

# MT-180



**OPERATOR AND MAINTENANCE MANUAL  
SPARE PARTS LISTS INCLUDED**

SERIAL NUMBER : 1178643 & UP

Printed in Canada



**3-YEAR LIMITED WARRANTY ON AC PRODUCTS, STOCK CHASER AND TRAILERS  
2-YEAR LIMITED WARRANTY ON DC 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 registers the product, provided it is registered within thirty (30) days of reception and in conformity with Motrec's registration process.

**REGISTRATION.** IMPORTANT: 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 FAIL TO REGISTER YOUR PRODUCT WITHIN THE THIRTY (30) DAYS, THE WARRANTY WILL NOT BE APPLICABLE. IF YOU PURCHASED THE PRODUCT DIRECTLY FROM MOTREC AND NOT FROM A MOTREC DEALER, YOU MUST REGISTER YOUR PRODUCT FOLLOWING THE INSTRUCTIONS BELOW (CLAUSE 3)  
<https://www.motrec.com/registration/>

**DEFECTS.** Subject to the terms and conditions described below, parts, components or accessories installed on the product by Motrec which 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. The warranty excludes items described in (Clause 6). 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. In the event the part is still under warranty and confirmed defective after inspection by Motrec, freight would be credited.

**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. Motrec parts must also be used when performing the warranty otherwise the warranty will be voided. 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 any and all liability for any modification made to the product, including but not limited to, modifications that are susceptible to alter the weight distribution and stability of the product, increase its speed or affect its safety. Such modifications can cause serious personal injury or property damage for which Motrec disclaims and excludes any and 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 a complete and adequate training has been provided by the purchaser. Driving an electrical vehicle constitutes a hazard. The driver is responsible for the control of the product while driving and must always evaluate all unusual or particular 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.

#### 1. Definitions

**“Product”:** the complete 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 using the AC technology is covered by the Motrec Limited Warranty for a period of three (3) years or 3,000 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.

Your Motrec stock chaser is covered by the Motrec Limited Warranty for a period of three (3) years or 3,000 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.

Your Motrec trailer is covered by the Motrec Limited Warranty for a period of three (3) years. 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.

Your Motrec product using DC or other technology is covered by the Motrec Limited Warranty for a period of two (2) years or 2,000 hours of use, whichever comes first. This period of two (2) 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 thirty (30) days of purchase of the product. If registration is not completed within this time, the warranty will be voided. 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, please make sure to go to this link (<https://www.motrec.com/registration/>) and register your vehicle. In case of registration problems, please contact your Motrec representative.

#### 4. Maintenance

Motrec requires that scheduled maintenance be performed at the times shown in the Owner's Manual (Refer to the “Preventive Maintenance Schedule”). 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 has been repaired with non-Motrec parts without Motrec's authorization
- The preventive maintenance schedule was not followed as specified in the Motrec Owner's Manual

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

- Batteries, charger, wheels (which are covered by warranties from manufacturers)
- Internal combustion engines (which are covered by warranties from manufacturers)
- Wearable parts (diodes & fuses, filters & spark plugs, lubricants, seals, switch, horn, tires, wheel bearings, seats, brake pads and shoes)
- Tear and wear 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 the freight carrier
- Shipping fees for warranty parts (if proven not admissible, refer to Defects section)
- Travel fees for technical support and repair

**TABLE OF CONTENTS**

<b>INSTRUCTIONS</b>	<b>5</b>
SAFETY WARNINGS FOR OPERATORS	6
OPERATING INSTRUCTIONS	7
<b>MAINTENANCE</b>	<b>8</b>
SAFETY WARNINGS FOR SERVICE TECHNICIANS	9
DECALS AND LABELS	11
PREVENTIVE MAINTENANCE SCHEDULE	12
ACCELERATOR	14
HYDRAULIC & PARKING BRAKES	17
FRONT AXLE AND STEERING	18
BATTERY MAINTENANCE	19
BATTERY CHARGER	21
ELECTRICAL TROUBLESHOOTING	22
<b>SPARE PARTS</b>	<b>36</b>
AC MOTOR FAN COOLED	37
AC MOTOR ENCLOSED	38
AUTOMATIC HITCH	39
ELECTRICAL DIAGRAM – MAIN CIRCUIT	42
DIAGRAMME ÉLECTRIQUE – CIRCUIT PRINCIPAL	42
PARTS LIST AC	43
MOTREC ILLUSTRATED ACCESSORIES – AC VEHICLES	45

**INSTRUCTIONS**

## **SAFETY WARNINGS FOR OPERATORS**

- FAILURE TO OBEY THE FOLLOWING SAFETY RULES MAY RESULT IN SEVERE INJURY.
- It is the responsibility of the owner of this vehicle to train operators to ensure that they understand the operating characteristics of this vehicle, including training in vehicle stability, and obey the following safety rules and guidelines. Owner shall comply with OSHA and ANSI/ITSDF B56.8 & B56.9 Standards for vehicle use, safety rules, operator training and certification. Do not drive this vehicle unless you are a qualified operator.
- Do not drive this vehicle under the influence of drugs or alcohol.
- Do not drive this vehicle on public roads and highways. This vehicle is designed to be driven in buildings.
- The electrical system of this vehicle will make sparks which can ignite inflammable materials. Never use the vehicle in hazardous areas where there are inflammable materials, explosive dust or fumes in the air.
- Have your vehicle inspected regularly by trained personnel, and cease operation if a malfunction occurs.
- Do not open battery compartment to prevent battery explosion, acid splashing, severe damage to eyes or skin.
- Do not open motor compartment. Keep clear from moving, rotating(wheels, sheaves, etc) or lifting parts.
- Never carry more passengers than number allowed for this vehicle. Wait until all occupants are seated and holding on before moving. Always keep all body parts inside vehicle. Keep both hands on steering wheel.
- Do not exceed the vehicle cargo load capacity and gross trailing weight capacity, rated for flat hard even surface. Different operating conditions such as loose terrain or ramps reduce vehicle capacity.
- Avoid loose, unbalanced or top-heavy loads to keep a good stability and prevent overturn. Do not load cargo that can fall off the vehicle. Do not carry cargo that is longer, wider or higher than this vehicle.
- Always depress slowly the accelerator for smooth acceleration. Avoid stunt driving or horseplay.
- Avoid sharp turns, always slow down before turning, to prevent vehicle overturn or trailer jack knife. Vehicle is more sensitive to overturn and jack knife when traveling on inclines or when carrying a heavy load.
- Always drive straight up and down the face of an incline, never across the face, to prevent overturn and trailer jack knife. Drive slower and start applying brakes sooner on inclines to adjust for longer stopping distance.
- Use extra care and drive slowly in reverse, in congested areas or on wet or slippery ground.
- Keep to the right under normal conditions. Maintain a safe distance from all objects.
- Slow down and sound the horn when approaching a corner or other blind intersections.
- Before leaving the vehicle, park on a level ground flat surface, turn off all switches, set the forward/reverse switch to neutral, set the parking brake, remove the key. Do not park the vehicle on an incline.
- Before battery charging, park the vehicle in a well ventilated area set for. Do not operate it when charging. To interrupt a charging cycle, disconnect the AC plug; disconnecting the DC plug or a battery terminal, or operating the vehicle, could damage the charger and produce a spark, battery explosion and acid splashing.
- Use another driver to steer this vehicle while it is towed. Be sure the driver uses brakes when you slow or stop the towing vehicle. Do not exceed 5 MPH or carry any passenger while towing this vehicle.

## **OPERATING INSTRUCTIONS**

It is the responsibility of the owner of this vehicle to ensure that the operator understands the operating characteristics of this vehicle, and obeys the safety instructions in this manual and ANSI/ITSDF B56.8 & 9 Standards. Do not drive this vehicle unless you are a certified operator as required by OSHA.

### **BEFORE TURNING ON KEYSWITCH**

Set to neutral, set parking brake, check for visible damage, check brake pedal.

### **AFTER TURNING ON KEYSWITCH**

Check safety devices: seat switch, reverse alarm, motion beeper, strobe light, and all other safety devices.

### **BATTERIES**

Never open the battery compartment unless you have received proper training for battery maintenance.

Batteries emit explosive hydrogen gas that can be ignited by a spark or loose terminal. Battery acid causes severe damage to eyes or skin. Flush the contaminated area immediately with water. Park the vehicle in a well ventilated area for battery charging. Most battery chargers come with an electronic control that starts when the charger is plugged and stop when the battery is fully charged. To interrupt the charging cycle, disconnect the AC-plug, do not disconnect the DC plug.

### **BATTERY DISCHARGE INDICATOR**

The green light moves from right to left as batteries are being discharged. When the green light is at the last position on the left the batteries must be recharged. A flashing light warns the operator that further discharge will damage batteries. See HOBBS indicator instructions.

### **EMERGENCY SAFETY DEVICE**

The emergency push button or battery disconnect handle, when present, should only be used in case of emergency. Use the key switch for normal ON/OFF control.

### **KEYSWITCH**

Depress brake pedal and turn the key switch clockwise for on position. Always turn off all switches, set the F/R selector to neutral, set the parking brake, remove the key before leaving the vehicle.

### **HORN**

Depress the horn button on the steering column or handle bar.

### **F/R SWITCH**

Three positions with neutral at center. Depress the front part of the rocker switch for forward direction. Depress the rear part of the rocker switch for reverse direction. Always set switch to neutral, turn off all switches, set the parking brake, remove the key before leaving the vehicle.

### **ACCELERATOR PEDAL**

It is designed for right foot operation only, and controls the speed of the vehicle. Apply slowly.

### **FOOT BRAKE PEDAL**

It is designed for right foot operation only. The brake force is proportional to the pressure on the pedal.

### **PARKING BRAKE**

Pull handbrake lever to apply. Never park the vehicle on an incline. Always turn off all switches, set the F/R selector to neutral, set the parking brake, remove the key before leaving the vehicle.

**MAINTENANCE**

## **SAFETY WARNINGS FOR SERVICE TECHNICIANS**

FAILURE TO OBEY THE FOLLOWING SAFETY RULES MAIN RESULT IN SEVERE INJURY.

Owner shall comply with OSHA and ANSI/ITSDF B56.8 & B56.9 Standards for vehicle maintenance.

Only qualified and authorized personnel shall be permitted to maintain, repair, adjust and inspect carriers, vehicles, tractors, and batteries.

Before any maintenance work, park the vehicle on flat level surface, turn off all switches, remove key, lift wheels off the ground and secure with jack stands of adequate capacity. Don't connect charger.

Keep clear from moving parts such as tires, sheaves and motor.

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

Always wear a face shield and gloves when working around batteries.

Before opening the battery compartment, disconnect the charger, turn off all switches and remove the key. Batteries emit highly explosive gases which greatly increase when charging; do not disturb connections or produce sparks around batteries to avoid a battery explosion and acid splashing. Battery acid causes severe damage to eyes or skin. Flush contaminated area immediately with water.

Use insulated tools to avoid sparks that can cause battery explosion and acid splashing.

Use two counteracting tools, double-wrench technique, when disconnecting or tightening terminals on the battery and the speed controller to avoid cracking the terminal or battery post welds.

Before cleaning or replacing a battery, charger, speed controller, contactor, relay, diode, or any other component in the power circuit, always disconnect the charger, turn off all switches, remove the key, wear a face shield and gloves, identify battery polarity and disconnect battery leads, discharge the capacitor in the controller with a 10 ohms, 25 W resistor for a few seconds across B+ and B-.

After cleaning, the power must not be reapplied until terminal areas are thoroughly dry.

On EE-Rated vehicles make sure that the control box is sealed, the static strap makes good contact with the ground, the motor is sealed by bands, the cable protectors are properly installed.

Keep cables and wires clear from mechanical and rubbing action. Make sure that cable insulation is free from cutting or visible damage. Make sure that EE-Rated cable protectors are properly installed.

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

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

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

SEPEX speed controls are protected by a diode in the power circuit to filter inductive loads in the event of a sudden power interrupt. Some speed controllers require a diode to filter inductive loads on the KSI input. Removing the diodes will cause the speed control failure.

Before resuming maintenance operations, inspect safety warnings stickers and replace any if damage is found and part of the text can't be read.

Check decals and labels, see "DECAL AND LABELS" page.

## DECALS AND LABELS

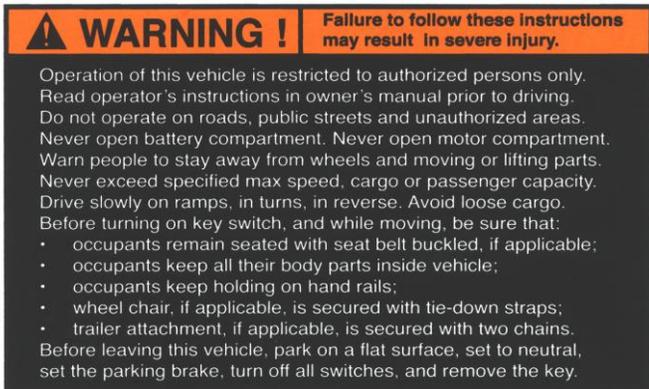
### ! CAUTION !

The images included in this section depict the decals/markings installed on the vehicle. It is of the utmost importance that these decals/markings remain unaltered and readable. Else, the sticker or the part bearing the marking has to be replaced.

Dashboard security warning label:  
# 5100000002



General security warning label:  
# 5100000001



When an emergency push button is installed, this label is required (located under push button): # 3109800006



When a disconnect handle is installed, this label is required (located in front of handle):  
# 4800012J



Respectively, key switch markings, forward/reverse selector markings and light switch marking:



# 266211

# 2819321003

# 1269004

**PREVENTIVE MAINTENANCE SCHEDULE**  
**FOR MODELS WITH AC DIRECT DRIVE**

**! WARNING!**

Maintenance operations must be made by properly trained service technicians.

- Keep clear from moving parts such as tires, sheaves and motor.
- Batteries contain Sulphur acid that can cause severe burns on skin or eyes.
- When working around batteries, wear acid proof protective equipment: face shield and gloves.
- Use electrically insulated tools to avoid sparks that can cause battery explosion.
- Before any maintenance work, park the vehicle on a flat level surface, turn off all switches, remove the key, lift the wheels off the ground and secure with jack stands of adequate capacity, identify and disconnect battery leads. Don't connect the charger.

<u>DESCRIPTION</u>	<u>PERIOD</u>	<u>ESTIMATED TIME (MINUTES)</u>			<u>CHECK</u>
		<u>SHIFT</u>	<u>500H</u>	<u>1000 H</u>	
Check for visible damage		1			
Examine floor around and beneath unit for signs of differential and brake fluid leaks.		1			
Turn steering, check for hard steering, excessive free play, or unusual sound when turning.		1			
Check accelerator for free & smooth movement.		1			
Check reverse alarm, horn, strobe light.		1			
Check brake pedal travel and parking brake for secure hold. Start slowly and check service brake.		1			
Check tire pressure, see pressure rating on tire		1			
Check deadman switch and static strap ( min 2` contact with the floor)		1			
Check warning decal & marking			1		
Clean battery with water			1		
Check master cylinder fluid level (DOT 3)			1		
Check brake pedal travel		1			
Turn front wheels straight, check steering play		1			
Check parking brake, requires 30-40 lbs. force to apply		1			
Check brake lines for leaks		1			
Check drive for leaks		1			
Inspect steering suspension linkages		1			
Inspect the frame for damage		1			
Check pedal & master cylinder linkages for wear		1			

<b>DESCRIPTION</b>	<b>PERIOD</b>	<b>ESTIMATED TIME (MINUTES)</b>				<b>CHECK</b>
		<b>SHIFT</b>	<b>500H</b>	<b>1000 H</b>	<b>2000 H</b>	
Inspect rear wheel bearings for play			3			
Inspect front wheel bearings and kingpins for play			3			
Inspect rear brake lining for wear 1/16" (2 mm) minimum lining thickness.			3			
Check service brake linings and linkages for wear			12			
Check parking brake linings and linkages for wear			5			
Check power circuit connections			5			
Check motor brushes & commutator			5			
Check accelerator pot and switch adjustment -1/8" (3 mm) travel to activate micro-switch; -0 to 50 ohms when micro-switch activated; -4500 to 5500 ohms with pedal down.			10			
Lubricate the vehicle			5			
Change differential oil MOBILUBE 1 SHC 75W-90			15			
Check and tighten all electrical connections				15		
Lubricate motor spline using Monocal GP 1499 from Lubrication Engineers grease				15		
Tighten all nuts and bolts				15		
Clean & repack front Wheel Bearing				15		
Clean & repack Rear Wheel Bearing				90		
Flush the hydraulic brake system (DOT 3), if appl.					60	
Replace differential oil seals & wheel bearings.					90	
<b>TOTAL TIME (MINUTES)</b>		<b>16</b>	<b>69</b>	<b>150</b>	<b>150</b>	

Check & fill batteries (add distilled water to cover plates. Fill to recommended level after batteries have been fully charged.)	<b>According to the battery manufacturer and the battery maintenance section of this manual.</b>
--	--

**Date:** \_\_\_\_\_ **Hour Meter Reading:** \_\_\_\_\_

**Inspected By:** \_\_\_\_\_ **Unit Number:** \_\_\_\_\_

**Any deficiencies found during inspection must be corrected before the unit is returned to service.**

## ACCELERATOR

### GEAR

- Remove the cover.
- Backlash between gears must be reduced to a minimum by sliding holder; use locktite 262 to lock the three screws.
- When the plastic gear is fully depressed a small backlash must remain between the gears.
- When the plastic gear is released its rear portion must not exceed the pedal case.

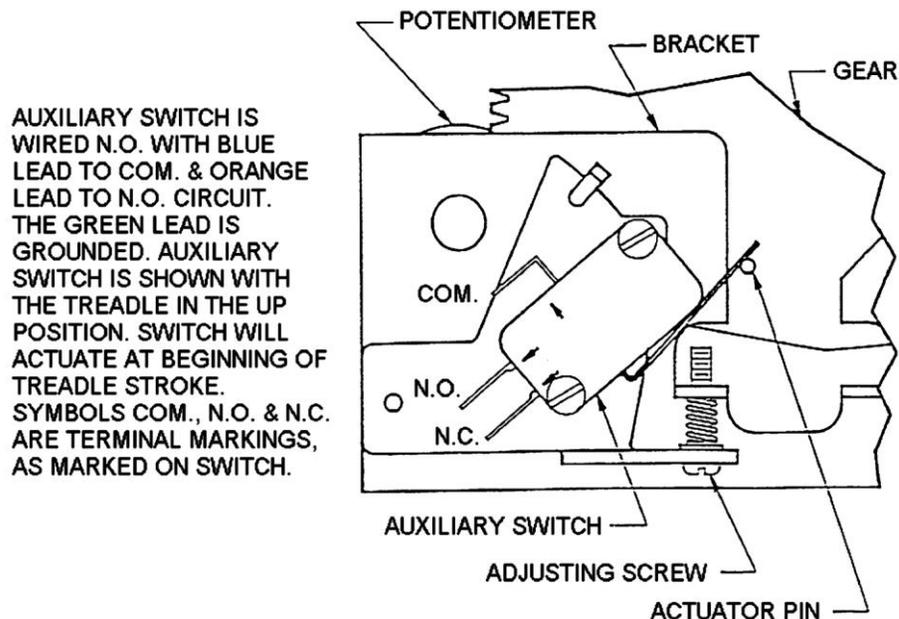
### MICRO-SWITCH

The micro-switch must deactivate the on/off solenoid when the accelerator is released; turn the adjusting screw (shown on figure below) to adjust the micro-switch height.

### POT

- Remove the terminals 2 and 3 on PMC to measure resistance signal.
- When the micro-switch is activated the signal must be less than 50 ohms. When the front portion of the pedal is fully depressed the signal must be more than 4600 ohms.
- To modify the resistance, turn the adjusting screw to change the micro-switch height (see figure below).

Proceed with the same verifications after the accelerator cover is on and then connect terminals 2 and 3.



## **FOOT PEDAL FP-6 MAINTENANCE GUIDELINES**

### **FEATURES -**

- FP 6 is designed for IP rating 64
  - It can work in dusty atmosphere.
  - It has sealing against splashing and spraying water from all side.
  - We do not recommend low pressure or high pressure washing.

### **SPECIFICATIONS -**

- Pedal high point is pedal free condition
- 1<sup>st</sup> Microswitch Setting ;
  - a) First micro switch should operate at  $3^\circ \pm 1^\circ$  (i.e. between  $2^\circ$  to  $4^\circ$ ) from free condition
- Pot setting
  - a) Operate pedal slowly; find reading at which first Microswitch operates.
  - b) Pot resistance reading across pot low and wiper (i.e. black and white) must be within 100 $\Omega$  to 400 $\Omega$ .
- 2nd Micro switch setting
  - a) 2<sup>nd</sup> micro switch should operate between 4600  $\Omega$  and *pot max* resistance, across *pot low and wiper* (i.e. black and white)

### **INSTALLATION PROCEDURE**

*Terminology* - "**Pot low**", "**wiper**" and "**pot high**" are pot terminals. (Black, white and red cables respectively) "**Pot max resistance**" is the resistance value across pot low and pot high. (Black and Red cables)

#### **1. MICRO SWITCHES AND POT SETTING**

For Foot Pedal FP-6, use pot low and wiper (black and white) for setting micro switches.

- Set Pedal at free condition.
- Adjust pedal at  $3^\circ$  deflection. Set first micro switch to operate about set deflection.
- Adjust pot resistance from high valve to get (100 to 400 $\Omega$ ) across *pot low and wiper* (i.e. black and white).
- Set 2<sup>nd</sup> micro switch between 4600  $\Omega$  and *pot max* resistance.

### ***CHECK LIST / CAUTION***

- Pedal angle must be within 30 +/- 3 degree. Check freeness of pedal.
- Select 'resistance' measurement range in as per requirement on the Multi meter. Minimum resistance between pot low and wiper must be less than 10 ohms. Pot Max Resistance (between pot low and pot high) must be within 4500 to 5500 ohms.
- Confirm that micro switch settings are as per specifications.
- Measure the resistance between each of the seven wires and the housing of the Foot Pedal. It should measure "Infinity"
- Visually check the insulating sleeves are put around the soldered side of all seven cables, and that the sleeves are firmly in place.

### ***YEARLY MAINTENANCE***

- Remove cover of Pedal.
- Apply 3 to 5 drops oil on pedal return spring.
- Apply 2 drops oil in the slot of front bush.
- Do not apply oil on shaft from outside. It is of no use, due to sealing on the shaft.
  - i. Oil Specification
  - ii. 20W Motor Oil (Or 3 in one motor oil)
  - iii. 20 stand for weight of motor oil.
  - iv. W Stands for winter grade.

## **HYDRAULIC & PARKING BRAKES**

FOR MODELS WITH TOWING CAPACITY UP TO 16,000 LB (7270 KG)

Revision 2012-01-23

### **DRUM BRAKES**

Remove brake drums and check lining wear. Replace shoes and springs if the lining thickness is 1/16" (2mm) or less. Turn the brake adjustment to reduce the clearance between lining and drum. Wheels must turn free when the pedal is released.

### **DISC BRAKES**

Check pad linings. Replace pads if lining thickness is 1/16" (2 mm) or less.

### **PARKING BRAKE**

Replace cables and stoppers if cable play exceeds 1/8" (4mm).

Wheels and/or differential pinion must turn freely when the parking brake is released.

On pinion brake, use spacers at pad fixed ends to reduce space between pads and pulley to 1mm.

To install new cables and stoppers:

- insert the new cable through the hand lever end;
- pull the cable out from the brake assembly end;
- insert the stopper on the cable and leave a maximum play of 1mm;
- for a two-cable system, make sure that cable length is the same at hand lever end;
- tighten 1/4-ncx3/4 grade-5 bolt in stopper at 8 Lb-Ft (11Nm) torque;
- cable must extend 1.5" (4cm) out of the cable stopper, cut cable excess.

Once cable play has been checked and/or adjusted, turn the knob on the brake lever until a force of 30-40 Lbs or 14-18 kg is required on the handle to set the parking brake. Tighten the locking screw.

### **BRAKE PEDAL**

If the brake pedal becomes soft or spongy, air may have entered the hydraulic system and the brake system has to be bled:

1. fill the master cylinder with brake fluid (DOT-3);
2. bleed front calipers one at a time by having someone applying a steady pressure on the brake pedal, and close the bleeder before allowing the brake pedal to return to up position;
3. fill the master cylinder with brake fluid (DOT-3);
4. bleed rear wheel brakes one at a time, following the same procedure;
5. fill the master cylinder with brake fluid (DOT-3);
6. clean every fitting and line, remove traces of oil;
7. apply a continuous pressure on the brake pedal for about five minutes ;
8. Finally, inspect brake lines and fittings for leaks ;

## **FRONT AXLE AND STEERING**

### **! CAUTION !**

Before maintenance, turn off all switches, set to neutral, set parking brake, remove the key, and raise the front end of the vehicle supporting it with two jack stands of adequate capacity

### **STEERING INSPECTION**

- Check tire inflation pressure, suspension components, tie rods straightness, tie rod ends play (wear), play (wear) in wheel bearings, kingpins and bushings.

### **REPLACING & ADJUSTING THE STEERING GEAR**

- Remove the pitman arm;
- The steering box makes 6.5 turns, center the steering gear (3.25 turns from either side);
- Align the front wheel straight. Install the pitman arm.

### **TOE-IN ADJUSTEMENT**

- 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;
- Turn the rear tie rod until the distances are equal and tighten the two lock nuts on the tie rod.

### **REMOVING & GREASING OF FRONT HUBS, required once-a-year**

- Remove dust cap and cutter pin, unscrew nut, remove hub;
- Inspect bearings and races for wear and replace worn bearings;
- Replace the seal;
- Pack the hub with wheel bearing grease and re-assemble.

### **ADJUSTING FRONT HUBS**

- Tighten spindle nut to 30 ft-lb to seat the bearing and back off the nut to the next slot;
- Install a new cutter pin and the dust cap.

## **BATTERY MAINTENANCE**

### **! WARNING !**

- It is the responsibility of the owner of this vehicle to ensure that the service technicians are properly trained, read and obey the safety rules and guidelines in this manual (ANSI B56).
- Maintenance operations must be made by properly trained service technicians only.
- Before any maintenance work, park the vehicle on a flat level surface, turn off all the switches, set to neutral, remove the key, lift the wheels off the ground and secure with jack stands of adequate capacity.
- Keep charger disconnected while doing any maintenance work.
- Always wear a face shield and scarf when working around batteries.
- Battery emits highly explosive gases; do not produce sparks to avoid battery explosion and acid splashing. Battery acid causes severe damage to eyes or skin. Flush contaminated area immediately with water.
- Use insulated tools to avoid sparks that can cause battery explosion and acid splashing.
- Use two counteracting tools, double-wrench technique, when disconnecting or tightening battery posts.
- Before cleaning or replacing a battery, discharge the capacitor in the controller with a 10 ohms, 25 W resistor for a few seconds across B+ and B-, identify battery polarity and disconnect battery leads.
- After cleaning, the power must not be reapplied until terminal areas are thoroughly dry.

### **BATTERY LEADS AND CONNECTORS**

Check for loose connections, damaged cables, acid spill, loose terminal posts, quarterly.

### **BATTERY POST CORROSION**

If corrosion is present on battery posts, remove the cable connectors, use a wire brush to remove particles, and then clean them with a cloth that has been moistened with ammonia.

### **ELECTROLYTE LEVEL**

Does not apply to sealed battery.

- Disconnect battery connectors on roll-out or lift-out installations.
- Make sure the battery roll-out tray is provided with stops before rolling out.
- Fill with distilled water.
- Daily charged batteries normally require watering once a week. Under watering leads to a shortened battery life. Over watering leads to battery corrosion. Be careful not to overfill any cell to avoid electrolyte to be forced out while charging.
- Fill each cell to plate level with distilled or de-ionized water, before battery charging. When the battery is charged, the fluid expands and can seep out if overfilled. Refill each cell after full charge, when the fluid has expanded to its maximum level.
- Reinstall battery caps before charging.

## **BATTERY MOUNTING**

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

## **BATTERY DISCHARGE LIMIT**

Discharging below a 20% state of charge cuts down the battery life and the number of cycles available. At 20% state of charge, specific gravity of 6V battery should be 1180; and 1220 for industrial battery.

## **CHARGING AREA**

- Always charge battery in a well ventilated area set for and approved for charging.
- Never leave a charger connected for more than 20 hours.

## **FREQUENCY OF CHARGE**

- When a battery is discharged to its 20% state of charge, it is best to charge immediately.
- Batteries require a low current equalization charge (min 4 hours) at least every week, to equalize battery cells, improve battery performance and life in number of cycles.
- Never leave a charger connected for more than 20 hours.

## **STORAGE**

- Keep the battery from getting cold, it would lose its capacity.
- Let the battery warm up before charging.
- Charge batteries in “stored” vehicles every month.

## **DEFECTIVE BATTERY**

Check specific gravity of each cell; if a cell is shorted, voltage drop may occur only when there is current.

## **BATTERY CHARGER**

### **! WARNING !**

Always unplug the AC and DC electrical cords before attempting any repairs to the charger.

#### **CHARGER DOES NOT TURN ON:**

- Dc cord of portable chargers must be disconnected from batteries after every charge to restart;
- Check dc fuse links;
- Check battery voltage at the battery connector;
- Check ac outlet and cordset;
- Replace electronic control ;

#### **RELAY CLOSSES AND TRANSFORMER HUMS BUT AMMETER DOES NOT REGISTER:**

- Check dc fuse links;
- Check the continuity of the dc output cord, ammeter, diodes and all connections in the dc circuit;
- Check diodes;
- Check capacitor(rapidely increasing resistance);

#### **SINGLE CHARGER FUSE BLOWS:**

- Disconnect and check diodes;

#### **BOTH FUSE LINKS BLOW:**

- Check the battery pack and battery connector polarity;
- Disconnect and check diodes.

#### **CHARGER OUTPUT IS LOW:**

- Disconnect and check diodes;
- Can be caused by a transformer failure.

#### **AMMETER READS 30 AMPS FOR MORE THAN 30 MINUTES:**

- Check the battery pack;

#### **CHARGER DOES NOT TURN OFF:**

- Check specific gravity in each battery cell;
- As much as 16 hours may be required to properly charge heavily discharged new or cold batteries;
- Replace electronic control.

#### **AC LINE FUSE OR CIRCUIT BREAKER BLOWS:**

- Check ac cordset;
- Check ac line fuse rating;
- Replace electronic control;
- Can be caused by a transformer failure.

## **ELECTRICAL TROUBLESHOOTING**

### **! WARNING !**

Maintenance work must be performed by trained service technicians only.

It is the responsibility of the owner of this vehicle to ensure that the services technicians are properly trained, understand and obey the safety rules and guidelines (ANSI B56).

All service technicians must read and understand the maintenance warning section in this manual.

### **! WARNING !**

Before any maintenance work, park the vehicle on a flat level surface, turn off all switches, remove the key, lift the wheels off the ground, secure with jack stands of adequate capacity, disconnect charger.

Always wear safety glasses.

Batteries emit highly explosive gases that can be ignited by a spark. Before disconnecting a high current terminal, turn off all switches, disconnect battery charger and disconnect batteries.

Keep clear from moving parts such as tires, sheaves and motor.

### **PMC SELF DIAGNOSTIC**

If the vehicle has a display, it will give the error codes to help troubleshooting. The PMC also comes with a status LED, which gives a flashing code to help troubleshooting.

### **BATTERY VOLTAGE**

Make sure batteries are securely connected. Measure voltage between + and - terminals. We will call this value B+ or full battery voltage.

### **ACCESSORIES NOT WORKING**

- Check the fuses on the batteries and the DC/DC converter.
- Check voltage across + and - terminals on the battery gage; if not B+, check wiring.
- Turn the key switch ON, check voltage between output terminal on the key switch and the - terminal on the battery gage; if not B+, replace the key switch.
- Check voltage across DC/DC converter output terminals; if not 12-Volt, replace the converter.
- Depress the accessory switch, check voltage across accessory terminals. If not 12-Volt, replace the switch. If 12-Volt, replace the accessory.

### **FORWARD ONLY**

Check the reverse signal input on the controller.

Switch to reverse and check voltage on the reverse control wire. If not B+, replace the F/R switch.

### **REVERSE ONLY**

Check the forward signal input on the controller.

Switch to forward and check the voltage on the forward control wire. If not B+, replace the F/R switch.

## **TRAVEL AT REDUCED SPEED**

### *Check batteries.*

Turn off all switches and disconnect charger. Wear face shield and gloves. Do not disturb any battery connection to avoid sparks. Check the specific gravity of each cell. Cold batteries, highly discharged batteries or dead cells are the most frequent causes of reduced travel speed.

### *Check potentiometer.*

Turn off the key switch, disconnect potentiometer terminals. Check the resistance between terminals.

Other causes of lower speed:

- dragging brakes;
- cold temperature (higher differential oil viscosity).

## **INTERMITTENT OPERATION**

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

- acceleration is not constant;
- maximum speed is erratic;
- 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 micro-switch; the pot signal must be less than 50 ohms when the micro-switch turns on.

PMC has a HPD safety feature that prevents the vehicle from moving if the accelerator pedal is depressed before the key switch is ON and seat switch is activated.

PMC also has a SRO safety feature that prevents the vehicle from moving if the F/R switch is activated before turning on the key switch and activating the seat switch.

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 cutback the current until the PMC and/or motor has cooled down.

## **NO MOTION**

Make sure that the PMC surface is clean and dry; check the terminal areas. Dust Particles or acid contamination, can create current leaks and cause a PMC malfunction.

### *Check F/R switch*

Turn on the key switch and set to forward. Check voltage between the forward terminal and the B– post on the PMC, check voltage between the reverse terminal and the B– post on the PMC; if both B+, replace the F/R switch.

### *Check switches and wiring*

Disconnect control terminals on the PMC and check all control signals. If a switch pin does not read B+, check wiring or replace the switch.

*Check potentiometer*

Turn the key switch to OFF, disconnect potentiometer terminals. Check the resistance across terminals: if not within the recommended limits, adjust or replace the potentiometer. Check for shorts between potentiometer wires and vehicle frame; resistance should read at least 1 megohm.

*Check main contactor or solenoid*

Check voltage on coil positive terminal; if not B+, check circuit breaker or replace the solenoid. Turn to on the key switch and activate the seat switch. Check voltage across the coil terminals; if not 24V, check wiring and interlock switches. Check resistance across power terminals; if not 0 ohms, replace the solenoid.

# 8

## DIAGNOSTICS AND TROUBLESHOOTING

These controllers detect a wide variety of faults or error conditions. Faults can be detected by the operating system or by the VCL code. This section describes the faults detected by the operating system.

Faults detected by VCL code (faults 51–67 in Table 5) cannot be defined here as they will vary from application to application. Refer to the appropriate OEM documentation for information on these faults.

### DIAGNOSTICS

Diagnostics information can be obtained in either of two ways: (1) by reading the display on a 1311 programmer or (2) by observing the fault codes issued by the Status LEDs. See Table 4 for a summary of LED display formats.

The 1311 programmer will display all faults that are currently set as well as a history of the faults that have been set since the history log was last cleared. The 1311 displays the faults by name.

The pair of LEDs built into the controller (one red, one yellow) produce flash codes displaying all the currently set faults in a repeating cycle. Each code consists of two digits. The red LED flashes once to indicate that the first digit of the code will follow; the yellow LED then flashes the appropriate number of times for the first digit. The red LED flashes twice to indicate that the second digit of the code will follow; the yellow LED flashes the appropriate number of times for the second digit.

Example: Battery Undervoltage (code 23).

In the Fault menu of the 1311 programmer, the words **Undervoltage Cutback** will be displayed; the real-time battery voltage is displayed in the Monitor menu (“Keyswitch Voltage”).

The controller’s two LEDs will display this repeating pattern:

RED	YELLOW	RED	YELLOW
*	**	**	**
(first digit)	(2)	(second digit)	(3)

The numerical codes used by the yellow LED are listed in the troubleshooting chart (Table 5), which also lists possible fault causes and describes the conditions that set and clear each fault.

### Summary of LED display formats

The two LEDs have four different display modes, indicating the type of information they are providing.

DISPLAY	STATUS
Neither LED illuminated	Controller is not powered on; or vehicle has dead battery; or severe damage.
Yellow LED flashing	Controller is operating normally.
Yellow and red LEDs both on solid	Controller is in Flash program mode.
Red LED on solid	Watchdog failure or no software loaded. Cycle KSI to restart, and if necessary load software.
Red LED and yellow LED flashing alternately	Controller has detected a fault. 2-digit code flashed by yellow LED identifies the specific fault; one or two flashes by red LED indicate whether first or second code digit will follow.

### TROUBLESHOOTING

The troubleshooting chart, Table 5, provides the following information on all the controller faults:

- fault code
- fault name as displayed on the programmer's LCD
- the effect of the fault
- possible causes of the fault
- fault *set* conditions
- fault *clear* conditions.

Whenever a fault is encountered and no wiring or vehicle fault can be found, shut off KSI and turn it back on to see if the fault clears. If it does not, shut off KSI and remove the 35-pin connector. Check the connector for corrosion or damage, clean it if necessary, and re-insert it.

**Table 5 TROUBLESHOOTING CHART**

CODE	PROGRAMMER LCD DISPLAY EFFECT OF FAULT	POSSIBLE CAUSE	SET/CLEAR CONDITIONS
12	Controller Overcurrent <i>ShutdownMotor;</i> <i>ShutdownMainContactor;</i> <i>ShutdownEMBrake;</i> <i>ShutdownThrottle;</i> <i>FullBrake;</i> <i>ShutdownPump.</i>	<ol style="list-style-type: none"> <li>External short of phase U,V, or W motor connections.</li> <li>Motor parameters are mis-tuned.</li> <li>Controller defective.</li> </ol>	<p><i>Set:</i> Phase current exceeded the current measurement limit.</p> <p><i>Clear:</i> Cycle KSI.</p>
13	Current Sensor Fault <i>ShutdownMotor;</i> <i>ShutdownMainContactor;</i> <i>ShutdownEMBrake;</i> <i>ShutdownThrottle;</i> <i>FullBrake;</i> <i>ShutdownPump.</i>	<ol style="list-style-type: none"> <li>Leakage to vehicle frame from phase U, V, or W (short in motor stator).</li> <li>Controller defective.</li> </ol>	<p><i>Set:</i> Controller current sensors have invalid offset reading.</p> <p><i>Clear:</i> Cycle KSI.</p>
14	Precharge Failed <i>ShutdownMotor;</i> <i>ShutdownMainContactor;</i> <i>ShutdownEMBrake;</i> <i>ShutdownThrottle;</i> <i>FullBrake;</i> <i>ShutdownPump.</i>	<ol style="list-style-type: none"> <li>External load on capacitor bank (B+ connection terminal) that prevents the capacitor bank from charging.</li> <li>See Monitor menu » Battery: Capacitor Voltage.</li> </ol>	<p><i>Set:</i> Precharge failed to charge the capacitor bank to the KSI voltage.</p> <p><i>Clear:</i> Cycle Interlock input or use VCL function <i>Precharge()</i>.</p>
15	Controller Severe Undertemp <i>ShutdownMotor;</i> <i>ShutdownMainContactor;</i> <i>ShutdownEMBrake;</i> <i>ShutdownThrottle;</i> <i>FullBrake;</i> <i>ShutdownPump.</i>	<ol style="list-style-type: none"> <li>See Monitor menu » Controller: Temperature.</li> <li>Controller is operating in an extreme environment.</li> </ol>	<p><i>Set:</i> Heatsink temperature below -40°C.</p> <p><i>Clear:</i> Bring heatsink temperature above -40°C, and cycle interlock or KSI.</p>
16	Controller Severe Overtemp <i>ShutdownMotor;</i> <i>ShutdownMainContactor;</i> <i>ShutdownEMBrake;</i> <i>ShutdownThrottle;</i> <i>FullBrake;</i> <i>ShutdownPump.</i>	<ol style="list-style-type: none"> <li>See Monitor menu » Controller: Temperature.</li> <li>Controller is operating in an extreme environment.</li> <li>Excessive load on vehicle.</li> <li>Improper mounting of controller.</li> </ol>	<p><i>Set:</i> Heatsink temperature above +95°C.</p> <p><i>Clear:</i> Bring heatsink temperature below +95°C, and cycle interlock or KSI.</p>
17	Severe Undervoltage <i>Reduced drive torque.</i>	<ol style="list-style-type: none"> <li>Battery Menu parameters are misadjusted.</li> <li>Non-controller system drain on battery.</li> <li>Battery resistance too high.</li> <li>Battery disconnected while driving.</li> <li>See Monitor menu » Battery: Capacitor Voltage.</li> <li>Blown B+ fuse or main contactor did not close.</li> </ol>	<p><i>Set:</i> Capacitor bank voltage dropped below the Severe Undervoltage limit (see page 55) with FET bridge enabled.</p> <p><i>Clear:</i> Bring capacitor voltage above Severe Undervoltage limit.</p>

Table 5 TROUBLESHOOTING CHART, continued

CODE	PROGRAMMER LCD DISPLAY EFFECT OF FAULT	POSSIBLE CAUSE	SET/CLEAR CONDITIONS
18	Severe Overvoltage <i>ShutdownMotor;</i> <i>ShutdownMainContactor;</i> <i>ShutdownEMBrake;</i> <i>ShutdownThrottle;</i> <i>FullBrake;</i> <i>ShutdownPump.</i>	<ol style="list-style-type: none"> <li>1. See Monitor menu » Battery: Capacitor Voltage.</li> <li>2. Battery menu parameters are misadjusted.</li> <li>3. Battery resistance too high for given regen current.</li> <li>4. Battery disconnected while regen braking.</li> </ol>	<p><i>Set:</i> Capacitor bank voltage exceeded the Severe Overvoltage limit (see page 55) with FET bridge enabled.</p> <p><i>Clear:</i> Bring capacitor voltage below Severe Overvoltage limit, and then cycle KSI.</p>
22	Controller Overtemp Cutback <i>Reduced drive and brake torque.</i>	<ol style="list-style-type: none"> <li>1. See Monitor menu » Controller: Temperature.</li> <li>2. Controller is performance-limited at this temperature.</li> <li>3. Controller is operating in an extreme environment.</li> <li>4. Excessive load on vehicle.</li> <li>5. Improper mounting of controller.</li> </ol>	<p><i>Set:</i> Heatsink temperature exceeded 85°C.</p> <p><i>Clear:</i> Bring heatsink temperature below 85°C.</p>
23	Undervoltage Cutback <i>Reduced drive torque.</i>	<ol style="list-style-type: none"> <li>1. Normal operation. Fault shows that the batteries need recharging. Controller is performance limited at this voltage.</li> <li>2. Battery parameters are misadjusted.</li> <li>3. Non-controller system drain on battery.</li> <li>4. Battery resistance too high.</li> <li>5. Battery disconnected while driving.</li> <li>6. See Monitor menu » Battery: Capacitor Voltage.</li> <li>7. Blown B+ fuse or main contactor did not close.</li> </ol>	<p><i>Set:</i> Capacitor bank voltage dropped below the Undervoltage limit (see page 55) with the FET bridge enabled.</p> <p><i>Clear:</i> Bring capacitor voltage above the Undervoltage limit.</p>
24	Overvoltage Cutback <i>Reduced brake torque.</i>	<ol style="list-style-type: none"> <li>1. Normal operation. Fault shows that regen braking currents elevated the battery voltage during regen braking. Controller is performance limited at this voltage.</li> <li>2. Battery parameters are misadjusted.</li> <li>3. Battery resistance too high for given regen current.</li> <li>4. Battery disconnected while regen braking.</li> <li>5. See Monitor menu » Battery: Capacitor Voltage.</li> </ol>	<p><i>Set:</i> Capacitor bank voltage exceeded the Overvoltage limit (see page 55) with the FET bridge enabled.</p> <p><i>Clear:</i> Bring capacitor voltage below the Overvoltage limit.</p>
25	+5V Supply Failure <i>None, unless a fault action is programmed in VCL.</i>	<ol style="list-style-type: none"> <li>1. External load impedance on the +5V supply (pin 26) is too low.</li> <li>2. See Monitor menu » outputs: 5 Volts and Ext Supply Current.</li> </ol>	<p><i>Set:</i> +5V supply (pin 26) outside the +5V±10% range.</p> <p><i>Clear:</i> Bring voltage within range.</p>
26	Digital Out 6 Overcurrent <i>Digital Output 6 driver will not turn on.</i>	<ol style="list-style-type: none"> <li>1. External load impedance on Digital Output 6 driver (pin 19) is too low.</li> </ol>	<p><i>Set:</i> Digital Output 6 (pin 19) current exceeded 15 mA.</p> <p><i>Clear:</i> Remedy the overcurrent cause and use the VCL function <i>Set_DigOut()</i> to turn the driver on again.</p>

Table 5 TROUBLESHOOTING CHART, continued

CODE	PROGRAMMER LCD DISPLAY EFFECT OF FAULT	POSSIBLE CAUSE	SET/CLEAR CONDITIONS
27	Digital Out 7 Overcurrent <i>Digital Output 7 driver will not turn on.</i>	1. External load impedance on Digital Output 7 driver (pin 20) is too low.	<i>Set:</i> Digital Output 7 (pin 20) current exceeded 15 mA. <i>Clear:</i> Remedy the overcurrent cause and use the VCL function <i>Set_DigOut()</i> to turn the driver on again.
28	Motor Temp Hot Cutback <i>Reduced drive torque.</i>	1. Motor temperature is at or above the programmed Temperature Hot setting, and the requested current is being cut back. 2. Motor Temperature Control Menu parameters are mis-tuned. 3. See Monitor menu » Motor: Temperature and » Inputs: Analog2. 4. If the application doesn't use a motor thermistor, Temp Compensation and Temp Cutback should be programmed Off.	<i>Set:</i> Motor temperature is at or above the Temperature Hot parameter setting. <i>Clear:</i> Bring the motor temperature within range.
29	Motor Temp Sensor Fault <i>MaxSpeed reduced (LOS, Limited Operating Strategy), and motor temperature cutback disabled.</i>	1. Motor thermistor is not connected properly. 2. If the application doesn't use a motor thermistor, Motor Temp Sensor Enable should be programmed Off. 3. See Monitor menu » Motor: Temperature and » Inputs: Analog2.	<i>Set:</i> Motor thermistor input (pin 8) is at the voltage rail (0 or 10V). <i>Clear:</i> Bring the motor thermistor input voltage within range.
31	Coil1 Driver Open/Short <i>ShutdownDriver1.</i>	1. Open or short on driver load. 2. Dirty connector pins. 3. Bad crimps or faulty wiring.	<i>Set:</i> Driver 1 (pin 6) is either open or shorted. This fault can be set only when Main Enable = Off. <i>Clear:</i> Correct open or short, and cycle driver.
31	Main Open/Short <i>ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; FullBrake; ShutdownPump.</i>	1. Open or short on driver load. 2. Dirty connector pins. 3. Bad crimps or faulty wiring.	<i>Set:</i> Main contactor driver (pin 6) is either open or shorted. This fault can be set only when Main Enable = On. <i>Clear:</i> Correct open or short, and cycle driver.
32	Coil2 Driver Open/Short <i>ShutdownDriver2.</i>	1. Open or short on driver load. 2. Dirty connector pins. 3. Bad crimps or faulty wiring.	<i>Set:</i> Driver 2 (pin 5) is either open or shorted. This fault can be set only when EM Brake Type = 0. <i>Clear:</i> Correct open or short, and cycle driver.
32	EMBrake Open/Short <i>ShutdownEMBrake; ShutdownThrottle; FullBrake.</i>	1. Open or short on driver load. 2. Dirty connector pins. 3. Bad crimps or faulty wiring.	<i>Set:</i> Electromagnetic brake driver (pin 5) is either open or shorted. This fault can be set only when EM Brake Type >0. <i>Clear:</i> Correct open or short, and cycle driver.
33	Coil3 Driver Open/Short <i>ShutdownDriver3.</i>	1. Open or short on driver load. 2. Dirty connector pins. 3. Bad crimps or faulty wiring.	<i>Set:</i> Driver 3 (pin 4) is either open or shorted. <i>Clear:</i> Correct open or short, and cycle driver.
34	Coil4 Driver Open/Short <i>ShutdownDriver4.</i>	1. Open or short on driver load. 2. Dirty connector pins. 3. Bad crimps or faulty wiring.	<i>Set:</i> Driver 4 (pin 3) is either open or shorted. <i>Clear:</i> Correct open or short, and cycle driver.

Table 5 TROUBLESHOOTING CHART, continued

CODE	PROGRAMMER LCD DISPLAY EFFECT OF FAULT	POSSIBLE CAUSE	SET/CLEAR CONDITIONS
35	PD Open/Short <i>ShutdownPD.</i>	<ol style="list-style-type: none"> <li>Open or short on driver load.</li> <li>Dirty connector pins.</li> <li>Bad crimps or faulty wiring.</li> </ol>	<p><i>Set:</i> Proportional driver (pin 2) is either open or shorted.</p> <p><i>Clear:</i> Correct open or short, and cycle driver.</p>
36	Encoder Fault <i>ShutdownEMBrake.</i>	<ol style="list-style-type: none"> <li>Motor encoder failure.</li> <li>Bad crimps or faulty wiring.</li> <li>See Monitor menu » Motor: Motor RPM.</li> </ol>	<p><i>Set:</i> Motor encoder phase failure detected.</p> <p><i>Clear:</i> Cycle KSI.</p>
37	Motor Open <i>ShutdownMotor;</i> <i>ShutdownMainContactor;</i> <i>ShutdownEMBrake;</i> <i>ShutdownThrottle;</i> <i>FullBrake;</i> <i>ShutdownPump.</i>	<ol style="list-style-type: none"> <li>Motor phase is open.</li> <li>Bad crimps or faulty wiring.</li> </ol>	<p><i>Set:</i> Motor phase U, V, or W detected open.</p> <p><i>Clear:</i> Cycle KSI.</p>
38	Main Contactor Welded <i>ShutdownMotor;</i> <i>ShutdownMainContactor;</i> <i>ShutdownEMBrake;</i> <i>ShutdownThrottle;</i> <i>FullBrake;</i> <i>ShutdownPump.</i>	<ol style="list-style-type: none"> <li>Main contactor tips are welded closed.</li> <li>Motor phase U or V is disconnected or open.</li> <li>An alternate voltage path (such as an external precharge resistor) is providing a current to the capacitor bank (B+ connection terminal).</li> </ol>	<p><i>Set:</i> 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.</p> <p><i>Clear:</i> Cycle KSI</p>
39	Main Contactor Did Not Close <i>ShutdownMotor;</i> <i>ShutdownMainContactor;</i> <i>ShutdownEMBrake;</i> <i>ShutdownThrottle;</i> <i>FullBrake;</i> <i>ShutdownPump.</i>	<ol style="list-style-type: none"> <li>Main contactor did not close.</li> <li>Main contactor tips are oxidized, burned, or not making good contact.</li> <li>External load on capacitor bank (B+ connection terminal) that prevents capacitor bank from charging.</li> <li>Blown B+ fuse.</li> </ol>	<p><i>Set:</i> With the main contactor commanded closed, the capacitor bank voltage (B+ connection terminal) did not charge to B+.</p> <p><i>Clear:</i> Cycle KSI.</p>
41	Throttle Wiper High <i>ShutdownThrottle.</i>	<ol style="list-style-type: none"> <li>See Monitor menu » Inputs: Throttle Pot.</li> <li>Throttle pot wiper voltage too high.</li> </ol>	<p><i>Set:</i> Throttle pot wiper (pin 16) voltage is higher than the high fault threshold (can be changed with the VCL function <i>Setup_Pot_Faults()</i>).</p> <p><i>Clear:</i> Bring throttle pot wiper voltage below the fault threshold.</p>
42	Throttle Wiper Low <i>ShutdownThrottle.</i>	<ol style="list-style-type: none"> <li>See Monitor menu » Inputs: Throttle Pot.</li> <li>Throttle pot wiper voltage too low.</li> </ol>	<p><i>Set:</i> Throttle pot wiper (pin 16) voltage is lower than the low fault threshold (can be changed with the VCL function <i>Setup_Pot_Faults()</i>).</p> <p><i>Clear:</i> Bring throttle pot wiper voltage above the fault threshold.</p>
43	Pot2 Wiper High <i>FullBrake.</i>	<ol style="list-style-type: none"> <li>See Monitor menu » Inputs: Pot2 Raw.</li> <li>Pot2 wiper voltage too high.</li> </ol>	<p><i>Set:</i> Pot2 wiper (pin 17) voltage is higher than the high fault threshold (can be changed with the VCL function <i>Setup_Pot_Faults()</i>).</p> <p><i>Clear:</i> Bring Pot2 wiper voltage below the fault threshold.</p>

**Table 5 TROUBLESHOOTING CHART, continued**

CODE	PROGRAMMER LCD DISPLAY EFFECT OF FAULT	POSSIBLE CAUSE	SET/CLEAR CONDITIONS
44	Pot2 Wiper Low <i>FullBrake.</i>	<ol style="list-style-type: none"> <li>1. See Monitor menu » Inputs: Pot2 Raw.</li> <li>2. Pot2 wiper voltage too low.</li> </ol>	<p><i>Set:</i> Pot2 wiper (pin 17) voltage is lower than the low fault threshold (can be changed with the VCL function <i>Setup_Pot_Faults()</i>).</p> <p><i>Clear:</i> Bring Pot2 wiper voltage above the fault threshold.</p>
45	Pot Low Overcurrent <i>ShutdownThrottle;</i> <i>FullBrake.</i>	<ol style="list-style-type: none"> <li>1. See Monitor menu » Outputs: Pot Low.</li> <li>2. Combined pot resistance connected to pot low is too low.</li> </ol>	<p><i>Set:</i> Pot low (pin 18) current exceeds 10mA.</p> <p><i>Clear:</i> Clear pot low overcurrent condition and cycle KSI.</p>
46	EEPROM Failure <i>ShutdownMotor;</i> <i>ShutdownMainContactor;</i> <i>ShutdownEMBrake;</i> <i>ShutdownThrottle;</i> <i>ShutdownInterlock;</i> <i>ShutdownDriver1;</i> <i>ShutdownDriver2;</i> <i>ShutdownDriver3;</i> <i>ShutdownDriver4;</i> <i>ShutdownPD;</i> <i>FullBrake;</i> <i>ShutdownPump.</i>	<ol style="list-style-type: none"> <li>1. 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.</li> </ol>	<p><i>Set:</i> Controller operating system tried to write to EEPROM memory and failed.</p> <p><i>Clear:</i> Download the correct software (OS) and matching parameter default settings into the controller and cycle KSI.</p>
47	HPD/Sequencing Fault <i>ShutdownThrottle.</i>	<ol style="list-style-type: none"> <li>1. KSI, interlock, direction, and throttle inputs applied in incorrect sequence.</li> <li>2. Faulty wiring, crimps, or switches at KSI, interlock, direction, or throttle inputs.</li> <li>3. See Monitor menu » Inputs.</li> </ol>	<p><i>Set:</i> HPD (High Pedal Disable) or sequencing fault caused by incorrect sequence of KSI, interlock, direction, and throttle inputs.</p> <p><i>Clear:</i> Reapply inputs in correct sequence.</p>
47	Emer Rev HPD <i>ShutdownThrottle;</i> <i>ShutdownEMBrake.</i>	<ol style="list-style-type: none"> <li>1. Emergency Reverse operation has concluded, but the throttle, forward and reverse inputs, and interlock have not been returned to neutral.</li> </ol>	<p><i>Set:</i> At the conclusion of Emergency Reverse, the fault was set because various inputs were not returned to neutral.</p> <p><i>Clear:</i> If EMR_Interlock = On, clear the interlock, throttle, and direction inputs. If EMR_Interlock = Off, clear the throttle and direction inputs.</p>
49	Parameter Change Fault <i>ShutdownMotor;</i> <i>ShutdownMainContactor;</i> <i>ShutdownEMBrake;</i> <i>ShutdownThrottle;</i> <i>FullBrake;</i> <i>ShutdownPump.</i>	<ol style="list-style-type: none"> <li>1. 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.</li> </ol>	<p><i>Set:</i> Adjustment of a parameter setting that requires cycling of KSI.</p> <p><i>Clear:</i> Cycle KSI.</p>
51–67	OEM Faults (See OEM documentation.)	<ol style="list-style-type: none"> <li>1. These faults can be defined by the OEM and are implemented in the application-specific VCL code. See OEM documentation.</li> </ol>	<p><i>Set:</i> See OEM documentation.</p> <p><i>Clear:</i> See OEM documentation.</p>

Table 5 TROUBLESHOOTING CHART, continued

CODE	PROGRAMMER LCD DISPLAY EFFECT OF FAULT	POSSIBLE CAUSE	SET/CLEAR CONDITIONS
68	VCL Run Time Error <i>ShutdownMotor;</i> <i>ShutdownMainContactor;</i> <i>ShutdownEMBrake;</i> <i>ShutdownThrottle;</i> <i>ShutdownInterlock;</i> <i>ShutdownDriver1;</i> <i>ShutdownDriver2;</i> <i>ShutdownDriver3;</i> <i>ShutdownDriver4;</i> <i>ShutdownPD;</i> <i>FullBrake;</i> <i>ShutdownPump.</i>	<ol style="list-style-type: none"> <li>1. VCL code encountered a runtime VCL error.</li> <li>2. 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.</li> </ol>	<p><i>Set:</i> Runtime VCL code error condition. <i>Clear:</i> Edit VCL application software to fix this error condition; flash the new compiled software and matching parameter defaults; cycle KSI.</p>
69	External Supply Out of Range <i>None, unless a fault action is programmed in VCL.</i>	<ol style="list-style-type: none"> <li>1. External load on the 5V and 12V supplies draws either too much or too little current.</li> <li>2. Fault Checking Menu parameters Ext Supply Max and Ext Supply Min are mis-tuned.</li> <li>3. See Monitor menu » Outputs: Ext Supply Current.</li> </ol>	<p><i>Set:</i> 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 (page 52). <i>Clear:</i> Bring the external supply current within range.</p>
71	OS General <i>ShutdownMotor;</i> <i>ShutdownMainContactor;</i> <i>ShutdownEMBrake;</i> <i>ShutdownThrottle;</i> <i>ShutdownInterlock;</i> <i>ShutdownDriver1;</i> <i>ShutdownDriver2;</i> <i>ShutdownDriver3;</i> <i>ShutdownDriver4;</i> <i>ShutdownPD;</i> <i>FullBrake;</i> <i>ShutdownPump.</i>	<ol style="list-style-type: none"> <li>1. Internal controller fault.</li> </ol>	<p><i>Set:</i> Internal controller fault detected. <i>Clear:</i> Cycle KSI.</p>
72	PDO Timeout <i>ShutdownInterlock;</i> <i>CAN NMT State set to Pre-operational.</i>	<ol style="list-style-type: none"> <li>1. Time between CAN PDO messages received exceeded the PDO Timeout Period.</li> </ol>	<p><i>Set:</i> Time between CAN PDO messages received exceeded the PDO Timeout Period. <i>Clear:</i> Cycle KSI or receive CAN NMT message.</p>
73	Stall Detected <i>ShutdownEMBrake;</i> <i>Control Mode changed to LOS (Limited Operating Strategy).</i>	<ol style="list-style-type: none"> <li>1. Stalled motor.</li> <li>2. Motor encoder failure.</li> <li>3. Bad crimps or faulty wiring.</li> <li>4. Problems with power supply for the motor encoder.</li> <li>5. See Monitor menu » Motor: Motor RPM.</li> </ol>	<p><i>Set:</i> No motor encoder movement detected. <i>Clear:</i> Either cycle KSI, or detect valid motor encoder signals while operating in LOS mode and return Throttle Command = 0 and Motor RPM = 0.</p>

Table 5 TROUBLESHOOTING CHART, continued

CODE	PROGRAMMER LCD DISPLAY EFFECT OF FAULT	POSSIBLE CAUSE	SET/CLEAR CONDITIONS
87	Motor Characterization Fault <i>ShutdownMotor;</i> <i>ShutdownMainContactor;</i> <i>ShutdownEMBrake;</i> <i>ShutdownThrottle;</i> <i>FullBrake;</i> <i>ShutdownPump.</i>	1. Motor characterization failed during characterization process. See Monitor menu » Controller: Motor Characterization Error for cause: 0=none 1=encoder signal seen, but step size not determined; set Encoder Step Size 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.	<i>Set:</i> Motor characterization failed during the motor characterization process. <i>Clear:</i> Correct fault; cycle KSI.
89	Motor Type Fault <i>ShutdownMotor;</i> <i>ShutdownMainContactor;</i> <i>ShutdownEMBrake;</i> <i>ShutdownThrottle;</i> <i>FullBrake;</i> <i>ShutdownPump.</i>	1. The Motor_Type parameter value is out of range.	<i>Set:</i> Motor_Type parameter is set to an illegal value. <i>Clear:</i> Set Motor_Type to correct value and cycle KSI.
91	VCL/OS Mismatch <i>ShutdownMotor;</i> <i>ShutdownMainContactor;</i> <i>ShutdownEMBrake;</i> <i>ShutdownThrottle;</i> <i>ShutdownInterlock;</i> <i>ShutdownDriver1;</i> <i>ShutdownDriver2;</i> <i>ShutdownDriver3;</i> <i>ShutdownDriver4;</i> <i>ShutdownPD;</i> <i>FullBrake;</i> <i>ShutdownPump.</i>	1. The VCL software in the controller does not match the OS software in the controller.	<i>Set:</i> 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. <i>Clear:</i> Download the correct VCL and OS software into the controller.
92	EM Brake Failed to Set <i>ShutdownEMBrake;</i> <i>ShutdownThrottle.</i>	1. Vehicle movement sensed after the EM Brake has been commanded to set. 2. EM Brake will not hold the motor from rotating.	<i>Set:</i> After the EM Brake was commanded to set and time has elapsed to allow the brake to fully engage, vehicle movement has been sensed. <i>Clear:</i> Activate the throttle.
93	Encoder LOS (Limited Operating Strategy) <i>Enter LOS control mode.</i>	1. Limited Operating Strategy (LOS) control mode has been activated, as a result of either an Encoder Fault (Code 36) or a Stall Detect Fault (Code 73). 2. Motor encoder failure. 3. Bad crimps or faulty wiring. 4. Vehicle is stalled.	<i>Set:</i> Encoder Fault (Code 36) or Stall Detect Fault (Code 73) was activated, and Brake or Interlock has been applied to activate LOS control mode, allowing limited motor control. <i>Clear:</i> Cycle KSI, <b>or</b> if LOS mode was activated by the Stall Fault, clear by ensuring encoder senses proper operation, Motor RPM = 0, and Throttle Command = 0.

**Table 5 TROUBLESHOOTING CHART, continued**

CODE	PROGRAMMER LCD DISPLAY EFFECT OF FAULT	POSSIBLE CAUSE	SET/CLEAR CONDITIONS
94	Emer Rev Timeout <i>ShutdownEMBrake;</i> <i>ShutdownThrottle.</i>	<ol style="list-style-type: none"> <li>1. Emergency Reverse was activated and concluded because the EMR Timeout timer has expired.</li> <li>2. The emergency reverse input is stuck On.</li> </ol>	<p><i>Set:</i> Emergency Reverse was activated and ran until the EMR Timeout timer expired.</p> <p><i>Clear:</i> Turn the emergency reverse input Off.</p>
98	Illegal Model Number <i>ShutdownMotor;</i> <i>ShutdownMainContactor;</i> <i>ShutdownEMBrake;</i> <i>ShutdownThrottle;</i> <i>FullBrake;</i> <i>ShutdownPump.</i>	<ol style="list-style-type: none"> <li>1. Model_Number variable contains illegal value (not 1234, 1236, 1238, or 1298).</li> <li>2. Software and hardware do not match.</li> <li>3. Controller defective.</li> </ol>	<p><i>Set:</i> 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.</p> <p><i>Clear:</i> Download appropriate software for your controller model.</p>

# 9

## MAINTENANCE

There are no user serviceable parts in Curtis 1234/36/38 controllers. **No attempt should be made to open, repair, or otherwise modify the controller.** Doing so may damage the controller and will void the warranty.

It is recommended that the controller and connections be kept clean and dry and that the controller's fault history file be checked and cleared periodically.

### CLEANING

Periodically cleaning the controller exterior will help protect it against corrosion and possible electrical control problems created by dirt, grime, and chemicals that are part of the operating environment and that normally exist in battery powered systems.



**When working around any battery powered system, proper safety precautions should be taken.** These include, but are not limited to: proper training, wearing eye protection, and avoiding loose clothing and jewelry.

Use the following cleaning procedure for routine maintenance. Never use a high pressure washer to clean the controller.

1. Remove power by disconnecting the battery.
2. Discharge the capacitors in the controller by connecting a load (such as a contactor coil) across the controller's **B+** and **B-** terminals.
3. Remove any dirt or corrosion from the power and signal connector areas. The controller should be wiped clean with a moist rag. Dry it before reconnecting the battery.
4. Make sure the connections are tight. Refer to Section 2, page 5, for maximum tightening torque specifications for the battery and motor connections.

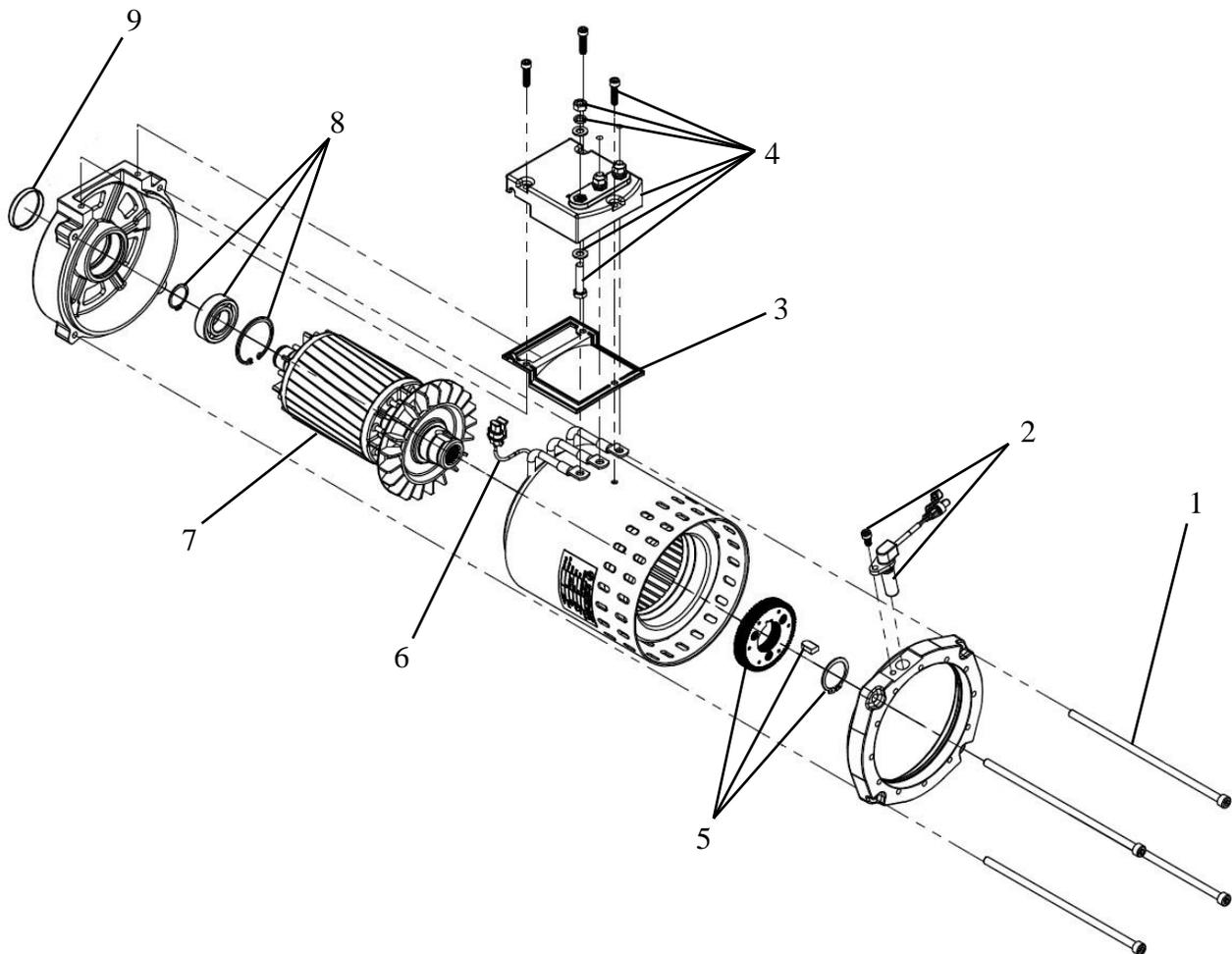
### FAULT HISTORY

The 1311 programmer can be used to access the controller's fault history file. The programmer will read out all the faults the controller has experienced since the last time the fault history file was cleared. Faults such as contactor faults may be the result of loose wires; contactor wiring should be carefully checked. Faults such as overtemperature may be caused by operator habits or by overloading.

After a problem has been diagnosed and corrected, it is a good idea to clear the fault history file. This allows the controller to accumulate a new file of faults. By checking the new fault history file at a later date, you can readily determine whether the problem was indeed fixed.

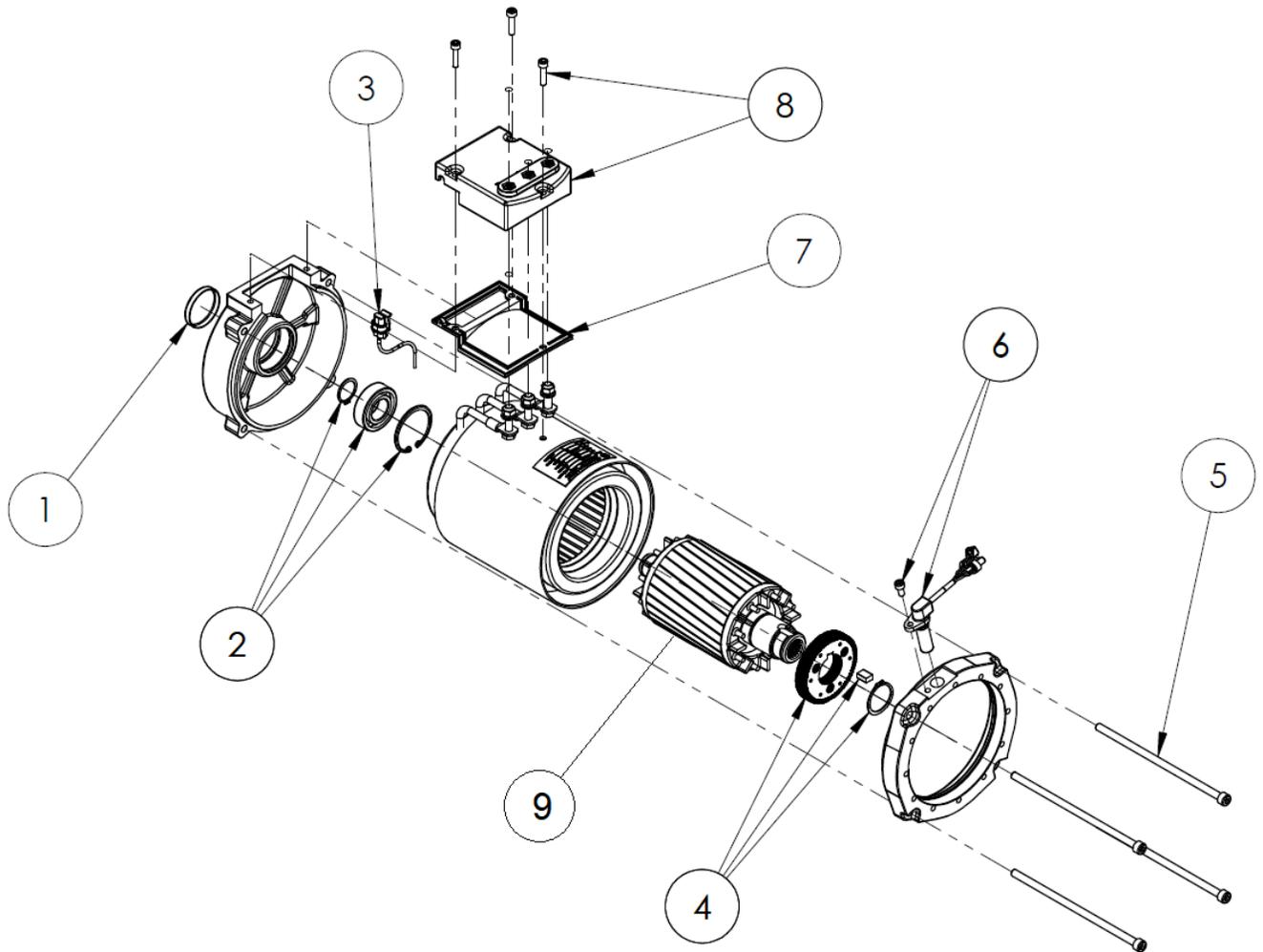
**SPARE PARTS**

**AC MOTOR FAN COOLED**



<b>REF.</b>	<b>PART NO.</b>	<b>DESCRIPTION</b>
1	8SD.909.020S	BOLT SERVICE KIT
2	3113248002	SPEED SENSOR SERVICE KIT
3	8SD.371.226	TERMINAL GASKET
4	3112248005SP	TERMINAL BLOCK SERVICE KIT
5	5SD.676.502S	PULSE WHEEL SERVICE KIT
6	H-303S	THERMAL SENSOR SERVICE KIT
7	3112248008	ROTOR
8	100218AS	REAR BEARING SERVICE KIT
9	8SD.310.310	REAR END SHAFT COVER

**AC MOTOR ENCLOSED**

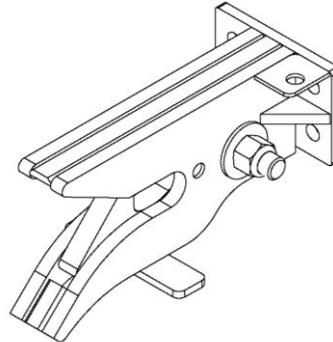


<b>REF.</b>	<b>PART NO.</b>	<b>DESCRIPTION</b>
1	8SD.310.310	REAR END SHAFT COVER
2	100218AS	REAR BEARING SERVICE KIT
3	H-303S	THERMAL SENSOR SERVICE KIT
4	5SD.676.502S	PULSE WHEEL SERVICE KIT
5	8SD.909.020S	BOLT SERVICE KIT
6	3113248002	SPEED SENSOR SERVICE KIT
7	8SD.371.226	TERMINAL GASKET
8	3112248005SP	TERMINAL BLOCK SERVICE KIT
9	5SD.674.3396	ROTOR

**AUTOMATIC HITCH**

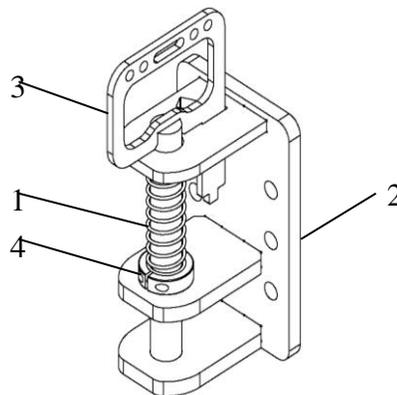
(2320210001)

10,000 lbs Towing Capacity



**1" CLEVIS HITCH WITH SPRING**

30,000 lbs Towing Capacity

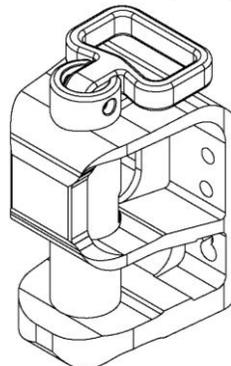


<i>REF.</i>	<i>PART NO.</i>	<i>DESCRIPTION</i>
1	2191000003	SPRING
2	2321000016	HITCH PLATE
3	2329448007	CLEVIS 1" WITH LOCK ASSEMBLY
	2329448009	CLEVIS 1" WITHOUT LOCK ASSEMBLY
4	2915016001	ONE PIECE CLAMP-ON COLLAR

**2" CLEVIS HITCH WITH SPRING**

(2320280001)

30,000 lbs Towing Capacity



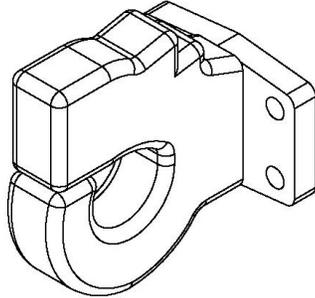
**PINTLE HITCH**

(260006)

10,000 lbs Towing Capacity

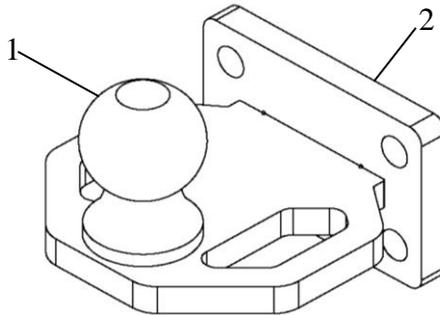
(2320448002)

30,000 lbs Towing Capacity



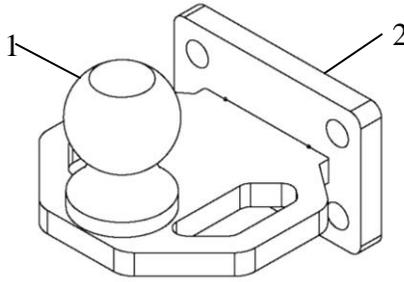
**BALL HITCH 1 7/8"**

2,000 lbs Towing Capacity



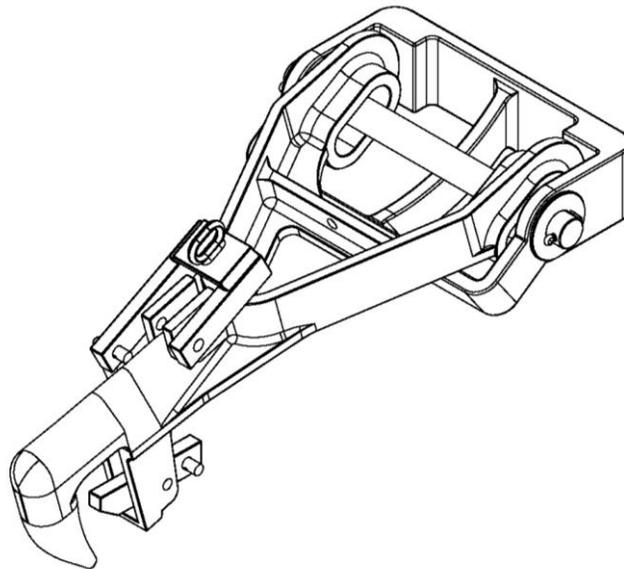
<i>REF.</i>	<i>PART NO.</i>	<i>DESCRIPTION</i>
<b>1</b>	2321000006	BALL 1 7/8"
<b>2</b>	2321501005	BALL HITCH SUPPORT

**BALL HITCH 2"**  
3,500 lbs Towing Capacity

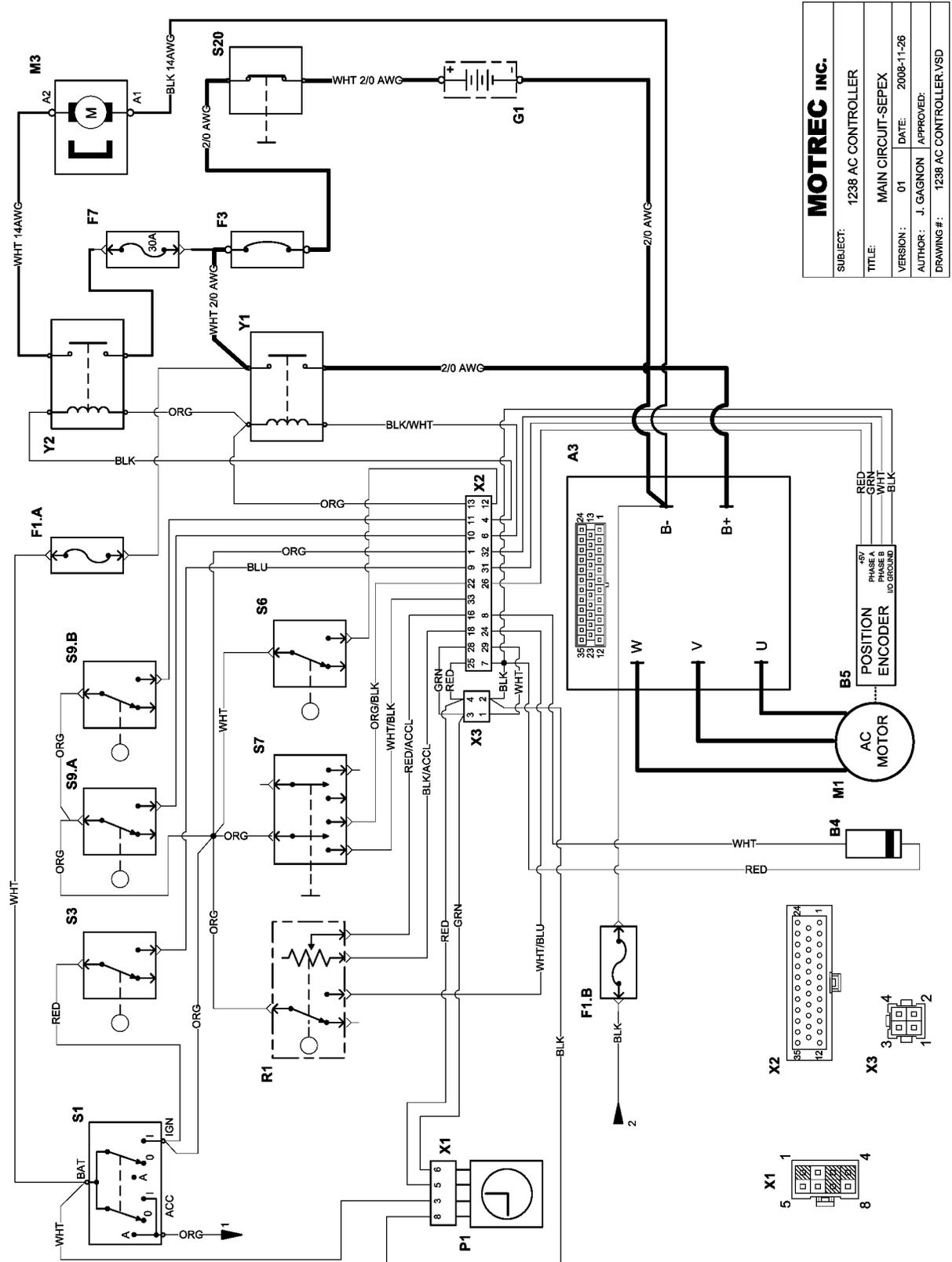


<i>REF.</i>	<i>PART NO.</i>	<i>DESCRIPTION</i>
<b>1</b>	2321000010	BALL 2"
<b>2</b>	2321501005	BALL HITCH SUPPORT

**ROSE HITCH**  
(2320000009)  
30,000 lbs Towing Capacity



## ELECTRICAL DIAGRAM – MAIN CIRCUIT DIAGRAMME ÉLECTRIQUE – CIRCUIT PRINCIPAL



<b>MOTREC INC.</b>	
SUBJECT:	1238 AC CONTROLLER
TITLE:	MAIN CIRCUIT-SEPEX
VERSION:	01
DATE:	2008-11-26
AUTHOR:	J. GAGNON
APPROVED:	
DRAWING #:	1238 AC CONTROLLER.VSD

**PARTS LIST AC**

<b>NO</b>	<b>DESIGNATION</b>	<b>REF</b>
A5	CURTIS AC CONTROL. 36-48V, 350A - 1234	3105236001
	CURTIS AC CONTROL. 36-48V, 350A – 1232SE	3105236008
	CURTIS AC CONTROL. CONNECTOR	3105800001-C
	CURTIS AC CONTROL. CONNECTOR PINS	3105800001-P
B1	STROBELIGHT	*
B2	HORN	*
B3	REVERSE / MOTION ALARM	*
E1	HEADLIGHT	*
E2	TAIL / BRAKE / TURN / BACKUP LIGHT	*
E5	SAFETY BLUE LIGHT	3111000063
F14	FUSE, ANN 250A	3118224001
	FUSE HOLDER BUSS 4164	3118224002
G1	BATTERY	CALL FACTORY
G2	BATTERY CHARGER	**
G3	USB CHARGER SOCKET	3119000083
G4	12V, 10A MAX SOCKET	3119000082
K3	FLASHER RELAY	3127000002
K6	RELAY 24VDC SPST 280 STYLE, FOR BRIC	3127024001
M4	WIPER MOTOR	*
M7	CAB HEATER	*
M14	CAB FAN	*
M16	AC MOTOR 36-48VAC FAN COOLED	3112248005
	AC MOTOR 36-48VAC ENCLOSED (EE)	3112248003
P3	LCD DISPLAY CURTIS	3108000006
	DISPLAY CONNECTOR	3119000062
	DISPLAY CONNECTOR PINS	3130000019
R1	ACCELERATOR, VERTICAL MOUNT	3062001C
S1	SEALED KEY SWITCH 2 POSITION	3109000046
	SEALED IGNITION SWITCH WITHOUT KEY 2 POS	3109000047
	KEY ONLY FOR SEALED KEY SWITCH	3109000046K
	AUTOMOTIVE CONNECTOR 6 PIN PLUD WEDGE	ASCAW6S
	AUTOMOTIVE CONNECTOR PLUG 6 WAYS	AT06-6S
	AUTOMOTIVE CONNECTOR TERMINAL 16-18	AT62-16-0122-L
S3	SEAT SWITCH, KIT	2392240003
	SEAT SWITCH, MICRO-SWITCH	3109100002
	SEAT SWITCH, SEAT MOUNTED (MICHIGAN)	3109000003
	CONNECTOR	3109000004
	SEAT SWITCH, SEAT MOUNTED (GRAMMER)	2205002SW
S6	FOOT SWITCH	1269003
S7	FOWARD/REVERSE SELECTOR, ROCKER TYPE	*
S8	LIGHT SWITCH, ROCKER TYPE	*
S10	HORN BUTTON	*
S11	BRAKE SWITCH	*
	HYDRAULIC BRAKE LIGHT SWITCH	2374001
S13	TURN SIGNAL SWITCH	*
S15	EMERGENCY PUSH BUTTON	3109800012
	EMERGENCY PUSH BUTTON, LABEL	3109800006
S16	UP/DOWN SWITCH	*
S25	WIPER SWITCH	*
S26	HEATER SWITCH	*
S44	MAGNETIC SWITCH FOR PARKING BRAKE LEVER	3109000037

S45	COMBINED MAIN CONTACTOR AND MANUAL DISCONNECT SWITCH	3104224001
S46	INCHING SWITCH	*
U1	DC-DC CONVERTER	*
X34	PROGRAMMATION CONNECTOR	3119000063
	PROGRAMMATION CONNECTOR PINS	3130800001
X35	ENCODER CONNECTOR – VEHICLE PART	3119000048
	ENCODER CONNECTOR PINS – VEHICLE PART	3119000052
	ENCODER CONNECTOR – MOTOR PART	3119000049
	ENCODER CONNECTOR PINS – MOTOR PART	3119000053
	ENCODER CONNECTOR SEAL	3119000051
	ENCODER CONNECTOR LOCK	3119000050
X36	THERMAL SENSOR CONNECTOR – VEHICLE PART	3119000045
	THERMAL SENSOR CONNECTOR PINS – VEHICLE PART	3119000052
	THERMAL SENSOR CONNECTOR – MOTOR PART	3119000049
	THERMAL SENSOR CONNECTOR PINS – MOTOR PART	3119000053
	THERMAL SENSOR CONNECTOR SEAL	3119000051
	THERMAL SENSOR CONNECTOR LOCK	3119000047
Y3	ELECTROMAGNETIC BRAKE	3129000023

\* Consult Motrec Illustrated parts

\*\* Consult Motrec chargers

**MOTREC ILLUSTRATED ACCESSORIES – AC VEHICLES**

 <p>Strobe light, pole mount Amber 12-80V: 3116000002 Red 12-80V: 2469001 Blue 12-80V: 3690008</p>	 <p>Tail/Brake/Turn/Back up light LED: 3111000055 Kit Connector: 3119000071K</p>	 <p>Horn button VIP: 2208224002</p>	 <p>Rocker switch Headlight: 3109922020 *Replace 1269004*</p>
 <p>Strobe light, cab mount Amber 12-48V: 3116250001 Red 12-48V: 3069026 Blue 12-48V: 3069014</p>	 <p>Pedestal lamp – 9W LED 12-24V: 3111000045 Support: 2392000009</p>	 <p>Horn 12V: 246003 24V: 246013</p>	 <p>Rocker switch Dome light: 3109922022</p>
 <p>LED Amber turn lamp 12V: 3111000022</p>	 <p>Front Headlight/Turn signal LED 12/48V : 3111000061 Connector : 3119000071K Rear light/Turn signal/Back up LED 12/48V: 3111000062 Connector: 3119000071K</p>	 <p>Back-up alarm or Motion beeper 12-48V : 3100000001 72-80V : 3105720001</p>	 <p>Rocker switch Wiper: 3109922031</p>
 <p>Amber turn lamp 2" LED white background 12V : 3111330003</p>	 <p>Dome light LED: 3111000066</p>	 <p>12-48V Adjustable PRECO: 3100000004</p>	 <p>Rocker switch On/Off: 3109922040</p>
 <p>DC-DC Converter, 300W 24-80V: 3124000005 Connector : 3119000074 3119000075</p>	 <p>Wiper arm 2800000001 14" Blade: 2800000002 18" Blade: 2800000003</p>	 <p>Brake switch : 3109000043</p>	 <p>Rocker switch Horn: 3109922130</p>
 <p>Turn signal switch: 246050</p>	 <p>Pantograph arm: 246233A Pantograph blade: 246233</p>	 <p>Cab heater 12V: 3103300001 36V: 3669008 48V: 4869020</p>	 <p>Rocker switch Forward/Reverse: 3109923010 *Replace 266211*</p>
 <p>12V Fan 3113000018</p>		 <p>Wiper motor 12V: 3113000001 24V: 486211</p>	 <p>Rocker switch Heater: 3109923032</p>  <p>Rocker switch Inching: 3109923111</p>