving away from each other. This ensures that the charging process will only commence when a perfect contact is established, optimizing charging efficiency and minimizing energy loss.

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, the will have weak spring pressure or not make contact at all.

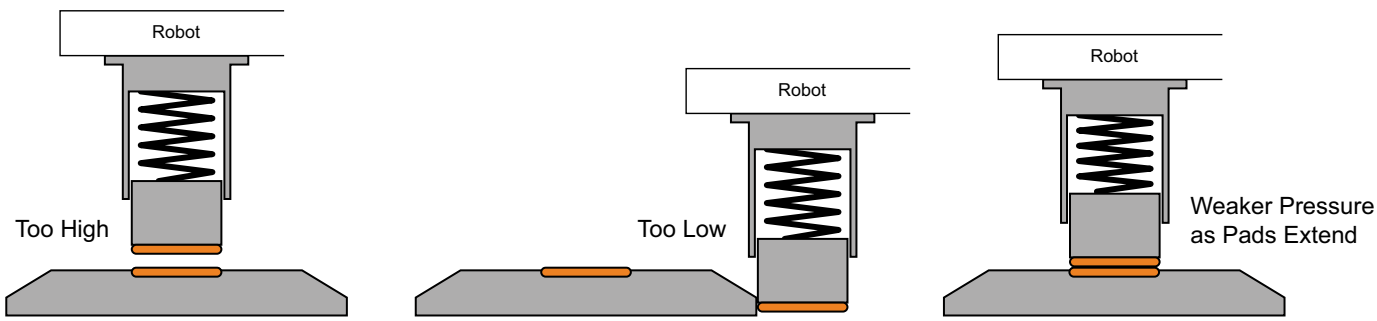


FIGURE 6. Spring loaded pads have lower ground clearance and must be adjusted tight height tolerance

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.

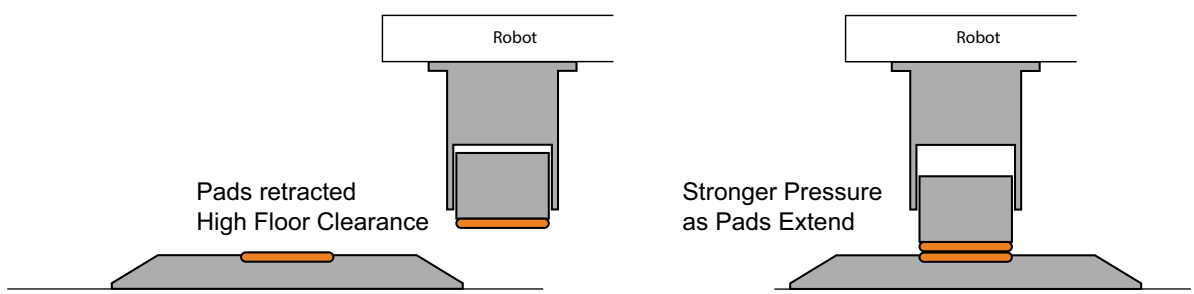


FIGURE 7. RoboPads have higher floor clearance and much stronger contact pressure

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.

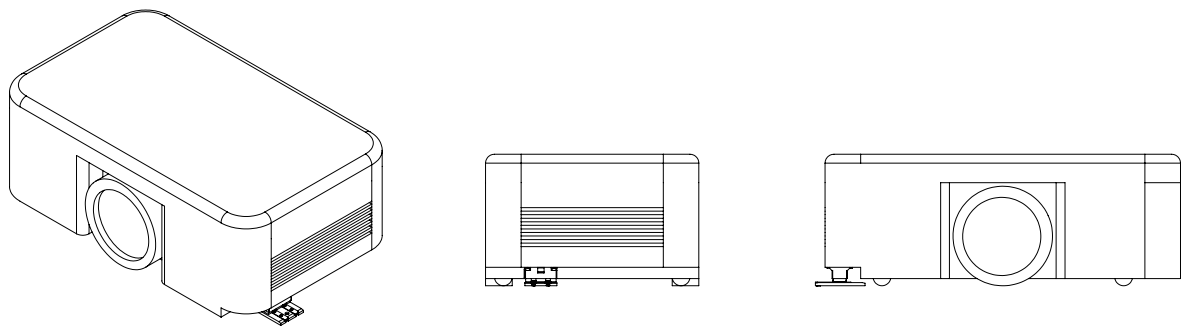


FIGURE 8. Base charge pads on floor and collector pads under robot

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.

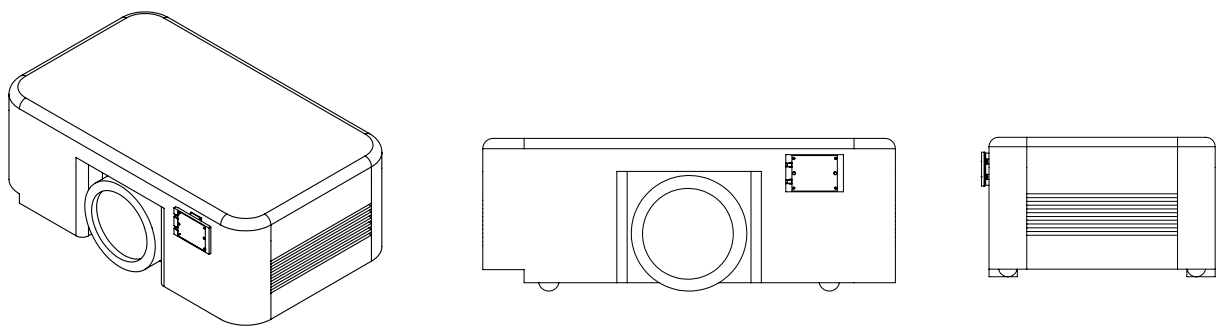


FIGURE 9. Base charge pads on wall and collector pads on robot's side

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.

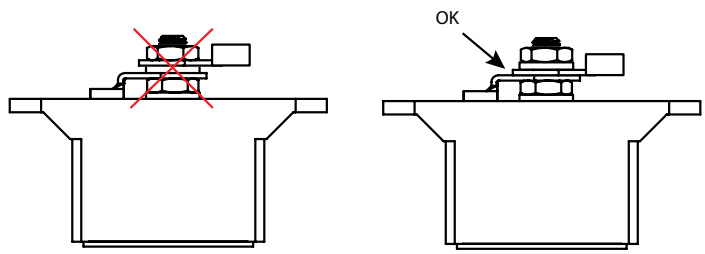


FIGURE 10. Attach user lug directly over the braid lug

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 Sensors

Both the Base and Collector components incorporate Hall sensors to report their states. The sensors are externally powered by a voltage ranging from 5 to 24 V, and they require a pull-up resistor with a resistance range of 1 to 10 kOhm to be connected to the sensor's output to function.

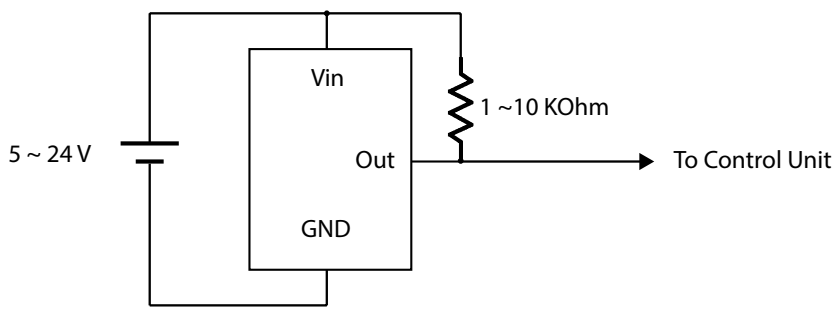


FIGURE 11. Hall sensors connection diagram

Collector Sensor

On the original version, 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).

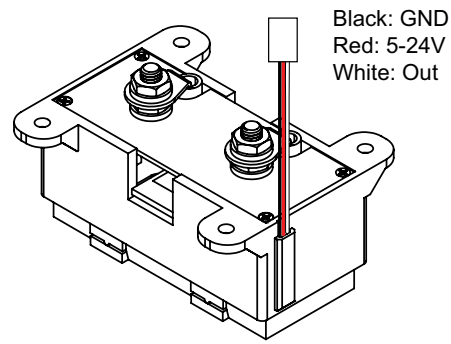


FIGURE 12. Version 1 Non-CAN Collector with Sensor cable output

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

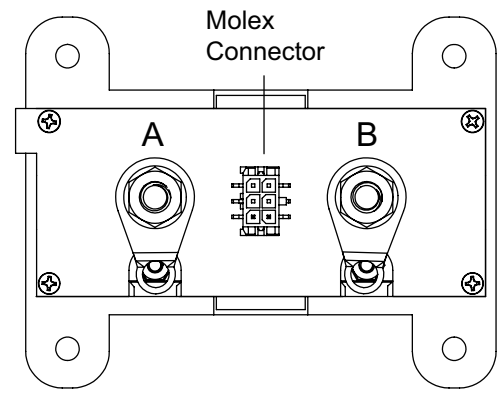


FIGURE 13. Version 2 Non-CAN Collector Layout

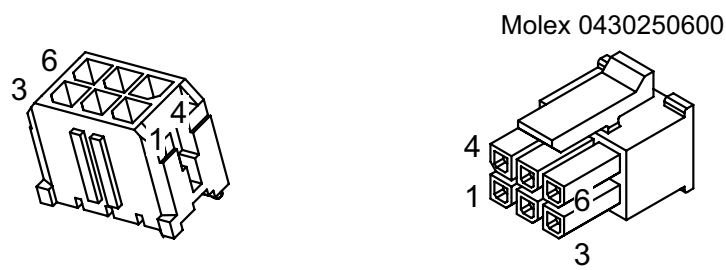


FIGURE 14. CAN and Hall Connector on Collector

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

TABLE 2. Collector Sensor Output Table

Collector State	Sensor Output State
Retracted	Low
Extracted	High

Base Sensor

A similar hall sensor is located in the base and will when the collector is retracted. Please note that the base hall sensor's output logic is inverted compared to the collector.

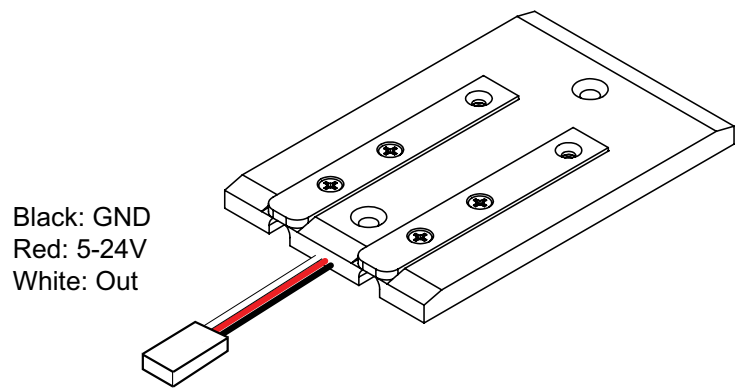


FIGURE 15. Non-CAN Base with Sensor cable output

TABLE 3. Base Sensor Output Table

Collector State	Sensor Output State
Retracted	High
Extracted	Low

Optional CANbus Transceiver (Patent Pending)

This version of the RoboPad Charging System includes a bi-directional optical transceiver, enabling the exchange of CAN data through the RoboPads' base-collector contacts. When the two pads are aligned, CANbus signals can be wirelessly transmitted between the collector and base pads, as if they were electrically connected.

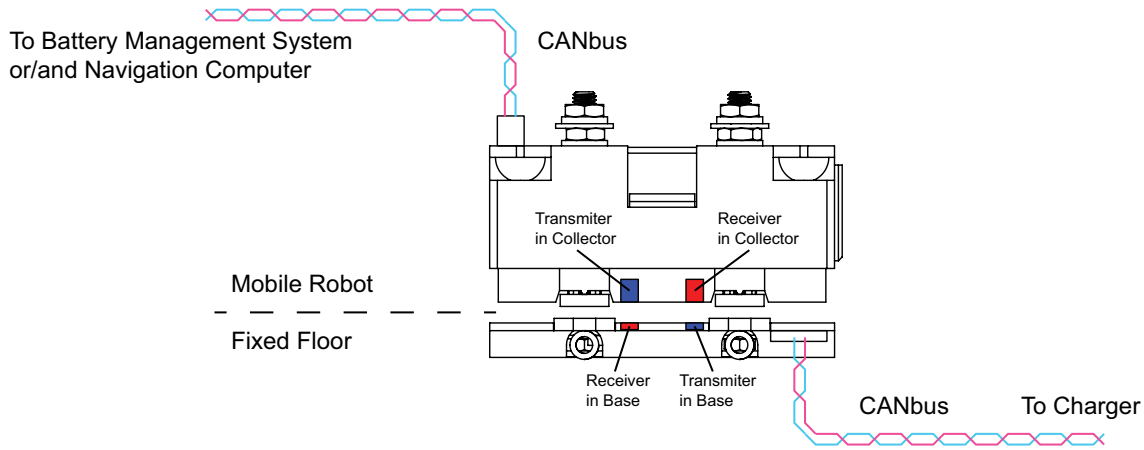


FIGURE 16. CANbus Transceiver for BMS to Charger Communication

The RoboPads serve solely as transceivers on the bus; they do not interface with the bus or accept/respond to CAN commands. CAN signals are transmitted through the transceivers at their native bit rate, up to 125 kbit/s, with a transmission range of 20mm.

An example application involves communication between the BMS and the Base charger, enabling current throttling based on the battery's State of Charge and/or temperature. For charge-only applications, the CAN version is fully compatible with the existing basic model of RoboPads.

Durable polycarbonate optical windows seal the optical sensors on both the Charging Base and Extensible Collectors to prevent dust and oil ingress. Electrical connections are made using industry-standard Molex Microfit connectors.

Please note that for proper operation, the transmitter of the collector must align with the receiver of the base, and the receiver of the collector must align with the transmitter of the base. Align the 'AB' marking on the collector with the 'AB' marking on the base

CAN-Enabled Collectors (Patent Pending)

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.

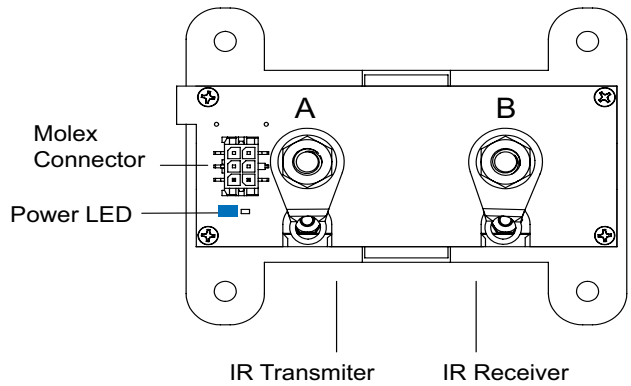


FIGURE 17. CAN-Enabled Collector Layout

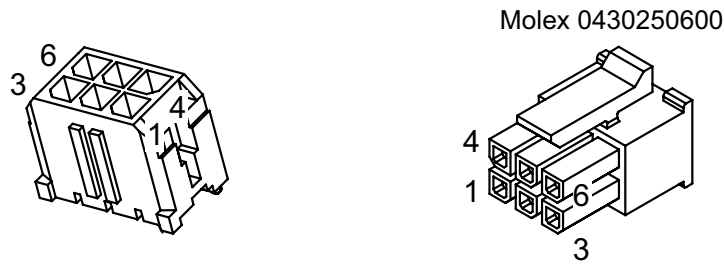


FIGURE 18. CAN-Enabled Collector Connector pins identification

TABLE 4. 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.

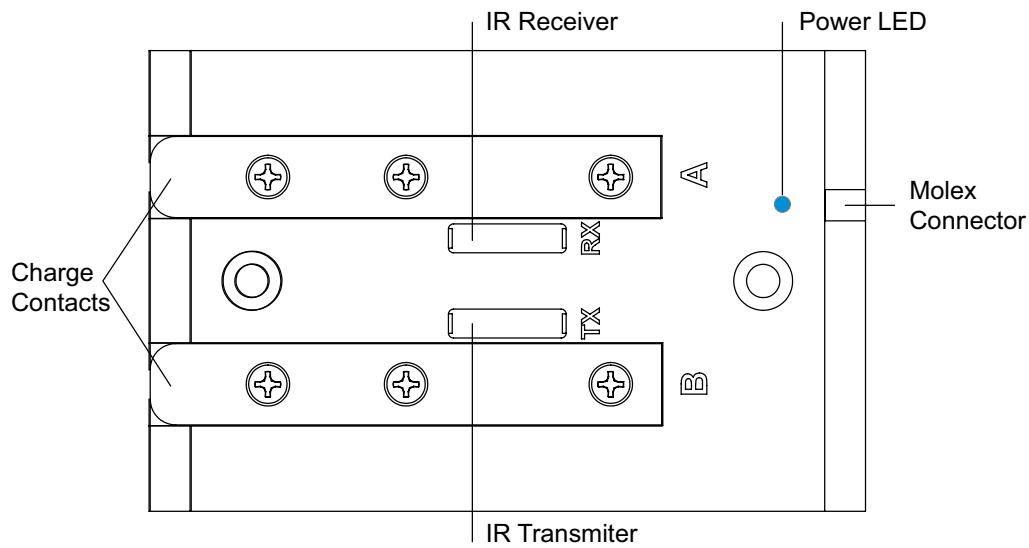


FIGURE 19. CAN-Enabled Base Layout

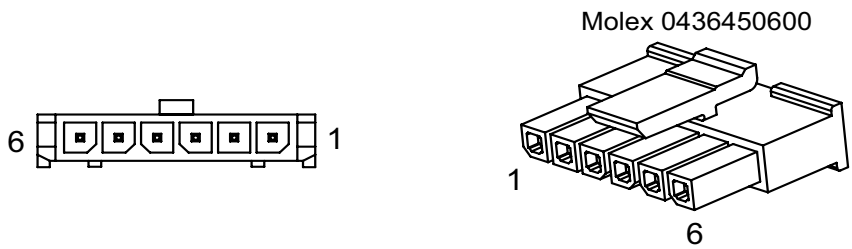


FIGURE 20. CAN and Hall Connector on Base

TABLE 5. 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.

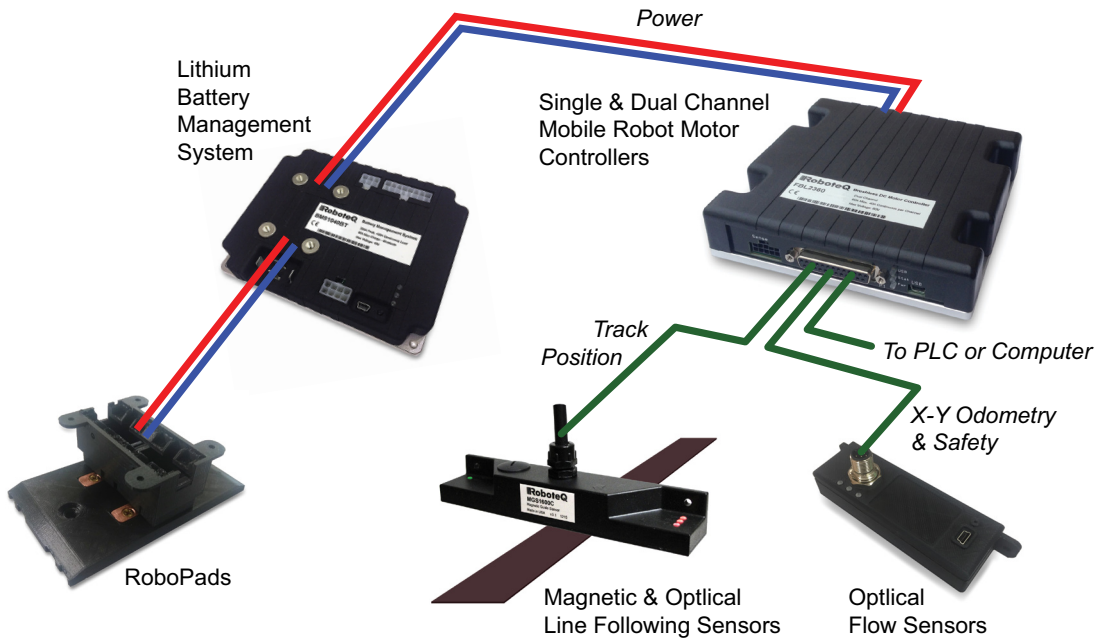


FIGURE 21. Roboteq's integrated product solution for Mobile Robots

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
Continuous Current	60 A
Current 80 sec on/60 sec off	75A
Current 30 sec on/60 sec off	100A
Current 10 sec on/60 sec off	120A
Voltage	75V 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	125kbit/s max

Mechanical Drawing

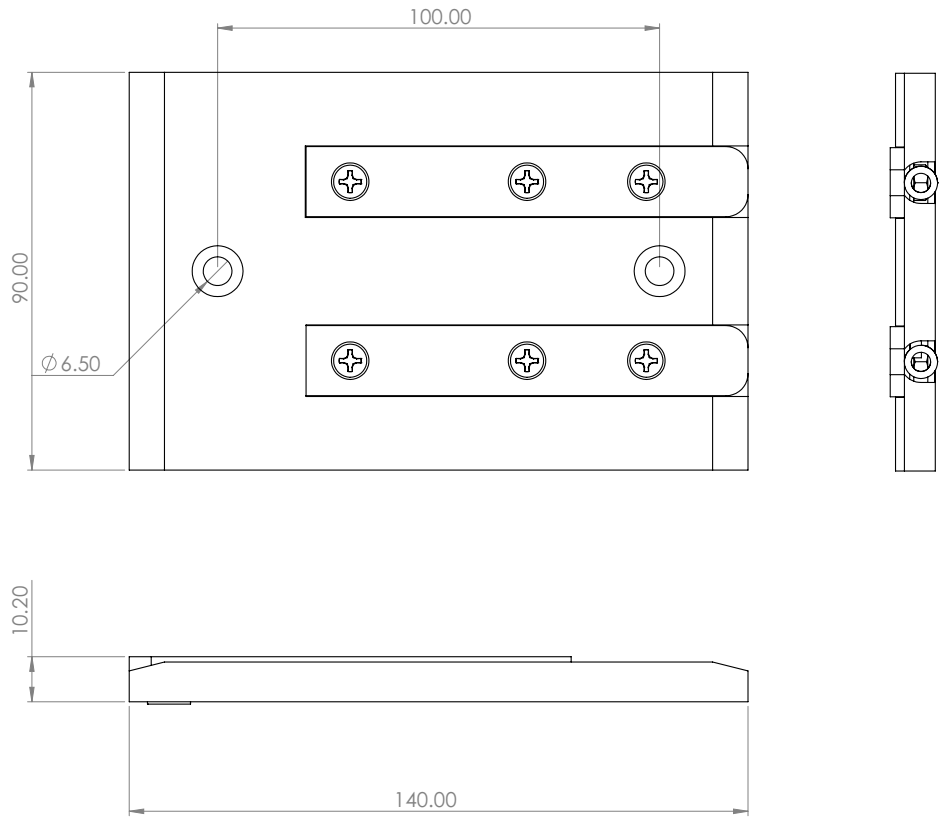


FIGURE 22. Base charge pads mechanical dimensions

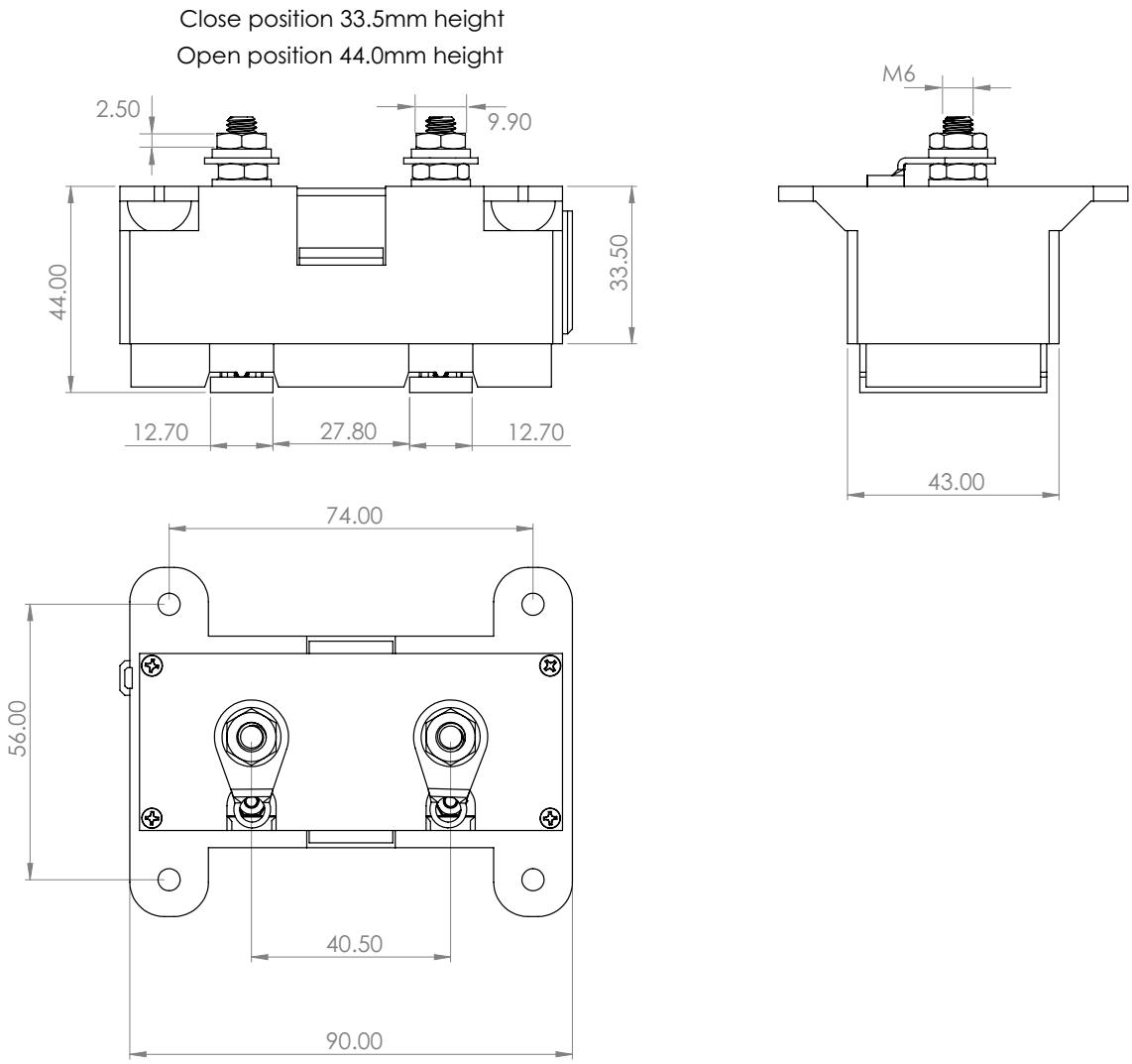


FIGURE 23. Collector charge pads mechanical dimensions