MP-250-DC

MOTREC

MAINTENANCE MANUAL

A GUIDE FOR PERFORMING MAINTENANCE AND REPAIRS ON MP-250

SERIAL NUMBER : 123 12 04 AND UP

UPDATED 28.06.2023
DESIGNED BY MOTREC INTERNATIONAL

MOTREC INTERNATIONAL INC.

5-YEAR LIMITED WARRANTY

FOR VEHICLES PRODUCED AFTER NOVEMBER 1, 2024

5-YEAR LIMITED WARRANTY ON AC-POWERED PRODUCTS, STOCK CHASERS AND TRAILERS

2-YEAR LIMITED WARRANTY ON DC OR IC POWERED PRODUCTS AND OTHER MOTREC PRODUCTS

Motrec warrants to the original purchaser that its products are free from defects in parts and workmanship.

STARTING DATE OF WARRANTY. The present terms and conditions of the Motrec Limited Warranty apply to new Motrec products only and do not replace any pre-existing warranty. The warranty period is effective from the date the purchaser receives the product, provided it is registered within ninety (90) days of reception and in conformity with Motrec's registration process.

REGISTRATION. IMPORTANT **:** AIMPORTANT: AS A PURCHASER OF A MOTREC PRODUCT, IT IS IMPORTANT THAT YOUR PRODUCT BE REGISTERED UNDER YOUR NAME AS REQUIRED BY MOTREC'S PRODUCT REGISTRATION PROCEDURE. PLEASE ASK YOUR MOTREC DEALER TO REGISTER YOUR PRODUCT. MOTREC'S LIMITED WARRANTY WILL BECOME EFFECTIVE AT THE TIME OF PRODUCT REGISTRATION. IF YOU DO NOT REGISTER YOUR PRODUCT, THE STARTING DATE OF YOUR MOTREC LIMITED WARRANTY WILL TAKE EFFECT ON THE DATE THE PRODUCT WAS DELIVERED TO YOUR MOTREC DEALER. IF YOU PURCHASED THE PRODUCT DIRECTLY FROM MOTREC AND NOT FROM A MOTREC DEALER, MOTREC HAS AUTOMATICALLY REGISTERED YOUR PRODUCT./

DEFECTS. Subject to the terms and conditions described below, parts, components, or accessories installed on the product by Motrec that fail under normal usage within the warranty period, and that are proven to be defective, will be repaired or replaced without charge for parts or labor unless stated otherwise herein. This is Motrec's sole liability under this Warranty. Motrec reserves the right to require that all parts or components claimed to be defective be returned for inspection and verification of defect. The purchaser is responsible for any and all shipping fees of any and all parts or components that it alleges to be defective.

WARRANTY SERVICES. All warranty services must be rendered by authorized Motrec distributors and approved in writing by Motrec prior to initiating any repairs or adjustments. All approved warranty services will be paid for based on standard rates established by Motrec. Rather than replace or repair parts or components, Motrec may, at its discretion, replace the product or refund a prorated amount of its purchase price (based on service time, wear and tear) upon return of the defective product.

AUTHORIZATION PROCESS. No product shall be returned to Motrec without its prior authorization. All warranty claims must be disclosed to Motrec or its authorized distributor as soon as the purchaser is aware of a suspected defect or any event susceptible to give rise to a claim under the Motrec Limited Warranty. All claims must be processed through an authorized Motrec distributor using the warranty claim procedure approved by Motrec.

THE ABOVE TERMS AND CONDITIONS REPRESENT THE ONLY REPRESENTATIONS MADE BY MOTREC IN RELATION TO ITS PRODUCTS. MOTREC DOES NOT PROVIDE ANY OTHER PARTICULAR WARRANTY TO THE USER OF ITS PRODUCTS. MOTREC DOES NOT MAKE ANY EXPRESS OR IMPLIED WARRANTIES OR REPRESENTATION WITH RESPECT TO ANY RESULT, PERFORMANCE OR DURABILITY EXPECTED FROM THE USE OF ANY OF ITS PRODUCTS. MOTREC EXCLUDES AND DECLINES ANY OTHER WARRANTY OF SUITABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE WOULD THEY BE PROVIDED BY LAW, BY CONTRACT OR OTHERWISE.

PRODUCT MODIFICATIONS ARE PROHIBITED. Motrec prohibits and disclaims all liability for any modification made to the product, including but not limited to, modifications that are susceptible to altering the weight distribution and stability of the product, increasing its speed or affecting its safety. Such modifications can cause serious personal injury or property damage, which Motrec disclaims and excludes all responsibility. It is the purchaser's responsibility to ensure that any technicians servicing the product are properly trained as required by OSHA (Occupational Safety and Health Administration: https://www.osha.gov/) and ANSI-B56 (American National Standards Institute: https://webstore. ansi.org/default.aspx). Service technicians shall read, understand and follow the instructions in the Motrec Owner's Manual before servicing the product. Only qualified and authorized personnel shall be permitted to maintain, repair, adjust and inspect the product.

TRAINING. It is the purchaser's responsibility to ensure that the driver or any person operating, using, maintaining or handling the product (or its accessories) is properly trained and instructed on the product's safety features and operation, including its stability. Operators shall read, understand and follow the safety and operating instructions in the Motrec Owner's Manual before driving the vehicle. Operators shall not be permitted to operate the product unless complete and adequate training has been provided by the purchaser. Driving an electric vehicle constitutes a hazard. The driver is responsible for the control of the product while driving and must always evaluate all unusual situations that he or she may encounter while driving. The driver assumes the inherent hazards related to this activity. Motrec products are designed for off-road use only.

EXCLUSION OF LIABILITY. Motrec disclaims any liability for incidental or consequential damages, including, but not limited to, personal injury or property damage arising from misuse of the product, lack of maintenance or any defect in the vehicle.

UNDER NO CIRCUMSTANCE WILL MOTREC BE LIABLE FOR ANY DAMAGE, WHETHER DIRECT, INDIRECT OR OTHERWISE, RESULTING FROM THE USE OF ITS PRODUCTS, EVEN IF MOTREC OR ONE OF ITS REPRESENTATIVES WAS AWARE OF THE POSSIBILITY OF SUCH DAMAGE. ANY LIABILITY FOR LATENT DEFECT IS LIMITED TO THE PRICE OF THE PRODUCT.

MOTREC INTERNATIONAL INC.

5-YEAR LIMITED WARRANTY

FOR VEHICLES PRODUCED AFTER NOVEMBER 1, 2024

1. Definitions

"*Product*": the complete electrical vehicle manufactured and/or assembled by Motrec, including its parts, components and accessories installed by Motrec.

"*Purchaser*": The party in whose name the product is originally registered at the time of purchase pursuant to the product registration procedure maintained by Motrec at that time, either: (a) the party to whom Motrec sold the product, if that party purchased the product for its own use, or (b) the customer of a Motrec dealer, who bought the product directly from such dealer.

2. Warranty Period

Your Motrec product is covered by the Motrec Limited Warranty for a period of five (5) years or **5,000 hours** of use, whichever comes first. This period of three (3) years starts on the date the product is registered, as mentioned hereinabove. This coverage does not apply to wearable parts, normal use or abusive usage of the product.

3. Warranty Registration

The warranty registration must be completed within ninety (90) days of purchase of the product. If registration is not completed within this time, the warranty will begin on the date the product was delivered. If you purchased the product from a Motrec dealer, please make sure the dealer has completed the registration. If you purchased the product directly from Motrec, Motrec has automatically registered your purchase.

4. Maintenance

Motrec requires that scheduled maintenance be performed at the times shown in the Owner's Manual. If this scheduled maintenance is not done and the product fails as a result of a failure to properly maintain it, repairs will not be covered under any warranty.

5. Warranty will be void if :

- The product has been modified in any manner not approved in writing by Motrec.
- The product has been overloaded beyond its rated capacity.
- The product's maximum speed has been increased.
- The product's motor controller parameters have been tampered without Motrec's authorization.
- The product has been used abusively
- (including, but not limited to improper use; twisted, bent, misaligned front or rear axles; any signs of abusive use).
- The product has been involved in an accident.
- The product has been transferred to a second owner without Motrec's authorization.
- The product has been used in extreme environments (including, but not limited to freezers, excessive moisture areas, corrosive environments, etc.).
- The product has had its serial number modified or altered.
- The product was not maintained as specified in the Motrec Owner's Manual.

6. The following items are not covered by the limited Motrec warranty :

- Batteries, charger, wheels
- Wearable parts (fuses, tires, wheel bearings, seats, brake pads and shoes)
- Wear and Tear resulting from normal use
- Adjustments, including field set-up
- Damage or defects caused by using non-Motrec parts, components, or accessories
- Shipping damage caused by freight carrier
- Shipping fees for warranty parts
- Travel fees for technical support and repair

FOREWORD

WELCOME

MOTREC International Inc. has built a rock-solid reputation as a world-class designer and manufacturer of electric industrial vehicles for the horizontal transportation of goods and people. We innovated, reimagined, engineered, and drove ourselves tirelessly to this preeminent position.
We also consistently exceeded customer expectations, which is why legions of satisfied customers worldwide have been driving MOTREC since 1988.

INTELLECTUAL PROPERTY

MOTREC INFORMATION

• Find us :
4685 Portland Boulevard, Sherbrooke, QC J1L 0J1, Canada
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Fax : +1 (819) 846-3050
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ABOUT THE MANUAL

Make sure to read the manual in its entirety before operating or servicing the vehicle. Keep the manual close for reference when necessary. Do not discard the manual. If the vehicle is sold or transferred, provide this manual with it.
This manual is based on the latest available information at the time of publication.

MOTREC®

“AYONE CAN WORK WE PERFORM THAT’S MOTREC ”

-Motrec Tagline

CONTENTS

1. PREFACE

1.1. INTRODUCTION

Read Before Operating

Make sure to read and understand the content of this Maintenance Manual before operating or attempting maintenance on the vehicle. The present document provides a vehicle overview and safety information for the operator, passengers, and others, as well as a detailed list of the maintenance to be executed over the lifespan of the vehicle.

Keep this manual for future reference. If the vehicle is sold or transferred, provide this manual with the vehicle.

A list of quick maintenance references is included at the back of this document. These references are intended for an MP-250 experienced technician to accelerate the maintenance process. The Quick References should not be used by any untrained or inexperienced personnel.

The MP-250

The agile and versatile personnel carrier encompasses a range of impressive features. It includes a narrow deck, four wheels for enhanced stability on rough terrain, a powerful motor, a rugged automotive differential, and larger self-adjusting drum brakes. The all-steel unibody construction ensures durability, while the bolt-on front bumper and side bar protection provide added security. With an easy-to-access under-seat battery compartment and the ability to tow up to 6,000 lbs.*, it excels as a highly capable tow tractor. The extensive list of features makes this personnel carrier an ideal choice for various applications.

Modular Design

The MP-250 boasts a versatile and highly adaptable modular design. With customizable chassis and frame options, it can accommodate various load capacities and applications. The battery system is modular, allowing for different configurations based on range and power needs. The vehicle also offers modular attachments and accessories for quick adaptation to different cargo types. The control systems and electronics are designed with modularity in mind, enabling easy integration of advanced features and compatibility with various interfaces. This modular design enhances the MP-250's adaptability, functionality, and customization options, making it a reliable and efficient electric vehicle solution for diverse industry requirements. For more information on available configurations, please refer to the website www.motrec.com.

1.2. ACRONYMS AND ABBREVIATIONS

°C : Celsius
°F : Fahrenheit
ANSI : American National Standards Institute
AUX : Auxiliary
EMB : Electromagnetic Brake
ft : Feet
A : Amperes
HP : Horsepower
HPD : High Pedal Disable
Hz : Hertz
ITSDF :Industrial Truck Standards Development Foundation
kg : Kilogram
km/h : Kilometer per Hour
kW : Kilowatt
kWh : Kilowatt-Hour
lb : Pounds (Weight)
lbf : Pound (Force)
LED : Light Emitting Diode
m : Meter
mL : Milliliter
mm : Millimeter
N/A : Not Applicable
N·m : Newton Meter
OSHA :Occupational Safety and Health Administration
P/N : Part Number
PWM : Pulse Width Modulated
SOC : State of Charge
SRO : Static Return To Off
VAC/AC : Volts Alternating Current / Alternating Current
VDC/DC : Volts Direct Current / Direct Current

2. SAFETY INFORMATION

2.1 SAFETY SIGNAL WORDS AND SYMBOLS

Before operating the vehicle and reading the manual, it is important to familiarize yourself with the signal words and symbols that appear throughout the manual and on the vehicle. Understanding their meanings will help ensure safe and effective use of the vehicle.

WARNING

WARNING INDICATES A HAZARDOUS SITUATION WHICH, IF NOT AVOIDED, COULD RESULT IN SERIOUS INJURIES.

CAUTION

CAUTION INDICATES A SITUATION WHICH, IF NOT AVOIDED, COULD RESULT IN DAMAGE TO SOME EQUIPMENT.

NOTICE : Notice is used to address practices not related to personal injury.

2.2 SAFETY DECALS AND LABELS

WARNING

DECALS, MARKINGS, OR STICKERS MUST REMAIN UNALTERED AND READABLE AT ALL TIMES. REPLACE ANY UNREADABLE DECALS, MARKINGS OR STICKERS. FAILURE TO COMPLY COULD CAUSE SERIOUS INJURIES.

The vehicle contains numerous safety decals that provide essential information for both the operator and technicians. To view a complete list of all the decals, please refer to the **PARTS CATALOG**.

3. VEHICULE OVERVIEW

3.1. SPECIFICATIONS AND CONFIGURATIONS

The MP-250 specifications and configurations can vary depending on the specific model and year of the MP-250. For more information and the most up-to-date details, it is best to consult with Motrec directly or refer to our website www.motrec.com.

EQUIPMENT COMPARTMENTS:

Removing the deck at the back of the vehicle gives access to all the compartments containing the major systems of the vehicle. Refer to Figure 1 for more details.

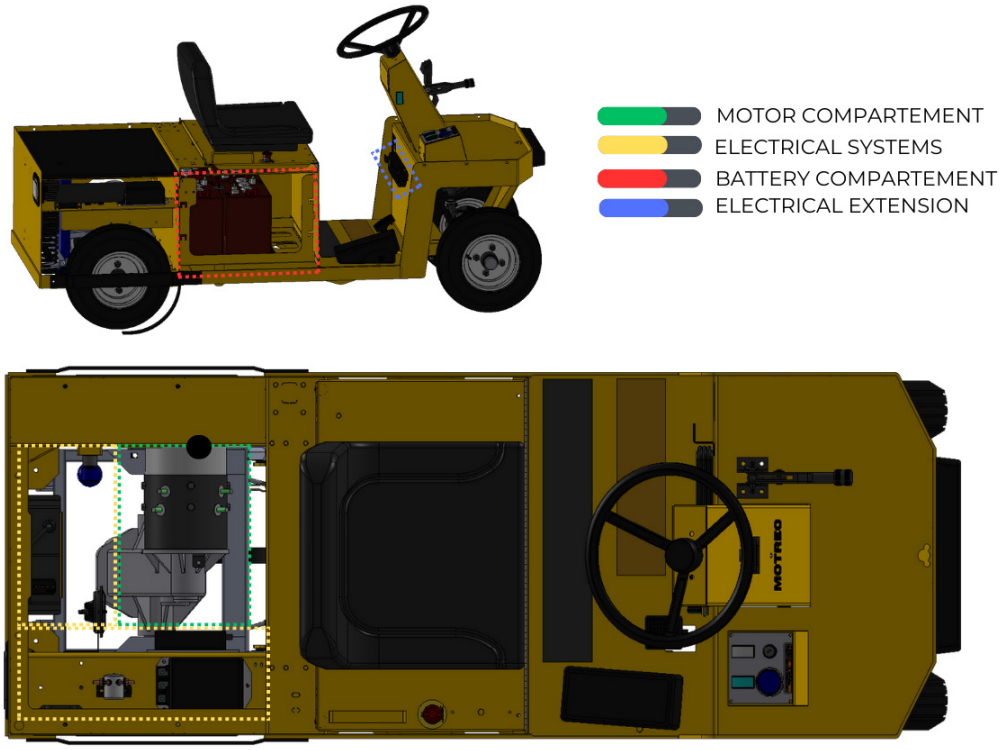


Figure 1. Equipment Compartments.

NOTE : The vehicle is equipped with an electrical extension wire for the charger conveniently located in the front, positioned within close proximity to the driver's knees, ensuring easy accessibility.

NOTE : To access the batteries located under the driver's seat, you simply need to lift the lid to the right of the driver.

3.2 BATTERY COMPARTMENT

CAUTION

DO NOT MODIFY THE BATTERY VOLTAGE OR REPLACE THE BATTERY CHARGER. THE INSTALLED BATTERY CHARGER IS SPECIFIC TO BATTERY VOLTAGE. FAILURE TO COMPLY CAN DAMAGE THE EQUIPMENT.

Depending on the configuration, the vehicle's total battery voltage can vary from 24 V to 36 V. The vehicle can be powered by multiple battery types, including:

- Flooded (lead-acid).
- TPPL (Thin Plate Pure Lead).
- GEL.
- AGM.

Standard battery Compartment :

This standard battery compartment is devoid of any mechanical components, allowing for easy removal of the batteries simply by lifting them out from the compartment. Additionally, depending on the number of battery boxes, you have the flexibility to choose between voltage options of 24V or 36V.

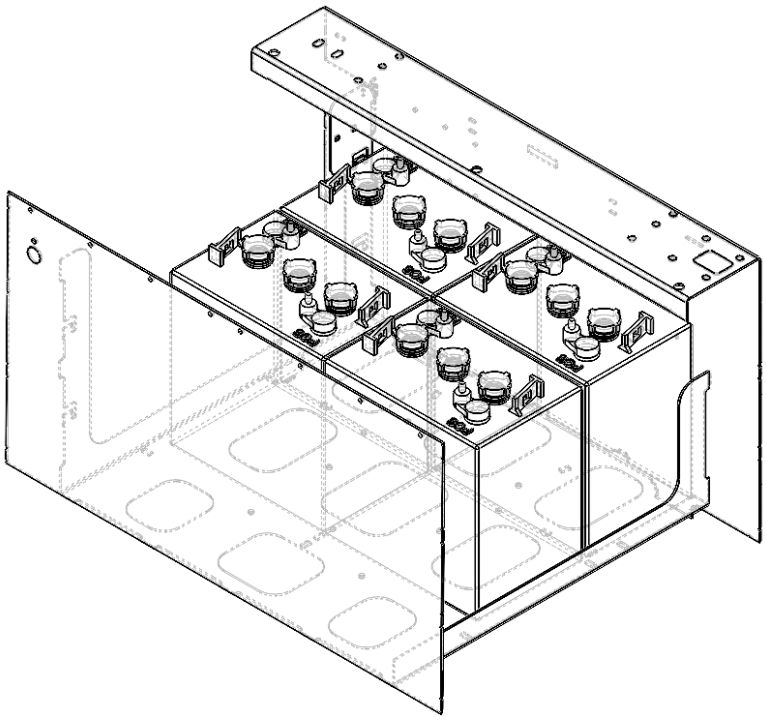


Figure 2. Standard Battery Compartment (24 V).

3.3 ELECTRICAL SYSTEMS

1 : BATTERY CHARGER
2 : DC/DC CONVERTER
3 : DC MOTOR CONTROLLER
4 : MAIN CONTACTOR
5 : HORN
6 : BACK UP ALARM

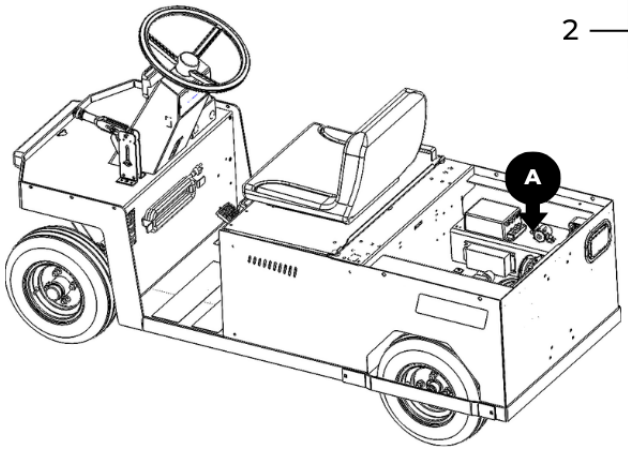


Figure 3. Electrical System Compartments.

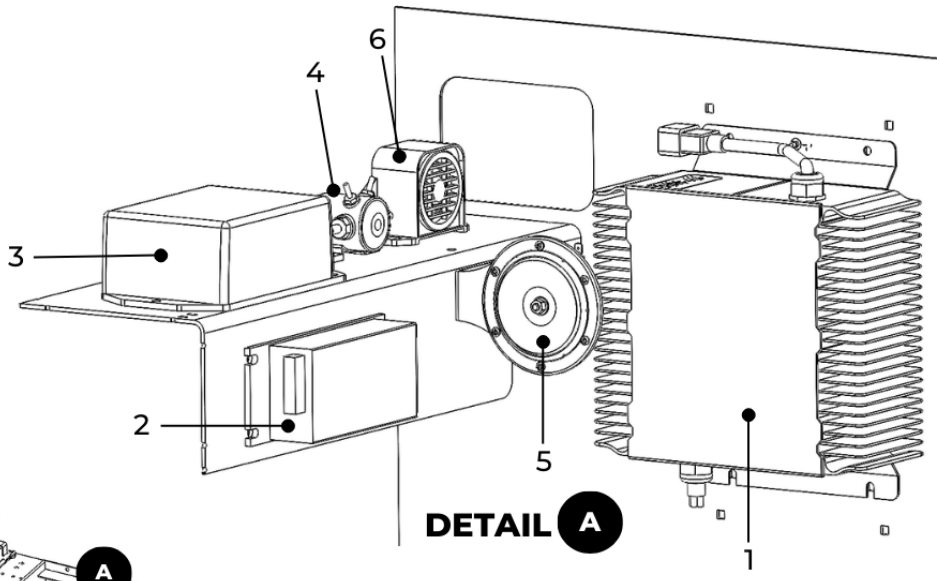


Figure 3. a. Electrical System Compartments Detail A.

This compartment receives the energy from the battery compartment and redistributes it to the different electrical systems of the vehicle. The energy systems can be divided into three categories:

-The Main Energy : which uses the full battery voltage to power various systems. The DC motor, in contrast to the AC motor, does not require voltage conversion by the AC motor controller since it operates on DC voltage.

- The Auxiliary Energy: which powers the different accessories of the vehicle (backup alarm, horn, console, etc.) (12V).
- The Charging Energy: which charges the batteries.

For connection details, refer to the vehicle's electrical schematic in section 5 Annexes.

NOTE: The vehicle's frame is not to be considered as a ground. No component is connected to the frame as a closed-circuit loop.

3.3.1 MAIN ENERGY

The main energy system encompasses all the elements responsible for the vehicle's movement, such as the DC motor, accelerator, seat switch and movement alarms, among others.

The energy flow starts from the batteries and passes through the master relay (battery solenoid) before reaching the DC motor controller. This controller utilizes the DC voltage to provide power to various components without the need for voltage conversion, as the DC voltage directly drives the DC motor.

NOTE: The wiring remains the same, but the component placement may vary from one vehicle model to another.

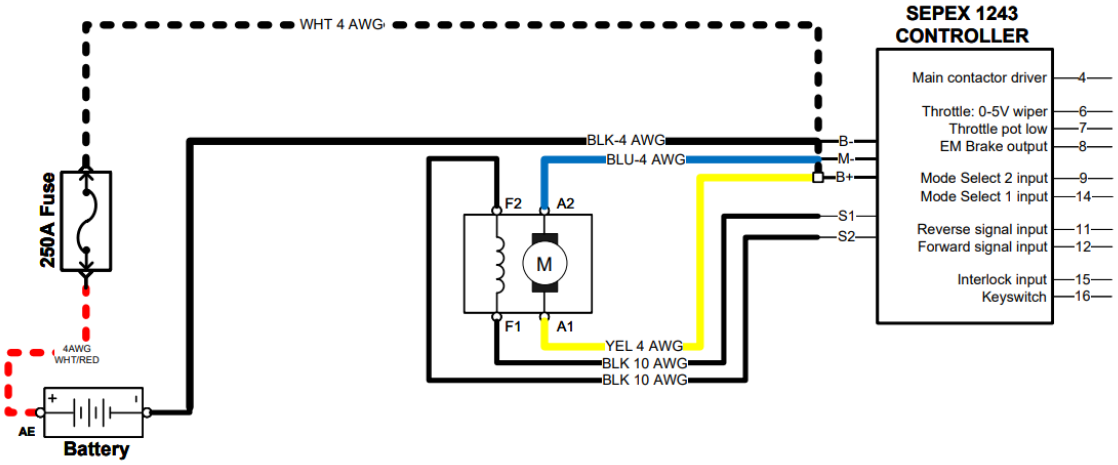


Figure 4. Main Energy Electrical connection (Annexe Section 5).

3.3.2 AUXILIARY ENERGY

To power the auxiliary systems of the vehicle, including the backup alarm, lights, horn, and others. This converter takes the battery voltage (24 or 36 VDC) and transforms it into an output of 12 VDC / 13.4 VDC. Subsequently, this voltage passes through the auxiliary fuse box and is distributed to the various accessories of the vehicle.

NOTE: The wiring remains the same, but the component placement may vary from one vehicle model to another.

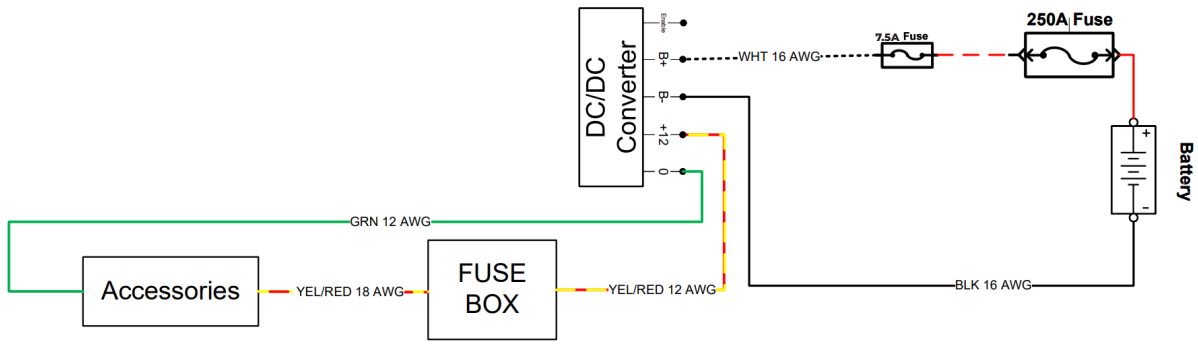


Figure 5. Auxiliary Energy Electrical connection (Annexe Section 5).

3.3.3 CHARGING ENERGY

NOTE: This section is applicable to all the vehicles equipped with onboard charging.

Certain configurations include a dedicated battery charger, designed to simplify the charging procedure. The installed charger is customized to match the specific battery voltage and type of the vehicle. The charger generates a voltage of either 24 or 36 VDC, depending on the particular configuration.

CAUTION

DO NOT MODIFY THE BATTERY VOLTAGE OR REPLACE THE BATTERY CHARGER. THE INSTALLED BATTERY CHARGER IS SPECIFIC TO BATTERY VOLTAGE. FAILURE TO COMPLY CAN DAMAGE THE EQUIPMENT.

For battery charging, the charger obtains voltage from an electrical extension wire and subsequently converts it to match the voltage required by the batteries. The converted current is then directed towards the batteries to initiate the charging process.

NOTE: The wiring remains the same, but the component placement may vary from one vehicle model to another.

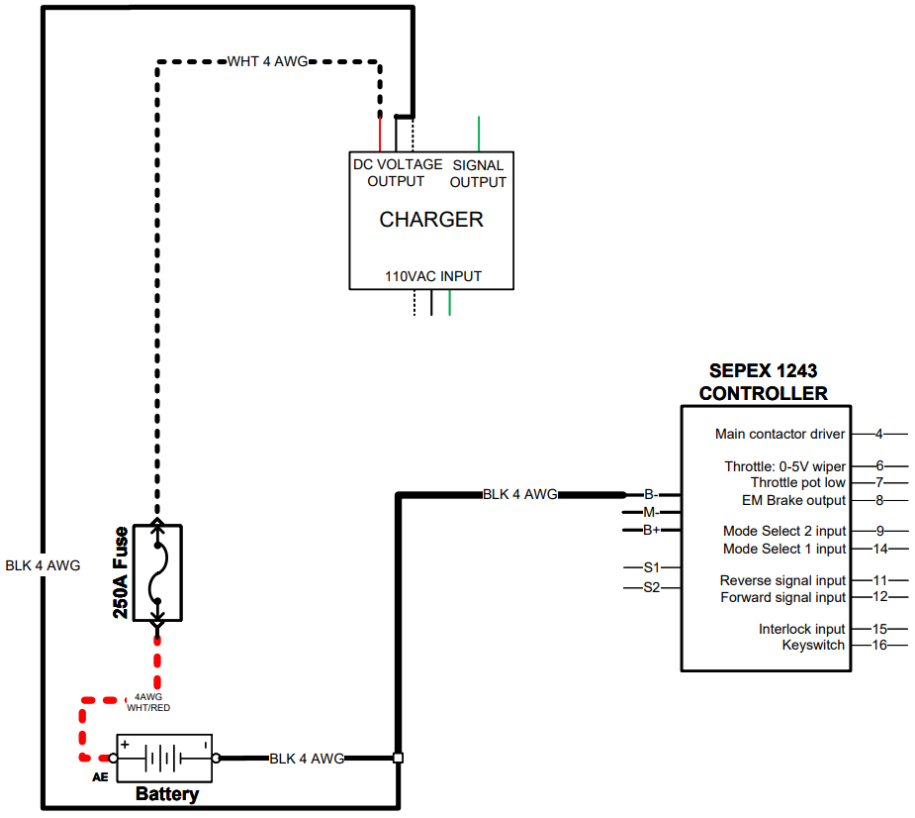


Figure 6. Charging Energy Electrical connection (Annexe Section 5).

3.4 MOTORS AND REAR AXLE

3.4.1 DC MOTORS

The DC motor integrated into the MP-250 electric vehicle brings several benefits, including precise speed control, high starting torque, and a compact size. With its efficient power delivery, this motor enables the vehicle to move effectively. Designed for reliable performance and durability, it meets the demands of diverse industrial and commercial applications. For more detailed information, please refer to section 3.3.1 MAIN ENERGY. Furthermore, the motor supports regenerative braking, allowing the vehicle to recover and repurpose energy during deceleration or braking. This feature significantly enhances energy efficiency and extends the overall driving range of the vehicle.

The DC motor, unlike the AC motor which offers two different casings, has a single casing that remains constant regardless of the vehicle's operating environment, called Fan cooled.

This motor is specifically designed to operate effectively in diverse environments. It features an integrated fan on its rotor, which efficiently draws air through the venting holes to enhance the motor's cooling capacity.

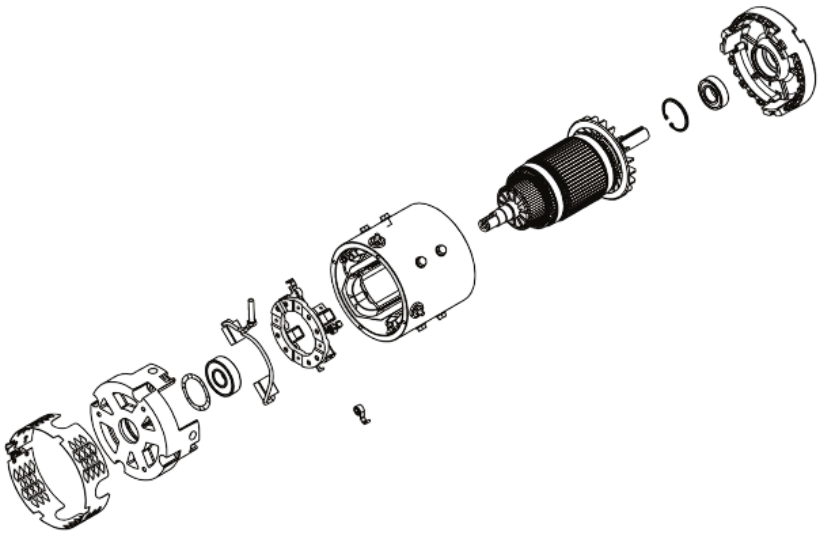


Figure 7. Fan Cooled DC Motor.

3.4.2 REGENERATIVE BRAKING

Regenerative braking for a DC motor involves modifying its operation to enable the recovery and reuse of energy during deceleration or braking. In regenerative braking mode, the DC motor in the vehicle's propulsion system reverses its operation and acts as a generator. The rotational energy of the wheels and drivetrain is harnessed to drive the motor as a generator instead of consuming power.

There are two distinct states of regenerative braking:

1. Coasting: Regenerative braking is engaged when the accelerator pedal is released, allowing the vehicle to slow down naturally. During this state, the motor acts as a resistance, converting the vehicle's kinetic energy into electrical energy, which is then fed back into the batteries.
2. Electrical Braking Assistance: Regenerative braking is activated when the brake pedal is depressed. In this state, regenerative braking provides additional assistance to the mechanical brakes, enhancing the overall braking performance of the vehicle. The motor's resistance aids in slowing down the vehicle while simultaneously generating electricity to recharge the batteries.

⚠ WARNING

ALL VEHICLE OPERATORS MUST BE NOTIFIED IF THE REGENERATIVE BRAKING'S DECELERATION LEVEL IS MODIFIED. FAILURE TO COMPLY CAN CAUSE INJURY OR DAMAGE TO THE EQUIPMENT.

It is important to note that modifying the behavior of regenerative braking in a DC motor requires expertise in motor control systems, power electronics, and electrical engineering. Consulting with professionals or specialists in the field is recommended to ensure safe and effective modifications.

3.5 ACCELERATOR

When the driver presses the accelerator pedal, the potentiometer (1) detects the change in position due to the gear mechanism (2,3) rotation, it generates a voltage signal proportional to the pedal position and sends that voltage signal to the controller. The DC motor controller then adjusts the electric current delivered to the motor according to the power demand, thereby increasing its output power and causing the vehicle to accelerate. A micro switch (4) in the accelerator pedal is also responsible for translating the movement of the pedal into an electrical signal that controls the engine's power output, contributing to the responsiveness and control of the vehicle's acceleration.

NOTE: By removing the accelerator pedal cover, all components become accessible for changes or maintenance.

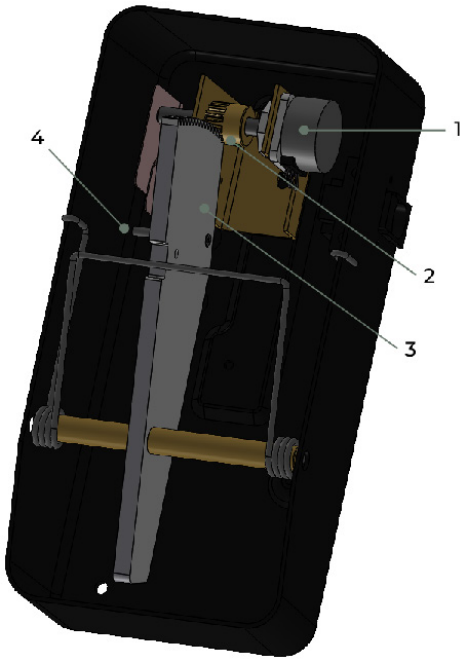


Figure 8. Accelerator system.

3.6 BRAKE SYSTEM

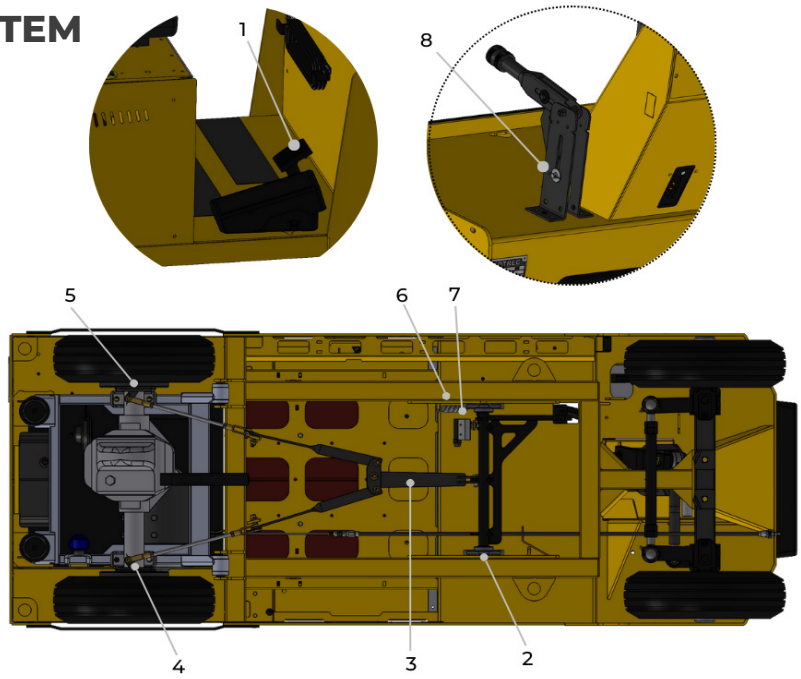


Figure 9. Brake System.

When the driver presses the brake pedal (1), the assembly rotates around the flange bearings (2), pushing the mechanical brake kit forward (3), therefore the rotational force causes the brake shoes to move outward. As the brake shoes (4) move outward, the friction linings on the shoes come into contact with the inner surface of the drum brake (5), creating friction which slows down the rotation of the wheel or stop the movement of the vehicle. Once released, the return springs (6) retract the brake kit (3) in a backward motion. The brake shoes (4), equipped with separate springs, are then brought back to their initial resting position. This action creates a gap between the shoes and the drum (5), restoring the system to its original state and enabling the wheel to rotate freely..

When the accelerator pedal is released, the controller activates the regenerative braking system in the “coasting” state. This utilizes the electrical current generated by the rotating motor armature to decelerate the vehicle and recharge the batteries. When the brake pedal is pressed, the controller activates the “braking” state of regenerative braking, further reducing the vehicle’s speed. This optimizes energy recovery during deceleration and minimizes wear on the traditional braking system, maximizing overall efficiency.

NOTE: Refer to *TECHNICAL TRAINING* on the dealer portal for more information on regenerative braking and its settings. (DC ragan training to be done)

A brake switch (7) is typically located near the brake pedal assembly, near the mechanical brake kit. The proximity of the brake switch to the mechanical brake kit allows for the direct mechanical interaction required to detect the engagement or disengagement of the brakes. When the brakes are not engaged, the switch is in its default position, indicating that the brakes are not activated. As soon as the brake pedal is pressed, it activates the brake lights and signaling to other drivers that the vehicle is slowing down, moving backwards or coming to a stop.

The MP-250 model also comes with a handbrake (8) also called parking brake (shown above) usually located in the front, on the left side of the driver, it is used to keep the vehicle stationary and prevent it from moving.

3.7 STEERING SYSTEM

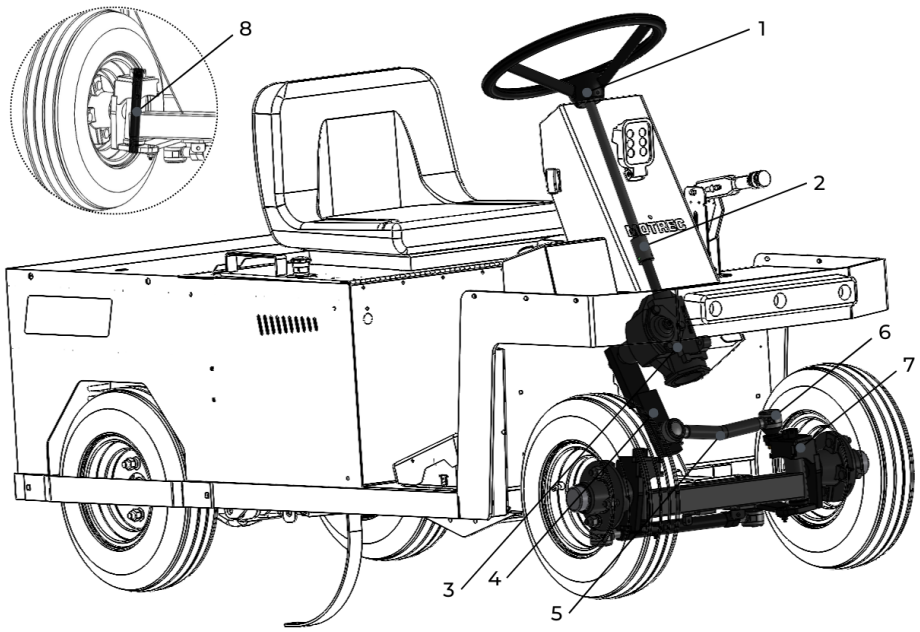


Figure 10. Steering System.

When the driver turns the steering wheel (1), the rotational force is transmitted through the coupler (2) to the steering box (3). The steering box amplifies and converts the rotational input into linear motion through the pitman arm (4). The pitman arm (4), in turn, moves the tie rods (5), causing the front wheels to turn via tie rods ends (6), spindles (7) and king pins (8). This coordinated action allows for precise steering control and directional changes in the vehicle.

The standard steering system is entirely mechanical and devoid of any electrical or hydraulic elements. It relies solely on mechanical linkages and mechanisms to enable steering control without the assistance of advanced technologies.

3.8 SUSPENSION SYSTEM

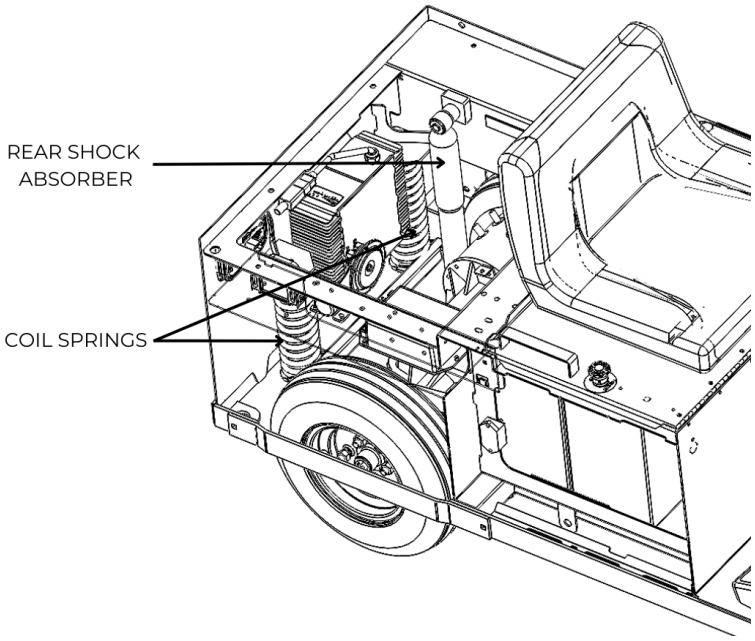


Figure 11. Suspension System.

The suspension system features two coil springs in the back. These springs are designed to absorb and distribute the impact from road imperfections and bumps. When the vehicle encounters an uneven surface, the coil springs compress and absorb the energy, helping to cushion the ride.

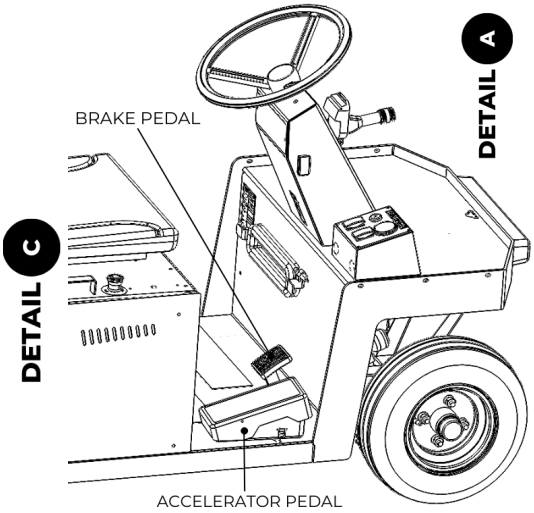
The rear shock absorber, also known as a damper, is connected between the vehicle's body and the suspension system. Its primary function is to control the oscillations of the coil springs. When the springs compress or rebound, the shock absorber helps regulate the rate at which these movements occur.

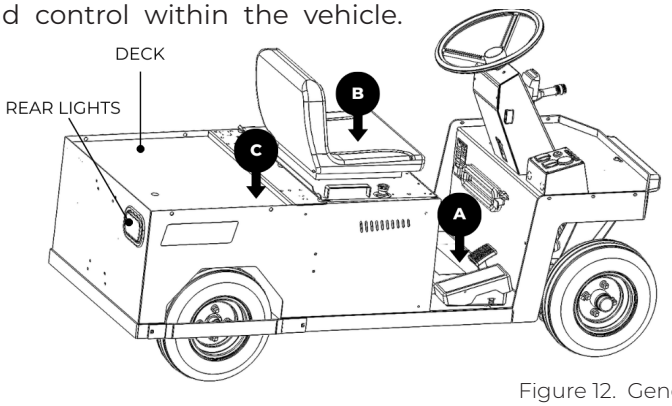
The suspension system with coil springs and shock absorbers provides several advantages. It enhances ride comfort by absorbing the impact from road irregularities, such as potholes or speed bumps. It also helps maintain tire contact with the road, improving traction, handling, and stability. Additionally, the suspension system contributes to vehicle safety by minimizing body roll during cornering and maintaining proper tire alignment. Another important function of the suspension system is to support the weight of the vehicle and its occupants. The coil springs in the back help bear the load and maintain proper ride height, preventing excessive sagging or bottoming out.

NOTE: The stiffness of a spring is highly dependent on the weight or load the vehicle carries.

3.9 GENERAL COMPONENTS

The electrical cables are carefully guided and routed beneath the vehicle. They follow the path provided by the frame, which acts as a designated cable tray. This routing ensures that the cables are neatly organized and protected from potential hazards or obstructions. Their ultimate destination is the console, where they connect to various electrical components, allowing for seamless operation and control within the vehicle.





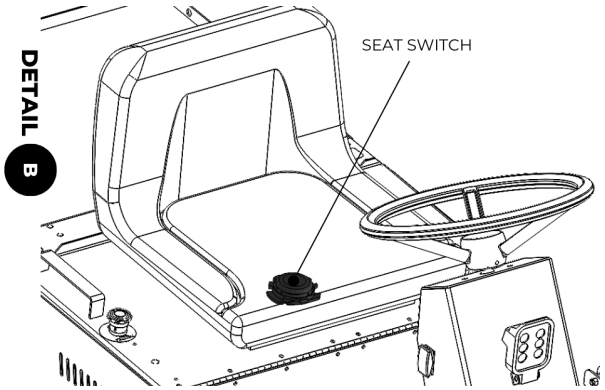


Figure 12. General Components.

Seat Switch

The seat switch installed in every driver's seat acts as a dead man's switch. The vehicle cannot be operated if the seat switch doesn't detect a pressure from the operator.

Figure 13. Circuit breaker.

Circuit breaker

It functions as a safety device that automatically interrupts the flow of electricity when it detects an overload or a fault in the circuit. Furthermore, it can be manually disconnected from power during maintenance or repairs.

Figure 14. Charging Indicator.

Battery charge indicator

The LED indicator will flash in accordance with the battery charge level. Its primary goal is to indicate the battery charge level to the operator during the charging process without needing to turn on the vehicle and look at the charge level on the display screen.

NOTE: The explanation of all the symbols on the battery discharge indicator can be found in section 5 Annexes section at the end of the document.

3.10 CONSOLE

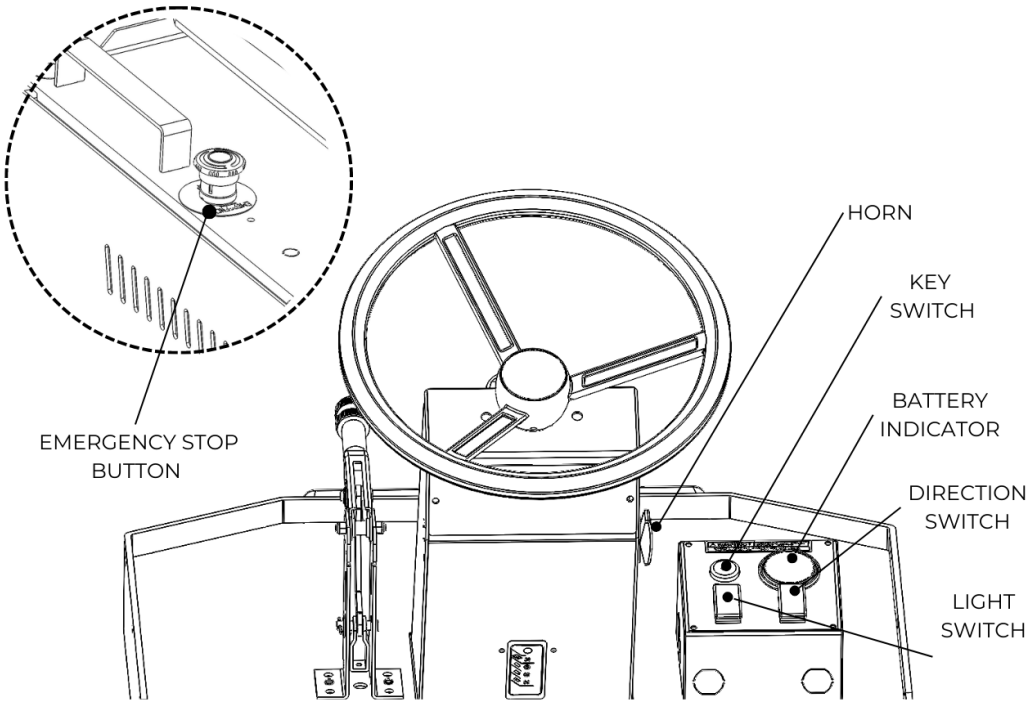


Figure 15. Console.

Direction Switch (Forward/Reverse)

This switch controls the motion direction of the vehicle:

- Pushing the top part sets the vehicle in forward drive.
- Putting the switch in the middle sets the vehicle in neutral.
- Pushing the bottom part sets the vehicle in reverse drive.

Key Switch

The key is used to engage or disengage the switch, allowing or preventing the flow of electricity or the operation of the associated device.

Battery Indicator

The battery indicator is a visual representation or a graphical element that provides information about the current battery level.

Emergency Stop Button

The emergency stop button, when present, should only be used in case of emergency.

CAUTION

DO NOT USE THE ENERGY STOP BUTTON TO TURN OFF THE VEHICLE. USE THE KEY SWITCH FOR NORMAL ON/OFF CONTROL. FAILURE TO COMPLY CAN DAMAGE THE EQUIPMENT.

Vehicle Speed

⚠ WARNING

NOTIFY AFTER THE MAXIMUM VEHICLE SPEED HAS BEEN MODIFIED. FAILURE TO COMPLY CAN CAUSE ACCIDENTS AND DAMAGE TO THE VEHICLE.

DC-powered vehicles using the Curtis controller have 4 drive modes built-in from the factory. All vehicles are set to DRIVE MODE 4 as a default (unless specified otherwise at time of sale).

- DRIVE MODE 1 will provide a 40% pulse width modulation (approximately 4 MPH).
- DRIVE MODE 2 will provide a 72% pulse width modulation (approximately 6 MPH).
- DRIVE MODE 3 will provide an 86% pulse width modulation (approximately 8 MPH).

SELECTING DRIVE MODE 1

To select DRIVE MODE 1: Cut both wires connected to pins 14 and 9 of the controller.

SELECTING DRIVE MODE 2

To select DRIVE MODE 2: Cut wire at pin 9 of controller (see blue selection Figure 16).

SELECTING DRIVE MODE 3

To select DRIVE MODE 3: Cut wire at pin 14 of controller (see orange selection in Figure 16).

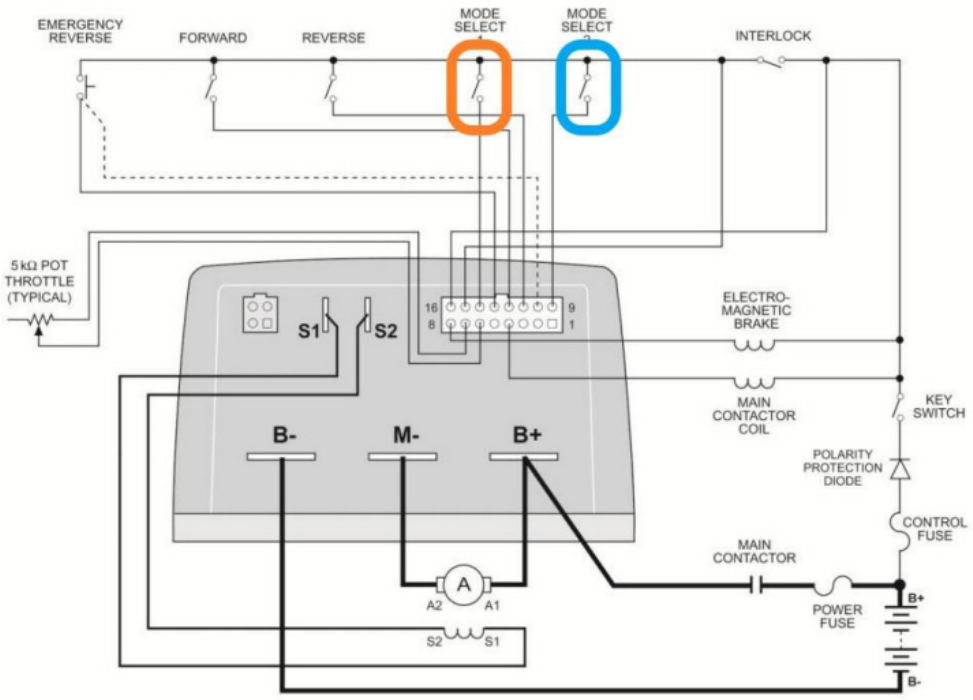


Figure 16. Drive Mode Selection.

3.11 FAULT CODE

3.11.1 FAULT CODE OVERVIEW

Each Motrec vehicle is equipped with a controller which relies on input signals, processes information and sends output commands. If a malfunction arises, the controller will emit a fault code, indicating it noticed an “out of parameters” situation. Fault codes are stored in the controller until they are erased. There are two kinds of fault codes:

1. ACTIVE fault codes indicate the controller “sees” the issue presently.
2. STORED fault codes indicate the controller “has seen” the issue and has recorded the fault. All codes are stored in the Fault History. Reading fault codes in section 5 Annexe should be your first step in diagnosing any issue.

3.11.2 FAULT CODE READING

There are 2 methods of reading fault codes on DC-powered vehicles:

1

CURTIS PROGRAMMER METHOD: (This is the preferred method) Connecting your Curtis handheld programmer will allow you to monitor and erase fault codes. Further diagnostics are also possible with the programmer.

2

STATUS LED METHOD: 2-digit fault codes will be “flashed” directly on the controller’s LED.

3.12 BACKLIGHT COLOR SIGNIFICATION

There are four available rear light colors in the vehicle, which are as follows:

1. White for Vehicle Reversing: White lights are used to indicate that a vehicle is moving in reverse. It serves as a signal to other road users that the vehicle is backing up.
2. Pale Red (Standard) for Vehicle Startup: When a vehicle starts up, a pale red light is typically illuminated. This light indicates that the vehicle is operational and serves as a general warning or notification.
3. Intense Red under Braking: When the vehicle applies the brakes, the pale red light increases in intensity. This brighter red light serves as a stronger warning to inform nearby drivers that the vehicle is slowing down or coming to a stop.
4. Orange for Turn Signal Activation (if applicable) : When the turn signal option is available in a vehicle, an orange light is activated. This light blinks or flashes to indicate the vehicle’s intention to change lanes or make a turn. It alerts other drivers of the upcoming maneuver.

These color signals are used to enhance safety and communication on the road.

4. MAINTENANCE

4.1 GENERAL INFORMATION

This section provides a general overview of the maintenance procedures for a standard MP-250 vehicle. While the images displayed may not match the exact product due to varying configurations and accessories, the maintenance steps outlined here are applicable to all MP-250 models as they cover the fundamental processes. If you have any maintenance-related questions specific to your product's features, please reach out to MOTREC for assistance.

Before undertaking any maintenance operations, except for daily and weekly preventive maintenance, it is recommended to remove any obstructing accessories installed on the deck or at the rear of the vehicle. This will facilitate the necessary manipulations and ensure smoother maintenance procedures.

WARNING

DO NOT MANIPULATE ELECTRICAL CONNECTIONS OR GENERATE SPARKS AROUND BATTERIES. SPARKS CAN CAUSE A BATTERY EXPLOSION AND ACID SPLASHING. DURING MAINTENANCE, ALWAYS DISCONNECT THE CHARGER AND USE INSULATED TOOLS THAT DO NOT GENERATE SPARKS. FAILURE TO COMPLY CAN CAUSE SERIOUS INJURIES.

WARNING

KEEP CLEAR FROM MOVING PARTS SUCH AS TIRES, SHEAVES, AND MOTOR. FAILURE TO COMPLY CAN CAUSE INJURIES.

WARNING

WHEN WORKING AROUND BATTERIES, ALWAYS WEAR ACID PROOF PROTECTIVE EQUIPMENT, SUCH AS FACE SHIELD AND THE APPROPRIATE GLOVES. BATTERIES CONTAIN SULFUR ACID THAT CAN CAUSE SEVERE BURNS ON SKIN OR EYES. RINCE CONTAMINATED AREA IMMEDIATELY WITH WATER.

CAUTION

ONLY QUALIFIED AND AUTHORIZED PERSONNEL ARE PERMITTED TO MAINTAIN, REPAIR, ADJUST, AND INSPECT THE VEHICLES AND THEIR BATTERIES. FAILURE TO COMPLY CAN LEAD TO DAMAGE TO THE EQUIPMENT.

CAUTION

USE TWO COUNTERACTING TOOLS, DOUBLE-WRENCH TECHNIQUE, WHEN DISCONNECTING OR TIGHTENING TERMINALS ON THE BATTERY OR THE DC MOTOR CONTROLLER. FAILURE TO COMPLY COULD CAUSE CRACKING OF THE TERMINAL OR BATTERY POST WELDS.

NOTICE Follow the maintenance instructions applicable to the type of repair, maintenance, or service.

NOTICE Before maintenance operations, inspect safety decals and labels. Replace if any damage is found and part of the text can't be read.

NOTICE Before replacing a fuse or circuit breaker, identify and repair the cause of failure.

4.1.1 LIFTING POINTS

Please refer to the serial data plate (see Figure 17), positioned on the left side of the console, to determine the total weight of the vehicle. It is important to note that the weight may differ based on the vehicle's specific configuration, accessories, and battery capacity.

When utilizing a lifting device, ensure that it can support the precise weight of the vehicle. The suggested lifting points are highlighted below (Figure 18) as a guide for safe and efficient lifting operations.

WARNING

BEFORE LIFTING, ALWAYS VALIDATE THAT THE LIFTING DEVICE CAN SUPPORT THE TOTAL WEIGHT OF THE VEHICLE, AS INDICATED ON THE VEHICLE'S SERIAL DATA PLATE. FAILURE TO COMPLY CAN LEAD TO SERIOUS INJURIES OR DEATH.

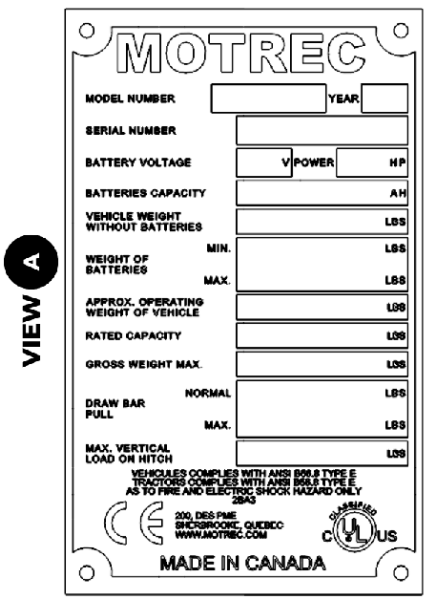


Figure 17. Serial Data Plate.

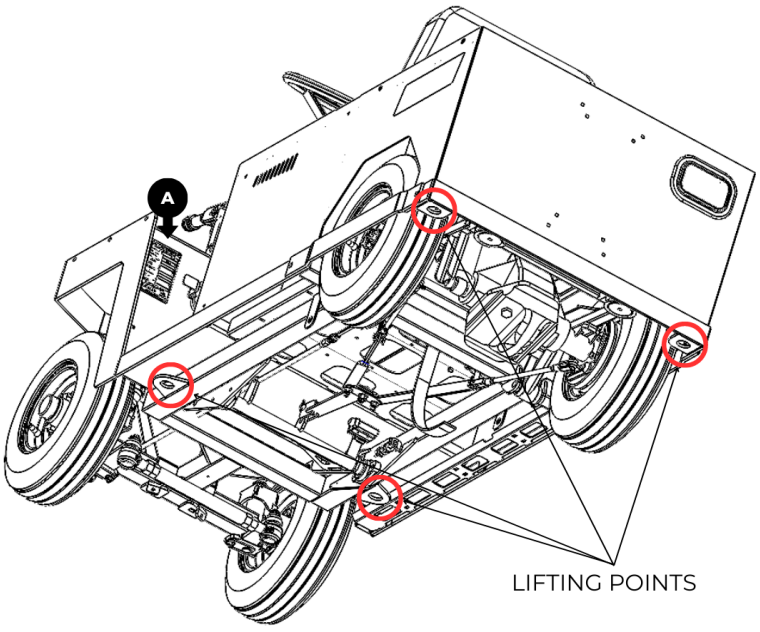


Figure 18. Lifting Points.

4.1.2 ELECTRICALLY ISOLATING THE VEHICLE

WARNING

WHEN WORKING AROUND BATTERIES, ALWAYS WEAR ACID PROOF PROTECTIVE EQUIPMENT, SUCH AS FACE SHIELD AND THE APPROPRIATE GLOVES. BATTERIES CONTAIN SULFUR ACID THAT CAN CAUSE SEVERE BURNS ON SKIN OR EYES. RINCE CONTAMINATED AREA IMMEDIATELY WITH WATER.

This procedure must be followed to isolate the vehicle from any electrical charge:

1. Remove the key.
2. Turn off all switches.
3. Disconnect the charger. It is crucial to verify that the charger is disconnected.

WARNING

DO NOT MANIPULATE ELECTRICAL CONNECTIONS OR GENERATE SPARKS AROUND BATTERIES. SPARKS CAN CAUSE A BATTERY EXPLOSION AND ACID SPLASHING. DURING MAINTENANCE, ALWAYS DISCONNECT THE CHARGER AND USE INSULATED TOOLS THAT DO NOT GENERATE SPARKS. FAILURE TO COMPLY CAN CAUSE SERIOUS INJURIES.

4. Lift the lid, to the right of the driver, to access the batteries located under the driver's seat.
5. Disconnect the battery pack according to the applicable configuration:

For lifting out the battery compartment:

5.1. Disconnect the negative (-) terminal (1) of the last battery.

5.2. Disconnect the positive (+) terminal (2) of the first battery.

6. To reconnect the electrical circuit, perform this procedure in reverse.

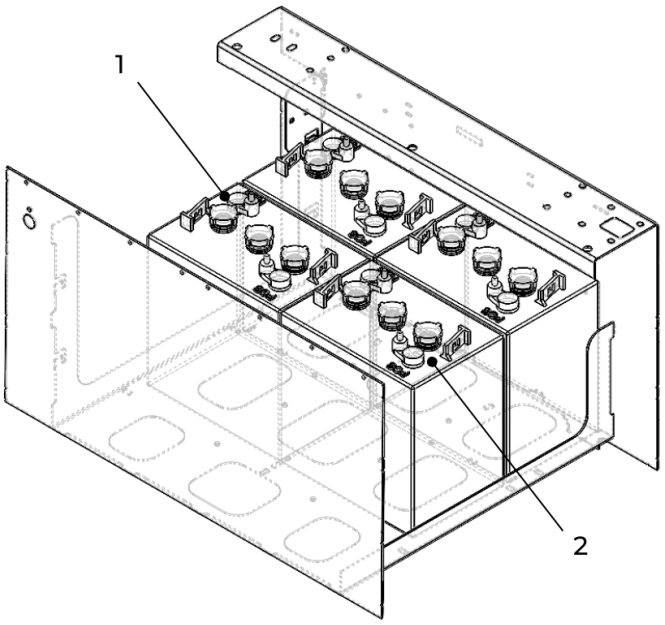


Figure 19. Electrical Isolation (Lift-out).

4.2 PREVENTIVE MAINTENANCE

⚠ WARNING

FOLLOW THE MAINTENANCE SCHEDULE PROVIDED IN THIS MANUAL. FAILURE TO COMPLY CAN LEAD TO INJURIES OR DAMAGE TO THE VEHICLE.

NOTICE

The preventive maintenance schedule specifies the minimum maintenance requirements based on standard use of the vehicle. An early preventive maintenance could be required if the vehicle is operated under severe conditions.

Preventive maintenance is essential for ensuring the durability of the product and the safety of the operator. Maintenance should be conducted at specific intervals (daily, weekly, 250 hours, 500 hours, 1000 hours, or 2000 hours), depending on the vehicle's runtime or the time elapsed, whichever occurs first. This proactive approach helps identify and address any potential issues before they escalate, contributing to the overall longevity and optimal performance of the product.

NOTE : The vehicle runtime (if applicable) is counted while the vehicle is in operation and won't be affected while the key is in the ON position and the vehicle is idle.

4.2.1 DAILY MAINTENANCE

Special Tools	Consumables
▸ N/A	▸ N/A

NOTICE Replace any defective component found during the inspection listed below.

Maintenance Procedures

Visible Damage Inspection

Inspect for excessive visible damage on the exterior of the vehicle or to components under the vehicle.

Fluid Leaks Inspection

A leak could come from the differential. The vehicle may be lifted for further inspection of this symptom as required.

Proceed as follows to inspect:

1. Remove the deck (1).

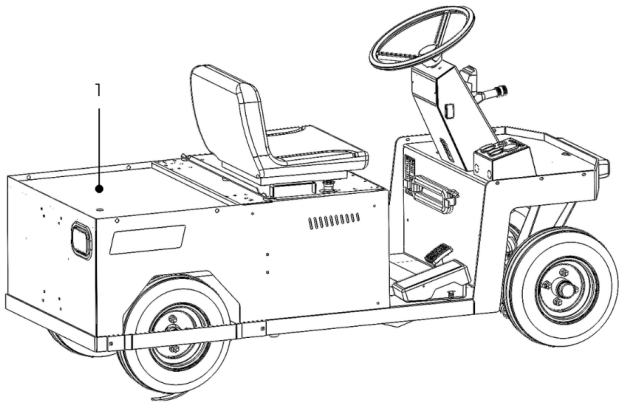


Figure 20. Deck Removal.

2. Inspect the drive assembly (2) for signs of leaks at following locations:
   - Covers.
   - Axle ends.
   - Casing mating surfaces.
   - Drain/fill plugs.

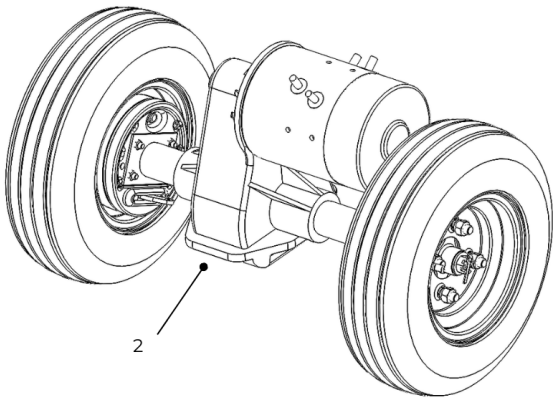


Figure 21. Drive Assembly Fluid Leaks.

3. Reinstall the deck (1).

Steering Inspection

Rock the steering wheel, inspect the steering system for hard steering, excessive play, or unusual sounds when turning.

1. If you notice excessive play in the gearbox while rocking the steering wheel, you should follow these steps:

   1.1. Begin by locating the adjusting screw (1) for the pitman shaft.

   1.2. Back off the lock nut (2) and adjusting screw (1) for the pitman shaft.

   1.3. Tighten the adjuster cap (3) until it requires 5-8 inch/lbs of force to rotate the input shaft.

   1.4. After setting the desired position, securely lock the large adjuster in place using the locknut.

   1.5. Ensure the gear is centered by aligning it to the neutral position.

   1.6. Gradually tighten the adjuster screw (1) for the pitman shaft while monitoring the resistance. It should require 10 to 18 inch pounds of force to rotate over the center tooth.

   1.7. Verify that both sides of the center position are easier to turn compared to the position of

1.7. Verify that both sides of the center position are easier to turn compared to the position of the adjuster cap (3).

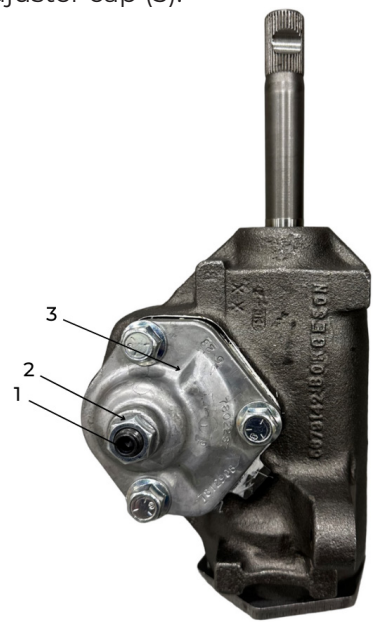


Figure 22. Assembly of pitman arm with the gearbox.

Horn and Lights Inspection

Inspect the correct operation of all lights, strobes, horn, and reverse alarm.

Seat Switch Inspection

1. Check that the seat switch is operational by sitting on the driver's seat and validating that no fault is generated on the display while sitting.

⚠ WARNING

DO NOT EXCEED SPEED OF 1 MPH (2 KM/H) WHEN TESTING THE SEAT SWITCH. THE ACTIVATION OF THE SEAT SWITCH WILL STOP THE VEHICLE SUDDENLY. FAILURE TO COMPLY CAN CAUSE INJURY.

2. Validate that the vehicle stops when removing all weight from driver's seat.

Parking Brake Inspection

1. Set the vehicle to neutral.
2. Engage the parking brake (handbrake).
3. Push the vehicle to validate that the parking brake is correctly engaged. The vehicle should not move.

Accelerator Pedal Inspection

1. Remove the accelerator pedal cover, so that all components become accessible.
2. Inspect visually the mechanical components, such as the accelerator pedal, brake pedal, potentiometer, and associated linkage or gears. Look for any signs of damage, excessive wear, or loose connections.
3. Check the potentiometer and ensure that it is securely attached and functioning correctly. Test the pedal movement and verify if the potentiometer signal changes smoothly and accurately.
4. Examine the mechanical gears that connect the pedals to the potentiometer and the vehicle's braking and acceleration systems. Look for any signs of wear, misalignment, or loose connections.
5. Check for smooth movement and any resistance or sticking points. Ensure that the pedal returns to its original position when released.

Brake Pedal Inspection

1. Test the pedal's ability to engage and disengage the braking system smoothly. Any inconsistencies or difficulty in brake pedal operation could indicate problems with the mechanical components or linkage.
2. Inspect the feel and travel of the brake pedal.

4.2.2 WEEKLY MAINTENANCE

Special Tools	Consumables
▸ N/A	▸ Distilled water

NOTICE Replace any defective component found during the inspection listed in this procedure.

Maintenance Procedures

Static Strap Inspection

Check the static strap (1) (if applicable) for signs of excessive wear and ensure it has an adequate length. When the vehicle is on its wheels and stationary, the strap should have a minimum of two inches in contact with the ground.

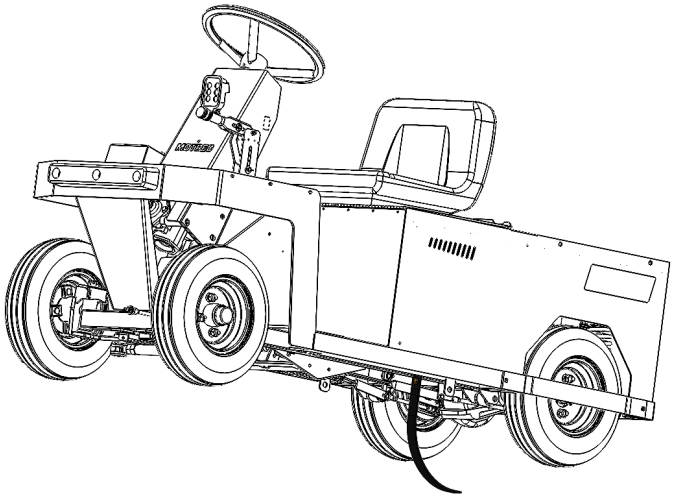


Figure 23. Static Strap.

Tire Pressure Inspection

Check that each tire maintains a pressure rating of approximately 60 psi (only if the tires are pneumatic). Additionally, thoroughly inspect the tires for any signs of punctures, damage or excessive wear.

Battery Electrolyte Inspection and Top-Up

WARNING

WHEN WORKING AROUND BATTERIES, ALWAYS WEAR ACID PROOF PROTECTIVE EQUIPMENT, SUCH AS FACE SHIELD AND THE APPROPRIATE GLOVES. BATTERIES CONTAIN SULFUR ACID THAT CAN CAUSE SEVERE BURNS ON SKIN OR EYES. RINCE CONTAMINATED AREA IMMEDIATELY WITH WATER.

NOTE: This inspection does not apply to sealed batteries.

1. Fully charge the batteries.

NOTE: When the batteries are charged, the fluid expands and can seep out if overfilled. Refill each cell after full charge when the fluid has expanded to its maximum level.

2. Disconnect the charger.

WARNING

DO NOT OPEN THE BATTERY COMPARTMENT BEFORE DISCONNECTING THE CHARGER. BATTERIES EMIT HIGHLY EXPLOSIVE GASES WHICH GREATLY INCREASE WHEN CHARGING. FAILURE TO COMPLY CAN CAUSE SERIOUS INJURIES.

3. Lift the lid, to the right of the driver, to access the batteries located under the driver's seat.
4. For each battery in the battery compartment, inspect and refill as necessary with distilled water to the recommended manufacturer level.
5. Lower the lid to conceal the batteries.

NOTE: Once the regular charging process is completed, it is recommended to disconnect the charger from the battery bank for approximately 10 seconds and then reconnect it. This step is crucial for performing the equalization charging. By briefly disconnecting and reconnecting the charger, you allow the charger to reassess the battery bank's condition and adjust the charging parameters accordingly. This helps distribute the charging current more evenly among the battery cells. Performing the equalizing charge regularly helps optimize the performance and longevity of the battery bank.

4.2.3 EVERY 250 HOURS OR 3 MONTHS MAINTENANCE

Special Tools	Consumables
▸ Lifting device	▸ Multi purpose grease ▸ Lubricant spray ▸ Compressed air

NOTICE Replace any defective component found during the inspection listed in this procedure.

NOTICE When required, lift the vehicle using a lifting device as per section 4.1.1 LIFTING POINTS.

Maintenance Preparation Steps

Before conducting any maintenance tasks, it is essential to follow the subsequent steps to ensure safety during maintenance and enable easy access to components.

1. Remove the deck (1).

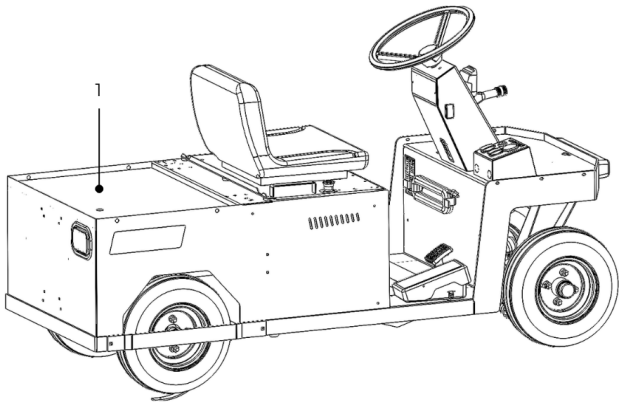


Figure 24. Deck Removal.

2. Remove the dashboard cover (2).

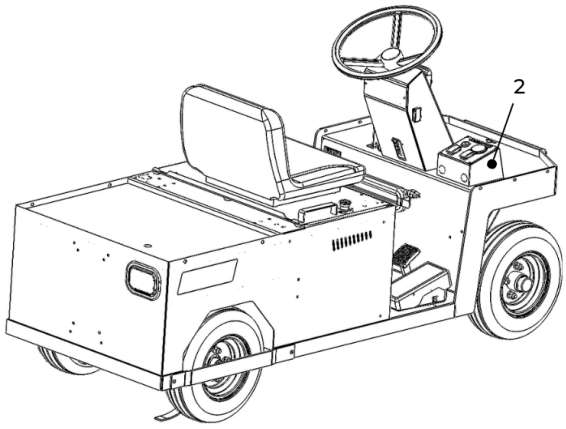


Figure 25. Dashboard Cover.

⚠ WARNING

DO NOT WORK ON ANY COMPONENTS OF THE ELECTRICAL SYSTEM UNTIL THE VEHICLE IS ELECTRICALLY ISOLATED. VOLTAGES OF UP TO 50 V AND HIGHER CAN BE PRESENT. FAILURE TO COMPLY CAN CAUSE INJURIES.

3. Take the necessary steps to remove electrical hazards in accordance with **Section 4.1.2**, which provides guidelines for electrically isolating the vehicle.

Maintenance Procedures

Suspension Inspection

1. Inspect visually the suspension components. Look for any signs of damage, corrosion, or leakage.
2. Inspect the coil springs (1) for any signs of wear or damage. Look for uneven spacing between the coils, as this could indicate a broken or weakened spring. Ensure that both coil springs (1) are properly seated and aligned.
3. Examine the rear shock absorber (2) for any oil leaks, damage, or excessive rust. Ensure that it is securely attached to the suspension and the vehicle frame. Test the rear shock absorber (2) by applying pressure and verifying that it provides resistance and rebounds smoothly.
4. Check the mounting points of the coil springs (1) and rear shock absorber (2).
5. Push down on the rear of the vehicle to test the suspension movement. It should respond smoothly, without any excessive bouncing or noise. Pay attention to any abnormal sounds, such as squeaks or rattles, which could indicate worn out components or loose connections.

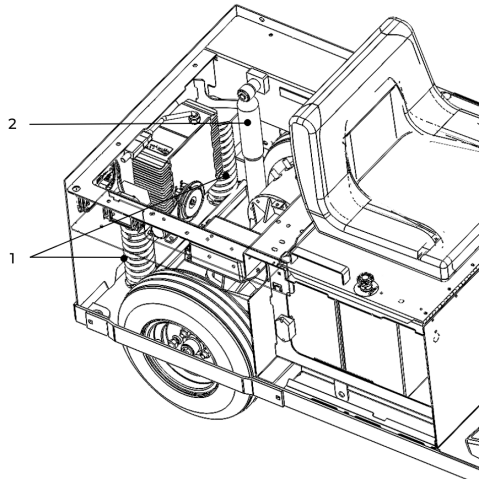


Figure 26. Rear Suspension Inspection.

Steering Inspection

1. Inspect the following elements for damage or corrosion:

- Steering wheel (1).
- Coupler (2).
- Steering gearbox (3).
- Pitman arm (4).
- Tie rods (5).
- Spindles (7).
- King pins (8).

2. Inspect the four tie rods ends (6) for:

- Play.
- Damage.
- Binding.
- Corrosion.

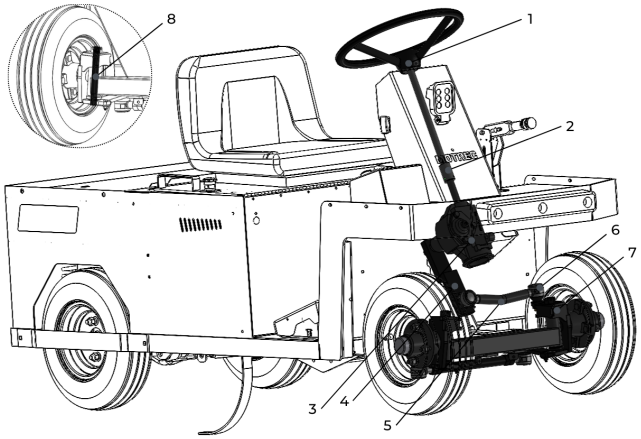


Figure 27. General Steering Inspection.

Grease Fittings Lubrication

Lubricate the grease fittings of the following components :

- The four tie rods ends (6) (see Figure 10).

Lubrication

Lubricate the following components :

- Mechanical Brake kit Linkage (3) (see Figure 9).

Maintenance Procedures

DC Motor Dusting

If the vehicle is equipped with the fan cooled DC motor (see Figure 28), clean the motor's air vents with compressed air.

NOTE: Clean any dust accumulation on other components if necessary.

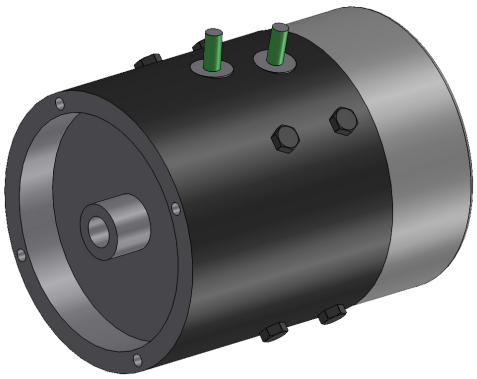


Figure 28. DC Motor.

Power Circuit Inspection

1. Inspect the power cables for visible damage.
2. Inspect the electrical connections for:
   - Corrosion.
   - Loose connections.

Battery Inspection

⚠ WARNING

WHEN WORKING AROUND BATTERIES, ALWAYS WEAR ACID PROOF PROTECTIVE EQUIPMENT, SUCH AS FACE SHIELD AND THE APPROPRIATE GLOVES. BATTERIES CONTAIN SULFURIC ACID THAT CAN CAUSE SEVERE BURNS ON SKIN OR EYES. RINCE CONTAMINATED AREA IMMEDIATELY WITH WATER.

1. Inspect the batteries for the following elements:
   - Loose connections.
   - Damaged cables.
   - Acid spill.
   - Loose terminal posts.
   - Corrosion.
   - Swelled casing.
2. If corrosion is present on battery posts:
   a. Remove the cable connectors.
   b. Use a wire brush to remove any particles.
   c. Clean the terminals with a suitable product.
   d. Reinstall the removed cables.

⚠ CAUTION

AFTER CLEANING, DO NOT REAPPLY POWER UNTIL TERMINAL AREAS ARE THOROUGHLY DRY. FAILURE TO COMPLY CAN DAMAGE THE VEHICLE.

Test Drive

After the maintenance is finished, it is necessary to reinstall any disassembled parts and conduct a thorough test on the vehicle to ensure that all systems are functioning correctly.

1. Reinstall the dashboard cover.
2. Reconnect the electrical circuit:
   i. Reconnect the battery leads.
   ii. Turn on all switches and test lights.
   iii. Insert the key.
3. Test drive the vehicle:
   i. Turn the steering wheel and feel for excessive play.
   ii. Listen for abnormal noise.
4. Reinstall the deck.

4.2.4 EVERY 500 HOURS OR 6 MONTHS MAINTENANCE

Special Tools	Consumables
▸ N/A	▸ Lubricant spray

NOTICE Replace any defective component found during the inspection listed in this procedure.

NOTICE When required, lift the vehicle using a lifting device as per section 4.1.1 LIFTING POINTS.

NOTICE The 250 hours or 3 months preventive maintenance should be carried out concurrently with this maintenance. Certain steps may not be necessary due to redundancy. Please consult the maintenance checklist in the QUICK REFERENCES section for the specific steps that are required.

Maintenance Preparation Steps

Before conducting any maintenance tasks, it is essential to follow the subsequent steps to ensure safety during maintenance and enable easy access to components.

1. Remove the deck (1)

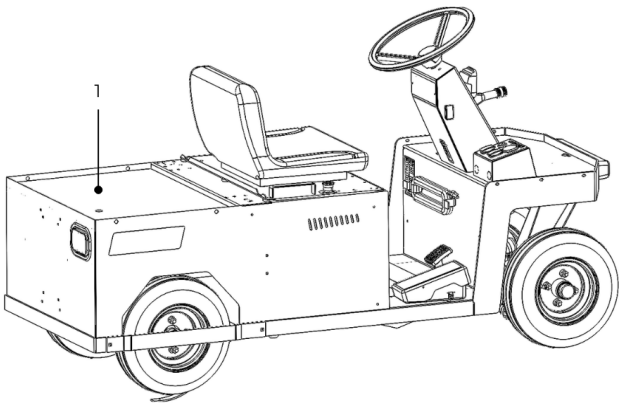


Figure 29. Deck Removal.

⚠ WARNING

DO NOT WORK ON ANY COMPONENTS OF THE ELECTRICAL SYSTEM UNTIL THE VEHICLE IS ELECTRICALLY ISOLATED. VOLTAGES OF UP TO 50 V AND HIGHER CAN BE PRESENT. FAILURE TO COMPLY CAN CAUSE INJURIES.

2. Take the necessary steps to remove electrical hazards in accordance with **Section 4.1.2**, which provides guidelines for electrically isolating the vehicle.

Maintenance Procedures

Decals and Labels Inspection

Inspect decals and safety labels for damage. Replace them if any part of the text is illegible.

Frame Inspection

1. Inspect the vehicle's frame for Cracks, damage or Corrosion.
2. The following frame locations should be inspected with care:
   - Side panels corners (1) (both sides). There is a possibility of cracks occurring in these corners as they undergo significant stress (see Figure 30).
   - Rear suspension mounting tabs (2) (see Figure 31).
   - Welds and Axle tube (see zone A in Figure 32).
   - Hitch mounting area (if applicable).

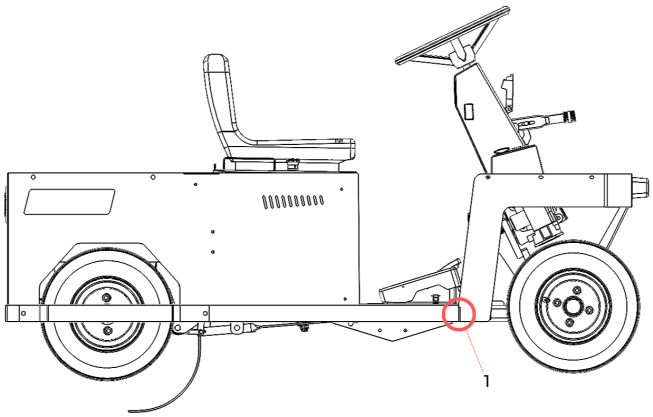


Figure 30. Side Panels.

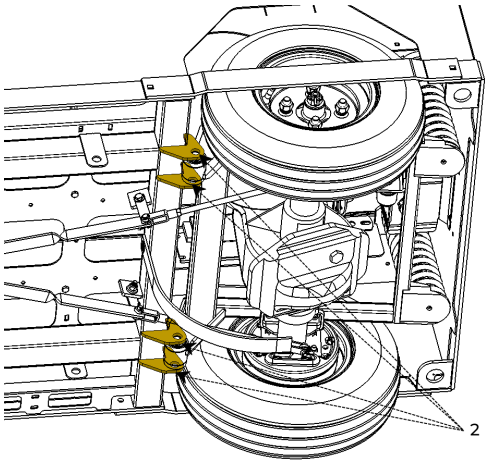


Figure 31. Rear Suspension Mounting Tabs.

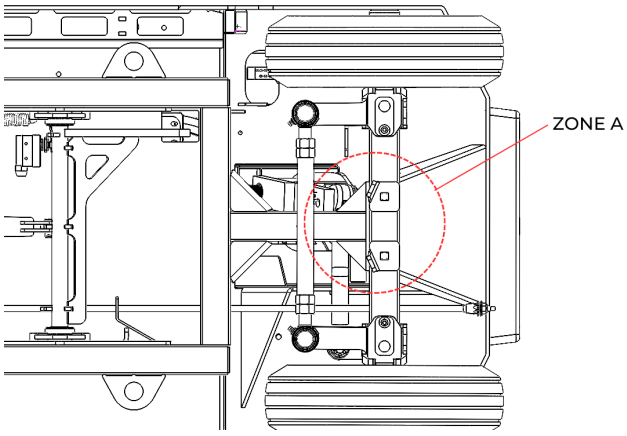


Figure 32. Zone A (Welds and Axle tube).

Drum Brakes Inspection

proceed as follows for each of the vehicle's drum brakes:

1. Remove the rear wheel guards (1).
2. Remove the wheel nuts (2).
3. Remove the wheel (3).
4. Remove the brake drum (4).
5. Clean brake dust with water.
6. Inspect the brake drum (4) for excessive wear or scoring.
7. Inspect the drum shoes. Replace the shoes and springs if the lining thickness is 1/16 in (2 mm) or less.
8. Inspect the brake system (5) for corrosion, wear, and brake dust.
9. Reinstall the brake drum (4), the wheel (3), and the wheel nuts (2).
10. Torque the wheel nuts (2) to standard values. The appropriate torque value is 80 ft lbs.

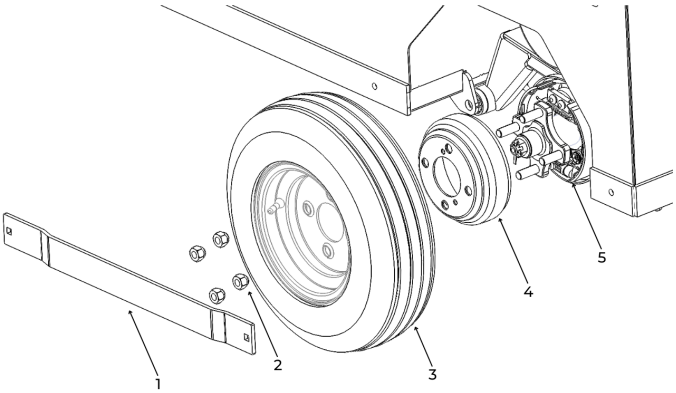


Figure 33. Drum Brakes Inspection.

Maintenance Procedures

Brake System Inspection

1. Inspect the following elements of the brake system for any signs of wear, corrosion, damage or looseness:
   - Brake pedal (1).
   - Two flange bearings (2).
   - Mechanical brake kit (3).

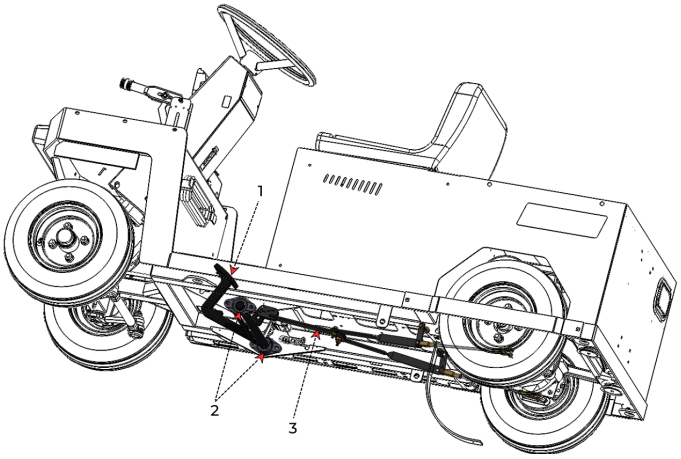


Figure 34. Brake System Inspection.

Test Drive

After the maintenance is finished, it is necessary to reinstall any disassembled parts and conduct a thorough test on the vehicle to ensure that all systems are functioning correctly.

1. Reconnect the electrical circuit:
   i. Reconnect the battery leads.
   ii. Turn on all switches and test lights.
   iii. Insert the key.
2. Test drive the vehicle:
   i. Turn the steering wheel and feel for excessive play.
   ii. Listen for abnormal noise.
3. Reinstall the deck.

4.2.5 EVERY 1000 HOURS OR 12 MONTHS MAINTENANCE

Special Tools	Consumables
▸ Lifting device ▸ Slings ▸ Oil recipient	▸ Differential oil: SAE 80W90 GL5 ▸ Molybdenum disulfide grease (6g) ▸ Lubricant spray ▸ Bearing grease ▸ Cotter pin (Size : 1/8x2 Front, 1/16x2 Rear)

NOTICE

When required, lift the vehicle using a lifting device as per section 4.1.1 LIFTING POINTS.

NOTICE

The 500 hours or 6 months preventive maintenance should be carried out concurrently with this maintenance. Certain steps may not be necessary due to redundancy. Please consult the maintenance checklist in the QUICK REFERENCES section for the specific steps that are required.

Maintenance Preparation Steps

Before conducting any maintenance tasks, it is essential to follow the subsequent steps to ensure safety during maintenance and enable easy access to components.

1. Remove the deck (1)

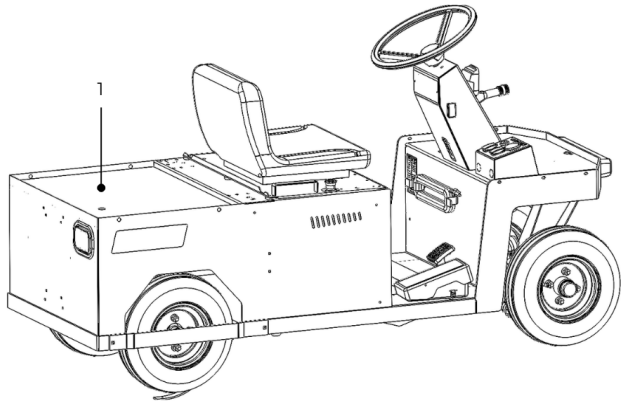


Figure 35. Deck Removal.

⚠ WARNING

DO NOT WORK ON ANY COMPONENTS OF THE ELECTRICAL SYSTEM UNTIL THE VEHICLE IS ELECTRICALLY ISOLATED. VOLTAGES OF UP TO 50 V AND HIGHER CAN BE PRESENT. FAILURE TO COMPLY CAN CAUSE INJURIES.

2. Take the necessary steps to remove electrical hazards in accordance with **Section 4.1.2**, which provides guidelines for electrically isolating the vehicle.

Maintenance Procedures

Drive Splines Maintenance

1. Disconnect all electrical cables from the DC motor (1).
2. Place the slings around the motor.
3. Support the DC motor (1) with the appropriate lifting device so that the motor can be slightly moved horizontally once the screws (2) are removed.

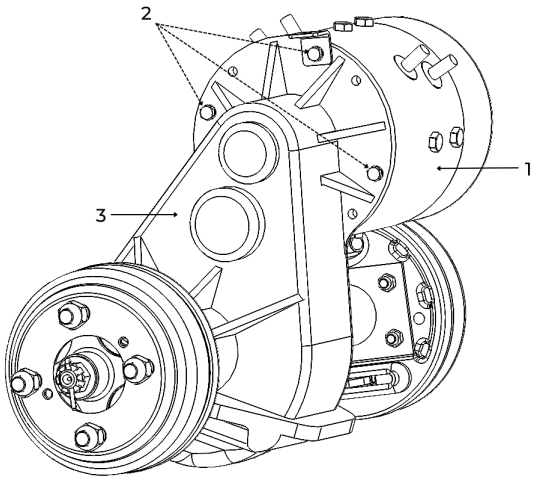


Figure 36. Supporting DC Motor.

CAUTION

DO NOT REMOVE THE DC MOTOR FROM THE DIFFERENTIAL UNTIL IT IS CORRECTLY SUPPORTED. THE MOTOR WEIGHS ABOUT 40 LB (18 KG). FAILURE TO COMPLY CAN DAMAGE THE EQUIPMENT.

4. Remove the screws (2) joining the DC motor (1) to the differential (3).
5. Remove the DC motor (1) from the differential (3), to access the drive splines (4).

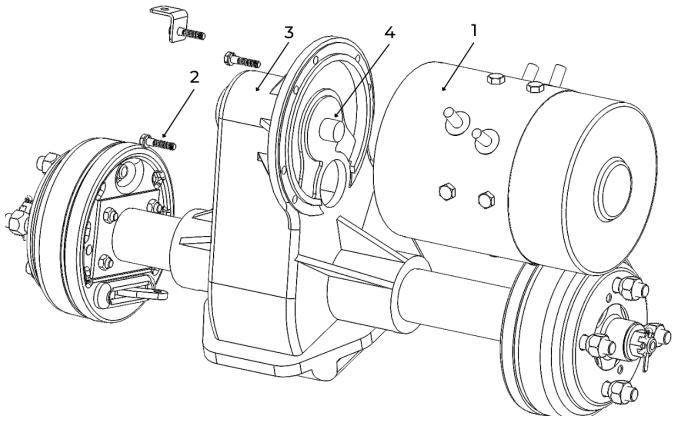


Figure 37. Removing DC Motor.

6. Clean the DC motor (1) from dust or debris accumulation (if applicable).
7. Inspect the DC motor and the differential drive splines (4) for corrosion or damage.
8. Lubricate the DC motor and the differential drive splines (4) with molybdenum disulfide grease (2.5 ml is required).
9. Reinstall the DC motor (1) on the differential (3) with the six screws (2).
10. Torque the screws (2) to standard values. The appropriate torque value is 24 ft lbs.
11. Remove the slings from the DC motor (1).
12. Reconnect the electrical cables to the DC motor (1).

Differential Maintenance

1. Position a recipient under the differential to collect the drained oil in next steps.
2. Remove the drain plug (1) until the oil pan (2) is completely drained of oil.
3. Reinstall the drain plug (1).
4. Remove and clean the oil pan (2)
5. Remove all old sealant and oil residue from cover and differential casing mating surfaces.
    - **NOTE**: Sealant recommended: Permatex RTV gasket maker (P/N 81182) or equivalent.
6. Apply a layer of sealant on the oil pan's (2) mating surface.
7. Add 350 mL of oil at the bottom of the oil pan (2). Do not mix oil with sealant.
8. Install the oil pan (2).
9. Torque the 5/16 screws to 178 in·lbf.

TIP: To ease the filling procedure of the DANA gear case with cover: Make a hose adapter that screws into the vent threads. Remove the vent. Fill with 500 mL of oil through the vent hole. Reinstall the vent.

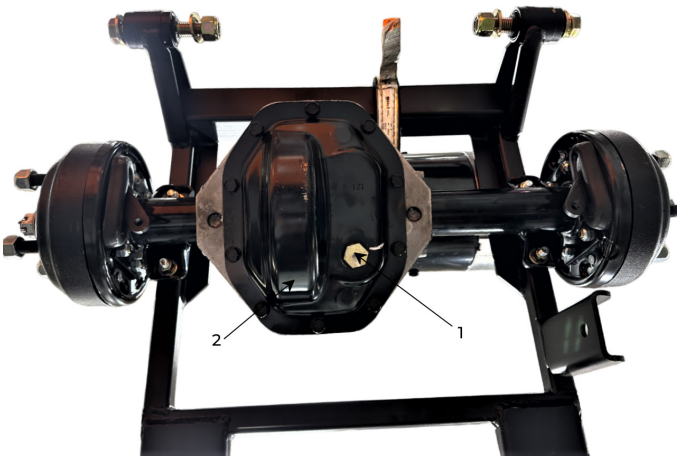


Figure 38. DANA Case Oil Change.

Front Hub Maintenance

1. Chock the rear wheels.
2. Remove the wheel nuts (1) and wheel (2).
3. Remove the dust cap (3).

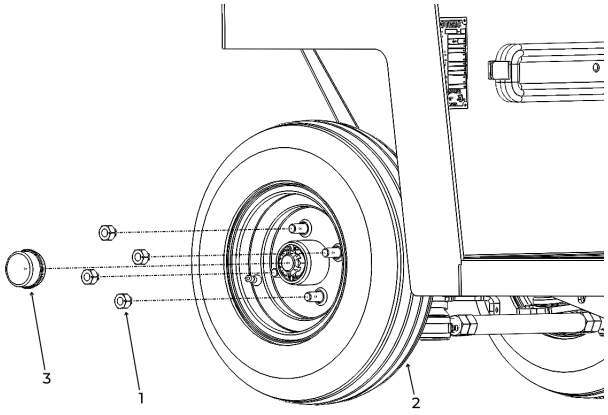


Figure 39. Front Wheel Removal.

4. Extract the cotter pin (4) and unscrew the castle nut (5).
5. Detach the hub (6) from the spindle (7).

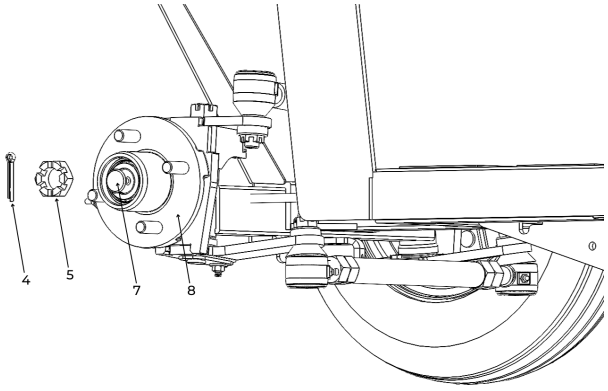


Figure 40. Front Hub.

6. Inspect the bearings (8) and their races for wear.
7. Discard the seal (9). Refer to the PARTS CATALOG for seal replacement.
8. Clean the bearing (8) and if they are still usable, apply the grease.
9. Install a new seal (9) and the bearings (8) into the hub (6).
10. On the spindle (7), clean the seating surface of the hub (6) from any debris.
11. Position the hub (6) on the spindle (7).
12. Tighten the castle nut (5) to 30 ft·lbf to seat the bearings (8), then loosen the castle nut (5) by unscrewing one full turn.
13. Hand-tighten the castle nut (5).
14. Install a new cotter pin (4) and the dust cap.

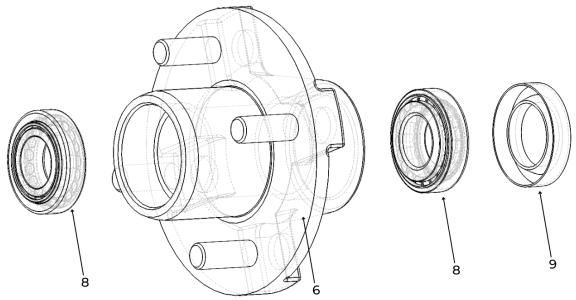


Figure 41. Wheel Hub.

Rear Hub Maintenance

1. Chock the front wheels.
2. Release hand brake.
3. Remove the rear wheel guards (1).
4. Remove the wheel nuts (2).
5. Remove the wheel (3).

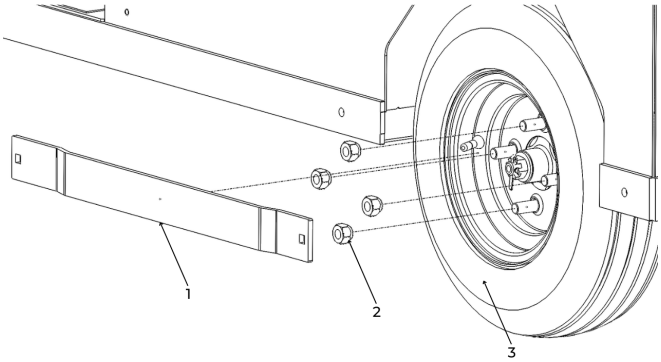


Figure 42. Rear Wheel Removal.

6. Remove the brake drum (4).
7. Clean brake dust with water.
8. Remove the cotter pin (5) and unscrew the castle nut (6).
9. Remove the hub (7) from the spindle (8).

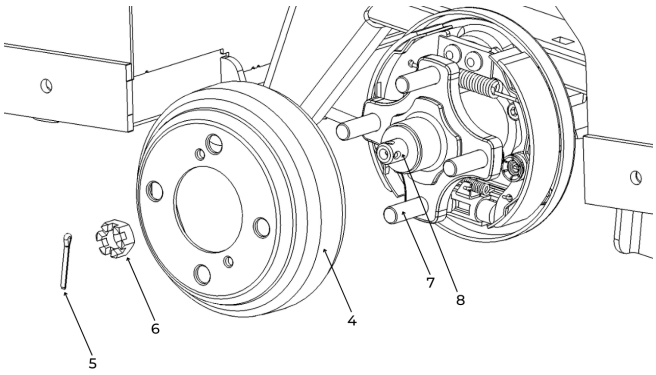


Figure 43 Rear Hub.

10. Examine the rear hub (7) for any abnormal sounds or signs of looseness.
11. Adjust the positioning of the hub (7) on the spindle (8).
12. Securely reinstall the castle nut (6) and tighten it to 103 ft·lbf.
13. Replace the cotter pin (5) with a new one and install it properly.
14. Reinstall the drum brake (4).
15. Reinstall the wheel (3) and the wheel nuts (2). Torque the wheel nuts (1) to standard values. The appropriate torque value is 80 ft lbs.
16. Reinstall the rear wheel guards (1).

Brake System Inspection

1. Inspect the following elements of the brake system for any signs of wear, corrosion, damage or looseness:
   - Brake pedal (1).
   - Two flange bearings (2).
   - Mechanical brake kit (3).

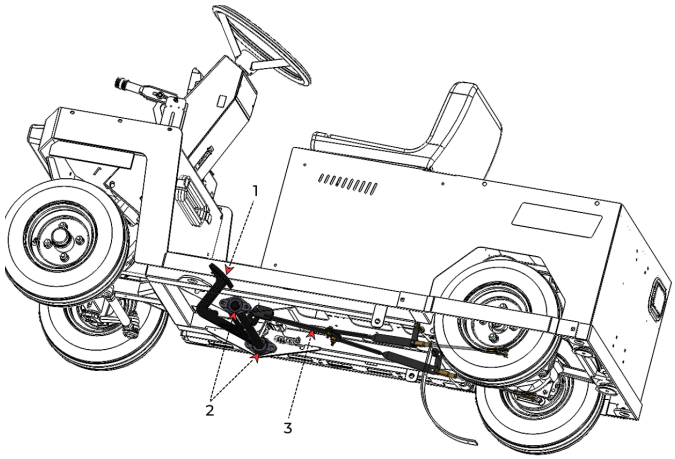


Figure 44. Brake System Inspection.

Hardware Maintenance

1. Inspect and tighten all electrical connections. Clean or replace any connection that shows signs of corrosion or damage.
2. Inspect and tighten all mechanical hardware. Replace any connection that shows signs of damage.

Refer to the QUICK REFERENCES at the end of this document for all torque values.

Test Drive

After the maintenance is finished, it is necessary to reinstall any disassembled parts and conduct a thorough test on the vehicle to ensure that all systems are functioning correctly.

1. Reconnect the electrical circuit:
   i. Reconnect the battery leads.
   ii. Turn on all switches and test lights.
   iii. Insert the key.
2. Test drive the vehicle:
   i. Turn the steering wheel and feel for excessive play.
   ii. Listen for abnormal noise.
3. Reinstall the deck.

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4.3 CORRECTIVE MAINTENANCE

4.3.1 DRUM BRAKES

Procedures

Drum Brakes Replacement

1. Safely secure the vehicle using jack stands.
2. Release hand brake.
3. Remove the rear wheel guards (1).
4. Remove the wheel nuts (2).
5. Remove the wheel (3).
6. Clean drum brake (4) dust with water.
7. Remove the brake drum (4).
8. Inspect the lining wear of the drum brake (3) system.
   - Replace the shoes and springs if the lining thickness is 1/16 in (2 mm) or less.

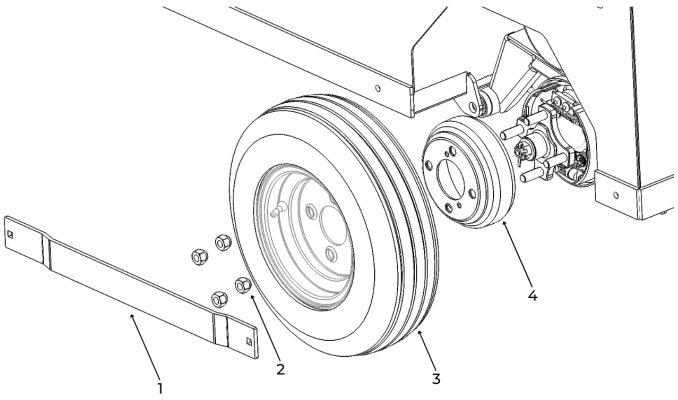

Figure 45. Drum Brakes Replacement.

9. Fully seat the brake drum (4) in position.
10. Spin the brake drum (4) to validate that the shoes aren't overly tightened. The wheels must turn free when the brake pedal is released.
11. Reinstall the wheels (3). Torque the wheel nuts (2) to standard values. The appropriate torque value is 80 ft lbs.
12. Reinstall the rear wheel guards (1).

4.3.2 REAR AXLE

Procedures

Rear Axle Removal

NOTE: Ensure that the vehicle is properly supported on jack stands or that the wheels are chocked to prevent any accidental movement.

1. Remove the rear wheel guards (1).
2. Remove the wheel nuts (2).
3. Remove the wheel (2).
4. Remove the brake drum (4).
5. Clean brake dust with water.

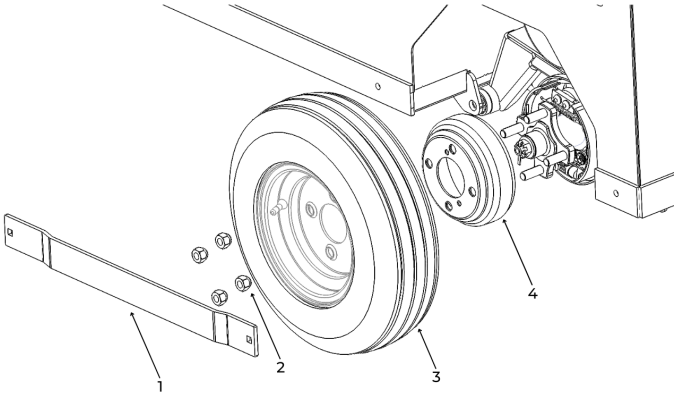

Figure 46. Drum Brake Removal.

6. Drain the differential fluid (if necessary). Keep a suitable container to catch the fluid and dispose of it properly.
7. Remove the cotter pin (5) which secures the castle nut. Use a pair of pliers or a cotter pin puller to remove it. Straighten the pin if necessary for easier removal.
8. Remove the castle nut (6) that secures the axle shaft by using an appropriate socket or wrench.
9. Remove the washer (7).
10. Remove the spindle (8) to access the axle shaft properly.

11. Remove the retaining circlip (9) that holds the bearings. Use the appropriate tool, such as snap ring pliers, to remove it. Carefully slide the clip out to release the axle shaft (10).
12. Remove gently the axle shaft (10) straight out, being cautious not to damage the seals or surrounding components.
13. Inspect it for any signs of damage or wear. If necessary, replace the axle shaft (10), seals, or any other components that show signs of deterioration.
14. Inspect the spindle (8) for any signs of damage or wear.

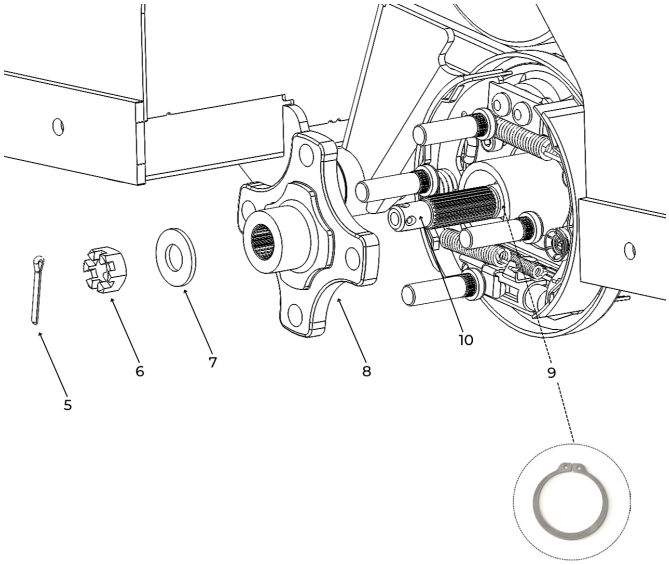

Figure 47. Axle Shaft Inspection

15. Slide the axle shaft (10) back into the differential, aligning it with the splines.
16. Reinstall the retaining circlip (9) to secure bearings in place. Ensure that the clip is properly seated and holds the axle shaft (10) securely.
17. Reinstall the spindle (8).
18. Reinstall the washer (7).
19. Put back and tighten the castle nut (6) using the appropriate socket. The appropriate torque value is 103 ft lbs.
20. Slide a new cotter pin (5) through the castle nut's hole and bend the ends of the pin to prevent it from coming loose.
21. Reinstall the brake drum (4).
22. Reinstall the wheel (3).
23. Torque the wheel nuts (2) to standard values. The appropriate torque value is 80 ft lbs.
24. Reinstall the rear wheel guards (1).
25. Validate that the differential oil level is adequate (it should reach the bottom of the filler hole). For more details, refer to section **4.3.4 DIFFERENTIAL subsection OIL CHANGE**.

4.3.4 CARBON BRUSHES

Procedures

Carbon Brushes Replacement

1. Detach all electrical components from the motor.
2. Support the DC motor (1) with the appropriate lifting device so that the motor can be slightly moved horizontally once the screws (2) joining the DC motor (1) to the differential (3) are removed. (See Figures 35 and 36)
3. Locate the carbon brushes (4). This may be as simple as removing the enclosure (5) to find them, or in some other cases just locating two clips (or brushes covers) on the outside of the motor.
4. Remove the electrical connections to the carbon brush.
5. Remove the spring (6) holding the brush in place.
6. Pull the carbon brush out, making sure to note the beveled edge's direction as the new brush needs to be installed in the same way. While removing the brush, you can keep track of the beveled edge by drawing an arrow on the motor.
7. Compare the old brush to the new one to ensure you have the correct parts.
8. Install the new brush into place and fasten with the spring (6).
9. Reattach electrical connection to the brush.

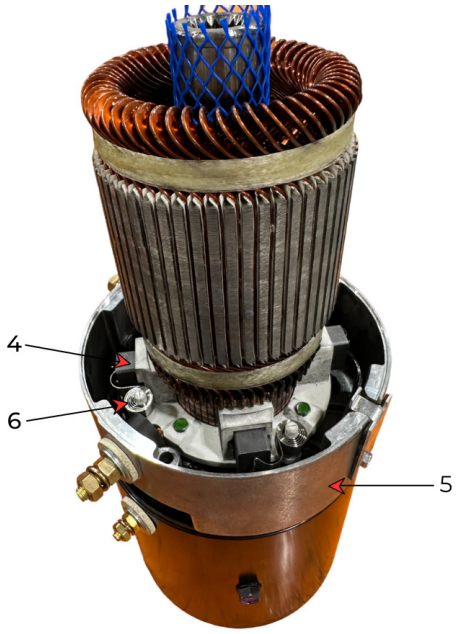

Figure 48. Carbon Brushes Replacement.

10. Repeat the same steps on all four brushes.
11. Reinstall the enclosure (5). It is important to ensure that both A1 and F1 are positioned in parallel. (See Figure 49)
12. Reinstall the DC motor (1) on the differential (3) with the six screws (2).
13. Torque the screws (2) to standard values. The appropriate torque value is 80 ft lbs.
14. Remove the lifting device from the DC motor.
15. Replace the motor in the vehicle. Bolt down and reattach electrical connections.
16. Run appliance to test.

Figure 49. A1 and F1 Orientation.

Inspection

1. Inspect the old brush for uneven wear burn marks or shiny rail marks.
2. While the brushes are out take some time to inspect the motor internals. Check the cavity for contaminants like dust, oil, water or carbon buildup from the worn brushes. This buildup can cause an art that will ground out the motor. It can be easily vacuumed with some help from low PSI compressed air.
3. Inspect the commutator for thread marks, grooves, and copper streaks, indicating that the old brushes were of poor quality or contaminated with small pieces of copper from the commutator surface. Signs of sparking indicate that the brushes have been short-circuited, which can also be caused by contamination.

NOTE: If there is any damage to the commutator, it is recommended to have it repaired by a motor repair shop. They have the expertise to machine and undercut the affected sections. Alternatively, it might be more advisable to consider replacing the entire motor.

4.3.5 DIFFERENTIAL

Inspection

1. Look for leaks around:
   - Covers.
   - At axle ends.
   - Casing mating surfaces.
   - Drain/fill plugs.
2. Look for signs of external damage cracks, deformed parts, signs of impacts.
3. Inspect for excessive looseness in internal gears by gently rocking wheels.
4. Drain and inspect oil for excessive shavings/debris. (If removing cover, perform visual inspection).
5. Inspect suspension mounting (U bolts, shocks, etc.).
6. Test drive: listen for abnormal noise, feel for excess play, **test while turning** as well.

Procedures

Oil Change

The recommended oil for MP-250 equipped with DANA Case differential is 80W90 GL5.

DANA Differential

1. Position a recipient under the differential to collect the drained oil in next steps.
2. Remove the drain plug (1) until the oil pan (2) is completely drained of oil.
3. Reinstall the drain plug (1).
4. Remove and clean the oil pan (2).
5. Remove all old sealant and oil residue from cover and differential casing mating surfaces.
   - **NOTE**: Sealant recommended: Permatex RTV gasket maker (P/N 81182) or equivalent.
6. Apply a layer of sealant on the oil pan's (2) mating surface.
7. Add 350 mL of oil at the bottom of the oil pan (2). Do not mix oil with sealant.
8. Install the oil pan (2).
9. Torque the 5/16 screws to 178 in·lbf.

TIP: To ease the filling procedure of the DANA gear case with cover: Make a hose adapter that screws into the vent threads. Remove the vent. Fill with 500 mL of oil through the vent hole. Reinstall the vent.

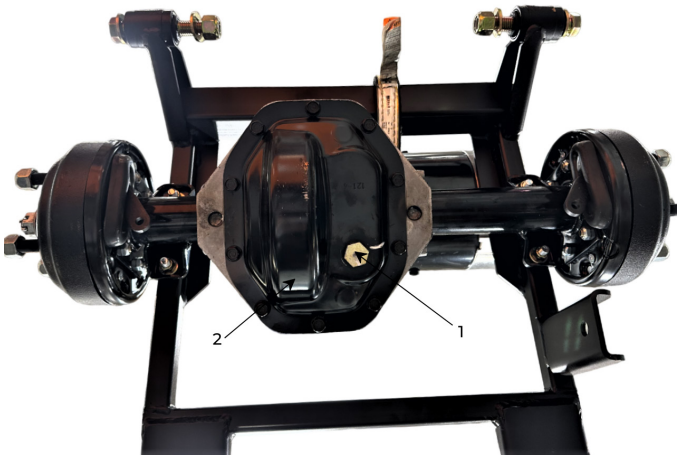

Figure 50. DANA Case.

4.3.6 BATTERY

WARNING

DO NOT MANIPULATE ELECTRICAL CONNECTIONS OR GENERATE SPARKS AROUND BATTERIES. SPARKS CAN CAUSE A BATTERY EXPLOSION AND ACID SPLASHING. DURING MAINTENANCE, ALWAYS DISCONNECT THE CHARGER AND USE INSULATED TOOLS THAT DO NOT GENERATE SPARKS. FAILURE TO COMPLY CAN CAUSE SERIOUS INJURIES.

WARNING

WHEN WORKING AROUND BATTERIES, ALWAYS WEAR ACID PROOF PROTECTIVE EQUIPMENT, SUCH AS FACE SHIELD AND THE APPROPRIATE GLOVES. BATTERIES CONTAIN SULFUR ACID THAT CAN CAUSE SEVERE BURNS ON SKIN OR EYES. RINCE CONTAMINATED AREA IMMEDIATELY WITH WATER.

Procedures

Battery Post Corrosion

If you notice corrosion on the battery posts, disconnect the cable connectors, utilize a wire brush to eliminate any debris, and proceed to clean them with a cloth dampened with ammonia solution.

CAUTION

AFTER CLEANING, DO NOT REAPPLY POWER UNTIL TERMINAL AREAS ARE THOROUGHLY DRY. FAILURE TO COMPLY CAN DAMAGE THE VEHICLE.

Electrolyte Level

NOTE: Does not apply to sealed batteries.

1. Fill with distilled water.
2. Regularly used batteries generally require water levels to be inspected weekly. Underwatering leads to a shortened battery life. Over watering leads to battery corrosion. Be careful not to overfill any cell to avoid forcing out electrolyte while charging.

NOTE : Some vehicles are equipped with batteries watering system. This watering system consists of a series of water fill tubes attached to each battery cell. These tubes are designed to allow for easy access to add water when needed (see Figure 51).

4. Fill each cell to plate level with distilled or deionized water, after battery charging. When the battery is charged, the fluid expands and can seep out if overfilled. Refill each cell after full charge, when the fluid has expanded to its maximum level.
5. Reinstall battery caps before charging.

Figure 51. Batteries Watering System.

Battery Mounting

A loose battery increases damaging effects of vibrations and is more prone to short circuiting.

Defective Battery

Discharging below a 20% SOC cuts down the battery life and the number of cycles available. Inspect specific gravity of each cell; if a cell is shorted, voltage drops may occur only when there is current. Refer to battery manufacturer's specifications for specific gravity of electrolyte.

TPPL Battery Maintenance

NOTE: TPPL batteries are generally designed to be maintenance-free. They do not require regular electrolyte level checks or addition of water, unlike some other types of batteries (ex. Lead-acid battery).

1. Inspect and clean the battery terminals to ensure good electrical connections.
2. Remove any corrosion or dirt using a wire brush or a battery terminal cleaner. Proper terminal connections help maintain optimal performance.
3. Monitor electrolyte levels (if applicable). Some TPPL batteries may have removable caps or access points to check and maintain electrolyte levels.

4.4 TROUBLESHOOTING

Errors Diagnostic

When the controller detects a problem, it generates ACTIVE fault codes to indicate the current issue. On the other hand, STORED fault codes are recorded by the controller when it has previously detected and stored the fault. All these codes are stored in the Fault History.

To begin diagnosing any problem, it is important to start by reading the fault codes.

For a comprehensive list of all the fault codes, please refer to section 5 ANNEXES located at the end of this document.

Battery Voltage

WARNING

DO NOT MANIPULATE ELECTRICAL CONNECTIONS OR GENERATE SPARKS AROUND BATTERIES. SPARKS CAN CAUSE A BATTERY EXPLOSION AND ACID SPLASHING. DURING MAINTENANCE, ALWAYS DISCONNECT THE CHARGER AND USE INSULATED TOOLS THAT DO NOT GENERATE SPARKS. FAILURE TO COMPLY CAN CAUSE SERIOUS INJURIES.

WARNING

WHEN WORKING AROUND BATTERIES, ALWAYS WEAR ACID PROOF PROTECTIVE EQUIPMENT, SUCH AS FACE SHIELD AND THE APPROPRIATE GLOVES. BATTERIES CONTAIN SULFUR ACID THAT CAN CAUSE SEVERE BURNS ON SKIN OR EYES. RINCE CONTAMINATED AREA IMMEDIATELY WITH WATER.

Some troubleshooting steps require to measure the voltage that the reaches the inspected components. The total battery voltage might be required for these inspections. Make sure batteries are securely connected and measure the voltage between the main braker terminal (**B+**) and the DC motor controller's (**B-**) terminal for full battery voltage.

4.4.1 ACCESSORIES

Accessories Not Working

1. Turn the key to the ON position.
2. Measure voltage across DC/DC converter input terminals.

   1. 1. Check for the presence of voltage between the positive terminal (**B+**) (White Wire) and the negative terminal (**B-**) (Black Wire) of the DC/DC converter (As shown in Figure 52).

      - If no voltage is present, it is necessary to inspect both the fuse and the wiring.

   1. 2. Check for the presence of voltage between the orange wire and the negative terminal (**B-**) (Black Wire) of the DC/DC converter (As shown in Figure 52).

      - If there is no voltage detected despite the key being ON, it is advisable to examine the wiring.

3. Measure voltage across DC/DC converter output terminals.

   2. 1. Check for the presence of voltage between the yellow/red wire and the green wire of the DC/DC converter (As shown in Figure 52).

      - If not between 11.8V and 14.2V, it indicates a defective converter that requires replacement.

4. Depress the accessory switch, measure voltage across accessory terminals.

- If the measured voltage is not between 11.8V and 14.2V, it indicates a problem with the switch, and it should be replaced.
- If the measured voltage is approximately 12V, it suggests a fault with the accessory itself, and it should be replaced.

NOTE : Ensure accurate voltage measurements by doing the voltage drop test between the switch's terminals, ensure that the voltage measurement registers 0 V. Alternatively, consider the voltage drop when measuring between the accessory's terminals.

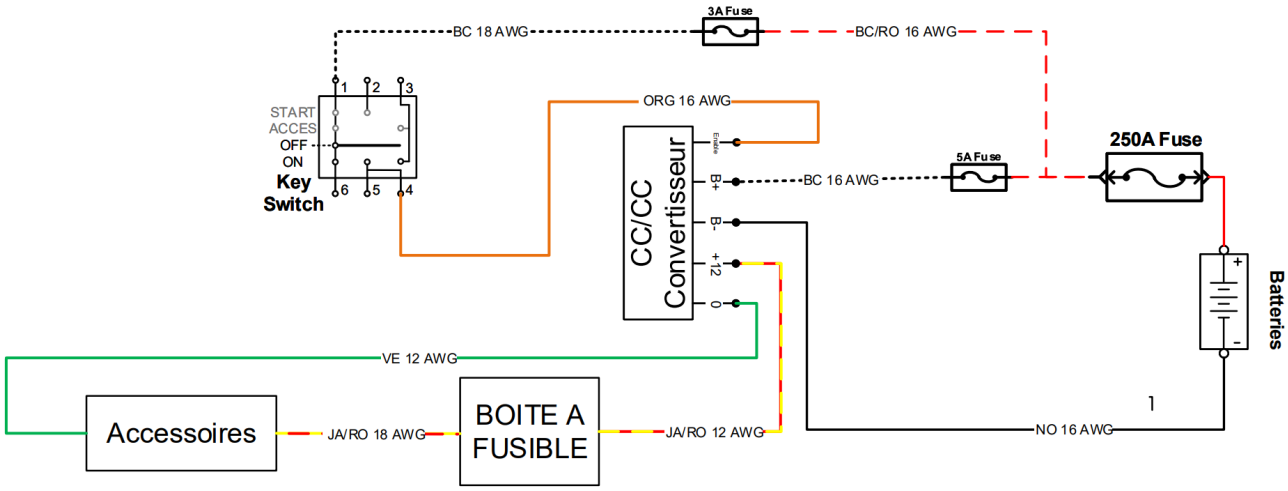

Figure 52. DC/DC Converter Input and Output Terminals Inspection.

4.4.2 BATTERY CHARGER

WARNING

ALWAYS UNPLUG THE DC ELECTRICAL CORDS BEFORE ATTEMPTING ANY REPAIRS TO THE CHARGER. FAILURE TO COMPLY CAN CAUSE INJURIES OR DAMAGE TO EQUIPMENT.

Charger Does Not Turn On

1. AC cord of portable chargers must be disconnected from the vehicle after every charge to restart.
2. Validate that the charger has not recorded any fault codes. (Please refer to the Annexes section 5 for the meaning/significance of the codes).
3. Measure single battery voltage at the battery's connector.

4.4.3 VEHICLE MOTION

Vehicle Does Not Move

1. Perform an inspection to detect any fault codes.

Please refer to Section 5 Annexes for the meaning/significance of the codes.

2. Inspect the Accelerator Pedal

To verify the proper functioning of the accelerator pedal, a Curtis handheld controller must be used. This tool allows for a comprehensive assessment of the pedal's performance and functionality. By connecting the diagnostic tool to the controller, it can retrieve and analyze relevant data such as throttle input, output signals, and any error codes or abnormalities.

This diagnostic process helps ensure that the accelerator pedal is operating correctly and allows for any necessary adjustments or repairs to be made if needed.

made if needed.

3. Inspect the Main Contactor or Solenoid

3.1 Verify the presence of voltage at the positive terminal (**B+**) of the contactor.

- If not, check for any fuse or wiring issues.

3.2 Check the voltage between the black/orange wire and the orange/black wire of the contactor.

- If no voltage is detected, it is necessary to inspect the wiring and the output wires of the controller.

3.3 Verify the output of voltage from the contactor to the negative terminal (**B-**) of the controller.

- If that's not the case, even if the contactor coil is energized (meaning it is receiving power), it is necessary to replace the contactor.

⚠ WARNING : Only applicable to DC vehicles equipped with an EMB brake and 36V

PLEASE PAY ATTENTION TO THE VOLTAGE VALUE INDICATED BY THE VOLTMETER. THE VOLTMETER MAY NOT ACCURATELY DISPLAY THE REAL VOLTAGE; INSTEAD, IT MIGHT SHOW A HIGHER VALUE (E.G., 48V) RATHER THAN THE AVERAGE VALUE (E.G., 24V) DUE TO THE IMPLEMENTATION OF PULSE WIDTH MODULATION (PWM).

Vehicle Moves Forward Only

1. Do not place the switch in the reverse position.
2. Measure the reverse signal input between pin 11 (Grey/White Wire) on the controller and the negative terminal (**B-**) (Black Wire).
   - If no voltage is detected, proceed to check the voltage at pin 5 of the switch. If there is still no voltage detected, it is necessary to inspect the wiring leading to the key switch.
3. Check for the presence of voltage at pin 4 of the Forward/Reverse switch (Gray/Blue Wire).
   - If no voltage is detected, replace the direction switch.

Vehicle Moves Backward Only

1. Do not place the switch in the forward position.
2. Measure the reverse signal input between pin 12 (Green/White Wire) on the controller and the negative terminal (**B-**) (Black Wire).
   - If no voltage is detected, proceed to check the voltage at pin 5 of the switch. If there is still no voltage detected, it is necessary to inspect the wiring leading to the key switch.
3. Check for the presence of voltage at pin 6 of the Forward/Reverse switch (green/blue wire).
   - If no voltage is detected, replace the direction switch.

⚠ WARNING

WHEN WORKING AROUND BATTERIES, ALWAYS WEAR ACID PROOF PROTECTIVE EQUIPMENT, SUCH AS FACE SHIELD AND THE APPROPRIATE GLOVES. BATTERIES CONTAIN SULFUR ACID THAT CAN CAUSE SEVERE BURNS ON SKIN OR EYES. RINCE CONTAMINATED AREA IMMEDIATELY WITH WATER.

NOTE: Certain faults could cause the vehicle to travel at reduced speeds. The maintenance timer reaching its limit could also cause reduced speeds.

1. Inspect the specific gravity of each battery cell. Cold batteries, highly discharged batteries, or dead cells are the most frequent causes of reduced travel speed.
2. Inspect potentiometer :
   i. Turn off the key switch.
   ii. Disconnect potentiometer terminals.
   iii. Inspect the resistance between terminals.

   NOTE: When inspecting the resistance between the terminals, a reading of 0 ohms indicates 0% throttle, while a reading of 5000 ohms corresponds to 100% throttle.

Other causes of lower speed:

a. Dragging brakes.
b. Cold temperature.
c. Slow speed programmed in the controller.

Intermittent Movements During Operation

A bad potentiometer is the most probable cause of the following:

- Irregular acceleration.
- Erratic maximum speed.
- Sudden stop after a bump or shock.
- Erratic starts, requiring several pedal cycles.

Erratic starts could also be the cause of a misadjusted potentiometer or microswitch. Monitor this value in the monitoring values section of the display troubleshooting function.

The PMC (Power Management Controller) incorporates two HPD (High Pedal Disable) safety features. The first feature prevents the vehicle from moving if the accelerator pedal is depressed prior to turning on the key switch and activating the seat switch (Presence detection pedal). The second feature prevents the vehicle from moving if the direction switch is activated before turning on the foot switch (Presence detection pedal) and activating the foot switch. These safety measures ensure that the vehicle remains stationary until the necessary conditions are met, promoting safe operation.

The PMC also has an SRO safety feature that temporarily keeps the vehicle in the OFF state when the key is turned ON. This brief moment of keeping the vehicle off allows for a safety check before enabling movement.

By placing the direction switch in the neutral position and subsequently selecting forward or reverse, the SRO feature ensures that the vehicle can move in the desired direction. This sequential process helps prevent sudden or unintended vehicle movements and allows for a controlled activation of the vehicle's motion.

The vehicle stops on a steep and long ramp or while towing a heavy load: the PMC monitors the temperature of the motor and is also equipped with an internal thermal protection that cuts back the current until the PMC and/or motor has cooled down, furthermore, an error code 4.3 may occur (Refer to Section 5 Annexes for a complete list of all codes).

Wiring: Standard Configuration

for the M8 bolts. The maximum bolt insertion depth below the surface of the bus bar is 1.3 cm (1/2"). Bolt shafts exceeding this length may damage the controller. The torque applied to the bolts should not exceed 16.3 N·m (12 ft-lbs).

Two 1/4" quick connect terminals (**S1** and **S2**) are provided for the connections to the motor field winding.

WIRING: Standard Configuration

Figure 3 shows the typical wiring configuration for most applications. **For walkie applications** the interlock switch is typically activated by the tiller, and an emergency reverse switch on the tiller handle provides the emergency reverse signal.

For rider applications the interlock switch is typically a seat switch or a foot switch, and there is no emergency reverse.

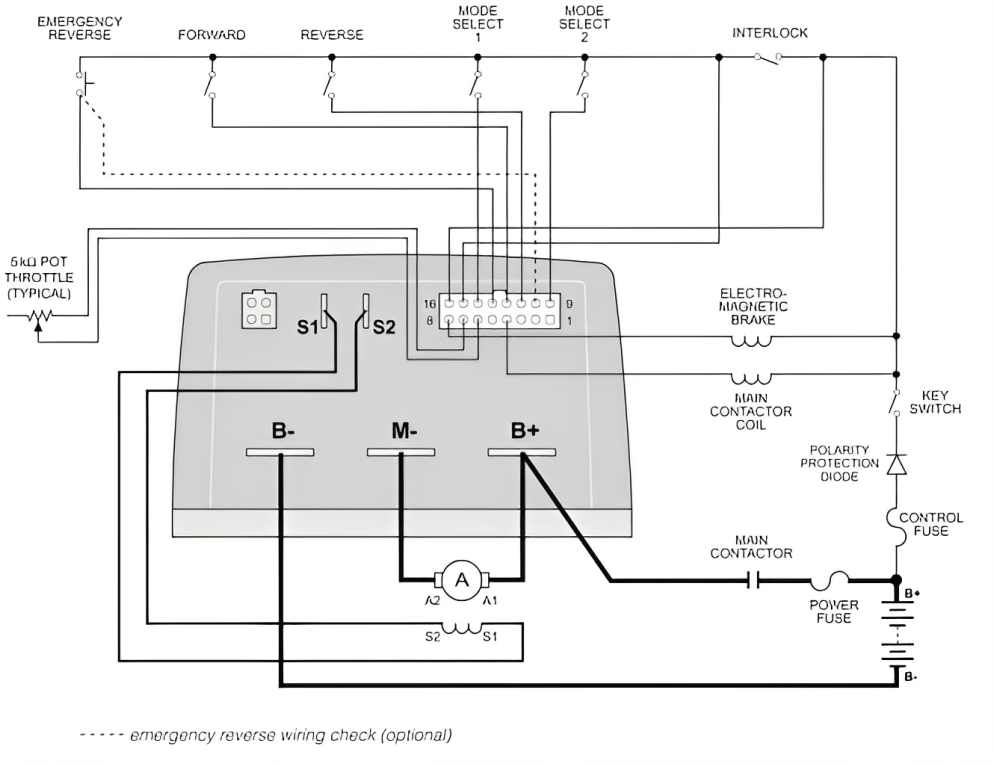

Fig. 3 *Standard wiring configuration, Curtis 1243GEN2 controller.*

Diagnostics and Troubleshooting

7

DIAGNOSTICS AND TROUBLESHOOTING

The 1243GEN2 controller provides diagnostics information to assist technicians in troubleshooting drive system problems. The diagnostics information can be obtained by observing the appropriate display on the handheld programmer, the fault message displayed on the Spyglass gauge, the fault codes issued by the Status LED, or the fault display driven by the controller's fault outputs (Fault 1 and Fault 2). Refer to the troubleshooting chart (Table 7) for suggestions covering a wide range of possible faults.

PROGRAMMER DIAGNOSTICS

The handheld programmer presents complete diagnostic information in plain language. Faults are displayed in the System Faults Menu, and the status of the controller inputs/outputs is displayed in the Monitor Menu.

Accessing the programmer's Fault History Menu provides a list of the faults that have occurred since the fault history file was last cleared. Checking (and clearing) the fault history file is recommended each time the vehicle is brought in for maintenance.

For information on 1311 programmer operation, see Appendix B. If you are using the older 1307 programmer, refer to existing documentation.

SPYGLASS DIAGNOSTICS

The eight-character LCD on the Spyglass displays a continuous sequence of hourmeter, battery state-of-charge, and fault messages.

Fault messages are displayed using the same codes that are flashed by the LED (see Table 8). For example, the LED flashes 3,2 for a welded main contactor:

□□□ □□	□□□ □□	□□□ □□
(3 , 2)	(3 , 2)	(3 , 2)

and the corresponding Spyglass message is:

```
CODE 32
```

When a fault message is being displayed, the red Fault LED (labeled with a wrench symbol) flashes to catch the operator's attention.

The LCD also displays a warning when either service timer expires. The service warning is not considered a fault and the red Fault LED does not flash. The word SERVICE is displayed for about 20 seconds on each key-on, after the hourmeter is displayed.

The Spyglass is available in 3-LED and 6-LED models; see Figure 21.

Troubleshooting Chart

Table 7 TROUBLESHOOTING CHART

LED CODE	PROGRAMMER LCD DISPLAY	FAULT CATEGORY	POSSIBLE CAUSE	FAULT CLEARANCE
0,1	NO KNOWN FAULTS	0	n/a	n/a
1,1	CURRENT SHUNT FAULT	1	1. Abnormal vehicle operation causing high current spikes. 2. Current sensor out of range. 3. Controller failure.	Cycle KSI. If problem persists, replace controller.
1,2	HW FAILSAFE	1	1. Noisy environment. 2. Self-test or watchdog fault. 3. Controller failure.	Cycle KSI. If problem persists, replace controller.
1,3	M- SHORTED	1	1. Internal or external short of M- to B-. 2. Incorrect motor wiring. 3. Controller failure.	Check wiring; cycle KSI. If problem persists, replace controller.
1,4	SRO	3	1. Improper sequence of KSI, interlock, and direction inputs. 2. Interlock or direction switch circuit open. 3. Sequencing delay too short. 4. Wrong SRO or throttle type selected. 5. Misadjusted throttle pot.	Follow proper sequence; adjust throttle if necessary; adjust programmable parameters if necessary.
2,1	THROTTLE WIPER HI	1	1. Throttle input wire open or shorted to B+. 2. Defective throttle pot. 3. Wrong throttle type selected.	When Throttle Wiper High input returns to valid range.
2,2	EMR REV WIRING	1	1. Emergency reverse wire or check wire open.	Re-apply emergency reverse or cycle interlock.
2,3	HPD	3	1. Improper sequence of KSI, interlock, and throttle inputs. 2. Misadjusted throttle pot. 3. Sequencing delay too short. 3. Wrong HPD or throttle type selected. 5. Misadjusted throttle pot.	Follow proper sequence; adjust throttle if necessary; adjust programmable parameters if necessary.
	SRVC TOTAL	3	1. Total maintenance timer expired.	Reset with programmer.
	SRVC TRAC	3	1. Traction maintenance timer expired.	Reset with programmer.
	TOTAL DISABLED	3	1. Total disable timer expired.	Reset with programmer.
	TRAC DISABLED	3	1. Traction disable timer expired.	Reset with programmer.
2,4	THROTTLE WIPER LO	1	1. Throttle pot wire open or shorted to B+. 2. Wrong throttle type selected. 3. Defective throttle pot.	When Throttle Wiper Low input returns to valid range.
3,1	FIELD SHORT	1	1. Main contactor coil shorted. 2. Field winding shorted to B+ or B-. 3. Field resistance too low.	Check contactor coil and field winding; cycle KSI.
3,2	MAIN CONT WELDED	1	1. Main contactor stuck closed. 2. Main contactor driver shorted.	Check wiring and contactor; cycle KSI.
3,3	FIELD OPEN	1	1. Field winding connection open. 2. Field winding open.	Check wiring and cycle KSI.
3,4	MISSING CONTACTOR	1	1. Main contactor coil open. 2. Main contactor missing. 3. Wire to main contactor open.	Check wiring and cycle KSI.

Table 7 TROUBLESHOOTING CHART, *cont'd*

LED CODE	PROGRAMMER LCD DISPLAY	FAULT CATEGORY	POSSIBLE CAUSE	FAULT CLEARANCE
4,1	LOW BATTERY VOLTAGE	2	1. Battery voltage < undervoltage cutback. 2. Corroded battery terminal. 3. Loose battery or controller terminal.	When voltage rises above undervoltage cutoff point.
4,2	OVERVOLTAGE	2	1. Battery voltage >overvoltage shutdown. limit. 2. Vehicle operating with charger attached.	When voltage falls below overvoltage cutoff point.
4,3	THERMAL CUTBACK	2	1. Temperature >85°C or < -25°C. 2. Excessive load on vehicle. 3. Improper mounting of controller.	Clears when heatsink temperature returns to within acceptable range.
4,4	ANTI-TIEDOWN	3	1. Mode switches shorted to B+. 2. Mode Select 1 "tied down" to select Mode 2 or Mode 4 permanently.	Release Mode Select 1.
	MOTOR HOT	3	1. Field resistance > motor hot setpoint.	When resistance < setpoint.
	MOTOR WARM	3	1. Field resistance > motor warm setpoint.	When resistance < setpoint.

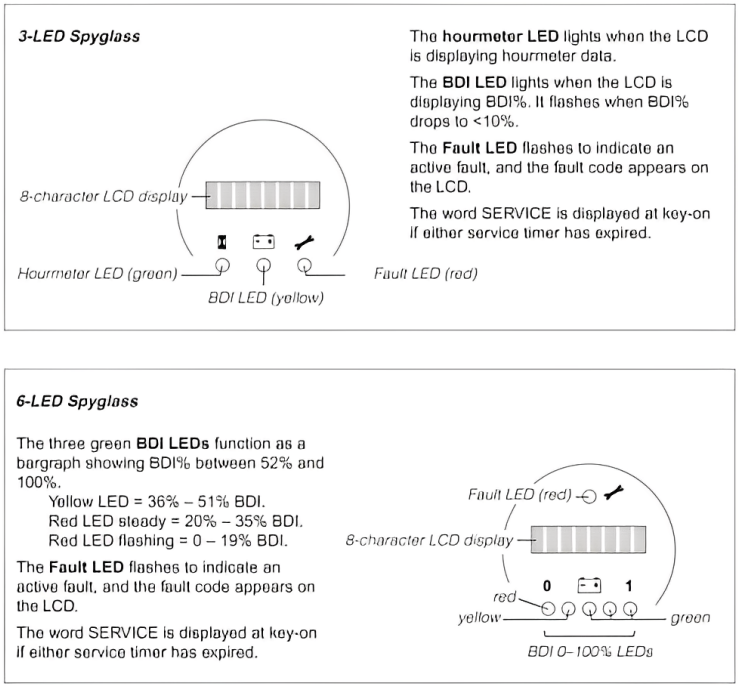

Fig. 21 *Curtis 840 Spyglass, 3-LED and 6-LED models.*

Led Diagnostics

STATUS LED DIAGNOSTICS

A Status LED is built into the 1243GEN2 controller. It is visible through a window in the label on top of the controller. This Status LED displays fault codes when there is a problem with the controller or with the inputs to the controller. During normal operation, with no faults present, the Status LED flashes steadily on and off. If the controller detects a fault, a 2-digit fault identification code is flashed continuously until the fault is corrected. For example, code "3,2"—main contactor welded—appears as:

□□□ □□	□□□ □□	□□□ □□
(3 , 2)	(3 , 2)	(3 , 2)

The codes are listed in Table 8.

Table 8 STATUS LED FAULT CODES

LED CODES		EXPLANATION
LED off	▬▬▬	no power or defective controller
solid on	▭▭▭	controller or microprocessor fault
0,1	■ □	controller operational; no faults
1,1	□ □	current sensor error
1,2	□ □□	hardware failsafe fault
1,3	□ □□□	M- fault or motor output short
1,4	□ □□□□	static return to off (SRO)
2,1	□□ □	throttle wiper high
2,2	□□ □□	emergency reverse circuit check fault
2,3	□□ □□□	high pedal disable (HPD), or expired timer
2,4	□□ □□□□	throttle wiper low
3,1	□□□ □	contactor driver overcurrent or field winding short
3,2	□□□ □□	main contactor welded
3,3	□□□ □□□	field winding open
3,4	□□□ □□□□	missing contactor
4,1	□□□□ □	low battery voltage
4,2	□□□□ □□	overvoltage
4,3	□□□□ □□□	thermal cutback, due to over/under temp
4,4	□□□□ □□□□	anti-tiedown fault, or overheated motor

Note: Only one fault is indicated at a time, and faults are not queued up. Refer to the troubleshooting chart (Table 7) for suggestions about possible causes of the various faults. Operational faults—such as a fault in SRO sequencing—are cleared by cycling the interlock switch or keyswitch.

Programming Parameters – MP-250

PROGRAMMING PARAMETERS – E-242, E-242HD, E-250

! WARNING !

The owner of this vehicle shall ensure that the service technicians are qualified, properly trained and obey the safety rules and guidelines in OSHA and ANSI B56 regulations, and in this manual.

Before installing and/or programming the PMC, park the vehicle on a flat level surface, lift the wheels off the ground and secure with jack stands of adequate capacity. Don't connect charger.

Programmable controllers must be programmed using the parameter settings in this service manual, before connecting the motor, to avoid sudden vehicle movement and accident.

Do not try to increase motor speed by changing parameter settings in the speed controller; it can cause accident and severe damage to the motor.

VOLTAGE	NOMINAL BATTERY VOLTAGE, IN VOLTS	2
M1 DRIVE C/L	MODE 1 DRIVE CURRENT LIMIT, IN AMPS	250
M2 DRIVE C/L	MODE 2 DRIVE CURRENT LIMIT, IN AMPS	250
M3 DRIVE C/L	MODE 3 DRIVE CURRENT LIMIT, IN AMPS	250
M4 DRIVE C/L	MODE 4 DRIVE CURRENT LIMIT, IN AMPS	250
M1 BRAKE C/L	MODE 1 BRAKING CURRENT LIMIT, IN AMPS	100
M2 BRAKE C/L	MODE 2 BRAKING CURRENT LIMIT, IN AMPS	100
M3 BRAKE C/L	MODE 3 BRAKING CURRENT LIMIT, IN AMPS	100
M4 BRAKE C/L	MODE 4 BRAKING CURRENT LIMIT, IN AMPS	100
M1 ACCEL RATE	MODE 1 ACCELERATION RATE, IN SEC.	3
M2ACCEL RATE	MODE 2 ACCELERATION RATE, IN SEC.	3
M3 ACCEL RATE	MODE 3 ACCELERATION RATE, IN SEC.	3
M4 ACCEL RATE	MODE 4 ACCELERATION RATE, IN SEC.	3
M1 DECEL RATE	MODE 1 DECELERATION RATE, IN SEC.	3.4
M2 DECEL RATE	MODE 2 DECELERATION RATE, IN SEC.	3.4
M3 DECEL RATE	MODE 3 DECELERATION RATE, IN SEC.	3.4
M4 DECEL RATE	MODE 4 DECELERATION RATE, IN SEC.	3.4
THROTTLE DECEL	THROTTLE DECEL, IN SEC.	0.3
M1 BRAKE RATE	MODE 1 BRAKING RATE, IN SEC.	2
M2 BRAKE RATE	MODE 2 BRAKING RATE, IN SEC.	2
M3 BRAKE RATE	MODE 3 BRAKING RATE, IN SEC.	2
M4 BRAKE RATE	MODE 4 BRAKING RATE, IN SEC.	2
INT BRAKE RATE	INT BRAKE RATE, IN SEC.	2
QUICK START	QUICK START THROTTLE FACTOR	1
TAPER RATE	Regen brak. Decrease rate when apporch. 0spd, 1/32s	20
M1 MAX FWD SPD	MODE 1 MAX. FWD SPEED, AS % PWM OUTPUT	40
M2 MAX FWD SPD	MODE 2 MAX. FWD SPEED, AS % PWM OUTPUT	72
M3 MAX FWD SPD	MODE 3 MAX. FWD SPEED, AS % PWM OUTPUT	86
M4 MAX FWD SPD	MODE 4 MAX. FWD SPEED, AS % PWM OUTPUT	100
M1 MAX REV SPD	MODE 1 MAX. REV SPEED, AS % PWM OUTPUT	40
M2MAX REV SPD	MODE 2 MAX. REV SPEED, AS % PWM OUTPUT	40
M3 MAX REV SPD	MODE 3 MAX. REV SPEED, AS % PWM OUTPUT	40
M4 MAX REV SPD	MODE 4 MAX. REV SPEED, AS % PWM OUTPUT	40
CREEP SPEED	CREEP SPEED, AS % PWM OUTPUT	0
THROTTLE TYPE	THROTTLE TYPE	3
THRO. DEADBAND	Thr. Neutral deadband % of 5kohms pot	6
THROTTLE MAX	Thr. Input req`d for 100%PWM %5kohm pot	90
THRTL MAP	THROTTLE MAP, AS %	30
FIELD MIN	MIN. FIELD CURRENT, IN AMPS	6
FIELD MAX	MAX. FIELD CURRENT, IN AMPS	20
FIELD MAP START	Arm. current at wich FIELD MAP takes effect, amps	70
FIELD MAP	Field winding current, as % armature current	50
CURRENT RATIO	CURRENT RATIO:FACTOR OF 1, 2, 4 OR 8	1
M1 RESTRAINT	MODE 1 RAMP RESTRAINT: 1 TO 10	6
M2 RESTRAINT	MODE 2 RAMP RESTRAINT: 1 TO 10	6
M3 RESTRAINT	MODE 3 RAMP RESTRAINT: 1 TO 10	6
M4 RESTRAINT	MODE 4 RAMP RESTRAINT: 1 TO 10	6
LOAD COMP	LOAD COMPENSATION: 0 TO 25	0

6 MPH MAX : disconnect wire MODE-2-B (PIN 9)
8 MPH MAX : disconnect wire MODE-1-A (PIN 14)

HPD	HIGH PEDAL DISABLE (HPD) TYPE	1
SRO	STATIC RETURN TO OFF (SRO) TYPE	1
SEQUENCING DLY	SEQUENCING DELAY, IN SEC.	1
MAIN CONT INTR	MAIN CONTACTOR INTERLOCK: ON OR OFF	ON
MAIN OPEN DELAY	MAIN CONTACTOR DROPOUT DELAY, IN SEC.	1
CONT DIAG	CONT DIAG, ON OR OFF	ON
AUX TYPE	AUXILIARY TYPE, 0 TO 5	0
AUX DELAY	AUXILIARY DRIVER DROPOUT DELAY, IN SEC.	0.0
EMR REV C/L	EMERGENCY REVERSE CURRENT LIMIT, IN AMPS	50.0
EMR REV CHECK	EMERGENCY REV. WIRING CHECK : ON OR OFF	OFF
EMR DIR INTR	EMR DIR INTR: ON OR OFF	OFF
VARIABLE BRAKE	VARIABLE BRAKE : ON OR OFF	OFF
ANTI-TIEDOWN	ANTI-TIEDOWN: ON OR OFF	OFF
POT LOW FAULT	POT LOW FAULT: ON OR OFF	ON
FULL VOLTS	FULL VOLTS: 174 TO 211	204
EMPTY VOLTS	EMPTY VOLTS : 0 TO 211	174
RESET VOLTS	RESET VOLTS: 174 TO 300	210
BATTERY ADJUST	BATTERY ADJUST : 0.1 TO 20.0	20
BDI LOCKOUT	BDI LOCKOUT : ON OR OFF	OFF
BDI DISABLE	BDI DISABLE: ON OF OFF	OFF
ADJ HRS LOW	ADJ HRS LOW: 0 TO 99	0
ADJ HRS MID	ADJ HRS MID: 0 TO 99	0
ADJ HRS HIGH	ADJ HRS HIGH: 0 TO 99	0
SET TOTAL HRS	SET TOTAL HRS: ON OR OFF	OFF
SET TRAC HRS	SET TRAC HRS: ON OR OFF	OFF
HOURMETER TYPE	HOURMETER TYPE: ON OR OFF	OFF
SRVC TOTAL HRS	SRVC TOTAL HRS: 0.0 TO 50.0	0.0
SRVC TRAC HRS	SRVC TRAC HRS: 0.0 TO 50.0	0.0
SRVC TOTAL	SRVC TOTAL : ON OR OFF	OFF
SRVC TRAC	SRVC TRAC: ON OR OFF	OFF
DIS TOTAL HRS	DIS TOTAL HRS: 0 TO 250	0
DIS TRAC HRS	DIS TRAC HRS: 0 TO 250	0
TRAC FAULT SPD	TRAC FAULT SPEED: 0 TO 100	100
BDI LIMIT SPD	BDI LIMIT SPEED: 0 TO 100	100
WARM SPD	WARM SPEED : 0 TO 100	100
MOT WARM	MOT WARM X 10 m : 10 TO 250	250
MOT HOT	MOT HOT X 10 m : 10 TO 250	250
MOTOR COMP	MOTOR COMP: ON OR OFF	OFF
MAX REV REGEN	MAX REV REGEN : 100 TO 300	100
MAX FWD REGEN	MAX FWD REGEN: 100 TO 300	100
MIN REV REGEN	MIN REV REGEN: 100 TO 300	25
MIN FWD REGEN	MIN FWD REGEN: 100 TO 300	25
MAX LOAD VOLTS	MAX LOAD VOLTS: 0.2 TO 5.5	0.2
MIN LOAD VOLTS	MIN LOAD VOLTS: 0.2 TO 5.0	0.2
INT BRAKE DLY	INT BRAKE DLY : 0.0 TO 8.0	0.0
FAULT CODE	ON OR OFF	ON
EMR BRAKE PWM	EMR BRAKE PWM : ON OR OFF	OFF
FIELD CHECK	FIELD CHECK: ON OR OFF	ON
PUMP METER	PUMP METER : ON OR OFF	OFF

Curtis Speed Controller

PROGRAMMING PARAMETERS – E-250-36V, E-300, E-302, E-322 & E-330

! WARNING !

The owner of this vehicle shall ensure that the service technicians are qualified, properly trained and obey the safety rules and guidelines in OSHA and ANSI B56 regulations, and in this manual.

Before installing and/or programming the PMC, park the vehicle on a flat level surface, lift the wheels off the ground and secure with jack stands of adequate capacity. Don't connect charger.

Programmable controllers must be programmed using the parameter settings in this service manual, before connecting the motor, to avoid sudden vehicle movement and accident.

Do not try to increase motor speed by changing parameter settings in the speed controller; it can cause accident and severe damage to the motor.

VOLTAGE	NOMINAL BATTERY VOLTAGE, IN VOLTS	3
M1 DRIVE C/L	MODE 1 DRIVE CURRENT LIMIT, IN AMPS	250
M2 DRIVE C/L	MODE 2 DRIVE CURRENT LIMIT, IN AMPS	250
M3 DRIVE C/L	MODE 3 DRIVE CURRENT LIMIT, IN AMPS	250
M4 DRIVE C/L	MODE 4 DRIVE CURRENT LIMIT, IN AMPS	250
M1 BRAKE C/L	MODE 1 BRAKING CURRENT LIMIT, IN AMPS	100
M2 BRAKE C/L	MODE 2 BRAKING CURRENT LIMIT, IN AMPS	100
M3 BRAKE C/L	MODE 3 BRAKING CURRENT LIMIT, IN AMPS	100
M4 BRAKE C/L	MODE 4 BRAKING CURRENT LIMIT, IN AMPS	100
M1 ACCEL RATE	MODE 1 ACCELERATION RATE, IN SEC.	3
M2ACCEL RATE	MODE 2 ACCELERATION RATE, IN SEC.	3
M3 ACCEL RATE	MODE 3 ACCELERATION RATE, IN SEC.	3
M4 ACCEL RATE	MODE 4 ACCELERATION RATE, IN SEC.	3
M1 DECEL RATE	MODE 1 DECELERATION RATE, IN SEC.	3.4
M2 DECEL RATE	MODE 2 DECELERATION RATE, IN SEC.	3.4
M3 DECEL RATE	MODE 3 DECELERATION RATE, IN SEC.	3.4
M4 DECEL RATE	MODE 4 DECELERATION RATE, IN SEC.	3.4
THROTTLE DECEL	THROTTLE DECEL, IN SEC.	0.3
M1 BRAKE RATE	MODE 1 BRAKING RATE, IN SEC.	2
M2 BRAKE RATE	MODE 2 BRAKING RATE, IN SEC.	2
M3 BRAKE RATE	MODE 3 BRAKING RATE, IN SEC.	2
M4 BRAKE RATE	MODE 4 BRAKING RATE, IN SEC.	2
INT BRAKE RATE	INT BRAKE RATE, IN SEC.	2
QUICK START	QUICK START THROTTLE FACTOR	0
TAPER RATE	Regen brak. Decrease rate when apporch. 0spd, 1/32s	20
M1 MAX FWD SPD	MODE 1 MAX. FWD SPEED, AS % PWM OUTPUT	40
M2 MAX FWD SPD	MODE 2 MAX. FWD SPEED, AS % PWM OUTPUT	72
M3 MAX FWD SPD	MODE 3 MAX. FWD SPEED, AS % PWM OUTPUT	86
M4 MAX FWD SPD	MODE 4 MAX. FWD SPEED, AS % PWM OUTPUT	100
M1 MAX REV SPD	MODE 1 MAX. REV SPEED, AS % PWM OUTPUT	40
M2MAX REV SPD	MODE 2 MAX. REV SPEED, AS % PWM OUTPUT	40
M3 MAX REV SPD	MODE 3 MAX. REV SPEED, AS % PWM OUTPUT	40
M4 MAX REV SPD	MODE 4 MAX. REV SPEED, AS % PWM OUTPUT	40
CREEP SPEED	CREEP SPEED, AS % PWM OUTPUT	0
THROTTLE TYPE	THROTTLE TYPE	3
THRO. DEADBAND	Thr. Neutral deadband % of 5kohms pot	6
THROTTLE MAX	Thr. Input req`d for 100%PWM %5kohm pot	90
THRTL MAP	THROTTLE MAP, AS %	30
FIELD MIN	MIN. FIELD CURRENT, IN AMPS	7
FIELD MAX	MAX. FIELD CURRENT, IN AMPS	20
FIELD MAP START	Arm. current at wich FIELD MAP takes effect, amps	70
FIELD MAP	Field winding current, as % armature current	50
CURRENT RATIO	CURRENT RATIO:FACTOR OF 1, 2, 4 OR 8	1
M1 RESTRAINT	MODE 1 RAMP RESTRAINT: 1 TO 10	10
M2 RESTRAINT	MODE 2 RAMP RESTRAINT: 1 TO 10	10
M3 RESTRAINT	MODE 3 RAMP RESTRAINT: 1 TO 10	10
M4 RESTRAINT	MODE 4 RAMP RESTRAINT: 1 TO 10	10
LOAD COMP	LOAD COMPENSATION: 0 TO 25	0

HPD	HIGH PEDAL DISABLE (HPD) TYPE	1
SRO	STATIC RETURN TO OFF (SRO) TYPE	1
SEQUENCING DLY	SEQUENCING DELAY, IN SEC.	1
MAIN CONT INTR	MAIN CONTACTOR INTERLOCK: ON OR OFF	ON
MAIN OPEN DELAY	MAIN CONTACTOR DROPOUT DELAY, IN SEC.	1
CONT DIAG	CONT DIAG, ON OR OFF	ON
AUX TYPE	AUXILIARY TYPE, 0 TO 5	0
AUX DELAY	AUXILIARY DRIVER DROPOUT DELAY, IN SEC.	0.0
EMR REV C/L	EMERGENCY REVERSE CURRENT LIMIT, IN AMPS	50.0
EMR REV CHECK	EMERGENCY REV. WIRING CHECK : ON OR OFF	OFF
EMR DIR INTR	EMR DIR INTR: ON OR OFF	OFF
VARIABLE BRAKE	VARIABLE BRAKE : ON OR OFF	OFF
ANTI-TIEDOWN	ANTI-TIEDOWN: ON OR OFF	OFF
POT LOW FAULT	POT LOW FAULT: ON OR OFF	ON
FULL VOLTS	FULL VOLTS: 174 TO 211	204
EMPTY VOLTS	EMPTY VOLTS : 0 TO 211	174
RESET VOLTS	RESET VOLTS: 174 TO 300	210
BATTERY ADJUST	BATTERY ADJUST : 0.1 TO 20.0	20
BDI LOCKOUT	BDI LOCKOUT : ON OR OFF	OFF
BDI DISABLE	BDI DISABLE: ON OF OFF	OFF
ADJ HRS LOW	ADJ HRS LOW: 0 TO 99	0
ADJ HRS MID	ADJ HRS MID: 0 TO 99	0
ADJ HRS HIGH	ADJ HRS HIGH: 0 TO 99	0
SET TOTAL HRS	SET TOTAL HRS: ON OR OFF	OFF
SET TRAC HRS	SET TRAC HRS: ON OR OFF	OFF
HOURMETER TYPE	HOURMETER TYPE: ON OR OFF	OFF
SRVC TOTAL HRS	SRVC TOTAL HRS: 0.0 TO 50.0	0.0
SRVC TRAC HRS	SRVC TRAC HRS: 0.0 TO 50.0	0.0
SRVC TOTAL	SRVC TOTAL : ON OR OFF	OFF
SRVC TRAC	SRVC TRAC: ON OR OFF	OFF
DIS TOTAL HRS	DIS TOTAL HRS: 0 TO 250	0
DIS TRAC HRS	DIS TRAC HRS: 0 TO 250	0
TRAC FAULT SPD	TRAC FAULT SPEED: 0 TO 100	100
BDI LIMIT SPD	BDI LIMIT SPEED: 0 TO 100	100
WARM SPD	WARM SPEED : 0 TO 100	100
MOT WARM	MOT WARM X 10 m : 10 TO 250	250
MOT HOT	MOT HOT X 10 m : 10 TO 250	250
MOTOR COMP	MOTOR COMP: ON OR OFF	OFF
MAX REV REGEN	MAX REV REGEN : 100 TO 300	100
MAX FWD REGEN	MAX FWD REGEN: 100 TO 300	100
MIN REV REGEN	MIN REV REGEN: 100 TO 300	25
MIN FWD REGEN	MIN FWD REGEN: 100 TO 300	25
MAX LOAD VOLTS	MAX LOAD VOLTS: 0.2 TO 5.5	0.2
MIN LOAD VOLTS	MIN LOAD VOLTS: 0.2 TO 5.0	0.2
INT BRAKE DLY	INT BRAKE DLY : 0.0 TO 8.0	0.0
FAULT CODE	ON OR OFF	ON
EMR BRAKE PWM	EMR BRAKE PWM : ON OR OFF	OFF
FIELD CHECK	FIELD CHECK: ON OR OFF	ON
PUMP METER	PUMP METER : ON OR OFF	OFF

6 MPH MAX : disconnect wire MODE-2-B (PIN 9)
8 MPH MAX : disconnect wire MODE-1-A (PIN 14)

QuiQ™ HFIPFC Battery Charger

Product Manual for:
QuiQ 912-24xx / 36xx / 48xx / 72xx

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SAVE THESE IMPORTANT SAFETY INSTRUCTIONS

This manual contains important safety, operating, and installation instructions – read before using charger.

Battery Safety Information

Warning: Use charger only on battery systems with an algorithm selected that is appropriate to the specific battery type. Other usage may cause personal injury and damage. Lead acid batteries may generate explosive hydrogen gas during normal operation. Keep sparks, flames, and smoking materials away from batteries. Provide adequate ventilation during charging. Never charge a frozen battery. Study all battery manufacturers' specific precautions such as recommended rates of charge and removing or not removing cell caps while charging.

Electrical Safety Information

Danger: Risk of electric shock. Connect charger power cord to an outlet that has been properly installed and grounded in accordance with all local codes and ordinances. A grounded outlet is required to reduce risk of electric shock – do not use ground adapters or modify plug. Do not touch uninsulated portion of output connector or uninsulated battery terminal. Disconnect the AC supply before making or breaking the connections to the battery while charging. Do not open or disassemble charger. Do not operate charger if the AC supply cord is damaged or if the charger has received a sharp blow, been dropped, or otherwise damaged in any way – refer all repair work to qualified personnel. Not for use by children.

INFORMATIONS IMPORTANTES DE SÉCURITÉ

Conserver ces instructions. Ce manuel contient des instructions importantes concernant la sécurité et le fonctionnement.

Information de Sécurité de la Batterie

Attention: Utiliser seulement sur les batteries 72V avec un algorithme approprié au type spécifique de batterie – voire le manuel. D´autres types de batteries pourraient éclater et causer des blessures ou dommages. Les batteries peuvent produire des gaz explosives en service normal. Ne jamais fumer près de la batterie et éviter toute étincelle ou flame nue à proximité de ces derniers. Fournisser la bonne ventilation lors du chargement. Ne jamais charger une batterie gelée. Prendre connaissance des mesures de précaution spécifiées par le fabricant de la batterie, p. ex., vérifier s´il faut enlever les bouchons des cellules lors du chargement de la batterie, et les taux de chargement recommandés.

Information de Sécurité Électrique

Danger: Risque de chocs électriques. Ne pas toucher les parties non isolées du connecteur de sortie ou les bornes non isolées de la batterie. Toujours connecter le chargeur à une prise de courant mise à la terre. Ne pas ouvrir ni desassembler le chargeur – referer toute reparations aux personnes qualifiés. Pas à l´usage des enfants.

Operating Instructions

1. Always use a grounded outlet. When using an extension cord, avoid excessive voltage drops by using a grounded 3-wire 12 AWG cord.
2. The charger will automatically turn on and go through a short LED indicator self-test (Models 912-xx0x will flash all LED's in an up-down sequence and Models 912-xx1x will alternatively flash its LED RED-GREEN) for two seconds. If the charger is connected to battery pack, a trickle current will be applied until a minimum voltage is reached. If the charger is used in an off-board application and the charger is waiting to be plugged into a battery pack, the charging algorithm number will be displayed for 11 seconds (see "Check / Change Charging Algorithm") before ultimately displaying an under-voltage fault (fault disappears when plugged into battery pack).
3. Once a minimum battery voltage is detected, the charger will enter the bulk charging constant-current stage. Models 912-xx0x will display the current to the battery on the bargraph and Model 912-xx1x will flash its LED GREEN off more than on to indicate <80% charge status. The length of charge time will vary by how large and how depleted the battery pack is, the input voltage (the higher, the better), and ambient temperatures (the lower, the better). If the input AC voltage is low (below 104VAC), then the charging power will be reduced to avoid high input currents (Models 912-xx0x 'AC' LED and Models 912-xx1x single LED both flash YELLOW). If the ambient temperature is too high, then the charging power will also be reduced to maintain a maximum internal temperature (Models 912-xx0x bargraph flashes and Models 912-xx1x single LED flashes YELLOW).
4. When the battery is at approximately 80% state of charge, the bulk stage has completed and an >80% charge indication is given (Models 912-xx0x turn on the '80%' LED and Models 912-xx1x will flash its LED GREEN on more than off). In the next phase known as the absorption or constant-voltage phase, the last 20% of charge is then returned to the battery. The charging could be terminated at this point if the vehicle requires immediate usage, however, it is highly recommended to wait until 100% charge indication is given to ensure maximum battery capacity and life.
5. A low current "finish-charge" phase is next applied to return and maintain maximum battery capacity (Models 912-xx0x will flash the '100%' LED).
6. When Models 912-xx0x '100%' LED or Models 912-xx1x single LED is continuously GREEN, the batteries are completely charged. The charger may now be unplugged from AC power (always pull on plug and not cord to reduce risk of damage to the cord). If left plugged in, the charger will automatically restart a complete charge cycle if the battery pack voltage drops below a minimum voltage or 30 days has elapsed.
7. If a fault occurred anytime during charging, a fault indication is given by flashing RED with a code corresponding to the error. There are several possible conditions that generate errors. Some errors are serious and require human intervention to first resolve the problem and then to reset the charger by interrupting AC power for at least 15 seconds. Others may be simply transient and will automatically recover when the fault condition is eliminated. To indicate which error occurred, a fault indication will flash RED a number of times, pause, and then repeat.
   [1 FLASH] Battery Voltage High: auto-recover
   [2 FLASH] Battery Voltage Low: auto-recover
   [3 FLASH] Charge Timeout: the charge did not complete in the allowed time. This may indicate a problem with the battery pack (voltage not attaining the required level), or that the charger output was reduced due to high ambient temperatures.
   [4 FLASH] Check Battery: the battery pack could not be trickle charged up to the minimum level required for the charge to be started. This may indicate that one or more cells in the battery pack are shorted or damaged.
   [5 FLASH] Over-Temperature: auto-recover. Charger has shutdown due to high internal temperature which typically indicates there is not sufficient airflow for cooling – see Installation Instructions 1). Charger will restart and charge to completion if temperature comes within accepted limits.
   [6 FLASH] QuiQ Fault: an internal fault has been detected. If Fault 6 is again displayed after interrupting AC power for at least 15 seconds, the charger must be brought to a qualified service depot.

Maintenance Instructions

1. For flooded lead-acid batteries, regularly check water levels of each battery cell after charging and add distilled water as required to level specified by battery manufacturer. Follow the maintenance and safety instructions recommended by the battery manufacturer.
2. Make sure charger connections to battery terminals are tight and clean.
3. Do not expose charger to oil, dirt, mud or to direct heavy water spraying when cleaning vehicle.

See flip side for **Product Specifications** and **Installation Instructions** for qualified personnel.

Specifications

DC Output – see Operating Instructions

QuiQ Model: 912-	24xx	36xx	48xx	72xx
Voltage-nom (V)	24	36	48	72
Voltage-max (V)	33.6	50.4	67.2	100
Current-max (A)	25	21	18	12
Battery Type	Specific to selected algorithm			
Reverse Polarity	Electronic protection – auto-reset			
Short Circuit	Electronic current limit			

AC Input

All models	
Voltage-max (Vrms)	85 – 265
Frequency (Hz)	45 - 65
Current-max (Arms)	12A @ 104VAC (reduced 20%<104V)
Current – nominal (Arms)	10A @ 120VAC / 5A @ 230VAC
AC Power Factor	>0.98 at nominal input current

Operation

Charger Model: 912-	xx0x (10 LED)	xx1x (1 LED)
AC ON	Solid YELLOW	LED Active
AC LOW	Flash YELLOW	Flash YELLOW
Thermal Cutback	Flash Bargraph	Flash YELLOW
<80% Charge Indicator	-	Short Flash GREEN
>80% Charge Indicator	Solid YELLOW	Long Flash GREEN
100% Charge Indicator	Solid GREEN	Solid GREEN
Fault Indicator	Flash RED	Flash RED
DC Ammeter	LED Bargraph	-
Bat Temp Compensation	Automatic	Optional
Maintenance Mode	Auto-restart if V<2.1Vpc or 30 days elapse	

Mechanical

All models	
Dimensions	28.0 x 24.5 x 11.0 cm (11 x 9.7 x 4.3")
Weight	<5 kg (<11 lbs) w/ standard output cord
Environmental	Enclosure: IP46
Operating Temperature	-30°C to +50°C (-22°F to 122°F), derated above 30°C, below 0°C
Storage Temperature	-40°C to +70°C (-40°F to 158°F)
AC input connector	IEC320/C14 (require ≥1.8m localized cord)
DC output connector	OEM specific w/ 12AWG wire

Regulatory

Safety	
EN 60335-1/2-29	Safety of Appliances/ Battery Chargers
UL2202	EV Charging System Equipment
UL1564 2nd Edition	Industrial Battery Charger
CSA-C22.2 No. 107.2	Battery Chargers- Industrial
Emissions	
FCC Part 15/ICES 003	Unintentional Radiators Class A
EN 55011	Radio disturbance characteristics (Class A)
EN 61000-3-2	Limits for harmonic current emissions
EN 61000-3-3	Limits of voltage fluctuations and flicker
Immunity	
EN 61000-4-2	Electrostatic discharge immunity
EN 61000-4-3	Radiated, radio-frequency, EMF immunity
EN 61000-4-4	Electrical fast transient/burst immunity
EN 61000-4-5	Surge immunity
EN 61000-4-6	Conducted Immunity
EN 61000-4-11	Voltage variations immunity

Installation Instructions

WARNING: The output of chargers with greater than 48V may pose an energy and/or shock hazard under normal use. These units must be installed in the host equipment in such a manner that the output cable and battery connections are only accessible with the use of a tool by qualified personnel.

1) Determine Mounting Location:
While its sealed nature allows the charger to be mounted virtually anywhere, the choice of mounting location and orientation is extremely important. For optimum performance and shortest charge times, mount the charger in an area with adequate ventilation. The charger should also be mounted in an area that will be relatively free of oil, dirt, mud, or dust since accumulations within the fins of the charger will reduce their heat-dissipating qualities. Optimal cooling also occurs when the charger is mounted on a horizontal surface with the fins vertical. More airflow from below the charger will help cool the fins, so mounting above open areas or areas with cut-outs for airflow is desirable. Contact Delta-Q for information on other mounting orientations. As the charger may get hot in operation, the charger must be installed such that risk of contact by people is reduced. The charger's AC plug must be located at least 18" above the floor/ ground surface and the status display must be visible to the user.

2) Mounting Procedure:
Mount the charger by the mounting plate using appropriate fasteners (i.e. 1/4" or M6 with locking hardware). For UL2202 compliance, a 12AWG green bonding wire with ring terminals must be attached from the bonding stud located on the front of the charger (identified by ⏚) to the vehicle frame. The vehicle connection must be made using corrosion resistant hardware (e.g., a #10 stainless steel machine screw with at least two threads of engagement and, if required, a paint piercing washer).

3) DC Battery Connection Procedure:
a) The green wire outputs battery voltage when the charger is not plugged into AC to provide an interlock function – see Fig. 1. **If used, a user-supplied 1A fast-blow external fuse must be installed inline to prevent damage. Shorting or drawing more than 1A may damage charger and void the warranty.**
b) Securely fasten the black ring terminal from the charger to the negative terminal ("-", "NEG", NEGATIVE") of the battery pack.
c) Check that the correct charge algorithm is being used – refer to section 4). Securely fasten the red ring terminal to the positive terminal ("+", "POS", "POSITIVE") of the battery pack.

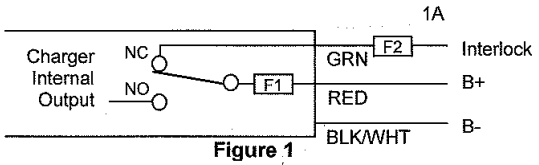


Figure 1

4) Check / Change Charging Algorithm:
The charger comes pre-loaded with algorithms for batteries as detailed in Table 1. If your specific battery model is not listed, please contact Delta-Q.
Each time AC power is applied with the battery pack NOT connected, the charger enters an algorithm select/display mode for approximately 11 seconds. During this time, the current Algorithm # is indicated on the '80%' LED (Models 912-xx0x) or on the single LED (Models 912-xx1x). A single digit Algorithm # is indicated by the number of blinks separated by a pause. A two digit Algorithm # is indicated by the number of blinks for the first digit followed by a short pause, then the number of blinks for the second digit followed by a longer pause.
To check / change the charging algorithm:
a) Disconnect the charger positive connector from battery pack. Apply AC power and after the LED test, the Algorithm # will display for 11 seconds.
b) To change algorithm, touch positive connector during the 11 second display period to the battery pack's positive terminal for 3 seconds and then remove – the Algorithm # will advance after 3 seconds. Repeat until desired Algorithm # is displayed. A 30 second timeout is extended for every increment. Incrementing beyond the last Algorithm moves back to the first Algorithm. After desired Algorithm # is displayed, touch the charger connector to the battery positive until the output relay is heard to click (~10 seconds) – algorithm is now in permanent memory.
c) Remove AC power from the charger and reconnect the charger positive connector to the battery pack. It is highly recommended to check a newly changed algorithm by repeating step 4) above.

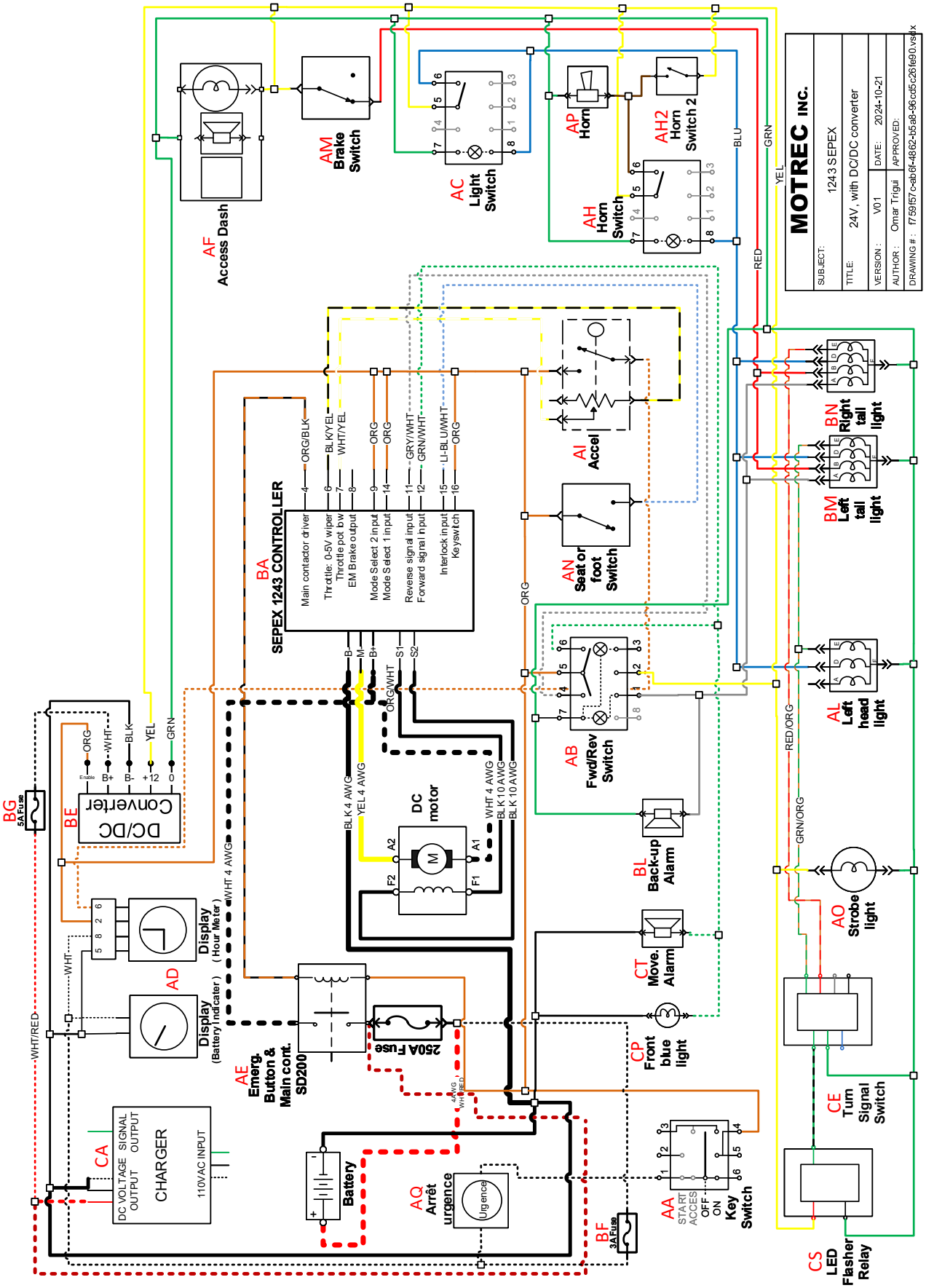
Alg #	Battery Type
35	Concorde 2xxAh AGM
27	Crown CR325 dv/dt
26	Deka 8GGC2 Gel
11	generic flooded CP dv/dt
8	Concorde 1xxAh AGM
7	Trojan J305 dV/dt
6	DEKA 8G31 Gel
5	Trojan 30XHS
4	US Battery US2200
1	Trojan T-105

Table 1.

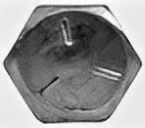
Product warranty is two years - please contact dealer of original equipment for warranty service.

Note: This is a Class A product. In a domestic environment this product may cause radio interference, in which case the user may be required to take adequate measures.

Electrical Diagram



Standard Torque



BOLT CLAMP LOADS

Suggested Assembly Torque Values

	USS/SAE GRADE 5					USS/SAE GRADE 8				
DIAMETER & THREADS PER INCH	TENSILE STRENGTH MIN. PSI	PROOF LOAD LB	CLAMP LOAD LB	TORQUE DRY FT LB	LUBRICATED FT LB	TENSILE STRENGTH MIN. PSI	PROOF LOAD LB	CLAMP LOAD LB	TORQUE DRY FT LB	LUBRICATED FT LB
1/4-20	120,000	2,700	2,020	8	6.3	150,000	3,800	2,850	12	9
28	120,000	3,100	2,320	10	7.2	150,000	4,350	3,250	14	10
5/16-18	120,000	4,450	3,340	17	13	150,000	6,300	4,700	24	18
24	120,000	4,960	3,700	19	14	150,000	6,950	5,200	27	20
3/8-16	120,000	6,680	4,950	30	23	150,000	9,300	6,980	45	35
24	120,000	7,450	5,600	35	25	150,000	10,500	7,900	50	35
7/16-14	120,000	9,050	6,780	50	35	150,000	12,800	9,550	70	50
20	120,000	10,100	7,570	55	40	150,000	14,200	10,650	80	60
1/2-13	120,000	12,100	9,050	75	55	150,000	17,000	12,750	110	80
20	120,000	13,600	10,200	85	65	150,010	19,200	14,400	120	90
9/16-12	120,000	15,500	11,600	110	80	150,010	21,800	16,350	150	110
18	120,000	17,300	12,950	120	90	150,010	24,400	18,250	170	130
5/8-11	120,000	19,200	14,400	150	110	150,010	27,100	20,350	210	160
18	120,000	21,800	16,350	170	130	150,010	30,700	23,000	240	180
3/4-10	120,000	28,400	21,300	260	200	150,010	40,100	30,100	380	280
16	120,000	31,700	23,780	300	220	150,010	44,800	33,500	420	310
7/8-9	120,000	39,300	29,450	430	320	150,010	55,400	41,600	600	450
14	120,010	43,300	32,450	470	350	150,010	61,100	45,800	670	500
1-8	120,010	51,500	38,600	640	480	150,010	72,700	54,500	910	680
14	120,010	57,700	43,300	720	540	150,010	81,500	61,100	1,020	760

MOTREC INTERNATIONAL