

MOTREC



E-480



OPERATOR AND MAINTENANCE MANUAL SPARE PARTS LISTS INCLUDED
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SERIAL NUMBER : 1033366 & UP

Printed in Canada

One Year Limited Warranty

Effective April 25, 2005, MOTREC, Inc. (MOTREC) hereby warrants to the Original Retail Purchaser (Owner) that any of its vehicles shall be free from any defect in materials for a period of 90 DAYS while in the possession of such Original Retail Purchaser. This warranty IS NOT TRANSFERABLE to any subsequent Buyer.

The warranty period is extended to one year or one thousand (1,000) hours, which ever first occurs, on the electric motor, differential (parts that bathe in oil) and the electronic speed controller. MOTREC makes no warranty or representation with respect to the internal combustion engine, tires and batteries, since their respective manufacturers cover such parts. Accessories (light, gage, horn, etc), electrical contacts (switch, solenoid, contactor, relay), diodes & fuses, belts & pulleys, filters & spark plugs, lubricants, brake linings & shoes, brake drums & discs, seals, seats, trim and other items subject to wear are not included in this warranty; nor is any item that in MOTREC sole opinion, shows evidence of neglect, misuse, abuse, collision or alteration.

This warranty shall not apply to normal maintenance requirements as described in the User Manual, and to damages during shipment. The latter is the carrier's responsibility. No compensation will be allowed for delays.

To initiate warranty coverage on any MOTREC vehicle, the Dealer must complete and return the "Sales/Installation Report" to MOTREC within 30 days after delivery to the Original Retail Purchaser; or within 90 days after the delivery date to the Dealer, which ever occurs first. Failure to follow these procedures will result in considering the warranty coverage effective as of the shipment date from the factory.

The defective vehicle must be returned, at the Owner's expense, to an authorised MOTREC Dealer within 30 days after failure. The Owner will not be charged for parts and labour required for warranty repairs, which must be performed by an authorised MOTREC Dealer only. The vehicle will be returned at the owner's expense. The Warranty Claim Forms must be completed and returned with the defective part(s) to MOTREC within 30 days after repair was done. No compensation will be allowed for damages caused by vehicle downtime.

It is the responsibility of the owner of the vehicle to make sure that the driver is properly trained and instructed in the safety features and operation of the vehicle, including vehicle stability, as required by OSHA and ANSI-B56. Operators shall read, understand and follow the safety and operating instructions in MOTREC Manual before driving the vehicle. Operators shall not be permitted to drive the vehicle unless a complete and adequate training has been provided. Driving a vehicle constitutes a hazard. The driver is responsible for the control of the vehicle while driving and must always evaluate and care for all peculiar situations that he or she may meet while driving. The driver assumes the inherent hazards related to this activity. The vehicle is designed for off-road use only. MOTREC disclaims any liability for incidental or consequential damages, to include, but not be limited to, personal injury or property damage arising from vehicle misuse, lack of maintenance or any defect in the vehicle.

It is the responsibility of the Owner of the vehicle to make sure that the service technicians are properly trained as required by OSHA and ANSI-B56. Service technicians shall read, understand and follow instructions in the MOTREC manual before servicing the vehicle. Only qualified and authorized personnel shall be permitted to maintain, repair, adjust and inspect the vehicle.

MOTREC prohibits, and disclaims responsibility for, any vehicle modification altering the weight distribution and stability, increasing the speed or affecting the safety of the vehicle. Such modifications can cause serious personal injury or property damage for which MOTREC disclaims any responsibility.

For Owners that are located outside North America, the warranty period starts the date of shipment from the factory, and the defective parts must be returned at the Owner's expense to MOTREC prior to warranty repair.

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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.

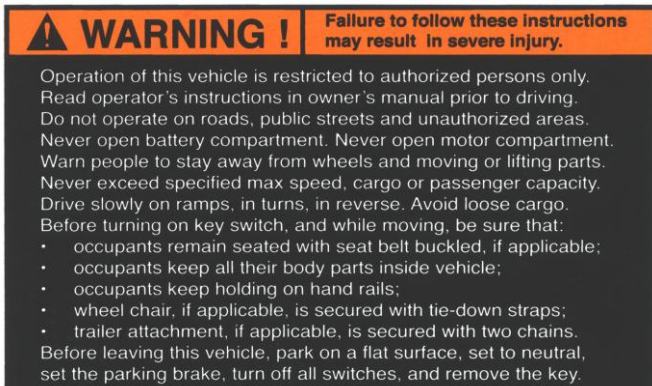
Dashboard security warning label:
5100000002



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



General security warning label:
5100000001



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

PERIODIC MAINTENANCE CHECKLIST

REVISION 080206

! WARNING !

Maintenance operations must be made by properly trained service technicians.

- Keep clear from moving parts such as tires, sheaves and motor.
- Check for all EE protections, when applicable, and keep cables and wires clear from mechanical and rubbing action
- Batteries contain sulphuric 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.

CHECK/PERFORM	PERIOD HOURS	DAY	WEEK 20	MONTH 50	QUART. 200	YEAR 1000	2 YEARS 2000
MECHANICAL DAMAGE, OIL LEAKS		X					
REVERSE ALARM, DEADMAN SWITCH		X					
STATIC STRAP, min 2" contact with ground		X					
TIRE PRESSURE, pressure rating on tire			X				
CHECK/FILL BATTERIES, add distilled water to cover plates. Fill to recommended level after batteries have been fully charged.			X				
WARNING DECALS & MARKINGS				X			
EE-Rated CABLE PROTECTORS, SEALED MOTOR, SEALED CONTROL BOX, STATIC STRAP.				X			
MASTER CYLINDER FLUID (DOT 3)				X			
BRAKE PEDAL TRAVEL 2" (50 mm) maximum travel				X			
STEERING FOR PLAY				X			
PARKING BRAKE LEVER requires 75 lbs. (34 kg) force to apply				X			
BELTS AND PULLEYS -10 lbs (5kg). force for 1/8" (3mm) deflexion; -pulleys alignment, see procedure.					X		
CLEAN/TIGHTEN WIRE TERMINALS					X		
WASH BATTERY TOP WITH WATER					X		
MOTOR BRUSHES FOR WEAR -brushes must exceed holders					X		
ACCELERATOR 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.					X		
HYDR. BRAKE LINES FOR LEAK					X		
STEERING ASSEMBLY, as instructed					X		
BRAKE MECHANICAL LINKAGES for wear & play					X		
BRAKE LININGS FOR WEAR 1/16" (2 mm) minimum lining thickness. 6 mm minimum thickness for brake-pulley lining.					X		
LUBRICATE (GREASE EP-2) brake pedal pivots, steering column, ball joints and kingpins.					X		
OIL (SAE 30) LEVEL IN DIFFERENTIAL Before adding oil, check oil seals for leaks.					X		
FRONT WHEEL BEARINGS PLAY					X		
TIGHTEN NUTS/BOLTS, electric terminals; drive; steering; brakes; suspension; body.					X		
REPLACE DIFFERENTIAL OIL(SAE 30)						X	
CLEAN AND RE-PACK FRONT HUBS						X	
SERVICE DIFFERENTIAL, replace the three oil seals, wheel bearings, oil (SAE 30)							X

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.

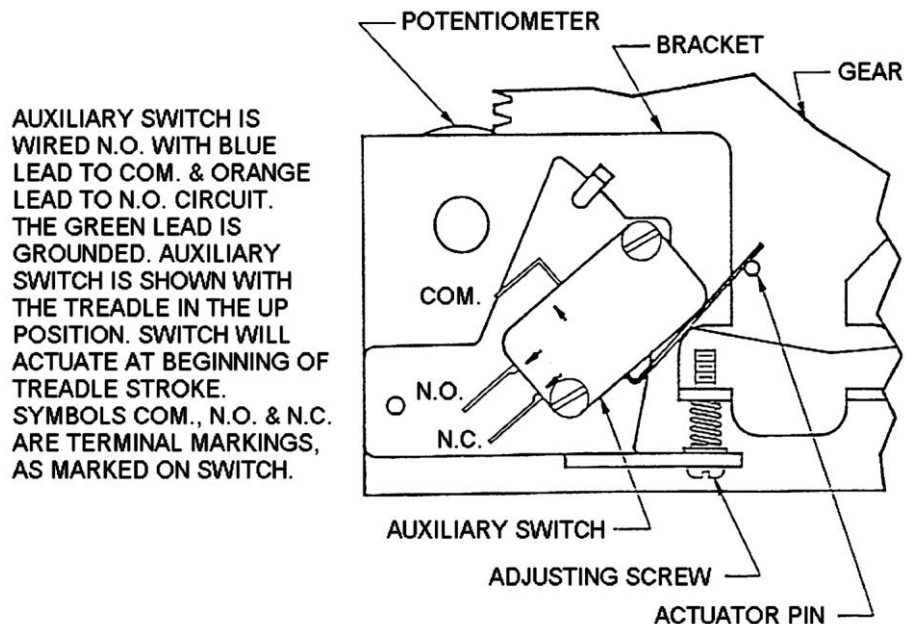
MICRO-SWITCH

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).

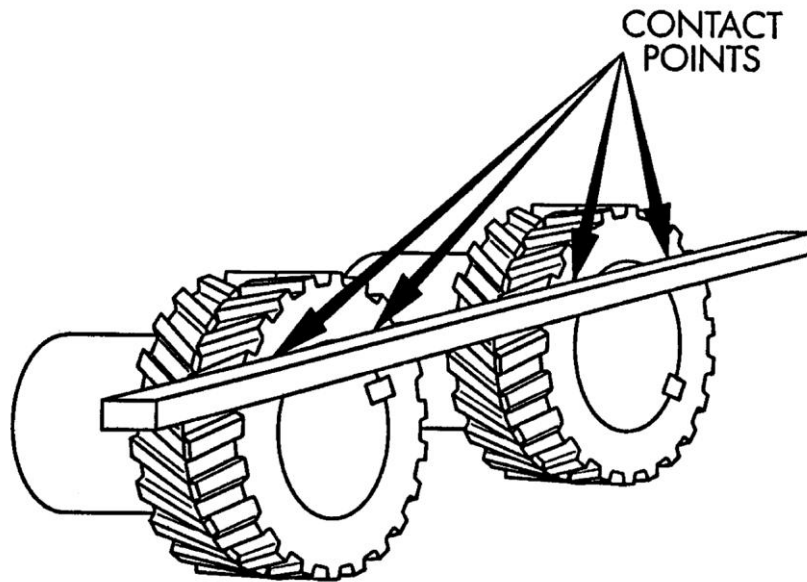
Proceed with the same verifications after the accelerator cover is on and then connect terminals 2 and 3.



BELT INSTALLATION AND TENSIONING

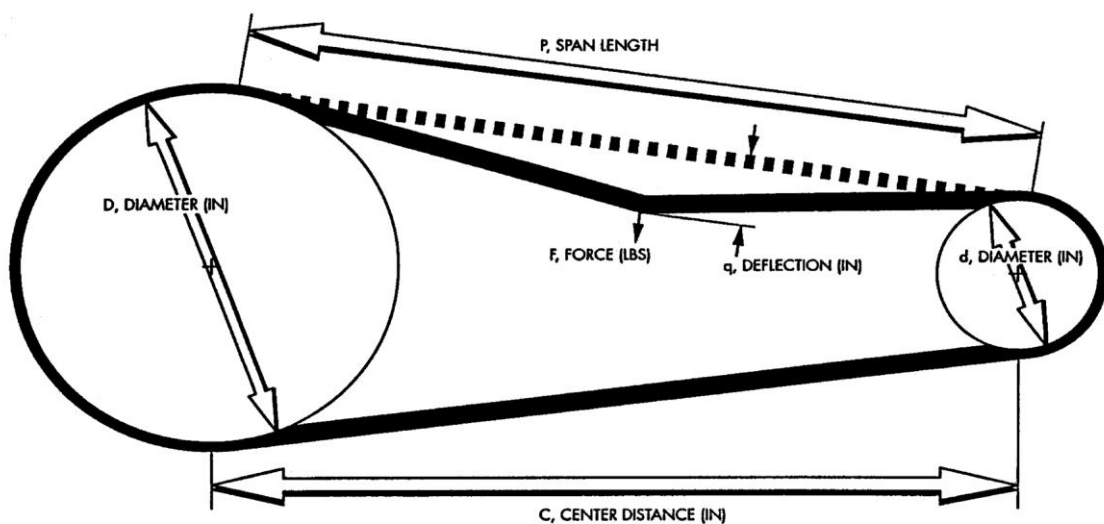
INSTALLATION

Adjust the sprockets using a straight edge. Slide up the edge on the larger pulley until it contacts the smaller pulley. Properly adjusted pulleys will provide three points of contact. Properly aligned pulleys will provide four points of contact. Tighten setscrews and recheck alignment.



TENSIONING

Check the force F required to provide a deflection of $1/8$ in. If the measured force is less than 15 lbs then lengthen centre distance C .



HYDRAULIC & PARKING BRAKES

Revision 2008-02-06

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 ¼-ncx3/4 grade-5 bolt in stopper at 8 LbFt (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 75 Lbs or 34 kg is required on the handle to set the parking brake.

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 callipers 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, disconnect batteries.

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

PMC SELF DIAGNOSTIC

If your PMC comes with a status led, use the 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

On a SEPEX motor control, check the reverse signal input on the controller.

On a series wound motor control, a bad reverse contactor is the most probable cause of the problem.

Switch to reverse and check voltage on the reverse control wire. If not B+, replace the F/R switch. If B+, turn off the key switch, disconnect batteries, disconnect power terminals on the F/R contactors, check the resistance across N.C. power terminals of the reverse contactor. If not 0 ohm, change the reverse contactor. If 0 ohms, switch to forward and check the resistance across the forward N.O. power terminals. If not 0 ohms, change the forward contactor.

REVERSE ONLY

On a SEPEX motor control, check the forward signal input on the controller.

On a series wound motor control, a bad forward contactor is the most probable cause of the problem. Switch to forward and check the voltage on the forward control wire. If not B+, replace the F/R switch. If B+, turn off the key switch, disconnect batteries, disconnect power terminals on the F/R contactors, check the resistance across N.C. power terminals of the forward contactor. If not 0 ohm, change the forward contactor. If 0 ohms, switch to reverse and check the resistance across the reverse N.O. power terminals. If not 0 ohms, change the reverse contactor.

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.

A bad F/R contactor is also a probable cause of the following:

- sudden stop after a bump or shock;
- would not start to move at times.

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 an 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 may also have an 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 circuit breaker has open to prevent motor overheating and will reset automatically after one minute. The PMC is also equipped with an internal thermal protection that cutback the current until the PMC 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 – terminal on the battery gage, check voltage between the reverse terminal and the – terminal on the battery gage; 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 across power terminals; 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 B+, check wiring and interlock switches. Check resistance across power terminals; if not 0 ohms, replace the solenoid.

Check circuit breaker and SEPEX DIODE

Before replacing the circuit breaker, check for shorts in the power circuit and check the SEPEX diode in the power circuit using a diode tester. If no such instrument is at hand, use an ohmmeter: the reading should be weak in one direction and strong in the other way.

Check the resistance across the circuit breaker. If not 0 ohms, replace the circuit breaker.

Check PMC

First disconnect battery B+ and B-, then PMC B+ and M-. Check the internal diode between B+ and M- terminals using a diode tester. If no such instrument is at hand, use an ohmmeter: the reading should be weak in one direction and strong in the other way. If the internal diode is defective, the PMC must be replaced.

Check the Motor

First disconnect battery B+ and B-, disconnect power terminals and check the motor armature and field for opens.

CURTIS SPEED CONTROLLER

MANUAL

CURTIS*PMC*

MODEL **1244**

MultiMode™
MOTOR CONTROLLER

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DESIGN OF CURTIS PMC 1200 SERIES
CONTROLLERS PROTECTED BY U.S.
PATENT NO. 4626750.

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1244 Manual, p/n 16958
Rev. B: January 2001

1244 Manual
p/n 16958, Rev. B: January 2001
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WIRING: Standard Configuration

Figure 3 shows the typical wiring configuration for most applications. The interlock switch is typically a seat switch, tiller switch, or foot switch.

Standard Power Wiring

Motor armature winding is straightforward, with the armature's A1 connection going to the controller's B+ bus bar and the armature's A2 connection going to the controller's M- bus bar.

The motor's field connections (**F1** and **F2**) to the controller are less obvious. The direction of vehicle travel with the forward direction selected will depend on

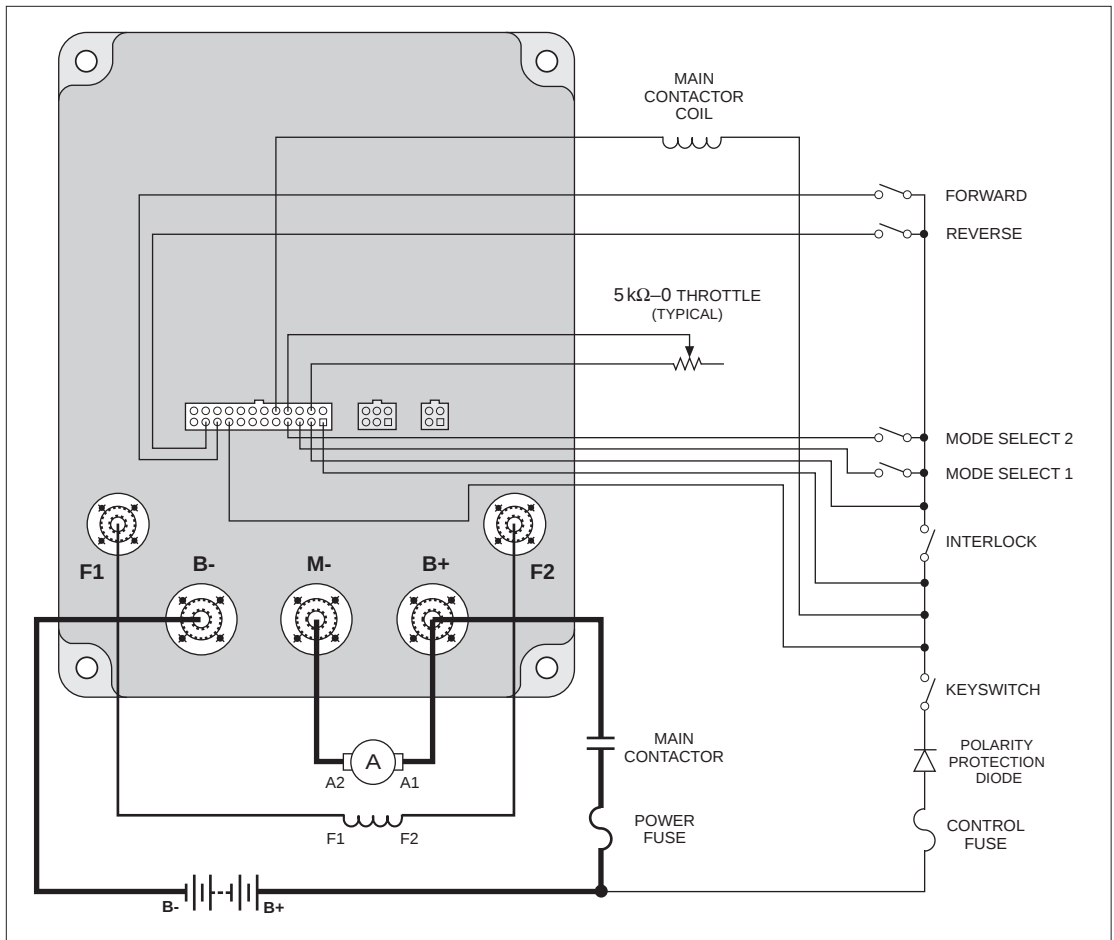


Fig. 3 Standard wiring configuration, Curtis PMC 1244 controller.

8

DIAGNOSTICS AND TROUBLESHOOTING

The 1244 controller provides diagnostics information to assist technicians in troubleshooting drive system problems. The diagnostics information can be obtained by observing the appropriate display on the handheld programmer, the fault codes issued by the Status LED, or the fault display driven by the controller's Fault 1 and Fault 2 outputs. Refer to the troubleshooting chart (Table 5) for suggestions covering a wide range of possible faults.

PROGRAMMER DIAGNOSTICS

The programmer presents complete diagnostic information in plain language. Faults are displayed in the Diagnostic Menu (see column 2 in the troubleshooting chart), and the status of the controller inputs/outputs is displayed in the Test Menu.

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

The following 4-step process is recommended for diagnosing and troubleshooting an inoperative vehicle: (1) visually inspect the vehicle for obvious problems; (2) diagnose the problem, using the programmer; (3) test the circuitry with the programmer; and (4) correct the problem. Repeat the last three steps as necessary until the vehicle is operational.

Example: A vehicle that does not operate in “forward” is brought in for repair.

STEP 1: Examine the vehicle and its wiring for any obvious problems, such as broken wires or loose connections.

STEP 2: Connect the programmer, select the Diagnostics Menu, and read the displayed fault information. In this example, the display shows “No Known Faults,” indicating that the controller has not detected anything out of the norm.

STEP 3: Select the Test Menu, and observe the status of the inputs and outputs in the forward direction. In this example, the display shows that the forward switch did not close when “forward” was selected, which means the problem is either in the forward switch or the switch wiring.

STEP 4: Check or replace the forward switch and wiring and repeat the test. If the programmer shows the forward switch closing and the vehicle now drives normally, the problem has been corrected.

Table 5 TROUBLESHOOTING CHART

LED CODE	PROGRAMMER LCD DISPLAY	FAULT CATEGORY	EXPLANATION	POSSIBLE CAUSE
1,2	HW FAILSAFE1 - 2 - 3	1	self-test or watchdog fault	1. Controller defective.
1,3	M- SHORTED	1	internal M- short to B-	1. Controller defective.
	FIELD OPEN	1	field winding fault	1. Motor field wiring loose. 2. Motor field winding open.
	ARM SENSOR	1	armature current sensor fault	1. Controller defective.
	FLD SENSOR	1	field current sensor fault	1. Controller defective.
2,1	THROTTLE FAULT 1	1	wiper signal out of range	1. Throttle input wire open. 2. Throttle input wire shorted to B+ or B-.
	THROTTLE FAULT 2	1	pot low fault	1. Throttle pot defective. 2. Wrong throttle type selected.
2,2	SRO	3	SRO fault	1. Improper sequence of KSI, interlock, and direction inputs. 2. Wrong SRO type selected. 3. Interlock or direction switch circuit open. 4. Sequencing delay too short.
2,3	HPD	3	HPD fault	1. Improper seq. of direction and throttle inputs. 2. Wrong HPD type selected. 3. Misadjusted throttle pot. 4. Sequencing delay too short.
2,4	BB WIRING CHECK	1	emergency reverse wiring fault	1. Emergency reverse wire open. 2. Emergency reverse check wire open.
3,1	CONT DRVR OC	1	cont. driver output overcurrent	1. Contactor coil shorted.
3,2	MAIN CONT WELDED	1	welded main contactor	1. Main contactor stuck closed. 2. Main contactor driver shorted.
3,3	PRECHARGE FAULT	1	internal voltage too low at startup	1. Controller defective. 2. External short, or leakage path to B- on external B+ connection.
3,4	MISSING CONTACTOR	1	missing contactor	1. Any contactor coil open or not connected.
	MAIN CONT DNC	1	main contactor did not close	1. Main contactor missing or wire to coil open.
4,1	LOW BATTERY VOLTAGE	2	low battery voltage	1. Battery voltage <undervoltage cutback limit. 2. Corroded battery terminal. 3. Loose battery or controller terminal.
4,2	OVERVOLTAGE	2	overvoltage	1. Battery voltage >overvoltage shutdown limit. 2. Vehicle operating with charger attached. 3. Battery disconnected during regen braking.
4,3	THERMAL CUTBACK	2	over-/under-temp. cutback	1. Temperature >85°C or < -25°C. 2. Excessive load on vehicle. 3. Improper mounting of controller. 4. Operation in extreme environments.
4,4	ANTI-TIEDOWN	3	Mode 2 or Mode 4 selected at startup	1. Mode switches shorted to B+. 2. Mode switches "tied down" to select Mode 2 or Mode 4 permanently.

LED DIAGNOSTICS

A Status LED is built into the 1244 controller. It is visible through a window in the label on top of the controller. This Status LED displays fault codes when there is a problem with the controller or with the inputs to the controller. During normal operation, with no faults present, the Status LED flashes steadily on and off. If the controller detects a fault, a 2-digit fault identification code is flashed continuously until the fault is corrected. For example, code “3,2”—welded main contactor—appears as:

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

The codes are listed in Table 6.

Table 6 STATUS LED FAULT CODES		
LED CODES		EXPLANATION
<i>LED off</i>	■	no power or defective controller
<i>solid on</i>	□	controller or microprocessor fault
0,1	■ □	controller operational; no faults
1,1	□ □	[not used]
1,2	□ □ □	hardware failsafe fault
1,3	□ □ □ □	M-, current sensor, or motor fault
1,4	□ □ □ □ □	[not used]
2,1	□ □ □	throttle fault
2,2	□ □ □ □	static return to off (SRO) fault
2,3	□ □ □ □ □	high pedal disable (HPD) fault
2,4	□ □ □ □ □ □	emergency reverse circuit check fault
3,1	□ □ □ □ □	contactor driver overcurrent
3,2	□ □ □ □ □ □	welded main contactor
3,3	□ □ □ □ □ □ □	precharge fault
3,4	□ □ □ □ □ □ □ □	missing contactor, or main cont. did not close
4,1	□ □ □ □ □ □	low battery voltage
4,2	□ □ □ □ □ □ □	overvoltage
4,3	□ □ □ □ □ □ □ □	thermal cutback, due to over/under temp.
4,4	□ □ □ □ □ □ □ □ □	anti-tiedown fault

NOTE: Only one fault is indicated at a time, and faults are not queued up. Refer to the troubleshooting chart (Table 5) for suggestions about possible causes of the various faults.

PROGRAMMING PARAMETERS – E-290HD, E-348, E-480, E-500, E-660, T-248, T-448**! WARNING !**

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

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

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

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

VOLTAGE	NOMINAL BATTERY VOLTAGE, IN VOLTS	4	THRO. DEADBAND	Thr. Neutral deadband % of 5kohms pot	6
M1 DRIVE C/L	MODE 1 DRIVE CURRENT LIMIT, IN AMPS	300	THROTTLE MAX	Thr. Input req'd for 100%PWM %5kohm pot	90
M2 DRIVE C/L	MODE 2 DRIVE CURRENT LIMIT, IN AMPS	300	M1 THRTL MAP	MODE 1 THROTTLE MAP, AS %	30
M3 DRIVE C/L	MODE 3 DRIVE CURRENT LIMIT, IN AMPS	300	M2 THRTL MAP	MODE 2 THROTTLE MAP, AS %	30
M4 DRIVE C/L	MODE 4 DRIVE CURRENT LIMIT, IN AMPS	300	M3 THRTL MAP	MODE 3 THROTTLE MAP, AS %	30
M1 BRAKE C/L	MODE 1 BRAKING CURRENT LIMIT, IN AMPS	150	M4 THRTL MAP	MODE 4 THROTTLE MAP, AS %	30
M2 BRAKE C/L	MODE 2 BRAKING CURRENT LIMIT, IN AMPS	150	FIELD MIN	MIN. FIELD CURRENT, IN AMPS	7
M3 BRAKE C/L	MODE 3 BRAKING CURRENT LIMIT, IN AMPS	150	FIELD MAX	MAX. FIELD CURRENT, IN AMPS	30
M4 BRAKE C/L	MODE 4 BRAKING CURRENT LIMIT, IN AMPS	150	FIELD MAP START	Armature current at wch FIELD MAP takes effect, amps	70
M1 THRT BRK %	MODE 1 THROT. BRAKING, AS % OF BRAKE C/L	50	FIELD MAP	Field Winding Current, as % of Armature Current	50
M2 THRT BRK %	MODE 2 THROT. BRAKING, AS % OF BRAKE C/L	50	CURRENT RATIO	CURRENT RATIO:FACTOR OF 1, 2, 4 OR 8	1
M3 THRT BRK %	MODE 3 THROT. BRAKING, AS % OF BRAKE C/L	50	RESTRAINT	RAMP RESTRAINT: 1 TO 10	3
M4 THRT BRK %	MODE 4 THROT. BRAKING, AS % OF BRAKE C/L	50	LOAD COMP	LOAD COMPENSATION: 0 TO 25	0
M1 ACCEL RATE	MODE 1 ACCELERATION RATE, IN SEC.	4	HPD	HIGH PEDAL DISABLE (HPD) TYPE	1
M2 ACCEL RATE	MODE 2 ACCELERATION RATE, IN SEC.	4	SRO	STATIC RETURN TO OFF (SRO) TYPE	1
M3 ACCEL RATE	MODE 3 ACCELERATION RATE, IN SEC.	4	SEQUENCING DLY	SEQUENCING DELAY, IN SEC.	1
M4 ACCEL RATE	MODE 4 ACCELERATION RATE, IN SEC.	4	MAIN CONT INTR	MAIN CONTACTOR INTERLOCK: ON OR OFF	ON
DECEL RATE	DECELERATION RATE, IN SEC.	2.5	MAIN OPEN DELAY	MAIN CONTACTOR DROPOUT DELAY, IN SEC.	1
M1 BRAKE RATE	MODE 1 BRAKING RATE, IN SEC.	3	WELD CHECK	MAIN CONTACTOR WELD CHECK: ON OR OFF	ON
M2 BRAKE RATE	MODE 2 BRAKING RATE, IN SEC.	3	MAIN CHECK	MAIN COIL OPEN CHECK: ON OR OFF	ON
M3 BRAKE RATE	MODE 3 BRAKING RATE, IN SEC.	3	AUX ENABLE	AUXILIARY ENABLE: ON OR OFF	OFF
M4 BRAKE RATE	MODE 4 BRAKING RATE, IN SEC.	3	EM BRAKE	ELECTROMAGNETIC BRAKE ON OR OFF	OFF
QUICK START	QUICK START THROTTLE FACTOR	1	AUX DELAY	AUXILIARY DRIVER DROPOUT DELAY, IN SEC.	0
TAPER RATE	Regen brak. Decrease rate when apporch. 0spd, 1/32s	32	AUX CHECK	AUXILIARY COIL OPEN CHECK: ON OR OFF	OFF
M1 MAX SPEED	MODE 1 MAX. SPEED, AS % PWM OUTPUT	40	EM BRAKE DELAY	ELECTROMAGNETIC BRAKE DELAY, IN SEC.	0
M2 MAX SPEED	MODE 2 MAX. SPEED, AS % PWM OUTPUT	100	EM BRAKE CHECK	ELECTROMAG. BRAKE OPEN CHECK: ON OR OFF	OFF
M3 MAX SPEED	MODE 3 MAX. SPEED, AS % PWM OUTPUT	40	REV DRVR CHECK	REVERSE SIGNAL OPEN CHECK: ON OR OFF	OFF
M4 MAX SPEED	MODE 4 MAX. SPEED, AS % PWM OUTPUT	40	CONT PULL IN	CONTACTOR COIL PULL-IN VOLTAGE, AS %	100
M1 CREEP SPEED	MODE 1 CREEP SPEED, AS % PWM OUTPUT	0	CONT HOLDING	CONTACTOR HOLDING VOLTAGE, AS %	100
M2 CREEP SPEED	MODE 2 CREEP SPEED, AS % PWM OUTPUT	0	EMR REV ENABLE	EMERGENCY REVERSE FUNCTION : ON OR OFF	OFF
M3 CREEP SPEED	MODE 3 CREEP SPEED, AS % PWM OUTPUT	0	EMR REV C/L	EMERGENCY REVERSE CURRENT LIMIT, IN AMPS	50
M4 CREEP SPEED	MODE 4 CREEP SPEED, AS % PWM OUTPUT	0	EMR REC CHECK	EMERGENCY REV. WIRING CHECK : ON OR OFF	OFF
REGEN SPEED	Min. speed for regen braking, as % of vehicle speed	25	ANTI-TIEDOWN	ANTI-TIEDOWN: ON OR OFF	OFF
CTRL MODE	CONTROL MODE	1	FAULT CODE	ON OR OFF	ON
THROTTLE TYPE	THROTTLE TYPE	3	PEDAL INTERLOCK	THREADLE, PB-6, CHECK WIRING	OFF
			PRECHARGE	ON OR OFF	ON

CURTIS PMC MOTOR CONTROLLER

MANUAL

CURTIS*PMC*

1204X/1205X

and 1209/1221

MOTOR CONTROLLERS

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DESIGN OF CURTIS PMC 1200 SERIES
CONTROLLERS PROTECTED BY U.S.
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CURTIS

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1204X / 1205X / 1209 / 1221 Manual
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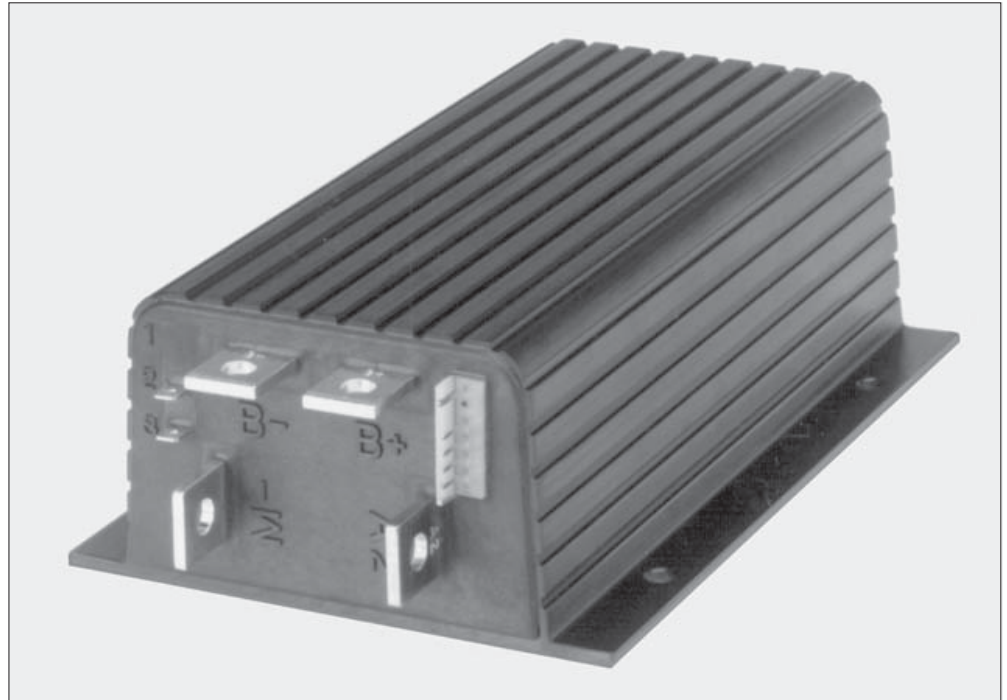
1

OVERVIEW

Curtis PMC Model 1204X/1205X and 1209/1221 electronic motor speed controllers are designed to provide smooth, silent, cost-effective control of motor speed and torque on a wide variety of industrial electric vehicles.

Fig. 1 *Curtis PMC 1205X full-feature electronic motor controller.*

Models 1204X, 1209, and 1221 have identical connections.



Like all Curtis PMC 1200 series controllers, the 1204X/1205X and 1209/1221 models offer superior operator control of the vehicle's motor drive speed. Key features of these controllers include:

- ✓ Infinitely variable drive and brake control
- ✓ Power MOSFET design provides high efficiency (for reduced motor and battery losses) and silent operation
- ✓ High pedal disable (HPD) function monitors throttle status during turn-on and prevents operation until throttle has been returned to neutral *[optional feature]*
- ✓ Thermal protection and compensation circuit provides both under-temperature and overtemperature cutback, as well as steady current limit throughout the entire operating range
- ✓ Undervoltage cutback function protects against low battery voltage, including low voltage caused by external loads

More Features 

- ✓ Fault detection circuitry monitors battery, throttle connections, output transistors, bypass contactor, etc., to prevent runaway conditions
- ✓ Static return to off (SRO) function requires that forward or reverse selectors be returned to neutral before output is allowed *[optional feature]*
- ✓ Emergency reverse enhances plugging current when “belly-button” is activated on walkie-type applications *[optional feature]*
- ✓ Delayed bypass (1A) output drives a bypass contactor *[optional feature]*
- ✓ Forward, reverse, and bypass contactor driver outputs are internally protected against shorts in the contactor coils
- ✓ Simple installation with no adjustments required
- ✓ Tin-plated solid copper bus bars
- ✓ Push-on connectors for control wiring

Familiarity with your Curtis PMC controller will help you to install and operate it properly. We encourage you to read this manual carefully. If you have questions, please contact the Curtis office nearest you.

CAUTION

Working on electric vehicles is potentially dangerous. You should protect yourself against runaways, high current arcs, and outgassing from lead acid batteries:

RUNAWAYS — Some fault conditions could cause the vehicle to run out of control. Jack up the vehicle and get the drive wheels off the ground before attempting these procedures or any other work on the motor control circuitry.

HIGH CURRENT ARCS — Electric vehicle batteries can supply very high power, and arcs can occur if they are short circuited. Always open the battery circuit before working on the motor control circuit. Wear safety glasses, and use properly insulated tools to prevent shorts.

LEAD ACID BATTERIES — Charging or discharging generates hydrogen gas, which can build up in and around the batteries. Follow the battery manufacturer’s safety recommendations. Wear safety glasses.

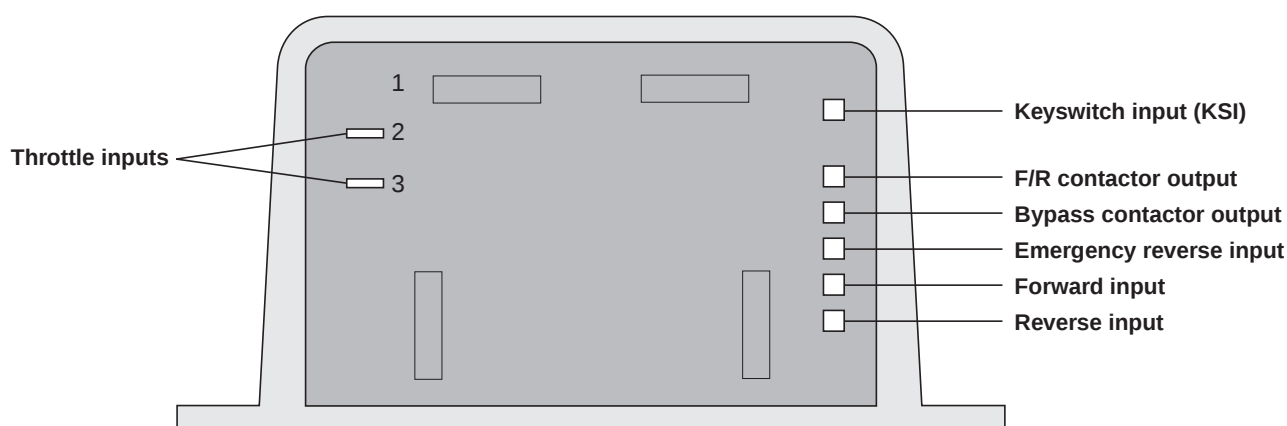
3

WIRING

CONNECTIONS: Low Current

Two 1/4" push-on terminals are provided for the throttle inputs. If your controller has a voltage throttle input, there will be only one throttle terminal.

A 6-pin low power connector molded into the right side of the controller face provides the low power logic control connections—KSI input, forward/reverse contactor output, bypass contactor output (*optional*), emergency reverse (*optional*), and forward and reverse inputs.

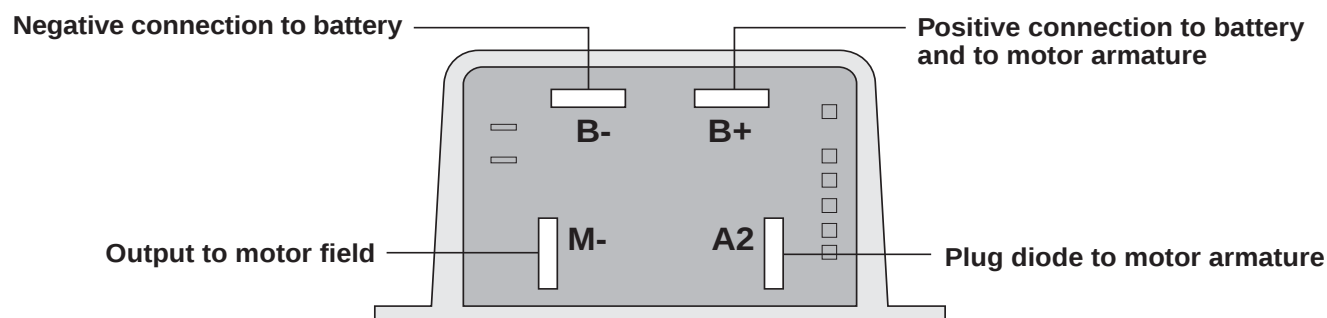


Several manufacturers make mating connectors that fit this connector. The part numbers listed are for the recommended 0.75 mm² (#18 AWG) vinyl insulated stranded wire.

MFR	PART NUMBER	DESCRIPTION
AMP	#640426-7	locking, insulation displacement terminals, wires at right angle to connector
Methode	#3300-107-218	locking, insulation displacement terminals
Molex	#09-50-3071	locking, crimp terminals
Panduit	#CE156F18-7	locking, insulation displacement terminals, wires at right angle to connector

CONNECTIONS: High Current

Four tin-plated solid copper bus bars are provided for the high current connections to the battery and motor.



The cables used for the battery and motor connections must be heavy enough to carry the high current required. Rubber insulated welding cable is convenient to work with because of its flexibility.

Connections to the controller bus bars should be made with lugs suitable for the cable used, fastened by M8 (5/16") bolts and nuts. **When tightening the bolts, two opposing wrenches should be used.** Failure to use the double-wrench technique could cause undue strain to be placed on the internal connections, and could also result in cracked seals around the bus bars.

WIRING: TYPICAL INSTALLATION

Curtis PMC 1204X/1205X/1209/1221 controllers are designed to satisfy the requirements of material handling applications using series motors. Figure 8 is a schematic diagram of the installation shown in Figure 7. Wired this way, the vehicle will plug brake if the direction is changed with the vehicle moving and the throttle applied. Reversing is accomplished via a forward/reverse changeover contactor or two single-pole, double-throw (2×SPDT) contactors. Coil suppression diodes should be used on the main and forward/reverse contactors.

KSI Wiring

The keyswitch input (KSI) circuit includes inputs from the keyswitch and from the various interlocks. The controller KSI is used to turn the controller on and off. KSI is turned on by connecting it to battery B+. Any positive voltage greater than about 8 volts will turn on the controller, but usually the full vehicle battery voltage is used.

In its simplest form, KSI is operated by a keyswitch that turns the vehicle off and prevents unauthorized use. The keyswitch should also turn off the main

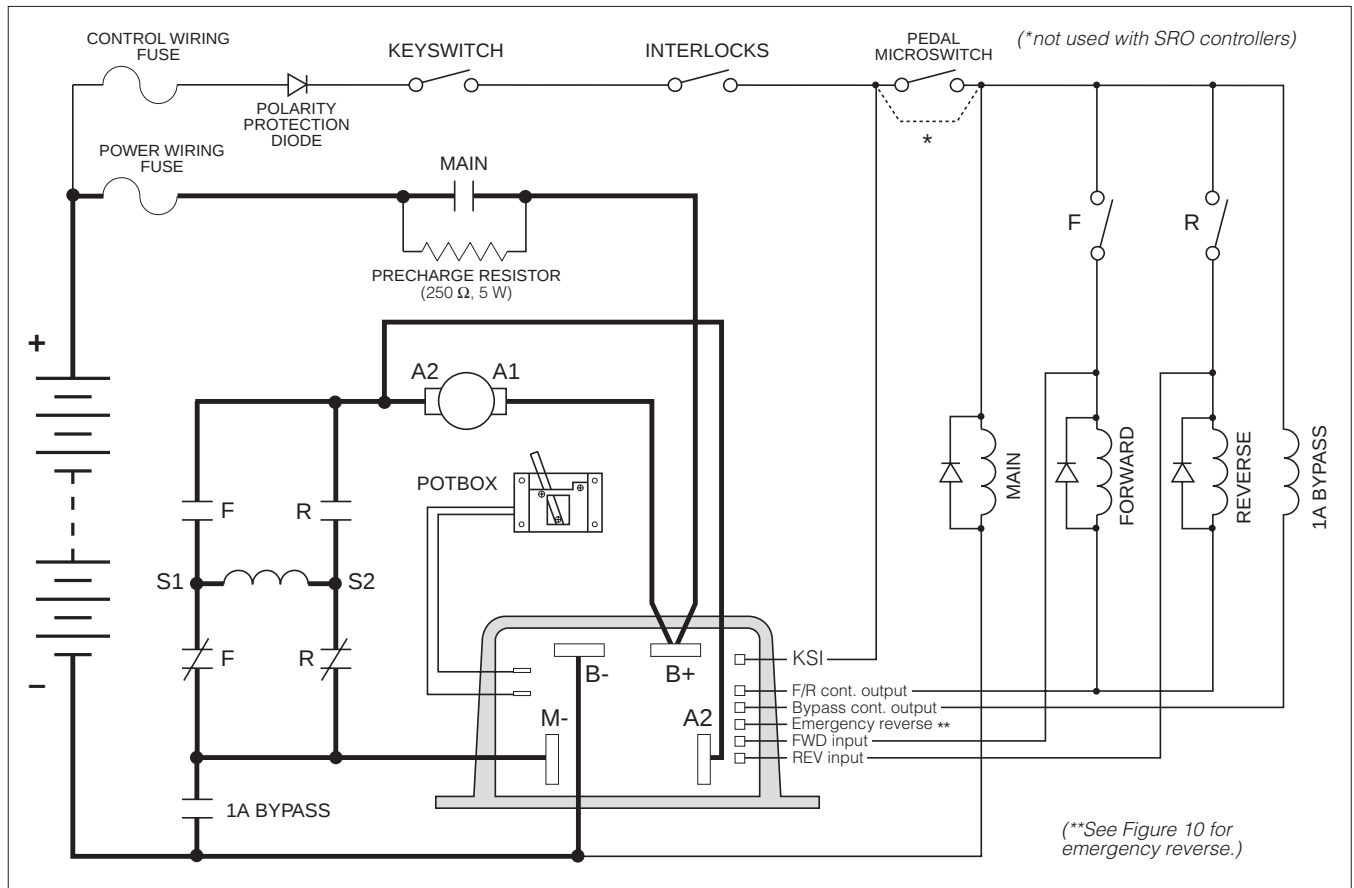


Fig. 8 Basic wiring configuration, Curtis PMC 1204X/1205X/1209/1221 controllers.

contactor and the forward/reverse contactors. This will act as a safety feature by removing power from the motor control system when the keyswitch is off.

Interlocks (seat switches, battery charger interlocks, etc.) should be wired in series so that they turn off the controller KSI and the contactors. An SRO interlock (a seat switch, for example) **must** be wired in order to implement the optional SRO feature.

Forward/Reverse Wiring

The forward/reverse wiring schemes described here all assume the power wiring shown by the heavy lines in Figure 8. Some vehicles, especially those previously using older, resistor-type controllers, may reverse the motor armature rather than the field winding. Be careful if you are replacing this type of controller. **When using the Curtis PMC controller it is essential that the field be reversed and that the armature be connected directly to the controller's B+ and A2 terminals, because the plug diode inside is connected to these terminals.**

4

MAINTENANCE & ADJUSTMENT

Curtis PMC 1204X/1205X/1209/1221 controllers and potboxes require only minimal maintenance if properly installed. NOTE: The controllers are sealed and thus are not field serviceable.

CONTROLLER

Maintenance**CAUTION**

It is recommended that the following two steps be performed occasionally. **First remove power by disconnecting the battery, and discharge the capacitors in the controller** (with a light bulb or a 2–10 Ω , 25 W resistor connected for a few seconds across B+, B-). Follow good safety practices: get the vehicle drive wheels off the ground, wear safety glasses, and use insulated tools (*see page 2*).

1. Make sure the electrical connections to the controller (and to the motor, contactors, etc.) are tight. When checking the controller bus bar connections for tightness, use two opposing wrenches. This double-wrench technique will help avoid putting stress on the bus bars, which could crack the seals. **Always use insulated wrenches.**
2. Inspect all seals at the front and back of the controller. If necessary, use a moist rag to wipe these areas clean enough so that you can see the seals. Look for cracks and other signs of seal damage.

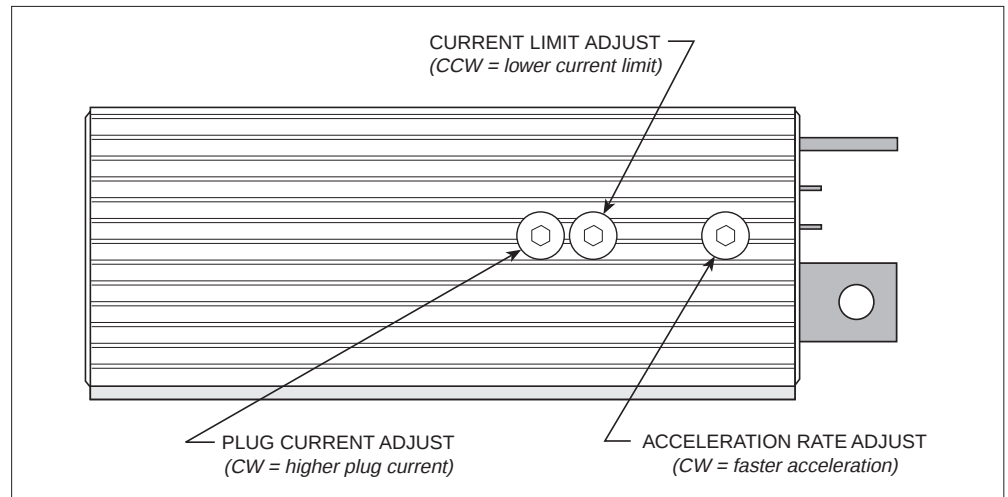
If the seals are intact, clean the controller thoroughly either by washing it off or by wiping it clean with a moist rag. **Power must not be reapplied until the controller terminal area is completely dry.**

If the seals have been damaged, there are several possible causes. Perhaps the double-wrench technique was not used when the cables were installed. Perhaps the vehicle's environment requires that the controller be better protected: either by mounting it in a different location, or by installing a protective cover.

Damaged seals can lead to faulty operation. We strongly recommend replacing controllers that have faulty seals.

Adjustment

Some controllers allow adjustment of the plug braking current, current limit, and acceleration rate settings. The adjustment pots on these models are located as shown in Figure 16.

Fig. 16 *Adjustment pots.*

Use the following adjustment procedure. **The keyswitch should be off during adjustment.**

1. Remove the socket head screw (1/8" Allen) for the adjustment you want to make.
2. Adjust the internal potentiometer using a small **insulated** screwdriver (*available from Curtis*).
3. Replace the socket head screw and nylon seal washer. To prevent stripping, do not over-tighten.

POTBOX

Maintenance

Potbox maintenance is similar to controller maintenance: inspect for integrity of connections and mounting, and clean (with a moist rag) as required.

Adjustment

Curtis PMC potboxes are factory set and rarely require user attention. To test and adjust, connect an ohmmeter to the potbox wires and use this procedure:

1. With the spring holding the lever arm against the return stop, the resistance should be less than 50 ohms. Slowly move the lever. If the resistance abruptly starts to increase when the lever is 3 mm (1/8") from the stop (1.5 mm [1/16"] for potboxes without the microswitch), no adjustment is needed.

2. If adjustment is required, loosen the screw holding the lever on the pot shaft. Use a screwdriver to rotate the pot shaft slightly with respect to the lever. Recheck the point at which the resistance starts to increase and continue making adjustments until the increase starts at 3 mm (1/8") [at 1.5 mm (1/16") for potboxes without the microswitch]. When adjustment is correct, tighten the screw holding the lever on the pot shaft, then recheck to see that this action did not disturb the adjustment. Make sure that the lever is still seated down on the pot shaft below the slight bevel on the end of the shaft.
3. Check the resistance with the lever pushed all the way to the other stop. It should be between 4500 and 5500 ohms. If it is outside this range, the potbox is faulty and should be replaced.
4. For potboxes equipped with a microswitch, check for correct switch operation. Use an ohmmeter, or simply listen for the slight click the switch makes. It should operate when the lever is 1.5 mm (1/16") from the return stop. If it does not, adjust by loosening the two screws holding the slotted microswitch mounting plate to the stop spacers and moving the plate. Recheck the switch operating point after tightening the screws.

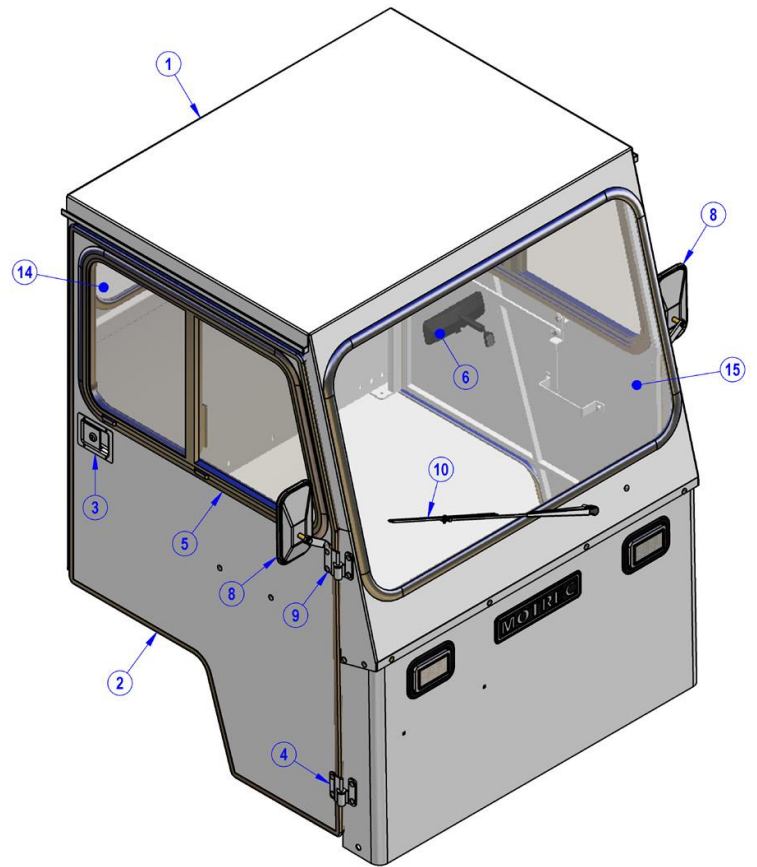
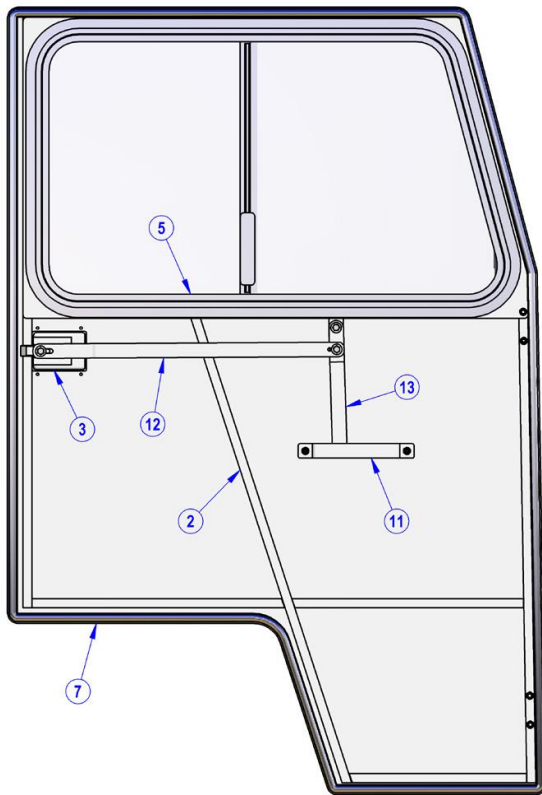
SPARE PARTS

BODY

REF	PART NO	DESCRIPTION
1	2383320004 1005003	SEAT BUCKET SEAT ON SLIDE ADJUSTERS
2	120003	TRIMMING
3	2314320001	FRONT BUMPER
5	300022 2223360001	5.7 X 8 L.R.D WHEEL ASS 5.00 X 8 SOLID SOFT RUBBER WHEEL
6	2382320011	BACKREST CUSHION
7	2803300009 2803300008	LEFT HANDLE RIGHT HANDLE
8	2353320001 480009 2662002 2352320001* 2352330013**	ROLL-OUT BATTERY TRAY ROLLER SPRING, LOCK PIN LIFT-OUT BATTERY TRAY LIFT-OUT BATTERY TRAY

* E-330 WITH MORE THEM 76in. OF DECK AND ALL E-360, E-480.

** E-330 WITH 62in. OF DECK.

CAB**REF PART NO DESCRIPTION**

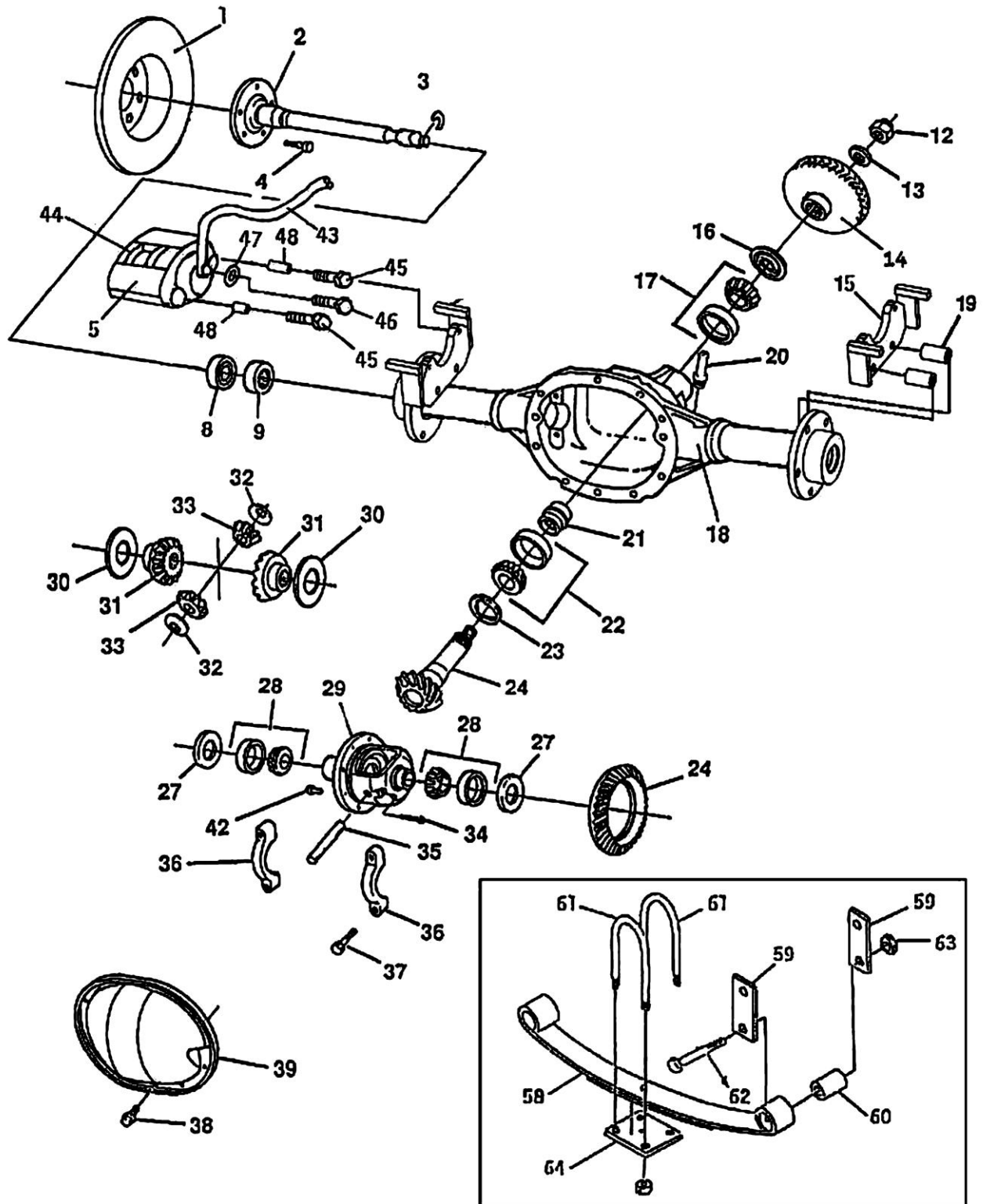
1	2360320012	STEEL CAB
	2382320009	SEATBACK CAB
2	2360320014	RIGHT DOOR
	2360320015	LEFT DOOR
	2360320024*	RIGHT DOOR, REAR PASSENGERS
3	2360320025*	LEFT DOOR, REAR PASSENGERS
	2803000003	PADDLE LATCH
	2366320015	DOOR LATCH
4	2365000001	RIGHT HINGES KIT
	2365000002	LEFT HINGES KIT
5	2367320002	RIGHT DOOR GLASS
	2367320001	LEFT DOOR GLASS
	2367320008*	RIGHT DOOR GLASS, REAR PASS.
	2367320007*	LEFT DOOR GLASS, REAR PASS.

REF PART NO DESCRIPTION

6	2801000002	REAR VIEW MIRROR
7	2802000001	TRIM DOOR
8	2801000001	SIDE MIRROR
9	2399000014	SIDE MIRROR BRACKET
10	3113000001	WIPER MOTOR
	2800000002	WIPER
	2800000001	ARM
11	2366320001	DOOR HANDLE
12	2366320002	DOOR HANDLE BAR
13	2366320003	DOOR LEVER
14	2367300001	REAR GLASS
15	2367300002	WINDSHIELD

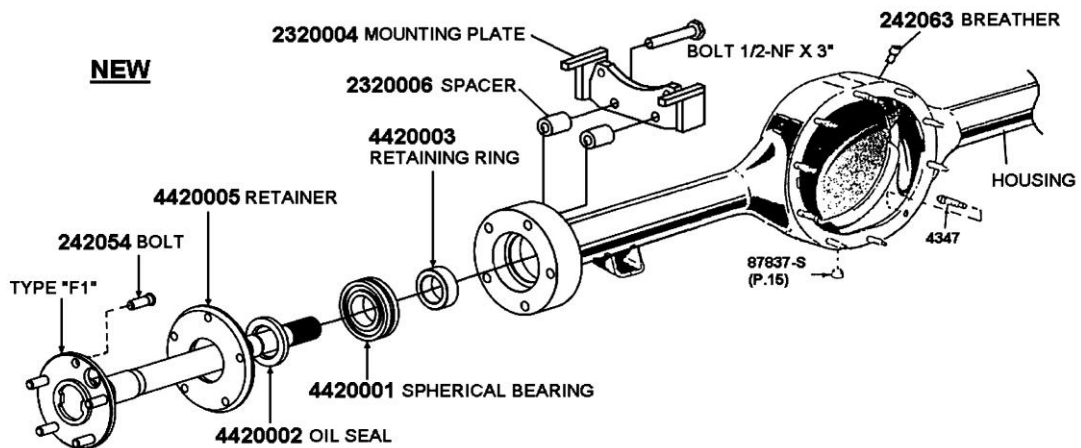
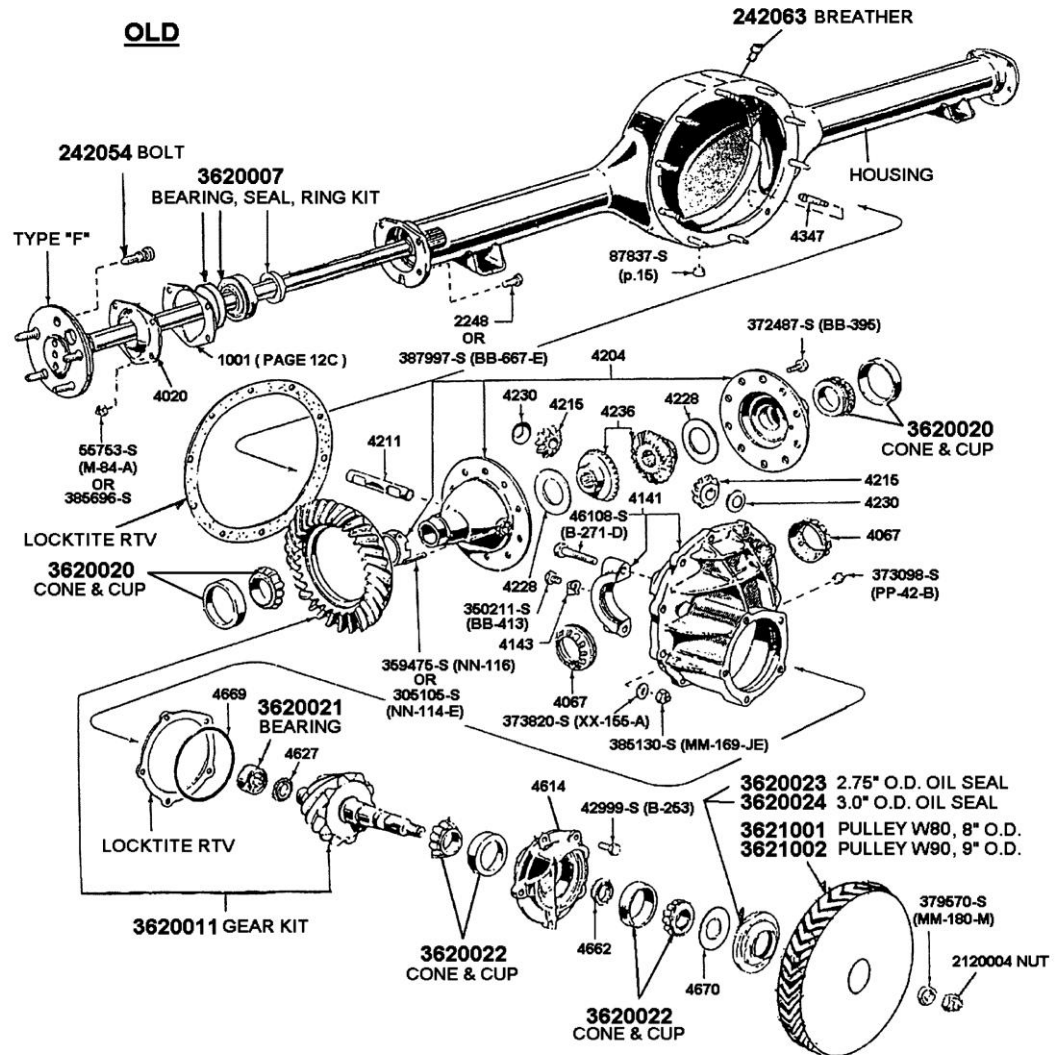
* 4 or 6 passengers option

DIFFERENTIAL AND REAR SUSPENSION

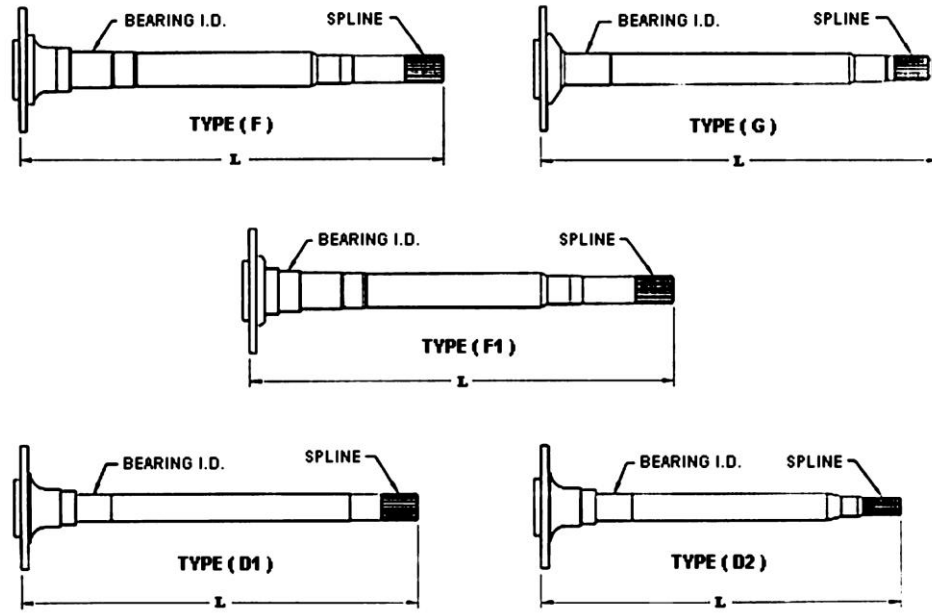


REF	PART NO	DESCRIPTION	REF	PART NO	DESCRIPTION
1	481433	DISC (HYDRAULIC BRAKE)	30	242072	WASHER
2		<u>REAR AXLE:</u>	31	242073	GEAR KIT
	302002	BEFORE SERIAL # 0710276	32	242074	WASHER
	2173300001	SERIAL # 0710276 & UP	33	242075	GEAR KIT
3	242053	LOCK	34	242076	SCREW
4	2910000001	WHEEL STUD	35		<u>SHAFT:</u>
5	481430K	LEFT CALIPER		3620006	WITH 4.56 GEAR RATIO
	481431K	RIGHT CALIPER		242077	OTHERS GEAR RATIO
	481430RK	REPAIRE KIT ,CALIPER	36	242078	CAP
8		<u>OIL SEAL:</u>	37		BOLT
	242056	BEFORE SERIAL # 0611200	38	242079	DRAIN PLUG
	2420011	SERIAL # 0611200 & UP	39	242080	DIFFERENTIAL COVER
9		<u>NEEDLE BEARING:</u>	42	2420019	BOLT
	242057	BEFORE SERIAL #0611200	43	481432	BRAKE HOSE FOR DISC BRAKE
	2420010	SERIAL # 0611200 & UP	44	2128280001	BRAKE PADS
12	242058	NUT	45	481434	BOLT, LONG
13	242059	FLAT WASHER		481442	BOLT, SHORT
14	2113000001	PULLEY W80	46	481440	HYDRAULIC BOLT
	2113300002	PULLEY W90	47	481441	WASHER
15	2122236001	MOUNTING PLATE (CALIPER)	48	3614002	BUSHING, LONG
16	242060	OIL SEAL		3614003	BUSHING, SHORT
17	242061	TAPERED BEARING	58	2192280001	1200 lbs CAP. SPRING, E-348
18	3620004	HOUSING		2192320001	3000 lbs CAP. SPRING, E-480
19	2320006	SPACER	59	2182320002	SHACKLE
20	242063	BREATHER	60	2183240002	BUSHING
21	242064	SPACER	61	2916320001	GM U-BOLT
22	242065	TAPERED BEARING		3640004	FORD U-BOLT
23	242066	SHIM	62		BOLT 5/8-NC X 3-½
24	242067	GEAR KIT	63		LOCK NUT 5/8-NC
27	242069	SHIM	64	2185320002	GM PLATE
28	242070	TAPERED BEARING		3640005	FORD PLATE
29	242071	CASE			

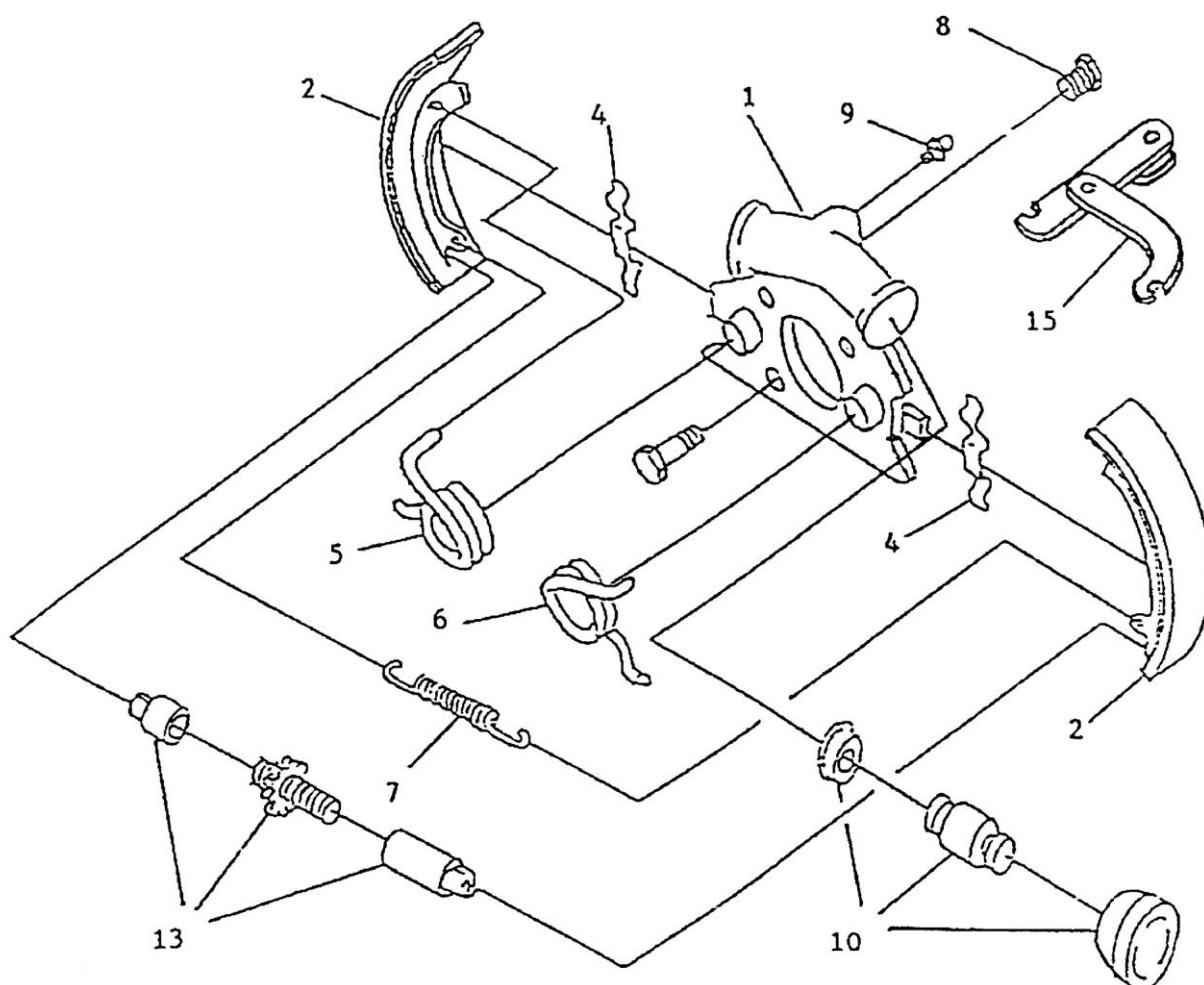
FORD F-150 DIFFERENTIAL



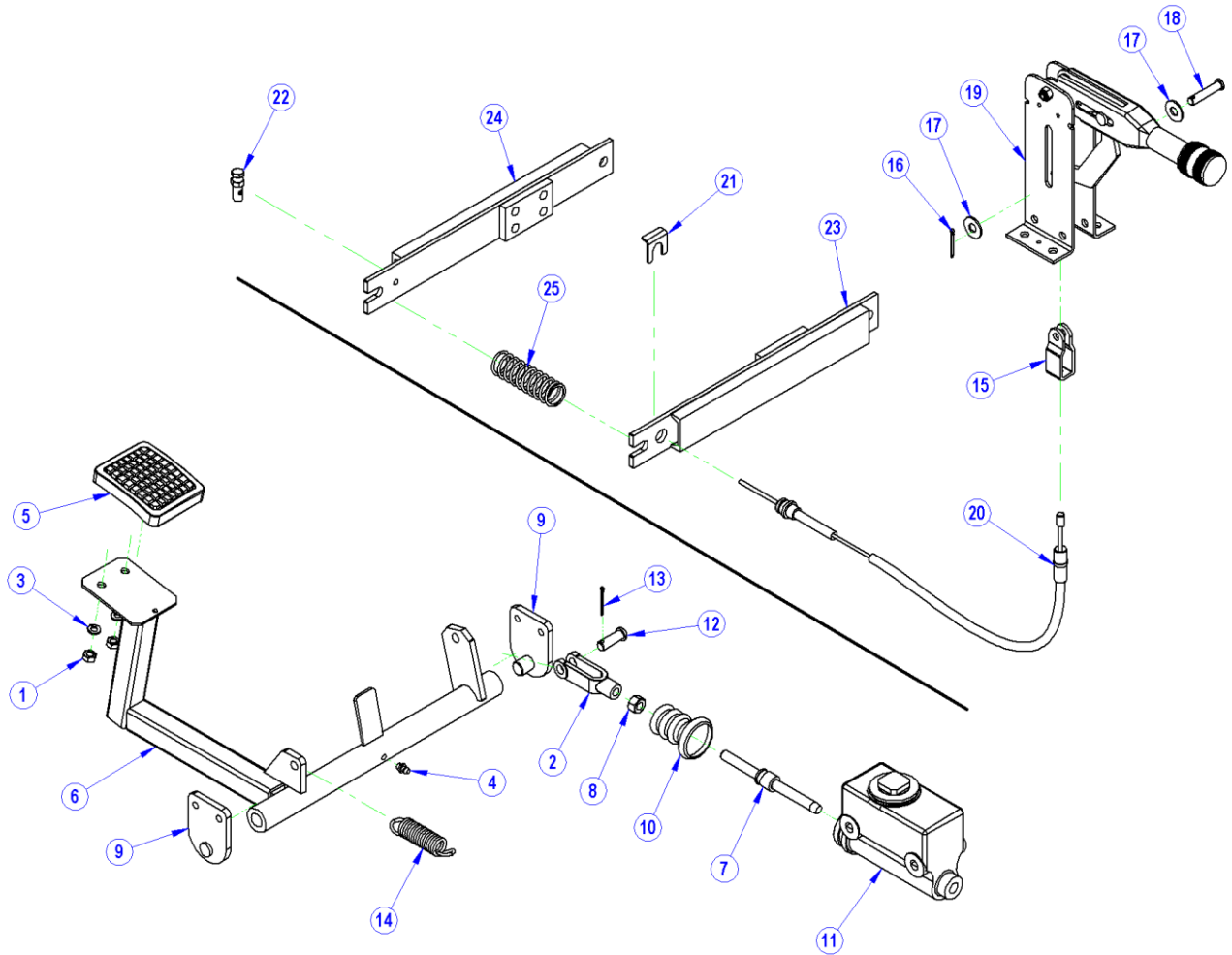
QTY.	PART NUMBER	DESCRIPTION	QTY.	PART NUMBER	DESCRIPTION
FORD WEC (NON-LOCKING) REAR AXLE SERVICE PARTS LIST NO. 237					
				4067	Shim (differential bearing adjustment) — Cont'd
			AR D9AZ	4067-AG	.299" thick
			AR D9AZ	4067-AH	.301" thick
			AR D9AZ	4067-AJ	.303" thick
			AR D9AZ	4067-AK	.305" thick
			AR D9AZ	4067-AL	.307" thick
				4200	Differential assy.—refer to group in Section 40
				4204	Case assy. (differential)
1	373098-S100	Plug (housing)—1/2"—14	1	E7TZ 4204-E	Use with axle #720C,724S,730D—1987/
	(PP-42-B)				
1	E3AZ 4033-A	Cover assy. (housing)—also serviced in assy.—group 4010			
	4036	Gasket (cover to housing)—use D6AZ 19562-B			
	4067	Shim (differential bearing adjustment)			
AR D9AZ	4067-A	.241" thick			
AR D9AZ	4067-B	.243" thick			
AR D9AZ	4067-C	.245" thick			
AR D9AZ	4067-D	.247" thick			
AR D9AZ	4067-E	.249" thick			
AR D9AZ	4067-F	.251" thick			
AR D9AZ	4067-G	.253" thick			
AR D9AZ	4067-H	.255" thick			
AR D9AZ	4067-J	.257" thick			
AR D9AZ	4067-K	.259" thick			
AR D9AZ	4067-L	.261" thick			
AR D9AZ	4067-M	.263" thick			
AR D9AZ	4067-N	.265" thick			
AR D9AZ	4067-P	.267" thick			
AR D9AZ	4067-R	.269" thick			
AR D9AZ	4067-S	.271" thick			
AR D9AZ	4067-T	.273" thick			
AR D9AZ	4067-U	.275" thick			
AR D9AZ	4067-V	.277" thick			
AR D9AZ	4067-W	.279" thick			
AR D9AZ	4067-X	.281" thick			
AR D9AZ	4067-Y	.283" thick			
AR D9AZ	4067-Z	.285" thick			
AR D9AZ	4067-AA	.287" thick			
AR D9AZ	4067-AB	.289" thick			
AR D9AZ	4067-AC	.291" thick			
AR D9AZ	4067-AD	.293" thick			
AR D9AZ	4067-AE	.295" thick			
AR D9AZ	4067-AF	.297" thick			
1	E7TZ 4236-A	Gear kit (differential side)—use with axle #720C,724S,730D—1987/	1	C7AZ 4628-A	Cup (driving pinion bearing—rear)—#M802011
		Consists of	1	C7AZ 4630-A	Cone and roller (drive pinion rear bearing)—#M802048
		2-E7TZ 4228-A Washer	1	B7A 4662-A	Spacer (driving pinion bearing)—1 5/16" I.D. x 15/32" long—collapsible—also serviced in kit—group 4209
		2-E7TW 4236-AA Gear		4663	Shim (pinion bearing)—serviced only in kit—group 4209
2	C7AZ 4N237-A	"U" washer (axle shaft retaining)	1	D5AZ 4670-A	Slinger (pinion shaft oil)
1	D8BZ 4241-A	Pin (differential pinion shaft lock)	1	E5DZ 4676-A	Seal assy. (drive pinion oil)—#E5DW 4676-AA
2	C7AZ 4A332-A	"O" ring (axle shaft)		4851	Flange assy. (universal joint)—axle end 1330 size—1987/
	4346	Bolt (housing cover)—self-locking—5/16"—18 x 5/8"—also serviced in assy.—group 4010	1	389546-S100	Locknut and washer assy. (flange to pinion)—3/4"—20—also serviced in kit—group 4209
10	E6TZ 4346-A	Use with axle #WEC-A,B,720C,724S,730D,760B,762T		4859	Deflector (driving pinion oil seal)
8	E6TZ 4346-A	Use with axle #780C,762P	1	E6TZ 4859-A	Plastic—"From 1/86"—1986/
2	E5TZ 4346-A	Stud (housing cover)—5/16"—18 and—5/16"—18 x 1 1/2" long—also serviced in assy.—group 4010—use with axle #760C,762P			
1	B7A 4616-A	Cup (driving pinion bearing front)—#88048			
1	B7A 4621-A	Cone and roller (drive pinion front bearing)—#M88048			



TYPE	LENGHT (In)	BOLT	BEARING I.D. (In)	SPLINE	NUMBER
F	12.6	5	1.565	28	2135000
F	12.6	5	1.565	31	2135001
F	14.84	5	1.374	28	4435001
F	14.84	5	1.374	31	4435002
F	16.1875	5	1.565	28	3620009
F	16.1875	5	1.565	31	3620014
F	18.375	5	1.565	28	3620013
F	18.375	5	1.565	31	3620015
F1	12.6	5	1.774	31	2135002
F1	12.6	5	1.774	28	2135003
F1	19.375	5	1.774	31	4435003
F1	18.375	5	1.774	31	4435004
F1	18.375	5	1.774	28	4435005
F1	14.88	5	1.774	31	4435006
F1	14.88	5	1.774	28	4435007
F1	23.375	5	1.774	28	4835006
F1	23.375	5	1.774	31	4835007
F1	16.88	4	1.374	26	2635002
F1	23.88	4	1.374	26	2635001
GM	16.88	5	1.774	31	2835001
GM	21	5	1.774	31	6635001
GM	11.125	4	1.395	26	242052
GM	14.125	4	1.395	26	282052
GM	16.875	4	1.395	26	382052
GM	11.125	4	1.374	26	2420014
GM	14.125	4	1.374	26	2820004
GM	12.6	5	1.374	26	2820013
GM	14.87	5	1.374	26	2235007
GM	17.12	4	1.374	26	3020004
GM	17.12	5	1.374	26	3620005
GM	25.12	5	1.374	26	4835002
GM	19.62	5	1.374	26	4835005
D1	14.75	5	1.188	27	282002
D1	17.125	5	1.188	27	302002
D2	15.625	5	1.188	24	012SR124-1
D2	18.875	5	1.188	24	012SR124-2
D2	17.375	5	1.188	24	012SR130-3
D2	18.625	5	1.188	24	012SR130-1

HYDRAULIC DRUM BRAKES

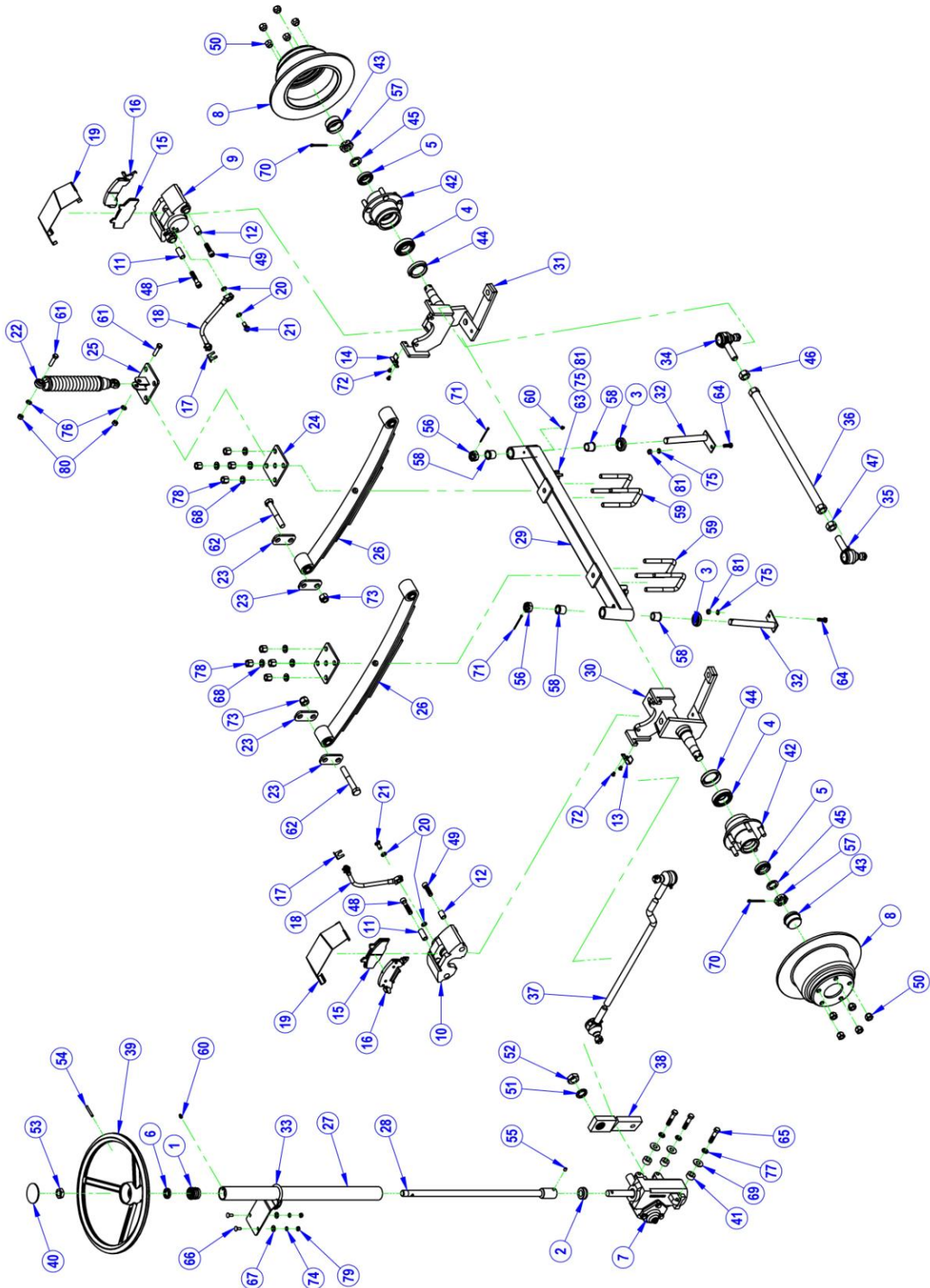
REF	PART NO	DESCRIPTION
1	362841	PLATE-CYLINDER
2	362842	BRAKE SHOE
4	362844	SPRING
5	362845	SPRING
6	362846	SPRING
7	362847	SPRING
8	362848	FITTING
9	362849	BLEEDER
10	362850	PISTON
13	362853	ADJUSTER
14	362855	BOLT (GRADE 8)
15	3612001	LEFT LEVER
	3612002	RIGHT LEVER

BRAKE CONTROLS

REF	PART NO	DESCRIPTION	QTY	REF	PART NO	DESCRIPTION	QTY
1		Nut 1/4-20UNC	1	14	2190000003	Spring (Extention)	1
2	2910000015	Yoke	1	15	2910000013	Yoke	1
3		Lock washer ¼	1	16		Cotter pin 3/32 x 1	1
4	2930000012	Lubrication fitting	1	17		Flat washer 5/16	2
5	2131100002	Rubber pad	1	18		Clevis pin 5/16 x 1-1/2	1
6	2131360002	Lever	1	19	2139240002	Handbrake lever	1
6	2131360012	Lever	1	20	2129000003	Handbrake cable	1
7	2133280001	Push rod-Master cylinder	1	21	2129000001	Clip	1
8		Nut 3/8-16UNF	1	22	2921000001	Cable stop	1
9	2132320001	Pivot	2	23	2127000006	Handbrake band (side cable)	1
10		Boot, included with #2125000001	1	24	2127000001	Handbrake band	1
11	2125000001	Master cylinder	1	25	2191240002	Spring (compression)	1
12		Clevis pin 3/8 x 1-3/32	1				
13		Cotter pin 3/32 x 1	1				

* EE version

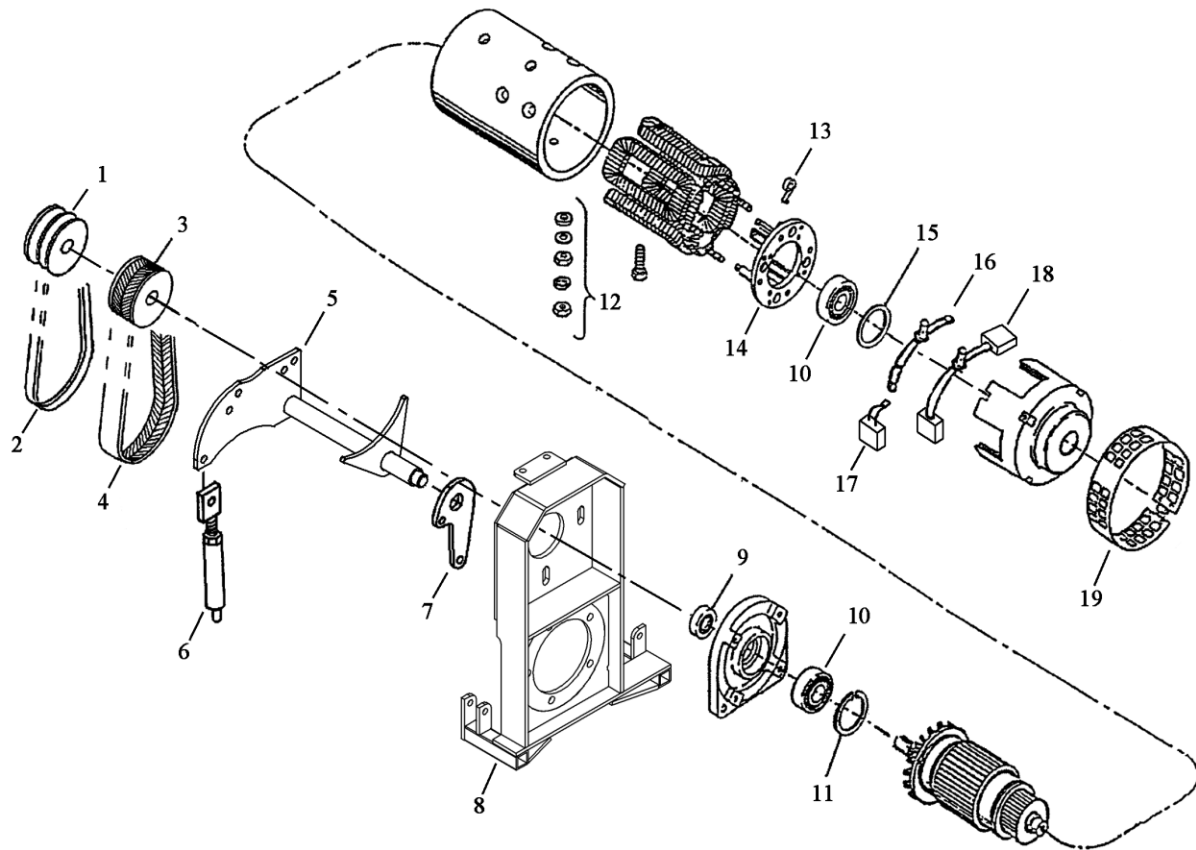
FRONT ASSEMBLY



REF	PART NO	DESCRIPTION	REF	PART NO	DESCRIPTION
1	2100300002	BUSHING	41	2219250001	SPACER
	2100300001	BUSHING WITH OIL SEAL	42	2224300002	HUB
2	2100300003	BUSHING	43	2229300001	DUST CAP
3	2103250001	THRUST BEARING	44	2229300002	OIL SEAL
4	2103300001	TAPER BEARING	45	2229300003	SPINDLE WASHER
5	2103300002	TAPER BEARING	46	2910000005	NUT, LEFT HAND
6	2104300004	OIL SEAL	47	2910000006	NUT, RIGHT HAND
7	2117250001	GEAR	48	2910000017*	BOLT, LONG
8	2120236001*	DISC	49	2910000018*	BOLT, SHORT
9	481431*	RIGHT CALIPER	50	2910000019	WHEEL NUT
10	481430*	LEFT CALIPER	51	2910000020	LOCK WASHER 7/8
11	2121000005*	BUSHING, LONG	52	2910000021	JAM NUT 7/8-NF
12	2121000006*	BUSHING, SHORT	53	2910000022	JAM NUT 3/4-NF
13	2122300001*	LEFT CALIPER SUPPORT	54	2910000023	SPRING PIN ¼ X 1 3/4
14	2122300002*	RIGHT CALIPER SUPPORT	55	2910000024	SET SCREW 5/16-NC
15	2128280001*	PADS	56	2910300001	CASTELLATED NUT 3/4-NF
16	2128280001*	PADS	57	2910300002	CASTELLATED NUT 1-UNEF
17	2129000001*	CLIP	58	2914364001	BUSHING
18	2134000001*	FLEX, HOXE	59	2916000001	U-BOLT
19	2139000001*	CALIPER PROTECTOR	60	2930000012	GREASE FITTING
20	2139000002*	WASHER	61**		BOLT 3/8-NC X 1 ½
21	2139000003*	BOLT	62		BOLT 5/8-NC X 4
22	2180240001**	SHOCK ABSORBER	63		BOLT 5/16-NC X 1 1/4
23	2182320001	SHACKLE LINK	64		BOLT 5/16-NC X 1
24	2185320001	PLATE	65		BOLT 7/16-NC X 2
25	2185488001**	PLATE	66		CARRIAGE BOLT 1/4-NC X 3/4
26	2192280001	LEAF SPRINGS	67		FLAT WASHER 1/4
27	2200300002	TUBE	68		FLAT WASHER 12mm
28	2200300003	SHAFT	69		FLAT WASHER 7/16
29	2201320001	AXLE BEAM	70		COTTER PIN 3/16 X 2
30	2201320008	LEFT SPINDLE	71		COTTER PIN 7/64 X 2
	2201360001*	LEFT SPINDLE, BRAKES	72*		MACHINE SCREW 1/4-NC X 3/8
31	2201320009	RIGHT SPINDLE	73		NYLON NUT 5/8-NC
	2201360002*	RIGHR SPINDLE, BRAKES	74		LOCK WASHER 1/4
32	2205250001	KING PIN	75		LOCK WASHER 5/16
33	2206300003	STEERING SUPPORT,	76**		LOCK WASHER 3/8
		BOLT PATTERN 2 3/8"	77		LOCK WASHER 7/16
	2206320001	STEERING SUPPORT,	78		HEAVY NUT 1/2-NF
		BOLT PATTERN 2 1/4"	79		NUT 1/4-NC
34	2207000001	ROD END, LEFT HAND	80**		NUT 3/8-NC
35	2207000002	ROD END, RIGHT HAND	81		NUT 5/16-NC
36	2207300006	REAR TIE ROD			
37	2207320001	FRONT TIE ROD			
38	2207320009	ARM			
39	2208240001	STEERING WHEEL			
40	2208240002	COVER			

* Front axle with hydraulic disc brakes

** Front axle with shock absorber

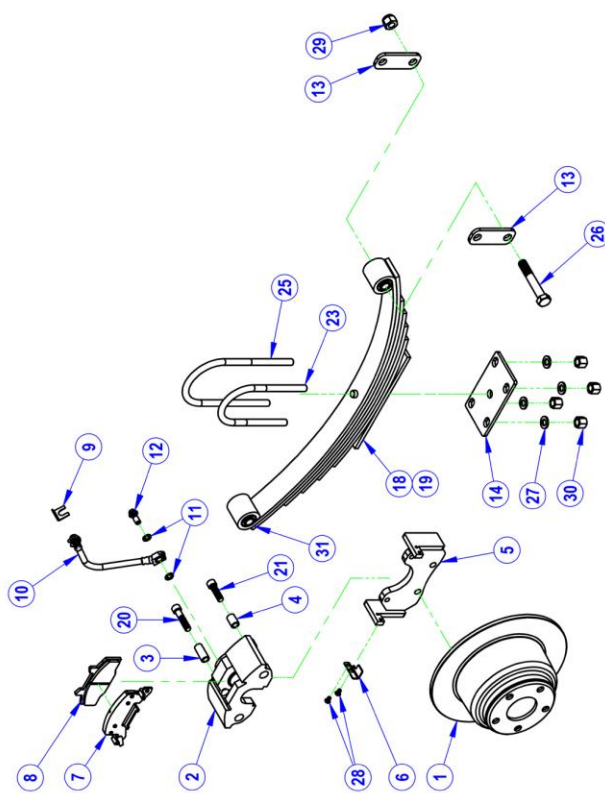
MOTOR AND DRIVE**COMMON PARTS**

REF	DESCRIPTION	PART #	REF	DESCRIPTION	PART #
1	PULLEY	262424	8	MOTOR BASE, FORD	Contact manuf.
2	V BELT	242431		BELT TENSIONER	2152002
3	PULLEY	3651001	9	SEAL	484001
4	BELT, EAGLE	3651002	10	BEARING	484003
5	MOTOR BASE, GM	Contact manuf.	11	SNAP RING	484004
6	BELT TENSIONER, LONG	2452005	12	NUT WASHER PACK	484006
	BELT TENSIONER, SHORT	2452003	15	WAVY WASHER	484013
7	PIVOT	2452002	19	HEADBAND	484015
				EE HEADBAND KIT	A91-107A

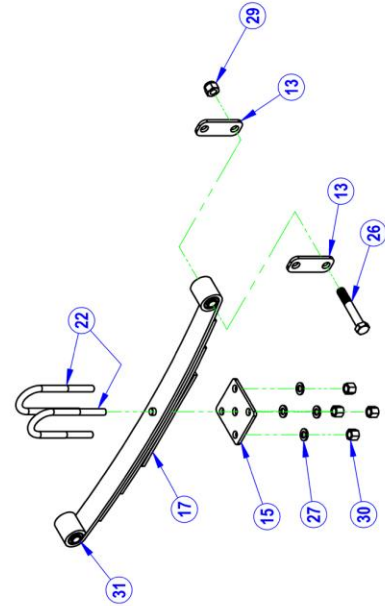
SPECIFIC

REF	DESCRIPTION	A89	B98	A00	D00 SEPEX	DC3 SEPEX	DANA DRIVE
	MOTOR ASS'Y	484000	204050	2450002	2450003	3112210001	3112230001
13	BRUSH SPRING	484010	484010	2450006	2450006	2450006	2450006
14	BRUSH PLATE	484011	484011	2450007	2450007	2450007	2450007
16	LEAD ASSY.	484017	484017	N/A	N/A	N/A	N/A
17	BRUSH	484009	484009	N/A	N/A	N/A	N/A
18	LEAD AND BRUSH ASSY.	N/A	N/A	2450008	2450008	3112210004	2450008

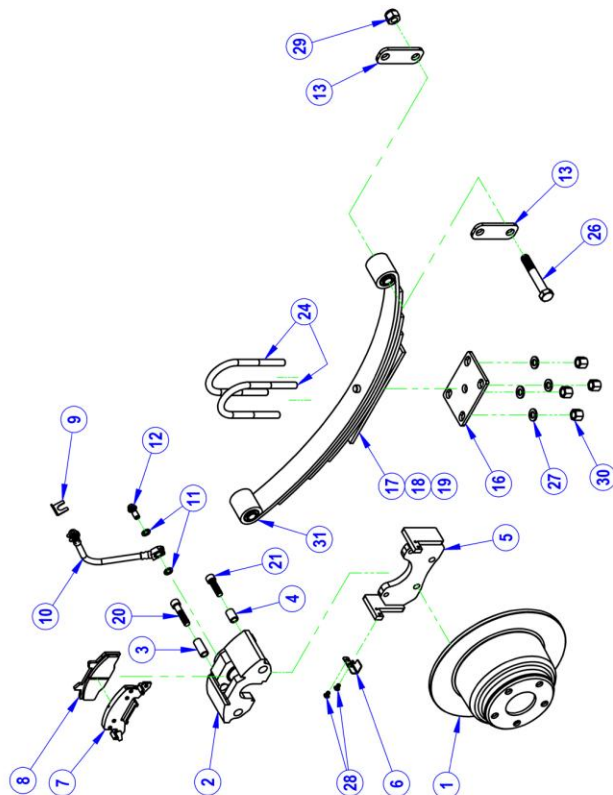
REAR SUSPENSION AND BRAKE



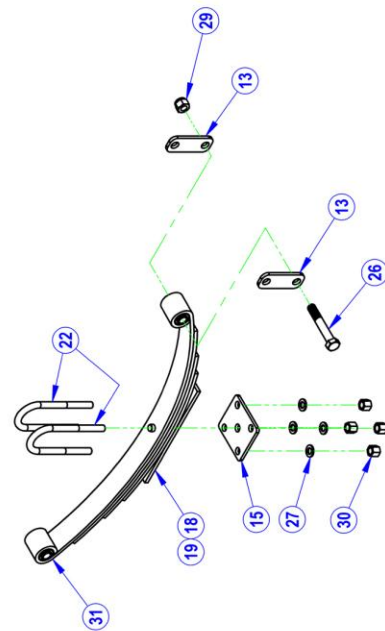
FORD DIFFERENTIEL



DANA DIFFERENTIEL - E-302



GM DIFFERENTIEL



DANA DIFFERENTIEL - E-322 & E-330

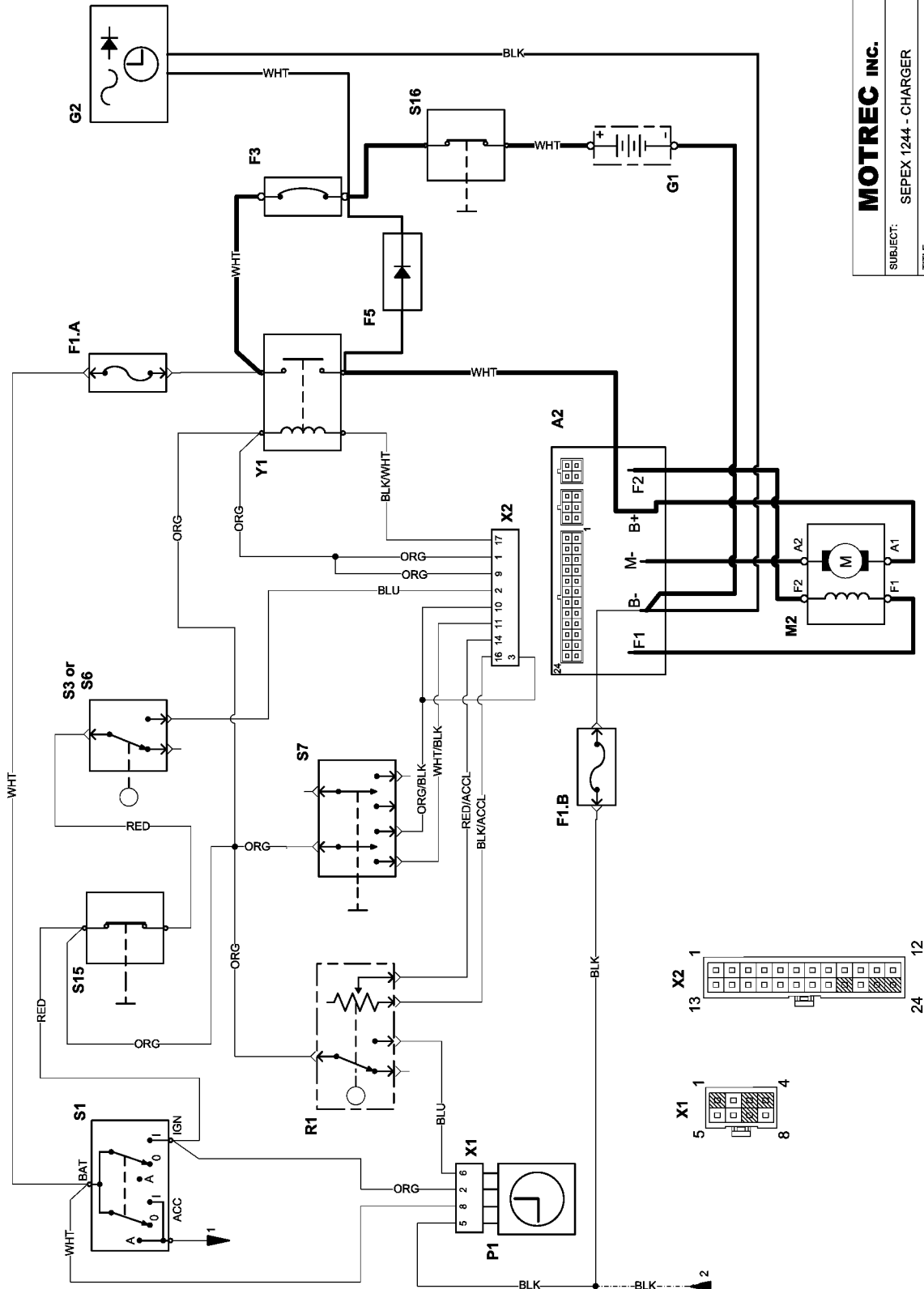
REF	PART NO	DESCRIPTION
1	2120236001	DISC
2	481431	RIGHT CALIPER
	481430	LEFT CALIPER
3	2121000005	BUSHING, LONG
4	2121000006	BUSHING, SHORT
5	2122236001	MOUNTING PLATE, CALIPER
6	2122300001	LEFT CALIPER SUPPORT
	2122300002	RIGHT CALIPER SUPPORT
7	2128280001	PADS
8	2128280001	PADS
9	2129000001	CLIPS
10	2134000001	FLEX. HOXE
11	2139000002	WASHER
12	2139000003	BOLT
13	2182320002	SHACKLE LINK
14	2185280001	FORD PLATE
15	2185320001	DANA PLATE
16	2185320002	GM PLATE
17*	2192320001	4 - LEAF SPRINGS
18**	2192320001	5 - LEAF SPRINGS
19***	2192320001	7 - LEAF SPRINGS, HEAVY DUTY
20	2910000017	BOLT, LONG
21	2910000018	BOLT, SHORT
22	2916000002	U-BOLT 1/2-NF X 2" I.D.
23	2916280002	U-BOLT 1/2-NF X 3 1/4" I.D.
24	2916320001	U-BOLT 1/2-NF X 2 3/4" I.D.
25	2916480001	U-BOLT 1/2-NF X 4" I.D.
26		BOLT 5/8-NC X 4
27		FLAT WASHER 12mm
28		MACHINE SCREW 1/4-NC X 3/8
29		NYLON NUT 5/8-NC
30		HEAVY NUT 1/2-NF
31	2183240002	BUSHING

* E-302 & 348

** E-320, 322, 330, 360 & 480

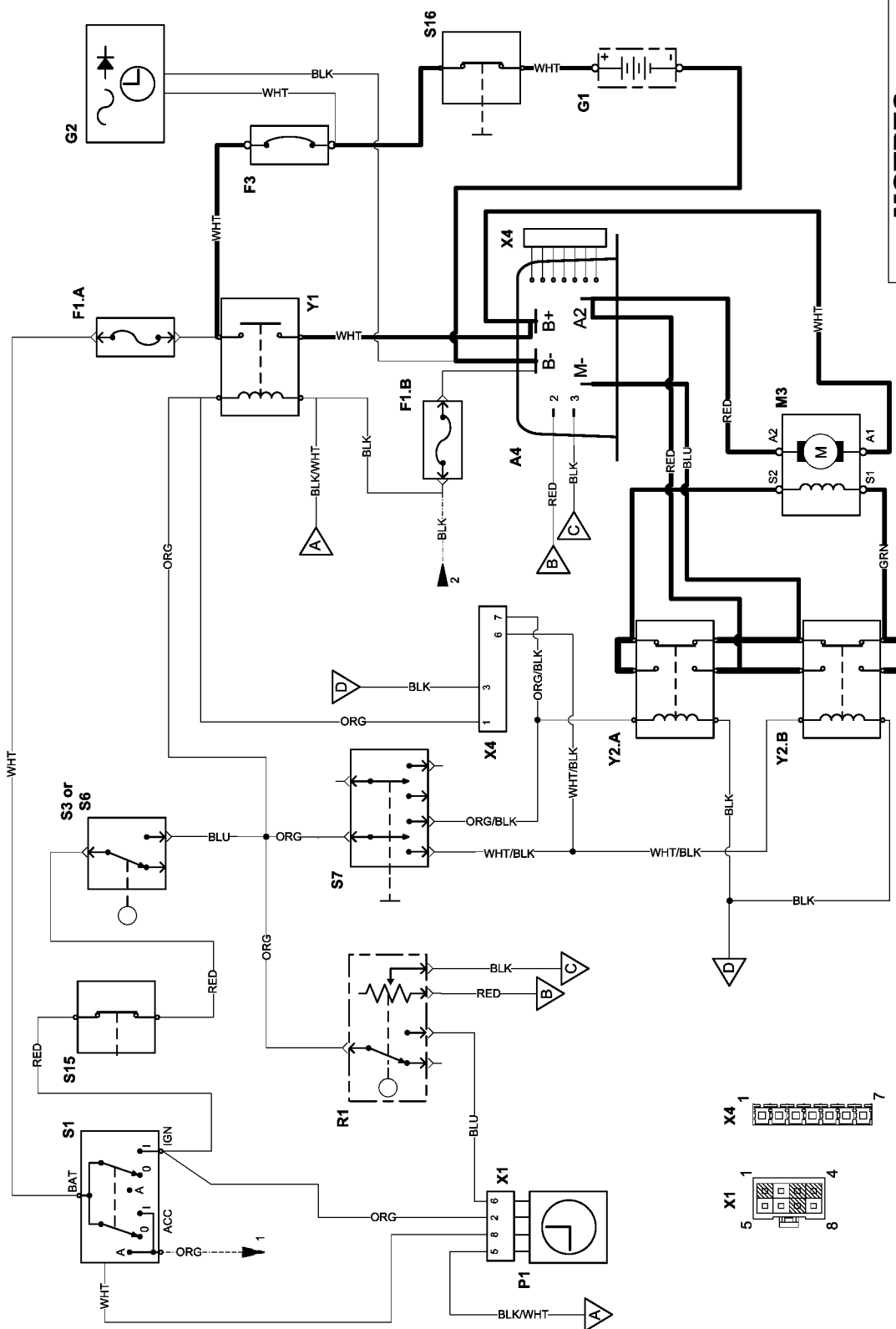
*** STANDARD, E-500 & 660 AND OPTIONAL, E-320, 322, 330, 360 & 480

ELECTRICAL DIAGRAM – SEPEX MAIN CIRCUIT **DIAGRAMME ÉLECTRIQUE – CIRCUIT PRINCIPAL SEPEX**



MOTREC INC.			
SUBJECT:	SEPEX 1244 - CHARGER		
TITLE:	MAIN CIRCUIT-SEPEX		
VERSION:	02	DATE:	2008-02-19
AUTHOR:	J. GAGNON	APPROVED:	
DRAWING #:	SEPEX 1244 - CHARGER.VSD		

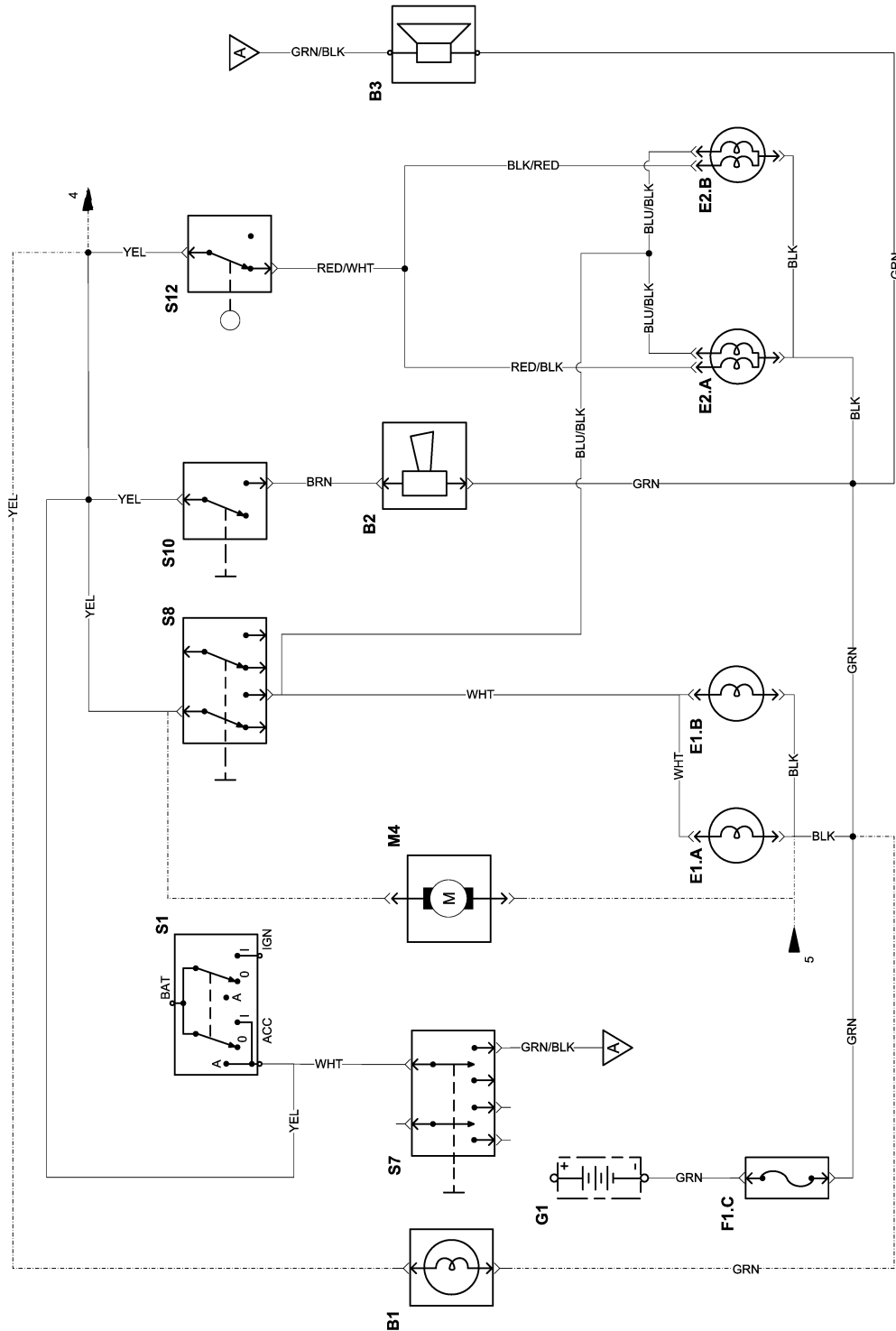
ELECTRICAL DIAGRAM – SERIES MAIN CIRCUIT
DIAGRAMME ÉLECTRIQUE – CIRCUIT PRINCIPAL SÉRIES



MOTREC INC.	
SUBJECT:	SERIES 1205X - CHARGER
TITLE: MAIN CIRCUIT-SERIES	
VERSION:	02 DATE: 2008-02-19
AUTHOR:	J. GAGNON APPROVED:
DRAWING #:	SERIES 1205X - CHARGER VSD

ACCESSORIES – NO DC/DC CONVERTER

ACCESSOIRES – SANS CONVERTISSEUR DC/DC

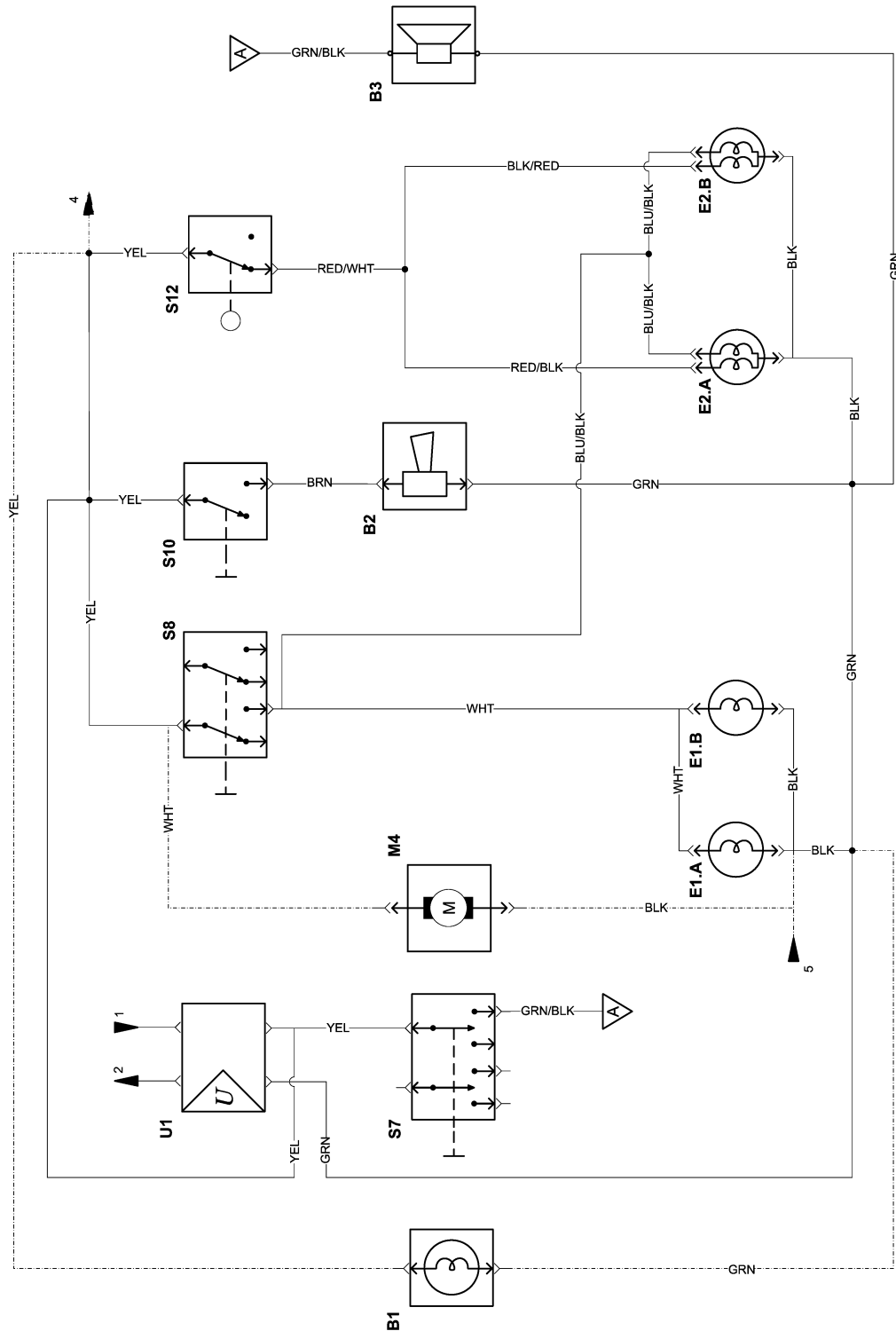


MOTREC INC.			
SUBJECT:	ACC - 2HL2TL1SL1WM		
TITLE:	ACCESSORIES - NO DC/DC CONVERTER		
VERSION :	01	DATE:	2008-04-08
AUTHOR :	J. GAGNON	APPROVED:	
DRAWING #	ACC - NO DC-DC - 2HL2TL1SL1WM.VSD		

* Accessories ground is connected at an intermediate post relative to vehicle battery set positive post when DC-DC converter option is not taken.
The relative voltage is either 12V or 24V depending on accessories

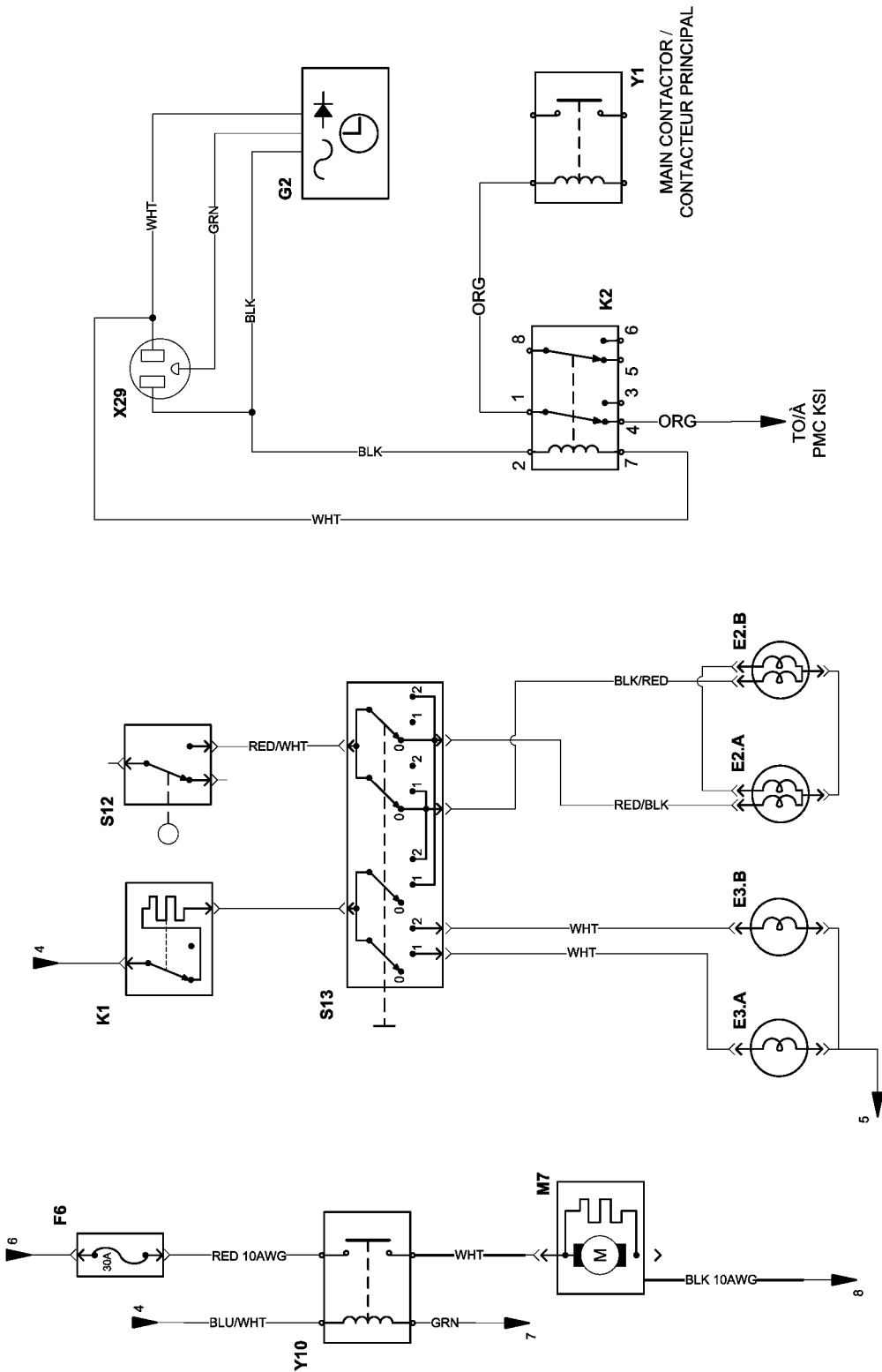
ACCESSORIES – DC-DC CONVERTER

ACCESSOIRES – CONVERTISSEUR DC-DC



MOTREC INC.			
SUBJECT:	ACC - 2HL2TL1SL1WM		
TITLE:	ACCESSORIES – DC/DC CONVERTER		
VERSION:	01	DATE:	2005-04-27
AUTHOR:	J.GAGNON	APPROVED:	
DRAWING #:	ACC - DC-DC - 2HL2TL1SL1WM.VSD		

OPTIONS



MOTREC INC.			
SUBJECT: OPTIONS - FLASHERS, HEATER & INTERLOCK AC RELAY			
TITLE: OPTIONS			
VERSION: 01	DATE: 2008-02-29		
AUTHOR: B. FILTEAU	APPROVED:		
DRAWING #: OPTIONS - FLASHERS, HEATER & INTERLOCK AC RELAY VSD			

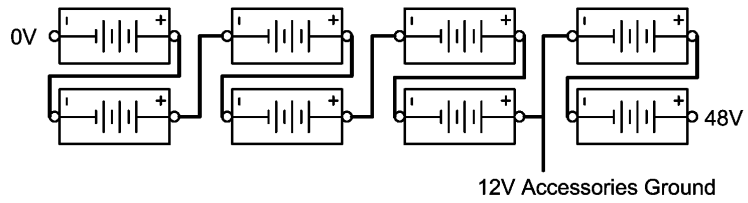
PARTS LIST

NO	DESIGNATION	REF	QTY
A2	SEPEX SPEED CONTROL	1244-5451	1
A4	SERIES SPEED CONTROL, 350A	1205X-5301	1
B1	STROBELIGHT	*	1
B2	HORN	*	1
B3	REVERSE ALARM	*	1
E1.A,B	HEADLIGHT	*	2
E2.A,B	TAIL/BRAKE LIGHT	*	2
E3.A,B	AMBER FRONT LIGHT	*	2
F1.A,B,C	FUSE, 15A	246108K	3
F3	CIRCUIT BREAKER, 150A	3107000002	1
F5	DIODE BRIDGE	3669027	1
G1	BATTERY		
G2	BATTERY CHARGER		1
K1	FLASHER RELAY	3069004	1
K2	110 VAC RELAY	366213	1
	RELAY BASE	246216	1
	RELAY RETAINING CLIP	246216C	1
M2	SEPEX MOTOR		1
M3	SERIES MOTOR		1
M4	WIPER MOTOR	*	1
M7	CAB HEATER	*	1
P1	INDICATOR (BDI), HOUR METER	*	1
R1	ACCELERATOR	2142100001	1
	MICROSWITCH	367002	1
	POTENTIOMETER	367003	1
	PLASTIC GEAR	367015	1
	SPRING	2462008	1
R4	RESISTANCE, 250 OHMS	367014	1
S1	KEY SWITCH	246205	1
S3	SEAT SWITCH, MICRO-SWITCH	3109100002	1
S7	FORWARD/REVERSE SELECTOR	266211	1
S8	LIGHT SWITCH, ROCKER TYPE	1269004	1
	LIGHT SWITCH, PUSH/PULL	486002	1
S10	HORN BUTTON	*	1
S12	BRAKE LIGHT SWITCH	246207	1
	HYDRAULIC BRAKE LIGHT SWITCH	3669004	1
S13	FLASHER SWITCH	*	1
S15	EMERGENCY PUSH BUTTON	3109800001	1
	EMERGENCY PUSH BUTTON, LABEL	3109800006	1
S16	EMERGENCY PUSH BUTTON 250AMP	3109000005	1
U1	DC-DC CONVERTER	*	1
X1	HOUR METER CONNECTOR		1
X2	SPEED CONTROL CONNECTOR		1
X4	SPEED CONTROL CONNECTOR		1
X5	BATTERY CHARGER CONNECTOR		1
X29	PVC GROUNDING PLUG, YELLOW	80003	1
Y1	36 VOLT MAIN CONTACTOR	3104236001	1
	48 VOLT MAIN CONTACTOR	486222	1
Y2.A,B	36 VOLT F/R CONTACTOR	366217	2
	48 VOLT F/R CONTACTOR	486217	2
Y10	HEATER SOLENOID	246101	1
	F/R BUSSBARS	2469003	1
	STATIC STRAP	2450001	1

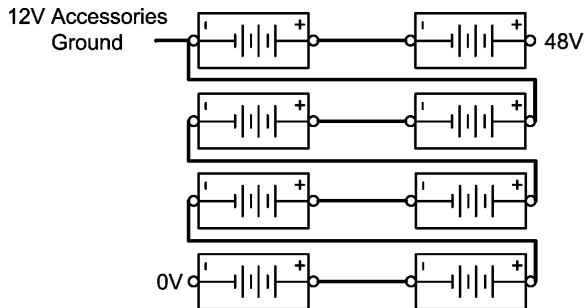
* Consult Motrec Illustrated parts

BATTERY CONFIGURATIONS - 48V CONFIGURATIONS DES BATTERIES – 48V

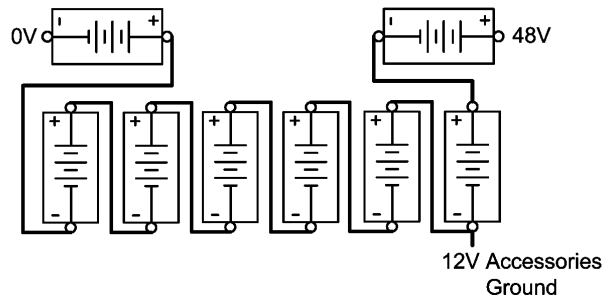
E-480
E-480TT
E-500

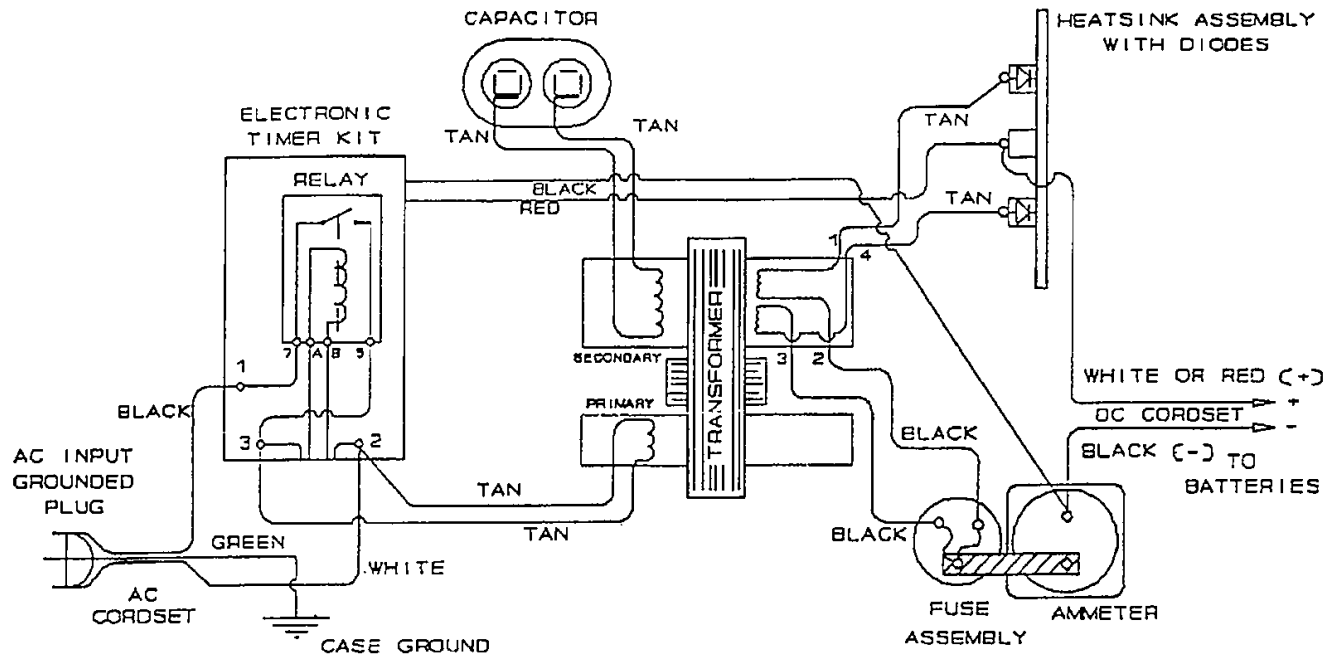


E-660



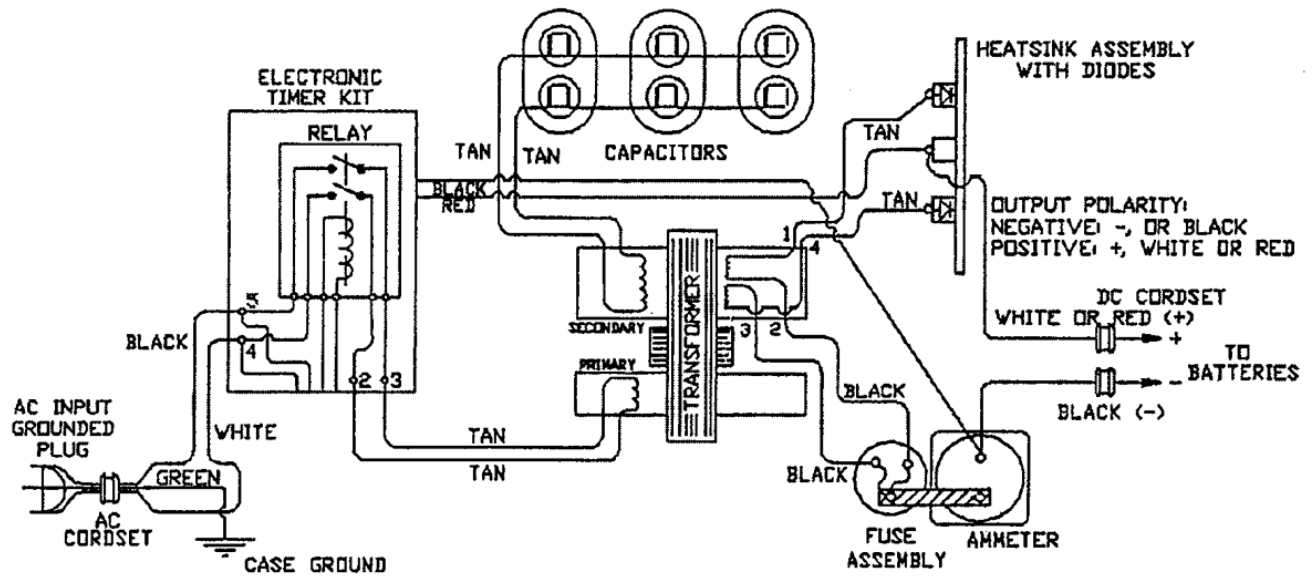
E-348



BUILT-IN / PORTABLE 25A CHARGER

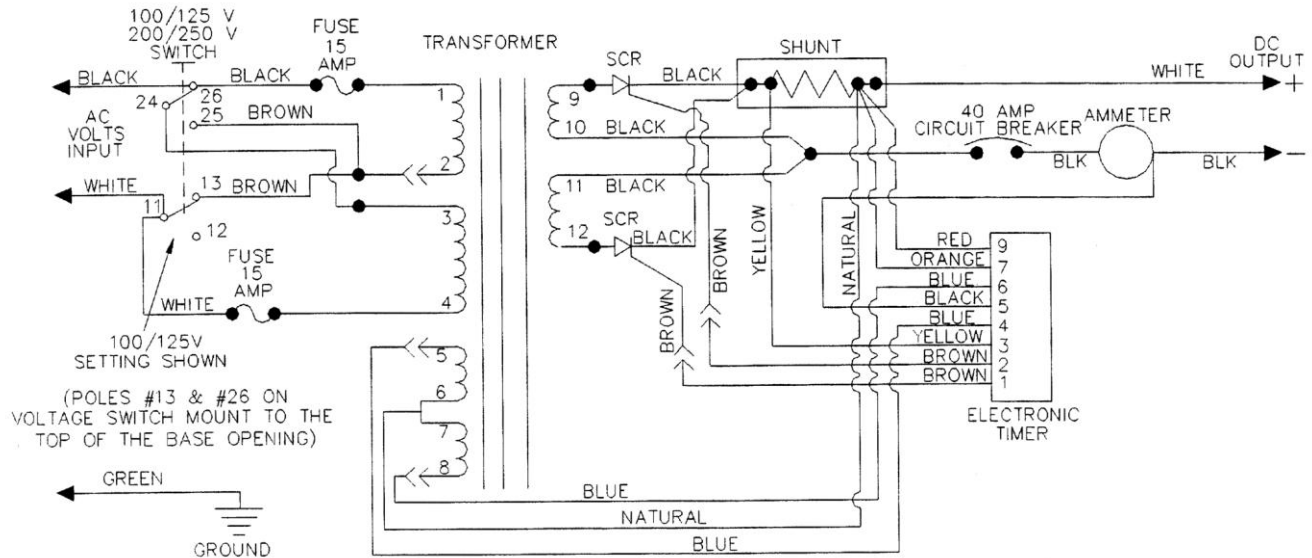
**Parts list for LESTRONIC II charger MODEL 09695
TYPE 48LC25-8ET 115 VAC 60 Hz**

PART NO	DESCRIPTION
09727S	CASE ASSEMBLY
09696S	TRANSFORMER ASSEMBLY
16354S	HEATSINK ASSEMBLY, WITH DIODES
04127S	AMMETER
09664S	ELECTRONIC TIMER ASSEMBLY (RELAY - 03735S)
02390S	CAPACITOR, 6.0 MFD, 660 VAC
08776S	FUSE ASSEMBLY
02028S	BUSHING, 7W-2, INSULATOR FOR CORDSETS
02506S	CORDSET, AC
08512S	CORDSET, DC, NO PLUG
14973S	CORDSET, DC, WITH SILICONE PLUG
8020S	CORDSET, DC, WITH LESTER PLUG
08607S	CORDSET, DC, WITH 50 AMP ANDERSON PLUG
10536S	CORDSET, DC, WITH 50 AMP EZ GO PLUG
08224S	CORDSET, DC, WITH 175 AMP ANDERSON PLUG
08313S	PLUG ASSY, DC, 50 AMP ANDERSON PLUG
02957S	PLUG ASSY, DC, 175 AMP ANDERSON PLUG



Parts list for LESTRONIC II charger MODEL 10150
TYPE 48LC50-8ET 230 VAC 60 Hz

<i>PART NO</i>	<i>DESCRIPTION</i>
10364S	CASE ASSEMBLY
09425S	TRANSFORMER ASSEMBLY
09041S	HEATSINK ASSEMBLY, WITH DIODES
08849S	DIODE ASSEMBLY
20726S	AMMETER
09881S	ELECTRONIC TIMER ASSEMBLY (03735S RELAY)
02390S	CAPACITOR, 6.0 MFD, 660 VAC
08799S	FUSE ASSEMBLY
02028S	BUSHING, 7W-2, INSULATOR FOR CORDSETS
08842S	CORDSET, AC
08817S	CORDSET, DC, NO PLUG
09908S	CORDSET, DC, WITH ANDERSON SB50 PLUG
08823S	CORDSET, DC, WITH ANDERSON SB175 PLUG
17823S	CORDSET, DC, WITH SB350 BLUE PLUG
08313S	PLUG ASSY, DC, SB50 PLUG
02957S	PLUG ASSY, DC, SB175 PLUG
17824S	PLUG ASSY, DC, SB350 BLUE PLUG

BUILT-IN/PORTABLE CHARGER MODEL 16510

L2115S50

Parts list for MODEL 16510
TYPE 48EL20-8ET
100-125 or 200-250 VAC / 50-60 Hz

PART NO	QTY.	DESCRIPTION
21149S	1	CASE ASSEMBLY
15945S	1	TRANSFORMER ASSEMBLY
16369S	1	AMMETER
16595S	1	ELECTRONIC TIMER ASSEMBLY
18696S	1	SHUNT ASSEMBLY
21249S	2	HEATSINK ASSEMBLY, W/ SCR
21152S	1	CONTROL CABLE ASSEMBLY
02028S	1	BUSHING, INSULATOR, 7W-2, FOR AC CORDSET
02008S	1	BUSHING, INSULATOR, 8P-2, FOR DC CORDSET
21147S	1	CORDSET, AC, 14/3, W/ PLUG
25248S	1	CORDSET, AC, 1.5mm ³ , HARMONIZED, NO PLUG
28113S	1	CORDSET, DC, SY120 PLUG, GRAY
29052S	1	CORDSET, DC, LESTER PLUG, GRAY
21146S	1	CORDSET, DC, NO PLUG
05322S	1	FUSEHOLDER
16499S	2	FUSE, 15 AMP, MDA-15
17558S	1	SWITCH, ROCKER, DPDT
21333S	1	CIRCUIT BREAKER, 40 AMP

DELTA-Q HF CHARGER



NO	PART NO	DESCRIPTION
1	3102240002	24V CHARGER (U.S. BATTERY)
	3102240003	24V CHARGER (LIFELINE BATTERY)
	3102240004	24V CHARGER (GEL 180AH BATTERY)
	3102240005	24V CHARGER (27TM BATTERY)
	3102302001	36V CHARGER (U.S. BATTERY)
	3102302002	36V CHARGER (LIFELINE BATTERY)
	3102302003	36V CHARGER (GEL 180AH BATTERY)
	3102480002	48V CHARGER (U.S. BATTERY)
	3102480003	48V CHARGER (LIFELINE BATTERY)
	3102480004	48V CHARGER (GEL 180AH BATTERY)
	3119000011	CONNECTOR C13

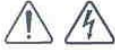


HF/PFC Battery Charger

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

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 – voir le manuel. D'autres types de batteries pourraient éclater et causer des blessures ou dommages. Les batteries peuvent produire des gaz explosifs en service normal. Ne jamais fumer près de la batterie et éviter toute étincelle ou flamme nue à proximité de ces derniers. Fournir 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 désassembler le chargeur – référer toute réparations aux personnes qualifiées. Pas à l'usage des enfants.

Operating Instructions

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

Maintenance Instructions

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

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

Specifications

DC Output – see Operating Instructions

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

AC Input

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

Operation

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

Installation Instructions



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

1) Determine Mounting Location:

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

2) Mounting Procedure:

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

3) DC Battery Connection Procedure:

- 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.
- Securely fasten the black ring terminal from the charger to the negative terminal ("–", "NEG", "NEGATIVE") of the battery pack.
- 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

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

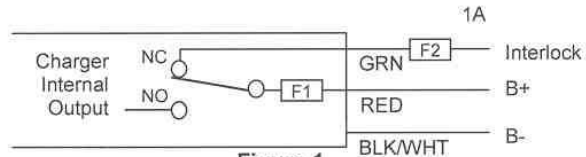


Figure 1

4) Check / Change Charging Algorithm:

The charger comes pre-loaded with algorithms for batteries as detailed in Table 1. If your specific battery model is not listed, please contact Delta-Q.

Each time AC power is applied with the battery pack NOT connected, the charger enters an algorithm select/display mode for approximately 11 seconds. During this time, the current Algorithm # is indicated on the '80%' LED (Models 912-xx0x) or on the single LED (Models 912-xx1x). A single digit Algorithm # is indicated by the number of blinks separated by a pause. A two digit Algorithm # is indicated by the number of blinks for the first digit followed by a short pause, then the number of blinks for the second digit followed by a longer pause.

To check / change the charging algorithm:

- Disconnect the charger positive connector from battery pack. Apply AC power and after the LED test, the Algorithm # will display for 11 seconds.
- To change algorithm, touch positive connector during the 11 second display period to the battery pack's positive terminal for 3 seconds and then remove – the Algorithm # will advance after 3 seconds. Repeat until desired Algorithm # is displayed. A 30 second timeout is extended for every increment. Incrementing beyond the last Algorithm moves back to the first Algorithm. After desired Algorithm # is displayed, touch the charger connector to the battery positive until the output relay is heard to click (~10 seconds) – algorithm is now in permanent memory.
- Remove AC power from the charger and reconnect the charger positive connector to the battery pack. It is highly recommended to check a newly changed algorithm by repeating step 4) above.

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

Table 1.

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

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

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MOTREC ILLUSTRATED ACCESSORIES

 Strobelight, polemount Amber 12-80V: 3116000001 Red 12-80V: 2469001 Blue 12-80V: 3690008	 Red Tail/Brake light Housing: 3069012R Bulb 12V: 3117240001	 Headlight Left: 3111480003 Right: 3111480004 Bulb H/L: 3117480001 Bulb Turn: 3117480003 Bulb Mark: 3117480002	 Horn button VIP 2330014
 Strobelight, cab mount Amber 12-48V: 3116250001 Red 12-48V: 3069026 Blue 12-48V: 3069014 Amber 72-80V: 3116720001 Red 72-80V: 3116720002 Blue 72-80V: 3116720003	 Back-up lamp Grommet: 3269001 12V: 3669012 24V: 3669012A	 Turn signal switch 246050	 Horn button, column mount 246210
 Amber turn lamp 12V: 3069020 Bulb 12V: 3069021 Multi-LED amber turn lamp Round Light: 3111000010 Grommet: 3111000008 Plug: 3111000009	 Clear lamp 12V: 3069012 Bulb 12V: 1269008	 Multi-LED Red Tail/Brake Light: 3111000006 Grommet: 3111000008 Plug: 3119000009	 Horn button, dash mount 266210
 Red Tail/Brake light Grommet: 3269001 Plug: 246012A 12V: 2469021 24V: 2469022	 Pedestral head lamp 12V: 2569001 Bulb 12V: 2569001B Bulb 24V: 4469001	 Multi-LED Back-up Light: 3111000007 Strobe light: 3111000013 Grommet: 3111000008 Plug: 3119000009	 Horn button 3109250001
	 Headlight Left: 3111480003 Right: 3111480004 Bulb H/L: 3111480006 Bulb Turn: 3111480008 Bulb Mark: 3111480007	 Red Tail/Brake light 12V: 386002	 Limit switch 3109000029  Horn 12V: 246003 24V: 246013

 Analog Voltmeter 12V : 3069007 24V : 2469002 36-48V : 3669002	 Wiper motor 12V: 3113000001 24V: 486211	 Pantograph wiper blade 246233	 Headlamp 12V:3111250002
 HOBBS Gauge 24V: 2469026 36V: 3069038 48V: 4869037	 Wiper arm 2800000001	 Cab heater 12V: 3103300001 36V: 3669008 48V: 4869020	 Headlamp 12V: 3111300001 Bulb 12V: 3111300002
 DC-DC converter, 10A 12-48V: 3069019	 Wiper blade 14" Blade: 2800000002 18" Blade: 2800000003	 12V Dome light 3669006	 Red Pilot light 12V: 246212 Bulb 12V: 246212B
 DC-DC Converter, 25A 12-48V: 3124000002 72-80V: 3124880001	 Pantograph wiper arm 246233A	 12V Fan 3669013	 Back-up alarm or Motion beeper 12-48V : 3100000001 72-80V : 3105720001 12-24V Adjustable: 3100000002

BATTERY DISCHARGE INDICATOR (HOBBS)

This indicator monitors :

- the residual capacity of batteries;
- operating hours;
- status of service down counter.

The residual capacity of the battery is monitored via an 8-LED bar display. When the left red LED lights, the batteries must be charged to avoid damage. The LED display starts flashing as a pre-warning signal. The lower voltage limit is adjustable via potentiometer “M” on the rear.

A	B	C	D	E	F	G	H	I	J	K
1,57	1,63	1,68	1,73	1,78	1,82	1,84	1,86	1,89	1,91	1,93

In order to activate a new adjustment, the unit has to be reset :

- 2.35V/cell reset voltage with battery remaining in vehicle;
- 2,09V/cell reset voltage after battery has been disconnected.

To maintain a good battery performance, it is recommended to limit the discharging to 80% of the battery capacity. The recommended setting for 6V batteries is F and the recommended setting for an industrial battery is K.

An internal relay can prevent overdischarging and damaging the batteries. The relay can be wired to cut off the reverse direction, or energize an N.C. relay and alarm.

Turning off and on the vehicle will override the protection for 30 sec.

The current status (remaining operating hours before maintenance) of the service down counter is indicated for a period of 5 seconds after the key switch is turned on. When it is down to 0, the display flashes. After the maintenance, reset the counter: depress the button “R” on the rear. The service counter is factory programmable only.

24V UNIT #: 2469026

36V UNIT #: 3069038

48V UNIT #: 4869037

2- Orange, key switch

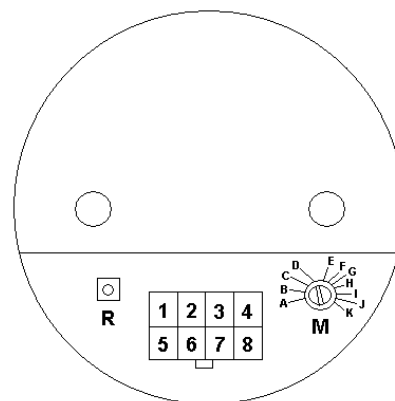
3- Relay +

4- Relay -

5- Black, battery –

6- Blue, hour counter

8- White, battery +



ADDENDUM

CURTIS FOOT PEDAL

