MC-680-AC





MAINTENANCE MANUAL

A GUIDE FOR PERFORMING MAINTENANCE AND REPAIRS ON MC-680

SERIAL NUMBER: 125 64 63 AND UP

UPDATED 10.06.2024
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

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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.



"AYONE CAN WORK WE PERFORM THAT'S MOTREC "

-Motrec Tagline

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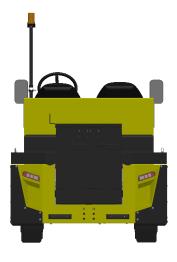
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1. PREFACE





MOTREC



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 <u>quick maintenance references</u> is included at the back of this document. These references are intended for an MC-680 experienced technician to accelerate the maintenance process. The Quick References should not be used by any untrained or inexperienced personnel.

The MC-680

The MC-680 is a versatile electric vehicle designed by Motrec. With its robust build and doublem powerful electric motors in the back, it's ideal for various industrial and commercial applications. It features a spacious cargo area, allowing for efficient transportation of goods and materials. Its ergonomic design ensures comfort for the driver during long shifts, while its maneuverability makes it suitable for navigating tight spaces. The MC-680 is equipped with advanced safety features, providing peace of mind in demanding work environments. Overall, it's a reliable and efficient solution for businesses looking to optimize their material handling operations.

If you need a do-it-all vehicle that's strong, safe, and easy to operate, you can't beat the MC-680 with its unlimited configurations and 3-year warranty (Equivalent of 3000 Hours).

Refer to our website <u>www.motrec.com</u> for more details on configurations.

1.2. ACRONYMS AND ABBREVIATIONS

°C: Celsius

°F: Fahrenheit

ANSI: American National Standards Institute

AUX: Auxiliary

EMB: Electromagnetic Brake

ft: Feet

A: Amperes

HD: Heavy Duty**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

Ib: Pounds (Weight)

lbf: Pound (Force)

LD: Low Duty

LED: Light Emitting Diode

m: MetermL: Millilitermm: Millimeter

N/A: Not Applicable
N·m: Newton Meter

OSHA: Occupational Safety and Health Administration

P/N: Part Number

PMC: Power Motor Controller **PWM**: Pulse Width Modulation

SOC: State of Charge

SRO: Static Return To Off

VAC/AC: Volts Alternating Current / Alternating Current

VDC/DC: Volts Direct Current / Direct Current

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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 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 (MPV).

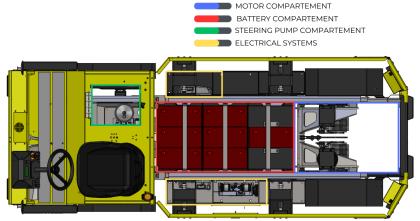
3. VEHICULE OVERVIEW

3.1. SPECIFICATIONS AND CONFIGURATIONS

The MT-800 specifications and configurations can vary depending on the specific model and year of the MT-800. 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.



(DECK, PASSENGER SEAT AND OTHER COMPONENTS ARE HIDDEN FOR CLARITY)



Figure 1. Equipment Compartments.

Procedures for lifting the deck

Follow these steps to lift the deck:

- 1. Loosen all four lock-in screws (1).
- 2. Remove the quick-release pin (2) to release the welded foot (3).
- 3. Extract the welded foot (3) and reinstall it back in.
- 4. Reinsert the quick-release pin (2) to secure the welded foot.
- 5. Utilize an impact wrench with the socket attachment to unscrew the platform jacks screw (acme screw) (4) and extract the welded movable foot (5).
- 6. Repeat the process **simultaneously** for the other three welded feet.

NOTE: Be cautious as this process cannot be done individually.

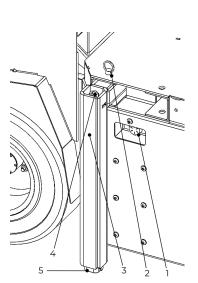
IMPORTANT NOTE: To reinstall the deck properly, it's crucial that the front UHMW sliding block (6) makes contact with the vehicle floor (7) to ensure proper deck realignment (see figure 4 page 11). Then, repeat steps 1 to 5 in reverse order.











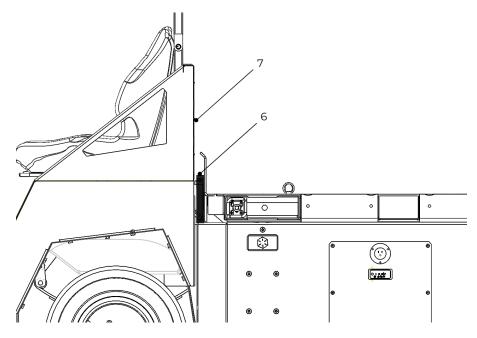


Figure 4. Positioning of front UHMW sliding block in reference to the vehicle floor.

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.

The total voltage of the vehicle battery remains consistently at **84V**, comprising **7 batteries** of **12V each**. The vehicle can only be powered by **AES**-type batteries.

Standard battery Compartment:

The standard battery compartment is s devoid of any mechanical components. To access the batteries, one must lift the vehicle's deck. This design choice eliminates complexity and simplifies maintenance, ensuring easy battery replacement without the need for additional mechanical parts or tools.

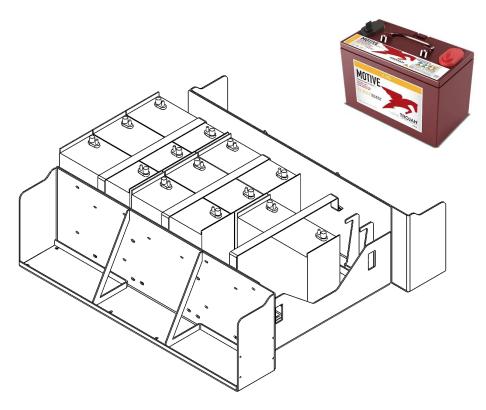
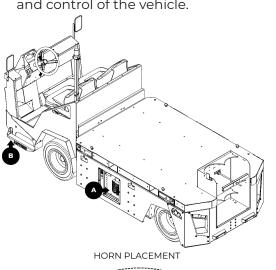


Figure 5. Standard Battery Compartment (84 V).

3.3 ELECTRICAL SYSTEMS

NOTE 1: In the vehicle system, there are two AC motor controllers, one for each motor. The first controller functions as the master controller, while the second serves as the slave controller. Although not depicted in the figure, the slave controller is positioned in parallel on the opposite side of the vehicle. It receives signals from the master controller, ensuring coordinated operation of both motors for effective propulsion and control of the vehicle.



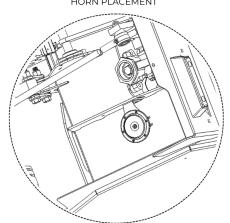


Figure 6. b. Electrical System
Compartments Detail B.

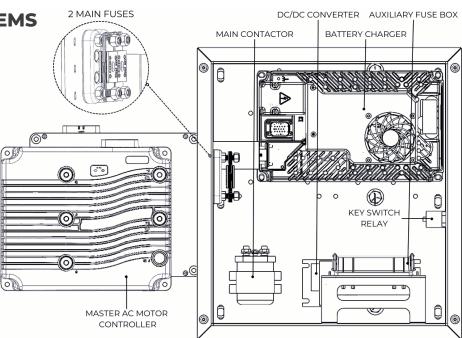


Figure 6. a. Electrical System Compartments Detail A.

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 voltage is also converted to AC voltage by the AC motor controllers to power the AC motors.
- The Auxiliary Energy: which powers the different accessories of the vehicle (backup alarm, horn, console, light strobe, etc.) (12V).
- The Charging Energy: which charges the batteries.

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

NOTE 2: The vehicle's frame is not to be considered as a ground. No component is connected to the frame as a closed-circuit loop.

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

3.3.1 MAIN ENERGY

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

The energy flow originates from the batteries and passes through the two main fuses and contactors before reaching the two AC motor controllers. These controllers utilize the DC voltage to power various components and convert the DC voltage to AC to drive the two AC motors.

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

3.3.2 AUXILIARY ENERGY

To power the auxiliary systems of the vehicle, including the backup alarm, lights, horn, and others. The DC-DC converter utilizes the battery voltage (84 VDC) and converts it to an output of 12 VDC / 13.4 VDC. This voltage is then directed through the auxiliary fuse box and distributed to the vehicle's accessories.

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

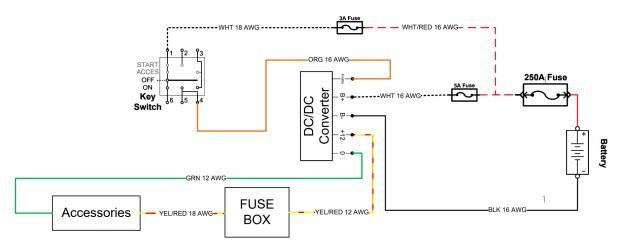


Figure 7. Auxiliary Energy Electrical connection (Annexe 5).

3.3.3 CHARGING ENERGY

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

All MC-680 vehicles are equipped with onboard chargers, customized to match the battery type of the vehicle and battery voltage of 84V and. The charger is designed to efficiently manage the charging process, ensuring optimal performance and longevity of the batteries.



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.

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For battery charging, the charger obtains voltage from the wall outlet 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.

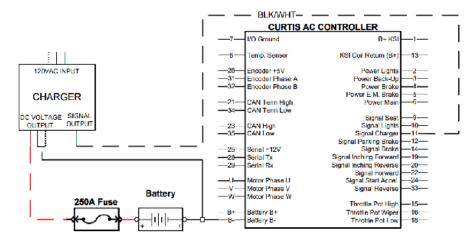


Figure 8. Charging Energy Electrical connection (Annexe 5).

3.4 MOTORS AND REAR AXLE

The PMS621 planetary gear motor is designed for applications requiring high torque and reliability. It is composed of three independent and integral parts:

- 1. The electric motor (1): Provides the driving force for the gear system, featuring a robust construction for demanding environments.
- 2. The planetary reduction gearboxes (2): Deliver high torque and efficiency through a compact and efficient gear arrangement.
- **3.** The main housing (3): Encloses and safeguards the internal braking components, featuring a wet disk braking system that enhances control and safety.

This vehicle is equipped with two motors at the back, each powered by a 3-phase current supplied by its own AC motor controller, one on each side of the vehicle. For more detailed information, please refer to section 3.3.1 MAIN ENERGY. Additionally, the motors feature regenerative braking functionality, enabling the vehicle to decelerate without relying solely on friction brakes and allowing a portion of the deceleration energy to be returned to charge the batteries.

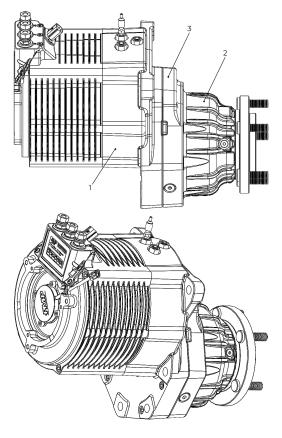


Figure 9. Drive Axle of MC-680.

3.4.1 REGENERATIVE BRAKING

The regenerative braking feature of the AC motor is specific to the drive wheels of the vehicle. It utilizes the motor's electrical resistance to assist in decelerating the vehicle while simultaneously recharging the batteries. By adjusting the amount of electrical current flowing through the motor, the behavior of regenerative braking can be modified.

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.



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.

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Although MOTREC optimizes this feature to deliver significant advantages such as enhanced energy efficiency, prolonged battery lifespan, minimized mechanical brake wear, and the ability to capture and repurpose dissipated heat energy, it may prove overly aggressive for specific applications. Fortunately, the level of deceleration can be customized through the display screen. For detailed instructions on adjusting the regenerative braking settings, please consult the TECHNICAL TRAINING section available on the dealer portal.

3.5 HYDRAULIC PUMP

The hydraulic pump (1) is driven by the motor (3) connected throughout to the motor-pump adapter (4), ensuring a continuous supply of hydraulic pressure. It draws hydraulic fluid from the integrated reservoir (2), pressurizes it, and directs it to the orbitrol and then to the cylinder. Additionally, it directs the pressurized hydraulic fluid to the drive unit at the back of the car for the parking brakes, ensuring effective operation.

Proper maintenance of the hydraulic pump is essential to ensure optimal steering performance. Regular checks for leaks and maintaining appropriate fluid levels are crucial for the longevity of the pump and the overall safety of the vehicle.

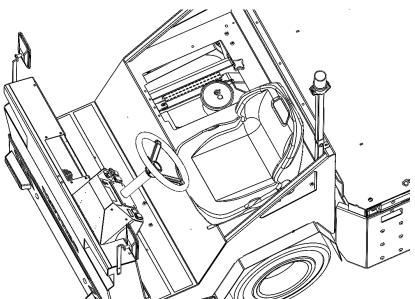
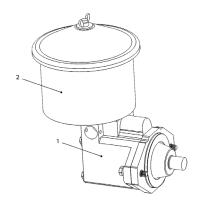


Figure 11. Hydraulic pumps Compartement.



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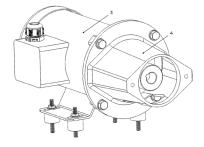


Figure 10. Hydraulic pump (1) / integrated reservoir (2) and Axial Piston Hydraulic Motor (3) / Motordifferential adapter (4) Assembly.

NOTE: To access the hydraulic pump compartment, the passenger side seat must be lifted.

3.6 STEERING SYSTEM

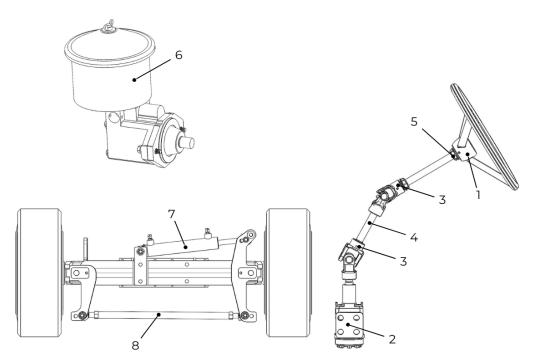


Figure 12. Steering System.

When the driver turns the steering wheel (1), the rotational motion is transmitted to the orbitrol (2) via the universal joint (3), the steering shaft (4) and igus bushing (5). In essence, the orbital steering unit takes the hydraulic pressure generated by the hydraulic pump (6) and channeled it towards the steering cylinder (7) to be converted into mechanical force to control the movement of the vehicle's wheels, prompting the wheel to turn as required. This coordinated movement is mirrored by the opposite wheel through an interconnected linkage system (8).

Collectively, these components harmonize their functions, allowing the driver's touch to translate into precise wheel movements, ensuring effortless steering, and ultimately, enhancing the vehicle's navigation and maneuvering capabilities.

A 180-degree steering sensor, connected to the front axle of the vehicle, utilizes a potentiometer to detect the angle of the front wheels. This data is then transmitted to the Master AC controller, which communicates with the Slave AC controller. The Master controller orchestrates adjustments to both propulsion and steering mechanisms based on the steering angle input. With two AC motors per rear wheel, each managed by its own controller, this setup ensures synchronized and precise vehicle movement, enhancing maneuverability and stability.

Figure 12. The 180-degree steering sensor.

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3.7 BRAKE SYSTEM

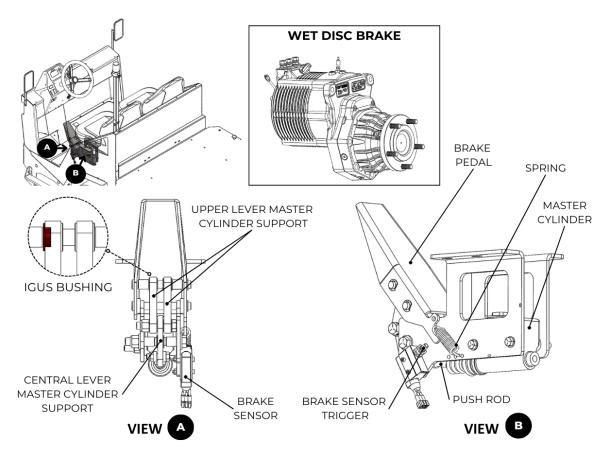


Figure 13. Brake System.

When the driver presses the brake pedal, it initiates the braking process by moving the push rod, which transmits the force to the master cylinder. The master cylinder converts this mechanical force into hydraulic pressure that is sent to the brake mechanisms. The limit switch detects the pedal's position and can activate brake lights to signal to others that the vehicle is slowing down, moving backwards, or coming to a stop. The spring ensures the pedal returns to its original position when released. Upper and central lever master cylinder supports provide structural alignment, while igus bushings reduce friction and wear, ensuring smooth and reliable operation.

When the accelerator pedal is released, the controller engages the regenerative braking in the "coasting" state. This slows down the vehicle using the electrical current produced by the rotating motor armature and charges the batteries. When the brake pedal is depressed, the controller engages the "braking" state of regenerative braking, making the vehicle slow down even more. This maximizes the amount of energy recovered from the deceleration and minimizes brake wear.

NOTE: Refer to *TECHNICAL TRAINING* on the dealer portal for more information on regenerative braking and its settings.

3.8 SUSPENSIONS

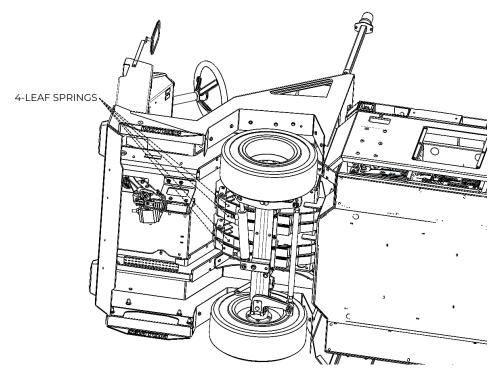


Figure 14. Suspensions.

As the default configuration, all MC-680 models feature a leaf spring suspension at the front. This design effectively stabilizes the vehicle by evenly distributing weight, absorbing road shocks and vibrations, and enhancing overall handling. The simplicity, reliability, and impressive load-carrying capacity of the leaf spring suspension make it a practical choice, providing a comfortable and stable ride.

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 15.a. General Components Detail A.

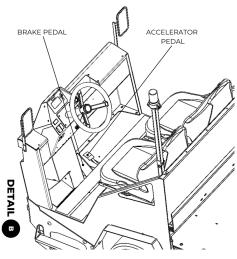
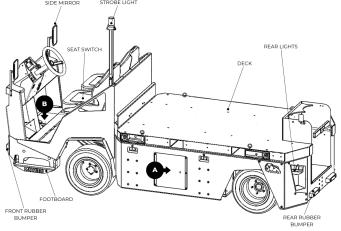


Figure 15.b. General Components Detail B.



Figure 15.c. General Components Detail C.



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Figure 15.d. General Components.

Seat Switch

The seat switch in every driver's seat acts as a dead man's switch, requiring operator pressure. Additionally, there's a 3-second delay for the vehicle to stop if pressure is lost.

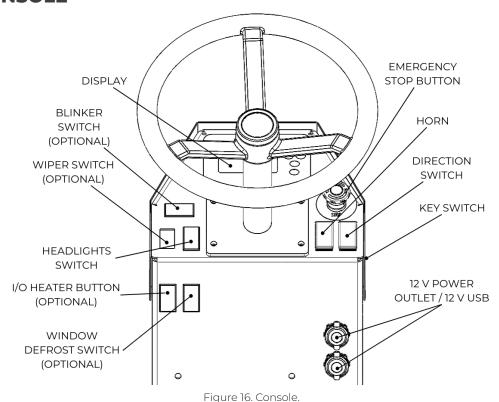
Charging port

The charging port is conceived for standard wall outlets, such as:

- 120 VAC, 60 Hz North American outlets.
- 240 VAC, 50 Hz European outlets (If paired with the compatible connector).

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3.9 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.

Display

It conveys information effectively and facilitate communication between the system and the user, providing a visual representation of data or content in a clear and understandable manner.

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.

3.9.1 DISPLAY

Parking Brake

This indicator lights up when the parking brake is engaged (if appicable).

For models equipped with the EMB, the indicator lights up every time the vehicle comes to a stop, since the EMB engages automatically and acts as a parking brake.

Headlights Indicator

Lights up when the headlights are ON.

Maintenance

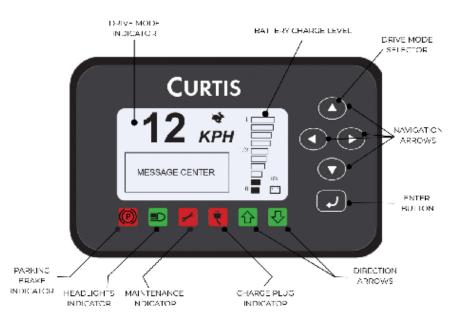
This indicator lights up when the maintenance timer has reached its limit, or when one of the systems has encountered a problem and requires further investigation.

Direction Arrows (Forward/ Reverse)

indicators These light up depending on the drive toggle's position to inform the operator of the direction the vehicle will move.

Navigation Arrows

Theses buttons are to be used when navigating through the operator interface.



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Figure 17. Display.

Enter Button

This button is to be used when selecting an option in the operator interface. When the button is held down, it initiates the opening of menus.

Drive Mode Selector

During operation, the up arrow is also used to change the drive mode between turtle and rabbit for a different vehicle speed.

Drive Mode Indicator

Indicates the current selected drive mode between rabbit and

Battery Charge Level

Indicates the state of charge of the batteries.

Vehicle Runtime

Indicates the total vehicle runtime. The engine runtime is only calculated while the vehicle is in motion and defines the interval of the preventive maintenance.

For more information, refer to section 4.2 PREVENTIVE MAINTENANCE.

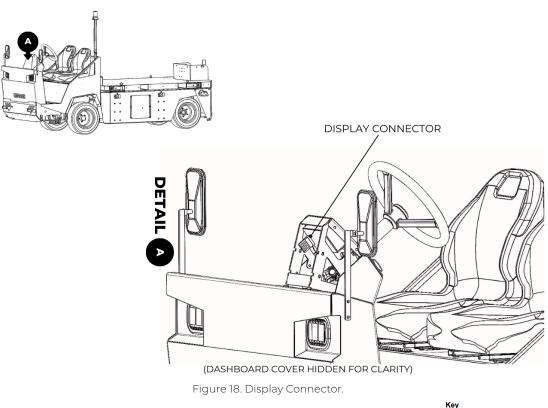
3.9.2 OPERATOR INTERFACE

Login Credentials

In order to access and modify the vehicle settings through the driver console, specific passwords need to be entered based on the desired settings. For MOTREC settings, the password "3050" is required.

Four Pin Diagnostics Connector

To access an advanced operator interface, you can connect a Curtis handheld programmer to the four-pin diagnostics connector located at the right side of the console's kick panel. It's important to note that the display connector (refer to Figure 18) needs to be disconnected each time the handheld programmer is used.



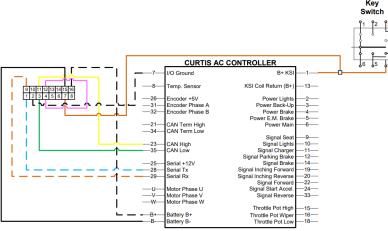


Figure 19. Display Connector Electrical connection (Annexe 5).

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Vehicle Speed



WARNING

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

Prior to changing the maximum vehicle speed, check that the speed modification is truly required by the operator and validate with MOTREC that the speed won't affect the integrity of the vehicle.

To modify the maximum speed:

- 1. Turn the ignition key to ON.
- 2. Hold the **Enter** button for 5 seconds.
- 3. Select MOTREC Settings.
- 4. Select Input Password.
- 5. Enter the password: 3050.
- 6. Navigate as follows: Programmer → Program → MOTREC Parameters → MOTREC Speed Limits (KMH) → KMH Max Speed Limits → Rabbit FWD Max Speed.
- 7. Press the right arrow.
- 8. Adjust the speed value using the up/down arrows.
- 9. Press the left arrow to exit the value modification.
- 10. Select Exit.
- 11. Turn the ignition key to OFF.

3.9.3 ALARMS AND FAULTS

While operating the vehicle, the display screen may display warnings to alert the driver about vehicle-related events. Each MOTREC vehicle is equipped with a controller that relies on input signals, processes information, and generates output commands. In the event of a malfunction, the controller will generate a fault code to indicate that it has detected a situation that falls outside the specified parameters. These fault codes are stored in the controller's memory until they are cleared.

It is recommended to begin by reading the fault codes in order to diagnose any issue. This will provide valuable information about the nature of the problem.

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

3.10 REAR LIGHT COLORS SIGNIFICATION

There are four available rear light colors in the vehicle, which are as follows: white is used for reversing, pale red (standard) indicates vehicle startup, the intensity of pale red increases under braking becomes Intense Red, and orange (if applicable) activates as a turn signal when available in the vehicle. 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 MC-680 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 MC-680 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. 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.



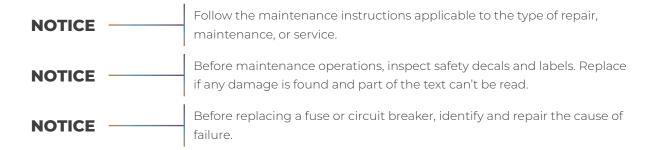
CAUTION

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 AC MOTOR CONTROLLER. FAILURE TO COMPLY COULD CAUSE CRACKING OF THE TERMINAL OR BATTERY POST WELDS.



4.1.1 LIFTING POINTS

Please refer to the serial data plate (see Figure 20), 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 21) 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.

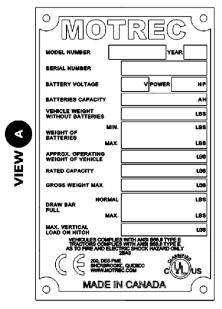


Figure 20. Serial Data Plate.

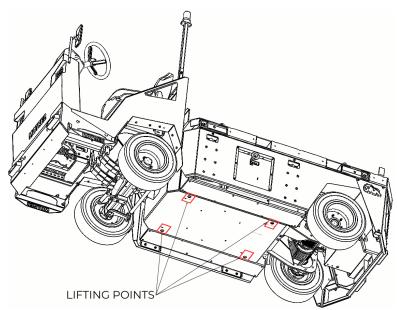


Figure 21. Lifting Points With Batteries.

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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 ACIDSPLASHING. 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 deck (see page 10 for deck lifting procedures).
- 5. Disconnect the negative (-) terminal (1) of the last battery.
- 6. Disconnect the positive (+) terminal (2) of the first battery at the main fuse (3).

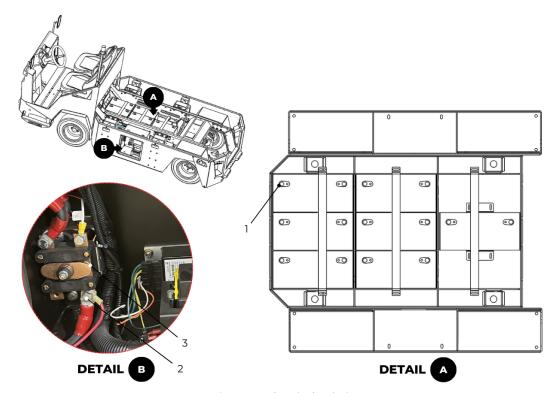
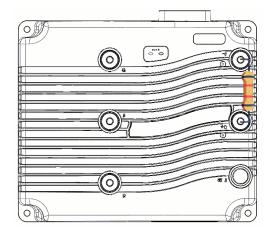


Figure 22. Electrical Isolation.

- 6. Discharge the capacitor in the master controller (4) by connecting a 10-ohm, 25-watt resistor (5) across the B+ and B- terminals of the master controller (4) for a few seconds. Do not leave the resistor (5) connected after the capacitor is discharged.
- 7. Next, use a multimeter to confirm there is no voltage between the **B+** and **B-** terminals of the master controller (4).
- 8. Repeat this process for the slave controller, which is positioned in parallel to the master controller on the opposite side of the vehicle.
- 9. To reconnect the electrical circuit, perform this procedure in reverse.

NOTE: No resistor needed for reconnection.



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Figure 23. AC Motor Controller Terminals.

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.



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 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. The vehicle runtime can be found on bottom left of the display screen when starting the vehicle.

Maintenance Timer Reset

When the vehicle reaches its predefined vehicle runtime limit, the vehicle speed will be reduced and the fault code 54 will appear on the dashboard to inform the operator that maintenance is due. It does not indicate a defect of any sort.

Once the preventive maintenance is completed, the timer must be reset, and the fault code erased. The timer can be reset as follows:

- 1. Put the ignition key ON.
- 2. Hold the **Enter** button for 5 seconds.
- 3. Select Operation Menu.
- 4. Select Reset Maintenance Monitor.
- 5. Select **Reset** and exit.

It could take up to 2 minutes of vehicle run time for the fault code to disappear.

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 or the brake system. The vehicle may be lifted for further inspection of this symptom as required.

NOTE: It is possible that a small amount of grease may leak from the steering gearbox in excessively heated environments. Only cleaning is required in this situation.

Proceed as follows to inspect:

1. Inspect the master cylinder (1) through the opening.

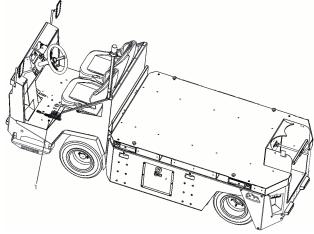


Figure 24. Front Fluid Leaks

2. Inspect the drive assembly (2) for signs of leaks at following locations:

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- Shaft Seals: Inspect the output shaft seals. These seals are common sources of leaks due to wear and tear or improper installation.
- Gaskets and Seals: Examine all gaskets and seals around the gearbox housing. These are critical for maintaining a leakproof assembly and can degrade over time.
- **Gearbox Housing**: Check the gearbox housing for any signs of cracks or damage. Even small cracks can lead to significant leaks.
- Drain and Fill Plugs: Inspect the drain and fill plugs for proper sealing. Ensure that the plugs are tightened to the correct torque specifications and that the washers or gaskets are intact.

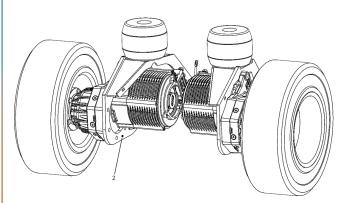


Figure 25. Drive Assembly Fluid Leaks.

Steering Inspection

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

Horn and Lights Inspection

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

Seat Switch Inspection

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



WARNING

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

Accelerator Pedal Inspection

- 1. Inspect the accelerator pedal for free movement and proper return spring tension.
- Test the accelerator pedal's sensitivity and response. It should provide a smooth and predictable increase in motor as the pedal is pressed. Any delays or irregularities in the response may indicate a problem.

Brake Pedal Inspection

- 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 pedal for free movement and firm pedal.

Emergency Button Inspection

1. Visually inspect the button for any visible damage or irregularities.

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2. Test the emergency button to verify that it activates as intended. Ensure it depresses and releases smoothly without any sticking.

4.2.2 WEEKLY MAINTENANCE

Special Tools	Consumables
▶ Oil recipient / Drain pan	► Hydraulic pump oil : ISO 32
► Safety glasses and gloves	► Gearbox Oil : AE 80W90 / API GL5

NOTICE	Replace any defective component found during the inspection listed in this procedure.
NOTICE	The daily maintenance should be carried out concurrently with this maintenance. Certain steps may not be necessary due to redundancy.
NOTICE	Perform "Gearbox Oil Replacement" after the first 100 hours of operation. Subsequently, repeat these tasks at intervals of 1000 or 1 year.

Maintenance Procedures

Gearbox Oil Replacement

- 1. For oil-draining operation, follow the steps below:
 - 1. 1. Place an oil drain pan beneath the gearbox to catch the draining oil.
 - 1. 2. Loosen and remove the drain plug (1) at the bottom of the gearbox (see figure 26).
 - 1.3. Allow the old oil to drain completely into the oil drain pan.
 - 1.4. Once the oil has drained completely, replace, and tighten the drain plug (1). The appropriate torque value is 24 ft lbs.
- 2. For oil-refilling operation, follow the steps below:
 - 2. 1. unscrew the fill plug (2) and level plug (3) (see figure 26).
 - 3. 2. Pour the recommended gearbox oil 0.4 L into the fill plug (2) hole slowly. Continue filling until oil begins to seep out of the level plug (3) hole, indicating that the gearbox is full.

NOTE: Due to the structure of the unit, the oil filling operation could be slow, to allow the complete filling of the chambers.

- 2. 3. Reinstall the level and fill plugs, then tighten them to a torque of 23 Nm.
- 3. Wipe away any spilled oil and clean the area around the plugs.

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- 4. Start the engine and let it run for a few minutes.
- 5. Turn off the engine and recheck for any leaks around the fill and level plugs.

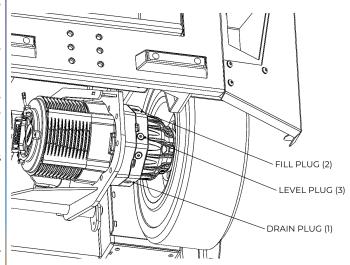


Figure 26. Plugs Positioning: Level, Fill, and Drain Plugs.

Static Strap Inspection

Check the static strap (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.

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Tire Pressure Inspection

Check that each tire maintains a pressure rating within the range of 100 psi. Additionally, thoroughly inspect the tires for any signs of of punctures, damage or excessive wear.

Hydraulic pump inspection

Follow these steps to check the oil level in the hydraulic pump and tank:

- 1. Locate and Clean: Park on a level surface, turn off the engine, and locate the power steering fluid reservoir (1). Clean the area around the cap.
- 2. Check Fluid Level: Remove the cap and check the fluid level using the dipstick or the markings on the reservoir.
- 3. Add Fluid if Needed: If the level is low, add the recommended power steering fluid (Hydraulic pump oil: ISO 32) until it reaches the correct level.
- 4. Secure and Inspect: Replace the cap securely and check for any leaks around the reservoir and hoses.

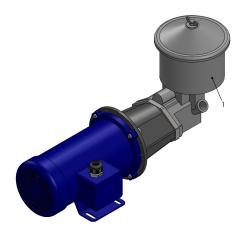


Figure 27. Hydraulic pump Oil Level Check.

EVERY 250 HOURS OR 3 MONTHS MAINTENANCE 4.2.3

Special Tools	Consumables
▶ Resistor: 10 ohms, 25 W	► Multi purpose Grease
► Lifting device	► Ammoniac

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 control panel (1).
- 2. Remove the dashboard cover (2).
- 3. If necessary, lift the deck by following the procedures outlined on page 10.

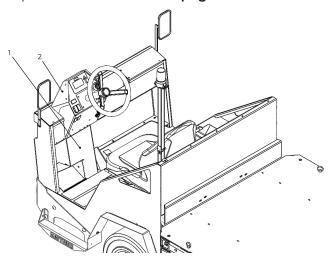


Figure 28. Kick Panel and Dashboard Cover.

4. Take the necessary steps to remove electrical hazards in accordance with Section 4.1.2 **ELECTRICALLY ISOLATING THE VEHICLE** page 29, which provides guidelines for electr ically isolating the vehicle.



WARNING

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

Maintenance Procedures

Suspension Inspection

- 1. Inspect the following equipment for damage, corrosion, cracks or oil stains:
 - Front leaf springs (1) and their fixtures (2).
 - Rear hollow rubber springs (3).
- 2. Inspect all suspension frame bearings for play.
- 3. Examine the bushings and mounts for wear or damage.

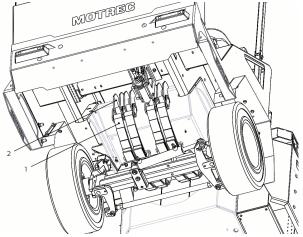


Figure 29. Suspension Inspection.

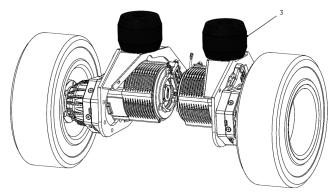


Figure 30. Hollow Rubber Springs Inspection.

Rubber Bellows Inspection

Inspect rubber bellows installed on the vehicle components for signs of damage, cracks or dryness.



Figure 31. Front Rubber Bumper Inspection.

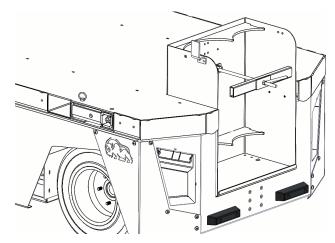


Figure 32. Rear Rubber Bumper Inspection.

Steering Inspection

- 1. Inspect the universal joint (1) and the four tie rods ends (2) for (See Figures 33 and 34):
 - Play.
 - Damage.
 - Binding.
 - Corrosion.

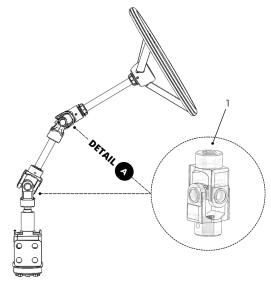


Figure 33. Universal Joints Inspection.

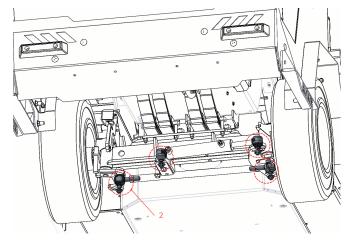


Figure 34. Tie Rods Ends Inspection.

- 2. Inspect the following elements for damage, corrosion or loose:
 - Steering cylinder (3). (See Figure 35)
 - Steering shafts (4). (see Figure 12 page 19 part no. 4).
 - Axle beam (5). (See Figure 35)
 - Right and left spindles (6). (See Figure 35)
 - Tie rod (7). (See Figure 3)

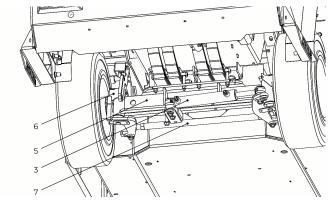


Figure 35. General Steering Inspection.

Grease Fittings Lubrication

Lubricate the grease fittings of the following components (See Figures 33 and 34 on page 37) using multi-purpose grease:

- The universal joint (1).
- The four tie rods end (2).
- Steering shaft (see Figure 12 page 19 part no. 4).
- Kingpin (see Figure 36)

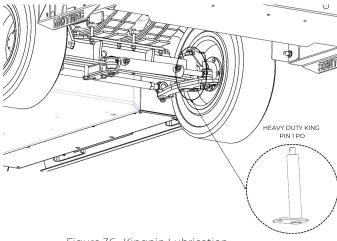


Figure 36. Kingpin Lubrication.

Lubrication

Lubricate the following components by using a lubricant spray:

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- Master cylinder push rod (see Figure 13 page 20).
- Igus bushing in the brake system (see Figure 13 page 20).
- Igus bushing in the right and left rear axle (see Figure 37).

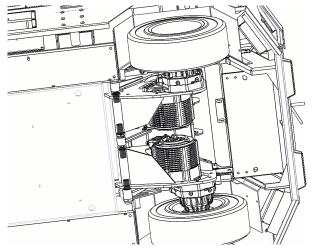


Figure 37. Rear Axle Igus Bushings Inspection.

- Platform jacks screw (acme screw) (see Figure 3 page 10- part no. 4).
- Lock-in screw (see Figure 3 page 10- part no. 1).

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.

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- 1. Inspect the batteries for the following elements:
 - Loose connections.
 - Damaged cables.
 - Cracked batteries.
 - 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. Reinstall the kick panel.
- 3. Reconnect the electrical circuit:
 - i. Reconnect the battery leads.
 - ii. Turn on all switches and test lights.
 - iii. Insert the key.
- 4. Test drive the vehicle:
 - i. Turn the steering wheel and feel for excessive play.
 - ii. Switch the drive mode from Turtle to Rabbit and test the speed.
 - iii. Depress and release the accelerator to test the electromagnetic brake.
 - iv. Listen for abnormal noise.
- 5. Reinstall the deck if it was lifted.

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4.2.4 EVERY 500 HOURS OR 6 MONTHS MAINTENANCE

Special Tools	Consumables
► Resistor: 10 ohms, 25 W	► ISO 32 fluid brake ► Gearbox Oil : AE 80W90 / API GL5

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.

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.

 Take the necessary steps to remove electrical hazards in accordance with Section 4.1.2 ELECTRICALLY ISOLATING THE VEHICLE page 29, which provides guidelines for electr ically isolating the vehicle.



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

2. If necessary, lift the deck by following the procedures outlined on page 10.

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 the following elements:
 - Cracks.
 - Damage.
 - Corrosion.
- 2. The following frame locations should be inspected with care:
 - Side panels corners (1) and footboard sides
 (2) (on both sides). There is a possibility of cracks occurring in these corners as they undergo significant stress (see Figure 38).
 - Front and rear suspension mounting tabs
 (3) (see Figure 39).
 - Ladder frame support union plates (4) and weld zones (5) (see Figure 40, not all welds are shown).

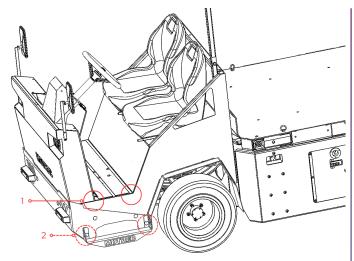


Figure 38. Side Panels and Footboard Sides.

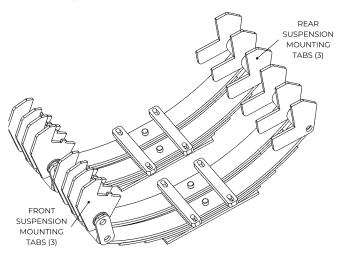


Figure 39. Front and Rear Suspension Mounting Tabs.

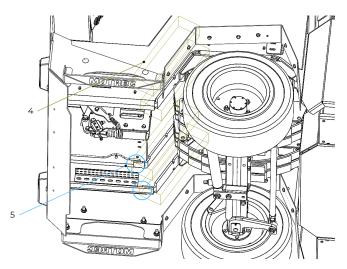


Figure 40. Ladder Frame Support UnionPlates and Weld Zones.

- 6. Reinstall the brake drum (3)
- 7. Reinstall the wheel (2) and the wheel nuts (1). Torque the wheel nuts (1) to standard values. The appropriate torque value is 80 ft lbs.

Brake System Inspection

- 1. Inspect the brake system components for signs of corrosion, damage or leaks.
- 2. Inspect the brake fluid level in the master cylinder (1) placed underneath the master pedal mat. Refill with ISO 32 fluid brake if required.

NOTE: A low level of brake fluid may indicate either brake wear or fluid leaks.

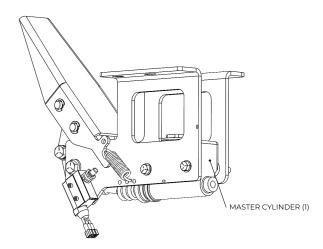


Figure 41. Brake System Inspection.

Front Wheels Bearings Inspection

Inspect all wheel bearings for:

- Play.
- Stiffness.
- Abnormal noise.

NOTE: Please refer to page 43, specifically the "Front Wheel Bearings Maintenance" section, for instructions on replacing the bearing.

Kingpins Inspection

- 1. Inspect the kingpins (1) assembly of the two front wheels for the following:
 - Play.
 - Damage.
 - Corrosion.
- 2. Inspect the condition of the castle nut (2) and the cotter pin (3).

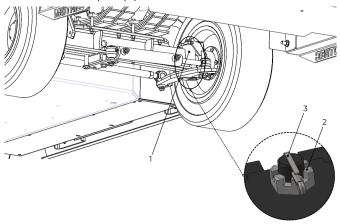


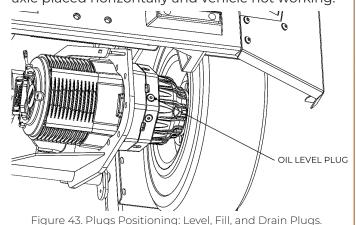
Figure 42. Kingpins Inspection.

Oil Level Check: Inside The Gearbox

To perform an oil check, follow these steps:

- 1. Unscrew the gearbox oil level plug (refer to Figure 43).
- 2. Verify the oil level, it should be near the oil level plug hole.

NOTE: Verification of oil level inside the gearbox shall be done under normal operative conditions: axle placed horizontally and vehicle not working.



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.

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- 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. Switch the drive mode from Turtle to Rabbit and test the speed.
 - iii. Depress and release the accelerator to test the electromagnetic brake.
 - iv. Listen for abnormal noise.
- 3. Reinstall the deck if it was lifted.

Special Tools	Consumables
▶ Resistor: 10 ohms, 25 W▶ Oil recipient / Drain pan	 ► ISO 32 fluid brake ► Hydraulic pump oil: ISO 32 ► Bearing grease ► Hub Seal ► Cotter pin (Size: 1/8x2)

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.

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.

 Take the necessary steps to remove electrical hazards in accordance with Section 4.1.2 ELECTRICALLY ISOLATING THE VEHICLE page 29, which provides guidelines for electr ically isolating the vehicle.



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

2. If necessary, lift the deck by following the procedures outlined on **page 10**.

Maintenance Procedures

Front Wheels Bearings Maintenance

- 1. Chock the rear wheels.
- 2. Remove the wheel nuts (1) and wheel (2).

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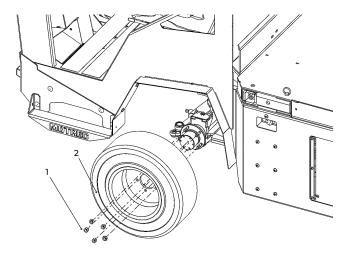
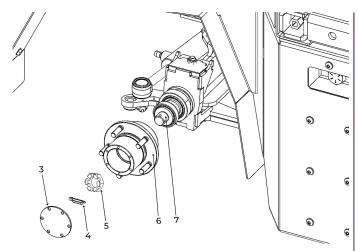


Figure 44. Wheel Removal.

- 3. Remove the dust cap (3).
- 4. Remove the cotter pin (4) and unscrew the castle nut (5).
- 5. Remove the hub (6) from the spindle (7).

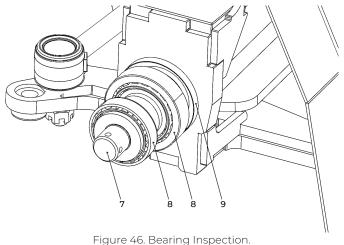


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MAINTENANCE

Figure 45. Cotter Pin, Castle Nut and Hub Removal.

- 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 103 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).
- 15. Reinstall the dust cap (3).
- 16. Reinstall the wheel (2) and the wheel nuts (1). Torque the wheel nuts (1) to standard values. The appropriate torque value is 80 ft lbs.



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Hydraulic pump Oil Replacement

Here are the steps to change the hydraulic pump

A. Oil change:

- Place a drain pan beneath the hose connection point to catch the oil.
- 2. Carefully loosen the hose clamp (1) using appropriate tools to disconnect the hose from the pump.
- 3. Allow the old oil to drain completely from the pump and hose into the drain pan.
- 4. Once all the old oil has drained out, reattach the hose to the pump.
- 5. Tighten the hose clamp securely to ensure there are no leaks.
- 6. Remove the cap from the reservoir to access the fill opening.
- 7. Pour ISO 32 power steering oil into the reservoir until it reaches the recommended level indicated on the reservoir or in the vehicle's manual.
- 8. Replace the cap tightly to prevent any leaks.

B. Check for leaks:

- 1. Start the engine and let it run for a few minutes to circulate the new oil throughout the system.
- 2. Check around the hose connection and reservoir for any signs of leaks.

3. If any leaks are detected, turn off the key and tighten the connections as necessary.

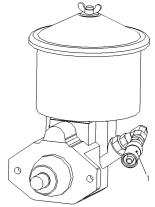


Figure 47. Hydraulic pump Oil Change.



! WARNING

ENSURE THAT THE HYDRAULIC SYSTEM IS SHUT OFF AND DEPRESSURIZED BEFORE STARTING ANY MAINTENANCE WORK. THIS WILL PREVENT ACCIDENTAL MOVEMENT OF HYDRAULIC COMPONENTS AND REDUCE THE RISK OF INJURY.



WARNING

WEAR APPROPRIATE SAFETY GEAR, INCLUDING GLOVES AND GOGGLES, TO PROTECT YOURSELF FROM HYDRAULIC FLUID AND OTHER CONTAMINANTS.

Brake System Inspection

- 1. Inspect the brake system components for signs of corrosion, damage or leaks.
- 2. Inspect the brake fluid level in the master cylinder (1) placed underneath the master pedal mat. Refill with ISO 32 fluid brake if required.

NOTE: A low level of brake fluid may indicate either brake wear or fluid leaks.

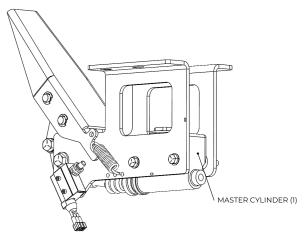


Figure 48. Brake System Inspection.

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.

- 3. 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. Switch the drive mode from Turtle to Rabbit and test the speed.
 - iii. Depress and release the accelerator to test the electromagnetic brake.
 - iv. Listen for abnormal noise.
- 3. Reinstall the deck if it was lifted.

4.2.6 EVERY 2000 HOURS OR 24 MONTHS MAINTENANCE

Special Tools	Consumables
► Lifting device	▶ ISO 32 brake fluid

NOTICE _____

The 1000 hours or 12 months preventive maintenance should be carried out concurrently with this maintenance. Certain steps may not be necessary due to redundancy.

Maintenance Procedures

Hydraulic Brake System Fluid Maintenance

NOTE: The most recommended approach for brake fluid replacement is utilizing a bleeder ball tank or a comparable automatic bleeding device. Alternatively, repetitive manual bleeding is also acceptable.

- 1. If required, lift the vehicle using a lifting device as per section 4.1.1 LIFTING POINTS.
- 2. Remove the master cylinder's (1) cap.
- 3. Bleed rear wheel brakes one at a time:
 - iv. Fill the master cylinder (1) with ISO 32 brake fluid, then reinstall the master cylinder's (1) cap.
 - ii. Bleed the rear brakes one at a time by having someone apply steady pressure on the brake pedal (2), open the bleeder valve (5) and fully depress the pedal by maintaining the pedal all the way down, and then close the bleeder valve (3) before allowing the brake pedal (2) to return to the up position. Repeat this process multiple times.

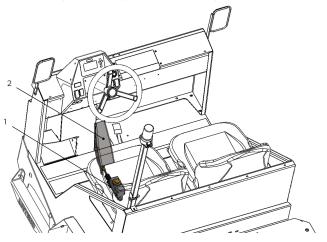


Figure 49. Brake System Bleeding.

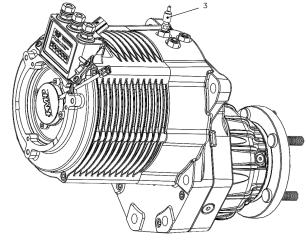


Figure 50. Rear Bleeding.

- 4. Once bleeding is completed, top-up the master cylinder (1) with ISO 32 brake fluid.
- 5. Reinstall the master cylinder's (1) cap.
- 6. Clean every fitting and line and remove traces of oil.

NOTE: Exercise with caution as oil fluid can potentially damage the paint.

- 7. Apply continuous pressure on the brake pedal for about ten seconds. Note any loss of pressure.
- 8. Inspect the brake lines and fittings for leaks.

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4.3 CORRECTIVE MAINTENANCE

4.3.1 ACCELERATOR

The accelerator cannot be repaired or serviced. Its maintenance only allows for inspection to verify the correct electrical values.

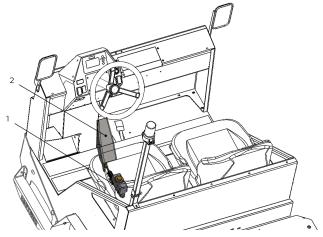
4.3.2 HYDRAULIC BRAKES

Brake Pedal Bleeding

If the brake pedal becomes soft or spongy, air may have entered the hydraulic system and the brake system must be bled.

NOTE: The most recommended approach for brake fluid replacement is utilizing a bleeder ball tank or a comparable automatic bleeding device. Alternatively, repetitive manual bleeding is also acceptable.

- 1. If required, lift the vehicle using a lifting device as per section 4.1.1 LIFTING POINTS.
- 2. Remove the master cylinder's (1) cap.
- 3. Bleed rear wheel brakes one at a time:
 - iv. Fill the master cylinder (1) with ISO 32 brake fluid, then reinstall the master cylinder's (1) cap.
 - ii. Bleed the rear brakes one at a time by having someone apply steady pressure on the brake pedal (2), open the bleeder valve (5) and fully depress the pedal by maintaining the pedal all the way down, and then close the bleeder valve (3) before allowing the brake pedal (2) to return to the up position. Repeat this process multiple times.



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Figure 51. Brake System Bleeding.

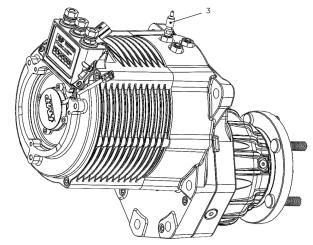


Figure 52. Rear Bleeding.

- 4. Once bleeding is completed, top-up the master cylinder (1) with ISO 32 brake fluid.
- 5. Reinstall the master cylinder's (1) cap.
- 6. Clean every fitting and line and remove traces of oil

NOTE: Exercise with caution as oil fluid can potentially damage the paint.

- 7. Apply continuous pressure on the brake pedal for about ten seconds. Note any loss of pressure.
- 8. Inspect the brake lines and fittings for leaks.

4.3.3 FRONT AXLE AND STEERING

Procedures

Toe-In Adjustment

- With the wheels in straight forward direction, measure the inside (left to right) distance between the front tires, at the front and rear of the tires.
- 2. Adjust by turning the tie rod connecting both wheels until the distances are equal and tighten the two lock nuts on the tie rod.

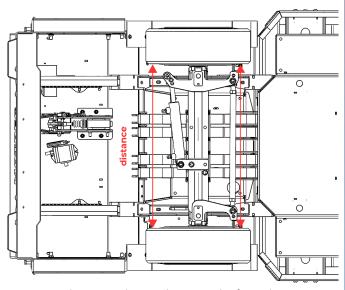


Figure 53. Distance between the front tires.

4.3.4 BATTERY



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.

MARNING

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

Procedures

1. Regular Inspection:

1. 1. Examine the outside appearance of the battery. The tops of the batteries and terminal connections should be clean, dry, and free of corrosion. Terminal corrosion may adversely affect the performance of the battery and present a safety hazard.

(!) CAUTION

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

- 1. 2. If fluid is present on the top of a deep-cycle AES / AGM battery, it may mean that the battery is being overcharged, which can reduce battery performance and life.
- 1. 3. Check battery cables and connections. Replace any damaged cables and tighten any loose connections. Refer to Section 5 "Quick References" for torque values page 76.

(!) CAUTION

A LOOSE BATTERY INCREASES DAMAGING EFFECTS OF VIBRATIONS AND IS MORE PRONE TO SHORT CIRCUITING.

2. Charging:

2. 1. Initial charging: Due to the potential for self-discharge during shipping and storage, batteries should be given a full charge prior to first use. See the next section for details on proper charging.

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Proper charging is imperative to maximize battery performance. Both under and over charging batteries can significantly reduce the life of the battery.

- Use the Right Charger: Always use a Motrec charger and avoid switching to a different type of charger.
- ▶ Charge only in well-ventilated areas.
- ► Temperature compensated charging is desirable for all batteries but should always be used with AES / AGM batteries. Temperature compensation coefficients raise the voltage/cell for temperatures below 77°F (25°C) and lower the voltage/cell for temperatures above 77°F (25°C).
- Never charge a frozen battery.
- Avoid charging at temperatures above 122°F (50°C).



DEEP-CYCLE AES / AGM BATTERIES SHOULD <u>NEVER</u> BE EQUALIZED.

4.3.4 HYDRAULIC STEERING SYSTEM

The hydraulic steering system within your vehicle functions as an integrated ensemble as illustrated in figure 54.

The hydraulic pump serves as the primary source of hydraulic pressure, generating force for the system. The orbitrol steering unit, acting as a central control hub, directs the distribution of hydraulic fluid based on steering inputs. The double-acting cylinder then transforms hydraulic energy into rotational movement, facilitating wheel articulation.

This integrated system ensures a smooth and responsive steering experience, with the hydraulic pump activated in tandem with steering actions, pressure modulation regulated and fluid flow directed by the orbitrol unit.

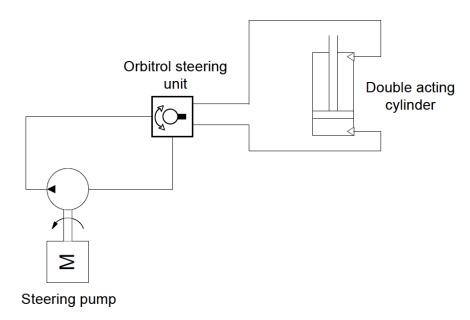


Figure 54. Hydraulic Steering System.

Maintenance procedures

Periodic maintenance of this symbiotic system is imperative to uphold consistent, reliable, and precision oriented steering performance.

To do preventive maintenance of the following elements of a hydraulic system: hydraulic pump, orbitrol steering unit and a double-acting cylinder, proceed as follows:

- 1. Inspect all the hydraulic system components for the following elements:
 - Inspect all components for signs of leaks, damage, or corrosion.
 - Look for loose fittings or connections.
- 2. Check the double-acting cylinder's condition by examining the rod and piston for signs of wear, scoring, and potential alignment issues.
- 3. Examine the hydraulic pump for any signs of damage and ensure that all connections and hoses are secure. Additionally, check the fluid level in the reservoir and inspect for any leaks.

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4.4 TROUBLESHOOTING

PMC Self-Diagnostic Errors

Active fault codes will be displayed on the display to ease troubleshooting. The PMC also comes with a status LED, which gives a flashing code to help troubleshooting.

Reading fault codes should be your first step in diagnosing any issue.

For a list of all the fault codes, refer to section 5 ANNEXES 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 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 fuse terminal (**B+**) and one of the AC 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 55).
 - 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 55).
 - If there is no voltage detected despite the key being ON, it is advisable to examine the key switch relay and 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 55).
 - 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 close to 0 V. Alternatively, consider the voltage drop when measuring between the accessory's terminals.

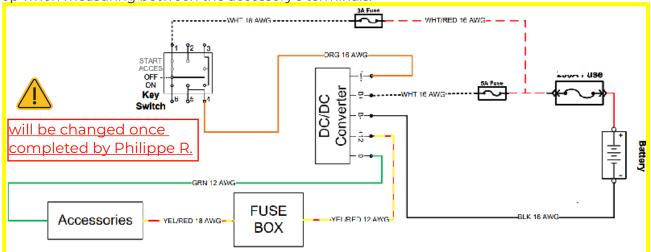


Figure 55. DC/DC Converter Input and Output Terminals Inspection.

4.4.2 BATTERY CHARGER



ALWAYS UNPLUG THE AC AND 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 charging process to re-start.
- 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 the voltage of each individual battery at its connector. Ensure each battery has a voltage above the 75 V threshold, as the charger will not engage if the voltage is below this level. Repeat this process for the entire battery pack.
- 4. Assuming the wiring is intact, if the batteries are low, it prevents the charger from operating. If this is not the case, and there is no voltage output despite power coming into the charger, resulting in no lights and no display of codes, then it is necessary to replace the charger.

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 parking brake.



WARNING

WEAR APPROPRIATE PERSONAL PROTECTIVE EQUIPMENT (PPE) SUCH AS GLOVES AND SAFETY GLASSES TO PROTECT YOURSELF FROM POTENTIAL HAZARDS.

2.1. Hydraulic Pump Operation:

- ► Turn the key to the "on" position.
- Listen for and confirm that the on-board hydraulic pump is activating and functioning correctly.

2.2. Oil Level Check:

- ▶ Open the reservoir and visually inspect the oil level.
- ▶ Ensure the oil level is within the recommended range as indicated on the reservoir.

2.3. Oil Leak Inspection:

- ► Carefully examine the hydraulic system for any signs of oil leakage.
- ▶ Check around all hoses, fittings, and the reservoir for any oil drips or stains.



WARNING

ENSURE THAT THE HYDRAULIC SYSTEM IS SHUT OFF AND DEPRESSURIZED BEFORE STARTING ANY OIL LEVEL OR OIL LEAK INSPECTION. THIS WILL PREVENT ACCIDENTAL MOVEMENT OF HYDRAULIC COMPONENTS AND REDUCE THE RISK OF INJURY.

2. 4. Solenoid Functionality:

▶ Locate the solenoid as illustrated in figure 56.

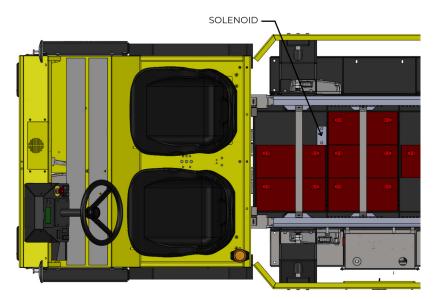


Figure 56. Location of the solenoid in the vehicle.

 Place the multimeter's red (positive) test lead on the power supply terminal of the solenoid (Violet/Black Wire).

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- Place the black (negative) test lead on a ground point or the ground terminal of the solenoid (Black/Orange Wire).
- Verify that the multimeter shows the correct voltage (12V). If there is no voltage, the problem is in the power supply or wiring.
- Listen for the solenoid click when energized, indicating proper operation.

2.5. Pressure Measurement:

- ▶ Measure the hydraulic pressure, it should read more than 7 bar.
 - Turn off the hydraulic system and relieve any built-up pressure before connecting the gauge.
 - Locate the hydraulic test port or an accessible fitting on the hydraulic system where you can connect the pressure gauge.
 - Attach the appropriate adapters or fittings to the gauge to ensure a secure and leakfree connection.
 - Securely connect the pressure gauge to the test port or fitting on the hydraulic system.
 Ensure all connections are tight and leak-free to prevent inaccurate readings and potential hazards.
 - Power up the hydraulic system and allow it to reach normal operating conditions.
 - Observe the pressure gauge and note the reading. The pressure should read more than
 7 bar if the system is functioning correctly.
 - Turn off the hydraulic system and relieve any built-up pressure before disconnecting the gauge.
 - Carefully disconnect the pressure gauge and any adapters or fittings.

2. 6. Verify Pressure Distribution:

- ► Ensure that the hydraulic pressure reaches the rear of the vehicle. This confirms that the pressure lines are properly connected and free from defects or blockages.
- ▶ Inspect the entire length of the pressure lines for any signs of damage, kinks, or leaks that could impede the flow of hydraulic fluid.
- 2.7. If all the above components are functioning correctly and there are no signs of leaks or defective parts, it suggests there may be an internal issue within the drive unit. In such a case, further inspection and possible servicing of the drive unit may be required.

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3. Inspect the Accelerator Pedal

To verify the proper functioning of the accelerator pedal, follow these steps to check the percentage of throttle by accessing the throttle command in the display:

- i. Turn the ignition key to the ON position.
- ii. Hold the ENTER button for 5 seconds.
- iii. Select MOTREC SETTINGS.
- iv. Select INPUT PASSWORD (3050).
- v. Select PROGRAMMER.
- vi. Select MONITOR.
- vii. Select INPUT.

By following these steps, you can monitor the variation of the throttle percentage on the display while stepping on the pedal. This allows you to assess the functionality of the accelerator pedal and ensure it is operating correctly.

4. Inspect the Vehicle

- 1. Ensure that both PMC surfaces are clean and dry:
 - i. Inspect the terminal areas. Dust particles or acid contamination can create current leaks and cause a PMC malfunction.

5. Inspect the Main Contactor

- 5.1 Inspect both 250A fuses situated next to the main contactor.
- 5.2 Verify the presence of voltage at the positive terminal (B+) of the contactor.
- If not, check for any fuse or wiring issues.
- 5.3 Verify the voltage drop between the contactor and the controller's negative terminal (B-), it should be 84V.
- If that's not the case, even if the contactor coil is energized, it is necessary to replace the contactor.
- 5.4 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.



WARNING:

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., 84V) RATHER THAN THE AVERAGE VALUE (E.G., 48V) DUE TO THE IMPLEMENTATION OF PULSE WIDTH MODULATION (PWM).

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Vehicle Moves Forward Only

- 1. Do not place the switch in the reverse position.
- 2. Measure the reverse signal input between pin 33 (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 22 (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.

Vehicle Travels at Reduced Speed



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 the potentiometer (of the main pedal) while monitoring the Throttle command on the display.

Other causes of lower speed:

- a. Dragging brakes.
- b. Cold temperature (effects batteries performance).
- c. Turtle Mode ON.
- d. Check for the following fault codes: 17, 22, 28, 29, and 54.

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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 (Static Return To Off) safety feature. 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 28 is displayed (Refer to Section 5 Annexes for a complete list of all codes).

180 Degrees Steering Sensor SAS Examination

- 1. Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving.
- 2. Ensure the wheels are in the straight-ahead position.
- 3. Read the "Steer Angle Max (deg)" value on the display. It should be 0 degrees.
 - 3.1. To access the steering angle monitoring value, follow these steps:
 - A. Hold the **Enter** button for 5 seconds.
 - B. Select "Advanced Settings".
 - C. Enter the password: 1988.
 - D. Navigate as follows: **Programmer** → **Program** → **Dual Drive** → **Manager** → **Steer Angle Max** (deg).
 - 3.2. If the maximum steering angle is not 0 degrees, adjust the 180-degree (90° in one direction and 90° in the other direction) steering sensor as follows:
 - A. Use a screwdriver to remove the screws (1) and (2) on the sensor to enable its movement (the screws positions are indicated in figure 57).
 - B. While monitoring the steering angle max (deg) on the display (refer to steps in section 3.1), adjust the sensor until the display reads 0 degrees.
 - C. Reinstall both screws to secure the sensor in place.

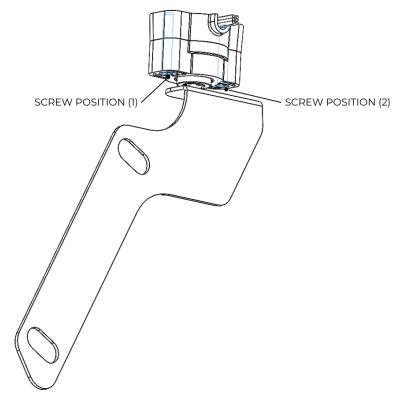


Figure 57. Positioning of screws on the sensor.

Fault Code List and Diagnostic

7 - TROUBLESHOOTING

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With Dual Drive systems there are two traction controllers, and when faults occur they usually affect both of the controllers.

The Dual Drive Troubleshooting Chart (Table 2) is written from the perspective of the controller that is issuing the fault. The effects on the other controller are shown as well.

DUAL DRIVE LIMITED OPERATING STRATEGY

Quick Links: LOS Max Speed p.6 When the Dual Drive Limited Operating Strategy (LOSDual) is initiated, the controller's motor(s)speed will be clamped to the parameter LOS Max Speed setting (VCL parameter name Dual_LOS_ Max_Speed). Then, if the Throttle Command (see the Monitor»Inputs menu in the controller's manual, and 1313/1314) results in the motor-speed request exceeding the LOS Max Speed, the motor rpm will be clamped to the LOS Max Speed, subject to normal slewing constraints.

If the steer angle input is invalid, both controllers will use the Dual Drive's LOS Max Speed and assume that the steer angle is 0 degrees (also see the Monitor»Inputs menu in the controller's manual, and 1313/1314).

If the motor encoder is invalid on only one side (i.e., manager or ancillary controller), that controller will have its bridge disabled, and the other controller will use the LOS Max Speed and assume that the steer angle is 0 degrees. If both encoder signals are invalid, the vehicle will not drive. (see Codes 36 and 73 in Table 2).

PMAC Considerations

NOTICE

PMAC applications are only compatible with controllers that are manufactured with a cross-connect diode. These controllers are models 123XE-xx7x and 123XSE-xx7x. All the 1239E models are PMAC compatible when operated as described below. The cross-connect diode allows the logic section of the controller to power up if the capacitor voltage is above the brownout voltage regardless of whether the KSI pin is powered. Since a field weakened IPM motor can generate voltages significantly above the ratings of the motor, the controller must be able to control the main power bridge if the motor is generating significant voltages in order to protect itself from these damaging voltages. If a controller without a cross connect diode is configured for PMAC operation, a non-clearable Parameter Mismatch Fault will be declared.

Supported 1232E, 1232SE, 1234SE, 1236SE and 1238SE models

The following newly introduced 123X-xx7x models are manufactured with a cross-connect diode and calibrated for operation with OS34+:

- 1232E-2171, 1232E-2371, 1232E-5171, 1232E-5271, 1232E-6271, 1232E-7271.
- 1232SE-2471, 1232SE-5371, 1232SE-6371.
- 1234SE-4571, 1234SE-5471, 1234SE-6371.
- 1236SE-4671, 1236SE-5671, 1236SE-6571.
- 1238SE-4971, 1238SE-5971, 1238SE-6971, 1238SE-7971.

The 1234E, 1236E and 1238E controllers are not available with cross-connect diodes.

1239E PMAC Support

All existing 1239E models and the 1269E support PMAC operation with OS 37.0, but the OEM must insure that KSI power is active any time the motor is moving. Removal of KSI power when the motor is spinning past the base speed may result in immediate controller damage.

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The fault actions (effect of fault) in Table 2 use the same bit-structure as the User_Fault_Action_xx listed in controller's manual (OEM-defined User Faults). The variable System_Action (available in the WinVCL Monitor, or TACT) returns the decimal number corresponding to the active fault action bit(s). The dual drive related fault actions, bits 12-15, are listed in this supplement.

System_Action Bit	Action
No Action	As noted in Table 2.
Bit0 = ShutdownMotor	Disable the motor.
Bit1 = ShutdownMainContactor	Shut down the main contactor (only if Main Enable = 0n).
Bit2 = ShutdownEMBrake	Shut down the EM brake (only if EM Brake Disable Upon Fault = On).
Bit3 = ShutdownThrottle	Set the Throttle_Command = 0%.
Bit4 = ShutdownInterlock	Set the Interlock_State = Off.
Bit5 = ShutdownDriverI	Shut down Driver1.
Bit6 = ShutdownDriver2	Shut down Driver2.
Bit7 = ShutdownDriver3	Shut down Driver3.
Bit8 = ShutdownDriver4	Shut down Driver4.
Bit9 = ShutdownPD	Shut down Proportional Driver.
Bit10 = FullBrake	Set the Brake_Command = 100%.
Bit11 = [Reserved]	N/A (for 1232-1238E/SE, and 1239E controllers).
Bit12 = TrimDisable	Disable Dual Drive trim calculation.
Bit13 = SevereDual	For Dual Drive system, one controller has a severe fault but the main contactor must stay closed so the other controller can continue to operate.
Bit14 = ShutdownSteer	Steer angle = 0° (DD applicable).
Bit15 = LOSDual	For Dual Drive system, set the max speed to Dual_LOS_Max_Speed parameter for operation in Limited Operating Strategy.

Example:

```
HPD/Sequencing Fault, Flash Code 47.
Effect of fault = Shutdown Throttle.
System_Action = 8 (equates to Bit3 set: 0000 0000 0000 1000).
```

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below 8.4V (Brownout occurs at 8.0V).

above 8.4 volts.

Clear: Bring KSI voltage above Brownout

Voltage. 1239E DD applicable: Bring KSI voltage

1239E DD applicable: If below

is switched off and reset may

Same effects as this controller.

Other controller:

brownout voltage, motor current

COMPANY NAME

MOTREC INTERNATIONAL

CODE PROGRAMMER LCD DISPLAY **POSSIBLE CAUSE** SET / CLEAR CONDITIONS (status#,bit) EFFECT OF FAULT **Controller Overcurrent** 1. External short of phase U,V, or W 12 Set: Phase current exceeded the current ShutdownMotor; motor connections. measurement limit. (Status4,3) ShutdownMainContactor: 2. Motor parameters are mis-tuned. Clear: Cycle KSI or perform a VCL reset. ShutdownFMBrake: 3. Controller defective. ShutdownThrottle: 4. Speed encoder noise problems. FullBrake. Other controller: Same effects as this controller. 13 **Current Sensor Fault** 1. Leakage to vehicle frame from phase U, Set: Controller current sensors have invalid ShutdownMotor; V, or W (short in motor stator). offset reading (Status4,4) ShutdownMainContactor: 2 Controller defective Clear: Cycle KSI or perform a VCL reset. ShutdownEMBrake; ShutdownThrottle: FullBrake. Other controller: Same effects as this controller. Precharge Failed 1. See Monitor menu » Battery: Set: Precharge failed to charge the capacitor 14 ShutdownMotor; ShutdownMainContactor; Capacitor Voltage. bank to the KSI voltage. (Status4,0) 1239E DD applicable: Precharge failed to 2. External load on capacitor bank (B+ ShutdownEMBrake; charge the capacitor bank from the external connection terminal) that prevents the ShutdownThrottle; precharge resistor. capacitor bank from charging. FullBrake. Clear: Cycle Interlock input or use VCL function Other controller: Enable_Precharge(). Same effects as this controller. 15 **Controller Severe Undertemp** 1. See Monitor menu » Set: Heatsink temperature below -40°C. ShutdownMotor; Controller: Temperature. (Status2,7) Clear: Bring heatsink temperature above -40°C, SevereDual. 2. Controller is operating in an and cycle interlock or KSI. extreme environment. Other controller: SevereDual; LOSDual; TrimDisable. **Controller Severe Overtemp** 1. See Monitor menu » 16 Set: Heatsink temperature above +95°C. ShutdownMotor: Controller: Temperature. (Status3,0) Clear: Bring heatsink temperature below ShutdownMainContactor: 2. Controller is operating in an +95°C, and cycle interlock or KSI. ShutdownEMBrake; extreme environment. ShutdownThrottle; 3. Excessive load on vehicle. FullBrake. 4. Improper mounting of controller. Other controller: Same effects as this controller. 17 Severe B+ Undervoltage 1. Battery parameters are misadjusted. Set: Capacitor bank voltage dropped below No drive torque, the Severe Undervoltage limit with FET (Status2,1) 2. Non-controller system drain on battery. TrimDisable. bridge enabled. 3. Battery resistance too high. Clear: Bring capacitor voltage above Severe Other controller: 4. Battery disconnected while driving. Same effects as this controller. Undervoltage limit. 5. See Monitor menu » Battery: Capacitor Voltage. 6. Blown B+ fuse or main contactor did not close. 17 Severe KSI Undervoltage 1. See Monitor menu » Battery: Set: When below Brownout Voltage for 2 No action Keyswitch Voltage. seconds (see Table D-1). (Status8,4) 1239E DD applicable: KSI voltage dropped 2. Non-controller system drain on battery/

KSI circuit wiring.

4. Blown KSI fuse.

3. KSI disconnected while driving.

CODE (status#,bit)	PROGRAMMER LCD DISPLAY EFFECT OF FAULT	POSSIBLE CAUSE	SET / CLEAR CONDITIONS
18 (Status4,3)	Severe B+ Overvoltage ShutdownMotor; SevereDual. Other controller: SevereDual; LOSDual; TrimDisable.	See Monitor menu » Battery: Capacitor Voltage. Battery parameters are misadjusted. Battery resistance too high for given regen current. Battery disconnected while regen braking.	Set: Capacitor bank voltage exceeded the Severe Overvoltage limit with FET bridge enabled. Clear: Bring capacitor voltage below Severe Overvoltage limit, and then cycle KSI.
19 (Status9, bit3)	PMAC Commissioning Needed Hold all three phases at 50% PWM and disables main weld and DNC faults.	The PMAC Commissioning Procedure has not yet been performed to set up the controller for a new PMAC motor.	Set: PMAC Commissioning Needed parameter set to 1. Clear: PMAC Commissioning Needed parameter set to 0.
22 (Status2,6)	Controller Overtemp Cutback Reduced drive torque; TrimDisable. Other controller: TrimDisable.	See Monitor menu » Controller: Temperature. Controller is performance-limited at this temperature. Controller is operating in an extreme environment. Excessive load on vehicle. Improper mounting of controller.	Set: Heatsink temperature exceeded 85°C. Clear: Bring heatsink temperature below 85°C.
23 (Status2,3)	B+ Undervoltage Cutback Reduced drive torque; TrimDisable. Other controller: TrimDisable.	Normal operation. Fault indicates the batteries need recharging. Controller is performance limited at this voltage. Battery parameters are misadjusted. Non-controller system drain on battery. Battery resistance too high. Battery disconnected while driving. See Monitor menu » Battery: Capacitor Voltage. Blown B+ fuse or main contactor did not close.	Set: Capacitor bank voltage dropped below the Undervoltage limit with the FET bridge enabled. Clear: Bring capacitor voltage above the Undervoltage limit.
24 (Status2,4)	B+ Overvoltage Cutback Reduced drive torque; TrimDisable. Other controller: TrimDisable.	Normal operation. Fault shows that regen braking currents elevated the battery voltage during regen braking. Controller is performance limited at this voltage. Battery parameters are misadjusted. Battery resistance too high for given regen current. Battery disconnected while regen braking. See Monitor menu » Battery: Capacitor Voltage.	Set: Capacitor bank voltage exceeded the Overvoltage limit with the FET bridge enabled. Clear: Bring capacitor voltage below the Overvoltage limit.
25 (Status5,3)	+5V Supply Failure None, unless a fault action is programmed in VCL. Other controller: Same effects as this controller.	External load impedance on the +5V supply (pin 26) is too low. See Monitor menu » outputs: 5 volts and Ext Supply Current.	Set: +5V supply (pin 26) outside the 5V±10% range. Clear: Bring voltage within range.

CODE (status#,bit)	PROGRAMMER LCD DISPLAY EFFECT OF FAULT	POSSIBLE CAUSE	SET / CLEAR CONDITIONS
26 (Status4,1)	Digital Out 6 Overcurrent Digital Output 6 driver will not turn on. Other controller: None.	External load impedance on Digital Output 6 driver (pin 19) is too low.	Set: Digital Output 6 (pin 19) current exceeded 1 Amp. Clear: Remedy the overcurrent cause and use the VCL function Set_DigOut() to turn the driver on again.
27 (Status4,2)	Digital Out 7 Overcurrent Digital Output 7 driver will not turn on. Other controller: None.	External load impedance on Digital Output 7 driver (pin 20) is too low.	Set: Digital Output 7 (pin 20) current exceeded 1 Amp. Clear: Remedy the overcurrent cause and use the VCL function Set_DigOut() to turn the driver on again.
28 (Status4,5)	Motor Temp Hot Cutback Reduced drive torque; TrimDisable. Other controller: TrimDisable.	Motor temperature is at or above the programmed Temperature Hot setting, and the current is being cut back. Motor Temperature Control Menu parameters are mis-tuned. See Monitor menu » Motor: Temperature and » Inputs: Analog2. If the application doesn't use a motor thermistor, Temp Compensation and Temp Cutback should be programmed Off.	Set: Motor temperature is at or above the Temperature Hot parameter setting. Clear: Bring the motor temperature within range.
29 (Status5,1)	Motor Temp Sensor Fault LOSDual and motor temperature cutback disabled. Other controller: MaxSpeed reduced to LOSDual.	Motor thermistor is not connected properly. If the application doesn't use a motor thermistor, Motor Temp Sensor Enable should be programmed Off. See Monitor menu » Motor: Temperature and » Inputs: Analog2.	Set: Motor thermistor input (pin 8) is at the voltage rail (OV or 10V). Clear: Bring the motor thermistor input voltage within range.
31 (Status3,1)	Coil1 Driver Open/Short ShutdownDriver1. Other controller: None.	Open or short on driver load. Dirty connector pins. Bad crimps or faulty wiring.	Set: Driver 1 (pin 6) is either open or shorted. This fault can be set only when Main Enable = Off. Clear: Correct open or short, and cycle driver.
31 (Status3,6)	Main Open/Short ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; FullBrake. Other controller: Same effects as this controller.	Open or short on driver load. Dirty connector pins. Bad crimps or faulty wiring.	Set: Main contactor driver (pin 6) is either open or shorted. This fault can be set only when Main Enable = On. Clear: Correct open or short, and cycle driver.
32 (Status3,2)	Coil2 Driver Open/Short ShutdownDriver2. Other controller: None.	Open or short on driver load. Dirty connector pins. Bad crimps or faulty wiring.	Set: Driver 2 (pin 5) is either open or shorted. This fault can be set only when EM Brake Type = 0. Clear: Correct open or short, and cycle driver.
32 (Status3,7)	EMBrake Open/Short ShutdownEMBrake; ShutdownThrottle; FullBrake. Other controller: Same effects as this controller.	Open or short on driver load. Dirty connector pins. Bad crimps or faulty wiring.	Set: Electromagnetic brake driver (pin 5) is either open or shorted. This fault can be set only when EM Brake Type >0. Clear: Correct open or short, and cycle driver.
33 (Status3,3)	Coil3 Driver Open/Short ShutdownDriver3. Other controller: None.	Open or short on driver load. Dirty connector pins. Bad crimps or faulty wiring.	Set: Driver 3 (pin 4) is either open or shorted. Clear: Correct open or short, and cycle driver.

CODE (status#,bit)	PROGRAMMER LCD DISPLAY EFFECT OF FAULT	POSSIBLE CAUSE	SET / CLEAR CONDITIONS
34 (Status3,4)	Coil4 Driver Open/Short ShutdownDriver4. Other controller: None.	Open or short on driver load. Dirty connector pins. Bad crimps or faulty wiring.	Set: Driver 4 (pin 3) is either open or shorted. Clear: Correct open or short, and cycle driver.
35 (Status3,5)	PD Open/Short ShutdownPD. Other controller: Same effects as this controller.	Open or short on driver load. Dirty connector pins. Bad crimps or faulty wiring.	Set: Proportional driver (pin 2) is either open or shorted. Clear: Correct open or short, and cycle driver.
36 (Status5,6)	Encoder Fault SevereDual; Motor disabled. Other controller: TrimDisable; SevereDual; LOSDual.	Motor encoder failure. One or both inputs. Bad crimps or faulty wiring. See Monitor menu » Motor: Motor RPM.	Set: Motor encoder phase or signal failure detected. Clear: Either cycle KSI, or controller detects valid motor encoder signals while operation in LOSDual mode and return Throttle Command = 0 and Motor RPM = 0.
37 (Status4,7)	Motor Open ShutdownMotor; SevereDual. Other controller: SevereDual; LOSDual; TrimDisable.	Motor phase is open. Bad crimps or faulty wiring.	Set: Motor phase U, V, or W detected open. Clear: Cycle KSI.
38 (Status1,0)	Main Contactor Welded ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; FullBrake. Other controller: Same effects as this controller.	Main contactor tips are welded closed. Motor phase U or V is disconnected or open. An alternate voltage path (such as an external precharge resistor) is providing a current to the capacitor bank (B+connection terminal).	Set: Just prior to the main contactor closing, the capacitor bank voltage (B+ connection terminal was loaded for a short time and the voltage did not discharge. Clear: Cycle KSI.
39 (Status1,1)	Main Contactor Did Not Close ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; FullBrake. Other controller: Same effects as this controller.	1. Main contactor did not close. 2. Main contactor tips are oxidized, burned, or not making good contact.* 3. External load on capacitor bank (B+ connection terminal) that prevents capacitor bank from charging. 4. Blown B+ fuse.	Set: With the main contactor commanded closed, the capacitor bank voltage (B+connection terminal) did not charge to B+. Clear: Cycle KSI. *New contactors may need to be cycled electrically & mechanically to remove any non-conductive material on the tips. Use reduced voltage (e.g., 12V) to prevent tip damage through excessive arcing.
41 (Status1,4)	Throttle Wiper High ShutdownThrottle. Other controller: Same effects as this controller.	See Monitor menu » Inputs: Throttle Pot. Throttle pot wiper voltage too high.	Set: Throttle pot wiper (pin 16) voltage is higher than the high fault threshold (can be changed with the VCL function Setup_Pot_Faults()). Clear: Bring throttle pot wiper voltage below the fault threshold.
42 (Status1,3)	Throttle Wiper Low ShutdownThrottle. Other controller: Same effects as this controller.	See Monitor menu » Inputs: Throttle Pot. Throttle pot wiper voltage too low.	Set: Throttle pot wiper (pin 16) voltage is lower than the low fault threshold (can be changed with the VCL function Setup_Pot_Faults()). Clear: Bring throttle pot wiper voltage above the fault threshold.
43 (Status1,6)	Pot2 Wiper High No Action. Other controller: Same effects as this controller.	See Monitor menu » Inputs: Pot2 Raw. Pot2 wiper voltage too high.	Set: Pot2 wiper (pin 17) voltage is higher than the high fault threshold (can be changed with the VCL function Setup_Pot_Faults()). Clear: Bring Pot2 wiper voltage below the fault threshold.

Table 2 DUAL DRIVE TROUBLESHOOTING CHART cont'd

CODE (status#,bit)	PROGRAMMER LCD DISPLAY EFFECT OF FAULT	POSSIBLE CAUSE	SET / CLEAR CONDITIONS
44 (Status1,5)	Pot2 Wiper Low No Action. Other controller:	See Monitor menu » Inputs: Pot2 Raw. Pot2 wiper voltage too low.	Set: Pot2 wiper (pin 17) voltage is lower than the low fault threshold (can be changed with the VCL function Setup_Pot_Faults()).
	Same effects as this controller.		Clear: Bring Pot2 wiper voltage above the fault threshold.
45 (Status1,2)	Pot Low OverCurrent No Action. (Does not shut down the pot's low-current source).	See Monitor menu » Outputs: Pot Low. Combined pot resistance connected to pot low is too low.	Set: Pot low (pin 18) current exceeds 10 mA. Clear: Clear pot low overcurrent condition and/ or cycle KSI.
	Other controller: Same effects as this controller.		
46 (Status1,7)	EEPROM Failure ShutdownMotor; ShutdownEMBrake; ShutdownThrottle; ShutdownDriver1; ShutdownDriver2; ShutdownDriver3; ShutdownDriver4; ShutdownPriver4; ShutdownPp; FullBrake; TrimDisable; SevereDual; ShutdownSteer; LOSDual. Other controller:	Failure to write to EEPROM memory. This can be caused by EEPROM memory writes initiated by VCL, by the CAN bus, by adjusting parameters with the programmer, or by loading new software into the controller.	Set: Controller operating system tried to write to EEPROM memory and failed. Clear: Download the correct software (OS) and matching parameter default settings into the controller and cycle KSI.
47	Same effects as this controller. HPD/Sequencing Fault	KSI, interlock, direction, and throttle	Set: HPD (High Pedal Disable) or sequencing
(Status2,0)	ShutdownThrottle. <u>Other controller:</u> Same effects as this controller.	inputs applied in incorrect sequence. 2. Faulty wiring, crimps, or switches at KSI, interlock, direction, or throttle inputs. 3. See Monitor menu » Inputs.	fault caused by incorrect sequence of KSI, interlock, direction, and throttle inputs. Clear: Reapply inputs in correct sequence.
47 (Status6,2)	Emer Rev HPD ShutdownThrottle; ShutdownEMBrake.	See Monitor menu » Inputs. Emergency Reverse operation has concluded, but the throttle, forward and reverse inputs, and interlock have not been returned to neutral.	Set: At the conclusion of Emergency Reverse, the fault was set because various inputs were not returned to neutral.
	Other controller: Same effects as this controller.		Clear: If EMR_Interlock = On, clear the interlock, throttle, and direction inputs. If EMR_Interlock = Off, clear the throttle and direction inputs.
49 (Status4,6)	Parameter Change Fault ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; FullBrake. Other controller: Same effects as this controller.	This is a safety fault caused by a change in certain parameter settings so that the vehicle will not operate until KSI is cycled. For example, if a user changes the Throttle Type this fault will appear and require cycling KSI before the vehicle can operate.	Set: Adjustment of a parameter setting that requires cycling of KSI. Clear: Cycle KSI.
51-67	OEM Faults (See OEM documentation).	These faults can be defined by the OEM and are implemented in the application-specific VCL code. See OEM documentation.	Set: See OEM documentation. Clear: See OEM documentation.

ANNEXES

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Table 2 DUAL DRIVE TROUBLESHOOTING CHART cont'd

CODE (status#,bit)	PROGRAMMER LCD DISPLAY EFFECT OF FAULT	POSSIBLE CAUSE	SET / CLEAR CONDITIONS
68 (Status5,2)	VCL Run Time Error ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownIntrottle; ShutdownDriver1; ShutdownDriver2; ShutdownDriver3; ShutdownDriver4; ShutdownPD; FullBrake; TrimDisable; SevereDual; ShutdownSteer; LOSDual. Other controller: Same effects as this controller.	VCL code encountered a runtime VCL error. See Monitor menu » Controller: VCL Error Module and VCL Error. This error can then be compared to the runtime VCL module ID and error code definitions found in the specific OS system information file.	Set: Runtime VCL code error condition. Clear: Edit VCL application software to fix this error condition; flash the new compiled software and matching parameter defaults; cycle KSI.
69 (Status5,0)	External Supply Out of Range None, unless a fault action is programmed in VCL. Other controller: Same effects as this controller.	External load on the 5V and 12V supplies draws either too much or too little current. Fault Checking Menu parameters Ext Supply Max and Ext Supply Min are mis-tuned. See Monitor menu » Outputs: Ext Supply Current.	Set: The external supply current (combined current used by the 5V supply [pin 26] and 12V supply [pin 25]) is either greater than the upper current threshold or lower than the lower current threshold. The two thresholds are defined by the External Supply Max and External Supply Min parameter settings. Clear: Bring the external supply current within range.
71 (Status5,4)	OS General ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownIntrottle; ShutdownDriver1; ShutdownDriver2; ShutdownDriver3; ShutdownDriver4; ShutdownPD; FullBrake; TrimDisable; SevereDual; ShutdownSteer; LOSDual. Other controller: Same effects as this controller.	1. Internal controller fault.	Set: Internal controller fault detected. Clear: Cycle KSI.
72 (Status5,5)	PDO Timeout ShutdownInterlock; CAN NMT State set to Preoperational. Other controller: Same effects as this controller.	Time between CAN PDO messages received exceeded the PDO Timeout Period.	Set: Time between CAN PDO messages received exceeded the PDO Timeout Period. Clear: Cycle KSI or receive CAN NMT message.
73 (Status5,7)	Stall Detected SevereDual; Motor disabled. Other controller: TrimDisable; SevereDual; LOSDual.	Stalled motor (motor current insufficient to move the vehicle, for example up a steep hill or over-loaded). Motor encoder failure (no feedback received at the controller). Bad crimps or faulty wiring. Problems with power supply for the motor encoder. See Monitor menu » Motor: Motor RPM.	Set: No motor encoder movement detected (no motor speed), yet controller is requesting current (throttle command). Clear: Either cycle KSI, or controller detects valid motor encoder signals while operation in LOSDual mode and return Throttle Command = 0 and Motor RPM = 0.

Table 2 DUAL DRIVE TROUBLESHOOTING CHART cont'd

CODE (status#,bit)	PROGRAMMER LCD DISPLAY EFFECT OF FAULT	POSSIBLE CAUSE	SET / CLEAR CONDITIONS
74 (Status7,6)	Fault On Other Traction Controller For information on this fault, plug the 1313/1314 programmer into the other controller.	A fault is active on the other traction controller.	Set. In a Dual Drive traction system, any fault in the other traction controller will cause this fault to be set. Clear. Clear all the active faults in the other traction controller.
75 (Status7,5)	Dual Severe Fault ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; FullBrake. Other controller: Same effects as this controller.	Both traction controllers have active severe faults and therefore both will be disabled.	Set: A severe fault in each traction controller will cause this fault to be set. Clear: Correct the severe fault(s) in either controller to clear the Dual Severe Fault. Clear all the faults on both controllers.
77 (Status6,5)	Supervisor Fault ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; ShutdownDriver1; ShutdownDriver2; ShutdownDriver3; ShutdownDriver4; ShutdownPD; FullBrake; TrimDisable; SevereDual; ShutdownSteer; LOSDual. Other controller: Same effects as this controller.	The Supervisor has detected a mismatch in redundant readings. Internal damage to Supervisor microprocessor. Switch inputs allowed to be within upper and lower thresholds for over 100 milliseconds.	Set: Mismatched redundant readings; damaged Supervisor; illegal switch inputs. Clear: Check for noise or voltage drift in all switch inputs; check connections; Cycle KSI or VCL reset.
78 (Status9,0)	Supervisor Incompatible ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownIhrottle; ShutdownDriver1; ShutdownDriver2; ShutdownDriver3; ShutdownDriver4; ShutdownPD; FullBrake; TrimDisable; SevereDual; ShutdownSteer; LOSDual. Other controller: Same effects as this controller.	The main OS is not compatible with the Supervisor OS.	Set: Incompatible software. Clear: Load properly matched OS code or update the Supervisor code; cycle KSI.
82 (Status6,0)	Bad Calibrations ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; FullBrake. Other controller: Same effects as this controller.	1. Internal controller fault.	Set: Internal controller fault detection. Clear: Cycle KSI or perform a VCL reset.

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Table 2 DUAL DRIVE TROUBLESHOOTING CHART cont'd

ANNEXES

(status#,bit) PROGRAMMER LCD DISPLAY EFFECT OF FAULT		POSSIBLE CAUSE	SET / CLEAR CONDITIONS			
83 (Status9,6)	Driver Supply ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; FullBrake. Other controller: Same effects as this controller.	Internal controller fault in the voltage supply for the driver circuits.	Set: Internal controller fault detection. Clear: Cycle KSI or perform a VCL reset.			
87 (Status6,6)	Motor Characterization Fault ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; FullBrake. Other controller: Same effects as this controller.	1. Motor characterization failed during characterization process. See Monitor menu » Controller: Motor Characterization Error for cause: 0 = Sequencing error. Normally caused by turning off Motor Characterization Test Enable before running the test. 1 = Encoder signal seen but step size not auto-detected; set up Encoder Steps manually. 2 = Motor temp sensor fault. 3 = Motor temp hot cutback fault. 4 = Controller overtemp cutback fault. 5 = Controller undertemp cutback fault. 6 = Undervoltage cutback fault. 7 = Severe overvoltage fault. 8 = Encoder signal not seen, or one or both channels missing. 9 = Motor parameters out of characterization range. 20 = Sin/cos sensor not found. 21 = Phasing not detected. 22 = Sin/cos sensor characterization procedure while motor rotating.	Set: Motor characterization failed during the motor characterization process. Normally caused by turning off Motor_Characterization_Test_Enable before running test. Needs controller reset. Clear: Correct fault; Cycle KSI or perform a VCL reset.			
88 (Status8,7)	Encoder Pulse Count Fault ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; ShutdownDriver1; ShutdownDriver2; ShutdownDriver3; ShutdownDriver4; ShutdownPD; FullBrake; TrimDisable; SevereDual; ShutdownSteer; LOSDual. Other controller: Same effects as this controller.	Encoder Steps parameter does not match the actual motor encoder.	Set: Motor lost IFO control and accelerated without throttle command. Clear: Ensure the Encoder Steps parameter matches the actual encoder; cycle KSI.			

Table 2 DUAL DRIVE TROUBLESHOOTING CHART cont'd

CODE (status#,bit)	PROGRAMMER LCD DISPLAY EFFECT OF FAULT	POSSIBLE CAUSE	SET / CLEAR CONDITIONS			
88 (Status2, bit5)	Sin/Cos Sensor Fault ShutdownMotor; ShutdownMainContactor; ShutdownFMBrake; ShutdownThrottle; FullBrake. Other controller: Same effects as this controller. — SinCos Sensor Misaligned Sin Cos Motor Feedback Fault	The relationship between the rotor magnets in a PMAC motor and the Sin/Cos sensor has shifted away from the value determined by the Commissioning process.	Set: The battery current significantly disagrees with the commanded torque and speed. Clear: Cycle KSI and Repeat the PMAC commissioning process or repair the Sin/Cos sensor.			
89 (Status6,4)	Motor Type Fault ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; FullBrake. Other controller: Same effects as this controller.	The Motor_Type parameter value is out of range for the loaded OS (e.g., os37.0).	Set: Motor_Type parameter is set to an incorrect (for the loaded OS) value. Clear: Set Motor_Type to correct value and cycle KSI.			
91 (Status7,1)	VCL/OS Mismatch ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownIntrottle; ShutdownDriver1; ShutdownDriver2; ShutdownDriver3; ShutdownDriver4; ShutdownPD; FullBrake; TrimDisable; SevereDual; ShutdownSteer; LOSDual. Other controller. Same effects as this controller.	The VCL software in the controller does not match the OS software in the controller.	Set: VCL and OS software do not match; when KSI cycles, a check is made to verify that they match and a fault is issued when they do not. Clear: Download the correct VCL and OS software into the controller.			
92 (Status7,2)	EM Brake Failed to Set Position Hold is engaged when Interlock = On. Follows the Position Hold parameter settings, including the Position Hold Timeout Time. Other controller: Same effects as this controller.	Vehicle movement sensed after the EM Brake has been commanded to set. EM Brake will not hold the motor from rotating.	Set: After the EM Brake was commanded to set and time has elapsed to allow the brake to fully engage, vehicle movement has been sensed. Clear: 1. Activate the Throttle (EM Brake type 2). 2. Activate the Interlock (EM Brake type 1).			
93 (Status7,3)	Encoder LOS (Limited Operating Strategy) Enter LOS control mode. NO_ACTION, in LOS mode. Other controller: None.	Limited Operating Strategy (LOS) control mode has been activated, as a result of either an Encoder Fault (Code 36) or a Stall Detected fault (Code 73). Motor encoder failure. Bad crimps or faulty wiring. Vehicle has stalled.	Set: Encoder Fault (code 36) or Stall Detected (code 73) was activated, if parameter LOS Upon Encoder Fault = On and Interlock has been cycled, then the Encoder LOS (code 93) control mode is activated, allowing limited motor control. Clear: Cycle KSI or, if LOS mode was activated by the Stall Detected fault, clear by ensuring encoder senses proper operation, Motor RPM = 0, and Throttle Command = 0.			

Table 2 DUAL DRIVE TROUBLESHOOTING CHART cont'd

CODE (status#,bit)	PROGRAMMER LCD DISPLAY EFFECT OF FAULT	POSSIBLE CAUSE	SET / CLEAR CONDITIONS
94 (Status7,4)	EMR Rev Timeout ShutdownEMBrake; ShutdownThrottle. Other controller: Same effects as this controller.	Emergency Reverse was activated and concluded because the EMR Timeout timer has expired. The emergency reverse input is stuck On.	Set: Emergency Reverse was activated and ran until the EMR Timeout timer expired. Clear: Turn the emergency reverse input Off.
98 (Status7,7)	Illegal Model Number ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; FullBrake. Other controller: Same effects as this controller.	Model_Number variable contains illegal value. Software and hardware do not match. Controller defective.	Set: Illegal Model_Number variable; when KSI cycles, a check is made to confirm a legal Model_Number, and a fault is issued if one is not found. Clear: Download appropriate software for the controller model.
99 (Status8,3)	Parameter Mismatch ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; FullBrake.	Dual drive enabled on only one controller. Incorrect position feedback type chosen for motor technology in use. Dual drive is enabled in torque mode. Controller hardware incompatible with PMAC operation or with the selected PMAC motor. This Control Mode does not support EM Brake Control. This Control Mode does not support Interlock Braking. Reserved. Controller/motor incompatibility. PMAC motor short circuit current too high for controller. This controller not compatible with released IPM PMAC software (no xconnect, and not a 1239e). Can't run Restricted Operation Mode on this motor (incomplete Motor Type).	Set: Multiple set conditions, see: Monitor » Controller » Parameter Mismatch Error. Clear: Adjust parameters to appropriate values and cycle KSI.



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



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Unit 3 – 5250 Grimmer St. Burnaby, BC, Canada V5H 2H2 Tel: 604.327.8244 Fax: 604.327.8246 www.delta-q.com

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

- Always use a grounded outlet. When using an extension cord, avoid excessive voltage drops by using a grounded 3-wire 12 AWG cord.
- 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).
- 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).
- 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.
- A low current "finish-charge" phase is next applied to return and maintain maximum battery capacity (Models 912-xx0x will flash the '100%' LED).
- 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.
- 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

- 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.
- Make sure charger connections to battery terminals are tight and clean.
- 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

Output - see Operating Instructions

QuiQ Model: 912-	24xx	36xx	48xx	72xx 72	
Voltage-nom (V)	24	36	48		
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 elaps		

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 $\frac{1}{2}$) 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.

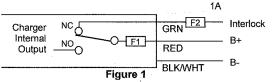
Mechanical

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		

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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 .		



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.

Alg

- 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.

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

Battery Type

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.

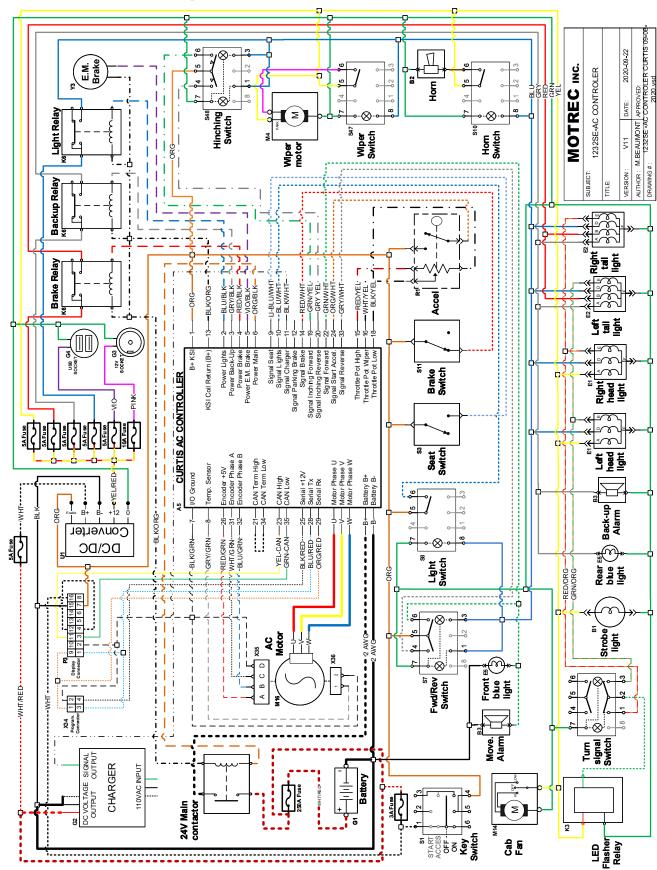
Product warranty is two years - please contact dealer of original equipment for warranty

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. Aug 2006 © Delta-Q Technologies Corp. All rights reserved. PN: 710-90xx Rev 1 V1.16

Standard Electrical Diagram

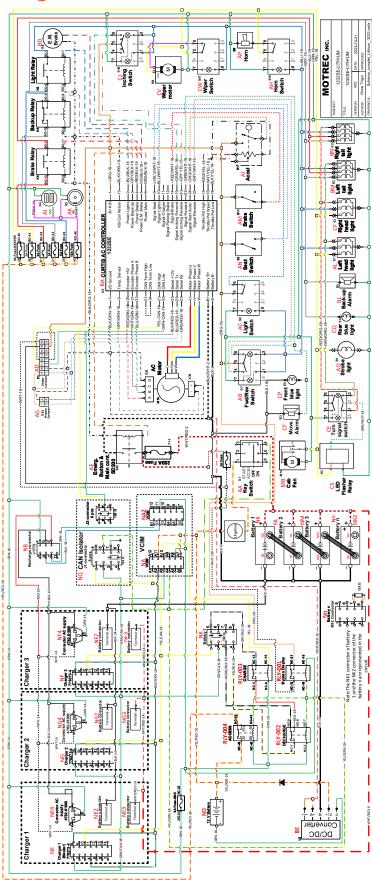
COMPANY NAME

MOTREC INTERNATIONAL



VERSION 01

Lithium Electrical Diagram



Standard Torque





BOLT CLAMP LOADS

Suggested Assembly Torque Values



DIAMETER & THREADS PER INCH	USS/SAE GRADE 5				USS/SAE GRADE 8					
	TUGILI STRENGTH Mrv. PSI	Proof Low LB	CLAHP LOID LB	Tolovi Dit FT LB	LUHUCUTO FT LB	TUKNU Stadnoth Mrv. PSI	Paoor Lou LB	CIAW? LOID LB	Totovi Der FT LB	Lumano FT LB
1/4-20	120,060	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	6,360	4,700	24	18
24	120,000	4,900	3,700	19	14	150,000	6,950	5,200	27	20
3/8-16	120,000	6,690	4,950	30	73	150,000	9,300	6,980	45	35
24	120,000	7,450	5,600	35	25	150,000	10,500	7,960	50	35
7/16-14	120,000	9,050	6,780	S0	35	150,000	12,800	9,550	70	50
20	120,000	10,100	7,570	SS	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	14,480	120	90
9/16-12	120,030	15,500	11,600	110	80	150,010	21,860	16,350	150	110
18	120,030	17,300	12,950	120	90	150,010	24,480	18,250	170	130
5/8-11	120,000	19,200	14,400	150	110	150,080	27,100	20,350	210	160
18	120,000	21,800	16,350	170	130	150,080	30,700	23,660	240	180
3/4-10	120,000	26,400	21,300	260	200	150,000	40,100	30,100	380	260
16	120,000	31,700	23,780	300	220	150,000	44,800	33,500	420	310
7/8-9	120,000	39,300	29,450	430	370	150,010	55,400	41,600	600	450
14	120,000	43,300	32,450	470	350	150,010	61,100	45,800	670	500
1-8	120,000	51,500	39,600	640	4 9 0	150,010	72,700	54,500	910	690
14	120,000	57,700	43,300	720	510	150,010	81,500	61,100	1,070	760



MOTREC INTERNATIONAL