E-GATOR®
UTILITY VEHICLE

TECHNICAL MANUAL

John Deere
Worldwide Commercial and
Consumer Equipment Division

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M99964

E-GATOR® UTILITY VEHICLE

This technical manual is written for an experienced technician and contains sections that are specifically for this product. It is a part of a total product support program.

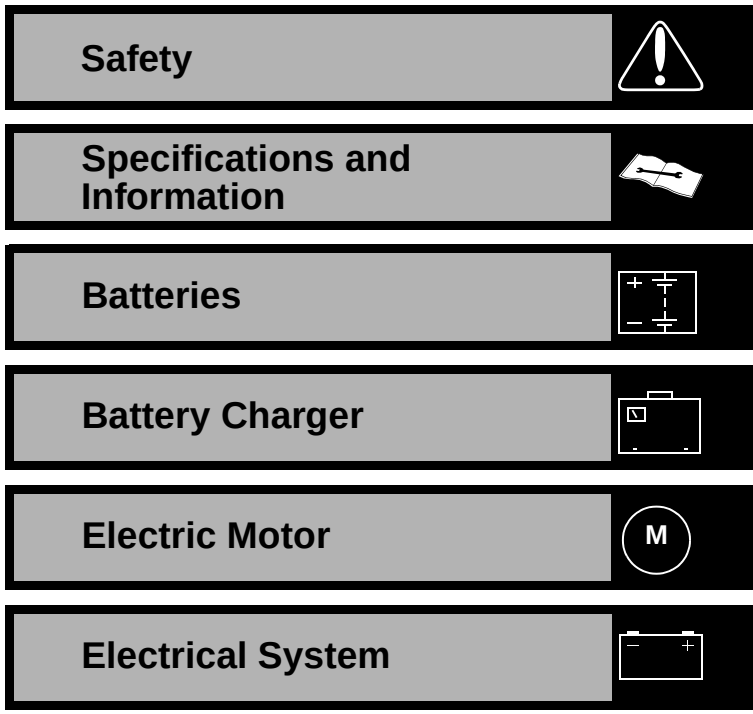
The manual is organized so that all the information on a particular system is kept together. The order of grouping is as follows:

- Table of Contents
- Specifications
- Component Location
- System Schematic
- Theory of Operation
- Troubleshooting Chart
- Diagnostics
- Tests & Adjustments
- Repair

Note: Depending on the particular section or system being covered, not all of the above groups may be used.

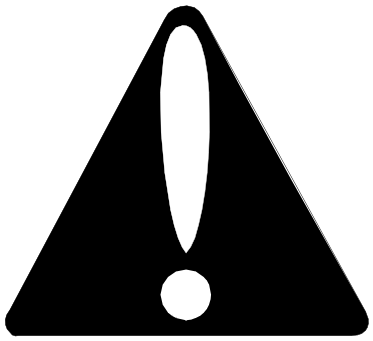
Each section will be identified with a symbol rather than a number. The groups and pages within a section will be consecutively numbered.

We appreciate your input on this manual. To help, there are postage paid post cards included at the back. If you find any errors or want to comment on the layout of the manual please fill out one of the cards and mail it back to us.



All information, illustrations and specifications in this manual are based on the latest information available at the time of publication. The right is reserved to make changes at any time without notice.

RECOGNIZE SAFETY INFORMATION



This is the safety-alert symbol. When you see this symbol on your machine or in this manual, be alert to the potential for personal injury.

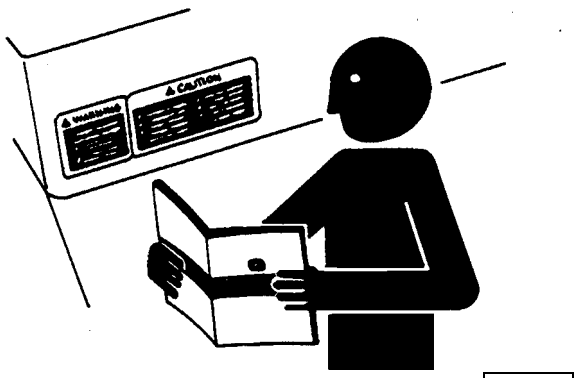
Follow recommended precautions and safe servicing practices.

Understand Signal Words

A signal word—DANGER, WARNING, or CAUTION—is used with the safety-alert symbol. DANGER identifies the most serious hazards.

DANGER or WARNING safety signs are located near specific hazards. General precautions are listed on CAUTION safety signs. CAUTION also calls attention to safety messages in this manual.

REPLACE SAFETY SIGNS



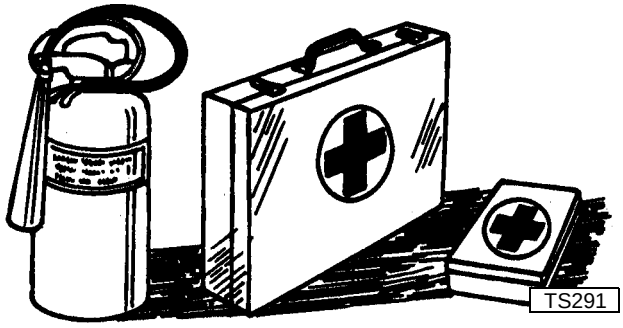
TS201

Replace missing or damaged safety signs. See the machine operator's manual for correct safety sign placement.

HANDLE FLUIDS SAFELY-AVOID FIRES

Be Prepared For Emergencies

TS227



TS291

When you work around batteries, do not smoke or work near heaters, sparks or other fire hazards.

Charge batteries in a well ventilated area.

Store flammable fluids away from fire hazards. Do not incinerate or puncture pressurized containers.

Make sure machine is clean of trash, grease, and debris.

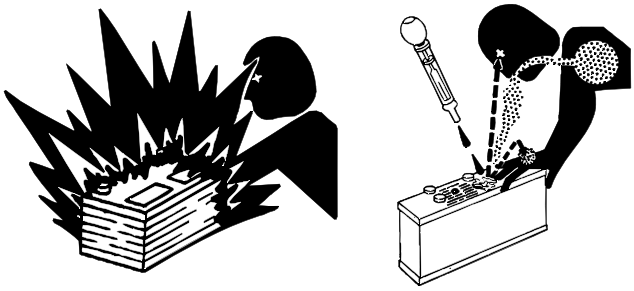
Do not store oily rags; they can ignite and burn spontaneously.

Be prepared if a fire starts.

Keep a first aid kit and fire extinguisher handy.

Keep emergency numbers for doctors, ambulance service, hospital, and fire department near your telephone.

USE CARE IN HANDLING AND SERVICING BATTERIES



Prevent Battery Explosions

Batteries contain sulfuric acid and produce explosive mixtures of hydrogen and oxygen. Because self-discharge action generates hydrogen gas even when the battery is not in operation, make sure batteries are stored and serviced in a well ventilated area.

- Always wear proper eye, face and hand protection.
- Keep sparks, lighted matches, and open flame away from the top of battery.
- Remove all jewelry (watches, rings, bracelets, etc.) before servicing the electrical system or batteries.
- Make sure work area is well ventilated.
- Never lean over battery while testing or charging.
- Keep removable vents tight and level except when servicing electrolyte.
- Exercise caution while working with metallic tools or conductors to prevent short circuits and sparks.
- Never check battery charge by placing a metal object across the posts. Use a battery tester, voltmeter or hydrometer.
- Do not charge a frozen battery; it may explode. Warm battery to 16°C (60°F).

Safe Charging

- Never attempt to charge a battery without first reviewing the instructions for the charger being used.
- Use only the battery charger provided with the utility vehicle. DO NOT use substitutes.
- Always wear proper eye, face and hand protection.
- Keep sparks, lighted matches, and open flame away from the top of battery.
- Make sure work area is well ventilated.
- Never lean over battery while testing or charging.
- Keep removable vents tight and level except when servicing electrolyte.
- To avoid dangerous sparks, Do not disconnect the DC output cord from the battery receptacle when the charger is on. Disconnect the AC power supply cord to turn the charger off before disconnecting the DC output plug.
- Never try to charge a visibly damaged or frozen battery.
- Be sure that the key switch and all electrical accessories are turned off.
- Make sure that the charger leads are not broken, frayed or loose.
- If the battery becomes hot, or if violent gassing or spewing of electrolyte occurs, unplug the charger AC source first before removing the DC plug
- If battery set is on charge, unplug the charger AC plug before disconnecting the charger DC cable plug to avoid dangerous sparks.

Prevent Acid Burns

Sulfuric acid in battery electrolyte is poisonous. It is strong enough to burn skin, eat holes in clothing, and cause blindness if splashed into eyes.

Use extreme caution when handling electrolyte and keep an acid neutralizing solution - such as baking soda or household ammonia mixed with water - readily available.

- **Avoid acid burns by:**
  1. Filling batteries in a well-ventilated area.
  2. Wearing eye and face protection a rubber apron and rubber gloves.
  3. Avoiding breathing fumes when electrolyte is added.
  4. Avoiding spilling or dripping electrolyte.

- **If you spill acid on yourself:**
  1. Flush area of body that has been exposed with clean water for at least 20 minutes.
  2. Remove contaminated clothing.
  3. Flush your eyes with clean, cool water for at least 20 minutes.
  4. Get medical attention immediately.

- **If acid is swallowed:**
  1. Drink large amounts of water or milk. Do not induce vomiting.
  2. Then drink milk of magnesia, beaten eggs, or vegetable oil.
  3. Get medical attention immediately.

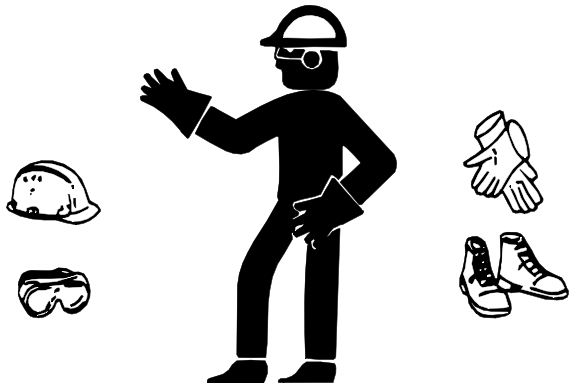
USE SAFE SERVICE PROCEDURES

Wear Protective Clothing

Wear close fitting clothing and safety equipment appropriate to the job.

Prolonged exposure to loud noise can cause impairment or loss of hearing. Wear a suitable hearing protective device such as earmuffs or earplugs to protect against objectionable or uncomfortable loud noises.

Operating equipment safely requires the full attention of the operator. Do not wear radio or music headphones while operating machine.



Service Machines Safely

Tie long hair behind your head. Do not wear a necktie, scarf, loose clothing, or necklace when you work near machine tools or moving parts. If these items were to get caught, severe injury could result.

Remove rings and other jewelry to prevent electrical shorts and entanglement in moving parts.

Use Caution When Servicing Electrical System

Always use extreme caution when servicing this utility vehicle. This utility vehicle is equipped with a 48 volt electrical system capable of passing a high voltage electrical current.

Only persons trained in electrical maintenance should repair or service this utility vehicle.

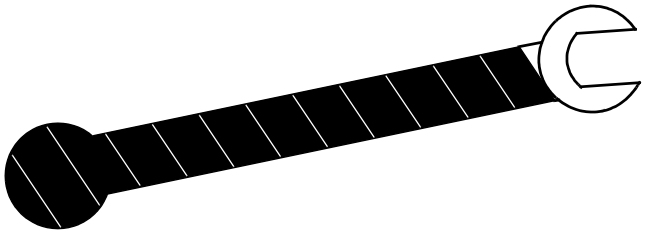
Always move the service/drive switch to the SERVICE position before servicing any part of the electrical system.

Always refer to the battery position/connection diagram when making battery connections to avoid battery explosion. Disconnect the battery set positive (B+) cable before servicing the electrical system.

Use Proper Tools

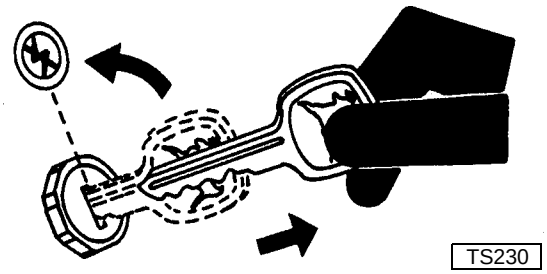
Use tools appropriate to the work.

Use extreme caution when using tools, wires, or metal objects near batteries! A short circuit and/or spark could cause an electrical shock or an explosion. Wrap tools with vinyl tape to prevent shorting out battery(s).



Makeshift tools and procedures can create safety hazards. Use power tools only to loosen threaded parts and fasteners. For loosening and tightening hardware, use the correct size tools. **DO NOT** use U.S. measurement tools on metric fasteners. Avoid bodily injury caused by slipping wrenches. Use only service parts meeting John Deere specifications.

Park Machine Safely

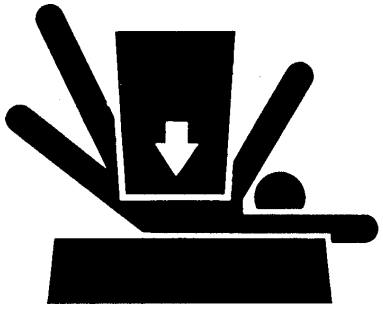


Before working on the machine:

1. Turn key switch to the OFF position and remove the key.
2. Move directional control lever to the NEUTRAL position.
3. Engage the park brake.
4. Raise and tilt operator seat forward. Move the service/drive switch to the SERVICE position.
5. Hang a “DO NOT OPERATE” tag in operator station.

Support Machine Properly And Use Proper Lifting Equipment

TS229



If you must work on a lifted machine or attachment, securely support the machine or attachment.

Do not support the machine on cinder blocks, hollow tiles, or props that may crumble under continuous load. Do not work under a machine that is supported solely by a jack. Follow recommended procedures in this manual.

Lifting heavy components incorrectly can cause severe injury or machine damage. Follow recommended procedure for removal and installation of components in the manual.

Work In Clean Area

Before starting a job:

1. Clean work area and machine.
2. Make sure you have all necessary tools to do your job.
3. Have the right parts on hand.
4. Read all instructions thoroughly; do not attempt shortcuts.

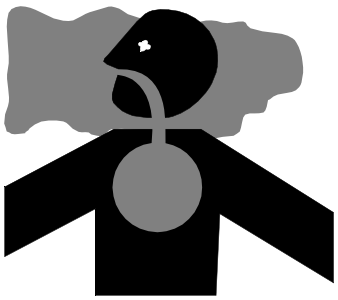
Using High Pressure Washers

Directing pressurized water at electronic/electrical components or connectors, bearings, or other sensitive parts and components may cause product malfunctions. Reduce pressure and spray at a 45 to 90 degree angle.

Illuminate Work Area Safely

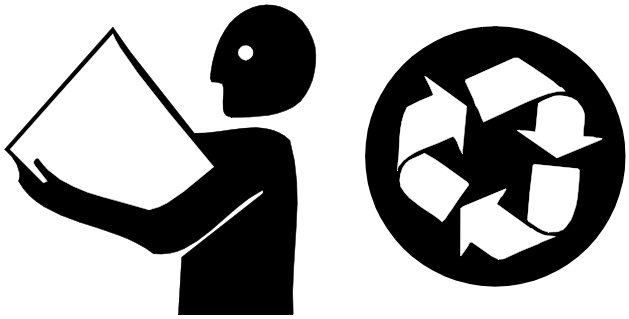
Illuminate your work area adequately but safely. Use a portable safety light for working inside or under the machine. Make sure the bulb is enclosed by a wire cage. The hot filament of an accidentally broken bulb can ignite hydrogen gases or spilled fuel or oil.

Work In Ventilated Area



Battery fumes can cause sickness or death. Make sure the work area is well ventilated if it is necessary to charge the batteries in an enclosed area.

HANDLE CHEMICAL PRODUCTS SAFELY



Direct exposure to hazardous chemicals can cause serious injury. Potentially hazardous chemicals used with John Deere equipment include such items as lubricants, coolants, paints, and adhesives.

A Material Safety Data Sheet (MSDS) provides specific details on chemical products: physical and health hazards, safety procedures, and emergency response techniques. Check the MSDS before you start any job using a hazardous chemical. That way you will know exactly what the risks are and how to do the job safely. Then follow procedures and recommended equipment.

Dispose of Waste Properly

Improperly disposing of waste can threaten the environment and ecology. Potentially harmful waste used with John Deere equipment include such items as oil, greases and batteries. Use leakproof containers when draining fluids.

- Waste products such as batteries, can harm the environment and people.
- Do not use food or beverage containers that may mislead someone into drinking from them.
- Do not pour waste onto the ground, down a drain, or into any water source. Inquire on the proper way to recycle or dispose of waste from your local environmental or recycling center, or from your John Deere dealer.
- A Material Safety Data Sheet (MSDS) provides specific details on chemical products: physical and health hazards, safety procedures, and emergency response techniques. The seller of the chemical products used with your vehicle is responsible for providing the MSDS for that product.

LIVE WITH SAFETY

Before returning machine to customer, make sure machine is functioning properly, especially the safety systems. Install all guards and shields.

CONTENTS

GENERAL VEHICLE SPECIFICATIONS

BATTERIES:

Type. . . . . .Trojan T-105
Voltage (Each Battery) . . . . . 6 VDC
Total Voltage (8 Batteries) . . . . . 48 VDC
Rating
Minutes @ 56 amps 165
Approximate weight. . . . . 28.1 kg (62 lbs)

Optional Type . . . . . .Trojan T-145
Voltage (Each Battery) . . . . . 6 VDC
Total Voltage (8 Batteries) . . . . . 48 VDC
Rating
Minutes @ 56 amps 200
Approximate weight. . . . . 32.2 kg (71 lbs)

MOTOR:

Type. . . . . Separately Excited D.C. Motor
Voltage . . . . . 48 VDC
Insulation Class. . . . . .H 180^{o}C

CONTROLLER:

Type. . . . . Separately Excited Solid State
Nominal Input Voltage . . . . . .36-48 VDC
Electrical Isolation to Heatsink (minimum) . . . . . 500 VAC
Armature Current Limit . . . . . 400 Amps

TRANSAXLE

Nominal Travel Speed-Forward . . . . . .25 km/h (15.5 mph)
Nominal Travel Speed-Reverse. . . . . .14.5 km/h (9 mph)
Transaxle Capacity . . . . . 0.4 L (15 oz)

STEERING and BRAKES

Steering—Type . . . . . Rack and Pinion Ackerman-type
Brake—Type . . . . . .Dual Rear Wheel Mechanical Drum, Auto Adjusting
Suspension
Front . . . . . Independent, Spring Over Shock Single A-Arm Design
Rear. . . . . Fixed Position Axle
Park Brake. . . . . .Three Position, Hand Operated

DIMENSIONS

Overall Length. . . . . 266.5 cm (104.9 in.)
Overall Width. . . . . 152.5 cm (60 in.)
Overall Height . . . . . 113 cm (44.5 in.)
Front tread centers . . . . . 127 cm (50 in.)
Rear tread centers . . . . . 122 cm (48 in.)
Wheelbase . . . . . 194.0 cm (76.4 in.)
Vehicle Weight w/T-105 Batteries . . . . . 634 kg (1395 lb)

GROUND CLEARANCE

Under transaxle . . . . . 196 mm (7.7 in.)
Under foot platform . . . . . 215 mm (8.5 in.)
Turning clearance circle . . . . . 6.7 m (22 ft)

CAPACITY

Seating . . . . . 2 persons
Seat type . . . . . Professional high back
Payload (total)[2] . . . . . 408 kg (900 lb)
Towing . . . . . 272 kg (600 lb)
Cargo Box - Volume . . . . . 0.32 m^3 (11.2 cu ft)
Cargo Box - Weight . . . . . 227 kg (500 lb)

2. Includes 200lb. operator, 200 lb. passenger and maximum box capacity.

TIRES

Size-Front . . . . . 22.5 x 10.00 - 8 2PR Hi-Flotation
Size-Rear . . . . . 25 x 12.00 - 9 2PR Hi-Flotation

ELECTRICAL

Headlights . . . . . Two 48 VDC 27 watt Incandescent (marked SP8)

Charger - N.A.:

Type . . . . . Ferro-Resonant Automatic Taper Charge
Input Voltage . . . . . 120 VAC 60 hz
Input Amperage . . . . . 12 Amps (15 amp breaker max.)
Power Factor 0.87
Output Voltage . . . . . 48 VDC Nominal
Output Amperage . . . . . 21 Amps DC Nominal
AC Power Cord
  Plug . . . . . 125 V 15 amp (NEMA Spec 5-15p)
  Length . . . . . 2.4 m (94 in.)
DC Power Cord
  Length . . . . . 2.8 m (110 in.)

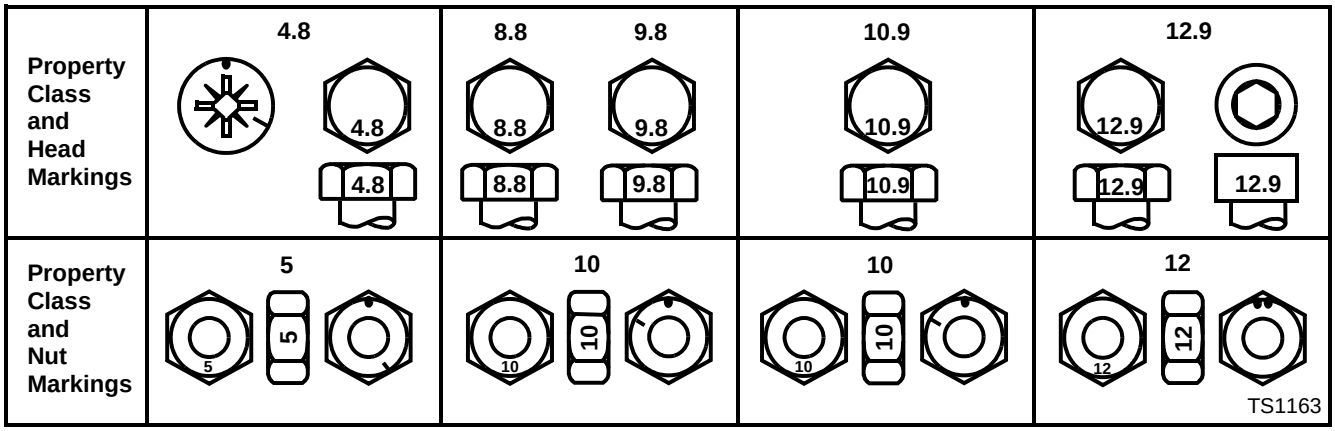
Charger - Export:

Type . . . . . Ferro-Resonant Automatic Taper Charge
Input Voltage . . . . . 230 VAC 50 hz
Input Amperage . . . . . 5.7 Amps (15 amp breaker max.)
Power Factor 0.95
Output Voltage . . . . . 48 VDC Nominal
Output Amperage . . . . . 22 Amps DC Nominal
AC Power Cord (User Supplied)
  Length (Maximum) . . . . . 4 m (13 ft)
DC Power Cord
  Length . . . . . 2.8 m (110 in.)

RECOMMENDED LUBRICANT

Grease
John Deere NON-CLAY HIGH TEMPERATURE EP GREASE®–JDM J13E4, NLGI Grade 2

METRIC FASTENER TORQUE VALUES



	Class 4.8				Class 8.8 or 9.8				Class 10.9				Class 12.9			
	Lubricated[a]		Dry[a]		Lubricated[a]		Dry[a]		Lubricated[a]		Dry[a]		Lubricated[a]		Dry[a]	
SIZE	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft
M6	4.8	3.5	6	4.5	9	6.5	11	8.5	13	9.5	17	12	15	11.5	19	14.5
M8	12	8.5	15	11	22	16	28	20	32	24	40	30	37	28	47	35
M10	23	17	29	21	43	32	55	40	63	47	80	60	75	55	95	70
M12	40	29	50	37	75	55	95	70	110	80	140	105	130	95	165	120
M14	63	47	80	60	120	88	150	110	175	130	225	165	205	150	260	109
M16	100	73	125	92	190	140	240	175	275	200	350	225	320	240	400	300
M18	135	100	175	125	260	195	330	250	375	275	475	350	440	325	560	410
M20	190	140	240	180	375	275	475	350	530	400	675	500	625	460	800	580
M22	260	190	330	250	510	375	650	475	725	540	925	675	850	625	1075	800
M24	330	250	425	310	650	475	825	600	925	675	1150	850	1075	800	1350	1000
M27	490	360	625	450	950	700	1200	875	1350	1000	1700	1250	1600	1150	2000	1500
M30	675	490	850	625	1300	950	1650	1200	1850	1350	2300	1700	2150	1600	2700	2000
M33	900	675	1150	850	1750	1300	2200	1650	2500	1850	3150	2350	2900	2150	3700	2750
M36	1150	850	1450	1075	2250	1650	2850	2100	3200	2350	4050	3000	3750	2750	4750	3500

DO NOT use these hand torque values if a different torque value or tightening procedure is given for a specific application. Torque values listed are for general use only and include a ±10% variance factor. Check tightness of fasteners periodically. DO NOT use air powered wrenches.

Shear bolts are designed to fail under predetermined loads. Always replace shear bolts with identical grade.

Fasteners should be replaced with the same class. Make sure fastener threads are clean and that you properly start thread engagement. This will prevent them from failing when tightening.

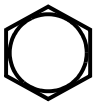
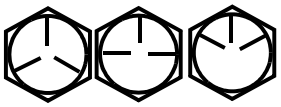
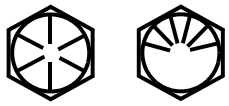
When bolt and nut combination fasteners are used, torque values should be applied to the **NUT** instead of the bolt head.

Tighten toothed or serrated-type lock nuts to the full torque value.

[a] *"Lubricated" means coated with a lubricant such as engine oil, or fasteners with phosphate and oil coatings. "Dry" means plain or zinc plated (yellow dichromate - Specification JDS117) without any lubrication.*

Reference: JDS—G200.

INCH FASTENER TORQUE VALUES

SAE Grade and Head Markings	**No Marks**  **1 or 2[b]**	 **5 5.1 5.2**	 **8 8.2**
SAE Grade and Nut Markings	**No Marks**  **2**	 **5**	 **8**

TS1162

	Grade 1				Grade 2[b]				Grade 5, 5.1 or 5.2				Grade 8 or 8.2			
	Lubricated[a]		Dry[a]		Lubricated[a]		Dry[a]		Lubricated[a]		Dry[a]		Lubricated[a]		Dry[a]	
SIZE	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft
1/4	3.7	2.8	4.7	3.5	6	4.5	7.5	5.5	9.5	7	12	9	13.5	10	17	12.5
5/16	7.7	5.5	10	7	12	9	15	11	20	15	25	18	28	21	35	26
3/8	14	10	17	13	22	16	27	20	35	26	44	33	50	36	63	46
7/16	22	16	28	20	35	26	44	32	55	41	70	52	80	58	100	75
1/2	33	25	42	31	53	39	67	50	85	63	110	80	120	90	150	115
9/16	48	36	60	45	75	56	95	70	125	90	155	115	175	130	225	160
5/8	67	50	85	62	105	78	135	100	170	125	215	160	215	160	300	225
3/4	120	87	150	110	190	140	240	175	300	225	375	280	425	310	550	400
7/8	190	140	240	175	190	140	240	175	490	360	625	450	700	500	875	650
1	290	210	360	270	290	210	360	270	725	540	925	675	1050	750	1300	975
1-1/8	470	300	510	375	470	300	510	375	900	675	1150	850	1450	1075	1850	1350
1-1/4	570	425	725	530	570	425	725	530	1300	950	1650	1200	2050	1500	2600	1950
1-3/8	750	550	950	700	750	550	950	700	1700	1250	2150	1550	2700	2000	3400	2550
1-1/2	1000	725	1250	925	990	725	1250	930	2250	1650	2850	2100	3600	2650	4550	3350

DO NOT use these hand torque values if a different torque value or tightening procedure is given for a specific application. Torque values listed are for general use only and include a ±10% variance factor. Check tightness of fasteners periodically. DO NOT use air powered wrenches.

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When bolt and nut combination fasteners are used, torque values should be applied to the **NUT** instead of the bolt head.

Tighten toothed or serrated-type lock nuts to the full torque value.

a *"Lubricated" means coated with a lubricant such as engine oil, or fasteners with phosphate and oil coatings. "Dry" means plain or zinc plated (yellow dichromate - Specification JDS117) without any lubrication.*

b *"Grade 2" applies for hex cap screws (not hex bolts) up to 152 mm (6-in.) long. "Grade 1" applies for hex cap screws over 152 mm (6-in.) long, and for all other types of bolts and screws of any length.*

Reference: JDS—G200.

TRANSAXLE OIL-NORTH AMERICA

IMPORTANT: DO NOT use engine oil or "Type F" (Red) Automatic Transmission Fluid in this transaxle. DO NOT mix any other oils in this transaxle. DO NOT use BIO-HY-GARD® in this transaxle.

Use recommended oil viscosity based on the expected air temperature range during the service interval.

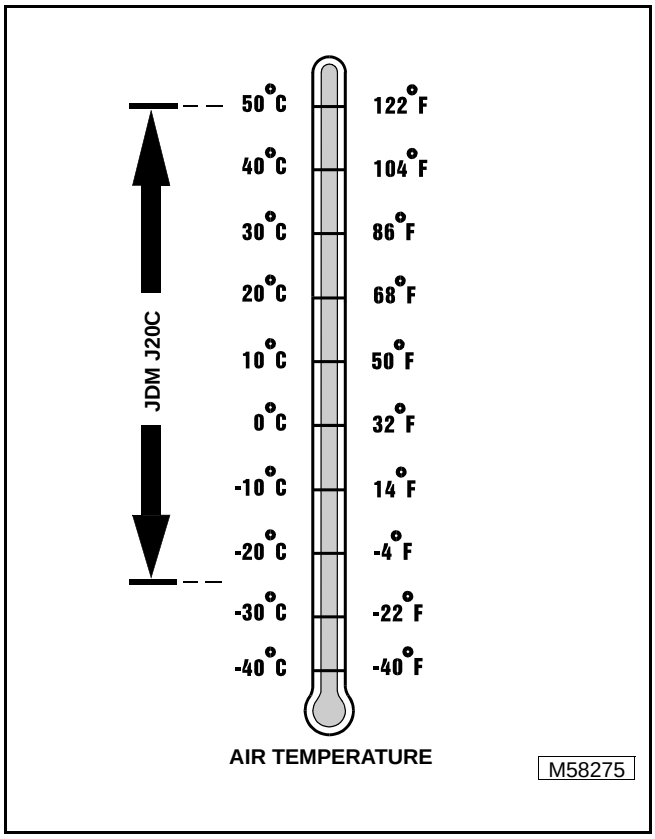
The following John Deere transmission and hydraulic oil is **preferred**:

- **HY-GARD®—JDM J20C.**

Other oils may be used if above recommended John Deere oil is not available, provided the meet the following specification:

- **John Deere Standard JDM J20C.**

IMPORTANT: If minimum air temperature should fall below -25°C (-13°F), the transaxle oil must be heated to at least five degrees above the lower limit before start-up or transaxle may be damaged. For prolonged operation under heavy load in air temperatures above 50°C (122°F) reduce service interval by 50%.



John Deere Dealers: You may want to cross-reference the following publications to recommend the proper grease for your customers:

- Module DX,GREA1 in JDS–G135;
- Section 530, Lubricants & Hydraulics, of the John Deere Merchandise Sales Guide;
- Lubrication Sales Manual PI7032.

NOTE: Disregard the John Deere All Weather Hydrostatic Fluid (JDM J21A) listing - it has been eliminated from the specification.

ANTI-CORROSION GREASE

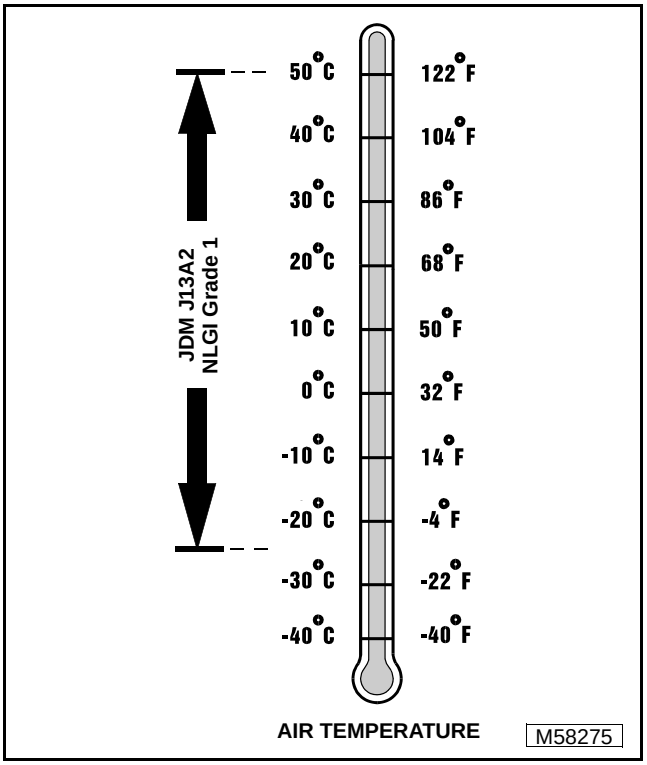
This anti-corrosion grease is formulated to provide the best protection against absorbing moisture, which is one of the major causes of corrosion. This grease is also superior in its resistance to separation and migration.

The following anti-corrosion grease is **PREFERRED**:

- **DuBois MPG-2® Multi-Purpose Polymer Grease—M79292.**

Other greases may be used if they meet or exceed the following specifications:

- John Deere Standard JDM J13A2, NLGI Grade 1.



John Deere Dealers: You may want to cross-reference the following publications to recommend the proper grease for your customers:

- Module DX,GREA1 in JDS–G135;
- Section 530, Lubricants & Hydraulics, of the John Deere Merchandise Sales Guide;
- Lubrication Sales Manual PI7032.

ALTERNATIVE LUBRICANTS

Conditions in certain geographical areas outside the United States and Canada may require different lubricant recommendations than the ones printed in this technical manual or the operator's manual. Consult with your John Deere Dealer, or Sales Branch, to obtain the alternative lubricant recommendations.

IMPORTANT: Use of alternative lubricants could cause reduced life of the component.

If alternative lubricants are to be used, it is recommended that the factory fill be thoroughly removed before switching to any alternative lubricant.

LUBRICANT STORAGE

All machines operate at top efficiency only when clean lubricants are used. Use clean storage containers to handle all lubricants. Store them in an area protected from dust, moisture, and other contamination. Store drums on their sides. Make sure all containers are properly marked as to their contents. Dispose of all old, used containers and their contents properly.

MIXING OF LUBRICANTS

In general, avoid mixing different brands or types of lubricants. Manufacturers blend additives in their lubricants to meet certain specifications and performance requirements. Mixing different lubricants can interfere with the proper functioning of these additives and lubricant properties which will downgrade their intended specified performance.

CHASSIS GREASE—NORTH AMERICA

Use the following grease based on the air temperature range. Operating outside of the recommended grease air temperature range may cause premature failures.

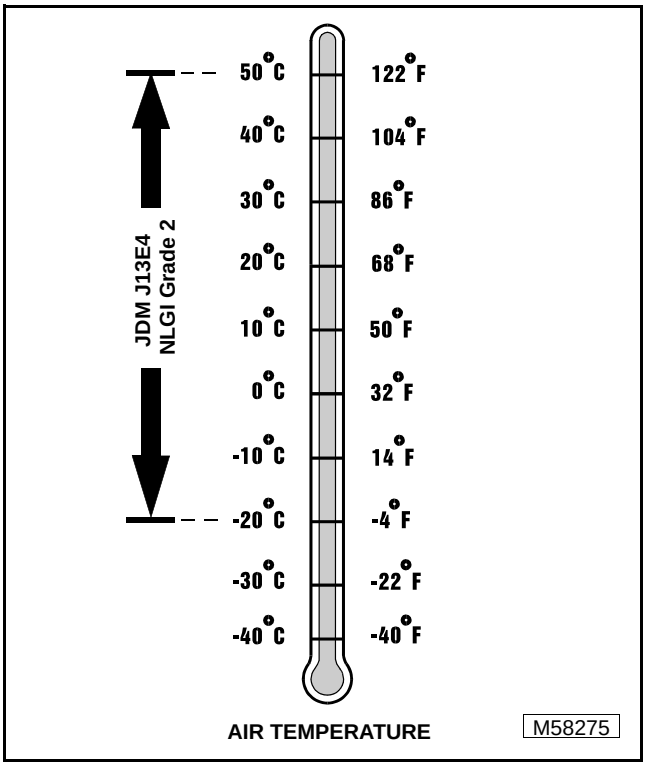
IMPORTANT: ONLY use a quality grease in this application. DO NOT mix any other greases in this application. DO NOT use any BIO–GREASE in this application.

The following John Deere grease is **PREFERRED**:

- **NON-CLAY HIGH-TEMPERATURE EP GREASE®—JDM J13E4, NLGI Grade 2.**

Other greases may be used if above preferred John Deere grease is not available, provided they meet the following specification:

- John Deere Standard JDM J13E4, NLGI Grade 2.



John Deere Dealers: You may want to cross-reference the following publications to recommend the proper grease for your customers:

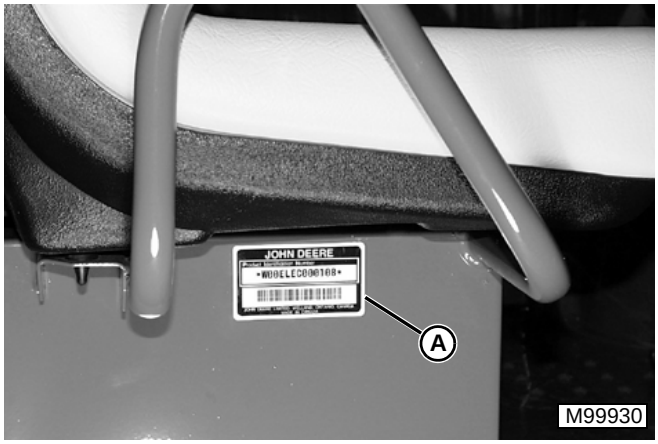
- Module DX,GREA1 in JDS–G135;
- Section 530, Lubricants & Hydraulics, of the John Deere Merchandise Sales Guide;
- Lubrication Sales Manual P17032.

PRODUCT IDENTIFICATION LOCATIONS

When ordering parts or submitting a warranty claim, it is IMPORTANT that you include the product identification number and the component product identification numbers.

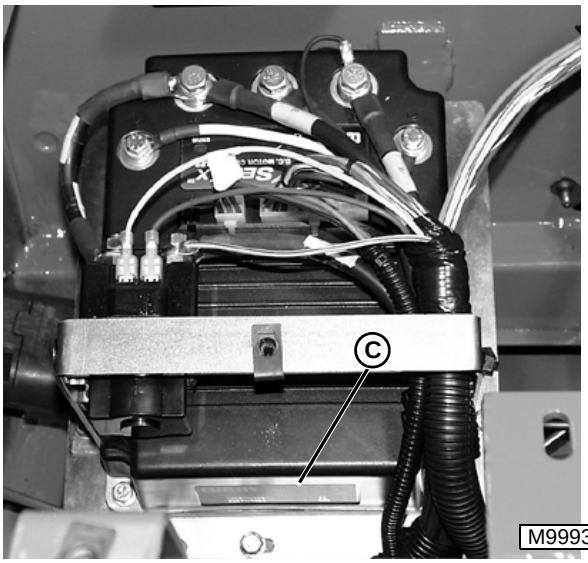
The location of identification numbers and component product identification numbers are shown.

E GATOR® UTILITY VEHICLE IDENTIFICATION NUMBER



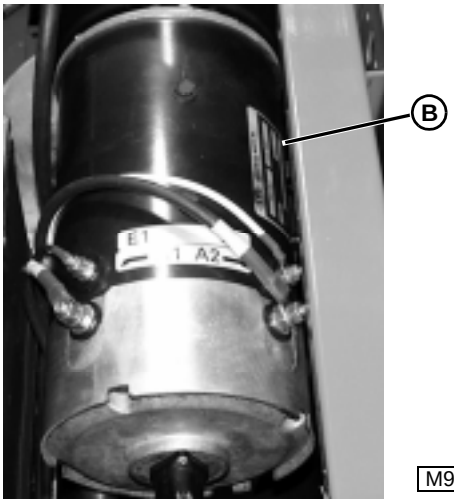
Vehicle identification number plate (A) is located on the frame under the passenger seat.

MOTOR CONTROLLER IDENTIFICATION NUMBER



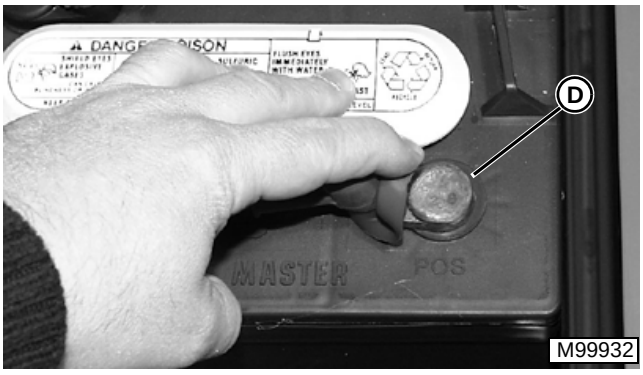
The motor controller serial number (C) is located on a label located on the lower surface of the controller.

ELECTRIC MOTOR IDENTIFICATION NUMBER



The electric motor serial number sticker (B) is located on the motor at the rear of the vehicle.

BATTERY IDENTIFICATION DATE CODE



The battery date codes (D) are stamped into the top surface of both the positive and negative terminal of each battery.

BATTERY CHARGER IDENTIFICATION NUMBER

The battery charger serial number (E) is located on the front control panel of the charger.

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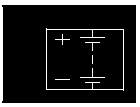


SPECIFICATIONS

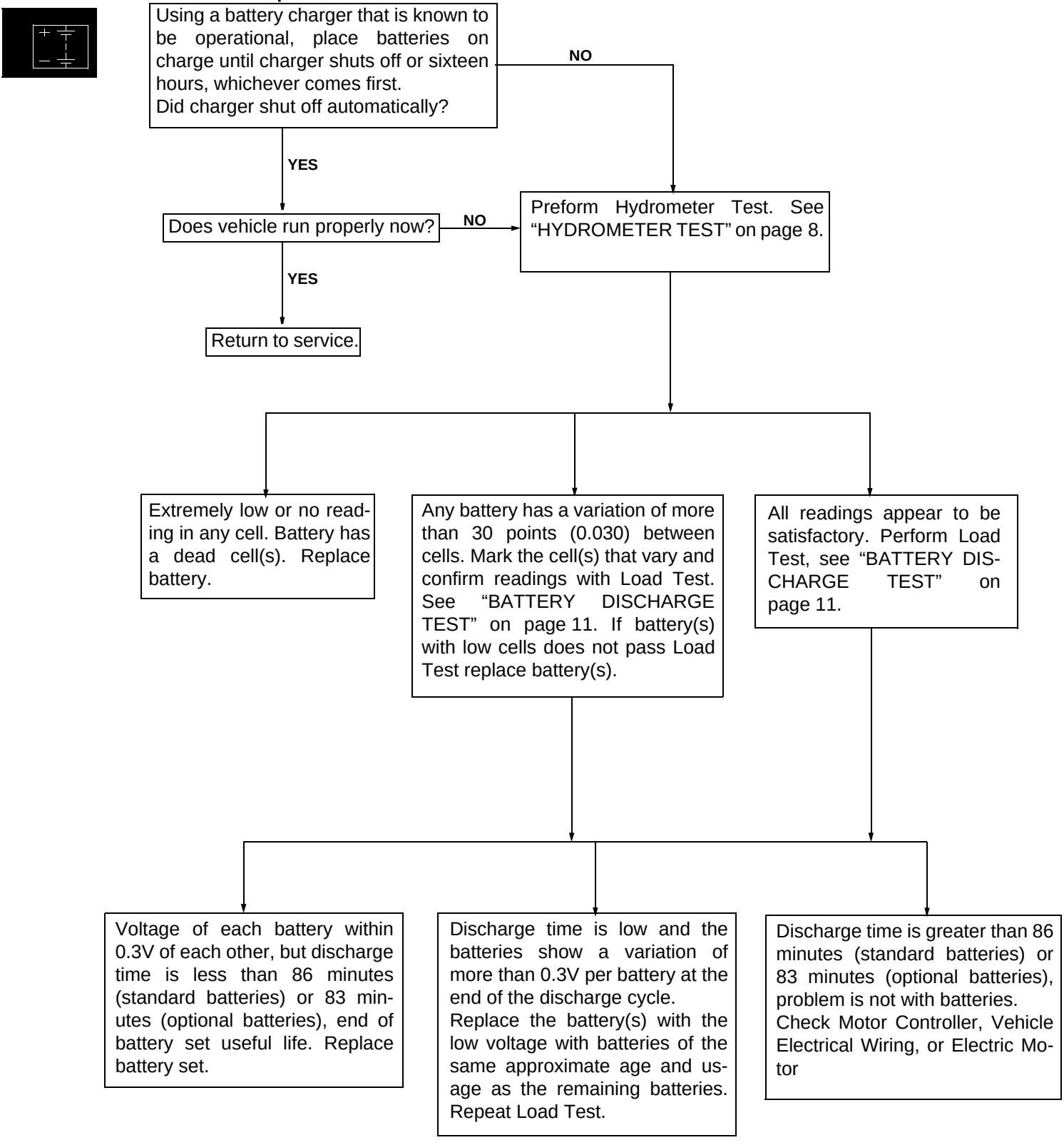
BATTERY SPECIFICATIONS

Type	Trojan T-105
Voltage (Each Battery)	6 VDC
Total Voltage (8 Batteries)	48 VDC
Rating	
Minutes @ 56 amps	165
Approximate weight	28.1 kg (62 lbs)
Optional Type	Trojan T-145
Voltage (Each Battery)	6 VDC
Total Voltage (8 Batteries)	48 VDC
Rating	
Minutes @ 56 amps	200
Approximate weight	32.2 kg (71 lbs)

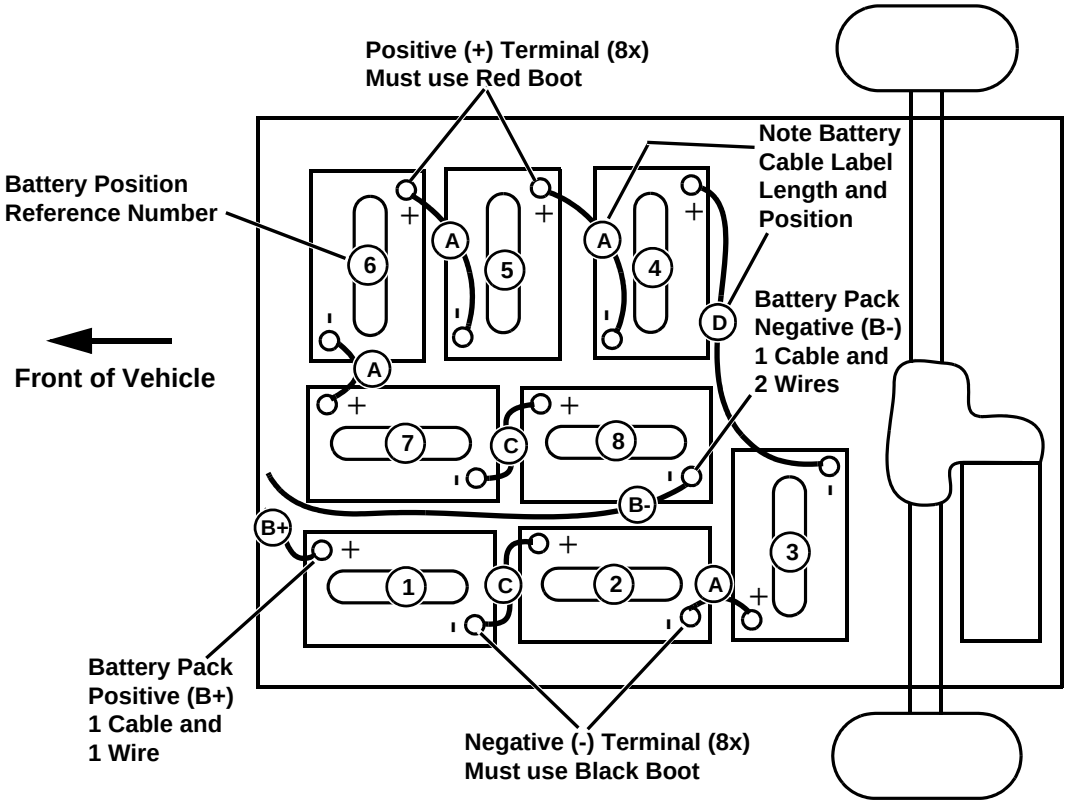
TORQUE SPECIFICATIONS

Battery Hold Downs	7 - 9 N•m (62 - 80 lb-in.)
Battery Post Connectors	14 - 16 N•m (124 - 142 lb-in.)
Battery Support Tray	95 N•m (70 lb-ft)

TROUBLESHOOTING BATTERIES

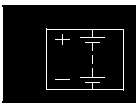


BATTERY POSITION/CONNECTION DIAGRAM



BATTERY THEORY AND OPERATION

DEEP CYCLE BATTERIES



DESCRIPTION:

A cycling battery has a service requirement which is quite different from that of an automotive battery. The automotive battery must deliver high cranking currents at a satisfactory voltage for a few seconds and a portion of the accessory load (10-25 amperes) for a minute or two at a time in city or heavy traffic. Therefore, the automotive battery is designed with maximum plate area and low internal resistance to provide high cranking performance. Power taken from this battery is immediately replaced by the alternator or generator. Therefore, the battery is subjected to shallow discharge cycles (2-3% of the battery capacity). These batteries operate in the 90-100% state of charge.

Cycling batteries supply all the motive power and power for the accessories for the vehicles in which they are used. The rate of discharge varies with the type of service. In electric vehicle service, the battery normally provides a nominal intermittent discharge of 75 amperes, with a typical range of 40-350 amperes. The depth of discharge varies with the length of time it is used before being recharged. Once the battery is discharged, it must be recharged to continue operating the vehicle since it is not maintained by a vehicle generator or alternator. These batteries usually receive “deep” discharge (60-70% or more of their capacity).

NOTE: New cycling batteries do not have their full capacity until they have been cycled several times (usually between 20 and 50 cycles). Therefore, they can be excessively discharged early in their vehicular life, thereby shortening their service life.

Cycling batteries are designed to have good life performance in “deep” cycle service. The major cause of battery failure in “deep” cycle service is poor maintenance:

- Dirt and corrosion on battery tops or terminals
- Water too much or too little
- Excessive discharge (lack of charging)

A battery is a perishable item that requires periodic maintenance. With a reasonable amount of care, the life of a battery can be significantly extended.

The life of a cycling battery is determined not only by the number of cycles (a discharge and a recharge) it receives, but also by the depth of each cycle. Assume a set of batteries is used 4 hours per day; let’s call that one life cycle. If they are used for 8 hours, this is a much deeper discharge and is equivalent to approximately three life cycles. A battery pack used 8 hours per day has a life span approximately one-third that of one used for 4 hours per day.

ELECTROLYTE AND SPECIFIC GRAVITY

The electrolyte in a lead-acid storage battery is a dilute sulfuric acid solution. A battery with a fully charged specific gravity of **1.250** corrected to **26.7°C (80°F)** contains an electrolyte with approximately 33.9% sulfuric acid by weight or 23.5% by volume. The remainder of the electrolyte is water. Pure (concentrated) sulfuric acid has a specific gravity of **1.835**.

The sulfuric acid in the electrolyte is one of the necessary ingredients for the chemical reactions taking place inside the battery. It supplies the sulfate ions (SO4) which combine with the active material in the plates. It is also the carrier for the electric current as it passes from plate to plate. When the battery terminals are connected to an external load, the sulfate combines with the active materials of the positive and negative plates forming lead sulfate (PbSO4) on both and releasing electrical energy.

Specific gravity is a unit of measurement for determining the sulfuric acid content of the electrolyte. The recommended fully charged specific gravity of most batteries today is in the range of **1.250 – 1.280** corrected to **26.7°C (80°F)**. The charts in this service manual assume a fully charged specific gravity of **1.250** or higher.

On the specific gravity scale, water by definition is **1.000**. Therefore, electrolyte with a specific gravity of **1.250** means it is **1.250** times heavier per unit volume than pure water.

TESTS AND ADJUSTMENTS

BATTERY TEST

Reason:

To check battery(s) and determine battery condition. Always follow safety procedures when testing or charging cycling batteries. If a vehicle is not performing satisfactorily, and it is suspected to be battery related, test the battery set for the cause. By following these procedures and recording the data on a copy of the Battery Test Log, see “BATTERY TEST LOG” on page 13, you will be able to verify if the problem is with the battery set or an individual battery within the set. If the battery set tests satisfactorily, then the problem is with the remaining electrical system.

⚠ CAUTION

Battery - Explosive Gases! DO NOT Smoke. Keep Sparks and flames away.

Risk of Electrical Shock. DO NOT touch unisulated battery terminals, connectors, or wires.

Battery - Poison! Batteries contain ACID which is poisonous and causes severe burns. Avoid contact with skin, eyes, or clothing.

ANTIDOTES:

- **EXTERNAL:**
  Flush with clear water for at least 20 minutes. Call a Physician Immediately.
- **INTERNAL:**
  Drink large quantities of milk or water. Follow with Milk of Magnesia or Vegetable Oil. Call a Physician Immediately.
- **EYES:**
  Force eye open and flush with clear water for at least 20 minutes. Call a Physician Immediately.
- **Neutralize all Acid spills with a solution of 1 part baking soda to 5 parts water.**

⚠ CAUTION

Only trained technicians should repair or service this vehicle. Anyone doing even simple repairs or service should have knowledge and experience in general electrical repair.

Always wear approved eye protection while servicing vehicle. Wear a full face shield, rubber gloves and rubber apron when working with batteries.

Remove all jewelry (Watches, rings, braclets, etc.) when working on the batteries or electrical systems.

Turn key switch off and remove key, place shift lever in neutral position, and place service/drive switch to service position prior to servicing.

Use extreme caution when using tools, wires, or metal objects near batteries! A short circuit and/or spark could cause an explosion. Wrap tools with vinyl tape to prevent shorting out a battery(s).

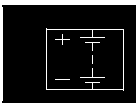
Batteries are heavy. Always use proper lifting techniques when moving them. When lifting batteries, use a commercially available battery lifting device.

Always refer to the battery position diagram when making battery connections. Wrong connections can cause a battery to explode.

HYDROMETER TEST

Purpose:

The state-of-charge of a lead acid battery can be determined by the specific gravity of the electrolyte (its weight compared to water). The specific gravity can be measured directly with a hydrometer.



The lower the float sinks in the electrolyte, the lower its specific gravity and the lower the state of charge.

Temperature Correction

Hydrometer floats are calibrated to give a true reading at one fixed temperature only. A correction factor must be applied for any specific gravity reading made when the electrolyte temperature is not **26.7°C (80°F)**. A temperature correction must be used because the electrolyte will expand and become less dense when heated. The float will sink lower in the less dense solution and give a lower specific gravity reading. The opposite occurs if the electrolyte is cooled. It will shrink in volume, becoming more dense. The float will rise higher and give a false high reading.

A correction factor of **0.004** specific gravity (sometimes referred to as 4 “points of gravity”) is used for each **5.5°C (10°F)** change in temperature. Four “points of gravity” (0.004) are added to the indicated reading each **5.5°C (10°F)** increment above **26.7°C (80°F)** and four points are subtracted for each **5.5°C (10°F)** below. This correction is important at temperature extremes because it can be a substantial value.

The thermometer used should be of the mercury-in-glass type with a scale reading as high as **52°C (125°F)**. The electrolyte should be drawn in and out of the hydrometer barrel a few times to bring the temperature of the hydrometer float and barrel to that of the electrolyte in the cell.

Hydrometer Check

Equipment:

- Hydrometer

Procedure:

1. Park machine safely.
2. Place service/drive switch in service position.
3. Inspect battery terminals, boots and case for breakage, cracks, hot spots or discoloration. Repair as needed.
4. Clean all dirt and moisture from battery top so that none is allowed to get into the battery cell.
5. Carefully remove the battery cap from the battery to be tested.

⚠ CAUTION

DO NOT squeeze the bulb while it is in the electrolyte. This will cause the electrolyte to bubble and spatter possibly causing acid burns.

Use care when squeezing the bulb as there may be electrolyte in the tip that could spray out.

Always wear full face shield, rubber gloves, and rubber apron when working on batteries.

Battery - Poison! Batteries contain ACID which is poisonous and causes severe burns. Avoid contact with skin, eyes, or clothing.

6. Read and note the specific gravity level of each cell by looking across the surface of the electrolyte to the float. The float is calibrated with a scale that ranges from 1.140 to 1.325.

For convenience and accuracy use the “BATTERY TEST LOG” on page 13. Make a copy of the page and record your results. This will also prepare you for additional testing should a problem be indicated by the hydrometer test.

7. Correct the reading for temperature. See “Temperature Correction” on page 8.
8. Repeat this procedure for each cell of each battery.

If the variation between the highest and lowest cell readings in any one battery is **0.030 (30 gravity points)** or more, it probably has a failing cell.

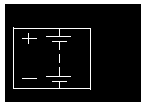
9. Mark the battery(s) and the cell(s) that vary by more than 0.030 points and perform a discharge test.

The following chart illustrates the approximate state of charge based on the specific gravity readings for the battery pack.

Specific Gravity	Percent Charge
1.250 of higher	100%
1.220 - 1.240	75%
1.190 - 1.210	50%
1.160 - 1.180	25%
1.110 - 1.120	Discharged

NOTE: If the cells have been overfilled frequently due to carelessness in adding water, there will be a gradual drop in specific gravity. This could create a 0.030 variation without an internal-mechanical problem. If water has just been added, an additional cycle may be required to mix the electrolyte and ensure a reliable measurement.

The charts on the following page give some examples of possible hydrometer readings. The examples are based on battery sets that are being tested after a full charge.



Example 1

Battery Number	1	2	3	4	5	6	7	8
Uncorrected Hydrometer Reading Before Load Test	1.255	1.250	1.245	1.255	1.250	1.260	1.255	1.250
	1.255	1.255	1.245	1.255	1.250	1.255	1.250	1.250
	1.250	1.250	1.245	1.255	1.255	1.250	1.255	1.250
Cell Temperature	90	90	90	90	90	90	90	90
	90	90	90	90	90	90	90	90
	90	90	90	90	90	90	90	90
Temperature Corrected Hydrometer Reading Before Load Test	1.259	1.254	1.249	1.259	1.254	1.264	1.259	1.254
	1.259	1.259	1.249	1.259	1.254	1.259	1.254	1.254
	1.254	1.254	1.249	1.259	1.259	1.264	1.259	1.254

In example 1 above, the readings indicate a good battery set. Each battery has readings well within 30 points. The battery set is well balanced, and based upon the specific gravity should be at 100% charge. A discharge test will verify the true condition of this batteries.

Example 2

Battery Number	1	2	3	4	5	6	7	8
Uncorrected Hydrometer Reading Before Load Test	1.255	1.250	1.225	1.255	1.250	1.245	1.255	1.250
	1.255	1.255	1.235	1.255	1.250	1.180	1.250	1.250
	1.250	1.250	1.225	1.255	1.255	1.230	1.255	no reading
Cell Temperature	60	60	60	60	60	60	60	60
	60	60	60	60	60	60	60	60
	60	60	60	60	60	60	60	60
Temperature Corrected Hydrometer Reading Before Load Test	1.247	1.242	1.217	1.247	1.242	1.237	1.247	1.242
	1.247	1.247	1.227	1.259	1.242	1.172	1.242	1.242
	1.242	1.242	1.217	1.247	1.247	1.222	1.247	no reading

In example 2 above, the battery set indicates several problems. Battery 1, 2, 4, 5, and 7 appear to be good batteries. Battery 3 does not show signs of having a bad cell but the specific gravity readings are low as compared with the other batteries. This battery may need a few more cycles to equalize with the other batteries. A discharge test will also help determine the condition of this battery. Battery 6 has a variation greater than 30 points. The center cell is 65 points lower than the outer cell. This battery probably has a failing cell. A discharge test should verify the true condition of this battery. Battery 8 has a cell that did not raise the float. This battery has a bad cell. Here again the discharge test will confirm the condition of this battery.

BATTERY DISCHARGE TEST

Reason

This test is designed to simulate the demands imposed on batteries supplying power to electric vehicles.
Fully charged batteries are discharged at the constant rate specified for the type battery being tested to a terminal voltage equivalent to 1.75 volts per cell. Batteries should be tested as indicated above at a rate of **56 amperes**. If the hydrometer check indicates a battery set, or one battery in a set of batteries, is failing, fully charge it and conduct the discharge test. Record the discharge time in minutes for the battery pack to reach 42 volts (5.25 volts per battery for a 6-volt battery). Batteries which deliver less than **86 minutes (83 minutes for optional batteries)** should be replaced.

Equipment:

- JDG1248 Discharger
- JT05791 Voltmeter

Procedure:

1. Park machine on level surface.
2. Turn key switch to OFF position.
3. Move shift lever to NEUTRAL position.
4. Engage park brake.
5. Raise cargo bed and secure.
6. Place service/drive switch in service position.
7. Inspect battery terminals, boots and case for breakage, cracks, hot spots or discoloration. Repair as needed before conducting this test.

⚠ CAUTION

Reduce the risk of fire. DO NOT use discharger near flammable materials or vapors. Batteries generate explosive gasses during operation. Keep sparks and flame away from batteries. NO Smoking.

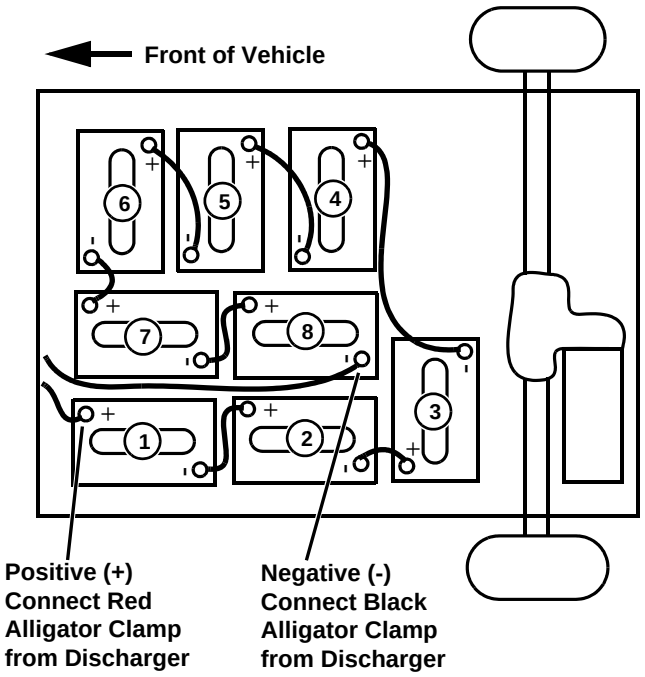
DO NOT touch the back or sides of the case during or just after operation of the discharge unit. A large amount of energy is being dissipated by the unit and the case will be hot.

DO NOT use a discharger other than the one specified by the manufacturer. Using other than specific discharger could result in damage or explosion of batteries.

IMPORTANT:

- **Keep the discharger dry, DO NOT expose to rain, power wash detergents or spray.**
- **Make sure cord, plug, and alligator clamps are in good condition. DO NOT use if cords, plug, or receptacles are damaged, loose, or feel hotter than normal. Replace worn or damaged parts immediately.**
- **To permit free air flow for cooling, allow 45.7 cm (18 in.) minimum between the discharger and any wall or other equipment.**
- **Never disconnect the discharge unit from the batteries while the unit is operating. This will subject the unit to heat stress and may immediately damage or shorten the life of the unit.**

8. Be sure batteries are fully charged and the electrolyte level is correct in all cells.



9. Slide the RED boot on the battery set positive terminal and the black boot on the battery set negative terminal back far enough to expose the terminal.
10. Connect the RED alligator clamp from the discharger, to the POSITIVE terminal of the battery pack.
11. Connect the BLACK alligator clamp from the discharger, to the NEGATIVE terminal of the battery pack.

12. Press the start/stop button. If needed pressing the start/stop button will shut the discharger off during the test cycle.
13. Allow the battery pack to discharge.
14. When the discharger has shut off, note the discharge time.
15. Test the discharged battery load voltage.
16. Press the start/stop button on the discharge unit and wait a few minutes for the discharger to shut OFF. Note the voltage reading on the discharge meter. It should be 42 volts or less.
17. Press the start/stop button again. With the battery set voltage at or below 42 volts, the discharge unit will start and run for 3 minutes. While the discharger is running measure and record the voltage of each battery.

The battery reading should all be within 0.30 volts of each other.

If the discharge time is less than **86 minutes (83 minutes for optional batteries)** and the voltages are within 0.30 volts, the battery pack is at the end of its life cycle and should be replaced.

If the discharge time is low and the voltage between batteries is greater than 0.30 volts, identify the low battery(s), recharge the pack and repeat the test. If the results are similar, replace the low batteries, recharge, and repeat the test.

If the discharge time is at or near the specification, see “SPECIFICATIONS” on page 3, and the voltage variations are less than 0.30 volts the battery pack is good.

Discharge Time	Voltage	Results
124 minutes or higher	within 0.30 volts	Battery Pack OK
124 minutes or higher	vary more than 0.30 volts	Bad battery(s)
83-124 minutes	within 0.30 volts	Batteries aging but still usable.
83-124 minutes	vary more than 0.30 volts	Bad battery(s)
83 minutes or less	within 0.30 volts	Batteries aging. Should be replaced as a set.
83 minutes or less	vary more than 0.30 volts	Bad battery(s) Batteries aging. Replace bad battery and retest. If results still low replace remaining old batteries.

In “Example 1” on page 10, The specific gravity reading of all the batteries were well balanced and have a specific gravity that indicates 100% charge.

In “Example 2” on page 10, batteries 3, 6, and 8 should be specifically watched for poor performance. Because batteries 6 and 8 have specific gravity readings that vary by more than 30 points, it would be expected that these batteries will also have voltages that vary by more than 0.3 volts. If the discharge test confirms this then replace the low batteries.

Battery Test Log

The Battery Test Log should be used whenever testing a battery set because a problem is suspected. Because battery testing is based on both specific data and comparison data the form will allow you to spot and circle specific batteries that may indicate a problem.

The form is designed to group the test result to give quick easy accurate diagnosis of a battery problem. By looking across the rows you can easily compare one battery to the rest of the set. By looking down the columns you can verify the pattern of an individual battery. If a battery set or battery consistently give good results then the battery set is good and any problem that may have initiated the testing is in some other vehicle operating system. If a battery set or battery in a set consistently give poor results then the battery set or battery within the set is bad and should be replaced.

BATTERY TEST LOG

Model Number:	Name
Serial Number:	Address
Ambient Temperature Before Discharge:	City, State
Discharge Time:	Zip Code
Ambient Temperature After Discharge:	Ph #
Test Date:	Fax #
Battery Type:	Battery Manufacturer:

Battery Code Number (see Pos. terminal)								
Battery Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Uncorrected Hydrometer Reading								
Cell Temperature								
Temperature Corrected Hydrometer Reading								
End Discharge Voltage								
						Total Set Voltage Batteries 1-8		

The following formula statements can be used to aid in determining the proper temperature correction value to be added or subtracted to the uncorrected hydrometer readings. Formula statement 1 is to be used if the temperature of the electrolyte is above **26.7°C (80°F).** Formula statement 2 is to be used if the temperature of the electrolyte is below **26.7°C (80°F).**

Formula Statement 1 is _____– 80 =_____ / 10 =_____ x .004 =_____ Add this number to your hydrometer readings.

Formula Statement 2 is 80 –_____=_____ / 10 =_____ x .004 =_____ Subtract this number from your hydrometer readings.

BATTERY MAINTENANCE

VISUAL INSPECTION

⚠ CAUTION

Battery - Explosive Gases! DO NOT Smoke. Keep Sparks and flames away.

Risk of 48 volt Electrical Shock. DO NOT touch unisulated battery terminals, connectors, or wires.

Use extreme caution when using tools, wires, or metal objects near batteries! A short circuit and/ or spark could cause an explosion. Wrap tools with vinyl tape to prevent shorting out a battery(s).

The visual inspection is intended to find and correct potential problems before they create more serious safety and operational concerns. Before use each day and before the vehicle is placed on charge a visually inspection shall be made of the batteries.

Visually inspection shall include but not be limited to:

- Discolored or melted terminal boots
- Burn spots
- Dirt or corrosion on or around the battery terminals
- Damage to Battery case or terminals
- Leakage of electrolyte.
- Electrolyte level (water level)

Replace any damaged battery(s) and place in an acid resistant container until the battery can be properly disposed of.

If any problems are found, proceed to “CLEANING” on page 14 to remove any dirt and corrosion, or “BATTERY REPLACEMENT” on page 17 if there are any damaged batteries.

Battery connections should be rechecked weekly, and tightened as needed. Discolored or melted terminal boots, Burn spots or Damage to Battery case or terminals are possible signs that the terminals may be loose.

Specification:

Battery Terminals . . . . . 14 - 16 N•m (124 - 142 lb-in.)

CLEANING

Reason:

Cleaning is a key element in battery maintenance, for both safety and performance. Regular cleaning will reduce dirt and corrosion from forming. This reduces the chance of acid contact, and will provide efficient electrical connections. Dirty batteries can provide a path for a small amount of current to slowly discharge the batteries wasting energy and shortening overall battery life. Always keep batteries clean and dry.

⚠ CAUTION

Battery - Poison! Batteries contain ACID which is poisonous and causes severe burns. Avoid contact with skin, eyes, or clothing.

Use extreme caution when using tools, wires, or metal objects near batteries! A short circuit and/ or spark could cause an explosion. Wrap tools with vinyl tape to prevent shorting out a battery(s).

Risk of 48 volt Electrical Shock. DO NOT touch uninsulated battery terminals, connectors, or wires.

If cleaning is needed, follow each of the steps below until all acid and corrosion is neutralized, dirt and rust removed, bare metal recoated and damaged batteries safely removed and stored.

1. Position the vehicle on a level surface.
2. Set the parking brake, turn the key switch to the OFF position, and place the shift lever in the NEUTRAL position.
3. Raise the cargo bed and secure the prop rod.
4. Set Service/Drive switch to Service position.
5. Note the position of each battery and the location of both the positive and negative terminals.
6. Using insulated tools and care not to touch wrench to other terminals or the frame of the vehicle, disconnect the battery pack positive wires.
7. Neutralize all moisture and corrosion on the battery case with a solution of 1 part baking soda to 5 parts water. Rinse with clean water and allow to dry. If no other cleaning is needed, return vehicle to service.
8. If corrosion is found on the battery terminal(s), remove the wires and cables with corrosion. The cables are of different length, note the length and position of each cable for installation.

9. Pull the boots on the wires back far enough to expose the terminal for cleaning.
10. Neutralize, wire-brush to shiny metal, rinsed with clear water and allowed to dry before reattaching wires and cables. Do not paint connectors. If no other cleaning is needed, proceed to step 15.
11. If the battery tray or hold downs show rust, scale or corrosion, remove batteries. See “BATTERY REPLACEMENT” on page 17 steps 7-9.
12. Neutralize all corrosion, rinse with clean water and allow to dry.
13. Paint with an acid resistant paint.
14. Install the new battery with the proper orientation as shown in the battery position/connection diagram.
15. Place the proper terminal boots (red on positive, and black on negative) securely over each battery terminal.
16. Using the Battery Position/Connection diagram reconnect the battery wires, Use caution not to touch the wrench to other terminals or the vehicle frame.
17. Tighten each terminal connection to **14 -16 N•m (124 -142 lb-in.)**.

Battery connections should be checked weekly, and tightened as needed. Discolored or melted terminal boots, burn spots or damage to battery case or terminals are possible signs that the terminals may be loose. Check the electrolyte level in each cell. If the level is below the top of the plates in any cell, top-off with water as described in “WATER” on page 15. Place batteries on charge, see BATTERY CHARGER SECTION, prior to being used to ensure all batteries are charged and all cells equalized.

WATER

Reason:

The proper electrolyte level is as important to the care and life of the batteries as charging. The electrolyte level in each cell should be check each day the vehicle is used, or at the recommended service interval if the vehicle is in storage, see “STORAGE PROCEDURE” on page 20. The electrolyte level should be checked both before and after the charging process. It is recommended that distilled water be used for filling battery cells. If distilled water is unavailable, any water safe for drinking (except mineral water) can be used. Do not use water with a known high mineral content. Do not use of metallic containers when storing acid or water. Metal impurities in the water will lower the performance of the battery. Many liquids such as salt water, vinegar, antifreeze and alcohol, or harmful acids such as nitric, hydrochloric or acetic, will cause severe grid corrosion and consequently ruin a battery.
If distilled water is not used, be sure that the mineral contents are below those listed in the following table.

Impurity	Maximum Content (parts per million)
• Suspended Matter	• Trace
• Total Solids	• 100.00
• Calcium and Magnesium Oxides	• 40.0
• Iron	• 5.0
• Ammonia	• 8.0
• Organic Matter	• 50.0
• Nitrates	• 10.0
• Nitrites	• 5.0
• Chloride	• 5.0

Contact your local water department for this analysis.
If the electrolyte level is low, add water near the end of charge or after taking the battery off charge. Never allow the electrolyte level to drop below the tops of the plates because the exposed portion of the plates will become permanently inactive due to sulfation.
Never overfill a battery cell above the level indicator or it will pump acid when it is placed on charge. This reduces the capacity of the battery and corrodes metal parts near it.

IMPORTANT: Overfilling or underfilling the batteries will void vehicle and battery warranties.

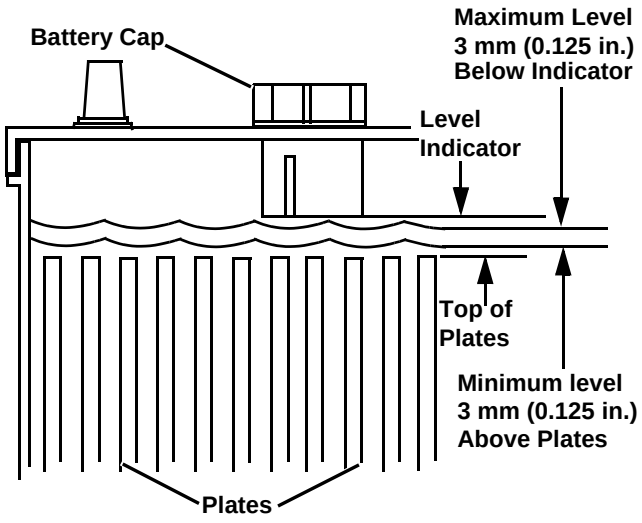
Equipment:

- JDG1247 Auto Battery Filler

Procedure

Filling the Batteries Before Charging

1. Position the vehicle on a level surface.
2. Set the parking brake, turn the key switch to the off position, and place the shift lever in the neutral position.
3. Raise the cargo bed and secure the prop rod.
4. Set Service/Drive switch to Service position.
5. Carefully remove the battery cap. look into each cell to see if the electrolyte level is above the top of the plates.



6. If the electrolyte level is below the top of the plates, add only enough water to bring the electrolyte to the minimum level before charging. Overfilling a discharged battery with water can easily result in an overflow of electrolyte from the cells.
7. If the electrolyte level is at or above the minimum level, DO NOT add any water.
8. Replace the battery cap.
9. Perform this procedure for each battery.
10. Place the vehicle on charge. See BATTERY CHARGER SECTION.

Filling the Batteries After Charging

1. Disconnect Battery charger. See BATTERY CHARGER SECTION.
2. Set the parking brake, turn the key switch to the off position, and place the shift lever in the neutral position.
3. Raise the cargo bed and secure the prop rod.
4. Set Service/Drive switch to Service position.
5. Carefully remove the battery cap. look into each cell to see the electrolyte level.
6. If the electrolyte level is low, add water to the indicator (maximum) level. Overfilling a battery with water can easily result in an overflow of electrolyte from the cells.
7. If the electrolyte level is at the indicator (maximum) level, DO NOT add any water.
8. Replace the battery cap.
9. Perform this procedure for each battery.
10. Place the vehicle in service.

⚠ CAUTION

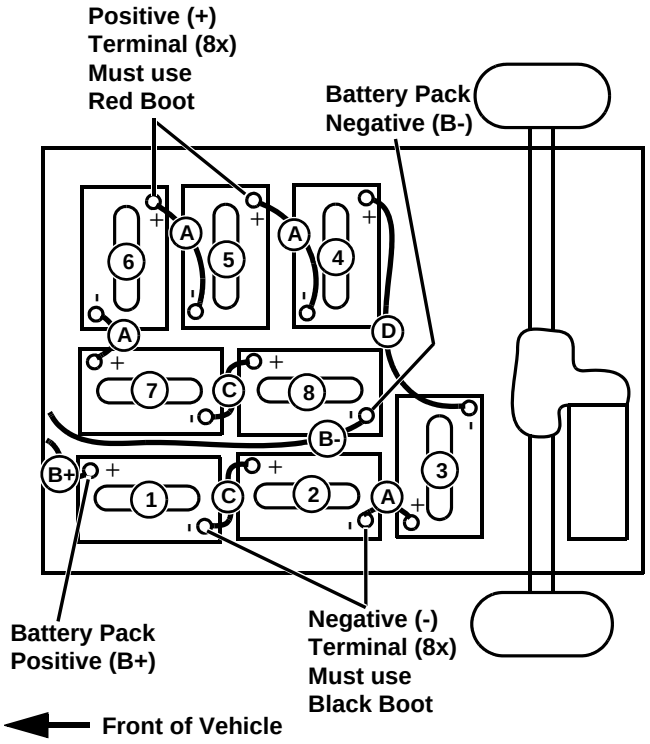
Overfilling of the battery could result in electrolyte (acid) being expelled from the battery during charging.

Battery - Poison! Batteries contain ACID which is poisonous and causes severe burns. Avoid contact with skin, eyes, or clothing.

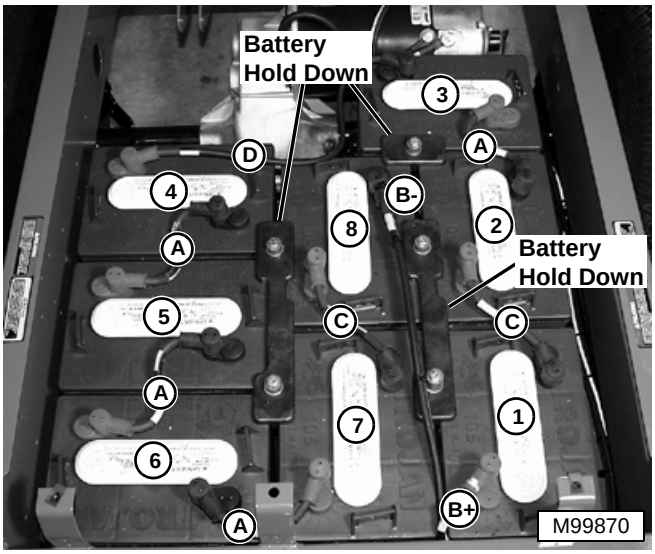
BATTERY REPLACEMENT

Procedure

1. Position the vehicle on a level surface.
2. Set the parking brake, turn the key switch to the off position, and place the shift lever in the neutral position.
3. Raise the cargo bed and secure the prop rod.
4. Set Service/Drive switch to Service position.
5. Note the position of each battery and the location of both the positive (B+) and negative (B-) terminals.



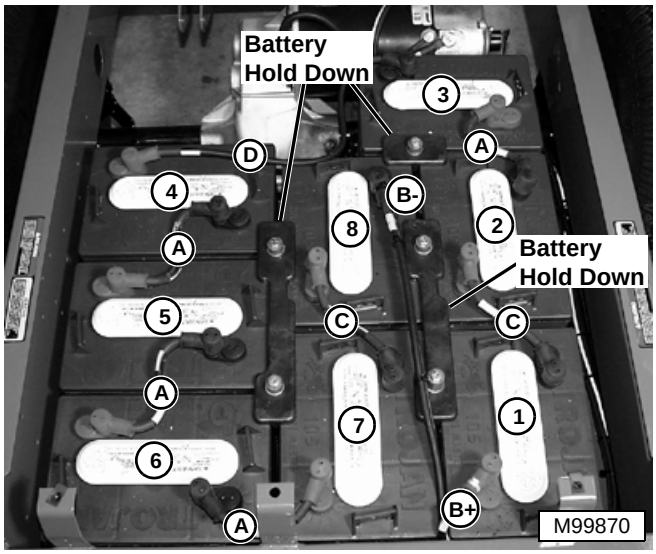
6. Using insulated tools and care not to touch wrench to other terminals or the frame of the vehicle, disconnect the battery pack positive wires.



7. Remove the remaining battery jumper wires. The cables are of different length, note the length and position of each cable for reassemble.
8. Remove the battery hold down(s) so that the battery can be removed.
9. Carefully lift the battery out of the vehicle, using extreme care for both proper personal lifting as well as to not damage, or drop the battery and cause a spill. Never lift by the battery terminals. When lifting batteries, use a commercially available battery lifting device.
10. Properly store the battery until it can be disposed of, see“STORAGE PROCEDURE” on page 20.
11. Clean the battery tray as directed in “CLEANING” on page 14.
12. Install the new battery with the proper orientation as shown in the battery position/connection diagram.

⚠ CAUTION

Keep battery hold downs in place and properly tightened. Under tightened hold downs can allow the batteries to bounce and spill acid, or cause internal damage to the plates. Overtightened hold downs can cause the battery case to crack or buckle, causing acid to leak out.



13. Install the battery hold down(s) and tighten to **7 - 9 N•m (62 - 80 lb-in.)**.

⚠ CAUTION

Failure to properly connect battery wiring could cause batteries to short circuit and/or spark(s) that could cause an explosion.

14. Place the proper terminal boots (red on positive, and black on negative) securely over each battery terminal.
15. Connect the battery wires. Place the proper cables on the proper terminals as marked earlier. Use caution not to touch the wrench to other terminals or the vehicle frame.
16. Tighten each terminal connection to **14 - 16 N•m (124 - 142 lb-in.)**.
17. Check battery connections weekly, and tighten as needed. Discolored or melted terminal boots, burn spots or damage to battery case or terminals are possible signs that the terminals may be loose.
18. Check the electrolyte level in each cell. If the level is below the top of the plates in any cell, top-off with water as described in the water section, see “WATER” on page 15.
19. Place batteries on charge prior to being used to ensure all batteries are charged and all cells equalized. See BATTERY CHARGER SECTION.

Specification:

Battery Terminals . . . . . 14 - 16 N•m (124 - 142 lb-in.)
Battery Hold Downs . . . . . 7 - 9 N•m (62 - 80 lb-in.)

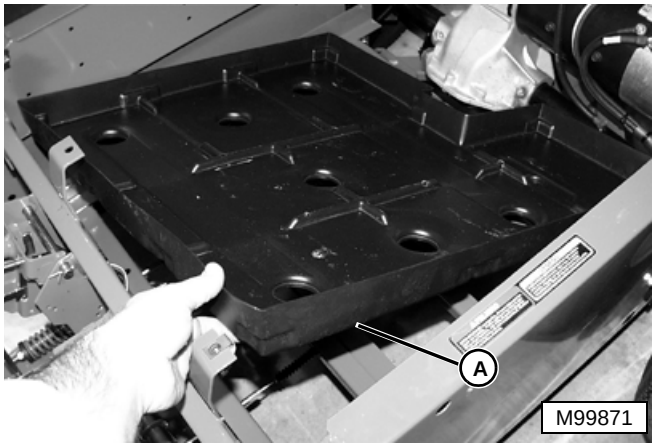
NOTE: New cycling batteries do not have their full capacity until they have been cycled several times (usually between 20 and 50 cycles). Therefore, they can be excessively discharged early in their vehicular life, thereby shortening their service life.

It is recommended to limit operation of new vehicles, or older vehicles with new batteries for at least the first 20 cycles and then gradually increase the operation.
Batteries that are discharged to the point that the vehicle does not run, can be harmed. The deeper the discharge, the less life you will ultimately obtain from the battery. If the batteries are being used more than normal, it is recommended that they be placed on charge for an hour or two during the day, see BATTERY CHARGER SECTION.
This procedure will reduce the depth of discharge and prolong battery life. Fully charge batteries

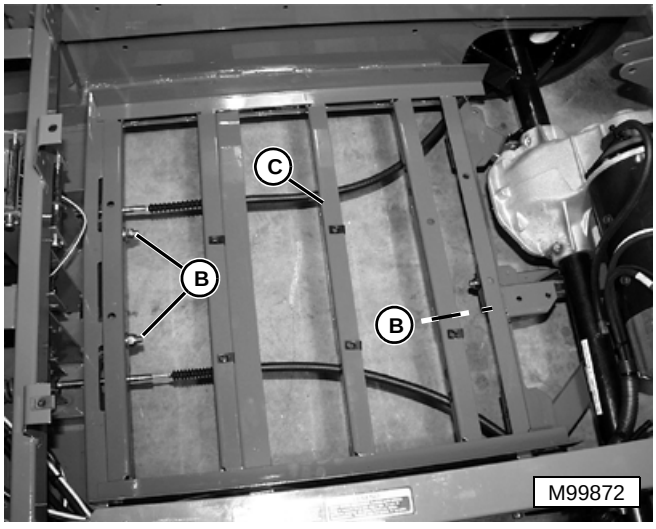
BATTERY TRAY & SUPPORT REMOVAL & INSTALLATION

Procedure

1. Position the vehicle on a level surface.
2. Set the parking brake, turn the key switch to the off position, and place the shift lever in the neutral position.
3. Raise the cargo bed and secure the prop rod.
4. Set Service/Drive switch to Service position.
5. Remove the batteries. See “BATTERY REPLACEMENT” on page 17.



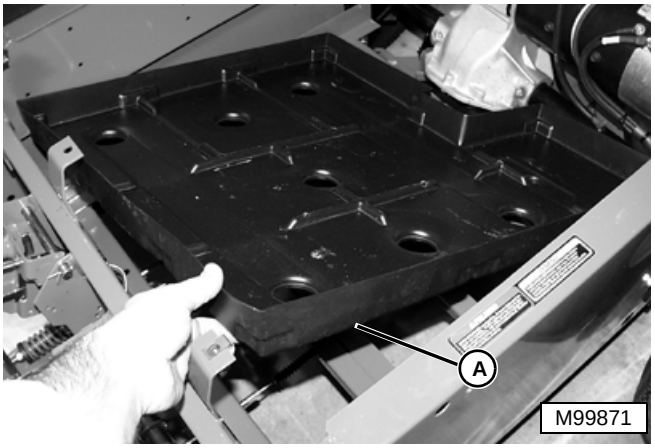
6. Lift the battery tray (A) out of the vehicle.



7. Remove the three lock nuts and capscrews (B) and lift the battery support tray (C) out of the vehicle.
8. Clean and repaint or replace the battery support tray and battery tray as needed.
9. If the battery tray or hold downs show rust, scale or corrosion, neutralize all corrosion, rinse with clean water and allow to dry.
10. Paint with an acid resistant paint.

Installation is done in the reverse order of removal.

1. Place the battery support tray (C) in the vehicle and install the three capscrews and lock nuts (B). Tighten to **95 N•m (70 lb-ft)**.



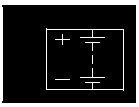
2. Set the battery tray (A) into the vehicle on top of the battery support.
3. Replace the batteries. See “BATTERY REPLACEMENT” on page 17.

Specification:

Battery Support Tray . . . . . 95 N•m (70 lb-ft)

STORAGE PROCEDURE

Storage must be considered for both vehicle that are out of service for an extended period of time (one month or more) and old batteries. All batteries should be stored in a cool, dry place in an upright position. While old batteries will not need periodic maintenance, they will need to be stored until they can be disposed of. Contact your local battery supplier for proper battery disposal and recycling.



Vehicle Storage

A battery is a perishable item that requires periodic maintenance. With a reasonable amount of care, the life of a battery can be significantly extended.
When an electric vehicle is not going to be in service for an extended period of time (one month or more), the batteries still require periodic maintenance. Battery testing should be considered an integral part of periodic maintenance during storage.

Before the vehicle is placed in storage the batteries should be:

- Cleaned
- Fully Charged
- Electrolyte level topped off

Store in an unheated, dry area.

While the vehicle is in storage:

- Set the parking brake
- Turn the key switch to the off position
- Place the shift lever in the neutral position.
- Set Service/Drive switch to Service position.
- Check Specific Gravity (monthly)
- Charge Batteries (monthly)
- Electrolyte level topped off as needed
- Cleaned as needed

Check the specific gravity of the electrolyte in each battery with a hydrometer and recharge the batteries on a monthly basis during storage. Cleaning the batteries and adding water to the batteries should be done as needed and checked each month while checking the specific gravity and charging the batteries.

Before the vehicle is placed back in service:

- Specific Gravity Checked
- Fully Charged
- Electrolyte level topped off
- Cleaned as needed
- Have all other systems checked for damage and proper operation.
- Placed back in service when no problems are found with any of the vehicle systems.

If batteries are left unattended while in storage they can self-discharge to the point that they become unusable. If dirt and corrosion are allowed to build up on the batteries this discharge rate can be accelerated. Improper care of batteries while in use or storage is misuse and will damage the battery shortening its useful service life.

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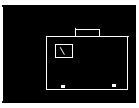


SPECIFICATIONS

Charger - N.A.:

Type . . . . . Ferro-Resonant Automatic Taper Charge
Input Voltage . . . . . .120 VAC 60 hz
Input Amperage . . . . . .12 Amps (15 amp breaker max.)
Power Factor 0.87
Output Voltage . . . . . 48 VDC Nominal
Output Amperage . . . . . 21 Amps DC Nominal
AC Power Cord
  Plug . . . . . .125 V 15 amp (NEMA Spec 5-15p)
  Length . . . . . 2.4 m (94 in.)
DC Power Cord
  Length . . . . . 2.8 m (110 in.)

Charger - Export:

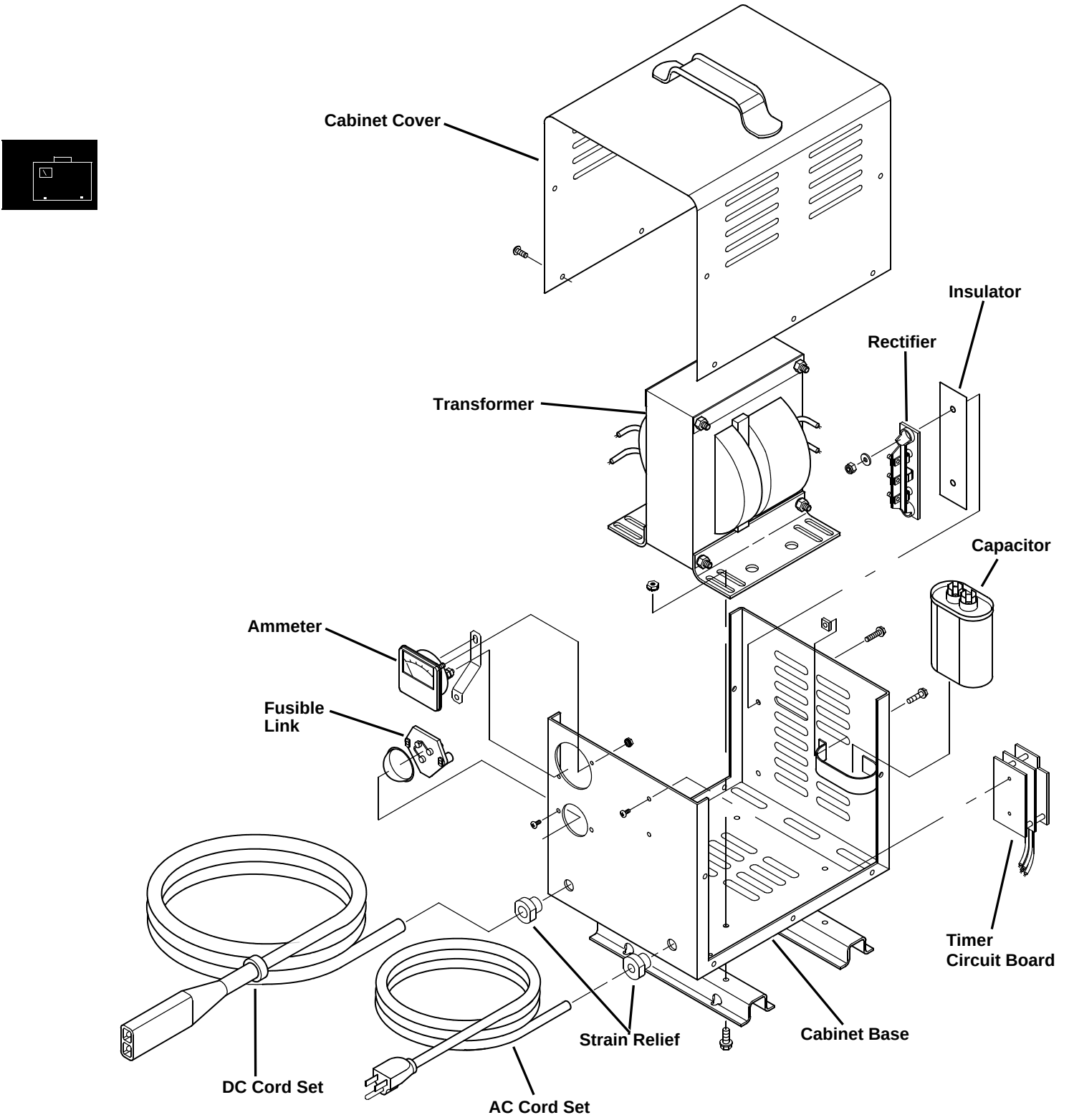
Type . . . . . Ferro-Resonant Automatic Taper Charge
Input Voltage . . . . . .230 VAC 50 hz
Input Amperage . . . . . 5.7 Amps (15 amp breaker max.)
Power Factor 0.95
Output Voltage . . . . . 48 VDC Nominal
Output Amperage . . . . . 22 Amps DC Nominal
AC Power Cord (User Supplied)
  Length (Maximum) . . . . . 4 m (13 ft)
DC Power Cord
  Length . . . . . 2.8 m (110 in.)

TORQUE SPECIFICATIONS

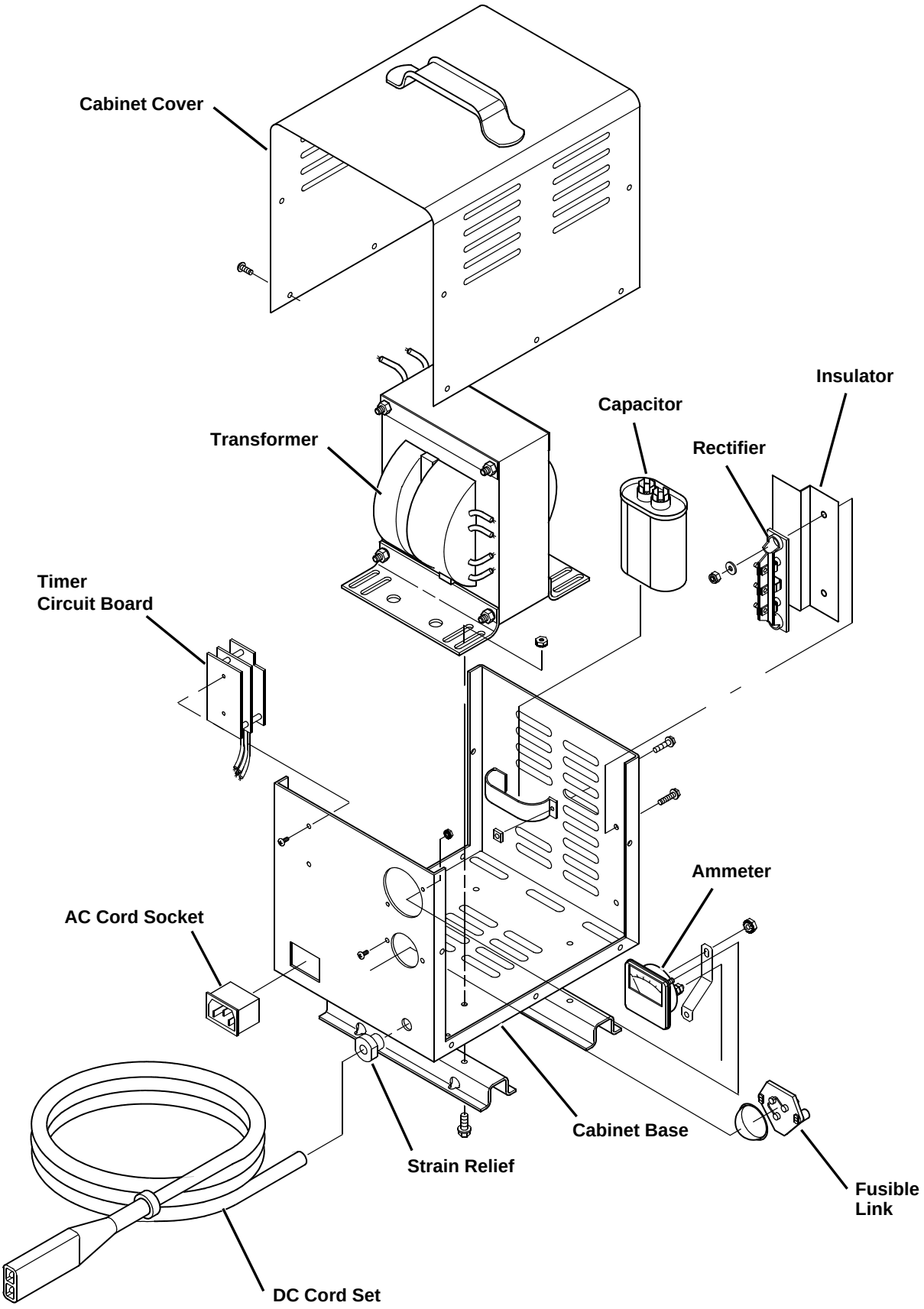
Battery Charger:

Transformer Mounting . . . . . 6.6 N•m (60 lb-in.)
Cover Screws . . . . . 0.9 N•m (9 lb-in.)
Capacitor Mounting Bracket . . . . . 1.9 N•m (18 lb-in.)
Ground Stud . . . . . 1.9 N•m (18 lb-in.)
Timer Circuit Board Mounting . . . . . 0.9 N•m (9 lb-in.)
Fusible Link Mounting . . . . . 0.9 N•m (9 lb-in.)
Fusible Link Terminals . . . . . 2.4 N•m (22 lb-in.)
Ammeter Mounting . . . . . 0.9 N•m (9 lb-in.)
Ammeter Terminals . . . . . 2.4 N•m (22 lb-in.)
Rectifier Mounting . . . . . 2.4 N•m (22 lb-in.)
Rectifier Terminals . . . . . 1.9 N•m (18 lb-in.)
DC Plug Terminals Screws . . . . . 1.65-2.2 N•m (15-20 lb-in.)
DC Plug Cover Screws . . . . . maximum 1.1 N•m (10 lb-in.)
DC Receptacle Terminal Screws . . . . . 1.65-2.2 N•m (15-20 lb-in.)
DC Receptacle Cover Screws . . . . . maximum 1.1 N•m (10 lb-in.)

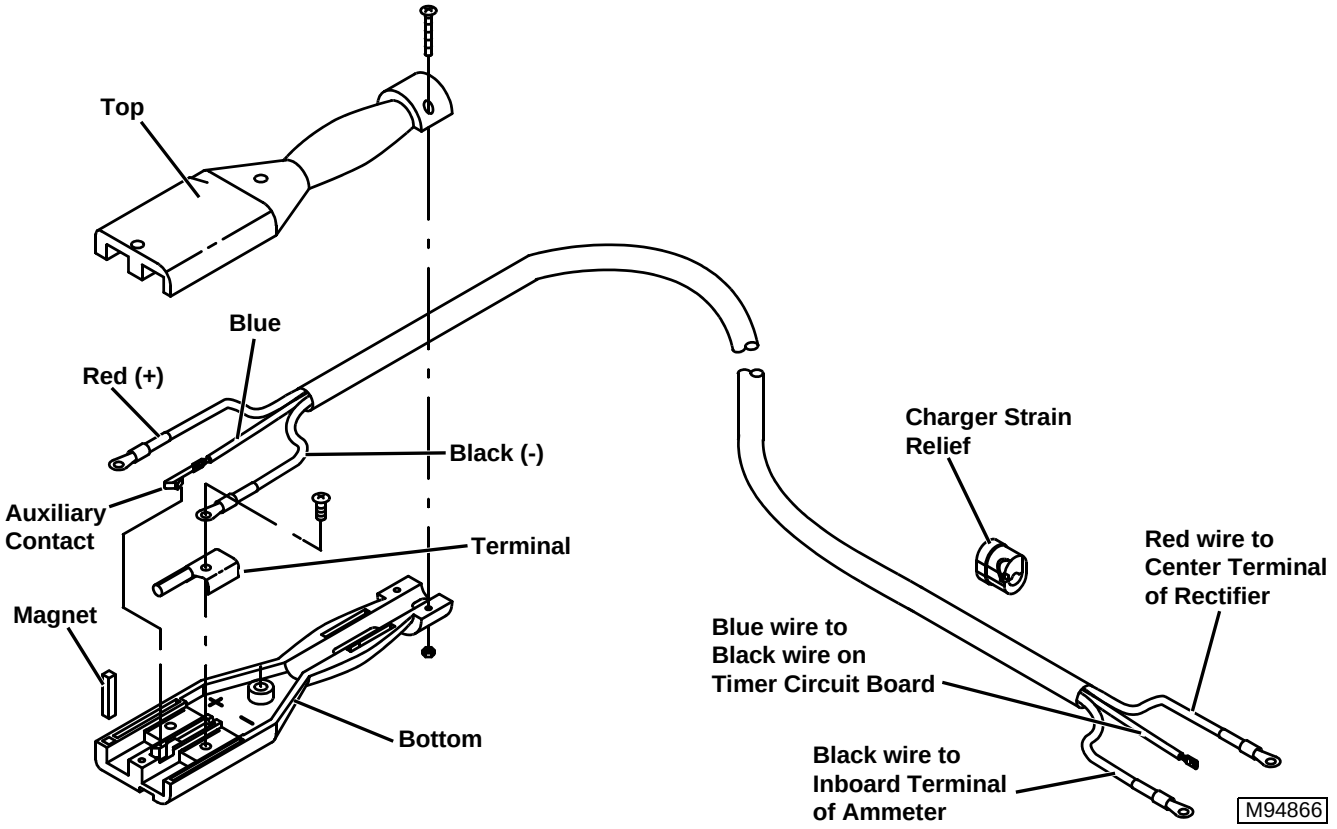
BATTERY CHARGER COMPONENT LOCATION - N.A.



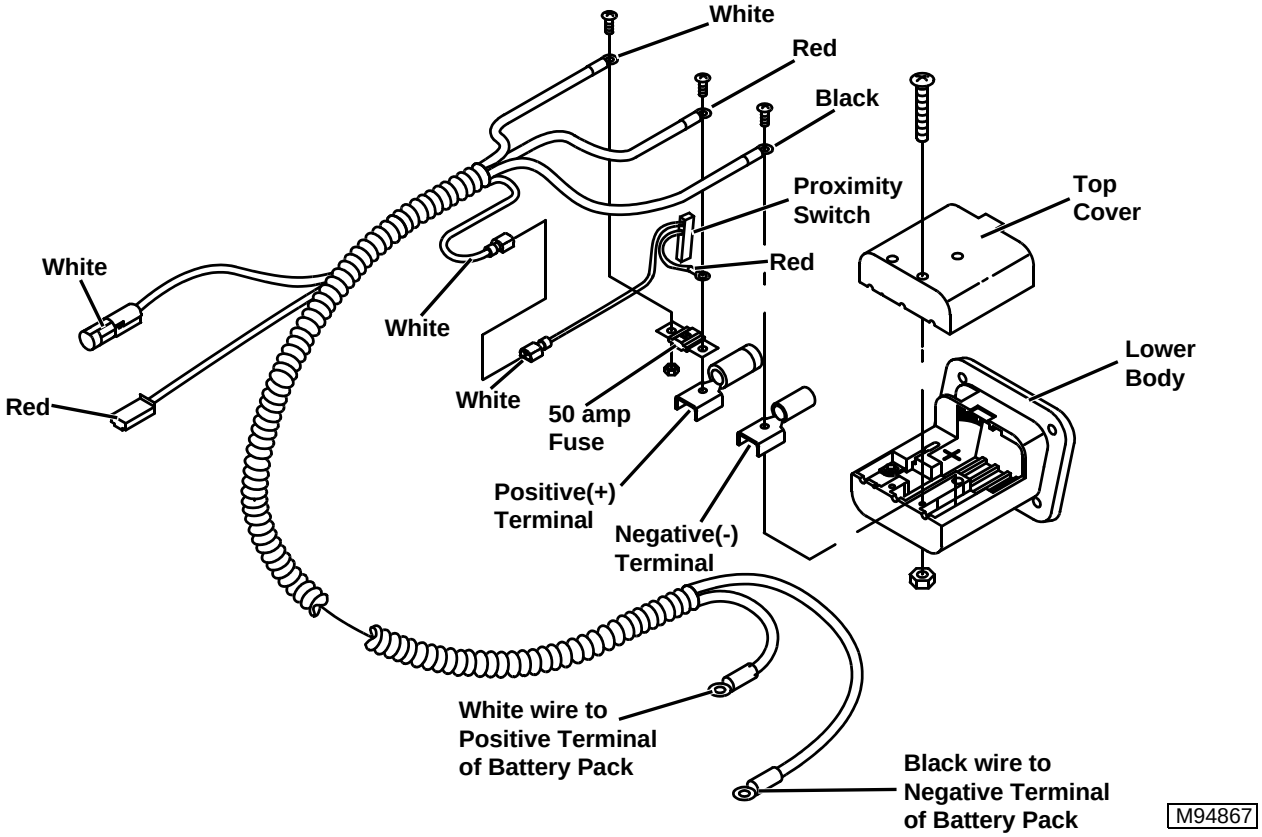
BATTERY CHARGER COMPONENT LOCATION - EXPORT



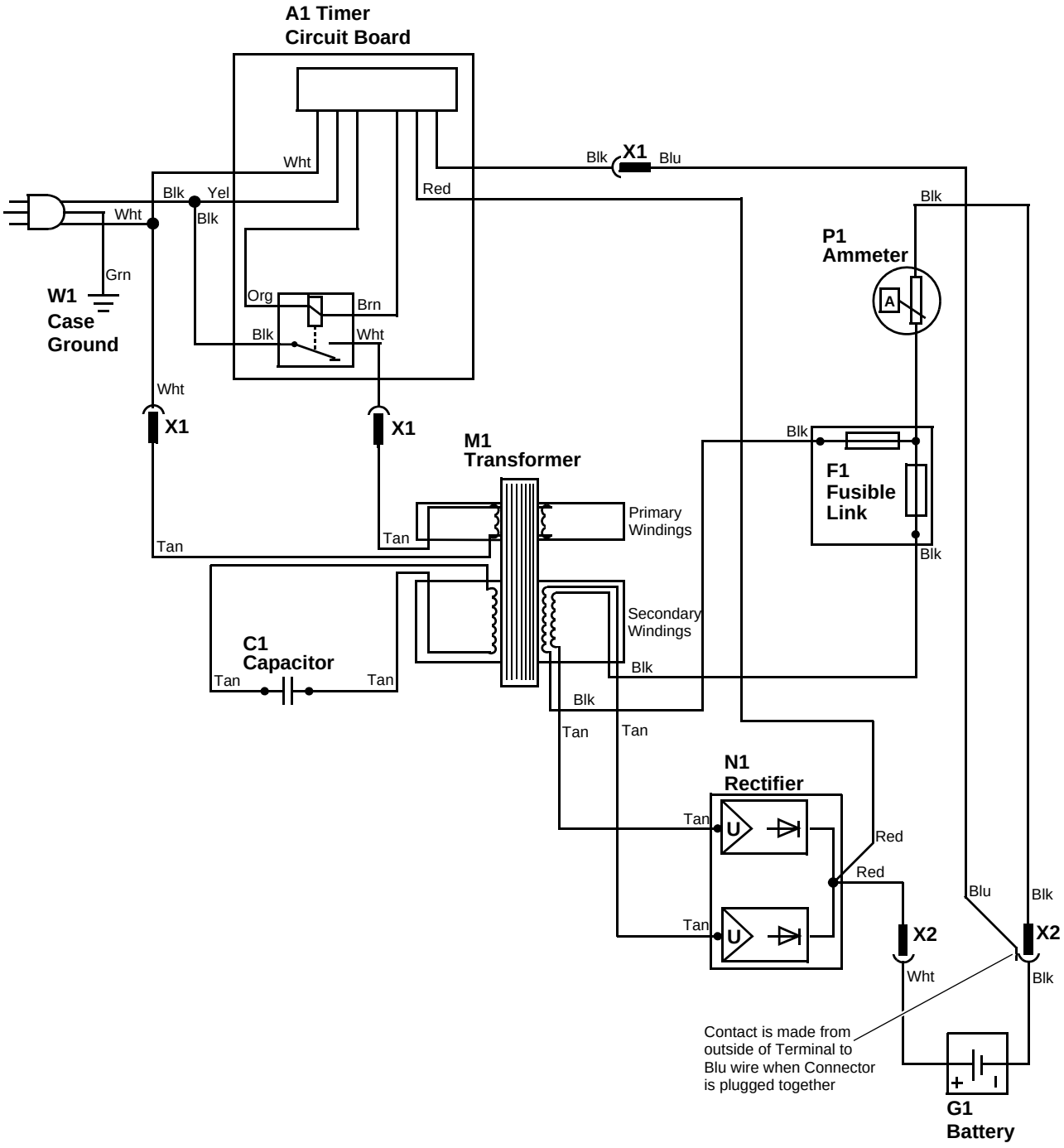
W5 CHARGER OUTPUT PLUG



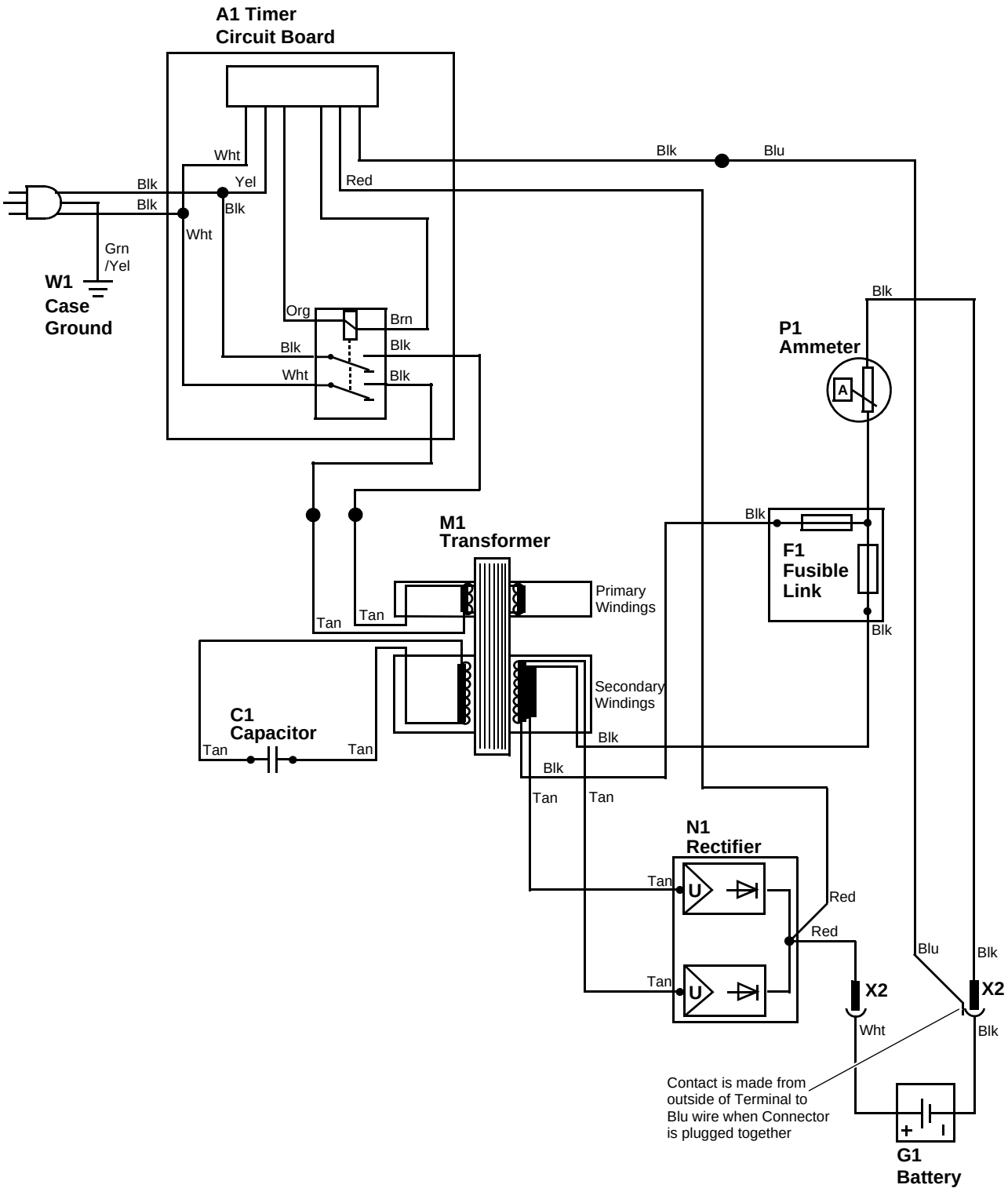
W6 CHARGER RECEPTACLE



BATTERY CHARGER ELECTRICAL SCHEMATIC - N.A.



BATTERY CHARGER ELECTRICAL SCHEMATIC - EXPORT



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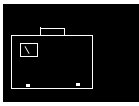


CHARGER THEORY & OPERATION

The battery charger is an integral part of the utility vehicle and is included with every vehicle. The charger is totally automatic and has no controls.

The charger monitors the battery set state of charge and contains an electronic timer that automatically turns the charger off as the batteries reach full charge.

The charger is a taper charge type which automatically decreases the rate of charge to provide good equalization of battery cells and reduce water usage.

Purpose:

Automatically charge batteries.

⚠ CAUTION

Each charger should have its own (15 ampere maximum) branch circuit protection in accordance with National Electrical Code, ANSI/ NFPA 70, and Local Codes and ordinances. Improper circuits may cause fires.

Make sure AC and DC cords, plugs, and receptacles are in good condition. DO NOT use if cords, plug, or receptacles are damaged, loose, or feel hotter than normal. Replace worn or damaged parts immediately.

DO NOT use charger near flammable materials or vapors such as fuels, grain dust or solvents.

Connect only to properly grounded three wire outlets. DO NOT use extension cords.

Explosive mixtures of hydrogen gas are present within battery cells. DO NOT service or charge vehicle batteries in an area where open flames, sparks, cigarettes, or any other source of combustion are present.

DO NOT use charger other than the type supplied with this vehicle.

Make sure the charger is sufficiently elevated above the ground to permit maximum ventilation underneath and around the charger.

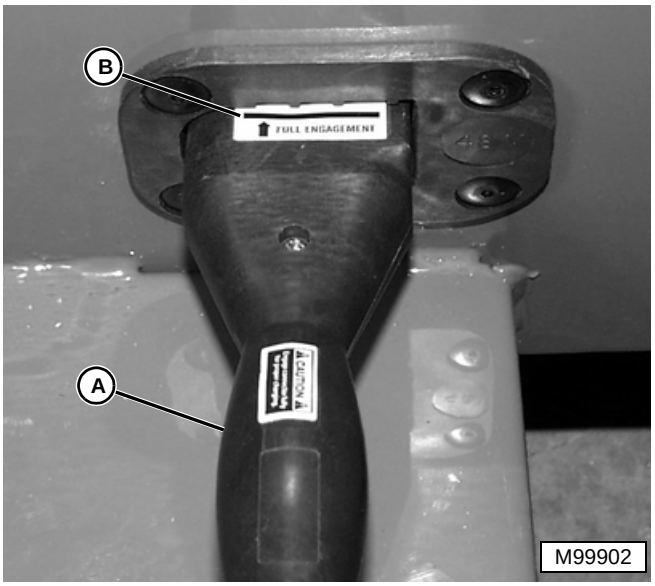
⚠ CAUTION

DO NOT touch portions of connector or battery terminals that are not properly insulated.

DO NOT use outdoors. Charger and power cords must be kept dry and not exposed to any form of moisture.

Procedure:

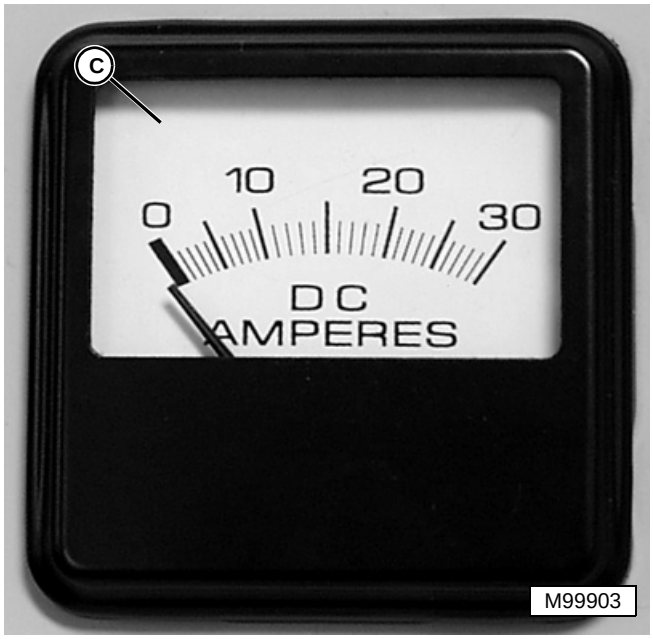
1. With the charger DC output cable disconnected from the batteries, connect the AC input plug to a properly grounded outlet.



2. Connect the DC output cable plug to the battery receptacle by grasping the plug body (A) and pushing the plug straight into the receptacle to the full engagement mark (B).
   The charger will turn on with an audible “click” after a short delay, (3-10 seconds). The charger will “hum”, and the ammeter will indicate initial charge rate.

⚠ CAUTION

Do not disconnect the DC output cord from the battery receptacle when the charger is on. The resulting arcing and burning will damage the connector and could cause the batteries to explode. Disconnect the AC power supply cord to turn the charger off before disconnecting the DC output plug.



3. Monitor the ammeter (C) for the initial charge rate. The initial charge rate will vary between 16 and 30 amperes depending upon the condition of the batteries or AC line voltage.

NOTE: If the batteries are heavily discharged, or the AC input line voltage is higher than nominal, the charge rate may exceed 30 amperes. Under normal conditions, the charge rate will taper to less than 30 amperes within 30 minutes.

IMPORTANT: Do not allow the battery charger to operate for more than 30 minutes with a charge rate over 30 amperes. This is misuse and will cause overheating and transformer burnout.

The charge rate will decrease to 4-9 amperes for the last few hours of charge if all batteries are good.

The charger turns off automatically when the batteries reach full charge. The required charge time varies with depth of discharge. Under normal operating conditions, the maximum necessary charge time is 10 to 12 hours.

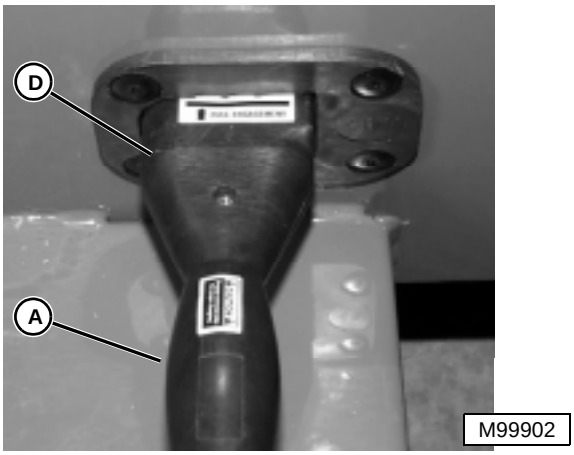
This normal charge time is for batteries which have been discharged to 80% of their rated capacity.
As much as four additional hours may be required to properly charge the batteries under the following conditions:

- Heavily discharged batteries (more than 80% discharged).
- Charging new batteries (batteries with less than 20 to 50 discharge/charge cycles).
- Charging cold batteries.
- Charging optional larger batteries.

When charging new or cold batteries, a higher than normal finishing charge voltage can be expected. This results in a low finish charge rate (2 to 5 amperes), and additional time is required to achieve equalization of all battery cells.

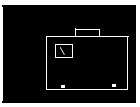
As batteries age, it is normal for the charge rate to increase above the 4 to 9 amp finish rate. The charger will still determine when the batteries are as charged as they can be and then turn off.

IMPORTANT: Do not leave the charger DC output connector plug connected while unattended for two or more days in a row. Severe overcharging and possible damage to the batteries will result if the charger electronic timer should fail and not turn off, or turn back on.
Avoid damage to the output cord, plug and receptacle. DO NOT pull on cord. DO NOT twist, rock, bend, or pull sideways.



4. After the charger has turned OFF, disconnect the DC output plug (D) from the receptacle by grasping the plug body (A) and pulling the plug straight out of the receptacle. DO NOT disconnect the DC plug if the charger is still ON. First unplug the AC cord and then unplug the DC cord.

TROUBLESHOOTING BATTERY CHARGING CIRCUIT



Battery Charger does not indicate output. Ammeter does not indicate current flow.

Do Headlights operate?

YES → Continue at top of next page. AC input voltage check.

NO

Electrical short circuit may have occurred in either the battery charger output circuit, or vehicle charging input or options and accessories circuit. Check and repair these circuits as needed. Then check and replace if needed, the 50 amp fuse in vehicle charger receptacle.

CAUTION:
Replacing the 50 amp fuse without verifying the charger and vehicle electrical systems could cause the fuse to fail again and sparks or arcs that could cause an explosion or fire.

Remove charger cover. Check DC cord for damage and continuity. Replace any damaged components.

Open charger plug, See “BATTERY CHARGER PLUG DISASSEMBLY & ASSEMBLY” on page 29. Check contacts and wiring for shorts. Replace any damaged components.

Test rectifier. See “RECTIFIER TEST” on page 20. Replace as needed.

Check vehicle options and accessories wiring. See ELECTRICAL SYSTEM SECTION. Repair or replace damaged components as needed.

Check vehicle Control circuit wiring. See ELECTRICAL SYSTEM SECTION. Repair or replace damaged components as needed.

Open charging receptacle and check 50 amp fuse, See “BATTERY CHARGER RECEPTACLE DISASSEMBLY & ASSEMBLY” on page 30. Repair or replace damaged components as needed.

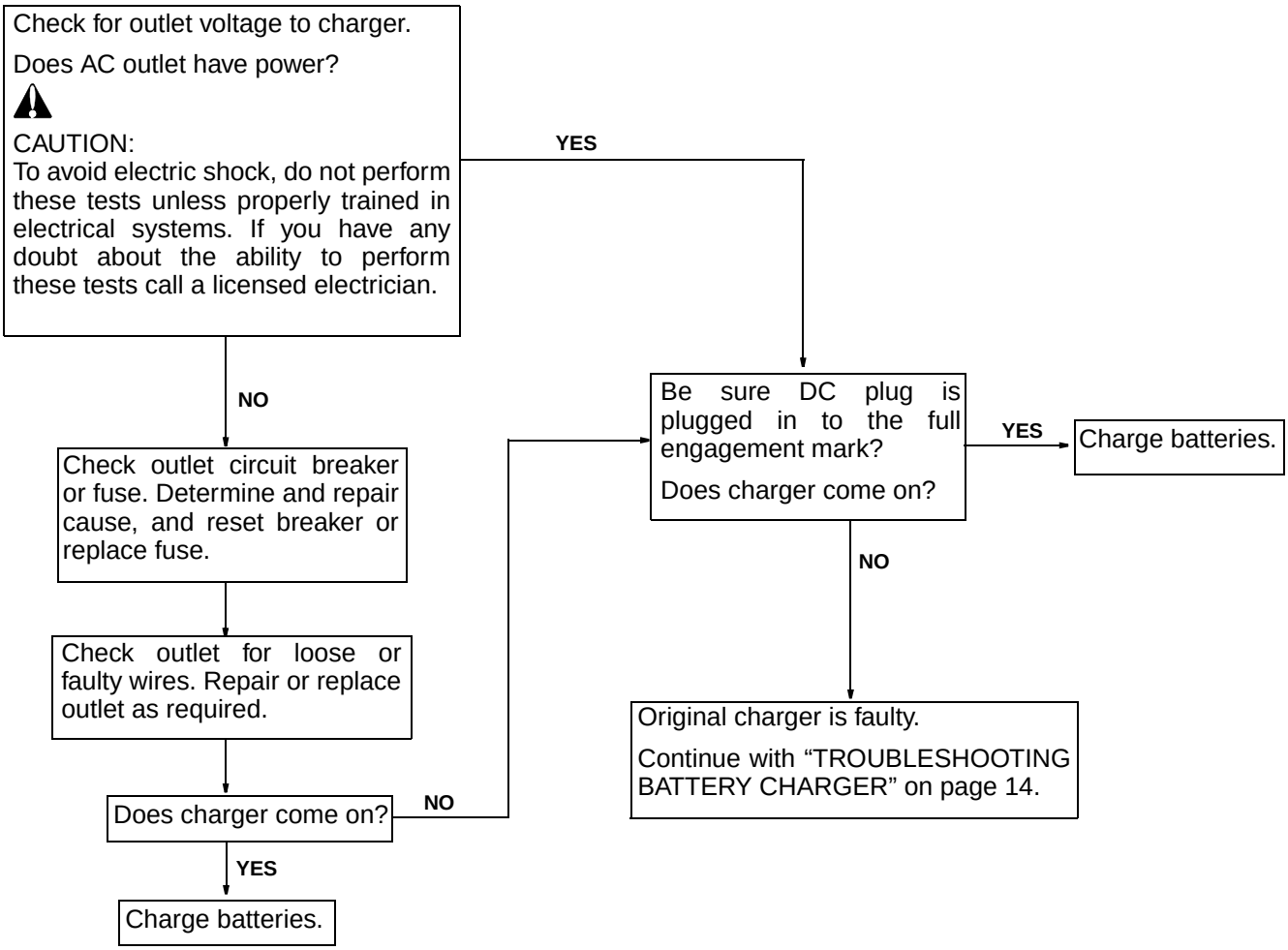
Do Headlights operate?

YES → Does charger operate?

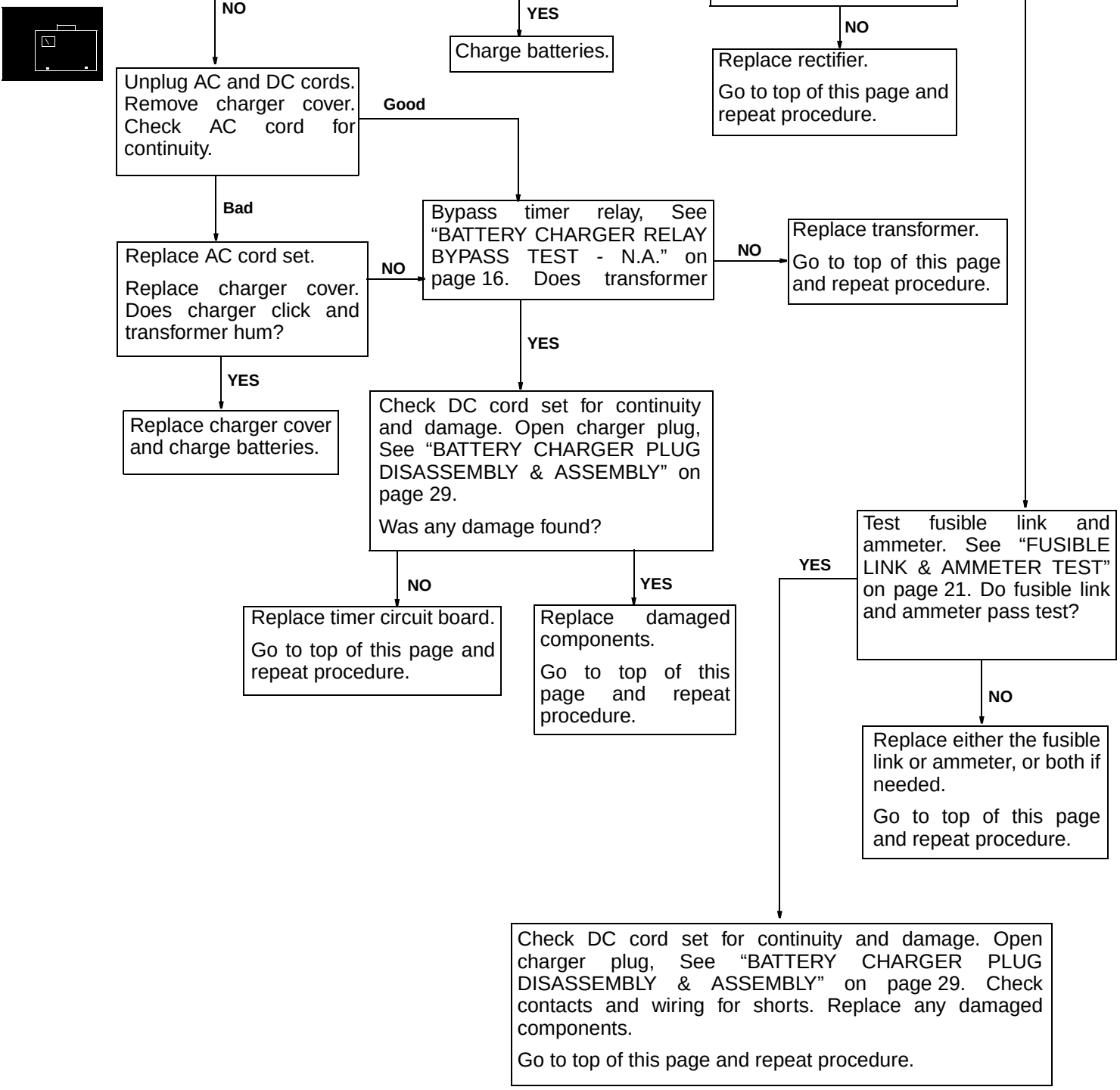
YES → Charge batteries.

NO → Continue on next page. AC input voltage check.

NO → Start over. Recheck charger and vehicle wiring. 50 amp fuse may have opened again.


Check for outlet voltage to charger.
Does AC outlet have power?
CAUTION:
To avoid electric shock, do not perform these tests unless properly trained in electrical systems. If you have any doubt about the ability to perform these tests call a licensed electrician.
YES
NO
Check outlet circuit breaker or fuse. Determine and repair cause, and reset breaker or replace fuse.
Check outlet for loose or faulty wires. Repair or replace outlet as required.
Does charger come on?
NO
YES
Charge batteries.
Be sure DC plug is plugged in to the full engagement mark?
Does charger come on?
YES
Charge batteries.
NO
Original charger is faulty.
Continue with “TROUBLESHOOTING BATTERY CHARGER” on page 14.

TROUBLESHOOTING BATTERY CHARGER



TESTS AND ADJUSTMENTS

BATTERY CHARGER OUTPUT TEST

Reason:

To verify proper DC output of the battery charger.

Equipment:

- JT05791 Multimeter

Procedure:

1. Disconnect both the charger AC plug from the outlet and the DC plug from the vehicle receptacle.

2. Check battery ammeter (A) and verify that the needle (B) is registering at zero. If it is at any position other than zero, the ammeter is damaged and must be replaced.
3. Visually check that the fusible link (C) on the front face of the charger is not burned. If the fusible link is burned or damaged, it must be replaced. See “BATTERY CHARGER DISASSEMBLY & ASSEMBLY - N.A.” on page 22.
4. Turn key switch to OFF position.
5. Move shift lever to NEUTRAL position and engage park brake.
6. Raise cargo bed and secure.
7. Place service/drive switch in service position.
8. Set your Multimeter to DC volts.
9. Insert RED test lead into VOLTS receptacle in meter.
10. Insert BLACK test lead into COM receptacle in meter.
11. Attach RED test lead clip to the positive terminal (B+) of the battery pack.
12. Attach the BLACK test lead clip to the negative terminal (B-) of the battery pack.
13. Record the reading. It should be approximately **48 VDC**.
14. Connect the AC input plug into a properly grounded 120 VAC 60 Hz outlet.
15. Connect the battery charger DC lead to the vehicle. After a short period of time **(3-10 seconds)** the charger should turn on with an audible click. If the charger does not turn on after **15-20 seconds**, proceed to “TROUBLESHOOTING BATTERY CHARGING CIRCUIT” on page 12.

Results:

- Note the ammeter on the front face of the battery charger. It should be indicating **an amp reading**.
- Note the voltage reading on the battery pack. It should indicate **a rise in voltage**.
- If both the ammeter and the voltmeter readings are as described, the charger is working properly. If either one or both are not correct, proceed to “TROUBLESHOOTING BATTERY CHARGING CIRCUIT” on page 12.

To shut the charger OFF disconnect the AC plug and then the DC plug.

BATTERY CHARGER RELAY BYPASS TEST - N.A.

Reason:

To verify proper operation of the transformer.

Equipment:

- JT05791 Multimeter

Procedure:

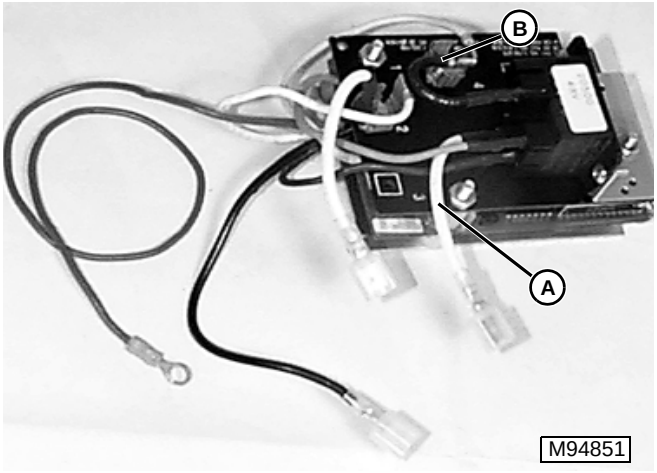
1. Disconnect both the charger AC plug from the outlet and the DC plug from the vehicle receptacle.

⚠ CAUTION

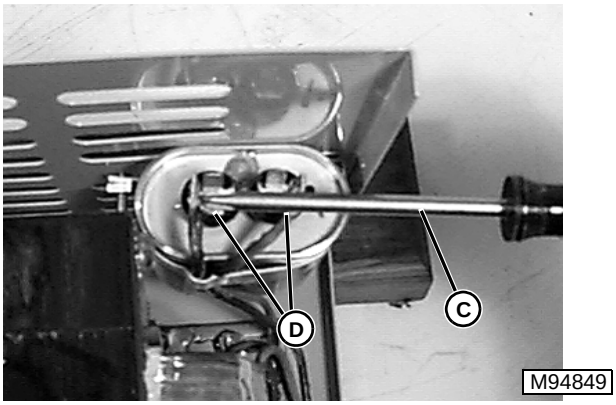
Lethal voltages are present when charger is plugged in and the cover is removed.

This is a test procedure only. DO NOT allow charger back into service until all repairs have been completed and the timer is connected properly.

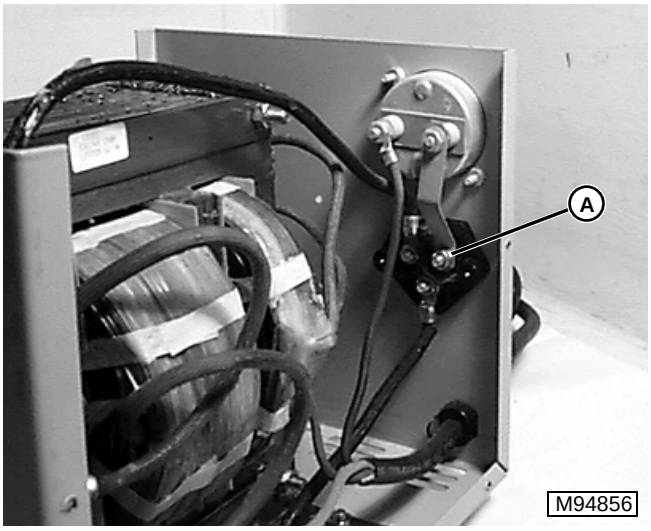
2. Remove the ten sheet metal screws, five on each side, that hold the cover on the charger and remove cover.



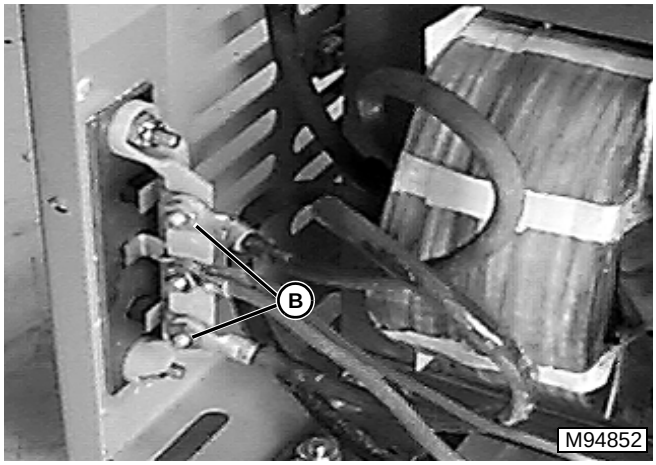
3. Remove the white wire (A) from the timer circuit board relay, and connect it to terminal (B).
4. Place DC plug so that it can not be shorted to any metal objects.



5. Using a well insulated screwdriver (C), touch the shaft of the screwdriver across the two terminals (D) of the capacitor to discharge it.
6. Remove the leads from the capacitor and position them so that they do not touch any metal objects.
7. Measure and record the AC line voltage at the outlet to be used for the test.
8. Plug AC cord into properly grounded outlet.
9. If AC line fuse or circuit breaker blows transformer has an internal short and must be replaced.
10. Transformer should hum. If transformer does not hum replace it.



11. Measure and record the transformer output voltage with the capacitor removed from the circuit.
12. Set the voltmeter to AC volts. Place the black test lead on the fusible link terminal (A).

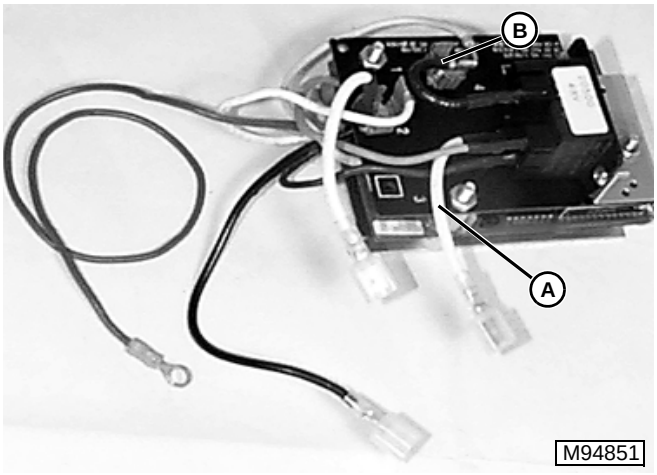


13. Place the red test lead one at a time on each rectifier input terminals (B) and note the voltage.
14. Disconnect the AC plug from the outlet.
15. Connect the leads to the terminals of the capacitor.
16. Measure and record the transformer output voltage with the capacitor in the circuit.

Results:

The results of the transformer output test will vary depending upon the AC input line voltage. Match your input line voltage to the high, nominal or low voltage listed below. If the transformer output voltage is below the voltages listed replace the transformer.

	AC Line Voltage	Output with Capacitor	Output without Capacitor
High Voltage	128 VAC	117 VAC	83 VAC
Nominal Voltage	120 VAC	115 VAC	78 VAC
Low Voltage	105 VAC	113 VAC	69 VAC



17. Remove the white wire (A) from terminal (B) and connect to the timer circuit board relay in its original position. This will be the only terminal on the relay that is open.
18. Slide the cover down onto the charger case. Install the attachment screws, starting with the bottom holes. Torque the screws to **0.9 N•m (9 lb-in.)**.

Specification:

Cover Screws . . . . . 0.9 N•m (9 lb-in.)

BATTERY CHARGER RELAY BYPASS TEST - EXPORT

Reason:

To verify proper operation of the transformer.

Equipment:

- JT05791 Multimeter
- Two Terminal Adaptors 0.3 cm (0.125 in.) male to 0.6 cm (0.25 in.) female

Procedure:

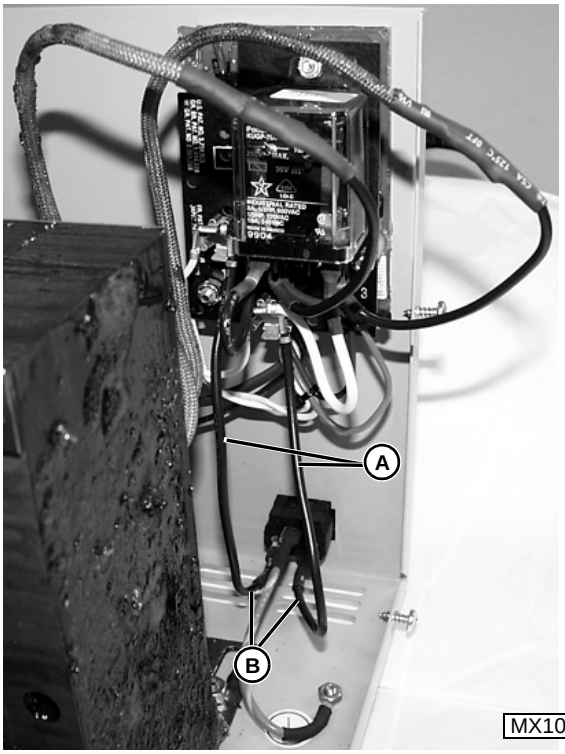
1. Disconnect both the charger AC plug from the outlet and the DC plug from the vehicle receptacle.

⚠ CAUTION

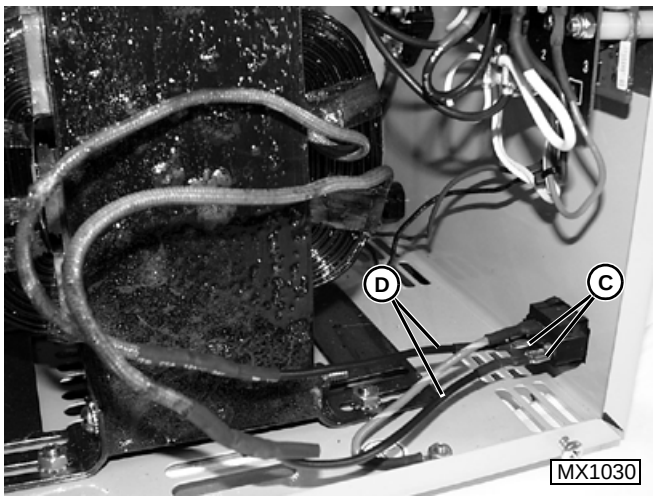
Lethal voltages are present when charger is plugged in and the cover is removed.

This is a test procedure only. DO NOT allow charger back into service until all repairs have been completed and the timer is connected properly.

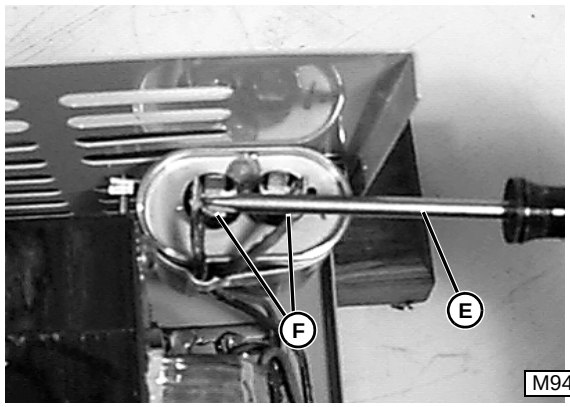
2. Remove the ten sheet metal screws, five on each side, that hold the cover on the charger and remove cover.



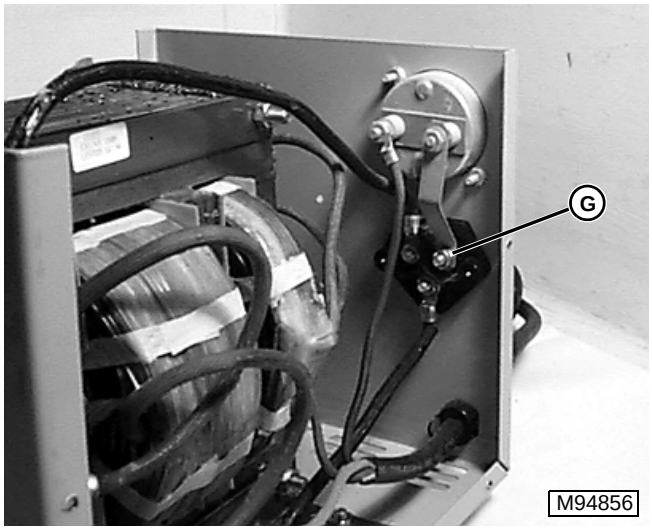
3. Remove the two black wires (A) from the AC plug terminals (B), and position them so that they do not touch any metal objects.



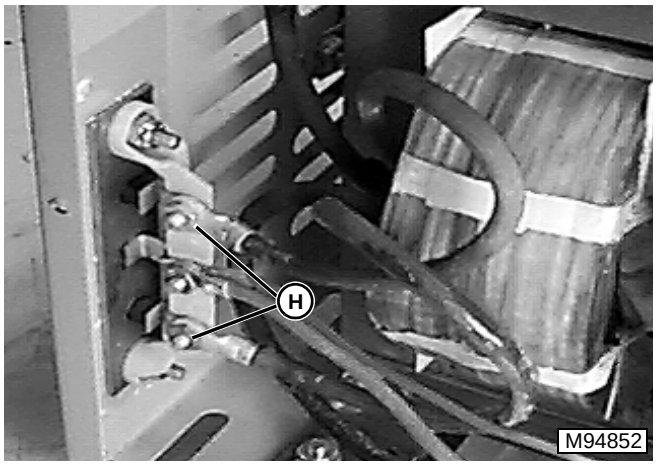
4. Using the 0.3 cm (0.125 in.) male to 0.6 cm (0.25 in.) female terminal adaptors (C), connect the two leads (D) from the primary transformer windings to the AC plug terminals.
5. Place DC plug so that it can not be shorted to any metal objects.



6. Using a well insulated screwdriver (E), touch the shaft of the screwdriver across the two terminals (F) of the capacitor to discharge it.
7. Remove the leads from the capacitor and position them so that they do not touch any metal objects.
8. Measure and record the AC line voltage at the outlet to be used for the test.
9. Plug an AC cord from a properly grounded outlet into the AC plug receptacle.
10. If AC line fuse or circuit breaker blows transformer has an internal short and must be replaced.
11. Transformer should hum. If transformer does not hum replace it.



12. Measure and record the transformer output voltage with the capacitor removed from the circuit.
13. Set the voltmeter to AC volts. Place the black test lead on the fusible link terminal (G).

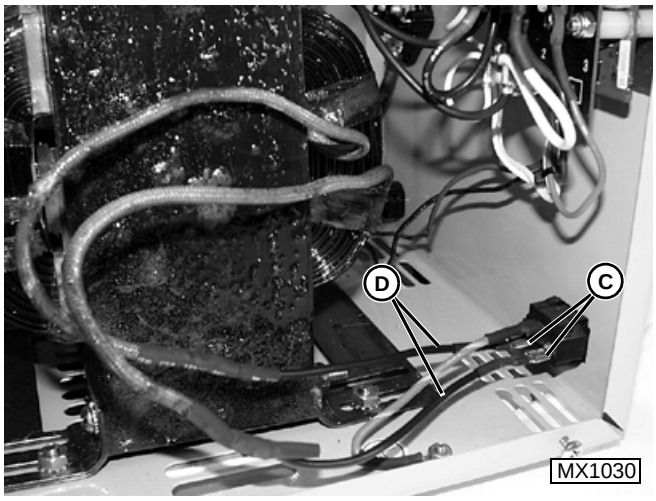


14. Place the red test lead one at a time on each rectifier input terminals (H) and note the voltage.
15. Disconnect the AC plug from the outlet.
16. Connect the leads to the terminals of the capacitor.
17. Measure and record the transformer output voltage with the capacitor in the circuit.

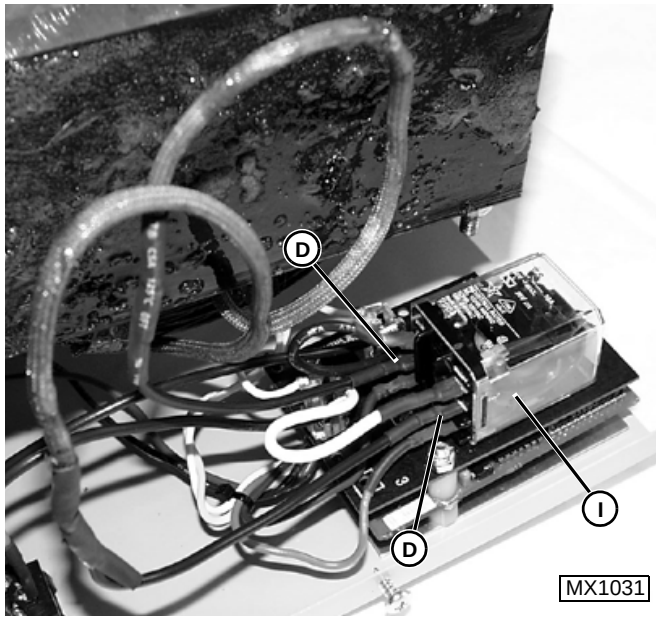
Results:

The results of the transformer output test will vary depending upon the AC input line voltage. Match your input line voltage to the high, nominal or low voltage listed below. If the transformer output voltage is below the voltages listed replace the transformer.

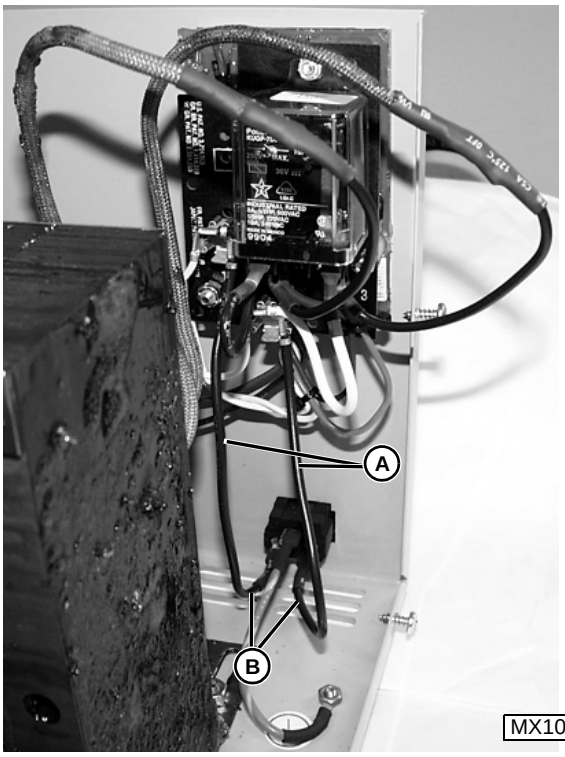
	AC Line Voltage	Output with Capacitor	Output without Capacitor
High Voltage	256 VAC	151 VAC	82 VAC
Nominal Voltage	230 VAC	140 VAC	76 VAC
Low Voltage	210 VAC	110 VAC	70 VAC



18. Remove the two transformer leads (D) from the AC plug terminals and remove the two terminal adaptors (C).



19. Connect the leads (D) from the transformer primary windings into the relay (I).



20. Connect the two black wires (A) from the timer circuit board terminals into the AC plug terminals (B).
21. Slide the cover down onto the charger case. Install the attachment screws, starting with the bottom holes. Torque the screws to **0.9 N•m (9 lb-in.)**.

Specification:

Cover Screws . . . . . 0.9 N•m (9 lb-in.)

RECTIFIER TEST

Reason:

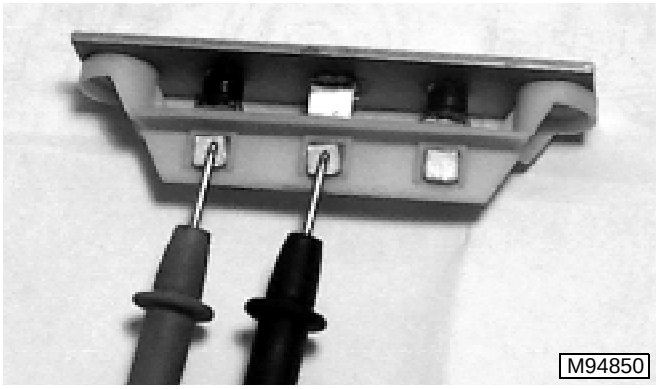
To verify the electrical integrity of the diodes.

Equipment:

- JT05791 Multimeter

Procedure:

1. Remove rectifier assembly from charger case. See “BATTERY CHARGER DISASSEMBLY & ASSEMBLY - N.A.” on page 22.



2. Set meter to diode test range.

NOTE: The meter will measure and display voltage drop across diode when set to diode test range.

3. Place the black meter lead on the center terminal of the rectifier, Then touch the red meter lead to one outside terminal, and then the other.
4. Meter should "beep" once in both positions. If you are using an Ohmmeter, the reading should be approximately **1.5 M Ohms**.
5. Reverse position of meter leads and retest. Place the red lead on the center terminal and touch the outside terminals with the black test lead.
6. Meter should display **“OL”** in both positions.
7. If the readings are different from those listed, replace rectifier.

Specification to outside terminals:

Black Lead on Center Terminal approx. 1.5 M Ohms
Red Lead on Center Terminal . . . . . OL (Infinity)

FUSIBLE LINK & AMMETER TEST

Reason:

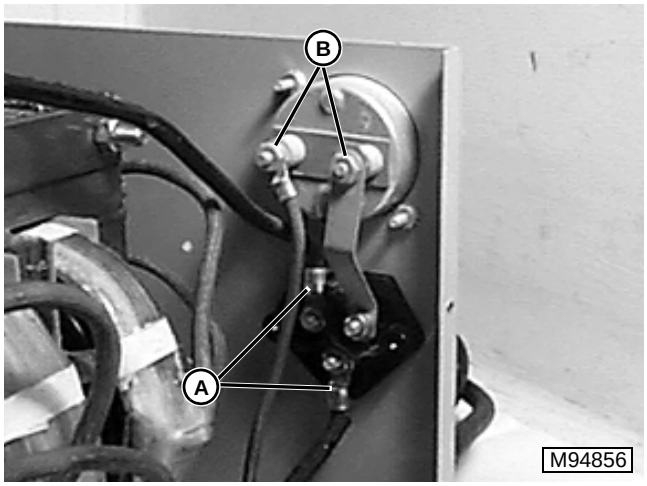
To verify the electrical integrity of the fusible link and ammeter.

Equipment:

- JT05791 Multimeter

Procedure:

1. Disconnect the charger from both the AC outlet and the vehicle.
2. Remove the ten sheet metal screws, five on each side, that hold the cover on the charger and remove cover.



3. Remove the two leads (A) from the transformer.
4. Set the multimeter to the diode setting.
5. Sequentially place the red test lead to each fusible link terminal. In each position, touch the black lead to the other two terminals.

Results:

- The meter should **"beep"** in each position.
- If the meter does not **"beep"** in any position and you are sure that the test probes have made good contact to the terminals, replace fusible link.

6. Place one test lead on each terminal (B) of the ammeter.

Results:

- The meter should **"beep"**.
- If the meter does not **"beep"** and you are sure that the test probes have made good contact to the terminals, replace ammeter.

CAPACITOR TEST

Reason:

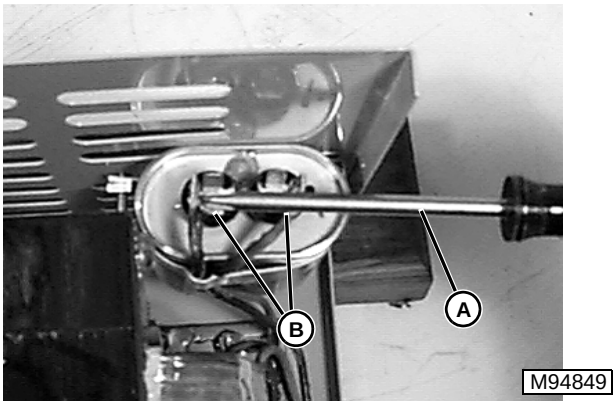
To verify the electrical integrity of the capacitor.

Equipment:

- JT05791 Multimeter

Procedure:

1. Disconnect the charger from both the AC outlet and the vehicle.
2. Remove the ten sheet metal screws, five on each side, that hold the cover on the charger and remove cover.



3. Using a well insulated screwdriver (A), touch the shaft of the screwdriver across the two terminals (B) of the capacitor to discharge it.
4. Remove the leads from the capacitor.
5. Set the multimeter to the ohms setting.
6. Place one lead from the meter to each terminal. Note the reading, then switch the leads.

Results:

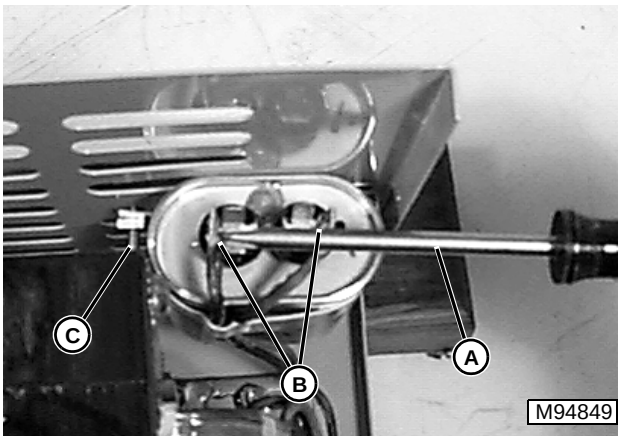
- The ohms reading should start out low, (as low a -2 M ohms) and raise as long as you are connected.
- If the reading is different then described, replace capacitor.

REPAIR

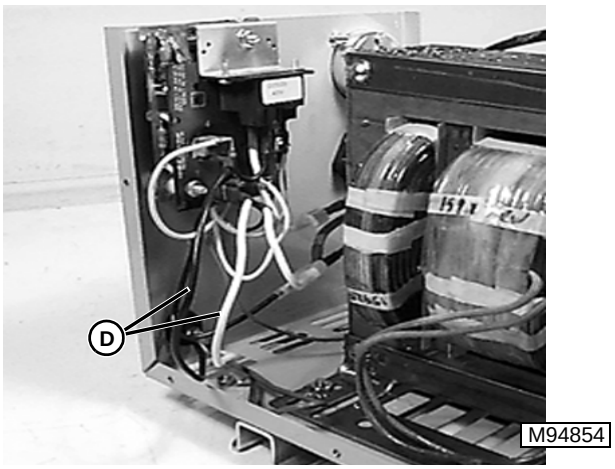
BATTERY CHARGER DISASSEMBLY & ASSEMBLY - N.A.

Disassembly:

1. Disconnect both the charger AC plug from the outlet and the DC plug from the vehicle receptacle.
2. Remove the ten sheet metal screws, five on each side, that hold the cover on the charger and remove cover.

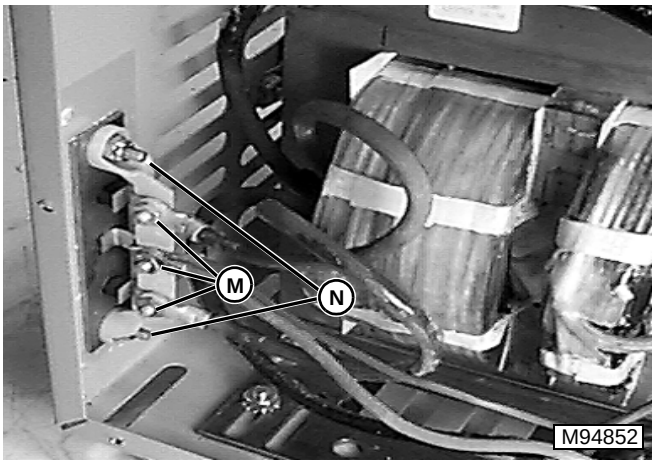


3. Using a well insulated screwdriver (A), touch the shaft of the screwdriver across the two terminals of the capacitor to discharge it.
4. Inspect the charger for any obvious damage, i.e. burned fuse, broken ammeter, burned wiring.
5. Disconnect the two leads (B) from the capacitor, loosen the retaining screw (C), and remove.
6. Mark each wire connection before disconnecting them from the internal components.

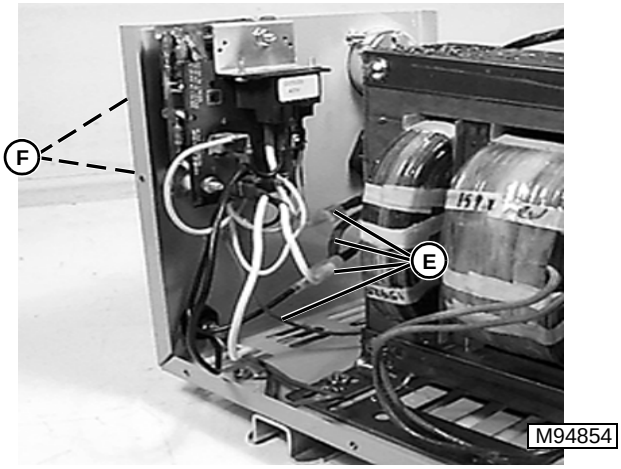


7. Disconnect the AC input wires (D)from the timer circuit board, and the case ground terminal.

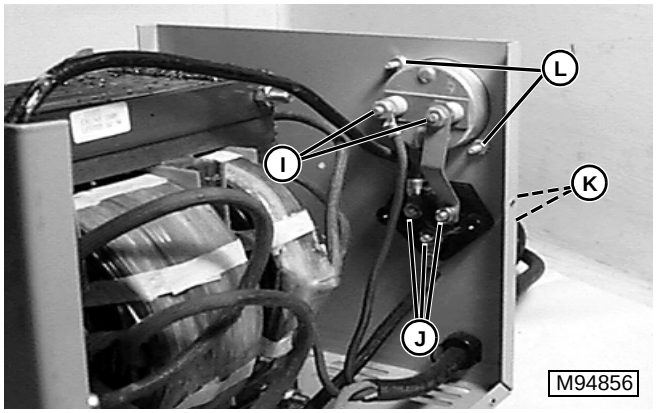
8. Using a pliers to compress the strain relief grommet, pull the AC cord out the front of the cabinet.



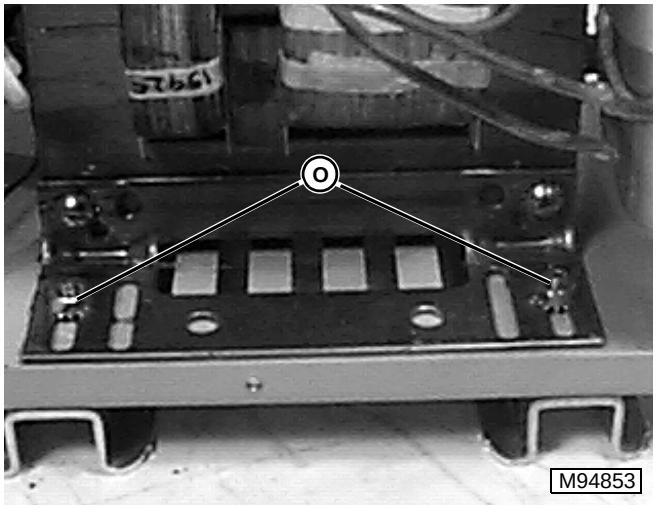
9. Disconnect the four leads (M) on the rectifier and then remove the two capscrews (N) holding the rectifier in place. Remove the clear plastic insulator along with the rectifier.



10. Disconnect the four wires (E) from the timer circuit board and remove the two sheet metal screws (F) that hold the timer in place.

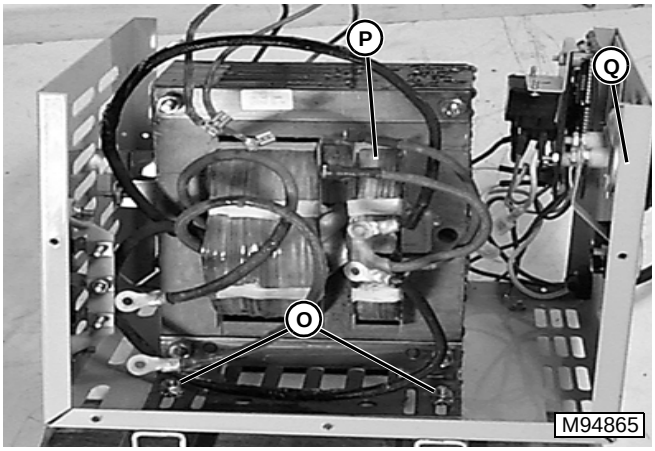


11. Disconnect the two leads (I) connected to the ammeter.
12. Disconnect the three leads (J) connected to the fusible link, and remove the two sheet metal screws (K) holding the fusible link and clear cover in place.
13. Remove the two nuts (L) holding the ammeter in place.
14. With the DC output wires disconnected, use a pliers to compress the strain relief grommet, and pull the DC cord out the front of the cabinet similar to the AC cord.

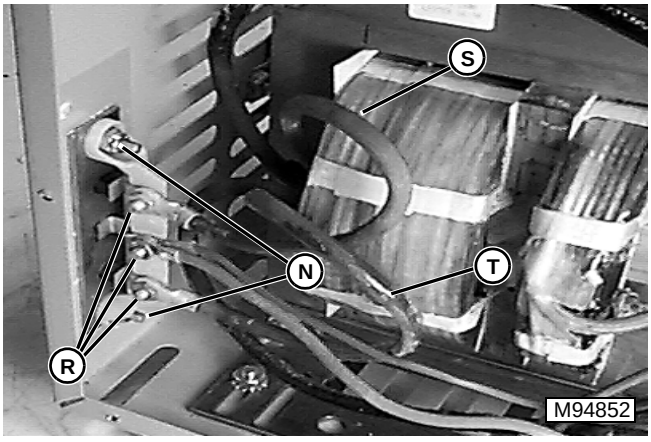


15. Remove the four capscrews (O) that hold the transformer and the support channels to the case.

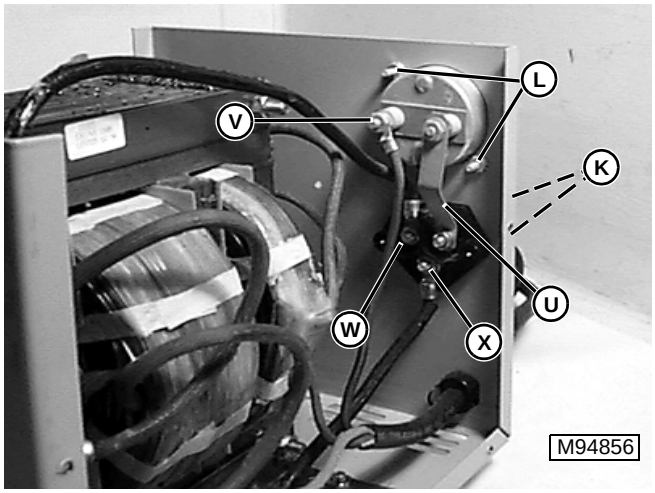
Assembly:



1. Position transformer in case with primary windings (P) (thinner windings) toward the front (Q) cabinet panel. Place support channels in place and fasten together with four capscrews (O) and tighten to **6.6 N•m (60 lb-in.)**.
2. Insert the DC cord into the cabinet so that the insulation sticks into the cabinet about **7.62 cm (3 in.)** and press the strain relief into the front cabinet panel.
3. If needed, thinly coat the clear plastic insulator with heat sink compound and position over rectifier mounting holes.



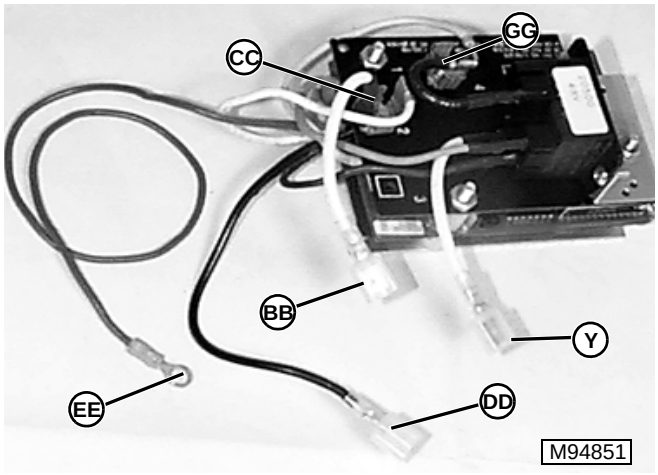
4. Install rectifier so that the terminal mounting studs (R) are facing out. Tighten the mounting capscrews (N) to **2.4 N•m (22 lb-in.)**.
5. Connect the inner tan lead (S) from the transformer secondary windings to the top terminal of the rectifier, and the outer tan lead (T) to the lower terminal. Tighten each terminal to **1.9 N•m (18 lb-in.).**

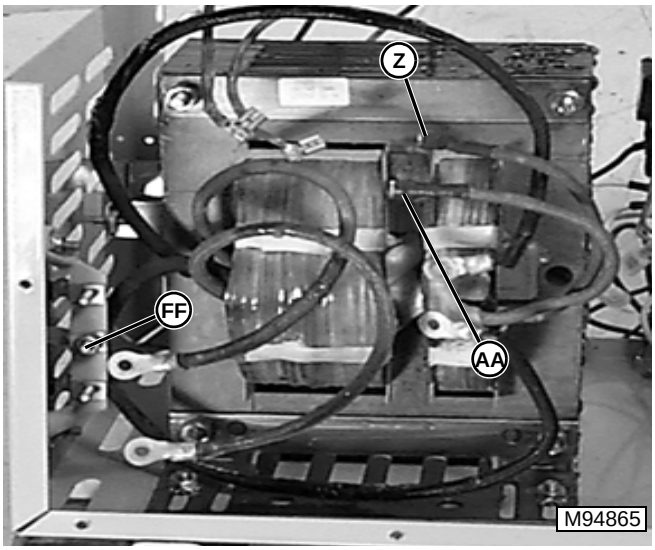


6. Install the ammeter and tighten the two mounting studs (L) to **0.9 N•m (9 lb-in.).**
7. Install the fusible link and tighten the two sheet metal screws (K) to **0.9 N•m (9 lb-in.).**

NOTE: When making connections to the ammeter terminals, DO NOT allow the terminal to rotate as the nut is tightened. This will damage the ammeter. Hold the inner nut and tighten the outer nut to it.

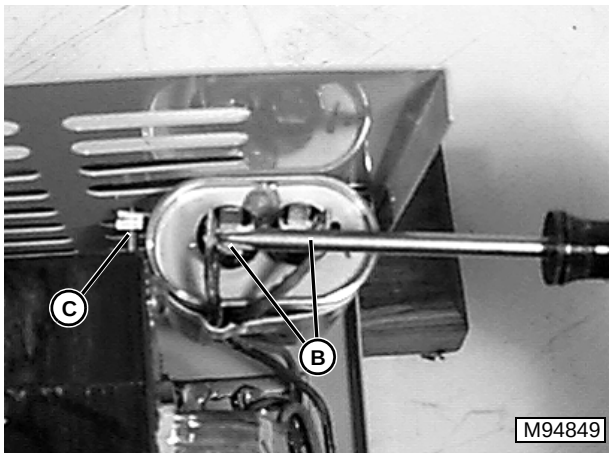
8. Connect the metal strap (U) from the fusible link to the ammeter and tighten the terminals to **2.4 N•m (22 lb-in.).**
9. Connect the black lead from the DC cord set to the inner terminal (V) of the ammeter. Tighten terminal to **2.4 N•m (22 lb-in.)**.
10. Connect the inner black lead from the transformer secondary windings to the upper inboard terminal (W) of the fusible link, and the outer black lead to the lower terminal (X). Torque each terminal to **2.4 N•m (22 lb-in.).**
11. Mount the timer circuit board assembly to the inside front face of the cabinet using the two sheet metal screws, and tighten to **0.9 N•m (9 lb-in.)**.





12. Connect the four wires from the timer circuit board to the proper terminals.
    - Connect the white wire (Y) from the relay connects to the inboard tan (Z) wire from the primary transformer windings.
    - Connect the outboard tan wire (AA) from the transformer primary to the short white jumper (BB) that is connected to terminal (CC) in the timer circuit board.
    - Connect the black wire from the timer circuit board (DD) to the blue wire from the DC cord set.
    - Connect the red wire from the timer circuit board (EE) to the center terminal (FF) of the rectifier along with the red lead from the DC cord set.

13. Insert the AC cord into the cabinet so that the insulation sticks into the cabinet about 2.54 cm (1 in) and press the strain relief into the front cabinet panel.
14. Connect the white AC lead to terminal (CC) on the timer circuit board, and the black AC wire to terminal (GG).
15. Connect the green wire to the case ground screw. The internal tooth washer **must be** positioned over the screw between the case and the terminal. Tighten to **1.9 N•m (18 lb-in.)**.



16. Position the wires for the capacitor through the retainer bracket and plug one wire (B) into each terminal in the capacitor.
17. Slide the capacitor half way down into the retainer, position the wires into the relief notch and tighten the retaining screw (C) to **1.9 N•m (18 lb-in.)**.
18. Slide the cover down onto the charger case. Install the attachment screws, starting with the bottom holes. Tighten the screws to **0.9 N•m (9 lb-in.)**.
19. Test the charger operation, See “BATTERY CHARGER OUTPUT TEST” on page 15.

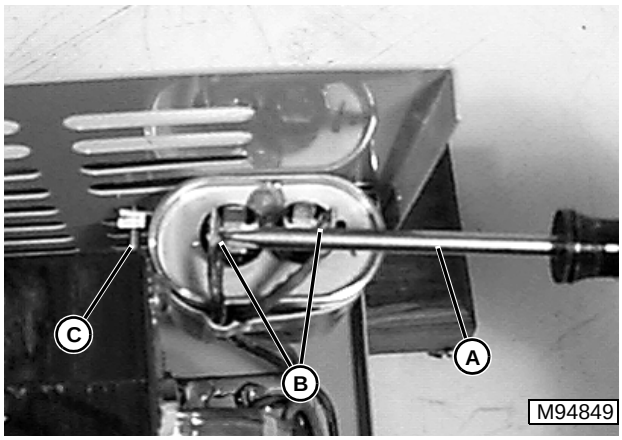
Specification:

Transformer Mounting	**6.6 N•m (60 lb-in.)**
Cover Screws	**0.9 N•m (9 lb-in.)**
Capacitor Mounting Bracket	**1.9 N•m (18 lb-in.)**
Ground Stud	**1.9 N•m (18 lb-in.)**
Timer Circuit Board Mounting	**0.9 N•m (9 lb-in.)**
Fusible Link Mounting	**0.9 N•m (9 lb-in.)**
Fusible Link Terminals	**2.4 N•m (22 lb-in.)**
Ammeter Mounting	**0.9 N•m (9 lb-in.)**
Ammeter Terminals	**2.4 N•m (22 lb-in.)**
Rectifier Mounting	**2.4 N•m (22 lb-in.)**
Rectifier Terminals	**1.9 N•m (18 lb-in.)**

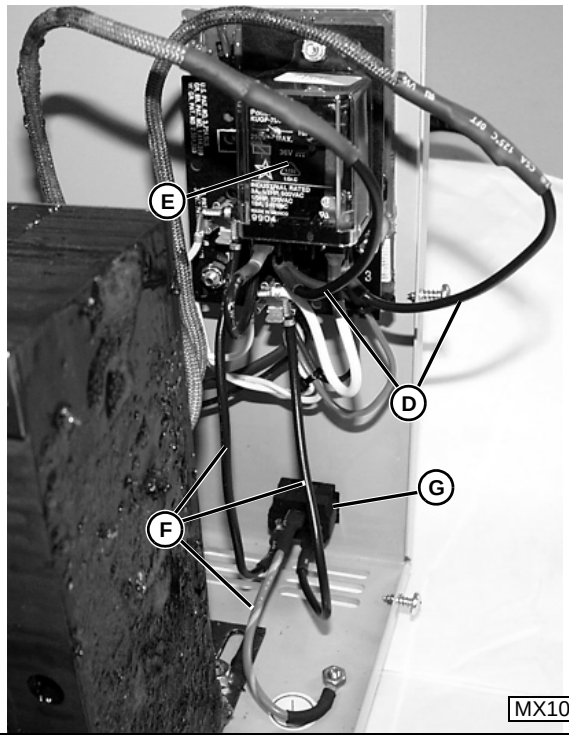
BATTERY CHARGER DISASSEMBLY & ASSEMBLY - EXPORT

Disassembly:

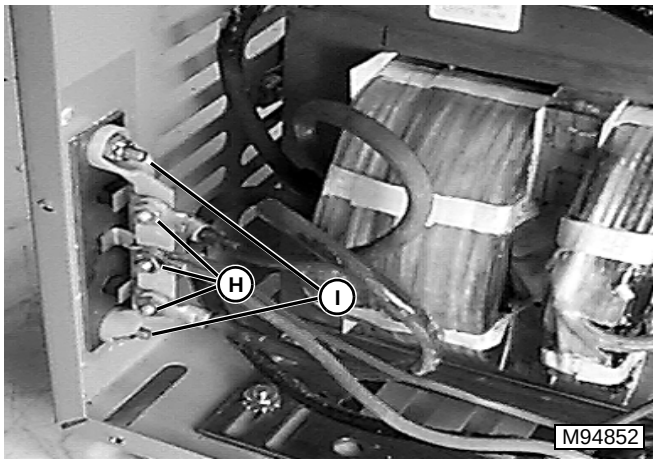
1. Disconnect both the charger AC plug from the outlet and the DC plug from the vehicle receptacle.
2. Remove the ten sheet metal screws, five on each side, that hold the cover on the charger and remove cover.



3. Using a well insulated screwdriver (A), touch the shaft of the screwdriver across the two terminals of the capacitor to discharge it.
4. Inspect the charger for any obvious damage, i.e. burned fuse, broken ammeter, burned wiring.
5. Mark each wire connection before disconnecting them from the internal components.
6. Disconnect the two leads (B) from the capacitor, loosen the retaining screw (C), and remove.

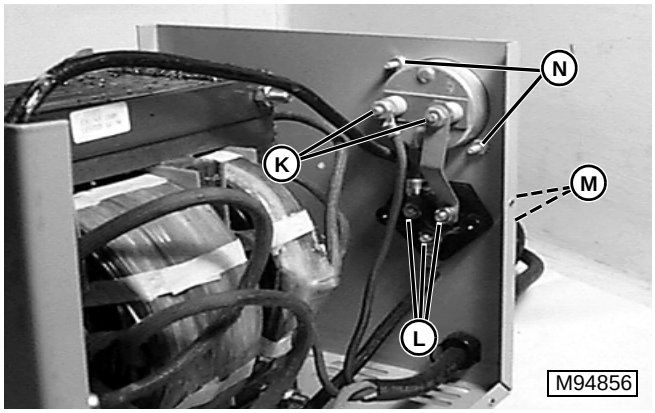


7. Disconnect the two primary transformer leads (D) from the relay (E).
8. Disconnect the AC input wires (F) from the AC plug receptacle (G).
9. Compress the lock tabs on the top and bottom of the AC plug receptacle (E) and push the receptacle out the front of the case.



10. Disconnect the four leads (H) on the rectifier and then remove the two capscrews (I) holding the rectifier in place. Remove the clear plastic insulator along with the rectifier.

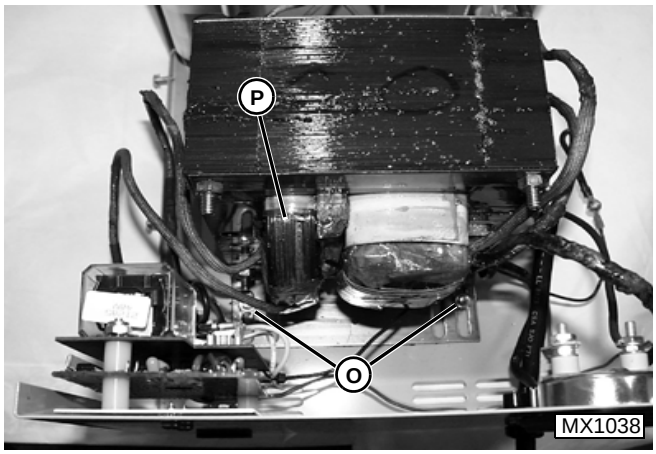
11. Disconnect the black wire connected to the blue wire of the DC cord set (J).
12. Remove the two sheet metal screws that hold the timer in place and remove timer.



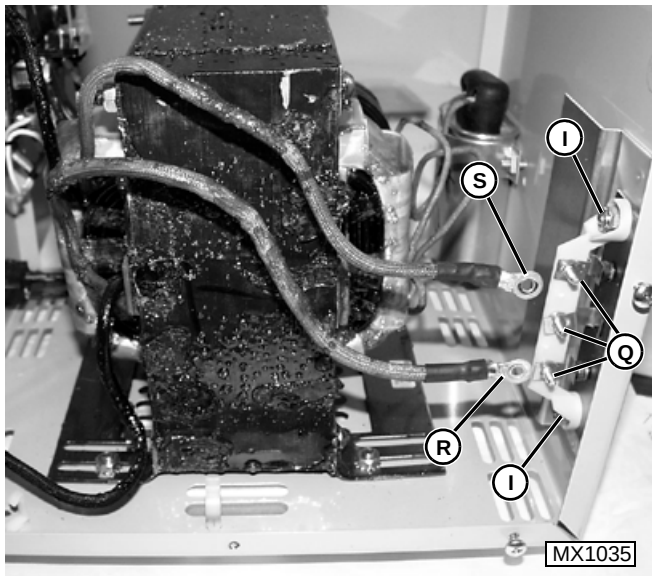
13. Disconnect the two leads (K) connected to the ammeter.
14. Disconnect the three leads (L) connected to the fusible link, and remove the two sheet metal screws (M) holding the fusible link and clear cover in place.
15. Remove the two nuts (N) holding the ammeter in place.
16. With the DC output wires disconnected, use a pliers to compress the strain relief grommet, and pull the DC cord out the front of the cabinet .

17. Remove the four capscrews (O) that hold the transformer and the support channels to the case.

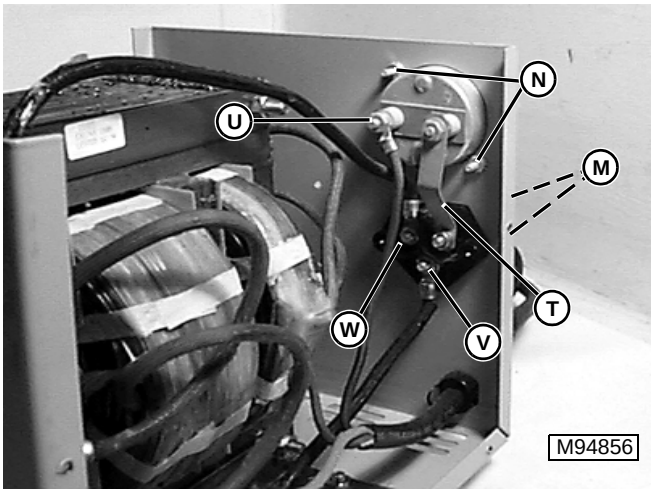
Assembly:



1. Position transformer in case with primary windings (P) (the thinner windings) toward the left side of the case. Place support channels in place and fasten together with four capscrews (O) and tighten to **6.6 N•m (60 lb-in.)**.
2. Insert the DC cord into the cabinet so that the insulation sticks into the cabinet about **7.62 cm (3 in.)** and press the strain relief into the front cabinet panel.
3. If needed, thinly coat the clear plastic insulator with heat sink compound and position over rectifier mounting holes.



4. Install rectifier so that the terminal mounting studs (Q) are facing out. Tighten the mounting capscrew (I) to **2.4 N•m (22 lb-in.)**.
5. Connect the inner tan lead (R) from the transformer secondary windings to the bottom terminal of the rectifier, and the outer tan lead (S) to the top terminal.
   Tighten each terminal to **1.9 N•m (18 lb-in.).**

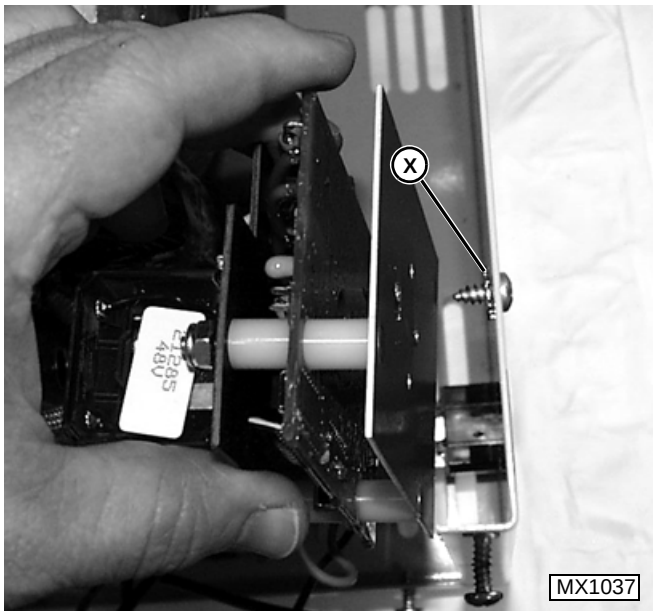


6. Install the ammeter and tighten the two mounting studs (N) to **0.9 N•m (9 lb-in.).**
7. Install the fusible link and tighten the two sheet metal screws (M) to **0.9 N•m (9 lb-in.).**

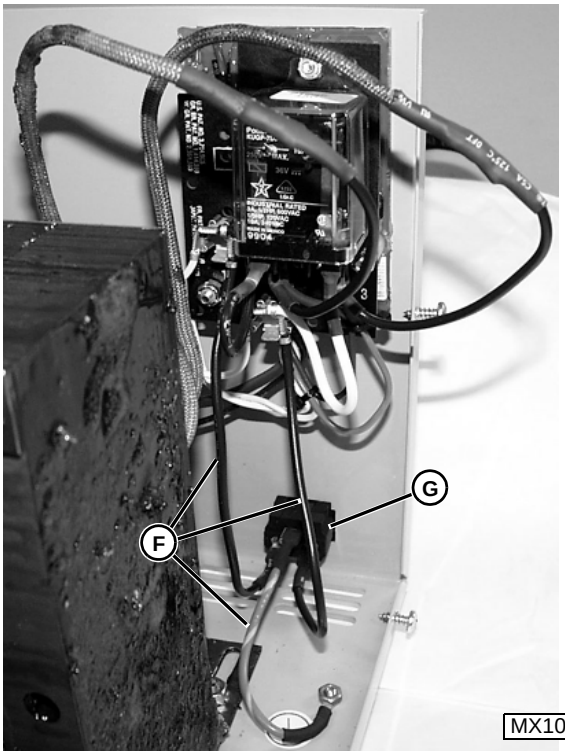
NOTE: When making connections to the ammeter terminals, DO NOT allow the terminal to rotate as the nut is tightened. This will damage the ammeter. Hold the inner nut and tighten the outer nut to it.

8. Connect the metal strap (T) from the fusible link to the ammeter and tighten the terminals to **2.4 N•m (22 lb-in.).**
9. Connect the black lead from the DC cord set to the inner terminal (U) of the ammeter. Tighten terminal to **2.4 N•m (22 lb-in.)**.
10. Connect the inner black lead from the transformer secondary windings to the lower terminal (V) of the fusible link, and the outer black lead to the upper inboard terminal (W). Torque each terminal to **2.4 N•m (22 lb-in.).**

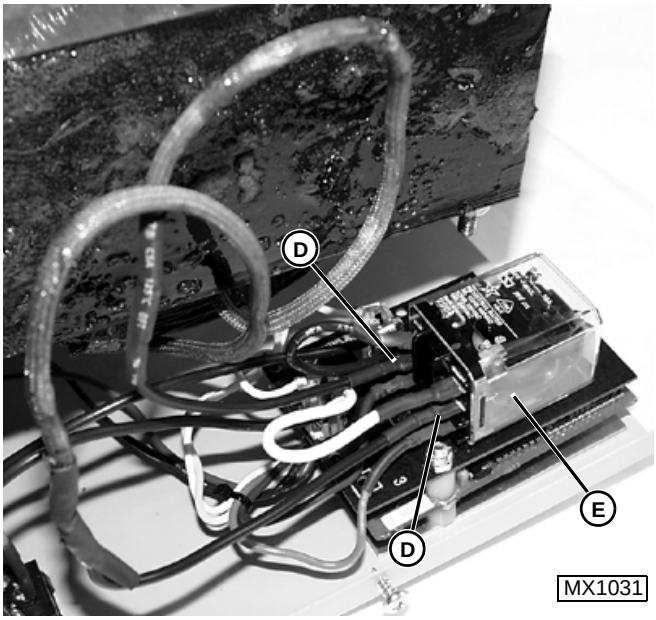
11. Insert the AC plug receptacle into the case with the terminals positioned as shown.



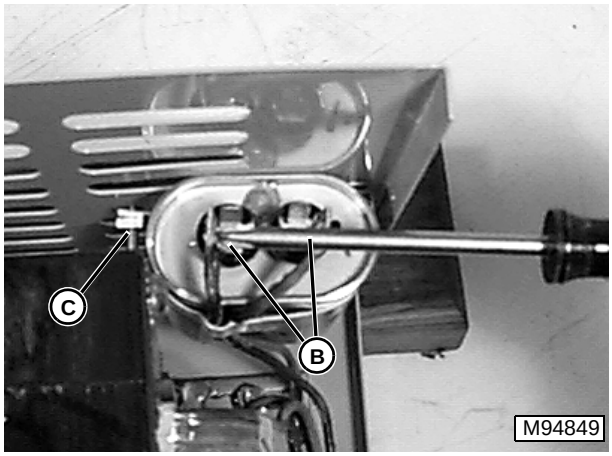
12. Mount the timer circuit board assembly to the inside front face of the cabinet using the two sheet metal screws. The external tooth washer (X) **must be** positioned over the screw between the case and the timer. Tighten to **0.9 N•m (9 lb-in.)**.



13. Connect the AC input wires (F) to the AC plug receptacle (G).
14. If removed, connect the green/yellow wire to the case ground screw. The internal tooth washer **must be** positioned over the screw between the case and the terminal. Tighten to **1.9 N•m (18 lb-in.)**.



15. Connect the leads (D) from the transformer primary windings into the relay (E).
16. Connect the black wire from the timer circuit board to the blue wire from the DC cord set.
17. Connect the red wire from the timer circuit board to the center terminal of the rectifier along with the red lead from the DC cord set.



18. Position the wires for the capacitor through the retainer bracket and plug one wire (B) into each terminal in the capacitor.
19. Slide the capacitor half way down into the retainer, position the wires into the relief notch and tighten the retaining screw (C) to **1.9 N•m (18 lb-in.)**.
20. Slide the cover down onto the charger case. Install the attachment screws, starting with the bottom holes. Tighten the screws to **0.9 N•m (9 lb-in.)**.
21. Test the charger operation, See “BATTERY CHARGER OUTPUT TEST” on page 15.

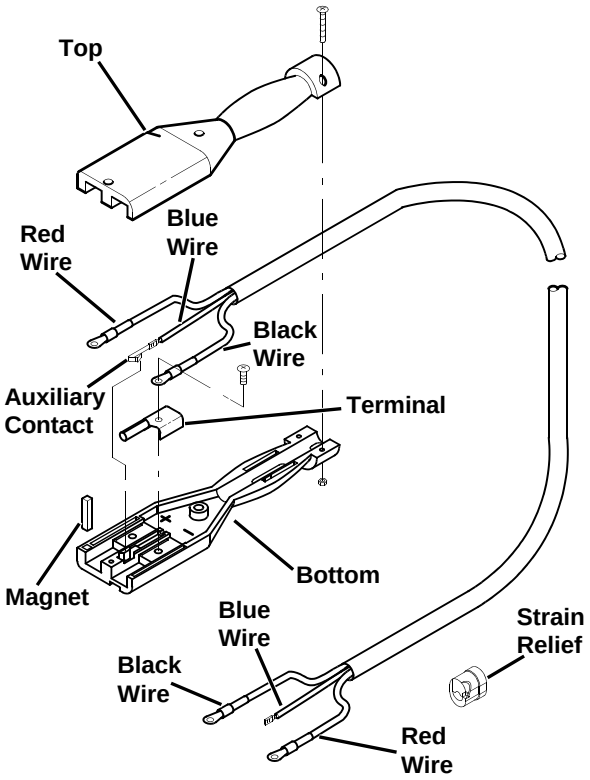
Specification:

Transformer Mounting . . . . . 6.6 N•m (60 lb-in.)
Cover Screws . . . . . 0.9 N•m (9 lb-in.)
Capacitor Mounting Bracket . . . . 1.9 N•m (18 lb-in.)
Ground Stud . . . . . 1.9 N•m (18 lb-in.)
Timer Circuit Board Mounting . . . 0.9 N•m (9 lb-in.)
Fusible Link Mounting . . . . . 0.9 N•m (9 lb-in.)
Fusible Link Terminals . . . . . 2.4 N•m (22 lb-in.)
Ammeter Mounting . . . . . 0.9 N•m (9 lb-in.)
Ammeter Terminals . . . . . 2.4 N•m (22 lb-in.)
Rectifier Mounting . . . . . 2.4 N•m (22 lb-in.)
Rectifier Terminals . . . . . 1.9 N•m (18 lb-in.)

BATTERY CHARGER PLUG DISASSEMBLY & ASSEMBLY

Disassembly:

1. Disconnect the charger from both the AC outlet and the vehicle.
2. Position the plug so that the screws are up.
3. Remove the four screws and nuts holding the plug together.
4. Carefully pull the top up and away from the bottom and the wires.



5. Remove the magnet.

NOTE: DO NOT allow the magnet to get near other strong magnetic fields. DO NOT drop the magnet. Place in a non ferrous container while plug is disassembled. Failure to follow these precautions could cause damage to the magnet.

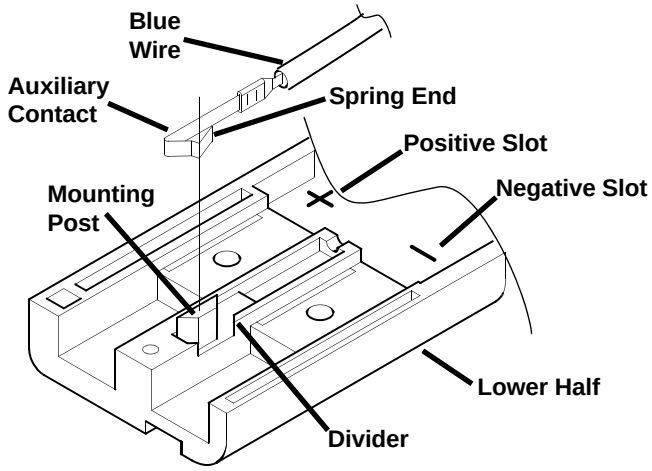
6. Note or mark the position of each wire and how the terminals are installed.
7. Remove the two screws holding the wires to the terminals.
8. Clean and replace the terminals if damage is present, such as, the threads are striped, terminal is worn or corroded.
9. If damage is found on the wire harness or wire terminals, replace the wire harness.
10. Replace the top or bottom halves if cracked, broken or other damage is present.

Assembly:

1. Lay bottom half of plug flat.
2. Place terminals in bottom half of plug.
3. Place wires in bottom so that the red wire is in the positive (+) slot (slot closest to magnet) and the black wire is in the negative (-) slot.
4. Route the wires to clear the supports. Attach wires to terminals so that the wires come straight off the back of the terminals when tightened.

IMPORTANT: Failure to properly tighten the terminal connections to specification could cause heating that can burn wiring causing a fire.

5. Attach the red wire from the harness to the positive terminal and tighten to **1.65-2.2 N•m (15-20 lb-in.)**.
6. Attach the black wire to the negative terminal and tighten to **1.65-2.2 N•m (15-20 lb-in.)**.



7. Be sure that the auxiliary contact terminal from the Blue wire is correctly installed around the mounting post and the spring end behind the divider.
8. Place magnet in bottom half.
9. Carefully set top half on lower half watching so that the wires do not become pinched. Wires must come straight off the back of the terminals to be properly positioned.
10. Firmly squeeze together the two halves and fasten with the four screws and nuts. Tighten to a maximum of **1.1 N•m (10 lb-in.)**.
11. Test the system using the "BATTERY CHARGER OUTPUT TEST" on page 15.

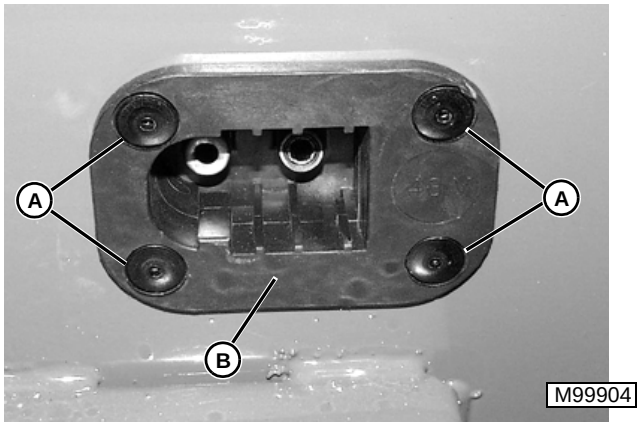
Specification:

Plug Terminals Screws . . 1.65-2.2 N•m (15-20 lb-in.)
Plug Cover Screws. . . .maximum 1.1 N•m (10 lb-in.)

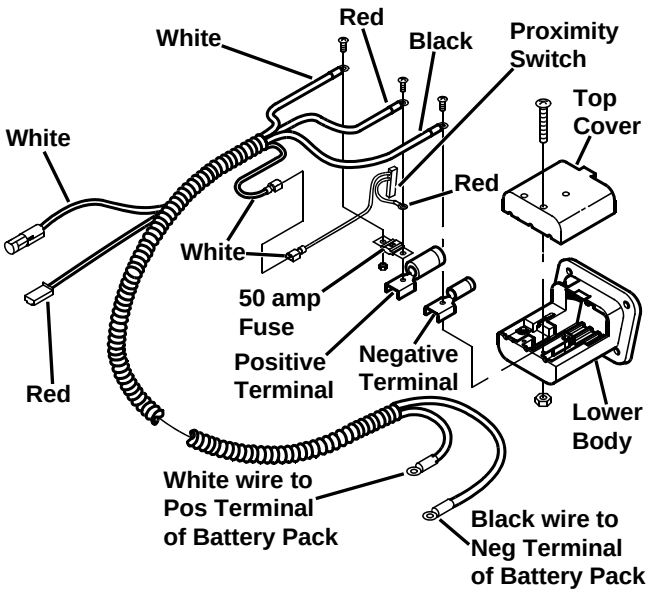
BATTERY CHARGER RECEPTACLE DISASSEMBLY & ASSEMBLY

Disassembly:

1. Disconnect the charger from vehicle.
2. Position the vehicle on a level surface.
3. Set the parking brake, turn the key switch to the off position, and place the shift lever in the neutral position.
4. Raise the cargo bed and secure.
5. Set Service/Drive switch to Service position.
6. Disconnect the wires from the battery set positive terminal and position them so that they can not touch anything.



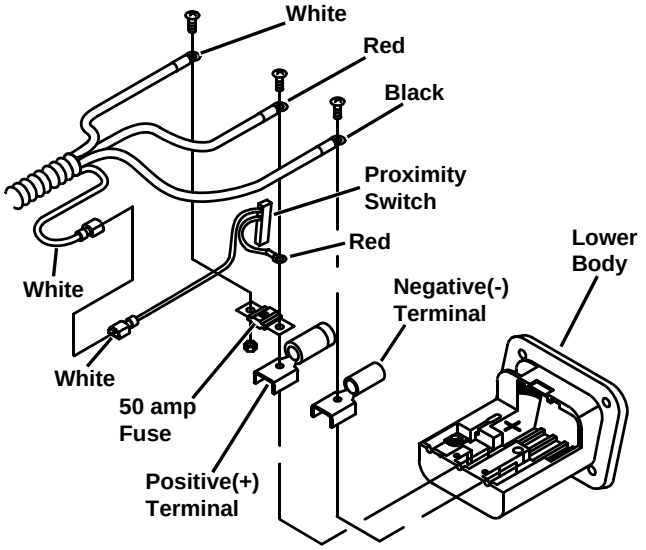
7. Using a **6.35 mm (0.25 in.)** drill, drill out the head of the four rivets (A) holding the receptacle (B) to the frame. DO NOT drill all the way through the body of the receptacle or the vehicle. This will cause the mounting holes to be oversized and need special fasteners to mount the receptacle.
8. Pull the receptacle out of the body far enough to gain access to the top cover. Be careful not to pull the receptacle out too far and damage the wires.



9. Position the receptacle so that the screws are up.
10. Remove the three screws and nuts holding the cover on the receptacle.
11. Carefully pull the top cover up and away from the lower body and the wires.
12. Note or mark the position of each wire.
13. Clean and replace the terminals if damage is present, such as, striped threads or corroded terminals.
14. Replace the top or bottom halves if cracked, broken or other damage is present.
15. Remove the screw holding the fuse to the positive terminal and screw and nut holding it to the white wire.
16. Replace **50 amp fuse**, if needed.

Assembly:

1. Place terminals in lower body of receptacle.
2. Place proximity switch in lower body.



3. Place wires in bottom so that the red wire is in the positive (+) slot and the black wire is in the negative (-) slot as shown above.
4. Route the red and black wires straight off the back of the terminals so that they clear the supports on the top and lower body.

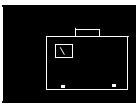
IMPORTANT: Failure to properly tighten the terminal connections to specification could cause heating that can burn wiring causing a fire.

5. Attach the white wire to one end of the fuse at a right angle to the fuse so that the other end of the fuse will be aligned with the mounting hole on the positive terminal. Tighten the screw and nut to **1.65-2.2 N•m (15-20 lb-in.)**.
6. Attach the red wires from the harness and the proximity switch along with the fuse to the positive terminal and tighten to **1.65-2.2 N•m (15-20 lb-in.)**.
7. Attach the black wire to the negative terminal and tighten to **1.65-2.2 N•m (15-20 lb-in.)**.
8. Carefully set top cover on lower body watching so that the wires do not become pinched. Wires must come straight out the back of the body to be properly positioned.
9. Firmly squeeze together the two halves and fasten with the three screws and nuts. Tighten to a maximum of **1.1 N•m (10 lb-in.)**.
10. Carefully slide the wires and receptacle back into the vehicle body. Watch so that the wire harness does not get tangled, pinched or caught on any other components that may damage it.
11. Rivet the receptacle back into the body using four rivets.
12. Connect the wires to the battery set positive terminal.
13. Set Service/Drive switch to Drive position.
14. Test the system by turning the headlights ON to see if the operate. If the headlights operate, the system should be working properly.

Specification:

Receptacle Terminal Screws
. . . . . .1.65-2.2 N•m (15-20 lb-in.)
Receptacle Cover Screws
. . . . . .maximum 1.1 N•m (10 lb-in.)

NOTES:



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M

SPECIFICATIONS

MOTOR:

Type	Separately Excited D.C. Motor
Voltage	48 VDC
Insulation Class	H 180°C

TORQUE SPECIFICATIONS

Motor:

A1 & A2 Terminals	10 - 12 N•m (90 - 110 lb-in.)
E1 & E2 Terminals	4 - 5 N•m (40 - 50 lb-in.)
Pole pieces screws	27.5 - 33 N•m (250 - 300 lb-in.)
Brush Mounting Plate	2.4 N•m (22 lb-in.)
Motor Thru Bolts	10 N•m (89 lb-in.)
Brush Leads	2.4 N•m (22 lb-in.)
Sensor Magnet	1.9 N•m (18 lb-in.)
Speed Sensor	1.9 N•m (18 lb-in.)
Motor to Transaxle	15.4 N•m (140 lb-in.)

REPAIR SPECIFICATIONS

Brush Spring Tension:

New Brush	1820 grams (65 oz)
Worn Brush	1120 grams (40 oz)

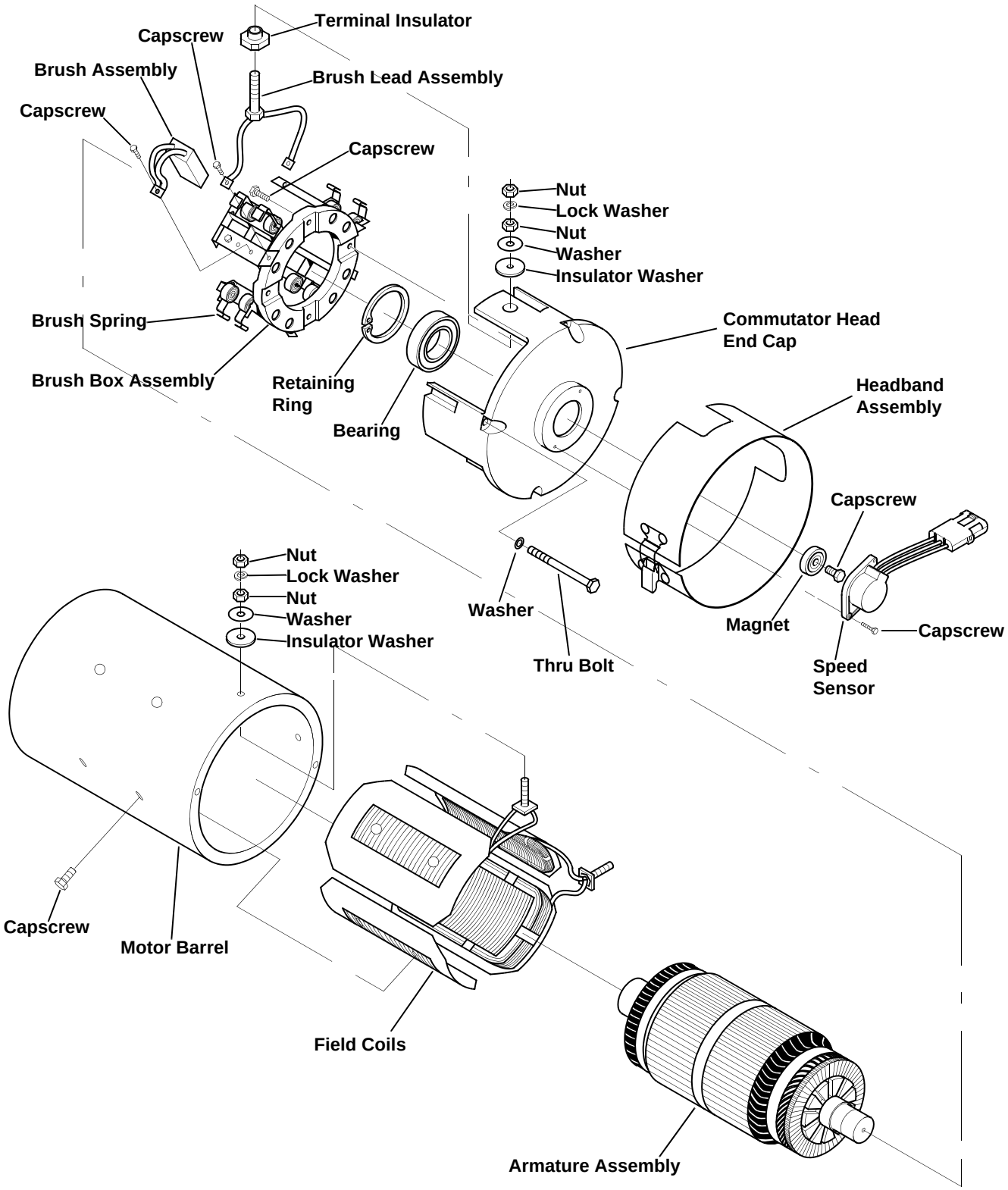
Brush Length:

Brush minimum length	16 mm (0.62 in.)

Commutator Dimensions:

Commutator minimum diameter	70 mm (2.75 in.)
Commutator maximum runout	0.076 mm (0.003 in.)
Commutator maximum variation bar to bar	0.025 mm (0.001 in.)

MOTOR COMPONENT LOCATION



MOTOR THEORY AND OPERATION

Purpose:

The purpose of the electric motor is to control and monitor the motion of the utility vehicle. The electric motor is the device that converts the electric operation of the vehicle to the mechanical operation.

The motor is equipped with a magnetically operated sensor. This sensor along with the motor armature and field windings provide the motion control.

While the obvious function of the motor is to propel the vehicle in a forward or reverse direction, other functions include Overspeed control, Rollaway control, Anti-Rollback control, and Compression Braking.

Theory:

The electric motor is a 48VDC separately excited motor. It has a separate power circuit for the armature and the field windings.

During operation the armature receives constant polarity from the motor controller while the polarity to the field windings will change depending on the position of the shift lever.

Speed of the motor is controlled by the motor controller and is based on the position of the accelerator.

Drive:

To propel the vehicle in either forward or reverse the following conditions must be met:

- Battery charger disconnected from vehicle
- Service/Drive switch in Drive position
- Key switch on
- Park brake off
- Shift lever placed in a direction
- Accelerator pedal pressed (particially to full travel)

When selecting a drive function the armature of the motor receives power from the motor controller B+ terminal to the motor A1 terminal. The ground circuit is supplied from the motor A2 terminal back to the motor controller M- terminal. The amount of current that is allowed to flow to the motor armature is regulated by the motor controller based on the position (how far it is pressed) of the accelerator pedal. This gives the operator proportional speed control up to the maximum speed of the vehicle.

The field windings receive power from the motor controller at this same time. The polarity of the voltage supplied to the field windings changes depending on the position of the shift lever. By changing the polarity of the current to the field windings, the magnetic field of the motor changes, allowing the armature to spin in either direction. This ability to change directions translates to forward or reverse travel.

When forward is selected, power will flow from the F1 terminal of the motor controller through the black cable to the E1 terminal of the motor. The return will be from the E2 terminal of the motor through the white cable to the F2 terminal of the motor controller.

This flow is opposite when the reverse function is selected.

Overspeed Control:

Overspeed control is needed when driving the vehicle down slopes in terrain or ramps. When the vehicle is traveling, the combination of accelerator pedal position, current supplied to the armature of the motor and the speed measured by the speed sensor on the motor indicate to the motor controller if the drive system is operating within acceptable limits. When the speed sensor indicates to the motor controller that the motor is operating at a speed faster than the accelerator input is indicating, the motor controller will use the motor's natural counter EMF (electro motor force) to place a load on the motor causing it to slow.

Rollaway Control:

A rollaway function has been incorporated into the electrical system through the motor controller. This function occurs after the operator has released the accelerator pedal for more than ten seconds and is based on the motor controller reading the accelerator as being in the off position with no power to the motor armature and field winding and the speed sensor indicating the motor is not turning (vehicle stopped). If the vehicle now starts to move, because it starts to coast down a slope or is being pushed or pulled, and the accelerator continues to indicate that it is in the off position, the motor and speed sensor will indicate movement. The motor controller will use the motors natural counter EMF (electro motor force) to place a load on the motor causing it to resist the movement. At the same time the system alarm will give a continuous beeping indicating that the vehicle is reading motion. The operator is then reminded to use the foot brake to hold the vehicle if stopped momentarily or the park brake if leaving the vehicle.

Anti-Rollback Control:

Anti-rollback control has been incorporated into the electrical system through the motor controller to cause the vehicle's drive system to resist movement if the operator is driving and within ten seconds after releasing the accelerator pedal the vehicle stops but then starts to roll in either direction. If the vehicle starts to move because it starts to rollback on a slope and the accelerator continues to indicate that it is in the off position, the motor and speed sensor will indicate movement. While the system alarm will not sound the motor controller will use the motor's natural counter EMF (electro motor force) to place a load on the motor causing it to resist the movement. The operator must use the foot brake to hold the vehicle if stopped momentarily or the park brake if leaving the vehicle.

Compression Braking:

Compression braking is a function of a combination of electrical components used to assist in controlling the coast or decceleration of the vehicle. There are two levels of compression braking.

The first level of compression braking occurs during the moment between the operator letting off of the throttle and pressing the brake pedal to bring the vehicle to a stop. While the brakes are intended to be used to stop the vehicle, this level of compression braking will feel smooth and similar to that of light to moderate braking.

The motor controller is reading the inputs from the throttle, directional switches, park brake switch, motor armature and field winding, and the speed sensor. When the operator lets the throttle pedal return to the off position while the vehicle is still moving, the motor controller reads the sequence of events to control the coast or decceleration of the vehicle until the operator has pressed the brakes to come to a complete stop. The motor controller uses the motor's natural counter EMF (electro motor force) to place a load on the motor causing it to resist the movement. The motor controller reads this as the operator letting off of the throttle to come to a stop, the reverse/warning alarm does not sound.

The second level of compression braking occurs when during a drive function the directional lever is shifted to neutral or the opposite direction, the park brake is engaged, or the key switch is turned to the OFF position. While the brakes are intended to stop the vehicle, this second level of compression braking is more aggressive in nature and may feel similar to that of moderate to severe braking.

The motor controller is again reading the inputs from the throttle, directional switches, park brake switch, motor armature and field winding, and the speed sensor. However in this condition the operator has not let the throttle pedal return to the off position. The input signal to the motor controller from either the directional switch, the park brake switch, or the key switch has been changed while the vehicle is still moving. The motor controller reads the sequence of events to control the coast or decceleration of the vehicle until the operator has pressed the brakes to come to a complete stop. The motor controller uses the motor's natural counter EMF (electro motor force) to place a load on the motor causing it to resist the movement. The motor controller reads this as a shut down condition with the operator present. The vehicle aggressively assists in slowing the vehicle but the reverse/warning alarm does not sound.

INSPECTING AND TESTING ELECTRIC MOTOR

EXTERNAL MOTOR INSPECTION

Reason:

The visual inspection is intended to find and correct potential problems before they create more serious safety and operational concerns.

Procedures:

Routine motor inspection shall include but not be limited to:

- Discolored or melted terminal boots
- Burn spots
- Clean, tight terminal studs and mounting bolts
- Check for any signs of oil leaks
- Make visual inspection of brush and commutation area. Remove head band for clear, proper viewing.

If any signs of wear or damage are found during the visual inspection the vehicle shall be removed from service and properly identified for repairs. Refer to the proper section in the technical manual to effect the repair.

EXTERNAL MOTOR TEST

Reason:

To verify the electrical integrity of the motor.

Equipment:

- Volt/Ohm Meter

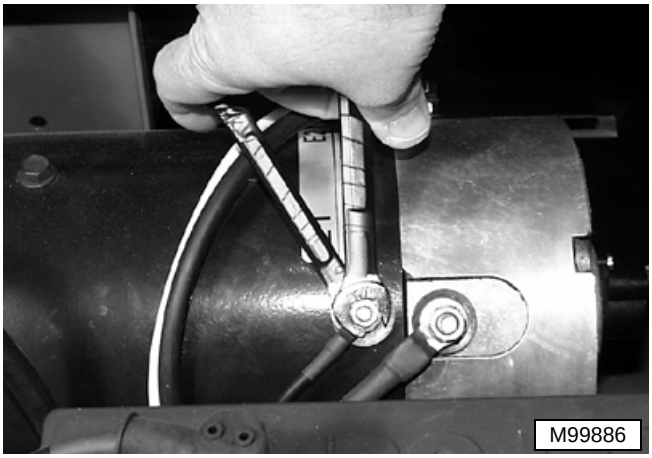
⚠ CAUTION

Always use insulated tools when working with or near the electrical system and batteries. Wrap tools with vinyl tape to prevent shorting out a battery(s).

INTERNAL SHORTS

Procedures:

1. Park machine on level surface.
2. Turn key switch to OFF position.
3. Move shift lever to NEUTRAL position.
4. Engage park brake.
5. Raise cargo bed and secure.
6. Place service/drive switch in service position.
7. Remove the wires from the battery set positive terminal.

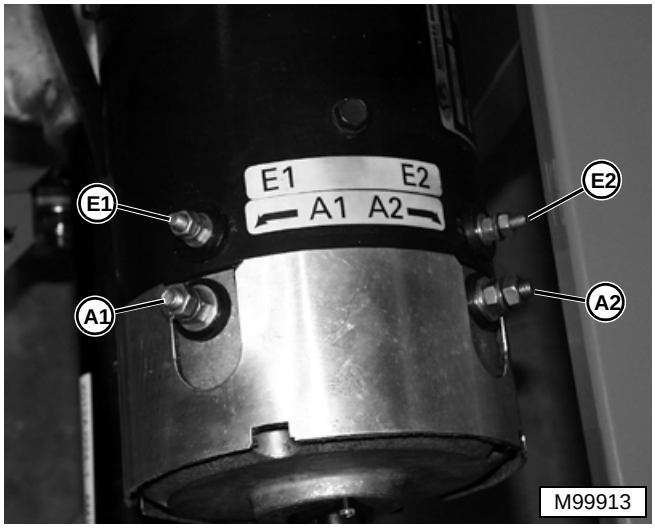


8. Note the position of each wire on the motor. Mark the wires if needed.

NOTE: When making connections to the motor terminals, DO NOT allow the terminal to rotate as the nut is loosened or tightened. This will damage the brush lead assembly.
Hold the inner nut and loosen or tighten the outer nut to it.

IMPORTANT: DO NOT allow either the E1 or E2 wires to contact either the A1 or A2 wires. This will cause an arc that will damage the motor controller.

9. Using two insulated wrenches to prevent the post from turning, remove the wires from the motor terminals as listed:
- Remove the black E1 motor lead and wrap the terminal with vinyl tape.
- Remove the white E2 motor lead and wrap the terminal with vinyl tape.
- Remove the both the A1 and A2 motor leads.



M

10. Using a multimeter set to ohms, follow the chart to sequentially test continuity across each terminal and case combination.

The red lead position of the VOM is listed across the top of the chart and the black lead position of the VOM is listed down the side of the chart.

Results:

Case to Terminals:

Multimeter should indicate NO CONTINUITY from the case to any of the terminals.

If the readings are incorrect from case to the A1 or A2 terminals there are three problems likely:

- A grounded A1 or A2 terminal
- A grounded wire in the brush area
- A grounded armature/commutator

If the readings are incorrect from case to the E1 or E2 terminals there are two problems likely:

- A grounded E1 or E2 terminal
- A grounded field coil

A1 and A2 Terminals:

Multimeter should indicate CONTINUITY between the A1 and A2 terminals.

If the readings are incorrect between the A1 or A2 terminals there could be:

- An open circuit in the brush assembly or wires
- And/or open armature windings.

Multimeter should indicate NO CONTINUITY between the “A” terminals and either of the “E” terminals or the case.

If the readings are incorrect between the “A” terminals and the “E” terminals there could be:

- A short between the armature and the field coil

E1 and E2 Terminals:

Multimeter should indicate CONTINUITY between the E1 and E2 terminals.

If the readings are incorrect between the E1 or E2 terminals there could be:

- An open field coil
- A bad terminal connection(s)

Multimeter should indicate NO CONTINUITY between the “E” terminals and either of the “A” terminals or the case.

If the readings are incorrect between the “E” terminals and the “A” terminals there could be:

- A short between the field coil and the armature

If the readings are incorrect, the motor will need to be removed from the vehicle and repaired. See “MOTOR REMOVAL & INSTALLATION” on page 9.

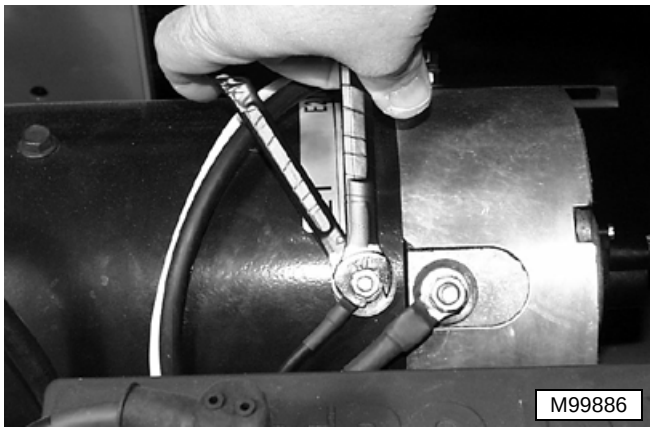
	Red to A1	Red to A2	Red to E1	Red to E2	Red to Case
Black to A1		Continuity	O.L.	O.L.	O.L.
Black to A2	Continuity		O.L.	O.L.	O.L.
Black to E1	O.L.	O.L.		Continuity	O.L.
Black to E2	O.L.	O.L.	Continuity		O.L.
Black to Case	O.L.	O.L.	O.L.	O.L.	

REPAIR

MOTOR REMOVAL & INSTALLATION

Removal:

1. Park machine on level surface.
2. Turn key switch to OFF position.
3. Move shift lever to NEUTRAL position.
4. Engage park brake.
5. Raise cargo bed and secure.
6. Place service/drive switch in service position.
7. Remove the wires from the battery set positive terminal.
8. Remove cargo bed. See “CARGO BOX REMOVAL & INSTALLATION” on page 8 in the MISC SECTION.



9. Note the position of each wire on the motor. Mark the wires if needed.

NOTE: When making connections to the motor terminals, DO NOT allow the terminal to rotate as the nut is loosened or tightened. This will damage the brush lead assembly.
Hold the inner nut and loosen or tighten the outer nut to it.

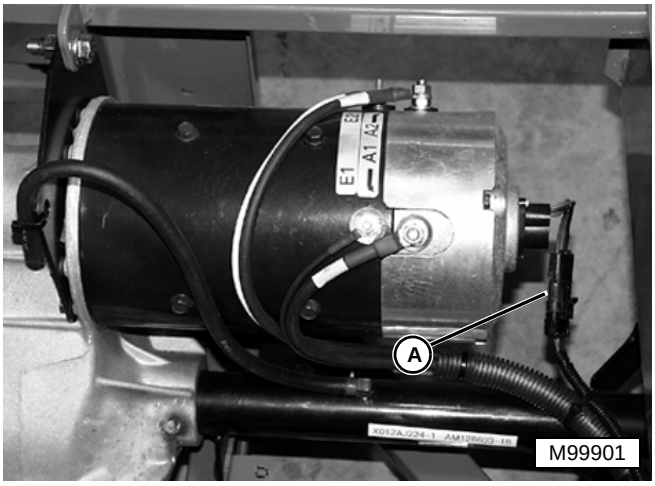
IMPORTANT: DO NOT allow either the E1 or E2 wires to contact either the A1 or A2 wires. This will cause an arc that will damage the motor controller.

10. Using two insulated wrenches to prevent the post from turning, remove the wires from the motor terminals as listed:
    - Remove the black E1 motor lead and wrap the terminal with vinyl tape.
    - Remove the white E2 motor lead and wrap the terminal with vinyl tape.
    - Remove the both the A1 and A2 motor leads.

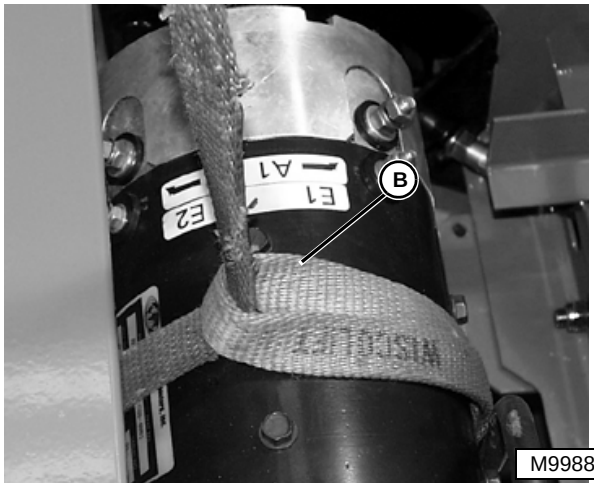
⚠ CAUTION

Electric Motor is heavy. Always use proper lifting techniques when moving it. When lifting motor, use a sling or an assistant.

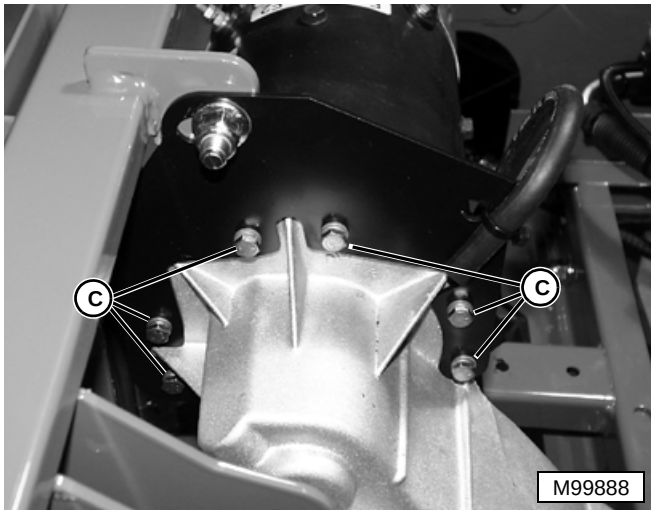
DO NOT place fingers or hands under motor during removal and installation. Severe injury could result if fingers or hands are caught between the motor and axle tube.



11. Unplug the connector (A) from the main wiring harness to the motor speed sensor.



12. Place a sling or belt (B) around the motor to support and lift it while removing the mounting capscrews. Do not place hands or fingers under motor.

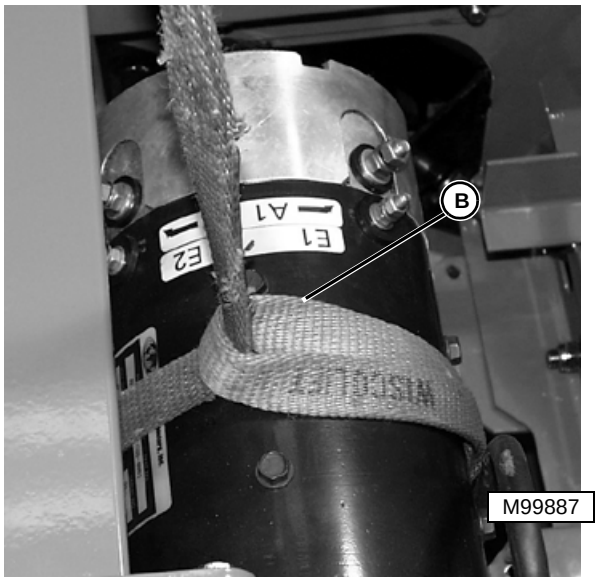


M

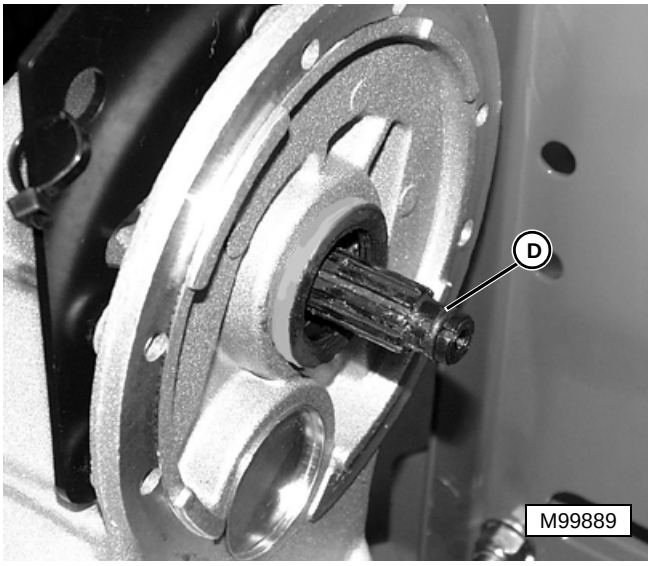
13. Note the position of the terminals on the motor so that the motor is installed in the same position.
14. Remove the six capscrews (C) holding the motor to the differential case.
15. Lifting slightly slide the motor off the differential input shaft and lift out of vehicle.

Installation:

1. Lightly coat the differential input shaft with molybdenum disulfide grease.

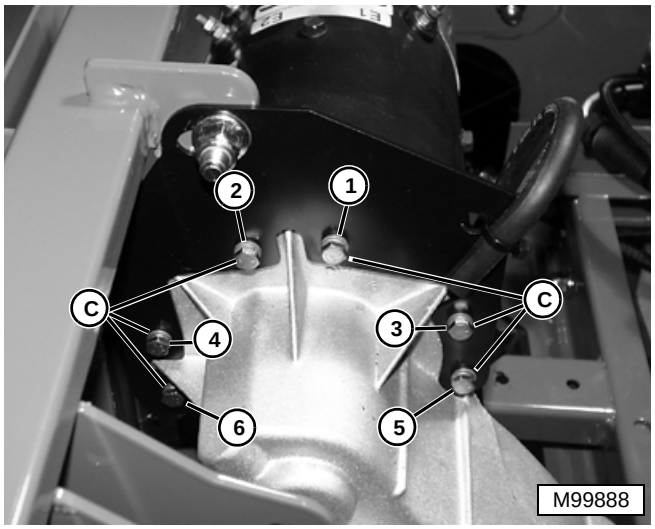


2. Position sling (B) on motor so that the terminals are on top of the motor when the motor is mounted into the vehicle. If the terminals are not positioned on top they could puncture the battery case or be positioned so that the wires will not reach the terminals properly.
3. Coat the outside of the armature output shaft with a light amount of motor oil.



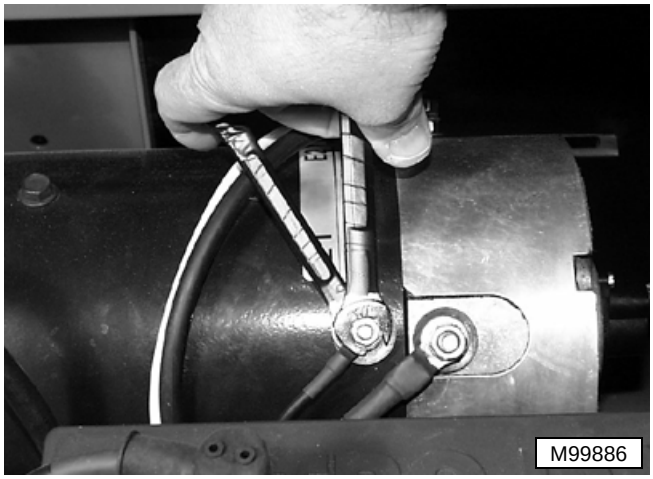
4. Check to be sure that O-ring (D) is on the end of the differential input shaft.
5. Carefully lift the motor in place and slide on input shaft until fully seated. It may be necessary to rotate the motor as you are aligning the splines of the motor and differential shafts.

6. Keeping the terminals toward the top, rotate the motor case until the mounting holes in the differential case line up with the motor case.



NOTE: Keep upward pressure on the back end of the motor until the initial torque has been completed.

7. Install the six capscrews (C) and lock washers.
8. Using the pattern shown in the picture tighten the mounting capscrews to an initial torque of **9 N•m (80 lb-in.)** to hold the motor in place.
9. Release the park brake and push the vehicle forward and reverse, **25 - 30 cm (10 - 12 in.)** to make sure the motor in not binding on the transaxle input shaft.
10. Using the pattern shown in the picture tighten the mounting capscrews to a final torque of **10.4 - 15 N•m (100 - 130 lb-in.)**.



IMPORTANT: DO NOT allow either the E1 or E2 wires to contact either the A1 or A2 wires. This will cause an arc that will damage the motor controller.

11. Matching each wire to the proper terminal on the motor, install the wires, lock washers and nuts finger tight on the motor terminals as listed:
    - Install both the A1 and A2 motor leads.
    - Remove the vinyl tape from the terminal and install the black E1 motor lead.
    - Remove the vinyl tape from the terminal and install the white E2 motor lead.

NOTE: When making connections to the motor terminals, DO NOT allow the terminal to rotate as the nut is loosened or tightened. This will damage the brush lead assembly.
Hold the inner nut and loosen or tighten the outer nut to it.

12. Using two wrenches hold the inner nut and tighten the outer nut to it.
    Tighten the A1 and A2 terminals to **10 - 12 N•m (90 - 110 lb-in.).**
    Tighten the E1 and E2 terminals to **4 - 5 N•m (40 - 50 lb-in.)**.
13. Install cargo bed. See “CARGO BOX REMOVAL & INSTALLATION” on page 8 in the MISC SECTION.
14. Install the wires onto the battery set positive terminal. Tighten to **14 - 16 N•m (124 - 142 lb-in.)**.
15. Operate the vehicle to test the motor.

Specifications:

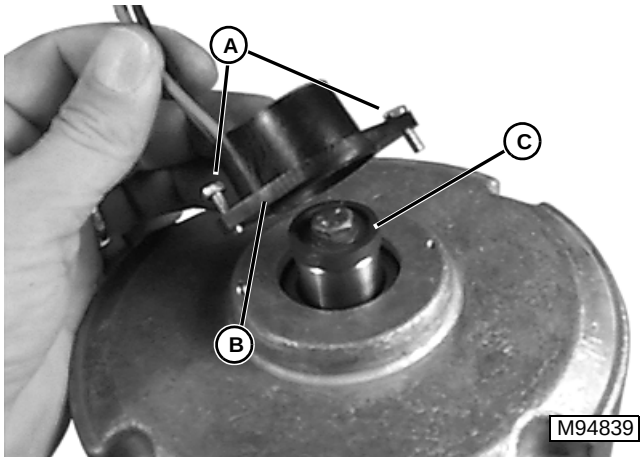
Motor to Transaxle . . . . . 15.4 N•m (140 lb-in.)
A1 and A2 Terminals . . .10 - 12 N•m (90 - 110 lb-in.)
E1 and E2 Terminals . . . . . .4 - 5 N•m (40 - 50 lb-in.)
Battery Terminals . . . . 14 - 16 N•m (124 - 142 lb-in.).

M

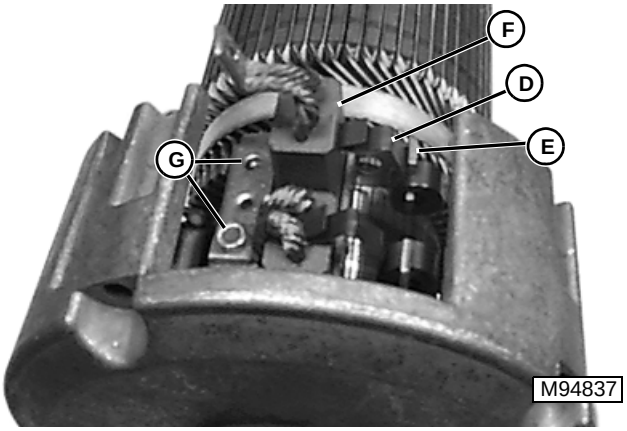
MOTOR DISASSEMBLY AND ASSEMBLY

Disassembly:

1. Unsnap the latch and slide the head band off of the motor end cap.



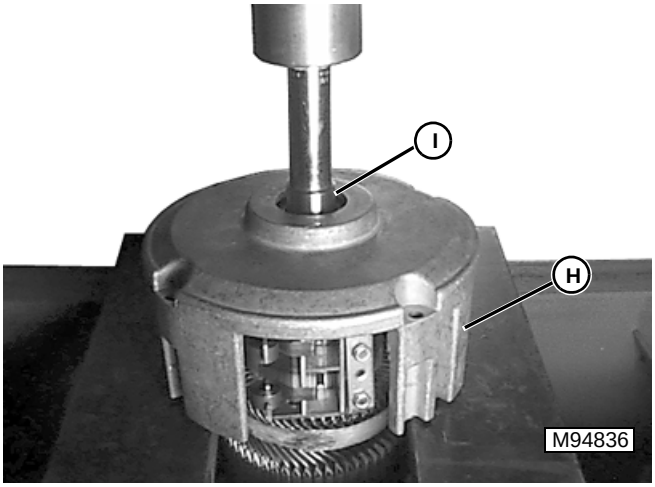
2. Remove two screws (A) securing sensor (B) to end of motor. Remove bolt securing magnet (C), and remove magnet.



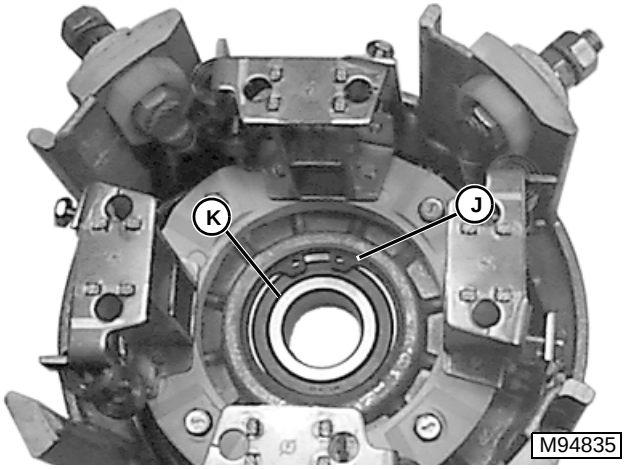
3. Hook the brush spring (D) behind the retaining tab (E).
4. Remove brushes (F) one at a time. Replace brush lead capscrews (G) after disconnecting leads.
5. Inspect brushes. See “INSPECTING BRUSH AND COMMUTATOR” on page 15.
6. Remove four bolts securing housing halves together.
7. Slide armature end housing and armature out of winding body.

NOTE: Armature end bearing is secured into housing with a snap ring. Do not press on bearing when removing armature.

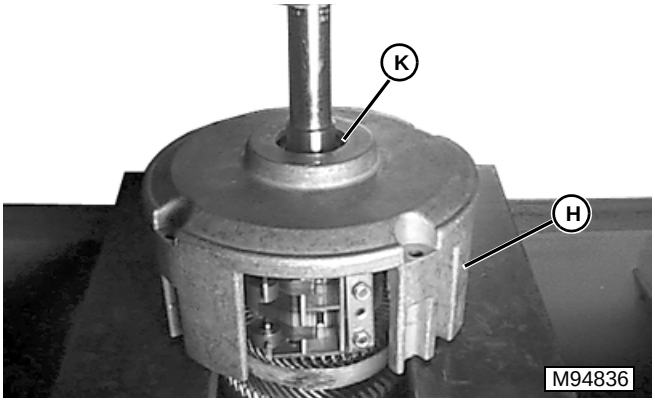
Armature is heavy. Support armature when removing it from end housing and bearing.



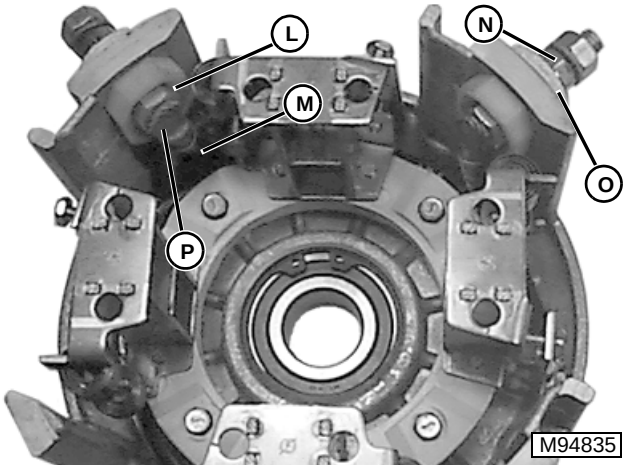
8. Support armature end housing (H), and press armature (I) from end bearing and housing.



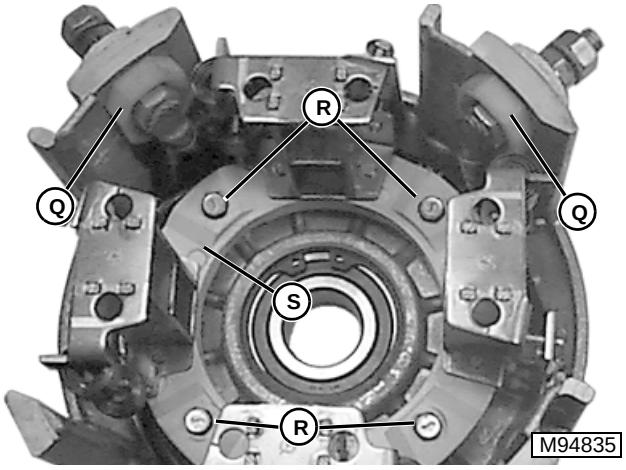
9. Remove snap ring (J) securing bearing (K).



10. Support end housing (H), and press bearing (K) from end housing.



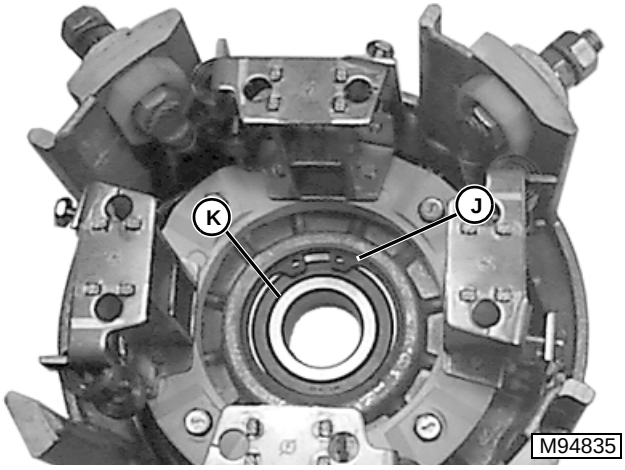
11. Mark the terminal studs (L) and the wire lead locations (M) and remove the full height inner terminal nut (N).
12. Note the position of the insulator washers (O) before removing them.
13. Push the terminal stud (L) to the inside of the end housing and remove the wire lead capscrews (P). Replace wire lead capscrews after disconnecting leads.



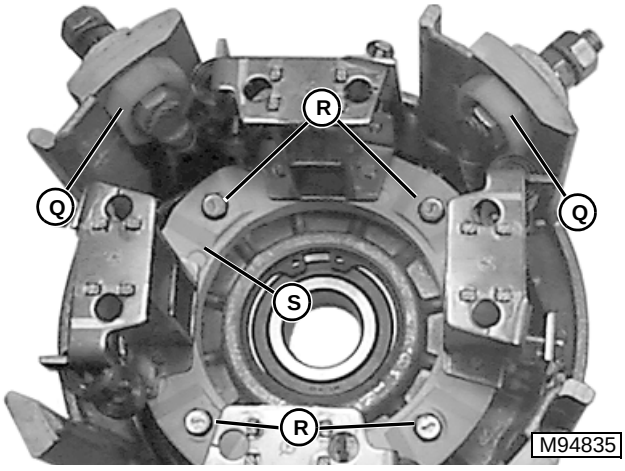
14. Remove the two terminal insulators (Q) pressed into the end cap housing.
15. Remove the four capscrews (R) holding the brush holder mounting plate (S) in place and remove the mounting plate.
16. Clean and replace any defective components.

Assembly:

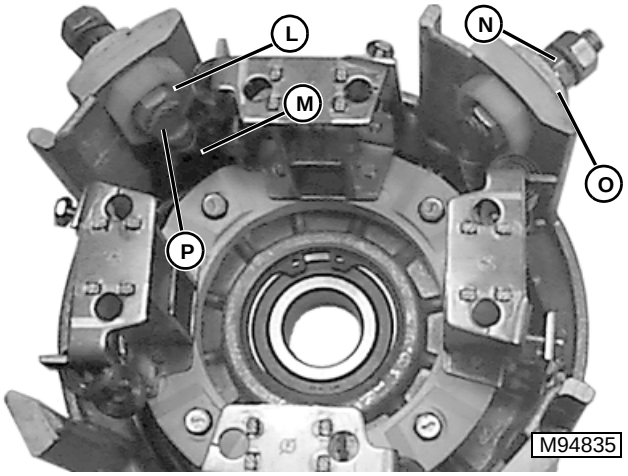
NOTE: It is recommended that a new bearing be installed whenever the motor has been disassembled. The bearing could have been damaged during removal or races could be brinelled and fail in a short period of service.



1. Press a new bearing (K) into the end housing bearing pocket just far enough to clear the snap ring groove.
2. Install the snap ring (J).



3. Place the brush holder mounting plate (S) in end cap housing and secure with four capscrews (R). Tighten to **2.4 N•m (22 lb-in.)**.
4. Press the terminal stud insulators (Q) into the end cap housing.

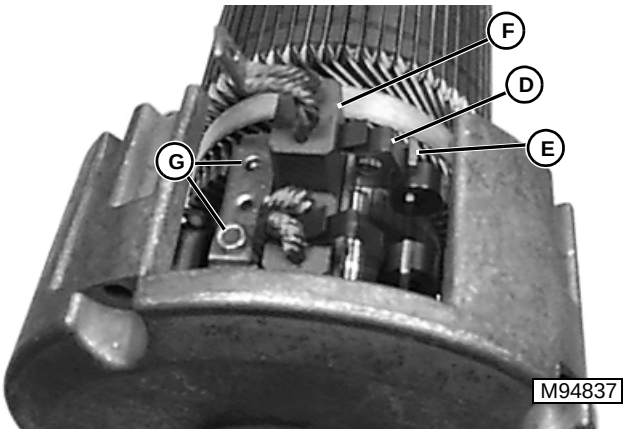


M

5. Install the terminal studs (L) into the insulator (O) as marked earlier.

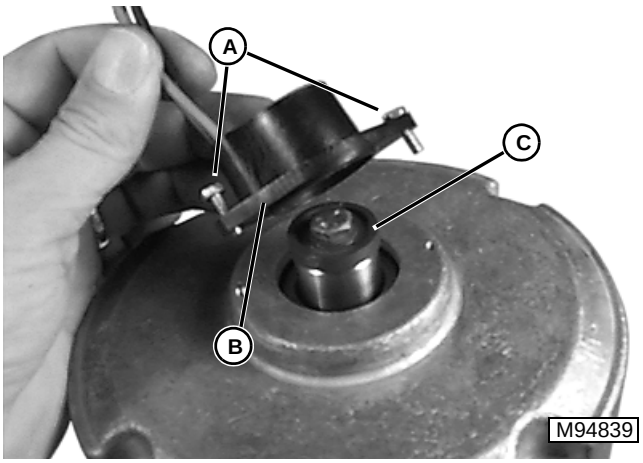
NOTE: Use the full height nuts to secure the terminal stud and insulator into the end cap housing. If the half height nut is use, you will NOT be able to get a wrench on the nut to tighten the wires properly.

6. Use the full height nuts (N) to secure the terminal stud and insulator into the end cap housing. Tighten the full height nut to the terminal stud to **10 N•m (90 lb-in.)**.
7. Reconnect the wire leads (M) to the brush holders as marked earlier.
8. Press the armature shaft into the end cap housing bearing.
9. Slide armature end housing and armature into winding body.
10. Install the four bolts securing housing halves together. Tighten to **10 N•m (90 lb-in.)**.



11. Install brushes (F) one at a time. Be sure the brush slide freely in the brush holder. Tighten the brush lead capscrews (G) to **2.4 N•m (22 lb-in.)**.

12. Unhook the brush spring (D) from behind the retaining tab (E) and center on the end of the brush.



13. Install the magnet (C) on the end of the armature shaft and tighten capscrew to **1.9 N•m (18 lb-in.)**.
14. Position sensor (B) over magnet and secure with two capscrews (A). Tighten to **1.9 N•m (18 lb-in.)**.
15. Position head band over end cap housing with terminals centered in notches and latch in place.

Specifications:

Brush Mounting Plate	**2.4 N•m (22 lb-in.)**
Motor Thru Bolts	**10 N•m (90 lb-in.)**
Brush Leads	**2.4 N•m (22 lb-in.)**
Terminal Stud Nuts	**10 N•m (90 lb-in.)**
Sensor Magnet	**1.9 N•m (18 lb-in.)**
Speed Sensor	**1.9 N•m (18 lb-in.)**

INSPECTING BRUSH AND COMMUTATOR

Procedure:

The most important part of any planned maintenance schedule is brush and commutator inspection. By recognizing undesirable commutator and/or brush conditions, corrective action can be taken before a major component is damaged beyond serviceability.

Brush and commutator inspection can usually be accomplished by removing the head band from the commutator end of the motor. The brushes and commutator should be inspected for smooth, even, polished wear and good communication.

Good communication will be indicated by a dark brownish, polished commutator and an evenly polished brush wearing surface.

If the commutator appears rough, pitted, scored or has signs of burning or heavy arcing between the commutator bars, the motor should be removed for servicing.

For a detailed inspection of the commutator the motor should be disassembled. See “MOTOR DISASSEMBLY AND ASSEMBLY” on page 12.

1. With the armature supported on both bearing journals, check run-out of commutator with a dial gage. Total indicated run-out should not exceed **0.076 mm (0.003 in.)** or **0.025 mm (0.001 in.)** bar to bar. If the readings fall outside this limit, commutator must be turned and undercut.
2. After the commutator has been undercut, the armature should be placed in a lathe and the commutator lightly sanded with No. 00 sandpaper. This will remove any burrs left from the undercutting operation.
3. Clean commutator with dry compressed air and check commutator run-out. Minimum commutator diameter before armature needs to be replaced is **70 mm (2.75 in.)**.
4. Brushes should be inspected for uneven wear and signs of overheating such as discolored brush shunts and brush springs. Brushes should be replaced if they show signs of damage from pitting, or if they have worn down to the specified limit of **16 mm (0.62 in.)** or less.
5. Check the brush holders for physical damage and make sure they are not loose on the end head or the brush holder plate.
6. Check the brush springs for correct alignment on the brush. A brush spring that does not apply equal pressure on the center of the brush will cause the brush to wear unevenly.
7. Check for correct clearance and freedom of brush movement in the holder.

If any of the brushes is worn to the point that replacement is necessary, the complete brush set should be replaced. Do not replace just one or two brushes.

Do not substitute brushes. The brushes are matched to the motor type and application to provide the best service. Substituting brushes of the wrong grade can cause commutator damage or excessive brush wear.

Specification:

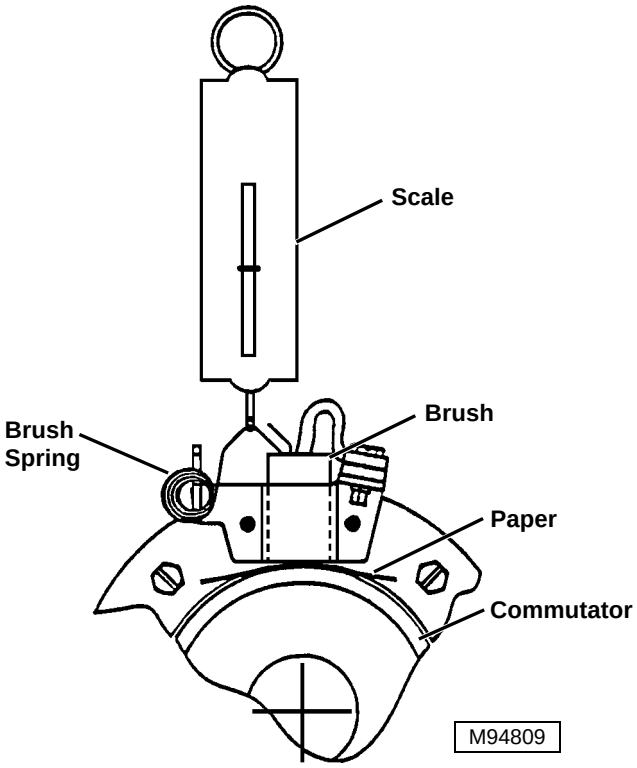
Brush minimum length . . . . . 16mm (0.62 in.)
Commutator minimum diameter . . . . . 70 mm (2.75 in.)
Commutator maximum runout . . . . . 0.076 mm (0.003 in.)
Commutator maximum variation bar to bar . . . . . 0.025 mm (0.001 in.)

M

MOTOR BRUSH SPRING TENSION

Procedure:

Check for proper motor brush spring tension. A brush spring that does not apply equal pressure on the center of the brush will cause the brush to wear unevenly.



1. Place paper strip between brush face and commutators.
2. Hook Spring Scale as shown on sketch below.
3. Pull spring scale on a line directly opposite the line of force exerted. When the paper strip begins to move freely, read spring tension on scale. If tension does not meet specification, replace springs and/or brushes as a set.

Specification:

New Brush . . . . . 1820 grams (65 oz)
Worn Brush. . . . . 1120 grams (40 oz)

SERVICING FRAME & FIELD ASSEMBLY

Procedure:

Motors which have been disassembled for servicing should also include a complete inspection of the frame and field assembly.

It is not uncommon that the frame and field of a motor becomes exceptionally dirty after many hours of operation. This may result in a grounding condition due to dirt, grease and other foreign materials.

In this case it is recommended to clean the complete frame and field in a cleaning solution of Safety-Kleen 105, washing solvent or an equivalent product.

After cleaning, the frame and field must be oven-cured for one hour at **148° C (300° F)**.

It is recommended to add a coat of WS-200 PT George varnish for proper insulation protection. This is a class H water soluble varnish. A similar air-dry varnish may also be used providing if it has a class H thermal specification.

If new field coils are installed the cross-over connection should be brazed for a good sound connection and to prevent breakage due to vibration.

Soldered connections are not recommended.

Motor terminals should be tightened to **5.5 - 6 N•m (40 - 50 lb-in.)**

Screws securing the pole windings to the frame should be tightened to **27.5 - 33 N•m (250 - 300 lb-in.)**

IMPORTANT: Do not use a torch for the cross-over connection. The insulation of the field coils is easily damaged by this method.

A high capacity resistance power unit with a plier-type handpiece may be used for brazing field connections.

Specification:

Motor Terminals . . . . . 5.5 - 6 N•m (40 - 50 lb-in.)
Pole Screws . . . . . 27.5 - 33 N•m (250 - 300 lb-in.)

CONTENTS

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READING ELECTRICAL SCHEMATICS

The schematic is made up of individual circuits laid out in a sequence of related functions. It is formatted with all power wires (A) across the top and all negative wires (B) across the bottom. Current flow is generally from top to bottom through each circuit and component. All components are shown in the OFF position. The diagram does not list connector (C) information unless needed to avoid confusion. If the connector is shown, the number next to it is the terminal pin location (D) in the connector.

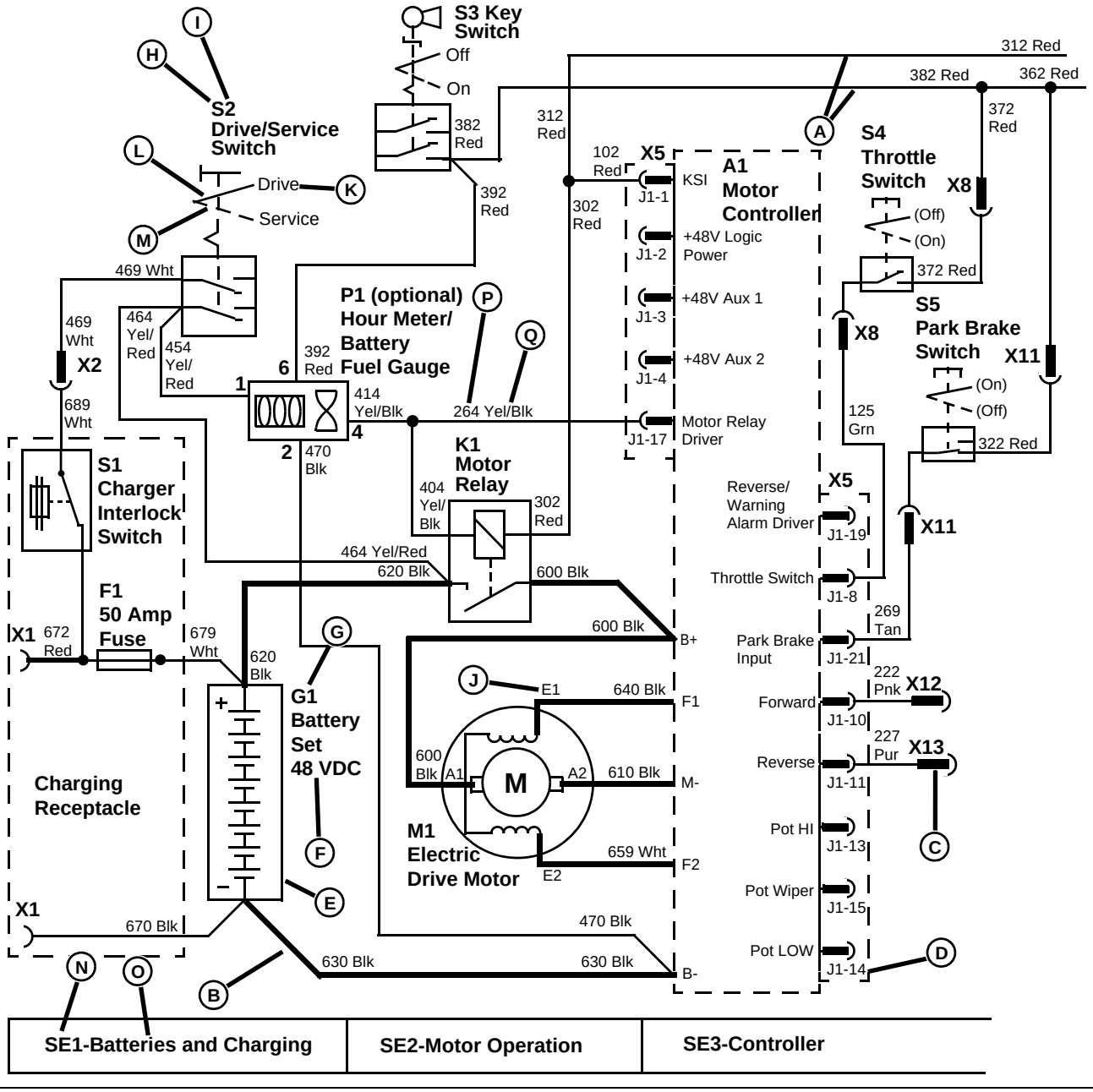
Each component is shown by a symbol (E), its name (F), and an identification code (G). The identification code contains a device identifying letter (H) and number (I).

The identifying letter is always the same for a specific component, but the identifying numbers are numbered consecutively from upper left to lower right. The terminal designation (J) is placed directly outside the symbol next to the connecting wire path. Switch positions (K) are also placed directly outside the symbol. The solid line (L) shows the position the switch is currently in and dash lines (M) represent other switch positions.

Each circuit is identified at the bottom of the drawing by a section number (N) and section name (O).

The circuit number (P) and wire color (Q) of the wires are shown directly next to the wire path.

The same component name and identification code are used consistently on all diagrams in this section. Components can be easily cross-referenced.

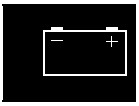


THEORY AND DIAGNOSTIC INFORMATION

THEORY OF OPERATION INFORMATION

The theory of operation stories divide the electrical system into individual circuits by function. Each circuit is isolated from the main wiring schematic and only shows the components that are used in it. The story contains information on function, operating conditions, and theory of operation. The circuit schematics are drawn with the components in the operating position, with the power, or battery positive, into them across the top battery negative, across the bottom.

DIAGNOSTIC INFORMATION



The diagnostic procedures is used to test the complete circuit regardless of the problem or complaint. Select a symptom or system from the quick check or troubleshooting chart and follow the test procedures under that heading.

The diagnostic procedure lists:

- Test conditions
- Test sequence
- Test location
- Normal reading
- Check or test to perform if reading is not normal

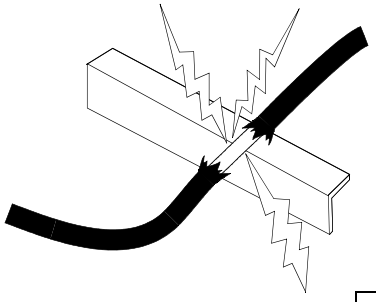
When performing the test or check, be sure to set your machine up to the test conditions listed and follow the sequence carefully. The middle **"NORMAL"** column gives the reading or condition that should be obtained when performing the test or check. If the results of the test or check are not normal, perform the test, check, or adjustment listed in the third **"IF NOT NORMAL"** column to repair the malfunction. The detailed tests or adjustments referred to in the **"IF NOT NORMAL"** column are located at the end of that group. The system diagram that accompanies each test procedure is drawn to resemble machine components. The key number on the art matches the number in the **"TEST LOCATION"** column and the leader line points to the exact point the test is to be made.

Unless otherwise specified, all readings using the multimeter are made with the black test lead connected to the battery set negative terminal and the red test lead connected to the **"TEST LOCATION"**.

WIRE COLOR ABBREVIATION CHART

Blk	Black
Blu	Blue
Brn	Brown
Grn	Green
Gry	Gray
Org	Orange
Pnk	Pink
Pur	Purple
Red	Red
Tan	Tan
Wht	White
Yel	Yellow
Blk/Wht	Black/White
Blu/Wht	Blue/White
Brn/Wht	Brown/White
Brn/Yel	Brown/Yellow
Dk Blu	Dark Blue
Dk Brn/Lt Grn	Dark Brown/Light Green
Dk Brn/Red	Dark Brown/Red
Dk Brn/Yel	Dark Brown/Yellow
Dk Grn	Dark Green
Lt Blue	Light Blue
Lt Grn	Light Green
Org/Wht	Orange/White
Pnk/Blk	Pink/Black
Pur/Wht	Purple/White
Red/Blk	Red/Black
Red/Wht	Red/White
Wht/Blk	White/Black
Wht/Red	White/Red
Yel/Blk	Yellow/Black
Yel/Red	Yellow/Red
Yel/Wht	Yellow/White

COMMON CIRCUIT TESTS

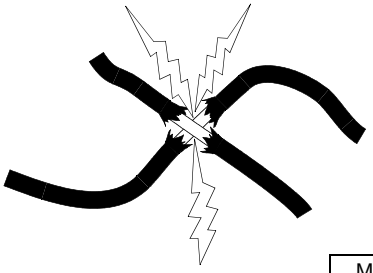


M85602

Shorted Circuit:

A shorted circuit may result in the wrong component operating (i.e. improper wire-to-wire contact). To test for a shorted or improperly wired circuit:

1. Turn component switch ON.
2. Start at the controlling switch of the component that should not be operating.
3. Follow the circuit and disconnect wires at connectors until component stops operating.
4. Shorted or improper connections will be the last two wires disconnected.



M85600

High Resistance or Open Circuit:

High resistance or open circuits usually result in slow, dim or no component operation (i.e. poor, corroded, or disconnected connections). Voltage at the component will be low when the component is in operation. To test for high resistance and open circuits:

1. Check all terminals and grounds of the circuit for corrosion.
2. If terminals are not corroded or loose, the problem is in the component or wiring.

M85601

Grounded Circuit:

Grounded circuits usually result in no component operation or a blown fuse.

SCHEMATIC AND WIRING HARNESS LEGEND

COMPONENTS:

A1—Motor Controller (SE3, W1)

A2—Diagnostic Display (SE4, W1) optional

E1—L.H. Headlight (SE4, W5)

E2—R.H. Headlight (SE4, W5)

F1—Fuse 50 Amp (SE1, W2)

G1—Battery Set (SE1, W1)

H1—Reverse/Warning Alarm (SE4, W1)

H2—Horn (SE4, W7)

K1—Motor Relay (SE2, W1)

K2—Cargo Box Lift Motor Relay (SE4, W6)

M1—Electric Drive Motor (SE2, W3)

M2—Cargo Box Lift Motor (SE4, W6)

P1—Hour Meter/Battery Fuel Gauge (optional) (SE2, W1)

R1—Throttle Potentiometer (SE4, W1)

S1—Charger Interlock Switch (SE1, W2)

S2—Drive/Service Switch (SE1, W1)

S3—Key Switch (SE2, W1)

S4—Throttle Switch (SE4, W1)

S5—Park Brake Switch (SE4, W1)

S6—Cargo Box Lift Switch (SE4, W6)

S7—Headlight Switch (SE4, W5)

S8—Forward Switch (SE4, W1)

S9—Reverse Switch (SE4, W1)

S10—Horn Switch (SE4, W7)

T1—Motor Speed Sensor (SE2, W4)

CONNECTORS:

X1—Battery Charger to W2 Charging Receptacle Harness (SE1, W2)

X2—W2 Charging Receptacle Harness to W1 Main Wiring Harness (SE1, W1)

X3—W1 Main Wiring Harness to S2 Drive/Service Switch (SE1, W1)

X4—W4 Motor Speed Sensor Wiring Harness to T1 Motor Speed Sensor (SE2, W4)

X5—W1 Main Wiring Harness to A1 Motor Controller (SE3, W1)

X6—W4 Motor Speed Sensor Wiring Harness to A1 Motor Controller (SE3, W4)

X7—A2 Diagnostic Display (optional) to A1 Motor Controller (SE3, A2)

X8—W1 Main Wiring Harness to S4 Throttle Switch (SE4, W1)

X9—W1 Main Wiring Harness to R1 Throttle Potentiometer (SE4, W1)

X10—W2 Charging Receptacle Wiring Harness to W5 Accessories Wiring Harness (SE4, W2)

X11—W1 Main Wiring Harness to S5 Park Brake Switch (SE4, W1)

X12—W1 Main Wiring Harness to S8 Forward Switch (SE4, W1)

X13—W1 Main Wiring Harness to S9 Reverse Switch (SE4, W1)

X14—W5 Accessories Wiring Harness to W6 Cargo Box Lift Wiring Harness (SE4, W5)

X15—W5 Accessories Wiring Harness to W7 Horn Wiring Harness (SE4, W5)

X16—W6 Cargo Box Lift Wiring Harness to M2 Cargo Box Lift Motor (SE4, W6)

X17—W6 Cargo Box Lift Wiring Harness to W1 Main Wiring Harness (SE1, W6)

WIRING HARNESSES:

W1—Main Wiring Harness

W2—Charger Receptacle Wiring Harness

W3—Power Wiring Harness

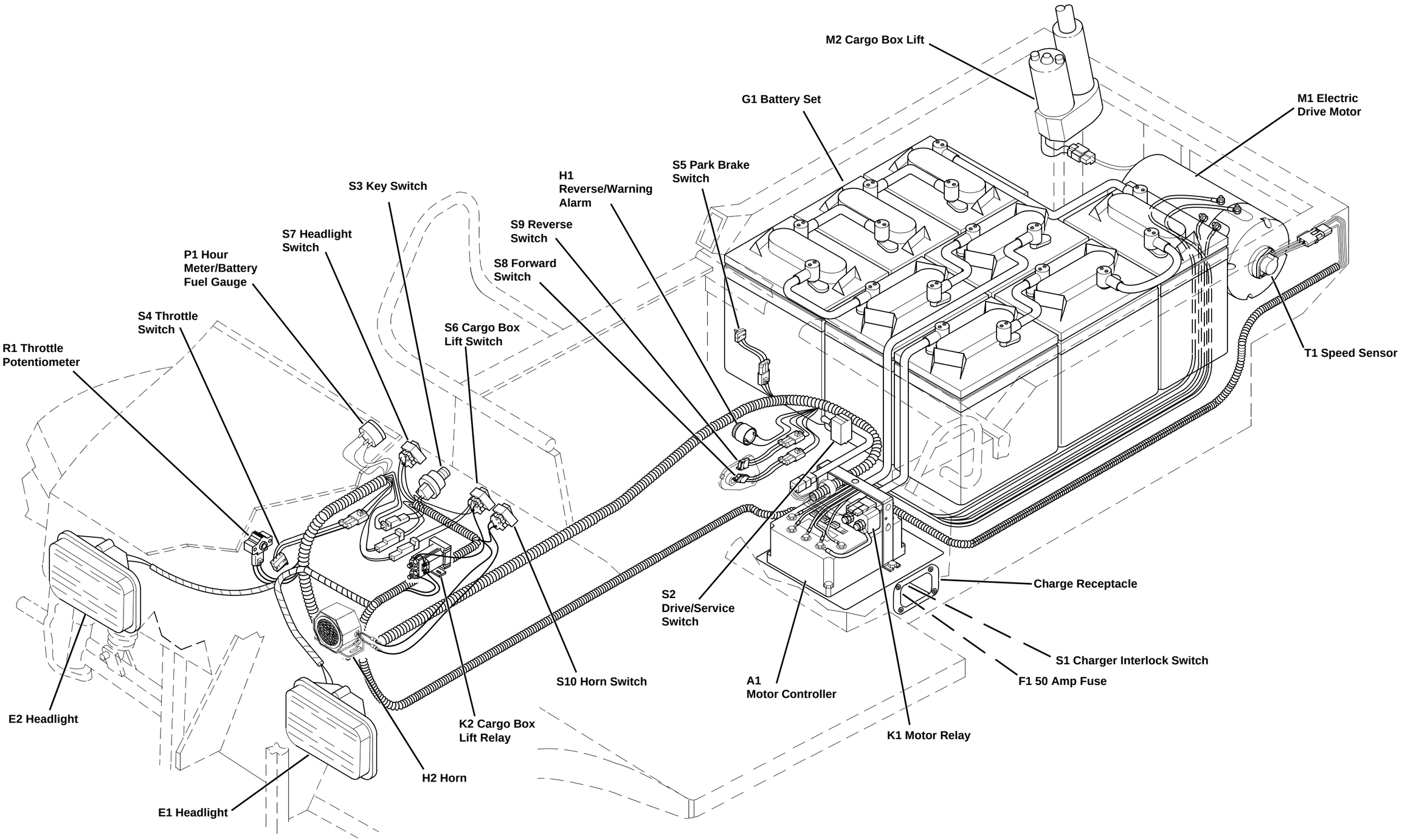
W4—Motor Speed Sensor Wiring Harness

W5—Accessories Wiring Harness

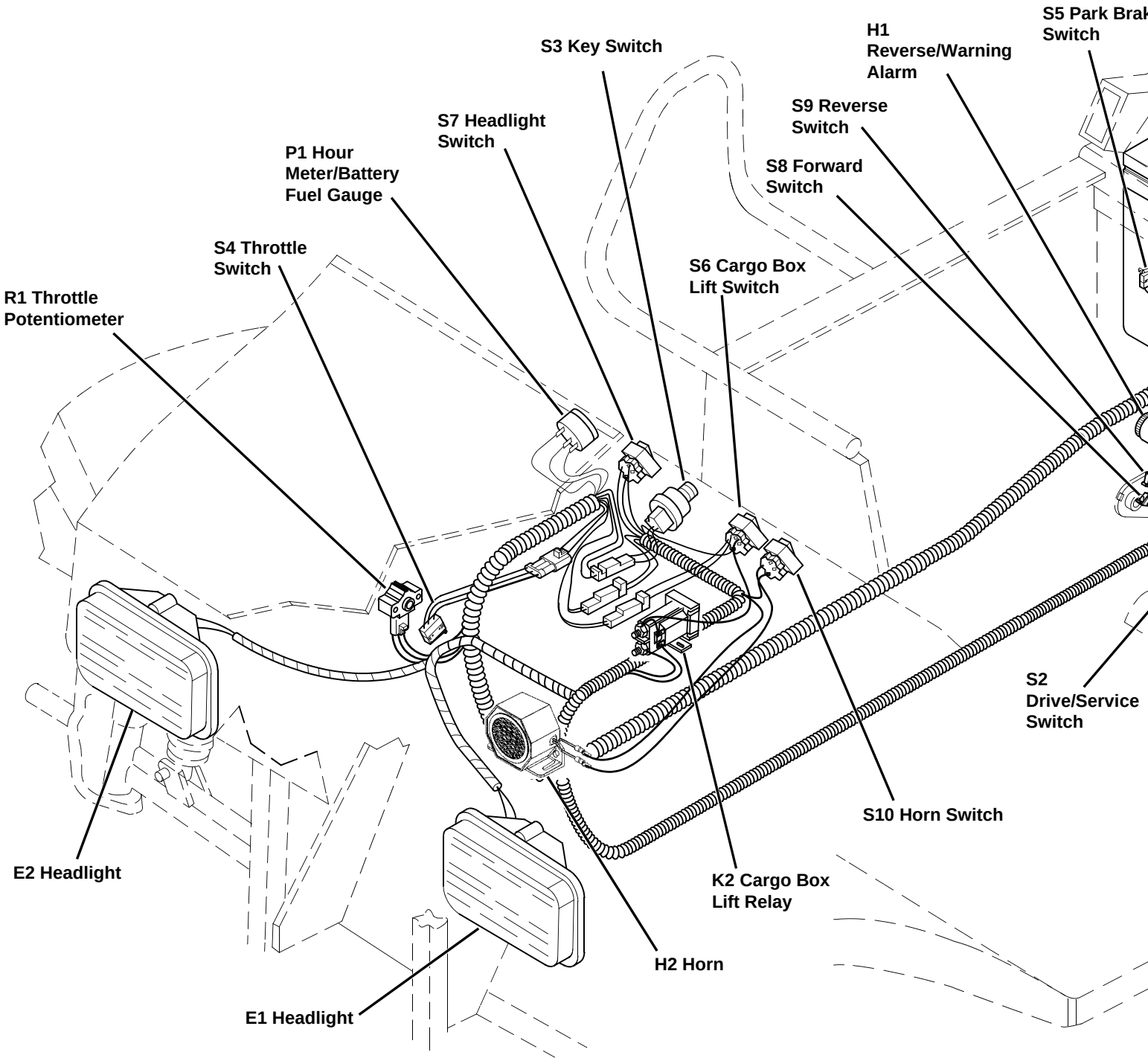
W6—Cargo Box Lift Wiring Harness

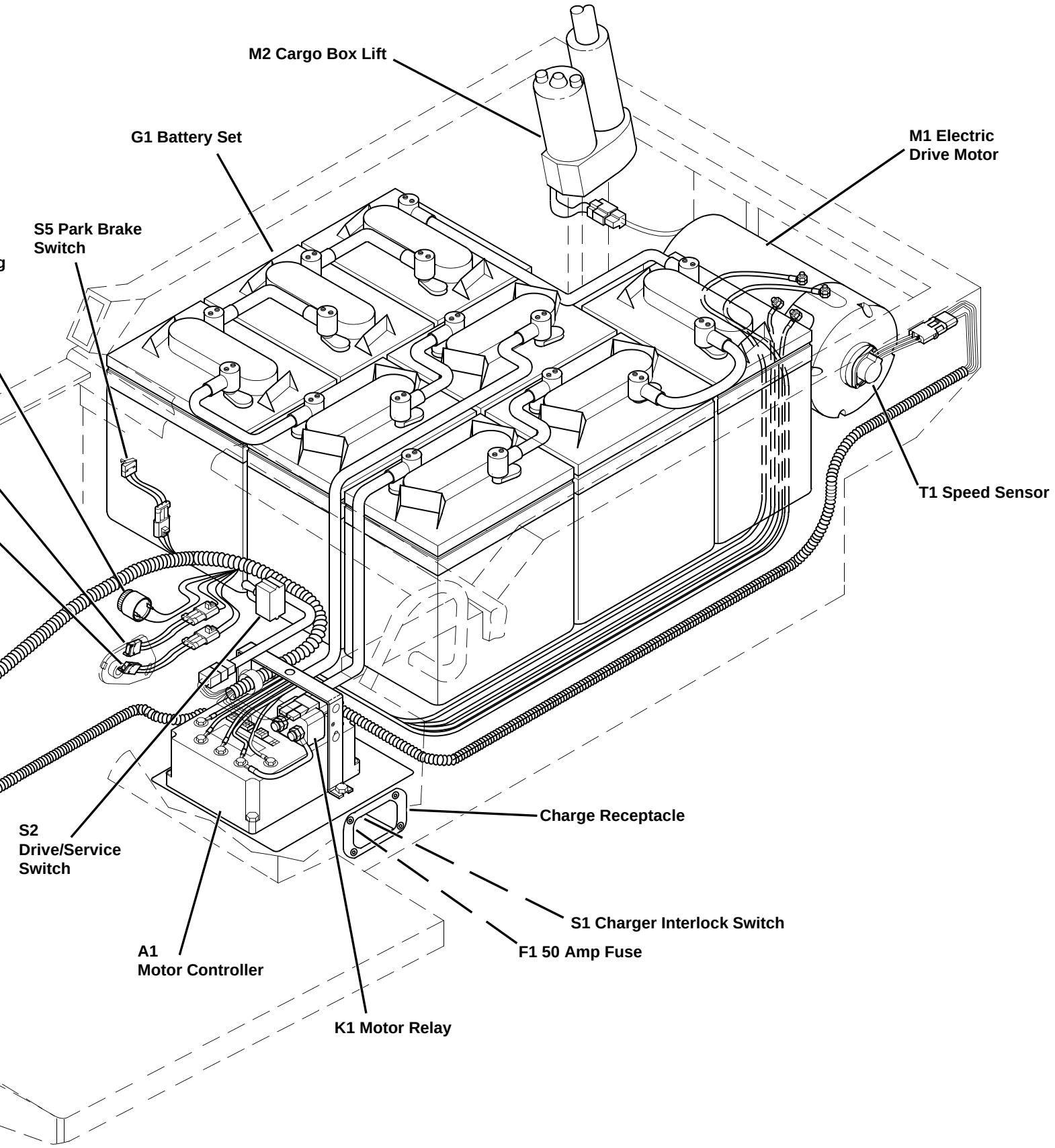
W7—Horn Wiring Harness

COMPONENT LOCATION

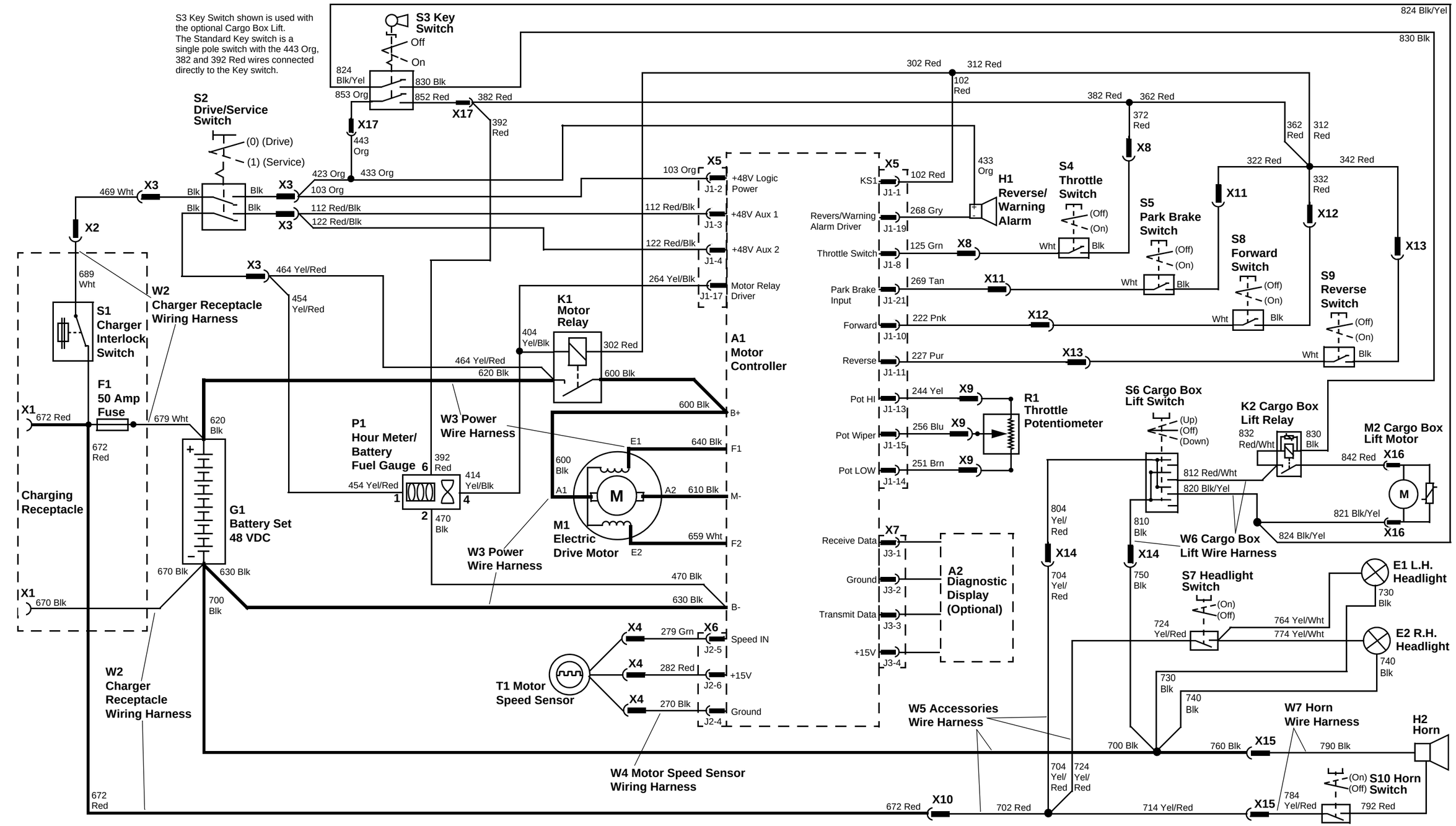


COMPONENT LOCATION



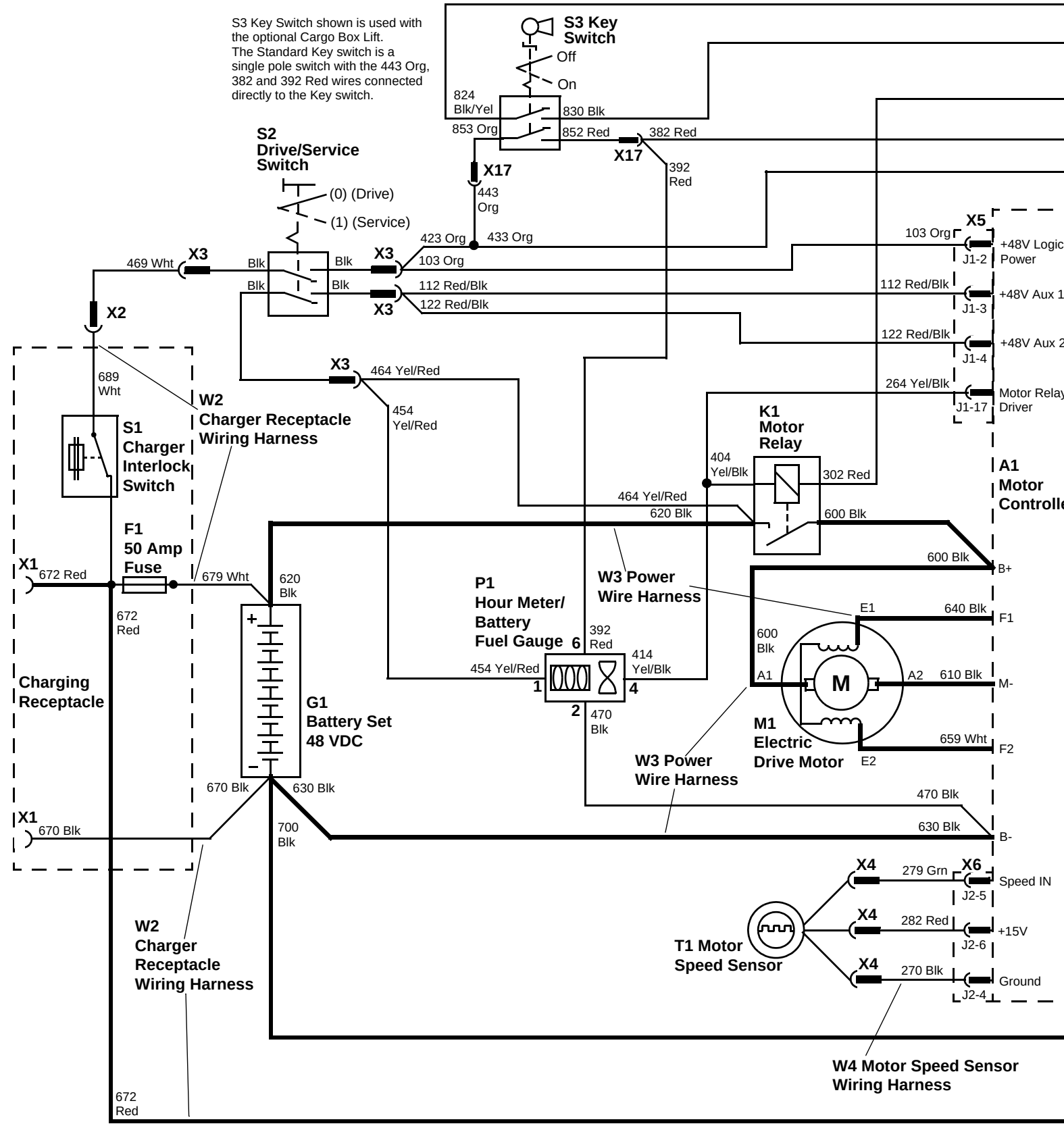

M2 Cargo Box Lift
G1 Battery Set
M1 Electric
Drive Motor
S5 Park Brake
Switch
T1 Speed Sensor
S2
Drive/Service
Switch
Charge Receptacle
S1 Charger Interlock Switch
F1 50 Amp Fuse
A1
Motor Controller
K1 Motor Relay

W1 MAIN ELECTRICAL SCHEMATIC

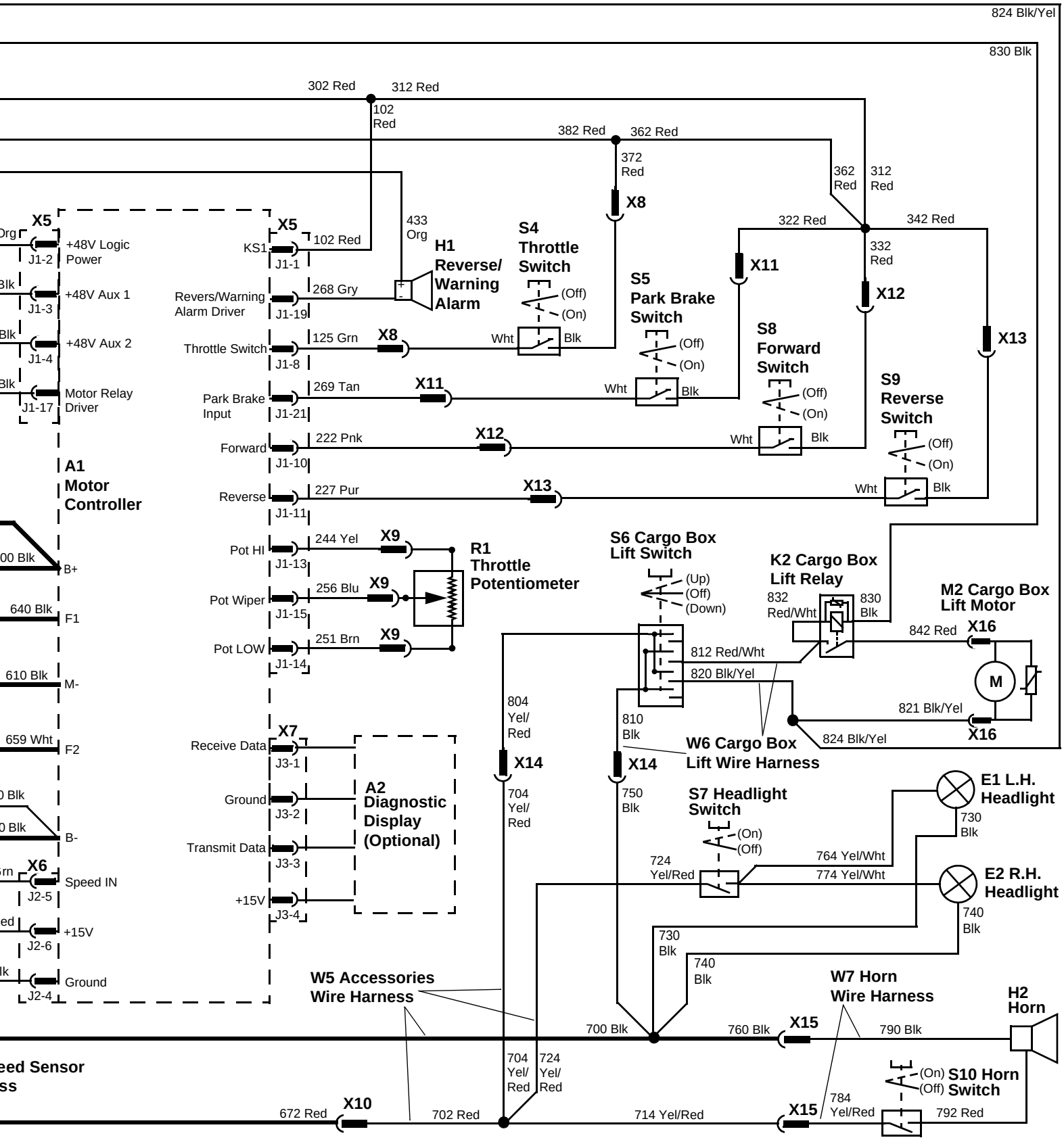


SE1 – Batteries and Charging	SE2 – Motor Operation	SE3 – Controller	SE4– Functions and Accessories

W1 MAIN ELECTRICAL SCHEMATIC

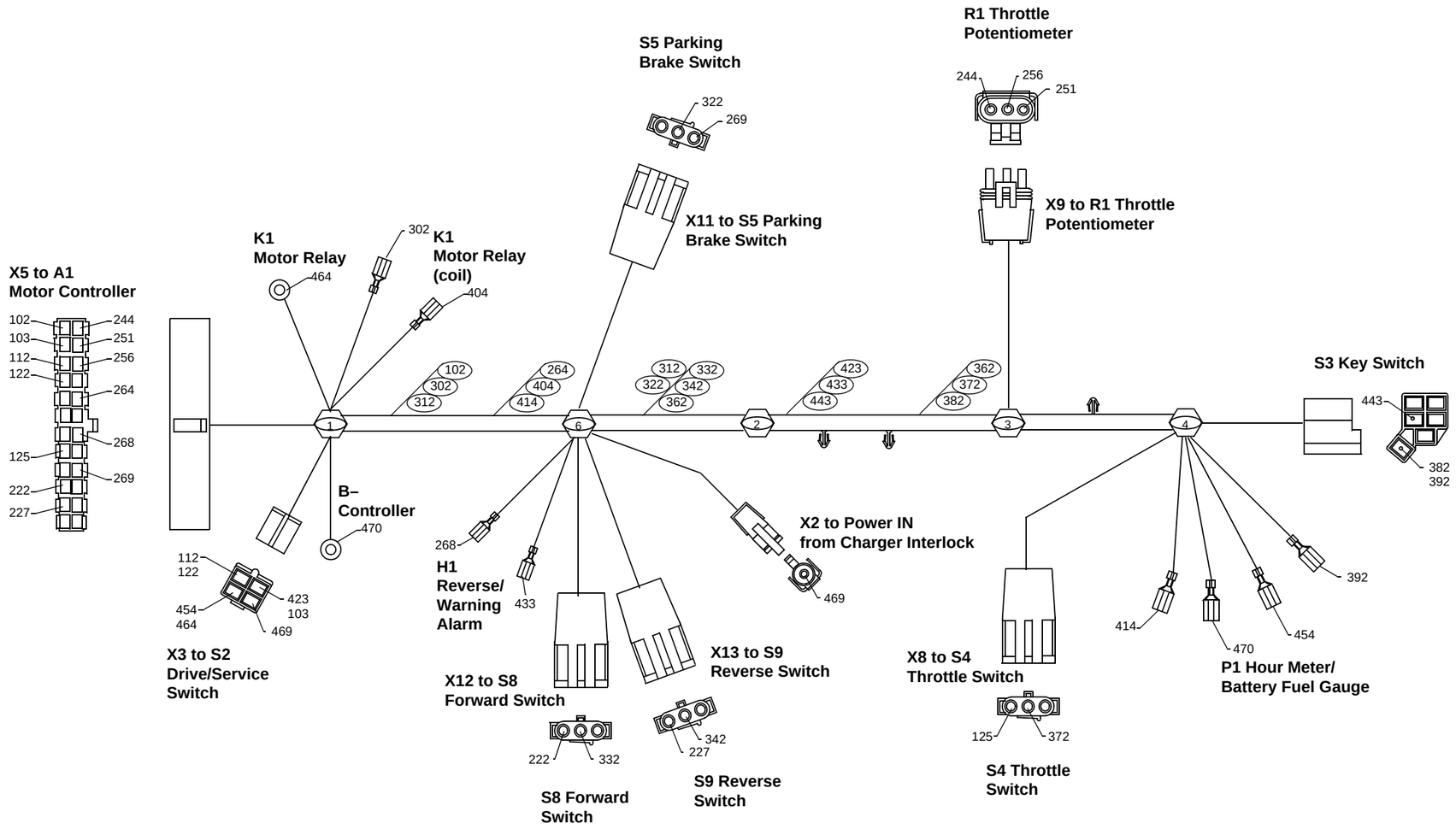


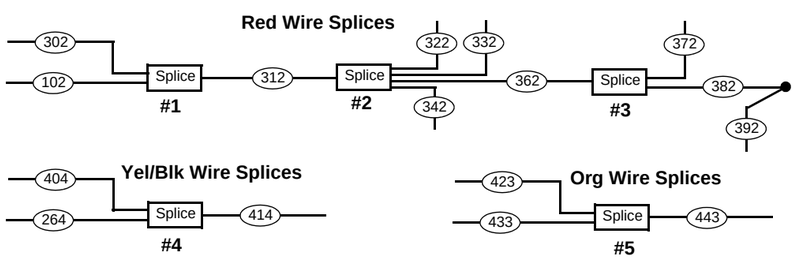
SE1 – Batteries and Charging	SE2 – Motor Operation	SE3 –



SE3 – Controller	SE4– Functions and Accessories

W1 MAIN WIRING HARNESS

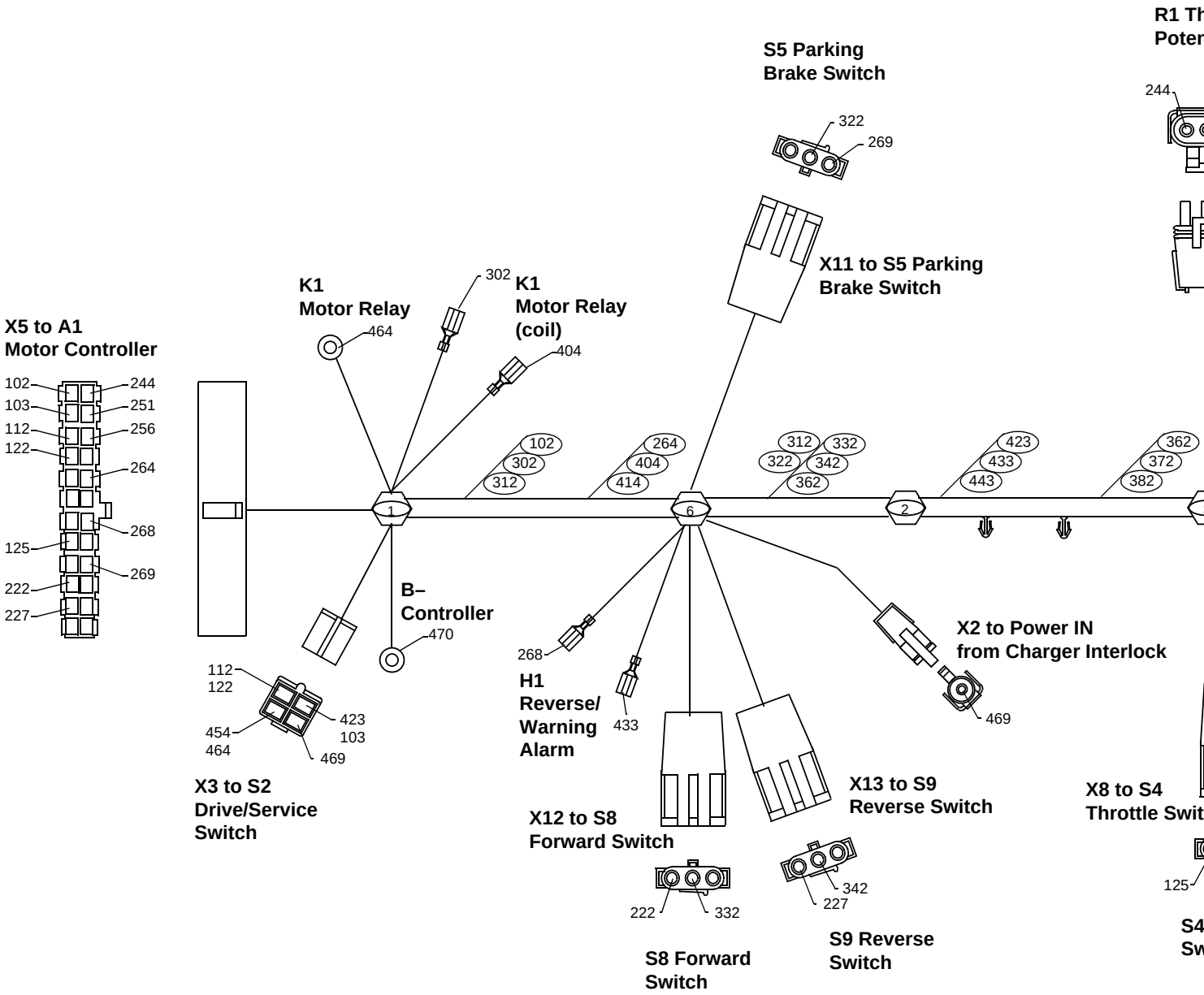


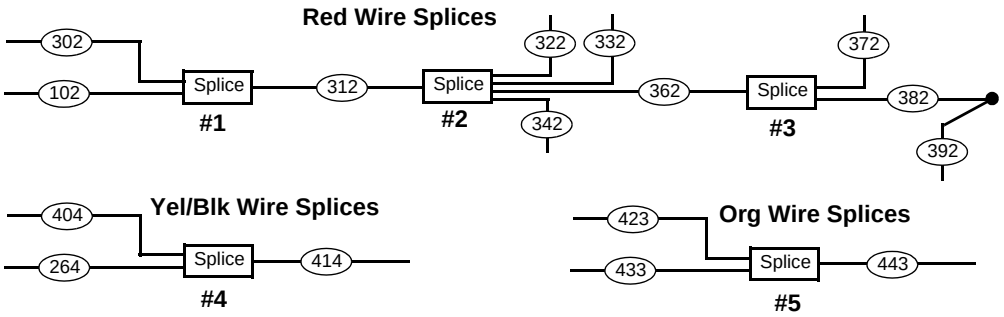


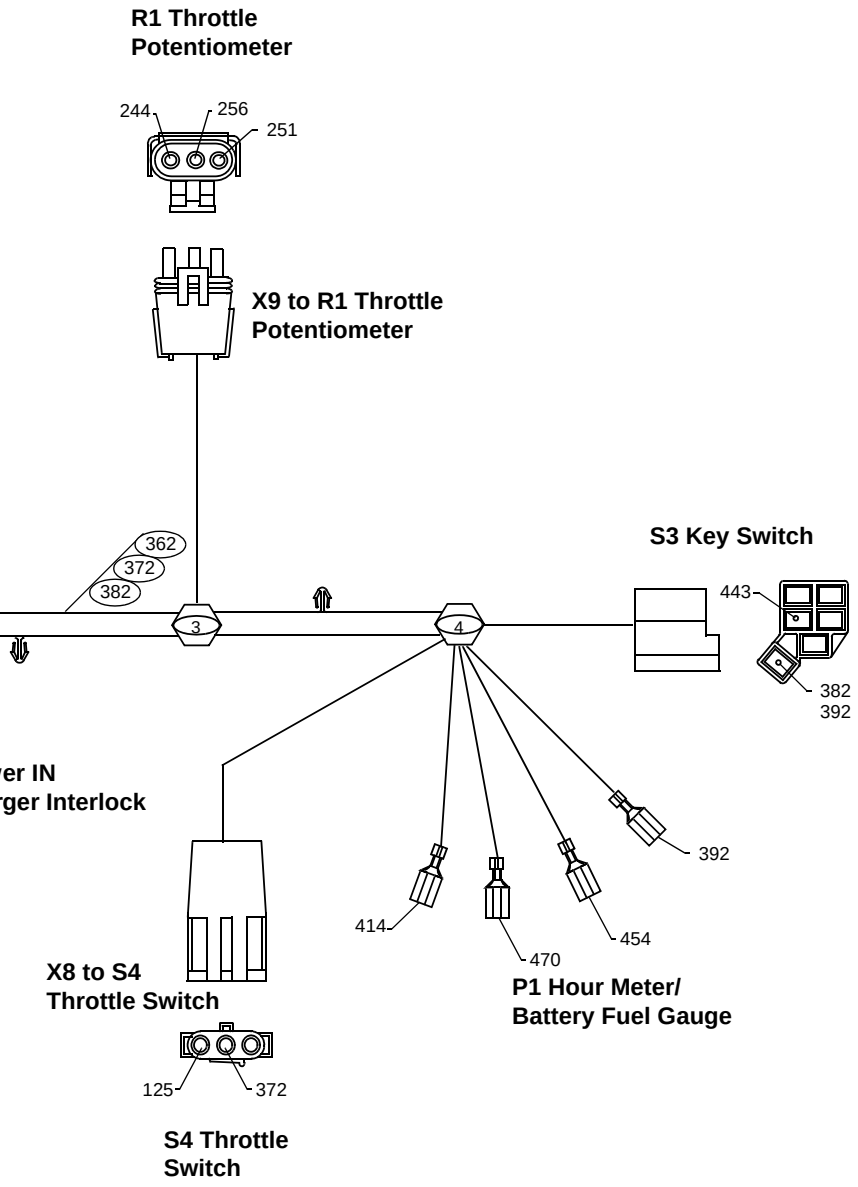
WIRE COLOR CODES

Circuit Number	Wire Size	Color	Termination Points
102	1.0	Red	X5, Splice #1
103	1.0	Org	X5, S2
112	1.0	Red/Blk	X5, S2
122	1.0	Red/Blk	X5, S2
125	1.0	Grn	X5, S4
222	1.0	Pnk	X5, S8
227	1.0	Pur	X5, S9
244	1.0	Yel	X5, R1
251	1.0	Brn	X5, R1
256	1.0	Blu	X5, R1
264	1.0	Yel/Blk	X5, Splice #4
268	1.0	Gry	X5, H1
269	1.0	Tan	X5, S5
302	1.0	Red	K1, Splice #1
312	1.0	Red	Splice #1, Splice #2
322	1.0	Red	Splice #2, S5
332	1.0	Red	Splice #2, S8
342	1.0	Red	Splice #2, S9
362	1.0	Red	Splice #2, Splice #3
372	1.0	Red	Splice #3, S4
382	1.0	Red	Splice #3, S3
392	1.0	Red	S3, P1
404	1.0	Yel/Blk	Splice #4, K1
414	1.0	Yel/Blk	Splice #4, P1
423	1.0	Org	S2, Splice #5
433	1.0	Org	Splice #5, H1
443	1.0	Org	Splice #5, S3
454	1.0	Yel/Red	S2, P1
464	1.0	Yel/Red	S2, K1
469	1.0	Wht	S2, X2
470	1.0	Blk	P1, B- at A1

W1 MAIN WIRING HARNESS



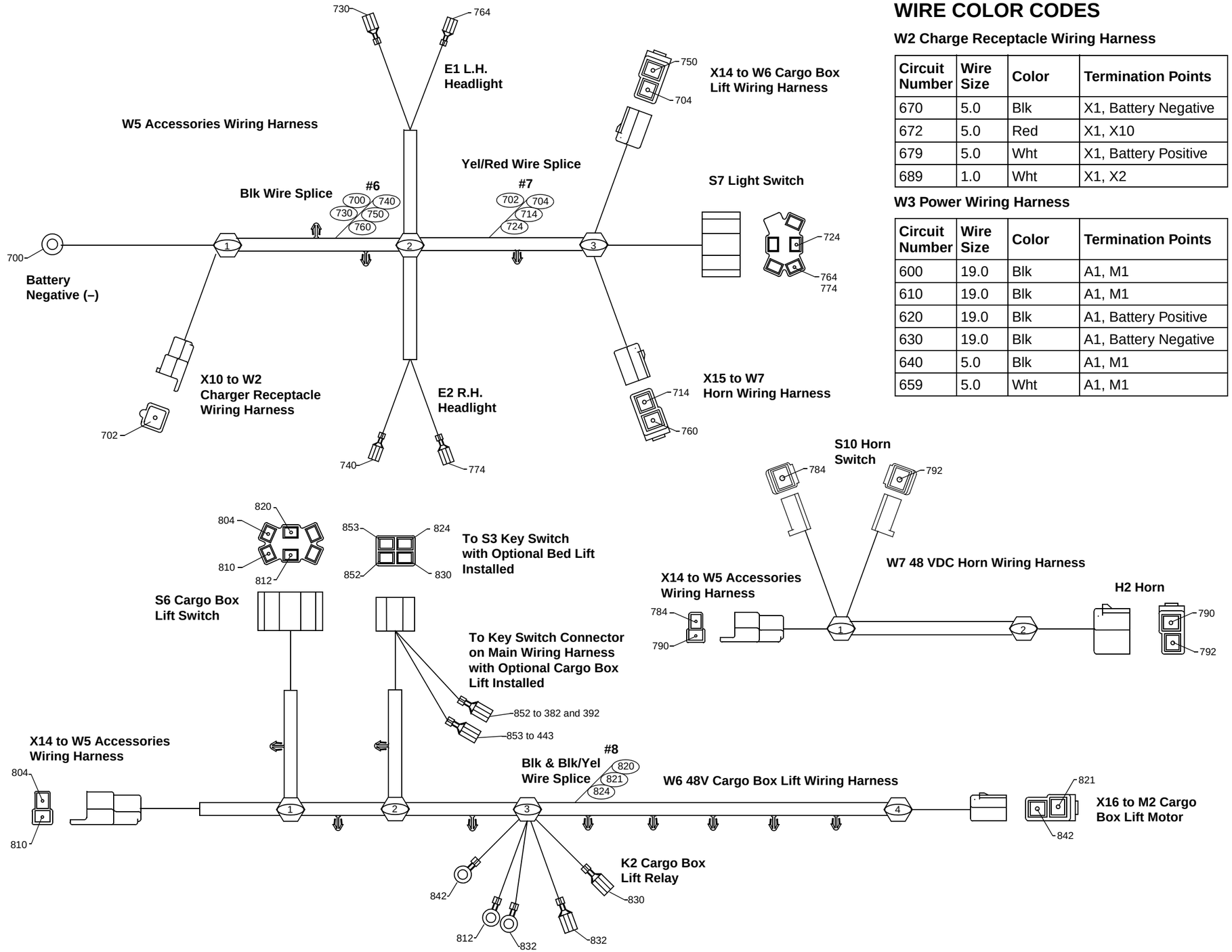




WIRE COLOR CODES

Circuit Number	Wire Size	Color	Termination Points
102	1.0	Red	X5, Splice #1
103	1.0	Org	X5, S2
112	1.0	Red/Blk	X5, S2
122	1.0	Red/Blk	X5, S2
125	1.0	Grn	X5, S4
222	1.0	Pnk	X5, S8
227	1.0	Pur	X5, S9
244	1.0	Yel	X5, R1
251	1.0	Brn	X5, R1
256	1.0	Blu	X5, R1
264	1.0	Yel/Blk	X5, Splice #4
268	1.0	Gry	X5, H1
269	1.0	Tan	X5, S5
302	1.0	Red	K1, Splice #1
312	1.0	Red	Splice #1, Splice #2
322	1.0	Red	Splice #2, S5
332	1.0	Red	Splice #2, S8
342	1.0	Red	Splice #2, S9
362	1.0	Red	Splice #2, Splice #3
372	1.0	Red	Splice #3, S4
382	1.0	Red	Splice #3, S3
392	1.0	Red	S3, P1
404	1.0	Yel/Blk	Splice #4, K1
414	1.0	Yel/Blk	Splice #4, P1
423	1.0	Org	S2, Splice #5
433	1.0	Org	Splice #5, H1
443	1.0	Org	Splice #5, S3
454	1.0	Yel/Red	S2, P1
464	1.0	Yel/Red	S2, K1
469	1.0	Wht	S2, X2
470	1.0	Blk	P1, B- at A1

ACCESSORY WIRING HARNESSES



WIRE COLOR CODES

W2 Charge Receptacle Wiring Harness

Circuit Number	Wire Size	Color	Termination Points
670	5.0	Blk	X1, Battery Negative
672	5.0	Red	X1, X10
679	5.0	Wht	X1, Battery Positive
689	1.0	Wht	X1, X2

W3 Power Wiring Harness

Circuit Number	Wire Size	Color	Termination Points
600	19.0	Blk	A1, M1
610	19.0	Blk	A1, M1
620	19.0	Blk	A1, Battery Positive
630	19.0	Blk	A1, Battery Negative
640	5.0	Blk	A1, M1
659	5.0	Wht	A1, M1

W4 Speed Sensor Wiring Harness

Circuit Number	Wire Size	Color	Termination Points
270	1.0	Blk	X6, X4 at T1
279	1.0	Grn	X6, X4 at T1
282	1.0	Red	X6, X4 at T1

W5 Accessories Wiring Harness

Circuit Number	Wire Size	Color	Termination Points
700	5.0	Blk	Battery Negative, Splice #6
702	5.0	Red	Splice #7, X10
704	1.0	Yel/Red	Splice #7, X14
714	1.0	Yel/Red	Splice #7, X15
724	1.0	Yel/Red	Splice #7, S7
730	1.0	Blk	Splice #6, E1
740	1.0	Blk	Splice #6, E2
750	1.0	Blk	Splice #6, X14
760	1.0	Blk	Splice #6, X15
764	1.0	Yel/Wht	S7, E1
774	1.0	Yel/Wht	S7, E2

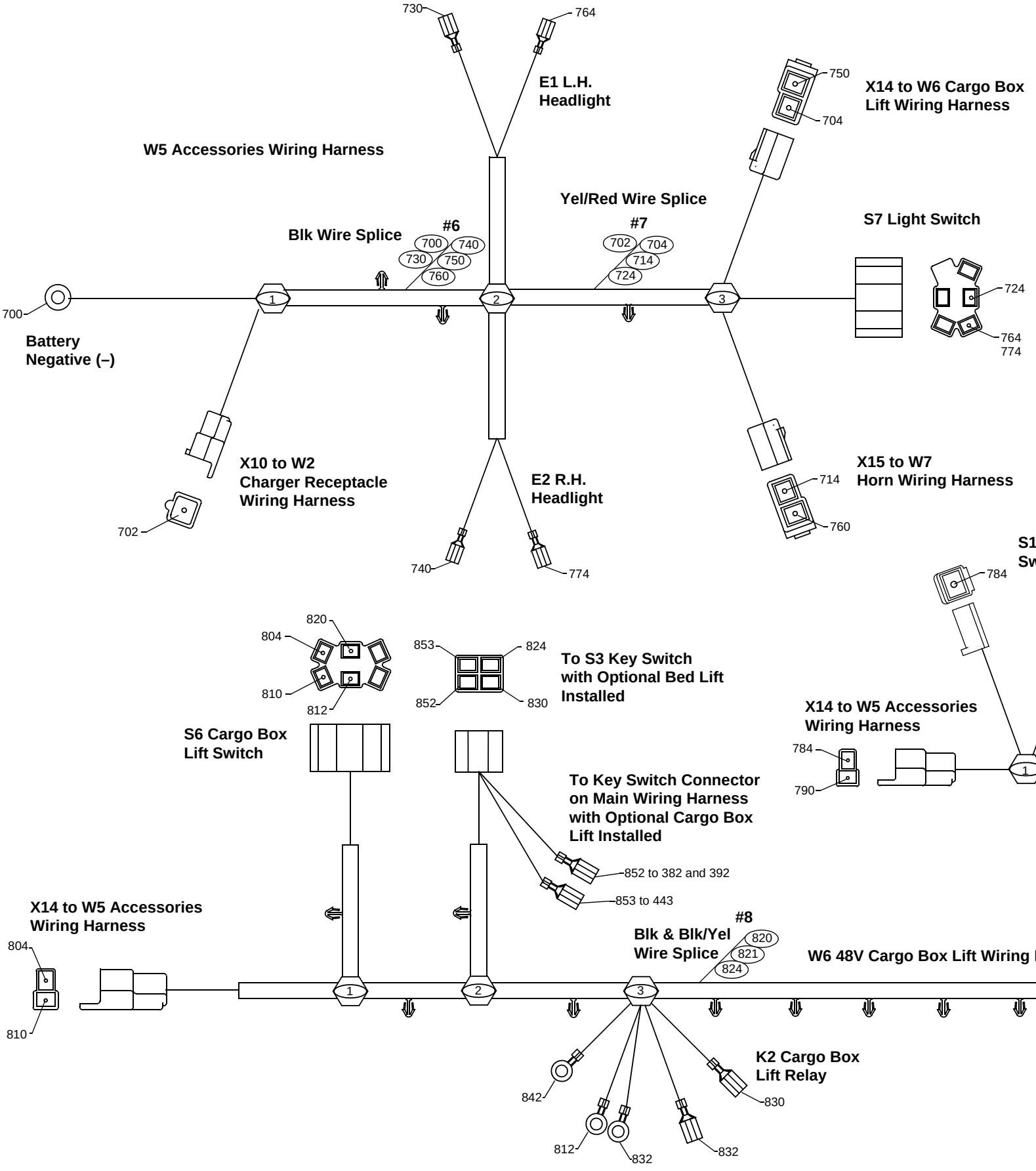
W6 48 VDC Cargo Box Lift Wiring Harness

Circuit Number	Wire Size	Color	Termination Points
804	1.0	Yel/Red	X14, S6
810	1.0	Blk	S6, X14
812	1.0	Red/Wht	S6, K2
820	1.0	Blk/Yel	S6, Splice #8
821	1.0	Blk/Yel	Splice #8, X16
824	1.0	Blk/Yel	Splice #8, S3
830	1.0	Blk	K2, S3
832	1.0	Red/Wht	K2, K2
842	1.0	Red	K2, X16

W7 48 VDC Horn Wiring Harness

Circuit Number	Wire Size	Color	Termination Points
784	1.0	Yel/Red	X15, S10
790	1.0	Blk	X15, H2
792	1.0	Red	H2, S10

ACCESSORY WIRING HARNESSES



WIRE COLOR CODES

W2 Charge Receptacle Wiring Harness

Circuit Number	Wire Size	Color	Termination Points
670	5.0	Blk	X1, Battery Negative
672	5.0	Red	X1, X10
679	5.0	Wht	X1, Battery Positive
689	1.0	Wht	X1, X2

W3 Power Wiring Harness

Circuit Number	Wire Size	Color	Termination Points
600	19.0	Blk	A1, M1
610	19.0	Blk	A1, M1
620	19.0	Blk	A1, Battery Positive
630	19.0	Blk	A1, Battery Negative
640	5.0	Blk	A1, M1
659	5.0	Wht	A1, M1

W4 Speed Sensor Wiring Harness

Circuit Number	Wire Size	Color	Termination Points
270	1.0	Blk	X6, X4 at T1
279	1.0	Grn	X6, X4 at T1
282	1.0	Red	X6, X4 at T1

W5 Accessories Wiring Harness

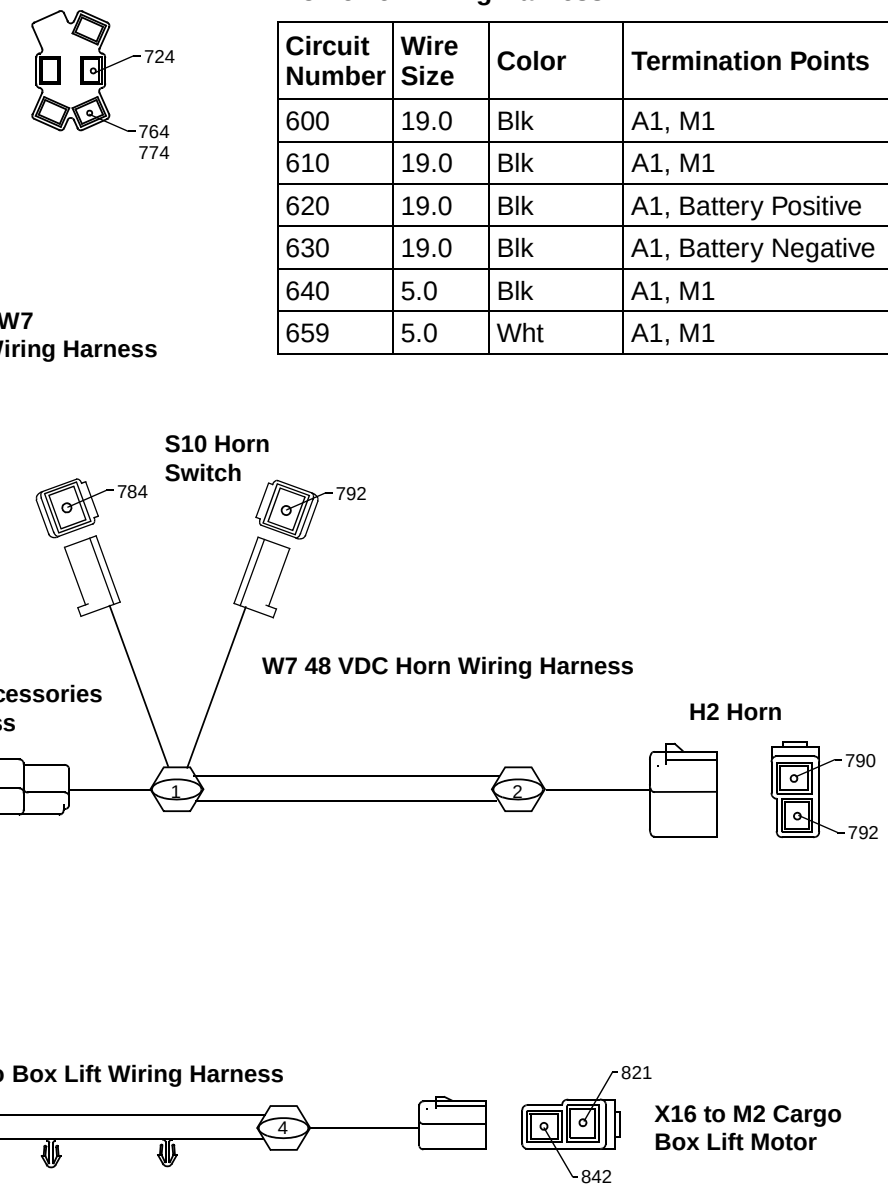
Circuit Number	Wire Size	Color	Termination Points
700	5.0	Blk	Battery Negative, Splice #6
702	5.0	Red	Splice #7, X10
704	1.0	Yel/Red	Splice #7, X14
714	1.0	Yel/Red	Splice #7, X15
724	1.0	Yel/Red	Splice #7, S7
730	1.0	Blk	Splice #6, E1
740	1.0	Blk	Splice #6, E2
750	1.0	Blk	Splice #6, X14
760	1.0	Blk	Splice #6, X15
764	1.0	Yel/Wht	S7, E1
774	1.0	Yel/Wht	S7, E2

W6 48 VDC Cargo Box Lift Wiring Harness

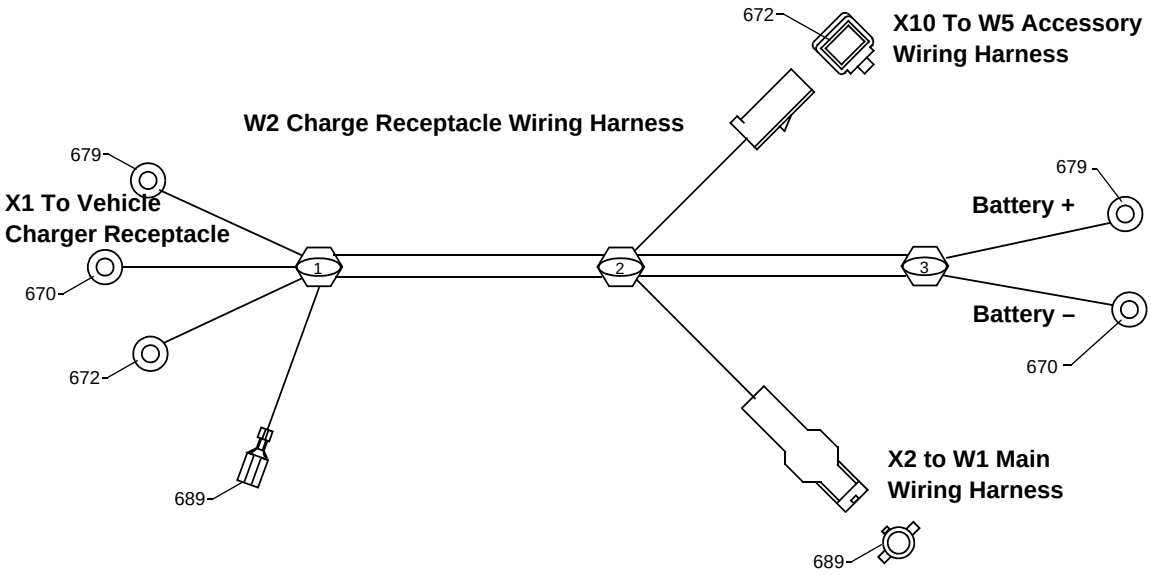
Circuit Number	Wire Size	Color	Termination Points
804	1.0	Yel/Red	X14, S6
810	1.0	Blk	S6, X14
812	1.0	Red/Wht	S6, K2
820	1.0	Blk/Yel	S6, Splice #8
821	1.0	Blk/Yel	Splice #8, X16
824	1.0	Blk/Yel	Splice #8, S3
830	1.0	Blk	K2, S3
832	1.0	Red/Wht	K2, K2
842	1.0	Red	K2, X16

W7 48 VDC Horn Wiring Harness

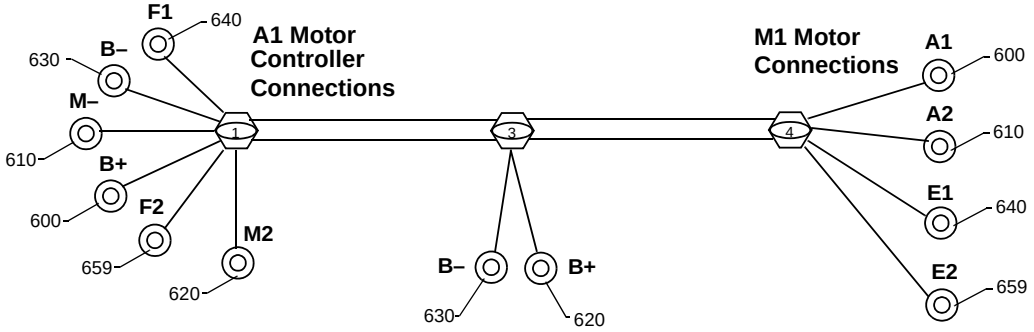
Circuit Number	Wire Size	Color	Termination Points
784	1.0	Yel/Red	X15, S10
790	1.0	Blk	X15, H2
792	1.0	Red	H2, S10



POWER, CHARGE & SPEED SENSOR WIRING HARNESSES

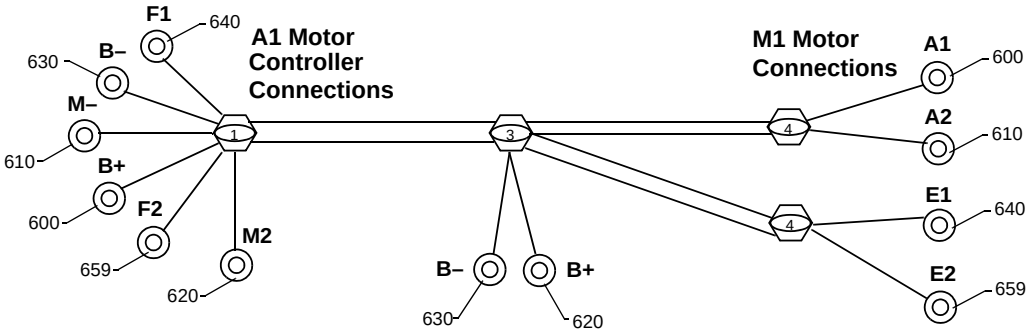


W3 Power Wiring Harness (Domestic)



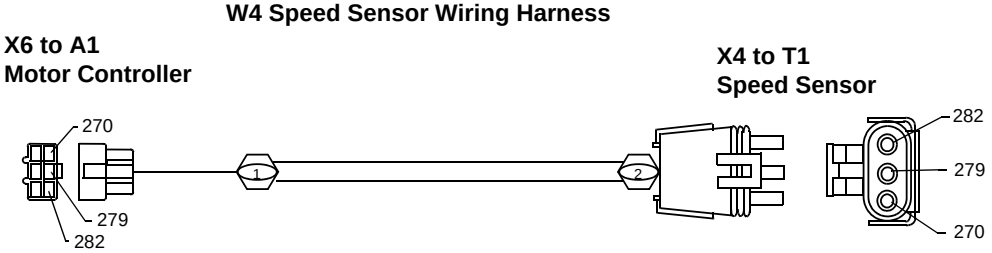
G1 Battery Connections

W3 Power Wiring Harness (Export)



G1 Battery Connections

W4 Speed Sensor Wiring Harness



ELECTRICAL SYSTEM THEORY OF OPERATION & DIAGNOSIS

MOTOR CONTROLLER

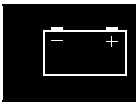
Function:

The purpose of the motor controller is to switch the low current electrical inputs to the high current outputs to run the electric drive motor.

The motor controller is connected to all the switches and devices that power up the electrical system to monitor, control and produce vehicle movement.

The motor controller is not connected to and does not monitor or control the vehicle accessories.

Theory:



The controller is a preprogrammed electrical device that links the vehicle electrical system inputs to corresponding electrical system outputs. The primary function is that of controlling both the speed and direction of the electric drive motor. Based on various electrical inputs, the electric drive motor will rotate either clockwise (forward) or counterclockwise (reverse) ranging from creep speed to a nominal speed of 25 km/h (15.5 mph) in forward and 14.5 km/h (9 mph) in reverse.

Operation:

The low current wires connected to the motor controller through the J1 and J2 connectors provide the signal inputs to the motor controller for the vehicle operation.

The motor controller receives input from all the switched circuits that effect when and how the electric drive motor is to operate. The drive/service switch and the key switch provide primary and secondary switched power to the controller to power it up. The functional switches and the throttle potentiometer provide input signals to cause the vehicle to move either forward or reverse. The motor speed sensor signals that the electric drive motor is rotating and provides speed of rotation feedback.

The motor controller reads each of these input and matches them to the other inputs that it is receiving at the same time. If the various inputs are correct the controller will respond with the corresponding outputs. If either the inputs or outputs are incorrect the motor controller will prevent the function from being performed, indicate a fault code on the LED status light and then depending upon the condition that has occurred, the motor controller will sound the reverse/warning alarm.

The motor controller inputs signals change (turn on) as the electrical system is powered up. In the unswitched circuit operation, drive/service switch in the service position, the motor controller receives no direct input power and thereby performs no direct output action.

When the drive/service switch is placed in the drive position, the motor controller receives primary switched power, See “PRIMARY SWITCHED POWER CIRCUIT OPERATION” on page 26. This supplies four full battery voltage inputs to the motor controller to power up the controller. With the primary switched circuits activated, the rollaway control of the motor is activated as well as the reverse/warning alarm.

From the drive/service switch, power is supplied through one pole of the switch to the motor controller at the J1-2 terminal, the key switch and the positive (+) terminal of the reverse/warning alarm. The negative (-) terminal of the reverse/warning alarm provides the path to battery negative for the reverse/warning alarm through the motor controller at the J1-19 terminal. The motor controller will switch this terminal to battery negative to sound the reverse/warning alarm when the vehicle is placed in reverse or if the vehicle is in a rollaway condition.

From the other pole of the drive/service switch, power is supplied through the switch to the motor controller at the J1-3 terminal and the J1-4 terminal.

Because the A1 motor controller has logic power it now has several outputs present. The motor controller supplies power at approximately 15 VDC to the motor speed sensor.

When the key switch is placed in the on position, the motor controller receives secondary switched power, See “SECONDARY SWITCHED POWER CIRCUIT OPERATION” on page 30. This supplies power to the hour meter/battery fuel gauge, the four functional switches, the J1-1 terminal of the motor controller and power is supplied to and through the motor relay to the J1-17 terminal of the motor controller.

The power input of the J1-1 terminal of the motor controller along with the input through the motor relay to the J1-17 terminal of the motor controller signals that the key switch is in the ON position and the the system is ready for functional inputs.

The park brake switch will not supply power to the motor controller at the J1-21 terminal until the park brake is released. While the park brake is ENGAGED, the park brake input to the J1-21 terminal will be missing, this will not allow the motor controller to switch the J1-17 terminal (motor relay and hour meter) to battery negative, thus preventing a drive function. When the park brake is released, the park brake switch will be closed and allow power to be supplied to the J1-21 terminal of the motor controller.

During a forward drive function the directional lever will be pushed down to activate the forward switch. This will supply power across the forward switch to the J1-10 terminal of the motor controller. This input will produce an output on the F1 terminal of the motor controller to the drive motor when the throttle pedal is pressed down. When the throttle pedal is pressed down it will activate the throttle switch as well as the throttle potentiometer. The throttle switch will signal to the motor controller to switch the J1-17 terminal to battery negative, energizing the motor relay and hour meter. The throttle potentiometer will signal to the motor controller how far the pedal has been pressed, percentage of travel, and the motor controller M- terminal will respond by allowing the similar percentage of current to flow to the drive motor armature.

During a reverse drive function the directional lever will be pulled up to activate the reverse switch. This will supply power across the reverse switch to the J1-11 terminal of the motor controller. This input will cause the motor controller to switch the J1-19 terminal to battery negative causing the reverse/warning alarm to sound a steady signal until the directional lever is placed in either neutral or forward or until the key switch is turn off. The reverse input will also produce an output on the F2 terminal of the motor controller to the drive motor when the throttle pedal is pressed down. When the throttle pedal is pressed down it will activate the throttle switch as well as the throttle potentiometer. The throttle switch will signal to the motor controller to switch the J1-17 terminal to battery negative, energizing the motor relay and hour meter. The throttle potentiometer will signal to the motor controller how far the pedal has been pressed, percentage of travel, and the motor controller M- terminal will respond by allowing the similar percentage of current to flow to the drive motor armature.

With a drive function being performed, the speed control input from the motor speed sensor is activated. Speed control is provided to assist when driving the vehicle up or down slopes in terrain or ramps. When the vehicle is traveling, the combination of throttle pedal position, current supplied to the armature of the motor and the speed measured by the speed sensor on the motor indicate to the motor controller if the drive system is operating within acceptable limits.

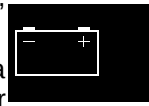
When the speed sensor indicates to the motor controller that the motor is operating at a speed slower than the throttle input is indicating, such as driving up a ramp, the motor controller will increase the current output to the motor to attempt to maintain the speed of the vehicle to a speed similar to that of driving on a level surface.

Similarly, when the speed sensor indicates to the motor controller that the motor is operating at a speed faster than the throttle input is indicating, such as driving down a ramp, the motor controller will place a load on the motor to attempt to maintain the speed of the vehicle to a speed similar to that of driving on a level surface.

Compression braking is a function of a combination of electrical components used to assist in controlling the coast or decceleration of the vehicle. There are two levels of compression braking.

Level one compression braking is the action that occurs during the moment between the operator letting off of the throttle and pressing the brake pedal to bring the vehicle to a stop. While the brakes are intended to be used to stop the vehicle, this level of compression braking will feel smooth and similar to that of light to moderate braking.

The motor controller is reading the inputs from the throttle, directional switches, park brake switch, motor armature and field winding, and the speed sensor. When the operator lets the throttle pedal return to the off position while the vehicle is still moving, the motor controller reads the sequence of events to control the coast or decceleration of the vehicle until the operator has pressed the brakes to come to a complete stop. The motor controller place a load on the motor causing it to resist the movement. The motor controller reads this as the operator letting off of the throttle to come to a stop, the reverse/warning alarm does not sound.



Level two compression braking occurs when during a drive function the directional lever is shifted to neutral or the opposite direction, the park brake is engaged, or the key switch is turned to the OFF position. While the brakes are intended to stop the vehicle, this second level of compression braking is more aggressive in nature and may feel similar to that of moderate to sever braking.

The motor controller is again reading the inputs from the throttle, directional switches, park brake switch, motor armature and field winding, and the speed sensor. However in this condition the operator has not let the throttle pedal return to the off position. The input signal to the motor controller from either the directional switch, the park brake switch, or the key switch has been changed while the vehicle is still moving. The motor controller reads the sequence of events to control the coast or decceleration of the vehicle until the operator has pressed the brakes to come to a complete stop. The motor controller place a load on the motor causing it to resist the movement. The motor controller reads this as a shut down condition with the operator present. The vehicle aggressively assists in slowing the vehicle but the reverse/warning alarm does not sound.

The anti-rollback control incorporated into the electrical system through the motor controller is activated to cause the vehicles drive system to resist movement if the operator is driving and within ten seconds after releasing the throttle pedal the vehicle stops but then starts to roll in either direction. If the vehicle starts to move because it starts to rollback on a slope and the throttle continues to indicate that it is in the off position, the motor and speed sensor will indicate movement. While the reverse/warning alarm will not sound the motor controller will place a load on the motor causing it to resist the movement. The operator must use the foot brake to hold the vehicle if stopped momentarily or the park brake if leaving the vehicle.

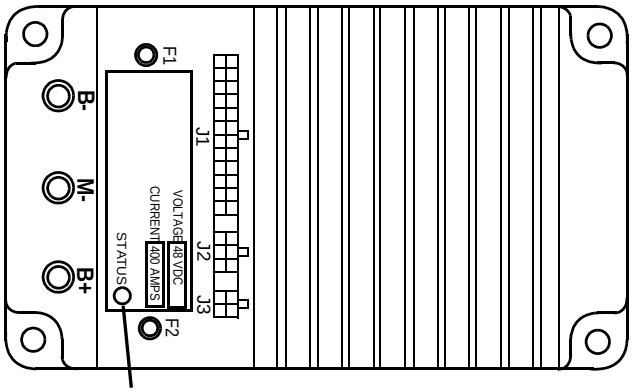
LED STATUS LIGHT FAULT CODES

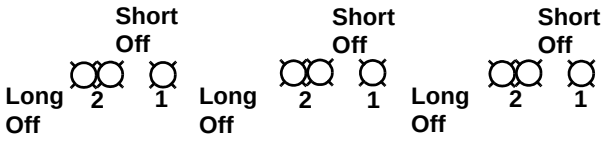
Reason:

The LED status light blinks in specific sequences to provide a visual indication of fault diagnostic codes. These fault codes will aid in the diagnosis of operational problems that may occur.

Operation:

During normal operation the status light on the motor controller will not be illuminated. The status light will begin to flash a specific fault code when an operational command input is given and any one or more parts of that circuit are not operating properly. The status light will begin to flash the fault code that will help identify the problem. Only one fault code at a time will flash, and faults are not stored or queued in memory. Each fault will have to be corrected and clear one by one should there be multiple fault. If more than one problem exist at any given time, the controller will flash the fault code that has been programmed with the highest priority. When the first fault has been cleared, the controller will reset. When the vehicle is operated the controller will flash the highest fault code in priority if there are any problem that still exist.





A fault flash code is a two digit flash that will flash continuously until the fault is corrected. A fault code of 2 then 1 flashes would be signaling a low battery voltage situation. When the battery set is recharged or replaced with fresh batteries, the motor controller would reset, clearing the fault code and resuming normal operation. This code would flash twice followed by a short OFF then flash once followed by a long OFF. This sequence would then repeat itself until the correction is made.

The short off period is approximately one second while the long off period is approximately 4 seconds. The flash code begins after the long off period. Whenever reading a fault flash code be sure to let the code cycle several times while reading the code to be sure you are at the beginning of the code.

Once a code has been read, it can then be matched to the fault code chart (See “FAULT CODE CHART” on page 15) to explain what the controller is reading as a problem and what corrective action is needed to positively identify and correct the source of the fault.

CLEARING FAULT CODES

Reason:

To clear the fault code and restore the vehicle to normal operation.

Operation:

The first step in clearing any fault code is to follow the diagnostics to identify and correct the source of the fault.

Once the condition that has initiated the fault code has been corrected, the controller must be cleared of the fault code it is displaying.

In most cases this will be a passive procedure that will occur as a result of placing the system in a safe condition to service the vehicle.

Many fault codes clear as soon as the condition causing the fault clears.

Some faults require the throttle to be returned to off and the vehicle brought to a complete stop.

Others require the key switch to be cycled through off to clear the fault.

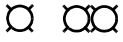
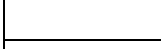
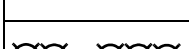
Still other require placing the drive/service switch in the service position to clear the fault codes.

Placing the drive/service switch will clear all fault codes and reset the system. If the condition causing the fault has been correct the vehicle will operate normally. If the condition that caused the fault has not been corrected the controller will repeat the fault code sequence.

FAULT CODE CHART

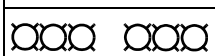
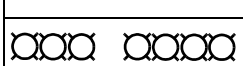
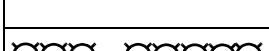
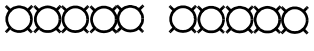
LED CODE	HAND HELD TESTER DISPLAY	WHEN FAULT IS TESTED FOR	MOTOR CONTROLLER RESPONSE	EXPLANATION	CORRECTIVE ACTION	MINIMUM ACTION TO CLEAR FAULT CODE
☼ ☼☼	THROTTLE FAULT	When the primary switched power is ON	The motor controller will activate compression braking	The J1-15 terminal of the motor controller is not receiving the proper input from the throttle potentiometer during a drive function.	Check specific drive function diagnostics. See “FORWARD & THROTTLE CIRCUIT DIAGNOSIS” on page 46. or See “REVERSE & THROTTLE CIRCUIT DIAGNOSIS” on page 52.	Condition is corrected Cycle Throttle through neutral
☼ ☼☼☼	SPEED SENSOR FAULT	When the throttle pedal is activated to a speed greater than 40%.	The motor controller will limit output to the armature to less than 30% while in drive, or to greater than 30% while in compression braking.	The J2-5 terminal of the motor controller is not receiving the proper input from the motor speed sensor during a drive function.	See “DRIVE MOTOR & SPEED SENSOR CIRCUIT DIAGNOSIS” on page 38. Also See “FORWARD & THROTTLE CIRCUIT DIAGNOSIS” on page 46. or See “REVERSE & THROTTLE CIRCUIT DIAGNOSIS” on page 52.	Condition is corrected When the J2-5 terminal of the motor controller receives the proper input from the motor speed sensor.
☼ ☼☼☼☼☼	MOTOR STALL	When the primary switched power is ON	The motor controller will reduce the current to the armature to zero.	High armature current and no motor armature rotation.	This condition could be caused by applying the throttle pedal to hold the vehicle on a slope. Defective drive motor. SEE ELECTRIC MOTOR SECTION. Defective transaxle. SEE POWER TRAIN SECTION. Brakes misadjusted and locking wheel rotation. SEE BRAKES SECTION.	This fault code will clear when speed sensor indicates armature rotation.
☼☼ ☼	LOW BATTERY VOLTAGE	When the primary switched power is ON	The motor controller will reduce the armature current limits until the controller is at zero.	Low battery voltage. Battery voltage less than 40 volts	See BATTERIES SECTION “TROUBLESHOOTING BATTERIES” on page 4. If batteries test OK, See “UNSWITCHED POWER CIRCUIT DIAGNOSIS” on page 24. If unswitched power circuit checks OK, See “PRIMARY SWITCHED POWER CIRCUIT DIAGNOSIS” on page 28.	Battery voltage is returned to 48 volts ± 10%
☼☼ ☼☼	OVER VOLTAGE	When the primary switched power is ON	The motor controller will reduce the armature current limits until the controller is at zero.	High battery voltage. Battery voltage higher the 57 volts.	Check batteries, improper batteries installed in vehicle. Battery charger plugged in to the vehicle with a defective charger interlock switch. See “CHARGER INTERLOCK SWITCH TEST” on page 77.	Battery voltage is returned to 48 volts ± 10%
☼☼ ☼☼☼	THERMAL CUTBACK	When the primary switched power is ON	The motor controller will reduce the armature current limits until the controller is at zero.	Temperature of motor controller internal components higher than 85°C (185°F) or less than -25°C (-13°F)	Check the ambient air temperature. Check if debris is obstructing air flow around motor controller. See ELECTRIC MOTOR SECTION “EXTERNAL MOTOR TEST” on page 7.	When the temperature of motor controller internal components is cooled below 85°C (185°F) or warmed above -25°C (-13°F)
☼☼ ☼☼☼☼	MAIN DRIVER ON	When primary and secondary switched power is ON	The motor controller will limit output to the armature to less than 30% while in drive, or to greater than 30% while in compression braking.	The J1-17 terminal of the motor controller is always switched to battery negative.	Check specific drive function diagnostics. See “FORWARD & THROTTLE CIRCUIT DIAGNOSIS” on page 46. or See “REVERSE & THROTTLE CIRCUIT DIAGNOSIS” on page 52.	Condition is corrected
☼☼ ☼☼☼☼☼	VDD FAULT	When the primary switched power is ON	The motor controller will reduce the armature current limits to zero, reduce the field windings current to zero and turn OFF the motor relay.	Logic voltage low	See BATTERIES SECTION “TROUBLESHOOTING BATTERIES” on page 4. If batteries test OK, See “UNSWITCHED POWER CIRCUIT DIAGNOSIS” on page 24. If unswitched power circuit checks OK, See “PRIMARY SWITCHED POWER CIRCUIT DIAGNOSIS” on page 28. If primary switched power checks OK replace motor controller.	Condition is corrected The key switch is cycled through OFF
☼☼☼ ☼	MAIN DRIVER OFF	When throttle pedal is pressed during a drive function	The motor controller will reduce the armature current limits to zero and turn OFF the motor relay.	The J1-17 terminal of the motor controller is not being switched to battery negative during a drive function.	Check specific drive function diagnostics. See “FORWARD & THROTTLE CIRCUIT DIAGNOSIS” on page 46. or See “REVERSE & THROTTLE CIRCUIT DIAGNOSIS” on page 52.	Condition is corrected Cycle Throttle through neutral

FAULT CODE CHART

LED CODE	HAND HELD TESTER DISPLAY	WHEN FAULT IS TESTED FOR	MOTOR CONTROLLER RESPONSE	EXPLANAT
	THROTTLE FAULT	When the primary switched power is ON	The motor controller will activate compression braking	The J1-15 t motor contr receiving th the throttle during a dr
	SPEED SENSOR FAULT	When the throttle pedal is activated to a speed greater than 40%.	The motor controller will limit output to the armature to less than 30% while in drive, or to greater than 30% while in compression braking.	The J2-5 te controller is proper inpu speed sens function.
	MOTOR STALL	When the primary switched power is ON	The motor controller will reduce the current to the armature to zero.	High armat motor arma
	LOW BATTERY VOLTAGE	When the primary switched power is ON	The motor controller will reduce the armature current limits until the controller is at zero.	Low battery voltage less
	OVER VOLTAGE	When the primary switched power is ON	The motor controller will reduce the armature current limits until the controller is at zero.	High batter voltage hig
	THERMAL CUTBACK	When the primary switched power is ON	The motor controller will reduce the armature current limits until the controller is at zero.	Temperatur controller in higher than less than -2
	MAIN DRIVER ON	When primary and secondary switched power is ON	The motor controller will limit output to the armature to less than 30% while in drive, or to greater than 30% while in compression braking.	The J1-17 t motor contr switched to
	VDD FAULT	When the primary switched power is ON	The motor controller will reduce the armature current limits to zero, reduce the field windings current to zero and turn OFF the motor relay.	Logic voltag
	MAIN DRIVER OFF	When throttle pedal is pressed during a drive function	The motor controller will reduce the armature current limits to zero and turn OFF the motor relay.	The J1-17 t motor contr switched to during a dr

	EXPLANATION	CORRECTIVE ACTION	MINIMUM ACTION TO CLEAR FAULT CODE
	The J1-15 terminal of the motor controller is not receiving the proper input from the throttle potentiometer during a drive function.	Check specific drive function diagnostics. See “FORWARD & THROTTLE CIRCUIT DIAGNOSIS” on page 46. or See “REVERSE & THROTTLE CIRCUIT DIAGNOSIS” on page 52.	Condition is corrected Cycle Throttle through neutral
	The J2-5 terminal of the motor controller is not receiving the proper input from the motor speed sensor during a drive function.	See “DRIVE MOTOR & SPEED SENSOR CIRCUIT DIAGNOSIS” on page 38. Also See “FORWARD & THROTTLE CIRCUIT DIAGNOSIS” on page 46. or See “REVERSE & THROTTLE CIRCUIT DIAGNOSIS” on page 52.	Condition is corrected When the J2-5 terminal of the motor controller receives the proper input from the motor speed sensor.
	High armature current and no motor armature rotation.	This condition could be caused by applying the throttle pedal to hold the vehicle on a slope. Defective drive motor. SEE ELECTRIC MOTOR SECTION. Defective transaxle. SEE POWER TRAIN SECTION. Brakes misadjusted and locking wheel rotation. SEE BRAKES SECTION.	This fault code will clear when speed sensor indicates armature rotation.
	Low battery voltage. Battery voltage less than 40 volts	See BATTERIES SECTION “TROUBLESHOOTING BATTERIES” on page 4. If batteries test OK, See “UNSWITCHED POWER CIRCUIT DIAGNOSIS” on page 24. If unswitched power circuit checks OK, See “PRIMARY SWITCHED POWER CIRCUIT DIAGNOSIS” on page 28.	Battery voltage is returned to 48 volts ± 10%
	High battery voltage. Battery voltage higher the 57 volts.	Check batteries, improper batteries installed in vehicle. Battery charger plugged in to the vehicle with a defective charger interlock switch. See “CHARGER INTERLOCK SWITCH TEST” on page 77.	Battery voltage is returned to 48 volts ± 10%
	Temperature of motor controller internal components higher than 85°C (185°F) or less than -25°C (-13°F)	Check the ambient air temperature. Check if debris is obstructing air flow around motor controller. See ELECTRIC MOTOR SECTION “EXTERNAL MOTOR TEST” on page 7.	When the temperature of motor controller internal components is cooled below 85°C (185°F) or warmed above -25°C (-13°F)
	The J1-17 terminal of the motor controller is always switched to battery negative.	Check specific drive function diagnostics. See “FORWARD & THROTTLE CIRCUIT DIAGNOSIS” on page 46. or See “REVERSE & THROTTLE CIRCUIT DIAGNOSIS” on page 52.	Condition is corrected
	Logic voltage low	See BATTERIES SECTION “TROUBLESHOOTING BATTERIES” on page 4. If batteries test OK, See “UNSWITCHED POWER CIRCUIT DIAGNOSIS” on page 24. If unswitched power circuit checks OK, See “PRIMARY SWITCHED POWER CIRCUIT DIAGNOSIS” on page 28. If primary switched power checks OK replace motor controller.	Condition is corrected The key switch is cycled through OFF
	The J1-17 terminal of the motor controller is not being switched to battery negative during a drive function.	Check specific drive function diagnostics. See “FORWARD & THROTTLE CIRCUIT DIAGNOSIS” on page 46. or See “REVERSE & THROTTLE CIRCUIT DIAGNOSIS” on page 52.	Condition is corrected Cycle Throttle through neutral

LED CODE	HAND HELD TESTER DISPLAY	WHEN FAULT IS TESTED FOR	MOTOR CONTROLLER RESPONSE	EXPLANATION	CORRECTIVE ACTION	MINIMUM ACTION TO CLEAR FAULT CODE
3 2	MAIN WELDED	When throttle pedal is released from a drive function	The motor controller will limit output to the armature to less than 30% while in drive, or to greater than 30% while in compression braking.	Motor relay contacts are welded	Check specific drive function diagnostics. See “FORWARD & THROTTLE CIRCUIT DIAGNOSIS” on page 46. or See “REVERSE & THROTTLE CIRCUIT DIAGNOSIS” on page 52. See “MOTOR RELAY TEST” on page 73.	Condition is corrected
3 3	PRECHARGE FAULT	When throttle pedal is pressed during a drive function	The motor controller will reduce the armature current limits to zero, reduce the field windings current to zero and turn OFF the motor relay.	B+ terminal not able to receive a full 12 volts	Shorted 600 Blk wire. Additional electrical components connected to the B+ terminal of the motor controller. Defective motor controller, replace motor controller.	Condition is corrected Cycle Throttle through neutral
3 4	FIELD MISSING	When the primary switched power is ON	The motor controller will reduce the armature current limits to zero, reduce the field windings current to zero and turn OFF the motor relay.	Field winding circuit open	Check 640 Blk and 659 Wht wires and connections. If OK See ELECTRIC MOTOR SECTION “EXTERNAL MOTOR TEST” on page 7.	Condition is corrected Cycle Throttle through neutral
3 5	FIELD OVERCURRENT	When the primary switched power is ON	The motor controller will shut down all output current circuitry to protect the motor controller.	Field windings circuit shorted	Check 640 Blk and 659 Wht wires and connections. If OK See ELECTRIC MOTOR SECTION “EXTERNAL MOTOR TEST” on page 7.	Condition is corrected The key switch is cycled through OFF
4 1	CURRENT SENSE FAULT	When the primary switched power is ON	The motor controller will reduce the armature current limits to zero and reduce the field windings current to zero.	Current sensor fault	Turn key switch OFF for two seconds, if problem does not clear, replace motor controller.	Condition is corrected The key switch is cycled through OFF
4 3	M- FAULT	When the primary switched power is ON	The motor controller will reduce the armature current limits to zero and reduce the field windings current to zero.	M- shorted to B-	Check for short between 610 Blk and either 470 Blk or 630 Blk. If OK, replace motor controller.	Condition is corrected The key switch is cycled through OFF
4 4	AUX CONT DNC	When throttle pedal is pressed during a drive function	The motor controller will reduce the armature current limits to zero and reduce the field windings current to zero.	Internal relay Did Not Close	Replace motor controller	Condition is corrected The key switch is cycled through OFF
4 5	WELDED AUX CONT	When throttle pedal is released from a drive function	The motor controller will limit output to the armature to less than 30% while in drive, or to greater than 30% while in compression braking.	Internal relay welded	Replace motor controller	Condition is corrected
5 1	EEPROM FAILSAFE	When the primary switched power is ON	The motor controller will reduce the armature current limits to zero, reduce the field windings current to zero and turn OFF the motor relay.	EEprom checksum	Replace motor controller	Condition is corrected
5 2	MAIN COIL OPEN	When primary and secondary switched power is ON	The motor controller will limit output to the armature to less than 30% while in drive, or to greater than 30% while in compression braking.	Motor relay coil circuit reads open.	Check specific drive function diagnostics. See “FORWARD & THROTTLE CIRCUIT DIAGNOSIS” on page 46. or See “REVERSE & THROTTLE CIRCUIT DIAGNOSIS” on page 52. See “MOTOR RELAY TEST” on page 73.	Condition is corrected
5 3	MAIN CONT DNC	When throttle pedal is pressed during a drive function	The motor controller will activate the motor relay auto-arc.	Motor relay contacts indicate that they Did Not Closed.	Check specific drive function diagnostics. See “FORWARD & THROTTLE CIRCUIT DIAGNOSIS” on page 46. or See “REVERSE & THROTTLE CIRCUIT DIAGNOSIS” on page 52. See “MOTOR RELAY TEST” on page 73.	Condition is corrected Cycle Throttle through neutral
5 4	MISSING CONTACTOR	When throttle pedal is pressed during a drive function	The motor controller will turn OFF the motor relay.	Motor relay contactor drops out while preforming a function.	Check specific drive function diagnostics. See “FORWARD & THROTTLE CIRCUIT DIAGNOSIS” on page 46. or See “REVERSE & THROTTLE CIRCUIT DIAGNOSIS” on page 52. See “MOTOR RELAY TEST” on page 73.	Condition is corrected Cycle Throttle through neutral

LED CODE	HAND HELD TESTER DISPLAY	WHEN FAULT IS TESTED FOR	MOTOR CONTROLLER RESPONSE	EXPLANAT
	MAIN WELDED	When throttle pedal is released from a drive function	The motor controller will limit output to the armature to less than 30% while in drive, or to greater than 30% while in compression braking.	Motor relay welded
	PRECHARGE FAULT	When throttle pedal is pressed during a drive function	The motor controller will reduce the armature current limits to zero, reduce the field windings current to zero and turn OFF the motor relay.	B+ termina a full 12 vo
	FIELD MISSING	When the primary switched power is ON	The motor controller will reduce the armature current limits to zero, reduce the field windings current to zero and turn OFF the motor relay.	Field windi
	FIELD OVERCURRENT	When the primary switched power is ON	The motor controller will shut down all output current circuitry to protect the motor controller.	Field windi
	CURRENT SENSE FAULT	When the primary switched power is ON	The motor controller will reduce the armature current limits to zero and reduce the field windings current to zero.	Current ser
	M- FAULT	When the primary switched power is ON	The motor controller will reduce the armature current limits to zero and reduce the field windings current to zero.	M- shorted
	AUX CONT DNC	When throttle pedal is pressed during a drive function	The motor controller will reduce the armature current limits to zero and reduce the field windings current to zero.	Internal rel
	WELDED AUX CONT	When throttle pedal is released from a drive function	The motor controller will limit output to the armature to less than 30% while in drive, or to greater than 30% while in compression braking.	Internal rel
	EEPROM FAILSAFE	When the primary switched power is ON	The motor controller will reduce the armature current limits to zero, reduce the field windings current to zero and turn OFF the motor relay.	EEprom ch
	MAIN COIL OPEN	When primary and secondary switched power is ON	The motor controller will limit output to the armature to less than 30% while in drive, or to greater than 30% while in compression braking.	Motor relay open.
	MAIN CONT DNC	When throttle pedal is pressed during a drive function	The motor controller will activate the motor relay auto-arc.	Motor relay that they D
	MISSING CONTACTOR	When throttle pedal is pressed during a drive function	The motor controller will turn OFF the motor relay.	Motor relay out while p function.

	EXPLANATION	CORRECTIVE ACTION	MINIMUM ACTION TO CLEAR FAULT CODE
	Motor relay contacts are welded	Check specific drive function diagnostics. See “FORWARD & THROTTLE CIRCUIT DIAGNOSIS” on page 46. or See “REVERSE & THROTTLE CIRCUIT DIAGNOSIS” on page 52. See “MOTOR RELAY TEST” on page 73.	Condition is corrected
	B+ terminal not able to receive a full 12 volts	Shorted 600 Blk wire. Additional electrical components connected to the B+ terminal of the motor controller. Defective motor controller, replace motor controller.	Condition is corrected Cycle Throttle through neutral
	Field winding circuit open	Check 640 Blk and 659 Wht wires and connections. If OK See ELECTRIC MOTOR SECTION “EXTERNAL MOTOR TEST” on page 7.	Condition is corrected Cycle Throttle through neutral
	Field windings circuit shorted	Check 640 Blk and 659 Wht wires and connections. If OK See ELECTRIC MOTOR SECTION “EXTERNAL MOTOR TEST” on page 7.	Condition is corrected The key switch is cycled through OFF
	Current sensor fault	Turn key switch OFF for two seconds, if problem does not clear, replace motor controller.	Condition is corrected The key switch is cycled through OFF
	M- shorted to B-	Check for short between 610 Blk and either 470 Blk or 630 Blk. If OK, replace motor controller.	Condition is corrected The key switch is cycled through OFF
	Internal relay Did Not Close	Replace motor controller	Condition is corrected The key switch is cycled through OFF
	Internal relay welded	Replace motor controller	Condition is corrected
	EEprom checksum	Replace motor controller	Condition is corrected
	Motor relay coil circuit reads open.	Check specific drive function diagnostics. See “FORWARD & THROTTLE CIRCUIT DIAGNOSIS” on page 46. or See “REVERSE & THROTTLE CIRCUIT DIAGNOSIS” on page 52. See “MOTOR RELAY TEST” on page 73.	Condition is corrected
	Motor relay contacts indicate that they Did Not Closed.	Check specific drive function diagnostics. See “FORWARD & THROTTLE CIRCUIT DIAGNOSIS” on page 46. or See “REVERSE & THROTTLE CIRCUIT DIAGNOSIS” on page 52. See “MOTOR RELAY TEST” on page 73.	Condition is corrected Cycle Throttle through neutral
	Motor relay contactor drops out while preforming a function.	Check specific drive function diagnostics. See “FORWARD & THROTTLE CIRCUIT DIAGNOSIS” on page 46. or See “REVERSE & THROTTLE CIRCUIT DIAGNOSIS” on page 52. See “MOTOR RELAY TEST” on page 73.	Condition is corrected Cycle Throttle through neutral

HAND HELD TESTER

Function:

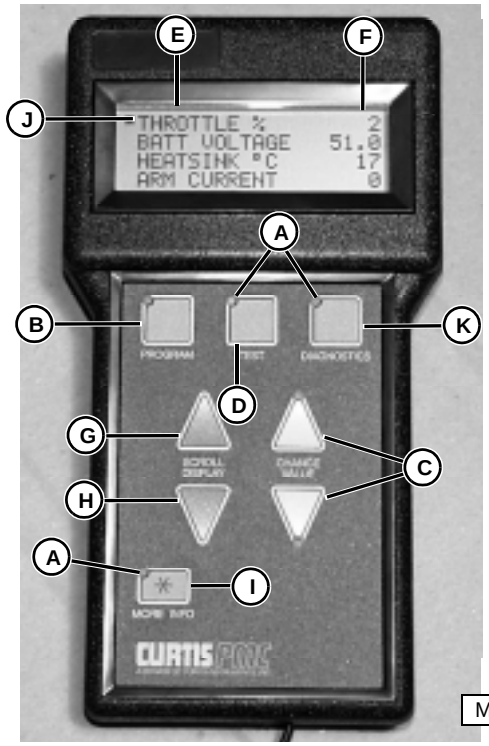
The purpose of the hand held tester (JDG1249) is to assist in testing and diagnosing the operational circuits of the motor controller.

Operation:

Generally the hand held tester will only be used when a vehicle is being serviced do to an operation irregularity.

To connect the tester to the motor controller the seat base cover and motor controller cover will need to be removed. See “SEAT BASE COVER REMOVAL & INSTALLATION” on page 5, MISC. SECTION.

With the service/drive switch in the SERVICE position the tester can then be connected to the controller. Turning the service/drive switch to the DRIVE position will supply power to the tester. The tester does not have is own power supply, it receives its power from the vehicle being tested through the controller.



When the tester has completed its self test, it will display a prompt for either the Program, Test or Diagnostics button to be pressed. Once a function button has been pressed the LED (A) in the upper left corner of the button will be lit to identify which function the tester is operating in.

Since there are no programable setting to be maintained, the program button (B) and the change value buttons (C) have been disabled and will perform no function.

Pressing the Test button (D) will display a list of the operational inputs and output (E) along with the present readings (F). The tester will display four lines of text at a time. Pressing the SCROLL arrow up (G) or down (H) will roll the display up or down. The table below lists the test menu in the order it will be displayed as well as the reading or range the reading will be within.

1307 Tester Menu	Minimum	Maximum
Throttle %	0%	100%
Battery Voltage	0 volts	80 volts
Heatsink Temperature	-55°C	105°C
Arm Current	0 amps	600 amps
Field Current	0 amps	40 amps
Arm PWM	0%	100%
Field PWM	0%	100%
Speed In	OFF	ON
Brake Input	OFF	ON
Foot Input	OFF	ON
Key Input	OFF	ON
Forward Input	OFF	ON
Reverse Input	OFF	ON
Main Cont	OFF	ON

If the More Info button (I) is pressed while in the Test mode, the top line (J) of the display will enlarged and present additional information on that line of data. Pressing either scroll button will return the tester to the test mode.

Pressing the Diagnostics button (K) will display any possible faults with the motor controller. Similar to the fault flash codes, these faults can then be used to direct the troubleshooting toward the specific function that is not operating properly. If the controller has no faults, the display will read “NO KNOWN FAULTS”. If a fault is displayed it can be matched to the “FAULT CODE CHART” on page 15 to find the suggested corrective action.

If the More Info button (I) is pressed while in the Diagnostics mode, The display will show the fault history in order, from newest to oldest. Pressing the scroll button will scroll the display up or down to view additional lines of information.

TROUBLESHOOTING CHART

Problem or Symptom / Check or Solution	Does not run	Runs Slow	Runs Fast	Has low torque	Has short run time	No reverse or warning buzzer	No forward or reverse	Features missing	Intermittent operation	Won't charge	Charger won't shut OFF	Ignition interlock inoperative
Tire Pressure		●			●							
Battery Voltage	●	●		●						●		
Speed Sensor		●	●									
Throttle Adjustment		●										
Motor Test	●	●	●	●	●			●	●			
Controller Test	●	●	●	●	●	●	●	●	●			
Charger Test					●					●	●	●
Tow-in					●							
Brake Test					●							
Battery Test					●							
Reverse/Warning Alarm Test						●						
Switch Test	●						●	●	●			
Loose Connections	●								●			
Controller Over Temperature									●			
Charger AC Supply Voltage										●		
Charger Plug & Receptacle										●		
Charger Interlock	●											●
Headlight Test	●											
Motor Relay Test	●											
Controller Diagnostics	●											
Throttle Potentiometer	●											

Tire Pressure

The tire pressure should be maintained at **10 psi** in all tires. Low tire pressure will increase the tire rolling resistance and can effect vehicle speed and will increase the battery load.

Battery Voltage

The no load battery voltage should be above **48 volts DC**. Even deeply discharged batteries will show this nominal voltage. If below 48 volts, then individual batteries should be checked to identify which one(s) is below its nominal 6 volt level. See BATTERIES SECTION “BATTERY TEST” on page 7.

Speed Sensor

The speed sensor circuit has the provision for reduced vehicle speed if the sensor is not detected by the controller. The travel speed of the vehicle will be reduced to a few miles per hour and continue at this slow speed until the speed sensor input is restored.

Check J2-6 for a voltage of 13 to 15 volts. Check voltage at J2-5, this pin is a pulsing input to reflect the motor speed. Pushing the vehicle slowly forward or reverse should cause the voltage on the J2-5 terminal to change from 0 volts to 5 volts then 0 volts and so on. This voltage should change at approximately each **2.5 cm (1.0 in.)** of travel. See “DRIVE MOTOR & SPEED SENSOR CIRCUIT OPERATION” on page 34.

Throttle Adjustment

The throttle linkage must be set correctly for proper vehicle performance. The stop bolt is not intended to be used as a means of setting the vehicle speed. See “THROTTLE STOP & LINKAGE ADJUSTMENT” on page 79.

Motor Test

The motor and axle must freely rotate without undue drag.

The continuity of the armature and field coils should be confirmed. These are very low resistances and with out special equipment the true resistance values can not be determined. The armature and field must be isolated from the motor frame and also from each other. Confirm that no continuity exists between coils and between frame. See ELECTRIC MOTOR SECTION “EXTERNAL MOTOR TEST” on page 7.

The maximum armature current under heavy load conditions is about 400 amps while the filed current is 20 amps. These heavy load conditions are hard to sustain unless on steep grades at full load. They may however be observed briefly during normal acceleration on flat ground with light loads.

Controller Test

With the drive/service switch in the DRIVE position and the key switch ON, the following voltages must be present:

Plug Number	Pin Number	Normal Value
J1	1	Battery Voltage
J1	2	Battery Voltage
J1	3	Battery Voltage
J1	4	Battery Voltage
J1	13	4 to 5 volts
J1	14	0.3 to 0.6 volts
J1	15	same as J1-14
J2	6	13 to 15 volts

Also see “PRIMARY SWITCHED POWER CIRCUIT OPERATION” on page 26 and “SECONDARY SWITCHED POWER CIRCUIT OPERATION” on page 30.

Charger Test

See BATTERY CHARGER SECTION “TROUBLESHOOTING BATTERY CHARGING CIRCUIT” on page 12.

Toe-In

If toe-in is not correct the power to propel the unit will be increased. See STEERING SECTION “TOE-IN ADJUSTMENT” on page 8.

Brake Test

The brakes must not be dragging during normal operation. Any unintentional brake drag will raise the power required for operation. Place the drive/service switch to the SERVICE position and rotate each rear wheel and check for dragging brakes. See BRAKES SECTION “TESTS AND ADJUSTMENTS” on page 10.

Battery Test

See BATTERIES SECTION “TESTS AND ADJUSTMENTS” on page 7.

Reverse/Warning Alarm Test

With the vehicle power circuits turned ON, place the vehicle in reverse, the alarm should sound. If the alarm does not sound, See “REVERSE & THROTTLE CIRCUIT OPERATION” on page 50 and “REVERSE/ WARNING ALARM TEST” on page 75.

Loose Connections

Often a visual examination will show where wires are broken, loose or burned off. Look for signs of heat or discoloration of the insulation.

Controller Over Temperature

The controller has a built in over-temperature sensor to limit the units temperature during operation. If the controller exceed approximately **90°C (194°F)** it will begin to shut down operation to protect itself. Allowing the controller to cool will return it to normal operation. See “FAULT CODE CHART” on page 15.

Charger AC Supply Voltage

For proper operation the input voltage of the charger should be 120 VAC ± 10%. Confirm that the supply is present and within the range of 108 to 132 VAC.

Charger Plug & Receptacle

There is a 50 amp fuse in the charger receptacle mounted in the vehicle frame. The vehicle will not drive or charge if the fuse is open. Headlight operation is an easy indicator of the fuse condition. If the headlights operate, the fuse is good. See “UNSWITCHED POWER CIRCUIT OPERATION” on page 22.

The charger plug has a three wire circuit. Two wires provide the charging current path while the third wire signals that the charger should turn ON. The third wire connection is a small spring loaded contact in the charger plug that completes the current path between the battery set negative and the charger timer. See BATTERY CHARGER SECTION “CHARGER THEORY & OPERATION” on page 10.

Charger Interlock

The charger interlock can be checked by placing the vehicle in reverse with the key switch ON. The alarm will sound if the circuit is good. Insert the charger plug into the vehicle, if the interlock switch is working properly the alarm will be silenced when completely plugged in. If the alarm does not turn ON see reverse. If the alarm does not turn OFF See “CHARGER INTERLOCK SWITCH TEST” on page 77.

Headlight Test

There is a 50 amp fuse in the charger receptacle mounted in the vehicle frame. The vehicle will not drive or charge if the fuse is open. This fuse will also disable the headlights. Headlight operation is an easy indicator of the fuse condition. If the headlights operate, the fuse is good.

The fact that this fuse may have opened is a signal of a major electrical short and the cause must be identified before the fuse is replaced. Possible causes could involve the following:

- Cable shorts in the charger DC cable
- Internal shorts in the charger receptacle harness
- Damaged charging plug or receptacle
- Diode failure inside the charger
- Internal charger shorts
- Vehicle option or accessory shorts

Motor Relay Test

For the vehicle to run, the motor relay must close and apply power to the motor circuit. The control of the motor relay is provided by the controller and it is the controller which signals the motor relay to close or open. In normal operation you can audibly hear the motor relay engage as the throttle is depressed in a normal drive function. When the vehicle comes to rest and the throttle is released, the motor relay typically releases following a few second delay. See “MOTOR RELAY TEST” on page 73.

Controller Diagnostics

See “LED STATUS LIGHT FAULT CODES” on page 14.

Throttle Potentiometer

The throttle potentiometer can be checked with a voltmeter. An increasing voltage from the potentiometer to the controller terminal J1-15 controls the vehicle travel speed. With the throttle in the neutral or up position, the voltage at the J1-15 terminal should be close or equal to the voltage on terminal J1-14. This voltage is typically less than 0.5 volts. As the throttle is depressed to the full down position, the potentiometer output on the J1-15 terminal will approach 4.5 volts for full travel speed. To test the throttle potentiometer circuit see either “FORWARD & THROTTLE CIRCUIT OPERATION” on page 44, or “REVERSE & THROTTLE CIRCUIT OPERATION” on page 50. Also see “THROTTLE POTENTIOMETER TEST” on page 74.

Switch Test

The switches are operated at 48 volts and are either at battery voltage (48 volts nominal) or 0 volts. They can be checked as follows:

Switch	Switch Position	Test From	Test To	Normal Value	Also See
Drive/ Service	Service	Battery Negative	J1-2	Zero Volts	“PRIMARY SWITCHED POWER CIRCUIT OPERATION” on page 26
Drive/ Service	Service	Battery Negative	J1-3	Zero Volts	“PRIMARY SWITCHED POWER CIRCUIT OPERATION” on page 26
Drive/ Service	Drive	Battery Negative	J1-2	Battery Voltage	“PRIMARY SWITCHED POWER CIRCUIT OPERATION” on page 26
Drive/ Service	Drive	Battery Negative	J1-3	Battery Voltage	“PRIMARY SWITCHED POWER CIRCUIT OPERATION” on page 26
Key Switch	OFF	Battery Negative	J1-1	Zero Volts	“SECONDARY SWITCHED POWER CIRCUIT OPERATION” on page 30
Key Switch	ON	Battery Negative	J1-1	Battery Voltage	“SECONDARY SWITCHED POWER CIRCUIT OPERATION” on page 30
Forward Switch	Neutral	Battery Negative	J1-10	Zero Volts	“FORWARD & THROTTLE CIRCUIT OPERATION” on page 44
Forward Switch	Forward	Battery Negative	J1-10	Battery Voltage	“FORWARD & THROTTLE CIRCUIT OPERATION” on page 44
Reverse Switch	Neutral	Battery Negative	J1-11	Zero Volts	“REVERSE & THROTTLE CIRCUIT OPERATION” on page 50
Reverse Switch	Reverse	Battery Negative	J1-11	Battery Voltage	“REVERSE & THROTTLE CIRCUIT OPERATION” on page 50
Throttle Switch	Neutral (Pedal Up)	Battery Negative	J1-8	Zero Volts	“FORWARD & THROTTLE CIRCUIT OPERATION” on page 44 or “REVERSE & THROTTLE CIRCUIT OPERATION” on page 50
Throttle Switch	Full Throttle (Pedal Down)	Battery Negative	J1-8	Battery Voltage	“FORWARD & THROTTLE CIRCUIT OPERATION” on page 44 or “REVERSE & THROTTLE CIRCUIT OPERATION” on page 50
Park Brake Switch	Brake ON	Battery Negative	J1-21	Zero Volts	“PARK BRAKE CIRCUIT OPERATION” on page 40
Park Brake Switch	Brake OFF	Battery Negative	J1-21	Battery Voltage	“PARK BRAKE CIRCUIT OPERATION” on page 40

UNSWITCHED POWER CIRCUIT OPERATION

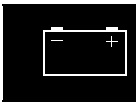
Function:

Provides unswitched power to the primary machine operating components whenever the battery set is connected as well as completing the circuit back to the battery set for the battery negative circuit for each functional component.

Operating Conditions, Unswitched Circuits:

Unswitched power is present when the vehicle has the:

- battery charger unplugged from vehicle
- key switch in off position
- drive/service switch in the service position
- park brake in the on position
- directional control lever in the neutral position
- any accessory control switches in the off position

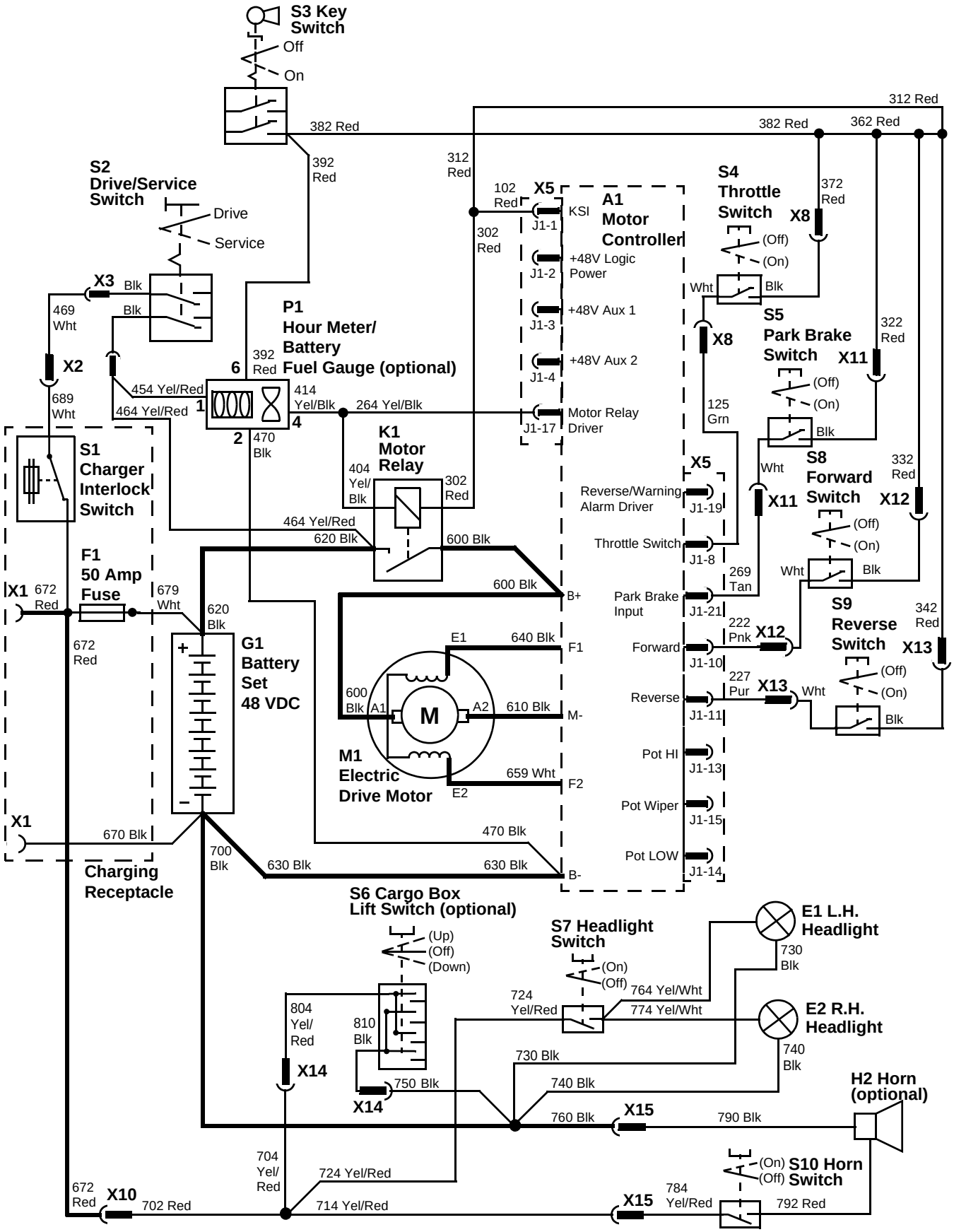


The negative (B-) terminal of the battery set will have three wires connected to it to provide the battery negative path for the charging, operating and accessories circuits. Measuring from the battery set negative terminal, continuity should be indicated at the 670 Blk wire of the charger receptacle, 760 Blk wire of the X15 connector, 750 Blk wire of the X14 connector, 740 Blk wire on the E2 R.H. headlight, the 730 Blk wire on the E1 L. H. headlight, the 630 Blk wire connected to the B- terminal of the A1 motor controller, and the 470 Blk wire connected to the P1 hour meter/battery fuel gauge (optional).

The positive (B+) terminal of the battery set will have two wires connected to it to provide the positive power path for the charging, operating and accessories circuits. Power is supplied from the battery set positive terminal to the 679 Wht wire, F1 50 amp fuse to the 672 Red wire of the charger receptacle and the S1 charger interlock switch. With the charger plug disconnected from the vehicle the S1 switch contacts are closed and supply power to the 689 Wht wire, X2 connector and 469 Wht wire to the S2 drive/service switch. The 672 Red wire supplies power to the X10 connector, 702 Red wire to the splice connecting to the 704, 714 and 724 Yel/Red wires. The 704 Yel/Red wire supplies to the X14 connector, 804 Yel/Red wire and the S6 cargo box lift switch. The 714 Yel/Red wire supplies power from the splice to the X15 connector, 784 Yel/Red wire and the S10 horn switch. The 724 Yel/Red wire supplies power to the S7 headlight switch. The remaining cable on the battery set positive (B+) terminal is the 620 Blk wire which supplies power to the K1 motor relay, 464 Yel/Red wire, S2 drive/service switch, and the 454 Yel/Red wire to the P1 hour meter/battery fuel gauge (optional).

Additional voltage may be measured as the capacitor circuit within the A1 motor controller discharges. With the black lead of the multimeter connected to the negative (B-) terminal of the battery set, voltage as high as 48 volts and dropping at the rate of approximately 0.1 volt in 30 - 90 seconds can be measured on the circuit path from the 600 Blk wire connected to the K1 motor relay, A1 motor controller B+ terminal, M1 electric drive motor terminals (A1 & A2) and back to the A1 motor controller at the M- terminal.

UNSWITCHED POWER CIRCUIT SCHEMATIC

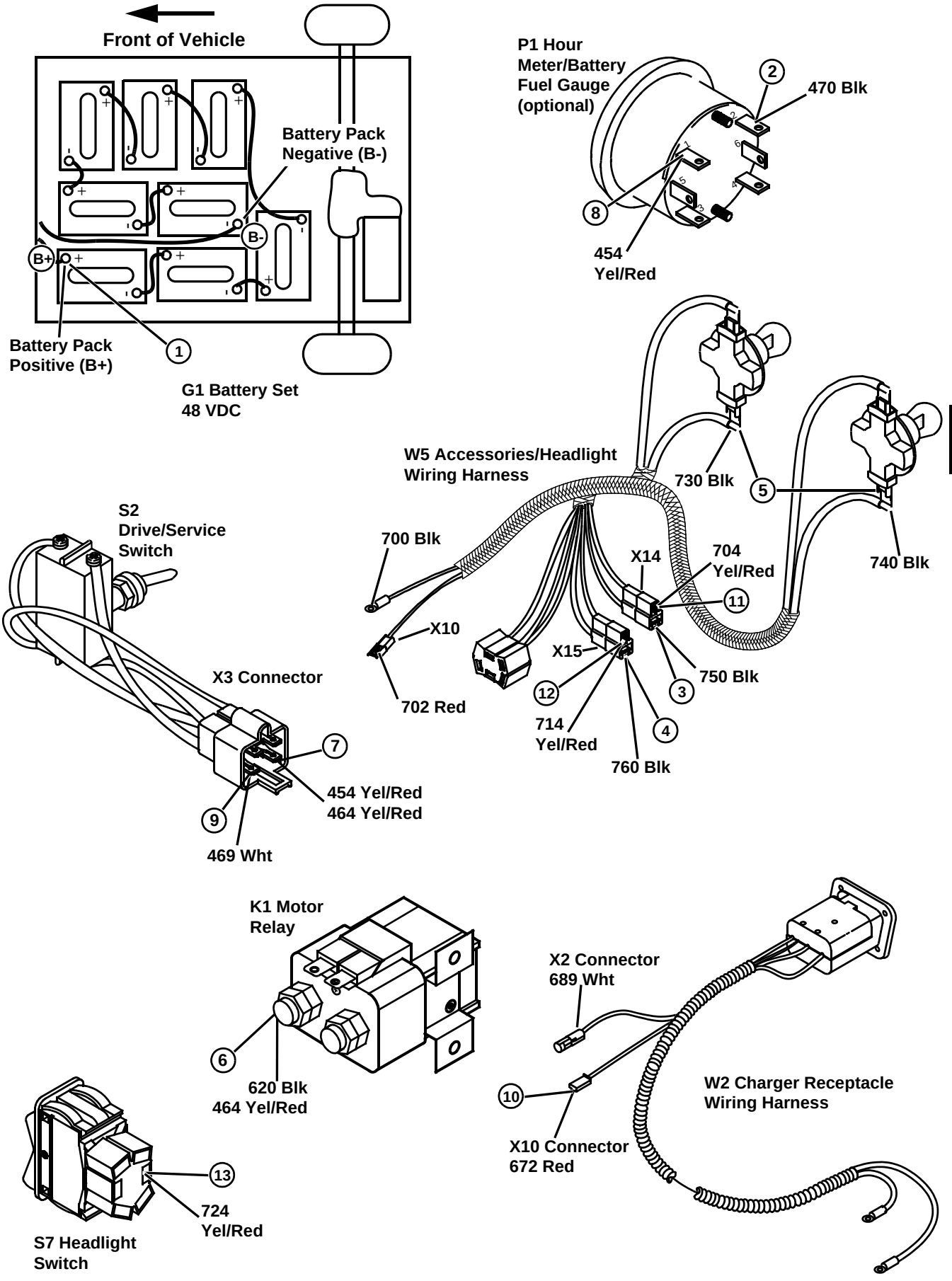


UNSWITCHED POWER CIRCUIT DIAGNOSIS

Test Conditions:

- Key switch OFF
- Park Brake ON
- Drive/Service switch in SERVICE position
- Battery set FULLY charged

Test/Check Point	Normal	If Not Normal
1. Battery set	48 volts DC or higher	Test batteries. See Battery Section
2. P1 Hour Meter/Battery Fuel Gauge (optional)	Continuity to battery negative	Check 470 and 630 Blk wires and connections
3. X14 Connector	Continuity to battery negative	Check 750 and 700 Blk wires and connections
4. X15 Connector	Continuity to battery negative	Check 760 and 700 Blk wires and connections
5. E1 & E2 Headlights	Continuity to battery negative	Check 730, 740 and 700 Blk wires and connections
6. K1 Motor Relay	48 volts DC or higher	Check 620 Blk wire and connections
7. S2 Drive/Service switch	48 volts DC or higher	Check 464 Yel/Red wire and connections
8. P1 Hour Meter/Battery Fuel Gauge (optional)	48 volts DC or higher	Check 454 Yel/Red wire and connections
9. S2 Drive/Service switch	48 volts DC or higher	Check 469, 689, and 679 Wht wires and connections. Check S1 charger interlock switch. Check F1 50 amp fuse.
10. X10 Connector	48 volts DC or higher	Check 679 Wht and 672 Red wires and connections. Check F1 50 amp fuse.
11. X14 Connector	48 volts DC or higher	Check 704 Yel/Red and 702 Red wires and connections
12. X15 Connector	48 volts DC or higher	Check 714 Yel/Red and 702 Red wires and connections
13. S7 Headlight switch	48 volts DC or higher	Check 724 Yel/Red and 702 Red wires and connections


Front of Vehicle
Battery Pack Negative (B-)
B-
B+
Battery Pack Positive (B+)
1
G1 Battery Set 48 VDC
P1 Hour Meter/Battery Fuel Gauge (optional)
2
470 Blk
8
454 Yel/Red
W5 Accessories/Headlight Wiring Harness
730 Blk
5
740 Blk
700 Blk
X14
704 Yel/Red
11
X10
X15
750 Blk
3
12
702 Red
714 Yel/Red
4
760 Blk
S2 Drive/Service Switch
X3 Connector
7
454 Yel/Red
464 Yel/Red
9
469 Wht
K1 Motor Relay
6
620 Blk
464 Yel/Red
X2 Connector
689 Wht
10
W2 Charger Receptacle Wiring Harness
X10 Connector
672 Red
13
724 Yel/Red
S7 Headlight Switch

PRIMARY SWITCHED POWER CIRCUIT OPERATION

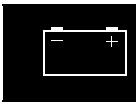
Function:

Provides switched power to the vehicle key switch and motor controller to activate the safety interlock system.

Operating Conditions, Primary Switched Power:

Primary switched power is present when the vehicle has the:

- battery charger unplugged from vehicle
- key switch in off position
- drive/service switch in the drive position
- park brake in the on position
- directional control lever in the neutral position
- any accessory control switches in the off position



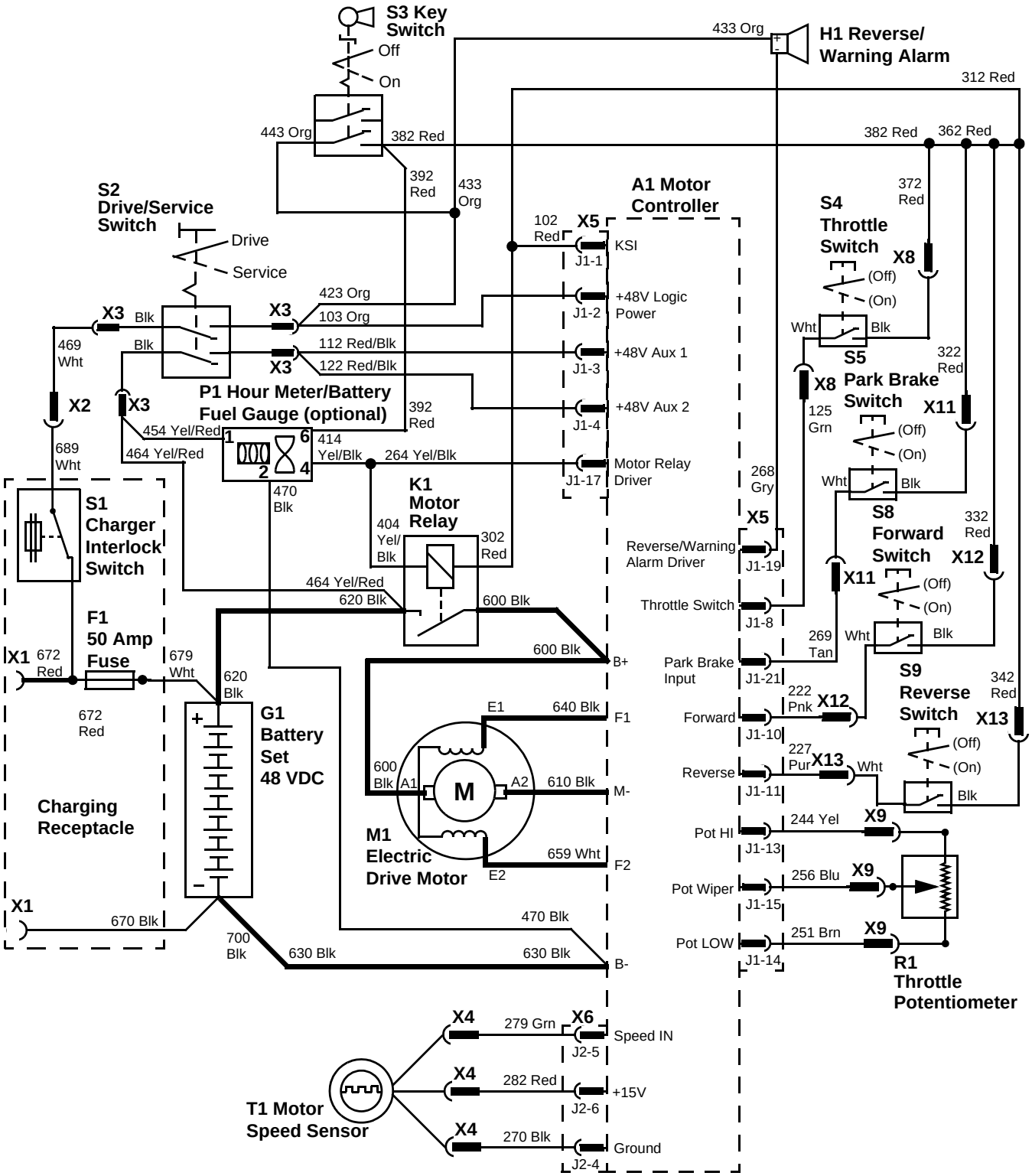
Placing the drive/service switch in the drive position will activate the primary switched circuits. With the primary switched circuits activated, the rollaway control of the motor is activated as well as the reverse/warning alarm. In addition power is supplied to the A1 motor controller and the S3 key switch through the S2 drive/service switch.

From the 469 Wht connected to one pole of the S2 drive/service switch power is supplied through the switch to the 103 and 423 Org wires. The 103 Org wire connects to the A1 motor controller at the J1-2 terminal. The 423 Org wire connects to the 433 and 443 Org wires. The 443 Org wire supplies power to the S3 key switch while the 433 Org wire supplies power to the positive (+) terminal of the H1 reverse/warning alarm. The 268 Gry wire connects to the negative (-) terminal of the H1 reverse/warning alarm and provides the battery negative for the reverse/warning alarm through the A1 motor controller at the J1-19 terminal. The A1 motor controller will switch the 268 Gry wire to battery negative to sound the reverse/warning alarm when the vehicle is placed in reverse or if the vehicle is in a rollaway condition.

From the 464 Yel/Red wire connected to the other pole of the S2 drive/service switch power is supplied through the switch to the 112 and 122 Red/Blk wires. The 112 Red/Blk wire connects to the A1 motor controller at the J1-3 terminal while the 122 Red/Blk wire connects to the A1 motor controller at the J1-4 terminal.

Because the A1 motor controller has logic power from the 103 Org wire, the motor controller supplies power at approximately 15 VDC from the J2-6 connector to the 282 Red wire and the Red wire of the T1 motor speed sensor.

PRIMARY SWITCHED POWER CIRCUIT SCHEMATIC

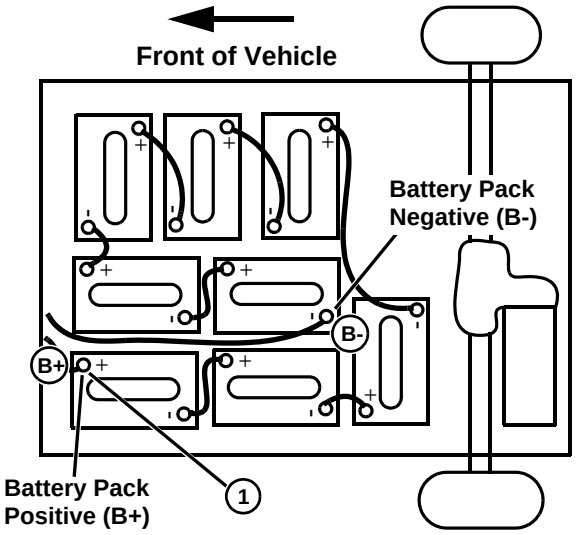


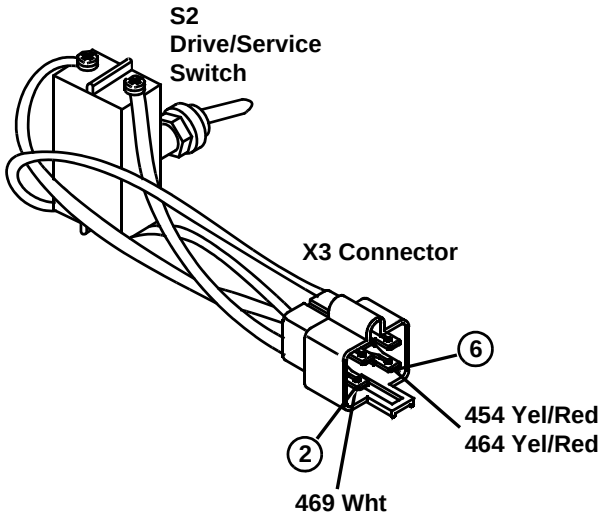
PRIMARY SWITCHED POWER CIRCUIT DIAGNOSIS

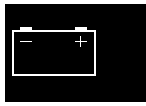
Test Conditions:

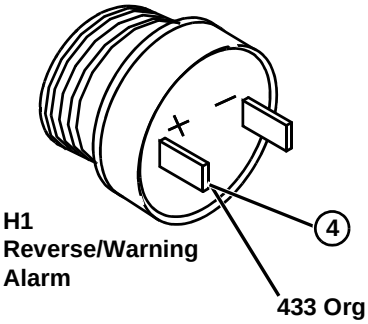
- Key switch OFF
- Park Brake ON
- Drive/Service switch in DRIVE position
- Battery set FULLY charged

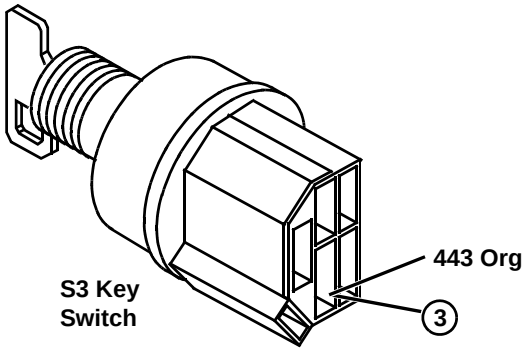
Test/Check Point	Normal	If Not Normal
1. Battery set	48 volts DC or higher	Test batteries. See Battery Section
2. S2 Drive/Service switch	48 volts DC or higher	Check 469, 689, and 679 Wht wires and connections. Check S1 charger interlock switch. Check F1 50 amp fuse. See “UNSWITCHED POWER CIRCUIT DIAGNOSIS” on page 24.
3. S3 Key switch	48 volts DC or higher	Check 443 and 423 Org wires and connections.
4. H1 Reverse/warning Alarm	48 volts DC or higher	Check 433 and 423 Org wires and connections. If OK, replace drive/service switch.
5. A1 Motor Controller—J1-2	48 volts DC or higher	Check 103 Org wire and connections. If OK, replace drive/service switch.
6. S2 Drive/Service switch	48 volts DC or higher	Check 464 Yel/Red and 620 Blk wires and connections
7. A1 Motor Controller—J1-3 & 4	48 volts DC or higher	Check 112 and 122 Red/Blk wires and connections. If OK, replace drive/service switch.
8. A1 Motor Controller—J2-6	Approximately 15 volts DC	Check 282 Red wire and connections. Verify all switch positions and primary switched inputs. If OK, replace motor controller.
9. A1 Motor Controller—J1-13	Approximately 4.6 volts DC	Check 244 Yel wire and connections. Verify all switch positions and primary switched inputs. If OK, replace motor controller.

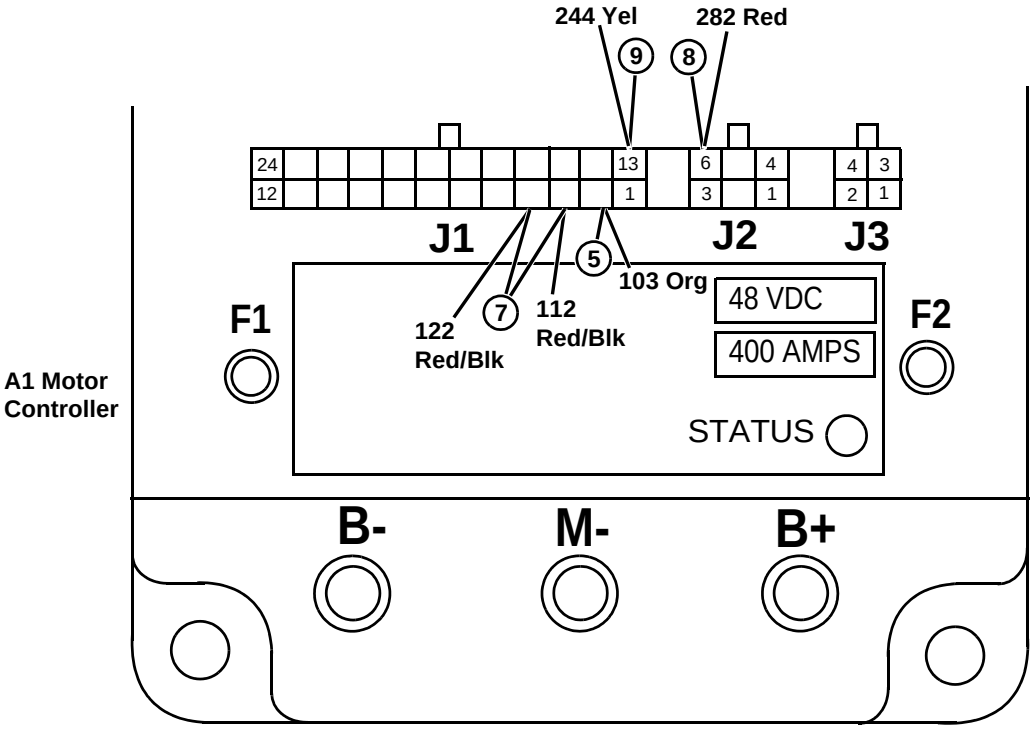

Front of Vehicle
Battery Pack
Negative (B-)
B-
B+
Battery Pack
Positive (B+)
1
G1 Battery Set
48 VDC


S2
Drive/Service
Switch
X3 Connector
6
454 Yel/Red
464 Yel/Red
2
469 Wht




H1
Reverse/Warning
Alarm
4
433 Org


443 Org
S3 Key
Switch
3


244 Yel
282 Red
9
8
24
12
13
1
6
3
4
1
4
2
3
1
J1
J2
J3
5
103 Org
F1
7
122
Red/Blk
112
Red/Blk
48 VDC
400 AMPS
F2
A1 Motor
Controller
STATUS
B-
M-
B+

SECONDARY SWITCHED POWER CIRCUIT OPERATION

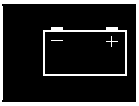
Function:

Provide switched power to the vehicle functional operating components and switches.

Operating Conditions, Secondary Switched Power:

Secondary switched power is present when the vehicle has the:

- battery charger unplugged from vehicle
- key switch in on position
- drive/service switch in the drive position
- park brake in the on position
- directional control lever in the neutral position
- any accessory control switches in the off position



With the S2 drive/service switch in the drive position and suppling power to the S3 key switch through the 423 and 443 Org wire, the key switch can now supply power across its contacts to the 382 and 392 Red wires. The 392 Red wire connects to the P1 hour meter/battery fuel gauge (optional). The 382 Red wire splices together with the 372 and 362 Red wires. The 362 Red wire splices together with the 322, 332, 342 and 312 Red wires. The 312 Red wire splices together with the 302 and 102 Red wires.

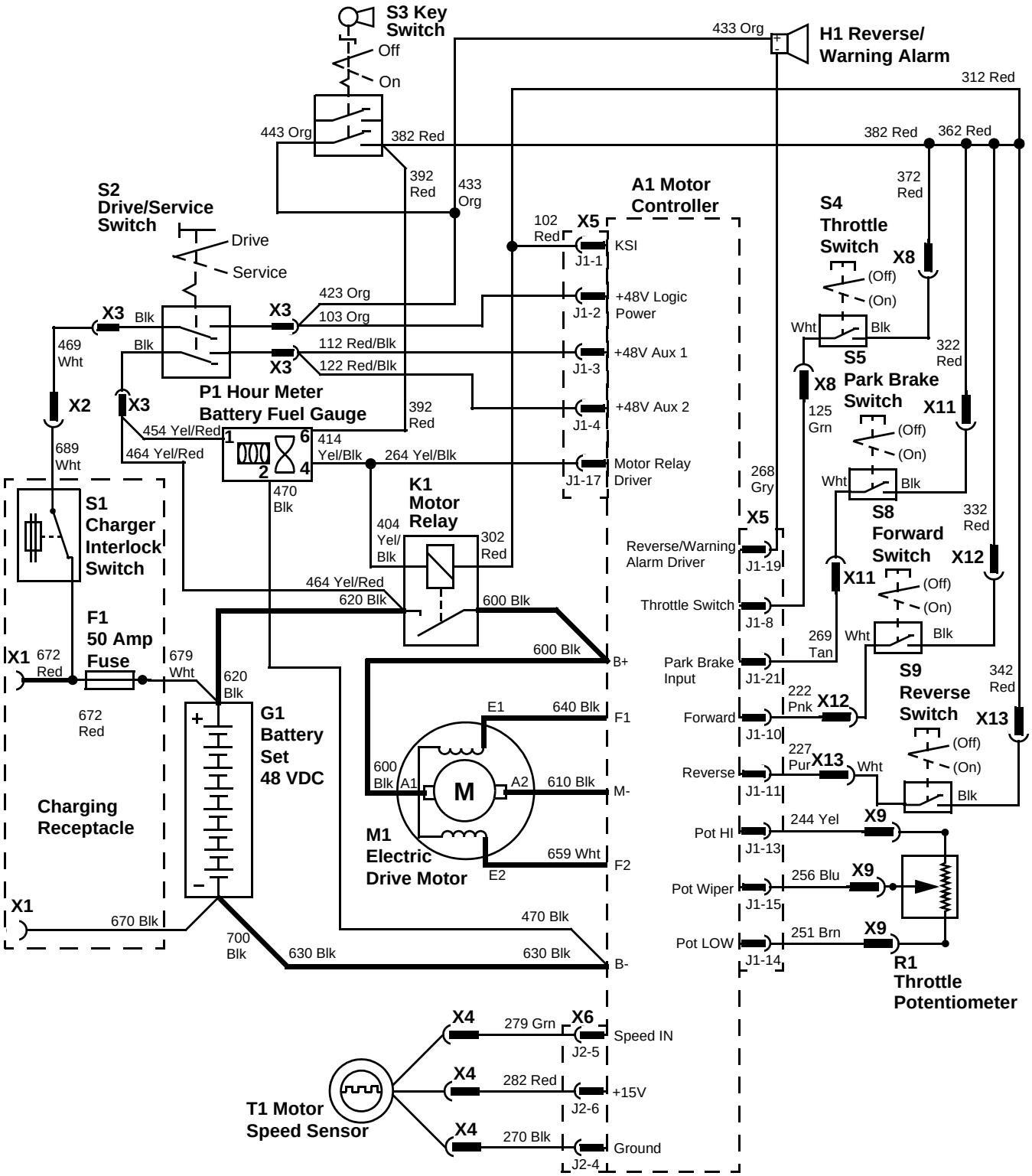
From the 382, 362 and 372 Red wire splice, the 372 Red wire supplies power through the X8 connector to the S4 throttle switch.

From the 362, 322, 332, 342 and 312 Red wire splice, the 322 Red wire supplies power through the X11 connector to the S5 park brake switch, the 332 Red wire supplies power through the X12 to the S8 forward switch, the 342 Red wire supplies power through the X13 connector to the S9 reverse switch, and the 312 Red wire supplies power to the 312, 302 and 102 Red wire splice.

From the 312, 302 and 102 Red wire splice, the 302 Red wire supplies power to the K1 motor relay and the 102 Red wire supplies power to the J1-1 terminal of the A1 motor controller.

From the K1 motor relay power is supplied to the 404 Yel/Blk wire spliced to the 414 and 264 Yel/Blk wires.

SECONDARY SWITCHED POWER CIRCUIT SCHEMATIC

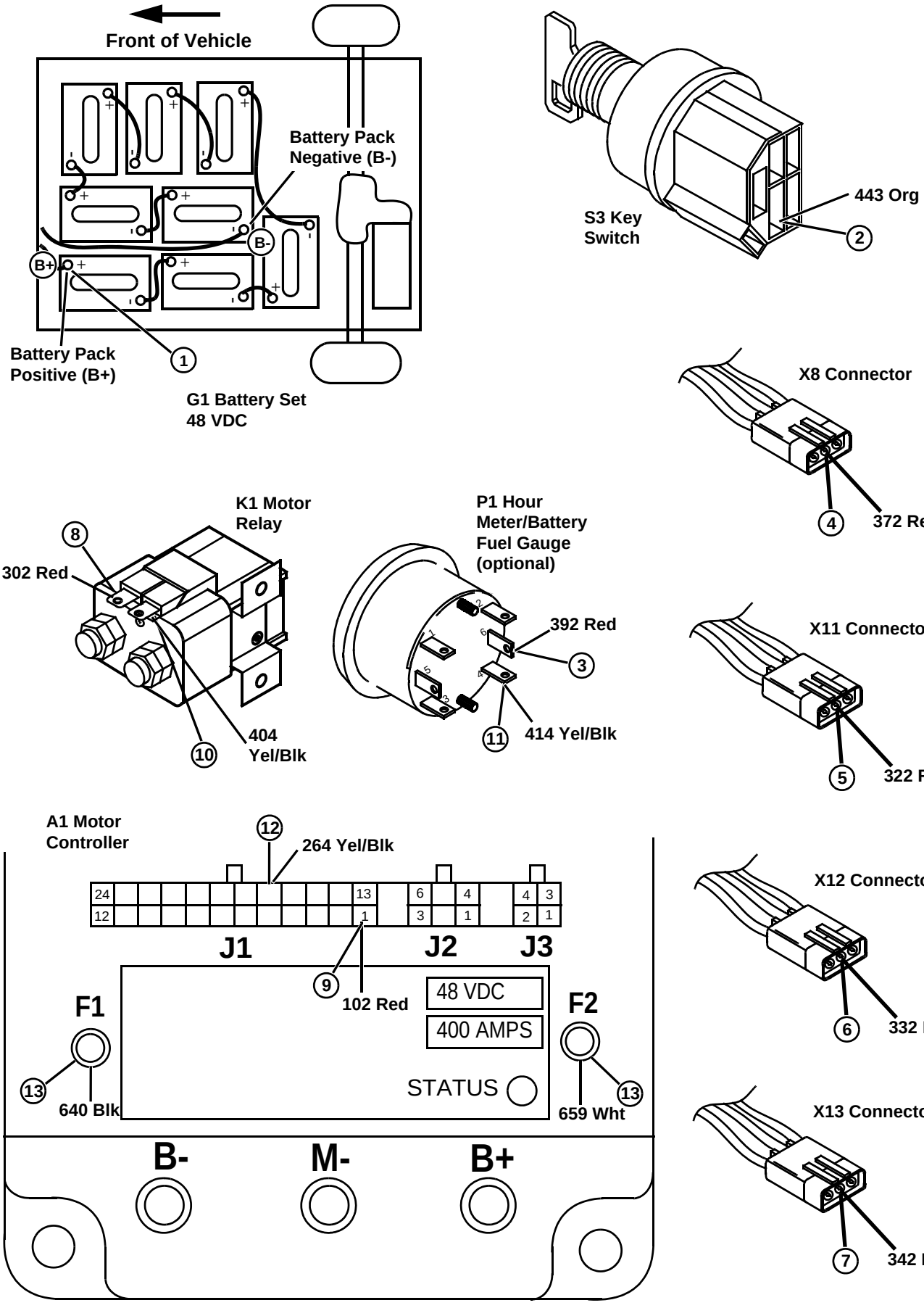


SECONDARY SWITCHED POWER CIRCUIT DIAGNOSIS

Test Conditions:

- Key switch ON
- Park Brake ON
- Drive/Service switch in DRIVE position
- Battery set FULLY charged

Test/Check Point	Normal	If Not Normal
1. Battery set	48 volts DC or higher	Test batteries. See Battery Section
2. S3 Key switch	48 volts DC or higher	Check 443 and 423 Org wires and connections. See “PRIMARY SWITCHED POWER CIRCUIT DIAGNOSIS” on page 28.
3. P1 Hour Meter/Battery Fuel Gauge (optional)	48 volts DC or higher	Check 392 Red wire and connections. If OK, replace key switch.
4. X8 Connector	48 volts DC or higher	Check 382 and 372 Red wires and connections. If OK, replace key switch.
5. X11 Connector	48 volts DC or higher	Check 382, 362 and 322 Red wires and connections. If OK, replace key switch.
6. X12 Connector	48 volts DC or higher	Check 382, 362 and 332 Red wires and connections. If OK, replace key switch.
7. X13 Connector	48 volts DC or higher	Check 382, 362 and 342 Red wires and connections. If OK, replace key switch.
8. K1 Motor Relay	48 volts DC or higher	Check 382, 362, 312 and 302 Red wires and connections. If OK, replace key switch.
9. A1 Motor Controller—J1-1	48 volts DC or higher	Check 382, 362, 312 and 102 Red wires and connections. If OK, replace key switch.
10. K1 Motor Relay	48 volts DC or higher	Disconnect J1 connector plugged into the A1 motor controller and 414 Yel/Blk wire connected to P1 hour meter/battery fuel gauge (optional), if voltage is still low or missing, replace motor relay. If voltage is now correct, Verify all switch positions and primary switched inputs. If OK, replace motor controller.
11. P1 Hour Meter/Battery Fuel Gauge (optional)	48 volts DC or higher	Check 414 and 404 Yel/Blk wires and connections.
12. A1 Motor Controller—J1-17	48 volts DC or higher	Check 264 and 404 Yel/Blk wires and connections.
13. A1 Motor Controller—F1 & F2	Less than 1 volt DC	Verify all switch positions and primary switched inputs. If OK, replace motor controller.


Front of Vehicle
Battery Pack Negative (B-)
B-
B+
Battery Pack Positive (B+)
1
G1 Battery Set 48 VDC
S3 Key Switch
443 Org
2
X8 Connector
4
372 Red
K1 Motor Relay
8
302 Red
10
404 Yel/Blk
P1 Hour Meter/Battery Fuel Gauge (optional)
392 Red
3
11
414 Yel/Blk
X11 Connector
5
322 Red
A1 Motor Controller
12
264 Yel/Blk
24
12
13
1
6
3
4
1
4
2
3
1
J1
J2
J3
9
102 Red
48 VDC
400 AMPS
STATUS
F1
F2
13
640 Blk
13
659 Wht
B-
M-
B+
X12 Connector
6
332 Red
X13 Connector
7
342 Red

DRIVE MOTOR & SPEED SENSOR CIRCUIT OPERATION

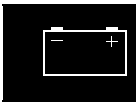
Function:

The purpose of the electric motor is to control and monitor the motion of the Utility Vehicle. The electric motor is the device that converts the electric operation of the vehicle to the mechanical operation.

The motor is equipped with a magnetically operated sensor. This sensor along with the motor armature and field windings provide the motion control.

While the obvious function of the motor is to propel the vehicle in a forward or reverse direction, other functions include Overspeed control, Rollaway control, Anti-Rollback control, and Compression Braking.

Operating Conditions:



The electric motor is a 48VDC separately excited motor. It has a separate power circuit for the armature and the field windings.

During operation the armature receives constant polarity from the motor controller while the polarity to the field windings will change depending on the position of the shift lever.

Speed of the motor is controller by the motor controller and is based on the position of the throttle (throttle potentiometer).

Drive:

To propel the vehicle in either forward or reverse the following conditions must be met:

- Battery charger disconnected from vehicle
- Service/Drive switch in Drive position
- Key switch on
- Park brake off
- Shift lever placed in a direction
- Throttle pedal pressed (particially to full travel)

When selecting a drive function the armature of the motor receives power from the motor controller B+ terminal to the motor A1 terminal. The battery negative circuit is supplied from the motor A2 terminal back to the motor controller M- terminal. The amount of current that is allowed to flow to the motor armature is regulated by the motor controller. When the vehicle is traveling, the combination of throttle potentiometer and speed sensor inputs indicate to the motor controller the amount of current the motor controller will supply to the motor armature.

When the speed sensor indicates to the motor controller that the motor is operating at a speed slower than the throttle input is indicating, such as driving up a ramp, the motor controller will increase the current output to the motor to attempt to maintain the speed of the vehicle to a speed similar to that of driving on a level surface.

Similarly, when the speed sensor indicates to the motor controller that the motor is operating at a speed faster than the throttle input is indicating, such as driving down a ramp, the motor controller will place a load on the motor to attempt to maintain the speed of the vehicle to a speed similar to that of driving on a level surface.

The field winding receive power from the motor controller at this same time. The polarity of the voltage supplied to the field windings changes depending on the position of the shift lever. By changing the polarity of the current to the field winding, the magnetic field of the motor changes, allowing the armature to spin in either direction. This ability to change directions translates to forward or reverse travel.

When forward is selected, power will flow from the F1 terminal of the motor controller through the black cable to the E1 terminal of the motor. The return will be from the E2 terminal of the motor through the white cable to the F2 terminal of the motor controller.

This flow is opposite when the reverse function is selected.

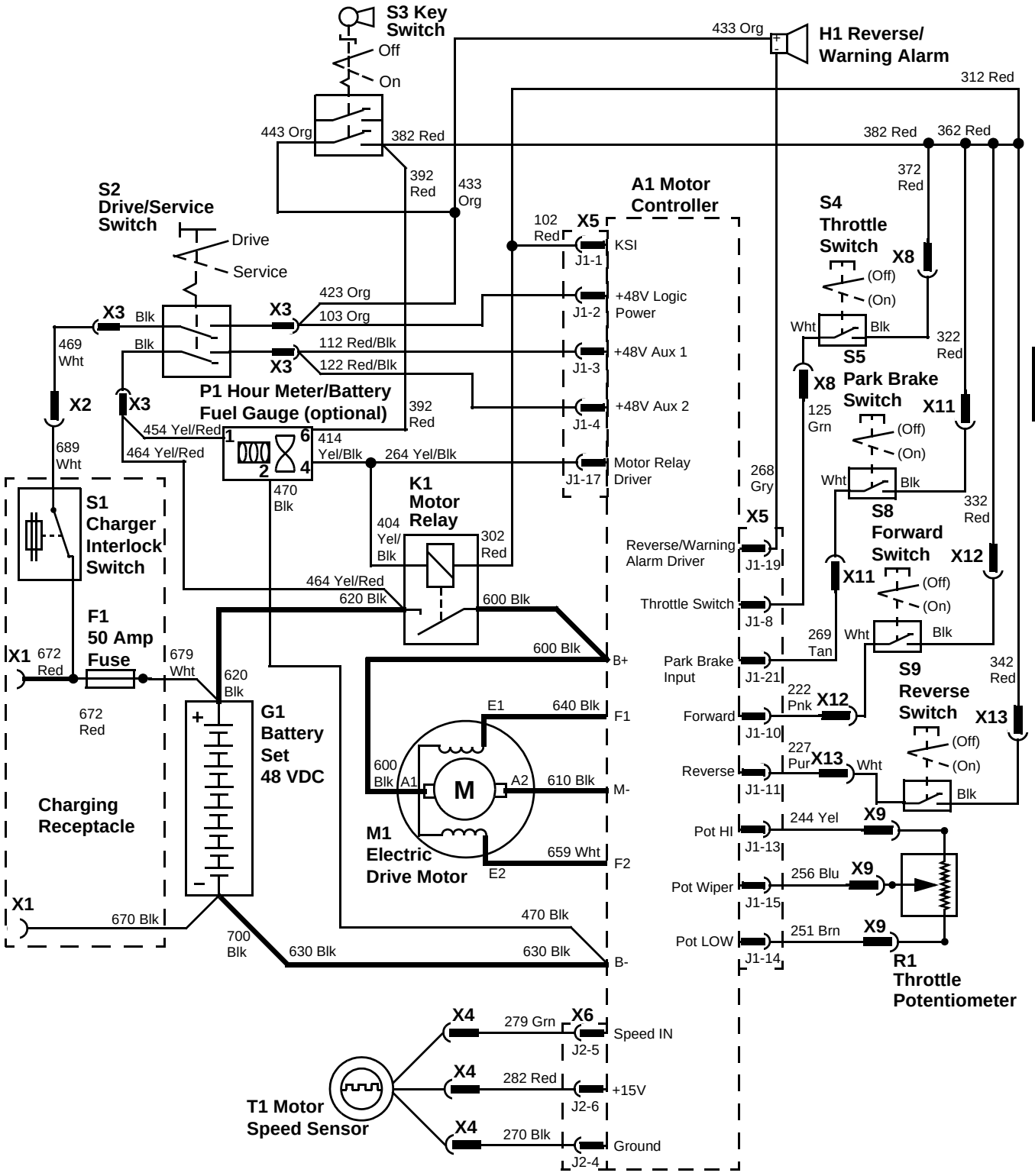
Overspeed Control:

Overspeed control is needed when driving the vehicle down slopes in terrain or ramps. When the vehicle is traveling, the combination of throttle pedal position, current supplied to the armature of the motor and the speed measured by the speed sensor on the motor indicate to the motor controller if the drive system is operating within acceptable limits. When the speed sensor indicates to the motor controller that the motor is operating at a speed faster than the throttle input is indicating, the motor controller will use the motors natural counter EMF (electro motor force) to place a load on the motor causing it to slow.

Anti-Rollback Control:

Anti-rollback control has been incorporated into the electrical system through the motor controller to cause the vehicles drive system to resist movement if the operator is driving and within ten seconds after releasing the throttle pedal the vehicle stops but then starts to roll in either direction. If the vehicle starts to move because it starts to rollback on a slope and the throttle continues to indicate that it is in the off position, the motor and speed sensor will indicate movement. While the reverse/warning alarm will not sound the motor controller will use the motors natural counter EMF (electro motor force) to place a load on the motor causing it to resist the movement. The operator must use the foot brake to hold the vehicle if stopped momentarily or the park brake if leaving the vehicle.

DRIVE MOTOR & SPEED SENSOR CIRCUIT SCHEMATIC



DRIVE MOTOR & SPEED SENSOR CIRCUIT OPERATION (continued)

Compression Braking:

Compression braking is a function of a combination of electrical components used to assist in controlling the coast or decceleration of the vehicle. There are two levels of compression braking.

Level one compression braking is the action that occurs during the moment between the operator letting off of the throttle and pressing the brake pedal to bring the vehicle to a stop. While the brakes are intended to be used to stop the vehicle, this level of compression braking will feel smooth and similar to that of light to moderate braking.

The motor controller is reading the inputs from the throttle, directional switches, park brake switch, motor armature and field winding, and the speed sensor. When the operator lets the throttle pedal return to the off position while the vehicle is still moving, the motor controller reads the sequence of events to control the coast or deceleration of the vehicle until the operator has pressed the brakes to come to a complete stop. The motor controller uses the motors natural counter EMF (electro motor force) to place a load on the motor causing it to resist the movement. The motor controller reads this as the operator letting off of the throttle to come to a stop, the reverse/warning alarm does not sound.

Level two compression braking occurs when during a drive function the directional lever is shifted to neutral or the opposite direction, the park brake is engaged, or the key switch is turned to the OFF position. While the brakes are intended to stop the vehicle, this second level of compression braking is more aggressive in nature and may feel similar to that of moderate to sever braking.

The motor controller is again reading the inputs from the throttle, directional switches, park brake switch, motor armature and field winding, and the speed sensor. However in this condition the operator has not let the throttle pedal return to the off position. The input signal to the motor controller from either the directional switch, the park brake switch, or the key switch has been changed while the vehicle is still moving. The motor controller reads the sequence of events to control the coast or decceleration of the vehicle until the operator has pressed the brakes to come to a complete stop. The motor controller uses the motors natural counter EMF (electro motor force) to place a load on the motor causing it to resist the movement. The motor controller reads this as a shut down condition with the operator present. The vehicle aggressively assists in slowing the vehicle but the reverse/warning alarm does not sound.

Rollaway Control:

A rollaway function has been incorporated into the electrical system through the motor controller. This function occurs after the operator has released the throttle pedal for more than ten seconds and is based on the motor controller reading the throttle as being in the off position with no power to the motor armature and field winding and the speed sensor indicating the motor is not turning (vehicle stopped). If the vehicle now starts to move, because it starts to coast down a slope or is being pushed or pulled, and the throttle continues to indicate that it is in the off position, the motor and speed sensor will indicate movement. The motor controller will use the motors natural counter EMF (electro motor force) to place a load on the motor causing it to resist the movement. At the same time the reverse/warning alarm will give a continuous beeping indicating that the vehicle is reading motion. The operator is then reminded to use the foot brake to hold the vehicle if stopped momentarily or the park brake if leaving the vehicle.

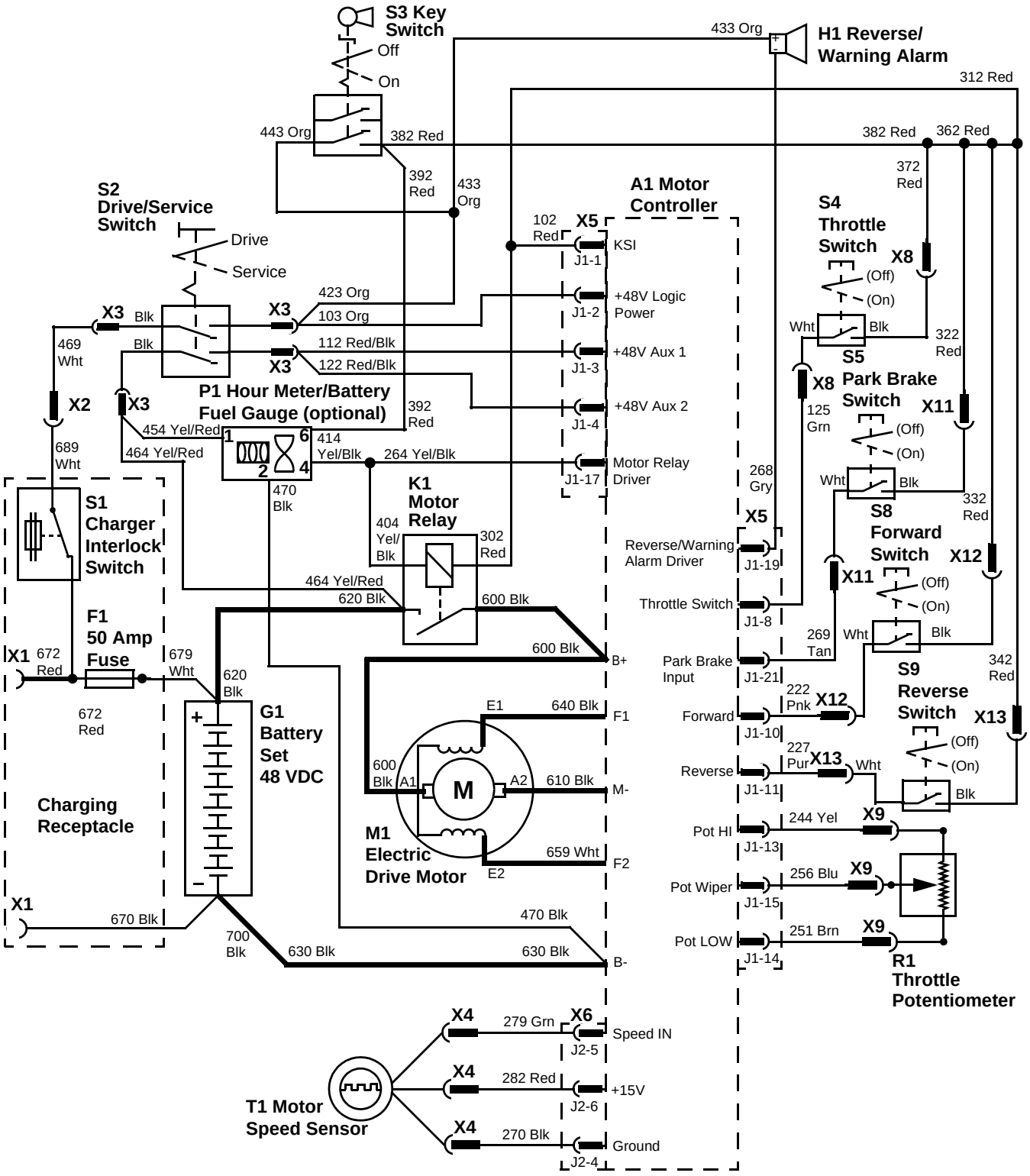
Motor Speed Sensor:

The motor is equipped with a magnetically operated hall effect speed sensor. This sensor along with the motor controller, and the electric motor armature and field windings provide the motion control. The speed sensor circuit has the provision for reduced vehicle speed if the sensor is not detected by the controller. The travel speed of the vehicle will be reduced to a few miles per hour and continue at this slow speed until the speed sensor input is restored.

The J2-6 terminal of the A1 motor controller provides approximately +15 VDC to the 282 Red wire of the speed sensor. When the vehicle is running the 279 Grn wire connected to the A1 motor controller J2-5 terminal will pulse ON and OFF. The ON pulse will be 5 volts while the OFF pulse will be 0 volts. If the J2-5 terminal voltage is measured during a drive function, an average reading of approximately 2.2 VDC will be present. Pushing the vehicle slowly forward or reverse will cause the voltage on the J2-5 terminal to change from 0 volts to 5 volts then 0 volts and so on. This voltage should change at approximately each **2.5 cm (1.0 in.)** of travel.

The speed sensor is connected back to battery negative through the 270 Blk wire back to the motor controller at the J2-4 terminal.

DRIVE MOTOR & SPEED SENSOR CIRCUIT SCHEMATIC

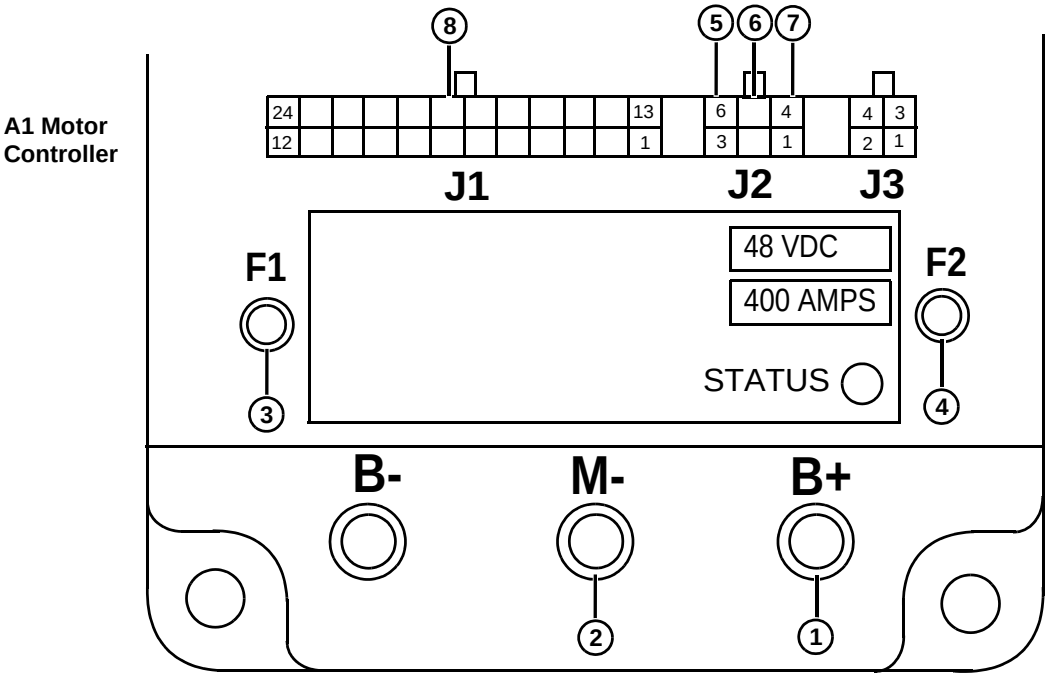


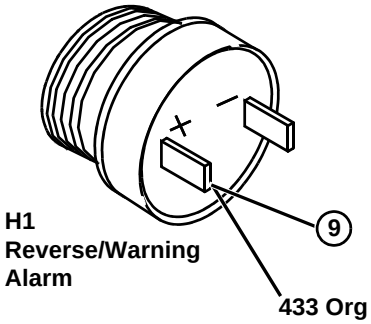
DRIVE MOTOR & SPEED SENSOR CIRCUIT DIAGNOSIS

Test Conditions:

- Key switch ON
- Park Brake OFF
- Drive/Service switch in DRIVE position
- Push the vehicle slowly forward and reverse about **30 cm (12 in.)** during each test
- Vehicle should resist movement during each test
- Reverse/Warning Alarm should beep during each test
- Battery set FULLY charged

Test/Check Point	Normal	If Not Normal
1. A1 Motor Controller—B+	Approximately 12 volts raising to 48 volts DC or higher	If 48 volts is present at start of test motor relay contacts welded, replace motor relay. Test drive motor. See Electric Motor Section
2. A1 Motor Controller—M-	Approximately 12 volts raising to 48 volts DC or higher	Test drive motor. See Electric Motor Section
3. A1 Motor Controller—F1	Less than 0.1 volts changing to a variable voltage that chances to fast for meter to record	Verify all switch positions and primary switched inputs. Test drive motor. See Electric Motor Section If OK, replace motor controller.
4. A1 Motor Controller—F2	Less than 0.1 volts changing to a variable voltage that chances to fast for meter to record	Verify all switch positions and primary switched inputs. Test drive motor. See Electric Motor Section If OK, replace motor controller.
5. A1 Motor Controller—J2-6	Approximately 15 volts	Verify all switch positions and primary switched inputs. If OK, replace motor controller.
6. A1 Motor Controller—J2-5	Less than 0.1 volt raising to approximately 5 volts	Check 279 Grn wire and connections. If OK, replace motor speed sensor.
7. A1 Motor Controller—J2-4	Less than 0.1 volt	Verify all switch positions and primary switched inputs. If OK, replace motor controller.
8. A1 Motor Controller—J1-19	48 volts DC or higher changing to less than 0.1 volt	If NO voltage at the start of test, check 268 Gry wire and connections, reverse/warning alarm, and 433 Org wire and connections. See “PRIMARY SWITCHED POWER CIRCUIT DIAGNOSIS” on page 28. If voltage does not drop to less than 0.1 volt, verify all switch positions and primary switched inputs. If OK, replace motor controller.
9. H1 Reverse/warning Alarm	48 volts DC or higher Reverse/warning Alarm beeps during test 1 - 8 above	Check 433 and 423 Org wires and connections. See “PRIMARY SWITCHED POWER CIRCUIT DIAGNOSIS” on page 28.


A1 Motor Controller
8
5
6
7
24
12
13
1
6
3
4
1
4
2
3
1
J1
J2
J3
48 VDC
400 AMPS
STATUS
F1
F2
3
4
B-
M-
B+
2
1


H1
Reverse/Warning
Alarm
9
433 Org

PARK BRAKE CIRCUIT OPERATION

Function:

The park brake switch provides an input to the motor controller to indicate if the parking brakes are engaged or released.

When the park brake is released (brakes off) the motor controller will receive a voltage input through the park brake switch and allow the vehicle to operate normally.

If the park brake is engaged (brakes on) there will be no input to the motor controller from the park brake switch and the motor controller will shut down drive motor operation.

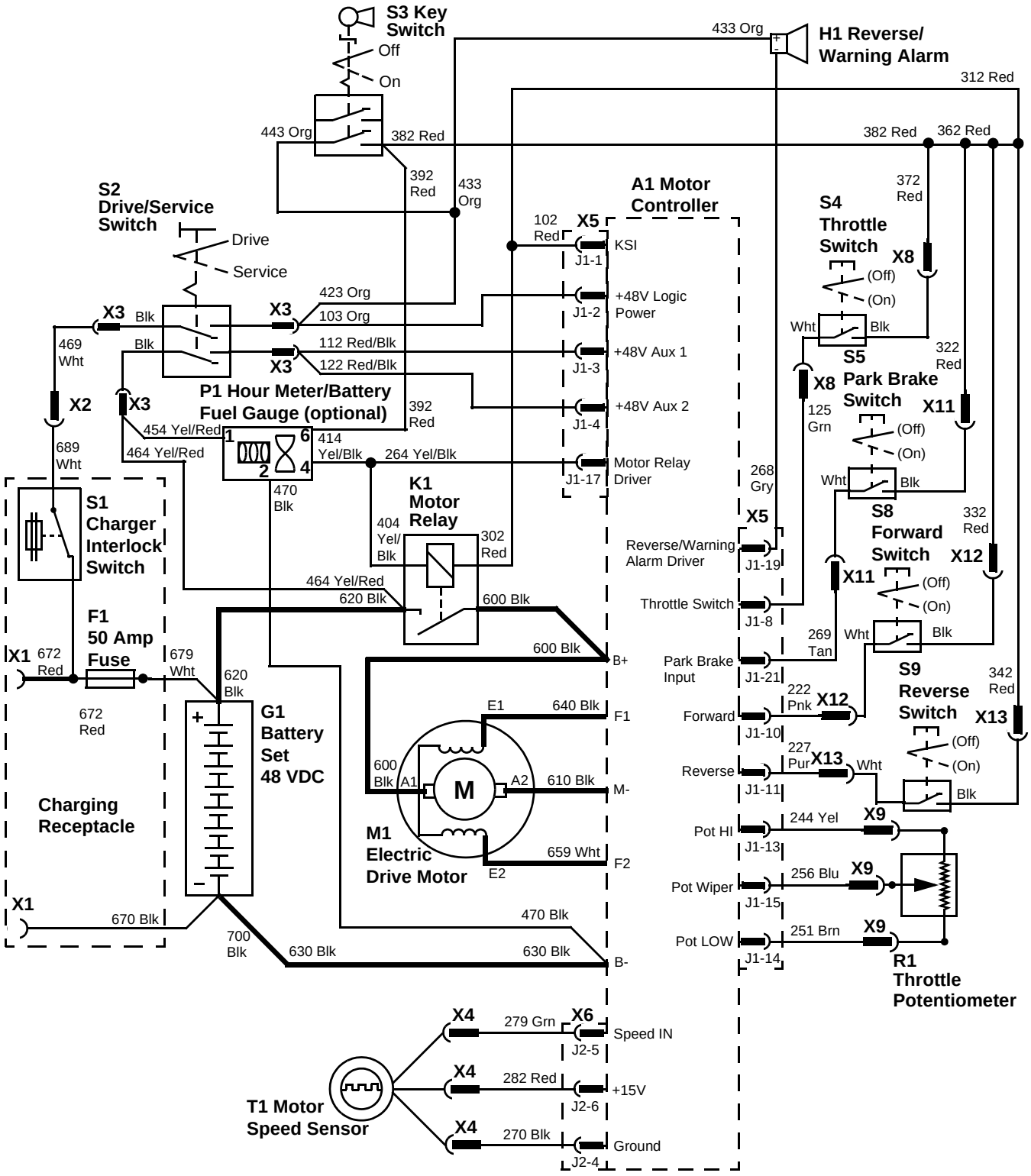
If the vehicle is being driven at the time the park brake is engaged, the input signal from the park brake switch will be lost and the motor controller will remove the output signal to the drive motor field windings (F1 for forward or F2 for reverse). Because the motor controller has remove the output to the motor field windings, the motor will see this as the operator attempting to stop the vehicle and go into level two compression braking. See ELECTRIC MOTOR SECTION “Compression Braking:” on page 6.

Operating Conditions

The park brake switch is a normally open switch that is held closed when the park brake lever is in the OFF position. When the key switch is turned ON the park brake switch will see full battery voltage.

From the battery set positive terminal, power is supplied to the 679 Wht wire, F1 50 amp fuse, 672 Red wire, S1 charger interlock switch, 689 Wht wire, X2 connector, 469 Wht wire, S2 drive/service switch, 423 and 443 Org wires, S3 key switch, 382, 362, and 322 Red wires, S5 park brake switch, 269 Tan wire and A1 motor controller at the J1-21 terminal.

PARK BRAKE CIRCUIT SCHEMATIC

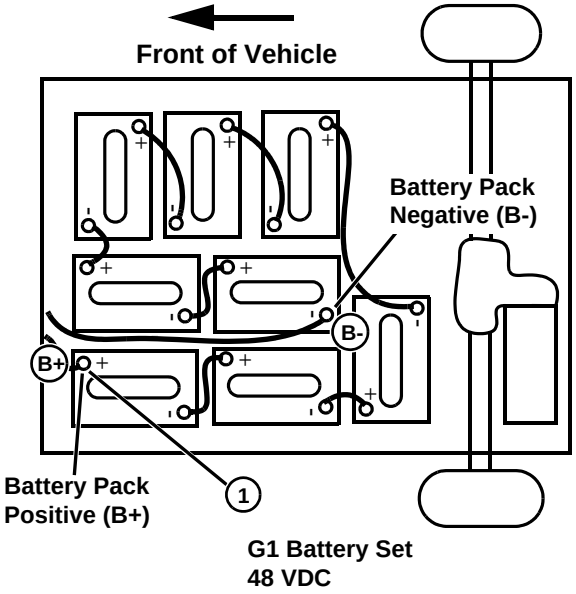


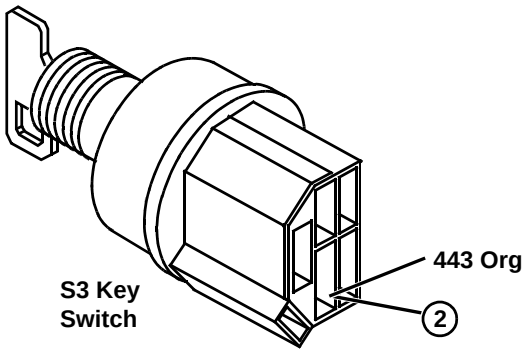
PARK BRAKE CIRCUIT DIAGNOSIS

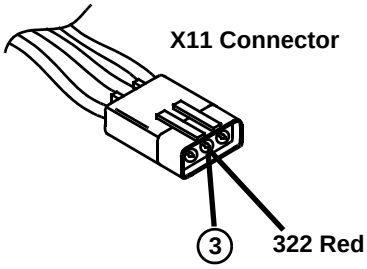
Test Conditions:

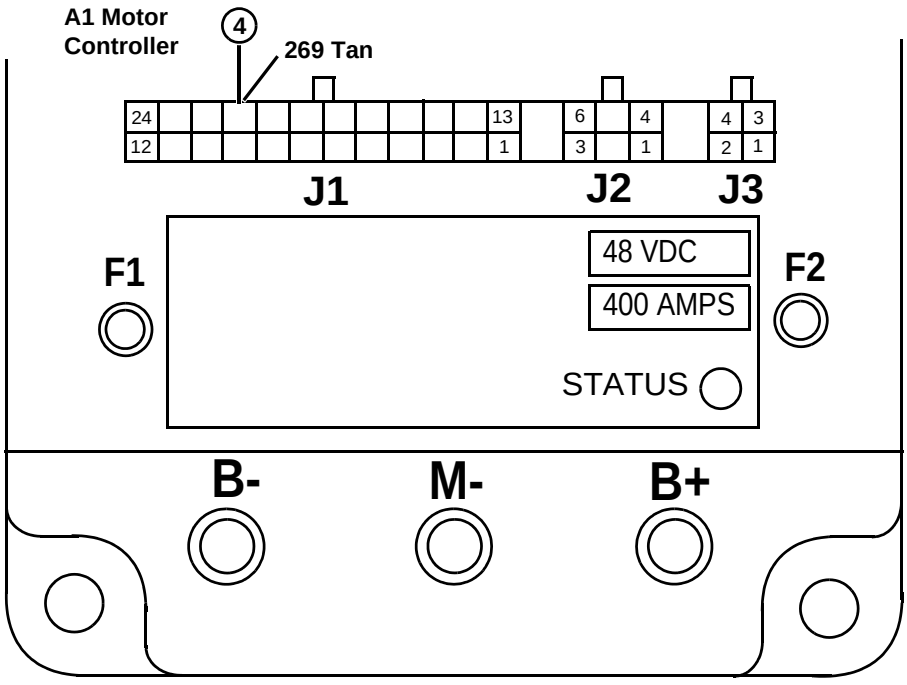
- Key switch ON
- Park Brake OFF
- Drive/Service switch in DRIVE position
- Battery set FULLY charged

Test/Check Point	Normal	If Not Normal
1. Battery set	48 volts DC or higher	Test batteries. See Battery Section
2. S3 Key switch	48 volts DC or higher	Check 443 and 423 Org wires and connections. See “PRIMARY SWITCHED POWER CIRCUIT DIAGNOSIS” on page 28.
3. X11 Connector	48 volts DC or higher	Check 382, 362 and 322 Red wires and connections. If OK, replace key switch.
4. A1 Motor Controller—J1-21	48 volts DC or higher	Check 269 Tan wire and connections. If OK, replace park brake switch.


Front of Vehicle
Battery Pack
Negative (B-)
B-
B+
Battery Pack
Positive (B+)
1
G1 Battery Set
48 VDC


443 Org
S3 Key
Switch
2


X11 Connector
3
322 Red


A1 Motor
Controller
4
269 Tan
24
12
13
1
6
3
4
1
4
2
3
1
J1
J2
J3
F1
48 VDC
400 AMPS
F2
STATUS
B-
M-
B+

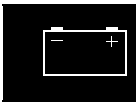
FORWARD & THROTTLE CIRCUIT OPERATION

Function:

To cause the vehicle to be propelled in a forward direction under the control of the operator.

Operating Conditions:

To operate the vehicle in forward, the drive/service switch must be in the DRIVE position, the key switch must be ON, the park brake must be OFF, the directional control in the FORWARD (pushed down) position, the throttle pedal PRESSED slowly and smoothly to the desired speed, and the area for the vehicle to be operated must be clear of bystanders.



System Operation:

The input signal power for the forward command is supplied through the S2 drive/service switch and the S3 key switch. See “SECONDARY SWITCHED POWER CIRCUIT OPERATION” on page 30.

When performing a forward command, several switches are activated at the same time. The S4 throttle switch, S5 park brake switch, and the S8 forward switch will all have their contacts closed to supply 48VDC input power to the A1 motor controller. The R1 throttle potentiometer will also be activated to supply an input to the A1 motor controller to signal the motor controller as to how far the throttle pedal has been pressed down (how fast the operator is attempting to travel).

For all of these inputs there are several outputs performed by the A1 motor controller that must happen for the vehicle to operate in forward. The J1-17 terminal must switch to battery negative causing the K1 motor relay to pull in completing the path from the battery positive (B+) terminal to the motor controller (B+) terminal and the M1 drive motor A1 terminal. The F1 terminal of the motor controller must supply output voltage to the motor field windings while the F2 terminal will become the battery negative path for the field winding. The motor controller as a result of the position of the R1 throttle potentiometer, will change the output on the M1 terminal causing the motor to run faster.

If any one or more of these inputs or outputs is not correct, the A1 motor controller will shut down and not allow the vehicle to respond to the forward command.

When performing a forward command 48 volt power is supplied from the S3 key switch to the 382, 372, 362, 322, 332, 342, 312, 302 and 102 Red wires.

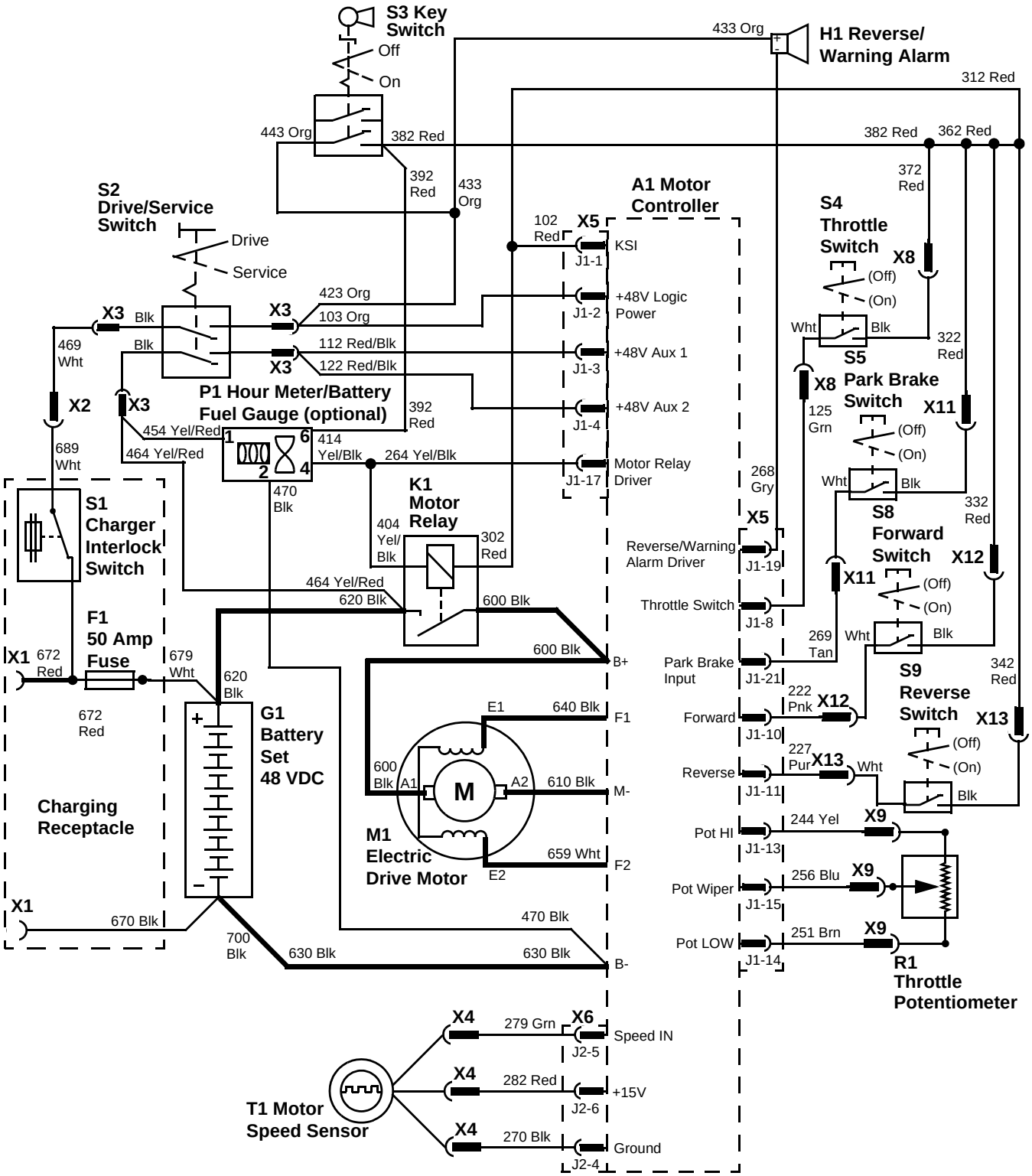
With the park brake in the OFF position, the 322 Red wire supplies power to the S5 park brake switch contacts (normally open), 269 Tan wire and the A1 motor controller J1-21 terminal. The A1 motor controller reads the input of full battery voltage on the J1-21 terminal and will power the motor controller to allow output on either the F1 (forward) or F2 (reverse) terminals.

With the directional lever in the forward position, power is supplied from the 332 Red wire to the S8 forward switch contacts (normally open), 222 Pnk wire and the A1 motor controller J1-10 terminal. The A1 motor controller will respond with the F1 terminal having a positive voltage output to the 640 Blk wire, M1 drive motor E1 terminal, through the field windings to the E2 terminal, 659 Wht wire and back to the A1 motor controller F2 terminal which is the battery negative path for the forward function.

When the throttle pedal is pressed the 372 Red wire supplies power to the S4 throttle switch contacts (normally open), 125 Grn wire to the A1 motor controller J1-8 terminal. The A1 motor controller will respond with the J1-17 terminal being switched to battery negative. As a result of this input the A1 motor controller will switch the J1-17 terminal to battery negative. This will then provide a battery negative path for the 264, 404 and 414 Yel/Blk wires, K1 motor relay, and P1 hour meter/battery fuel gauge (optional). This will energize the K1 motor relay closing the relay contacts supplying battery voltage to the 600 Blk wire and the B+ terminal of the motor controller and the A1 terminal of the drive motor. This will also provide the battery negative for the hour meter and begin recording the time that the K1 motor relay is energized.

The R1 throttle potentiometer receives 4.5 volts from the motor controller when the primary switch circuits are activated. The J1-13 terminal of the A1 motor controller supplies approximately 4.5 volts to the 244 Yel wire and the R1 throttle potentiometer. With the R1 throttle potentiometer in the neutral position the resistance of the throttle potentiometer drops the voltage to the 256 Blu and 251 Brn wires to between 0.3 - 0.6 volts. As the throttle pedal is pressed down, the voltage on the 256 Blu wire will raise to 4.0 volts when the pedal is pressed all the way down. If the pedal is only pressed half way down, throttle pot rotated 50%, the voltage on the 256 Blu wire will be approximately 50% or about 2- 2.2 volts. The 251 Brn wire will stay at approximately 0.4 volts. As a result of the throttle pedal being pressed down and changing the voltage on the 256 Blu wire the A1 motor controller will change the voltage of the M- terminal. When the throttle pedal is pressed down to the point that it just activates the S4 throttle switch, the voltage on the M- terminal will be approximately 48 volts. As the pedal is pressed further down, the M- terminal voltage will decrease to approximately 24 volts when the pedal has reached full travel. This then allows the drive motor to run at full rpm, and full speed drive.

FORWARD & THROTTLE CIRCUIT SCHEMATIC

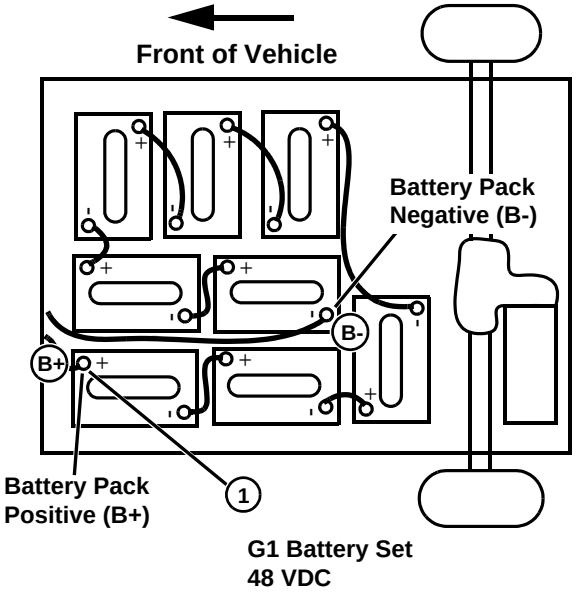


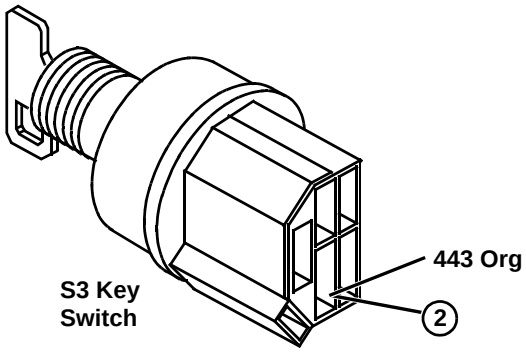
FORWARD & THROTTLE CIRCUIT DIAGNOSIS

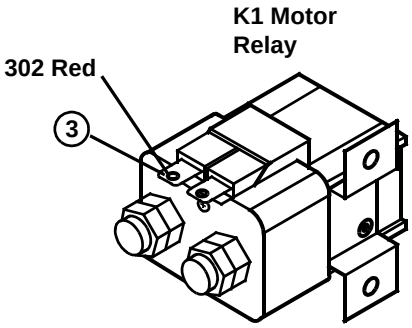
Test Conditions:

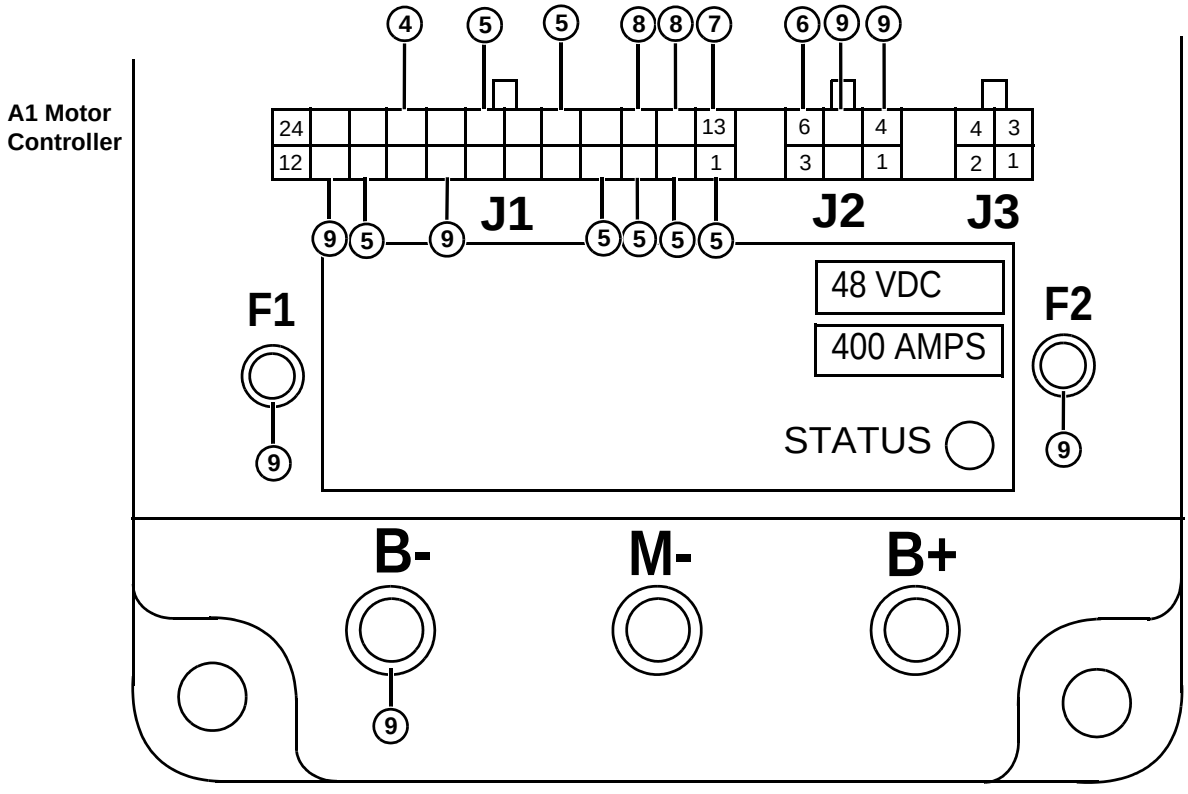
- Key switch ON
- Park Brake OFF
- Drive/Service switch in DRIVE position
- Directional lever in the FORWARD position
- Battery set FULLY charged
- Throttle pedal NOT pressed

Test/Check Point	Normal	If Not Normal
1. Battery set	48 volts DC or higher	Test batteries. See Battery Section
2. S3 Key switch	48 volts DC or higher	Check 443 and 423 Org wires and connections. See “PRIMARY SWITCHED POWER CIRCUIT DIAGNOSIS” on page 28.
3. K1 Motor Relay	48 volts DC or higher	Check 382, 362, 312 and 302 Red wires and connections. If OK, replace key switch.
4. A1 Motor Controller—J1-21	48 volts DC or higher	Check 322 Red and 269 Tan wire and connections. If OK, replace park brake switch.
5. A1 Motor Controller—J1-1, 2, 3, 4, 10, 17, and 19 terminals.	48 volts DC or higher	Verify all switch positions, primary and secondary switched inputs.
6. A1 Motor Controller—J2-6	Approximately 15 volts	Unplug J2 connector, retest terminal on motor controller. Verify all switch positions and primary switched inputs. If OK, replace motor controller.
7. A1 Motor Controller—J1-13	Approximately 4.5 volts	Verify all switch positions and primary switched inputs. If OK, replace motor controller.
8. A1 Motor Controller—J1-14 and 15 terminals.	Approximately 0.4 volts	Verify all switch positions and primary switched inputs. If OK, replace motor controller.
9. A1 Motor Controller—J1-8, 11; J2-4, 5; F1, F2 and B- terminals.	Less than 0.1 volts	Verify all switch positions and primary switched inputs. If OK, replace motor controller.


Front of Vehicle
Battery Pack
Negative (B-)
B-
B+
Battery Pack
Positive (B+)
1
G1 Battery Set
48 VDC


443 Org
S3 Key
Switch
2


K1 Motor
Relay
302 Red
3


A1 Motor
Controller
4 5 5 8 8 7 6 9 9
24 12 13 1 6 3 4 1 4 2 3 1
9 5 9 J1 5 5 5 5 J2 J3
48 VDC
400 AMPS
STATUS
F1
F2
9
9
B-
M-
B+
9

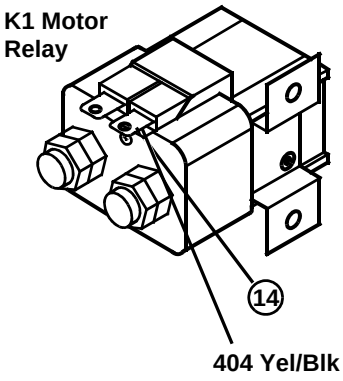
⚠ CAUTION

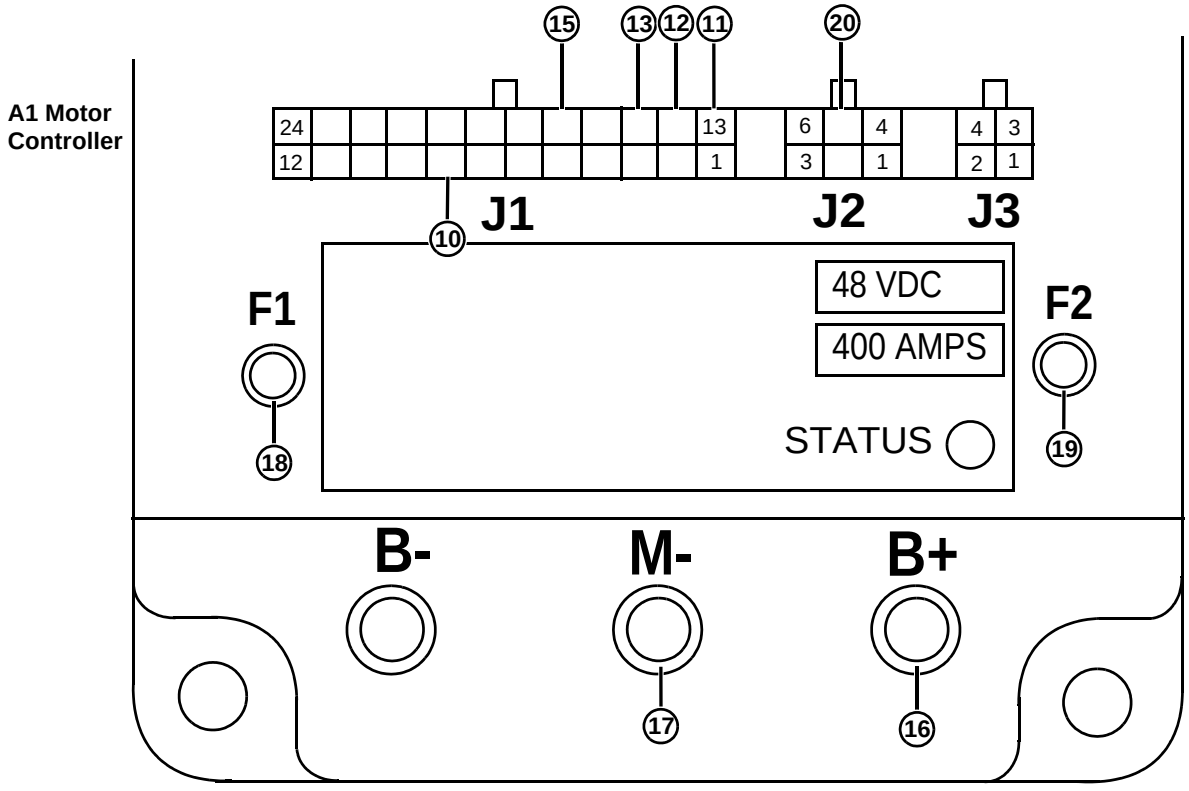
NEVER run the electric motor over half speed with wheels off of the ground. Motor could run over speed causing the armature to fly apart.

Test Conditions:

- Key switch ON
- Park Brake OFF
- Drive/Service switch in DRIVE position
- Directional lever in the FORWARD
- Battery set FULLY charged
- Drive wheel OFF the ground approximately 2.5 cm (1 in.)
- Throttle pedal PRESSED. Motor running not more than half speed.

Test/Check Point	Normal	If Not Normal
10. A1 Motor Controller—J1-8 terminal	48 volts DC or higher	Check 372 Red and 125 Grn wire and connections. If OK, replace throttle switch
11. A1 Motor Controller—J1-13 terminal	Approximately 4.5 volts	Verify all switch positions and primary switched inputs. If OK, replace motor controller.
12. A1 Motor Controller—J1-14 terminals.	Approximately 0.3 - 0.6 volts	Verify all switch positions and primary switched inputs. If OK, replace throttle potentiometer.
13. A1 Motor Controller—J1-15 terminals.	Approximately 2.2 volts	Verify all switch positions and primary switched inputs. If OK, replace throttle potentiometer.
14. K1 Motor Relay	Less than 0.1 volt	Check 414, 404 and 264 Yel/Blk wires and connections.
15. A1 Motor Controller—J1-17 terminal	Less than 0.1 volts	Verify all switch positions and primary switched inputs. If OK, replace motor controller.
16. A1 Motor Controller—B+ terminal	48 volts DC or higher	Check 600 Blk wire and connections. If OK, replace motor relay.
17. A1 Motor Controller—M- terminal	Approximately 35 volts	Check 610 and 600 Blk wires and connections. If OK, test and or replace drive motor. Verify all switch positions and primary switched inputs. If OK, replace motor controller.
18. A1 Motor Controller—F1 terminals.	Approximately 2.5 volts	Verify all switch positions and primary switched inputs. If OK, replace motor controller.
19. A1 Motor Controller—F2 terminal	Less than 0.1 volts	Verify all switch positions and primary switched inputs. If OK, replace motor controller.
20. A1 Motor Controller—J2-5 terminals	Approximately 2.0 volts	Verify all switch positions and primary switched inputs. If OK, test motor speed sensor. See “MOTOR SPEED SENSOR TEST” on page 76.


K1 Motor
Relay
14
404 Yel/Blk


A1 Motor
Controller
15
13
12
11
20
24
12
13
1
6
3
4
1
4
2
3
1
J1
J2
J3
10
48 VDC
400 AMPS
STATUS
F1
F2
18
19
B-
M-
B+
17
16

REVERSE & THROTTLE CIRCUIT OPERATION

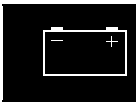
Function:

To cause the vehicle to be propelled in a reverse direction under the control of the operator.

Operating Conditions:

To operate the vehicle in reverse, the drive/service switch must be in the DRIVE position, the key switch must be ON, the park brake must be OFF, the directional control in the REVERSE (pulled up) position, the throttle pedal PRESSED slowly and smoothly to the desired speed, and the area for the vehicle to be operated must be clear of bystanders.

System Operation:



The input signal power for the reverse command is supplied through the S2 drive/service switch and the S3 key switch. See “SECONDARY SWITCHED POWER CIRCUIT OPERATION” on page 30.

When performing a reverse command, several switches are activated at the same time. The S4 throttle switch, S5 park brake switch, and the S9 reverse switch will all have their contacts closed to supply 48VDC input power to the A1 motor controller. The R1 throttle potentiometer will also be activated to supply an input to the A1 motor controller to signal the motor controller as to how far the throttle pedal has been pressed down (how fast the operator is attempting to travel).

With the primary and secondary switched circuits activated, the H1 reverse/warning alarm will sound a continuous steady tone when the directional lever is in the reverse position.

For all of these inputs there are several outputs performed by the A1 motor controller that must happen for the vehicle to operate in reverse. The J1-17 terminal must switch to battery negative causing the K1 motor relay to pull in completing the path from the battery positive (B+) terminal to the motor controller (B+) terminal and the M1 drive motor A1 terminal. The F1 terminal of the motor controller must supply output voltage to the motor field windings while the F2 terminal will become the battery negative path for the field winding. The motor controller as a result of the position of the R1 throttle potentiometer, will change the output on the M1 terminal causing the motor to run faster.

If any one or more of these inputs or outputs is not correct, the A1 motor controller will shut down and not allow the vehicle to respond to the reverse command.

When performing a reverse command 48 volt power is supplied from the S3 key switch to the 382, 372, 362, 322, 332, 342, 312, and 302 Red wires. With the park brake in the OFF position, the 322 Red wire supplies power to the S5 park brake switch contacts (normally open), 269 Tan wire and the A1 motor controller J1-21 terminal. The A1 motor controller reads the input of full battery voltage on the J1-21 terminal and will power the motor controller to allow output on either the F2 (reverse) or F1 (forward) terminals.

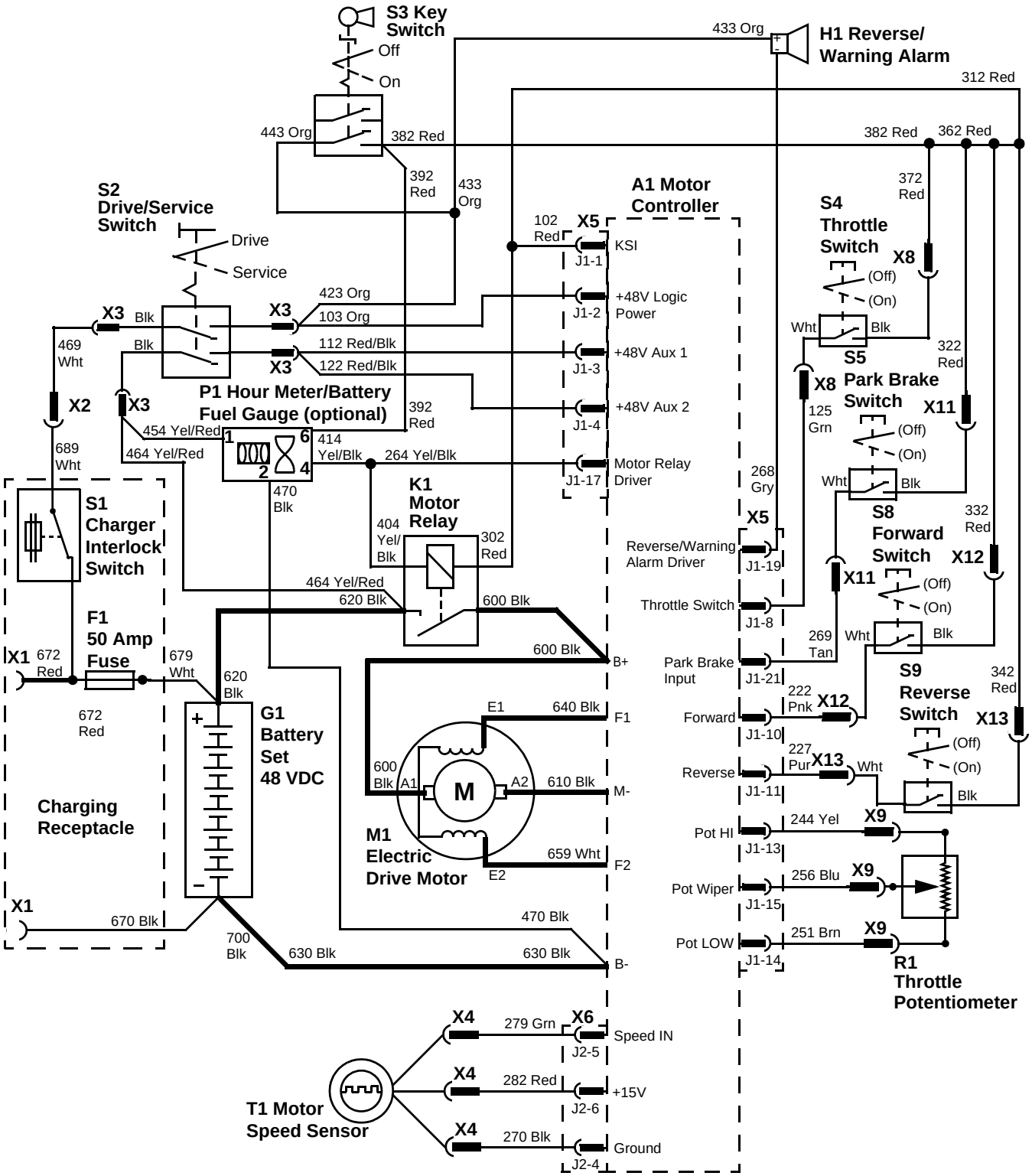
With the directional lever in the reverse position, power is supplied from the 342 Red wire to the S9 reverse switch contacts (normally open), 227 Pur wire and the A1 motor controller J1-11 terminal. The A1 motor controller will respond with the F2 terminal having a positive voltage output to the 659 Wht wire, M1 drive motor E2 terminal, through the field windings to the E1 terminal, 640 Blk wire and back to the A1 motor controller F1 terminal which is the battery negative path for the reverse function. The motor controller will also switch the J1-19 terminal to battery negative allowing the H1 reverse/warning alarm to sound signaling to the operator and bystanders that the vehicle is in reverse and may be backing up.

When the throttle pedal is pressed the 372 Red wire supplies power to the S4 throttle switch contacts (normally open), 125 Grn wire to the A1 motor controller J1-8 terminal. The A1 motor controller will respond with the J1-17 terminal being switched to battery negative.

As a result of this input the A1 motor controller will switch the J1-17 terminal to battery negative. This will then provide a battery negative path for the 264, 404 and 414 Yel/Blk wires, K1 motor relay, and P1 hour meter/battery fuel gauge (optional). This will energize the K1 motor relay closing the relay contacts supplying battery voltage to the 600 Blk wire and the B+ terminal of the motor controller and the A1 terminal of the drive motor. This will also provide the battery negative for the hour meter and begin recording the time that the K1 motor relay is energized.

The R1 throttle potentiometer receives 4.5 volts from the motor controller when the primary switch circuits are activated. The J1-13 terminal of the A1 motor controller supplies approximately 4.5 volts to the 244 Yel wire and the R1 throttle potentiometer. With the R1 throttle potentiometer in the neutral position the resistance of the throttle potentiometer drops the voltage to the 256 Blu and 251 Brn wires to between 0.3 - 0.6 volts. As the throttle pedal is pressed down, the voltage on the 256 Blu wire will raise to 4.0 volts when the pedal is pressed all the way down. If the pedal is only pressed half way down, throttle pot rotated 50%, the voltage on the 256 Blu wire will be approximately 50% or about 2 - 2.2 volts. The 251 Brn wire will stay at approximately 0.4 volts. As a result of the throttle pedal being pressed down and changing the voltage on the 256 Blu wire the A1 motor controller will change the voltage of the M- terminal. When the throttle pedal is pressed down to the point that it just activates the S4 throttle switch, the voltage on the M- terminal will be approximately 48 volts. As the pedal is pressed further down, the M- terminal voltage will decrease to approximately 35 volts when the pedal has reached full travel. This then allows the drive motor to run at full rpm, and full speed drive.

REVERSE & THROTTLE CIRCUIT SCHEMATIC

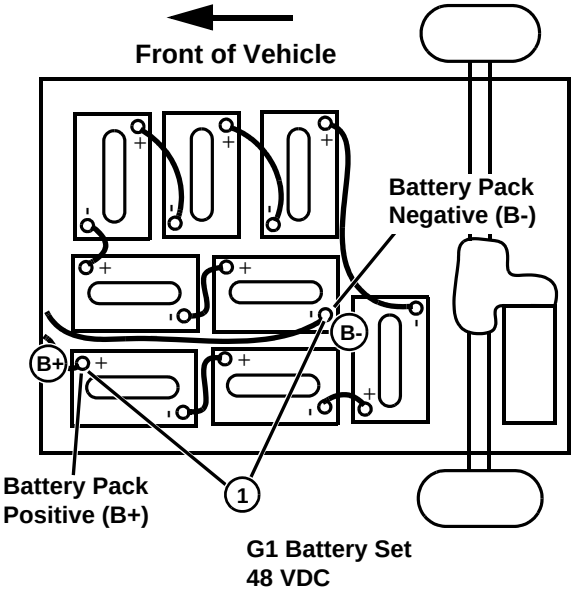


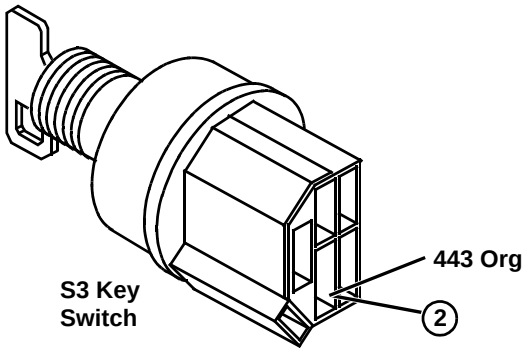
REVERSE & THROTTLE CIRCUIT DIAGNOSIS

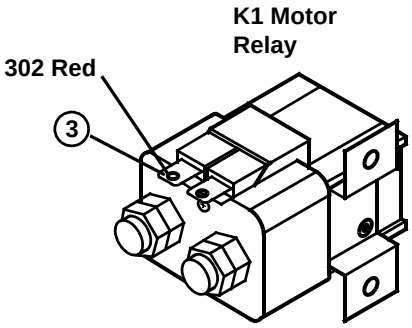
Test Conditions:

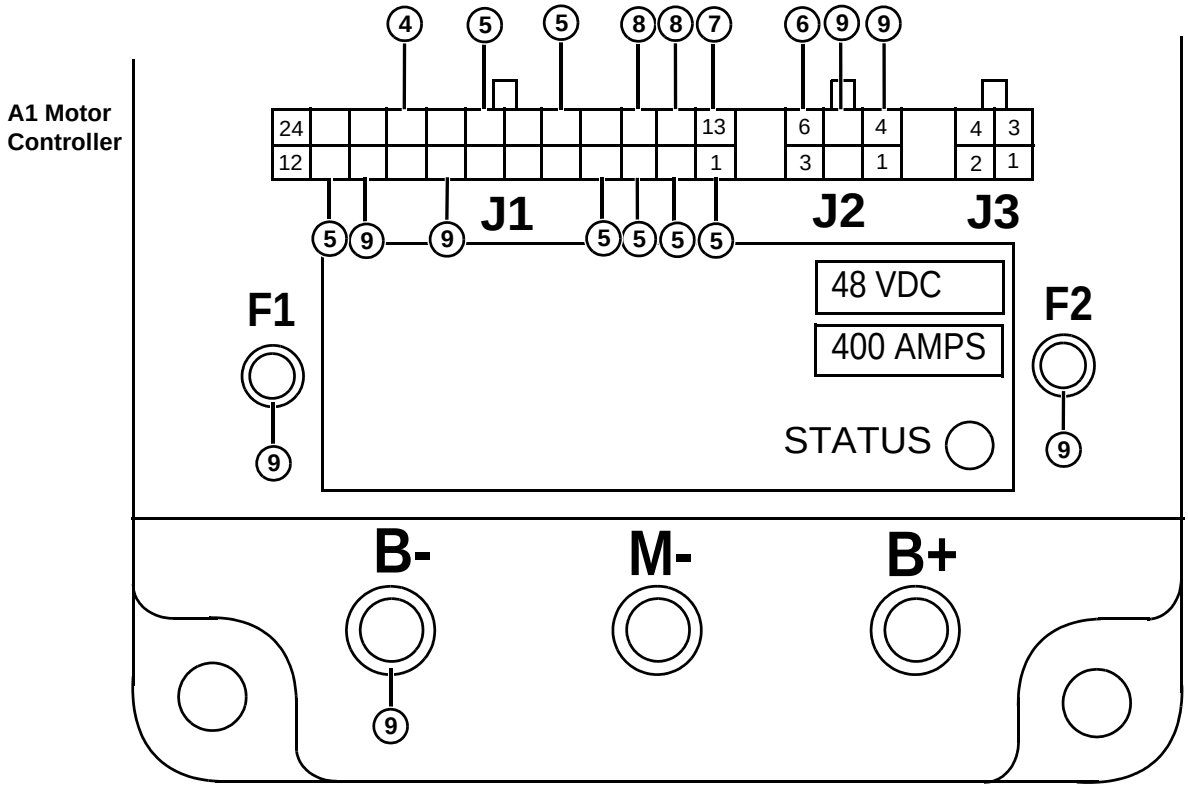
- Key switch ON
- Park Brake OFF
- Drive/Service switch in DRIVE position
- Directional lever in the REVERSE position
- Battery set FULLY charged
- Throttle pedal NOT pressed

Test/Check Point	Normal	If Not Normal
1. Battery set	48 volts DC or higher	Test batteries. See Battery Section
2. S3 Key switch	48 volts DC or higher	Check 443 and 423 Org wires and connections. See “PRIMARY SWITCHED POWER CIRCUIT DIAGNOSIS” on page 28.
3. K1 Motor Relay	48 volts DC or higher	Check 382, 362, 312 and 302 Red wires and connections. If OK, replace key switch.
4. A1 Motor Controller—J1-21 terminal	48 volts DC or higher	Check 322 Red and 269 Tan wire and connections. If OK, replace park brake switch.
5. A1 Motor Controller—J1-1, 2, 3, 4, 11, 17, and 19 terminals.	48 volts DC or higher	Verify all switch positions, primary and secondary switched inputs.
6. A1 Motor Controller—J2-6 terminal	Approximately 15 volts	Unplug J2 connector, retest terminal on motor controller. Verify all switch positions and primary switched inputs. If OK, replace motor controller.
7. A1 Motor Controller—J1-13 terminal	Approximately 4.6 volts	Verify all switch positions and primary switched inputs. If OK, replace motor controller.
8. A1 Motor Controller—J1-14 and 15 terminals.	Approximately 0.4 volts	Verify all switch positions and primary switched inputs. If OK, replace motor controller.
9. A1 Motor Controller—J1-8, 10; J2-4, 5; F1, F2 and B- terminals.	Less than 0.1 volts	Verify all switch positions and primary switched inputs. If OK, replace motor controller.


Front of Vehicle
Battery Pack
Negative (B-)
B-
B+
Battery Pack
Positive (B+)
1
G1 Battery Set
48 VDC


443 Org
S3 Key
Switch
2


K1 Motor
Relay
302 Red
3


A1 Motor
Controller
4 5 5 8 8 7 6 9 9
24 13 6 4 4 3
12 1 3 1 2 1
5 9 9 J1 5 5 5 5 J2 J3
48 VDC
400 AMPS
STATUS
F1
F2
9
9
B-
M-
B+
9

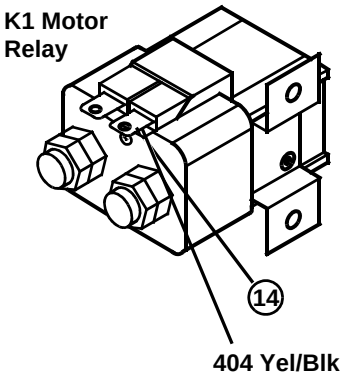
⚠ CAUTION

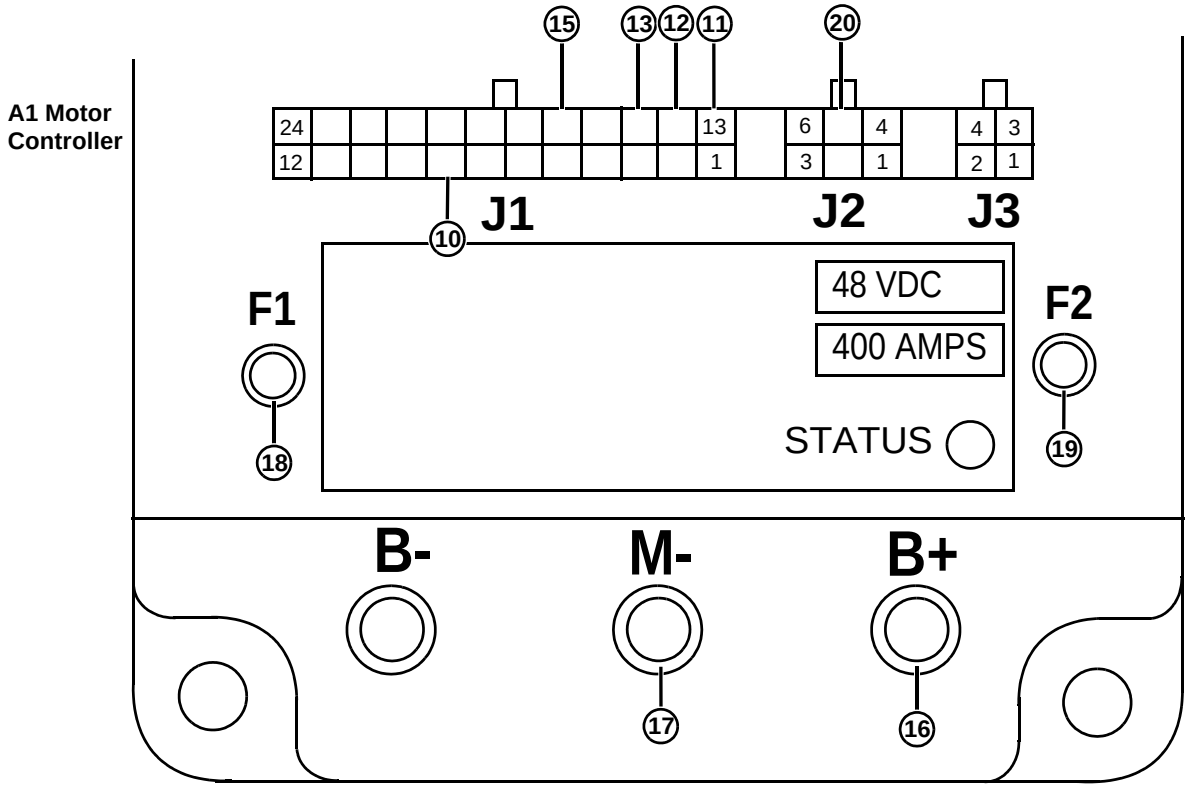
NEVER run the electric motor over half speed with wheels off of the ground. Motor could run over speed causing the armature to fly apart.

Test Conditions:

- Key switch ON
- Park Brake OFF
- Drive/Service switch in DRIVE position
- Directional lever in the REVERSE
- Battery set FULLY charged
- Drive wheel OFF the ground approximately 2.5 cm (1 in.)
- Throttle pedal PRESSED. Motor running not more than half speed.

Test/Check Point	Normal	If Not Normal
10. A1 Motor Controller—J1-8 terminal	48 volts DC or higher	Check 372 Red and 125 Grn wire and connections. If OK, replace throttle switch
11. A1 Motor Controller—J1-13 terminal	Approximately 4.6 volts	Verify all switch positions and primary switched inputs. If OK, replace motor controller.
12. A1 Motor Controller—J1-14 terminals.	Approximately 0.4 volts	Verify all switch positions and primary switched inputs. If OK, replace throttle potentiometer.
13. A1 Motor Controller—J1-15 terminals.	Approximately 2.2 volts	Verify all switch positions and primary switched inputs. If OK, replace throttle potentiometer.
14. K1 Motor Relay	Less than 0.1 volt	Check 414, 404 and 264 Yel/Blk wires and connections.
15. A1 Motor Controller—J1-17 terminal	Less than 0.1 volts	Verify all switch positions and primary switched inputs. If OK, replace motor controller.
16. A1 Motor Controller—B+ terminal	48 volts DC or higher	Check 600 Blk wire and connections. If OK, replace motor relay.
17. A1 Motor Controller—M- terminal	Approximately 36 volts	Check 610 and 600 Blk wires and connections. If OK, test and or replace drive motor. Verify all switch positions and primary switched inputs. If OK, replace motor controller.
18. A1 Motor Controller—F1 terminals.	Approximately 2.5 volts	Verify all switch positions and primary switched inputs. If OK, replace motor controller.
19. A1 Motor Controller—F2 terminal	Less than 0.1 volts	Verify all switch positions and primary switched inputs. If OK, replace motor controller.
20. A1 Motor Controller—J2-5 terminals	Approximately 2.0 volts	Verify all switch positions and primary switched inputs. If OK, replace motor speed sensor.


K1 Motor
Relay
14
404 Yel/Blk


A1 Motor
Controller
15
13
12
11
20
24
12
13
1
6
3
4
1
4
2
3
1
J1
J2
J3
10
48 VDC
400 AMPS
STATUS
F1
F2
18
19
B-
M-
B+
17
16

ACCESSORIES THEORY OF OPERATION & DIAGNOSIS

HOUR METER/BATTERY FUEL GAUGE CIRCUIT OPERATION

Function:

To record the number of hours the vehicle is driven and provide the operator with a visual display of the capacity remaining in the batteries.

Operating Conditions:

The hour meter/battery fuel gauge is connected directly to the battery set to monitor battery voltage at all times. See “UNSWITCHED POWER CIRCUIT OPERATION” on page 22. The LED display however will only be illuminated when the key switch is in the ON position.

Battery Fuel Gauge:

The battery fuel gauge has a multicolored 10-bar LED that displays the battery set state of charge. Only one LED will illuminate at a time. When the battery set is fully charged the tenth bar on the right side of the display will be illuminated. As the battery set discharges, the battery fuel gauge will move one bar at a time to the left towards the first bar.

When the LED range is between the tenth and sixth bars, the LED will be GREEN and signal that the vehicle “energy reserve” is between 50 and 100% of battery capacity.

When the LED range is between the fifth and third bars, the LED will be flashing YELLOW and signal that the battery charge is getting low and that the battery set “energy reserve” is between 30 and 50% of battery capacity.

When the LED range is between the second and first bars, the LED will alternately flash RED between the two bars. This double flashing signals to the operator the the battery charge is very low and the vehicle should be returned to an area where the battery set can be placed on charge. The “energy reserve at this point will be at 20% of battery capacity. This is the maximum discharge the battery set should receive before being placed on charge. If the battery set is allowed to discharge further than the 20% level, the battery set will be damaged and the useful life shortened.

During recharge the battery fuel gauge will not necessarily record the battery state of charge in the same proportional manner as during discharge. While the battery set will be near full charge when the gauge resets to full, the battery charger must be allowed to fully charge the batteries and automatically shut off to full condition the batteries and properly reset the battery fuel gauge to record the accurate state of charge during the next discharge.

When installing a new battery set, the battery fuel gauge will need several discharge and charge cycles to properly set itself to the new battery set.

Hour Meter:

The hour meter is connected to the motor controller on the same circuit that switches the drive motor relay coil to battery negative. When the drive motor relay is activated the hour meter is also activated to record the amount of time the vehicle is driven.

System Operation:

The hour meter/battery fuel gauge is connected directly to the battery set at all times. The battery negative path is from the battery set negative (B-), 630 Blk and 470 Blk wires to the number 2 terminal on the P1 hour meter/ battery fuel gauge.

The power is supplied from the battery set positive (B+), 620 Blk, 464 and 454 Yel/Red wires to the number 1 terminal on the P1 hour meter/battery fuel gauge.

With these two connections the battery fuel gauge can monitor the capacity in the battery set at all time.

When the key switch is turned to the ON position and the drive/service switch is in the DRIVE position, the face of the gauge will illuminate a LED bar on the fuel gauge to indicate the level of battery capacity remaining before needing a charge. This is also the power input for the hour meter to record the amount of time the vehicle is driven.

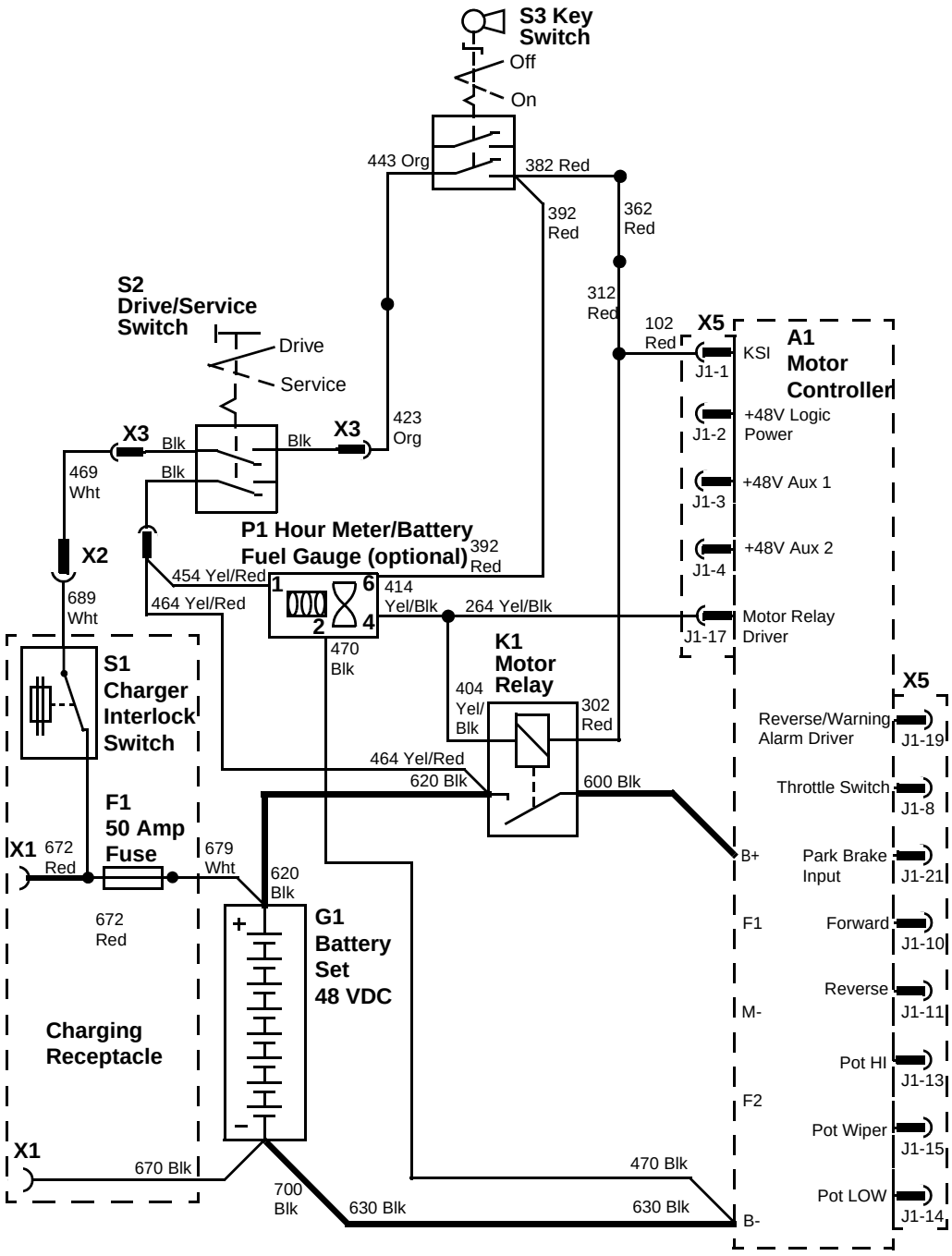
The power is supplied from the battery set positive (B+), 679 Wht, F1 50 amp fuse, S1 charger interlock switch (charger disconnected), 689 Wht wire, X2 connector, 469 Wht wire, S2 drive/service switch (contacts closed, drive position), 423 and 443 Org wires, S3 key switch (contacts closed, ON position), 392 Red wire to the number 6 terminal on the P1 hour meter/battery fuel gauge.

The battery negative for this circuit is from the number 2 terminal on the gauge to the 470 and 630 Blk wires back to the battery set negative (B-) terminal.

Because power has been supplied to the hour meter through the key switch the hour meter needs a battery negative to begin record running time. This battery negative path is created whenever the K1 motor relay is engaged to run the drive motor.

The K1 motor relay is engaged when the operator is performing a drive function. Electrically this requires that the S4 throttle switch and then either the S8 forward or S9 reverse switch be activated. This signals to the A1 motor controller to switch the K1 motor relay and the hour meter to battery negative. This battery negative path is from the J1-17 terminal on the A1 motor controller, 264 Yel/Blk wire spliced to the 404 Yel/Blk wire to the K1 motor relay and the 414 Yel/Blk wire to the number 4 terminal on the P1 hour meter/battery fuel gauge.

HOUR METER/BATTERY FUEL GAUGE CIRCUIT SCHEMATIC



HOUR METER/BATTERY FUEL GAUGE CIRCUIT DIAGNOSIS

Test Conditions:

- Key switch OFF
- Park Brake ON
- Drive/Service switch in the SERVICE position
- Battery set FULLY charged

Test/Check Point	Normal	If Not Normal
1. Battery set	48 volts DC or higher	Test batteries. See Battery Section
2. P1 Hour Meter/Battery Fuel Gauge	Continuity to battery negative	Check 470 and 630 Blk wires and connections.
3. P1 Hour Meter/Battery Fuel Gauge	48 volts DC or higher	Check 454, 464 Yel/Red and 620 Blk wires and connections.

Test Conditions:

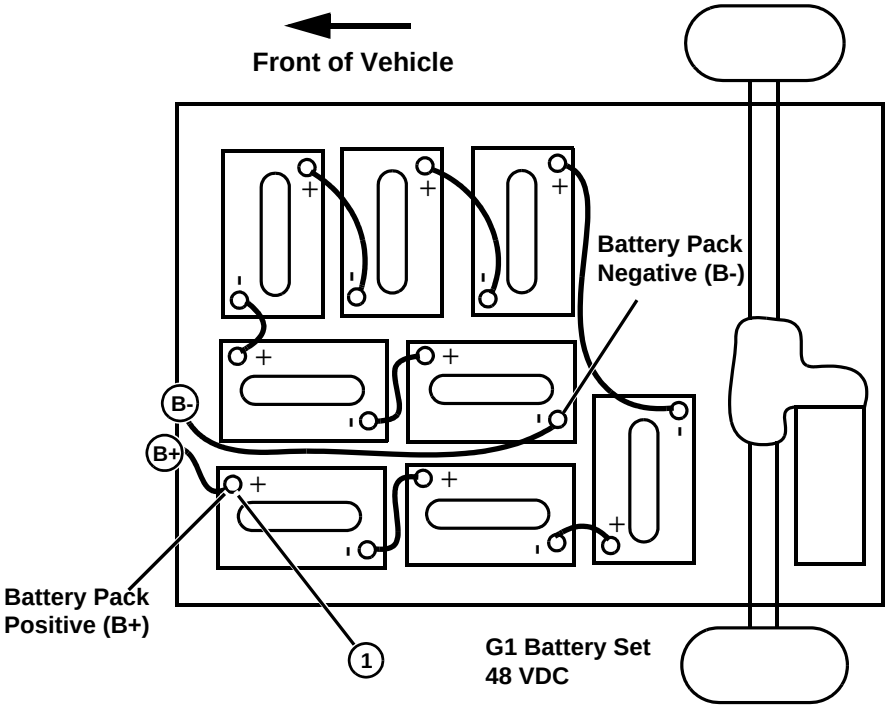
- Key switch ON
- Park Brake ON
- Drive/Service switch in the DRIVE position
- Battery Set FULLY charged

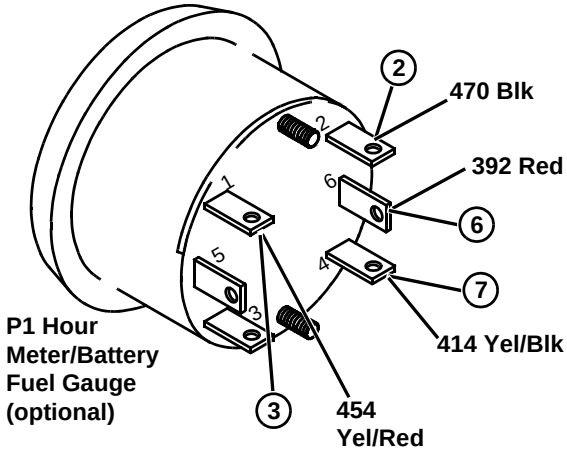
4. S2 Drive/Service switch	48 volts DC or higher	Check 469, 689 and 679 Wht sires and connections. Check S1
5. S3 Key switch	48 volts DC or higher	Check 443 and 423 Org wires and connections. If OK, replace drive/service switch.
6. P1 Hour Meter/Battery Fuel Gauge	48 volts DC or higher	Check 392 Red wire and connections. If OK, replace key switch.
7. P1 Hour Meter/Battery Fuel Gauge	48 volts DC or higher	Check 414, 404 Yel/Blk wires and connections. Check K1 motor relay. Check 302, 312, 362, and 382 Red wires and connection.

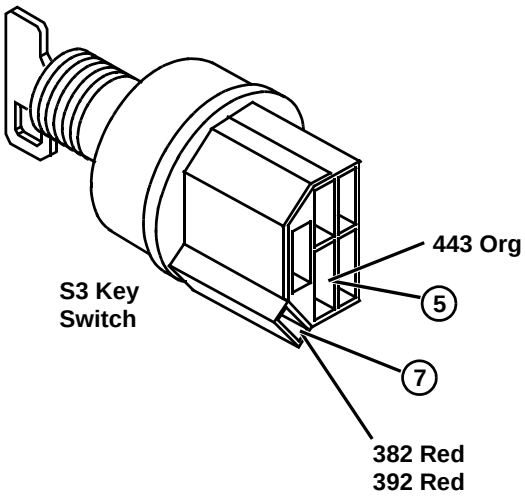
Test Conditions:

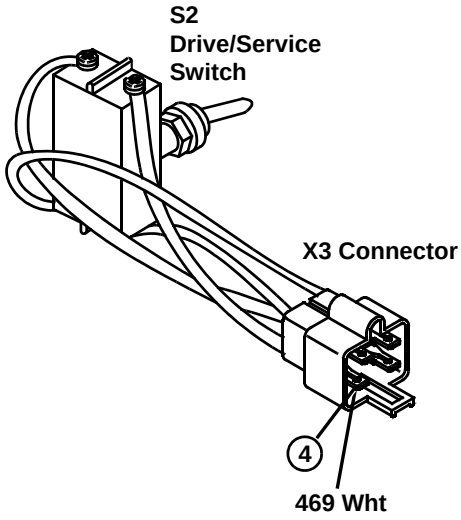
- Key switch ON
- Park Brake OFF
- Drive/Service switch in the DRIVE position
- Battery Set FULLY charged
- Drive vehicle and observe hour glass shaped indicator on left side of hour meter display.

8. P1 Hour Meter/Battery Fuel Gauge	Vehicle drives. Hour glass indicator on hour meter display blinks at approximately 4 second intervals.	Check 414, 404, and 264 Yel/Blk wires and connections. Check that all switches are in their proper positions. See diagnostics for dive function being used.


Front of Vehicle
Battery Pack
Negative (B-)
B-
B+
Battery Pack
Positive (B+)
1
G1 Battery Set
48 VDC


2
470 Blk
392 Red
6
7
414 Yel/Blk
P1 Hour
Meter/Battery
Fuel Gauge
(optional)
3
454
Yel/Red


443 Org
S3 Key
Switch
5
7
382 Red
392 Red


S2
Drive/Service
Switch
X3 Connector
4
469 Wht

HEADLIGHT CIRCUIT OPERATION

Function:

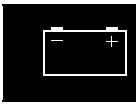
To provide power to the headlights for illumination if desired by the operator.

Operating Conditions:

- Headlight switch in ON position.

System Operation:

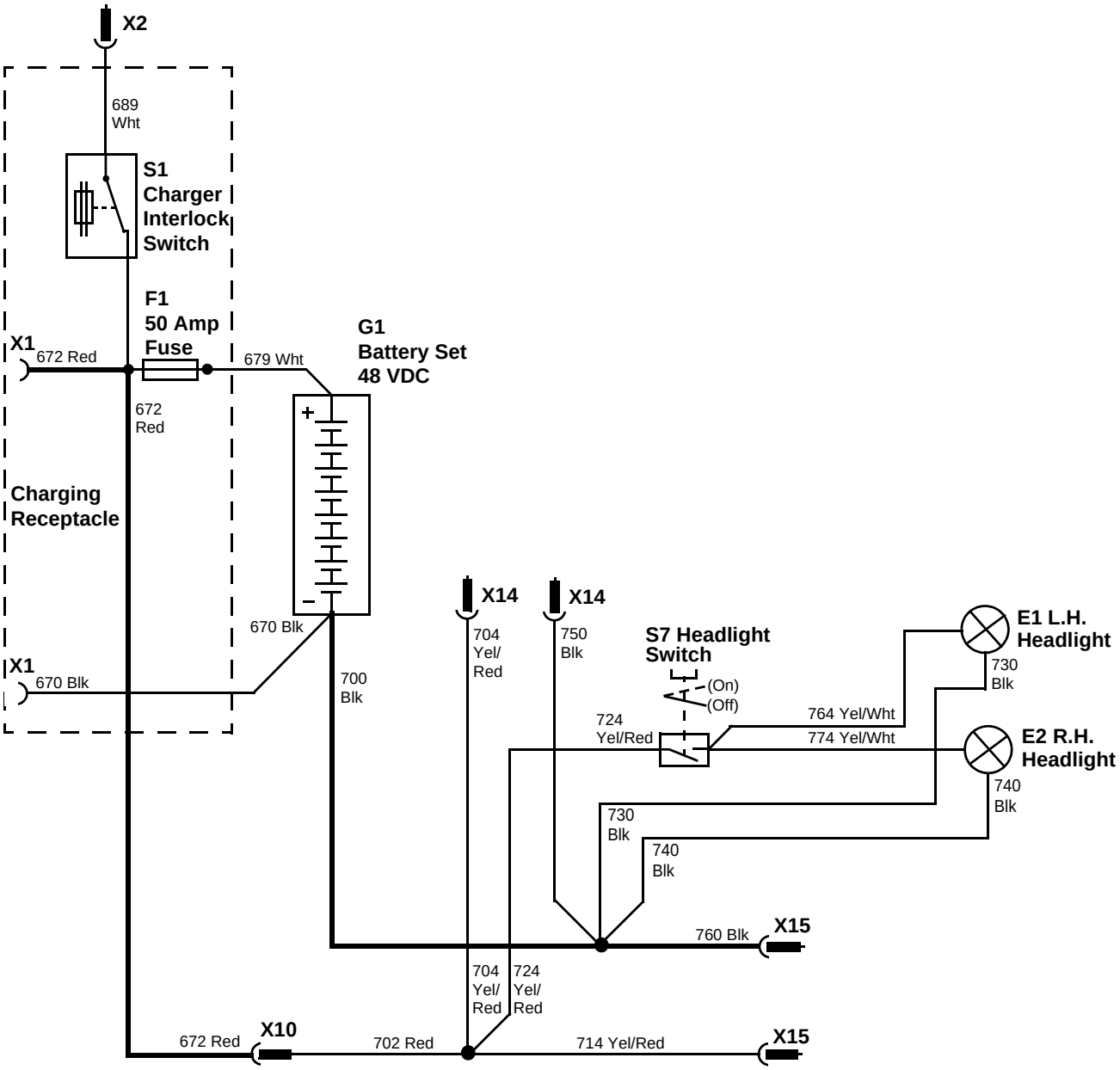
Power for the headlights is provided by the battery set positive (B+) through the 679 Wht wire, F1 50 amp fuse, 672 Red wire, X10 connector, 702 Red and 724 Yel/Red wire, S7 headlight switch, 764 Yel/Wht wire to the left hand headlight and 774 Yel/Wht wire to the right hand headlight.



The battery negative for the headlights is provided from the battery set negative (B-) through the 700 Blk, 730 Blk wire to the left hand headlight and 740 Blk wire to the right hand headlight.

IMPORTANT: This is not a standard replacement bulb. If bulb replacement is required, use only a 48 volt bulb. Using a 12 volt replacement bulb could cause a blown vehicle fuse.

HEADLIGHT CIRCUIT SCHEMATIC



HEADLIGHT CIRCUIT DIAGNOSIS

Test Conditions:

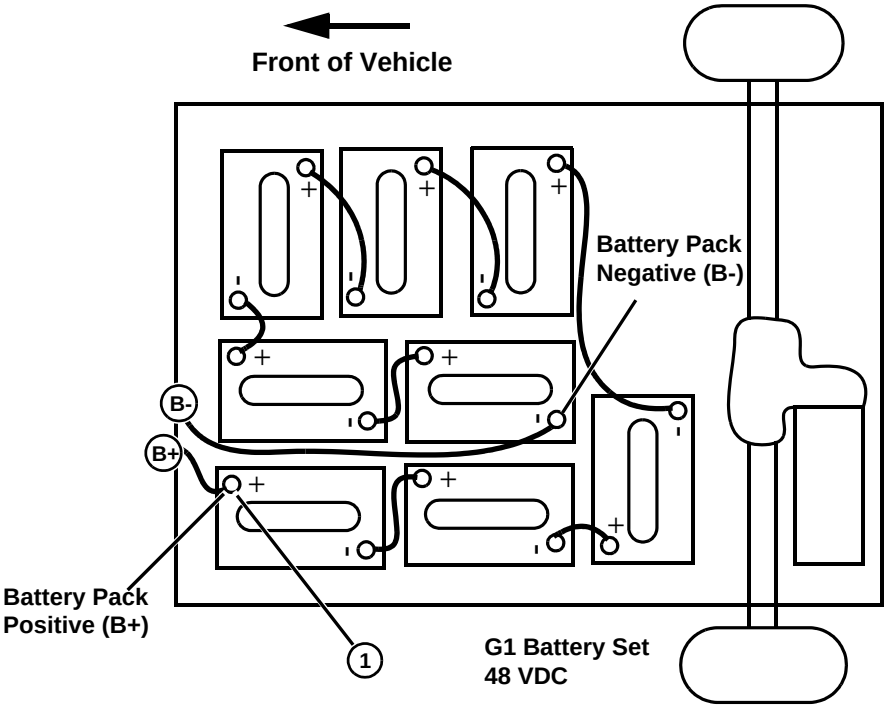
- Headlight switch ON
- Key switch OFF
- Drive/Service switch in the SERVICE position
- Park Brake ON
- Battery Set FULLY charged

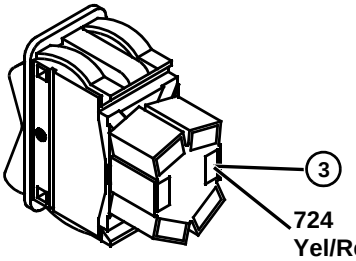
Test/Check Point	Normal	If Not Normal
1. Battery set	48 volts DC or higher	Test batteries. See Battery Section
2. X10 connector	48 volts DC or higher	Check 679 Wht and 672 Red wires and connections. Check F1 50 amp fuse.
3. S7 Headlight switch	48 volts DC or higher	Check 702 Red and 724 Yel/Red wires and connections
4. E1 and E2 Headlight Yel/Wht wires	48 volts DC or higher	Check 764 and 774 Yel/Wht wires and connections. If OK, replace headlight switch
5. E1 and E2 Headlight	Headlights ON	Check headlight bulbs

Test Conditions:

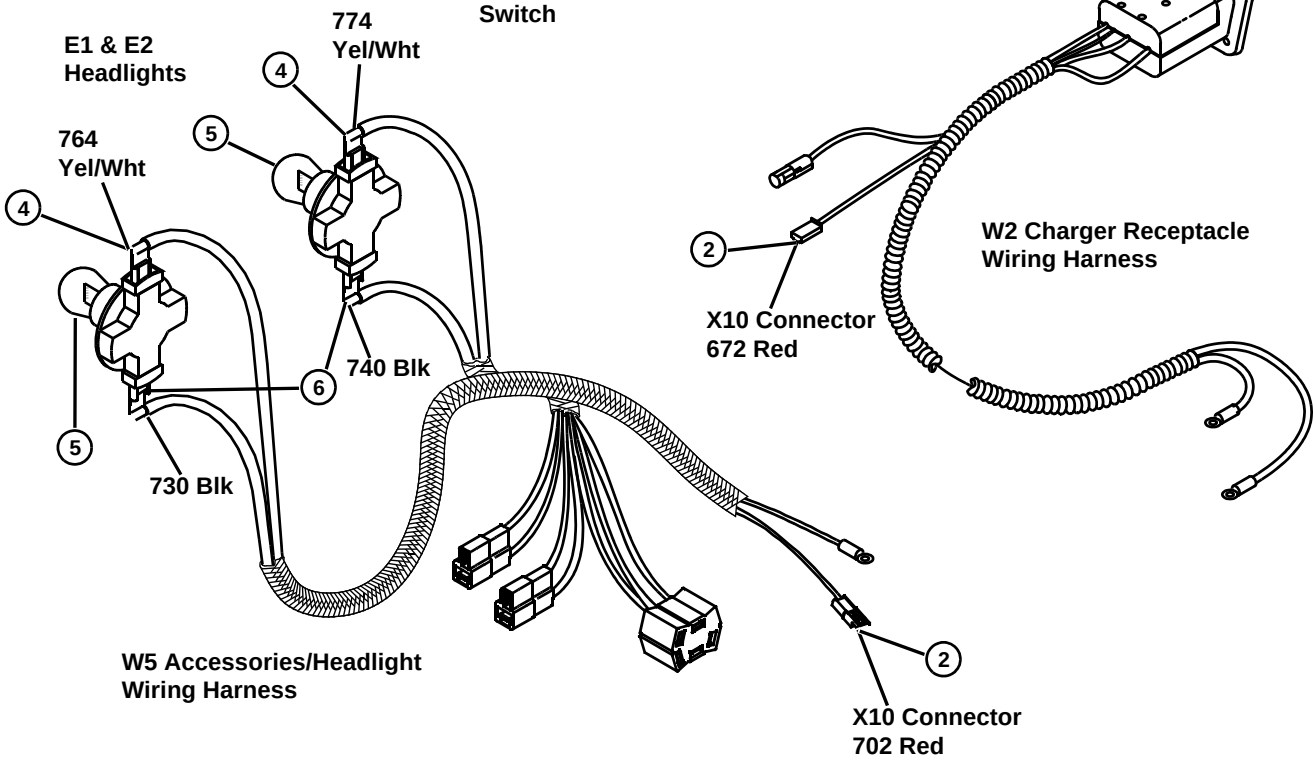
- Headlight switch OFF
- Key switch OFF
- Drive/Service switch in the SERVICE position
- Park Brake ON
- Battery Set FULLY charged

6. E1 and E2 Headlight Blk wires	Continuity to battery negative (B-)	Check 740, 730 and 700 Blk wires and connections.





S7 Headlight Switch



HORN CIRCUIT OPERATION

Function:

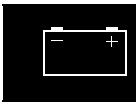
To provide power to the horn to create an audible alert if desired by the operator.

Operating Conditions:

- Horn switch in ON position.

System Operation:

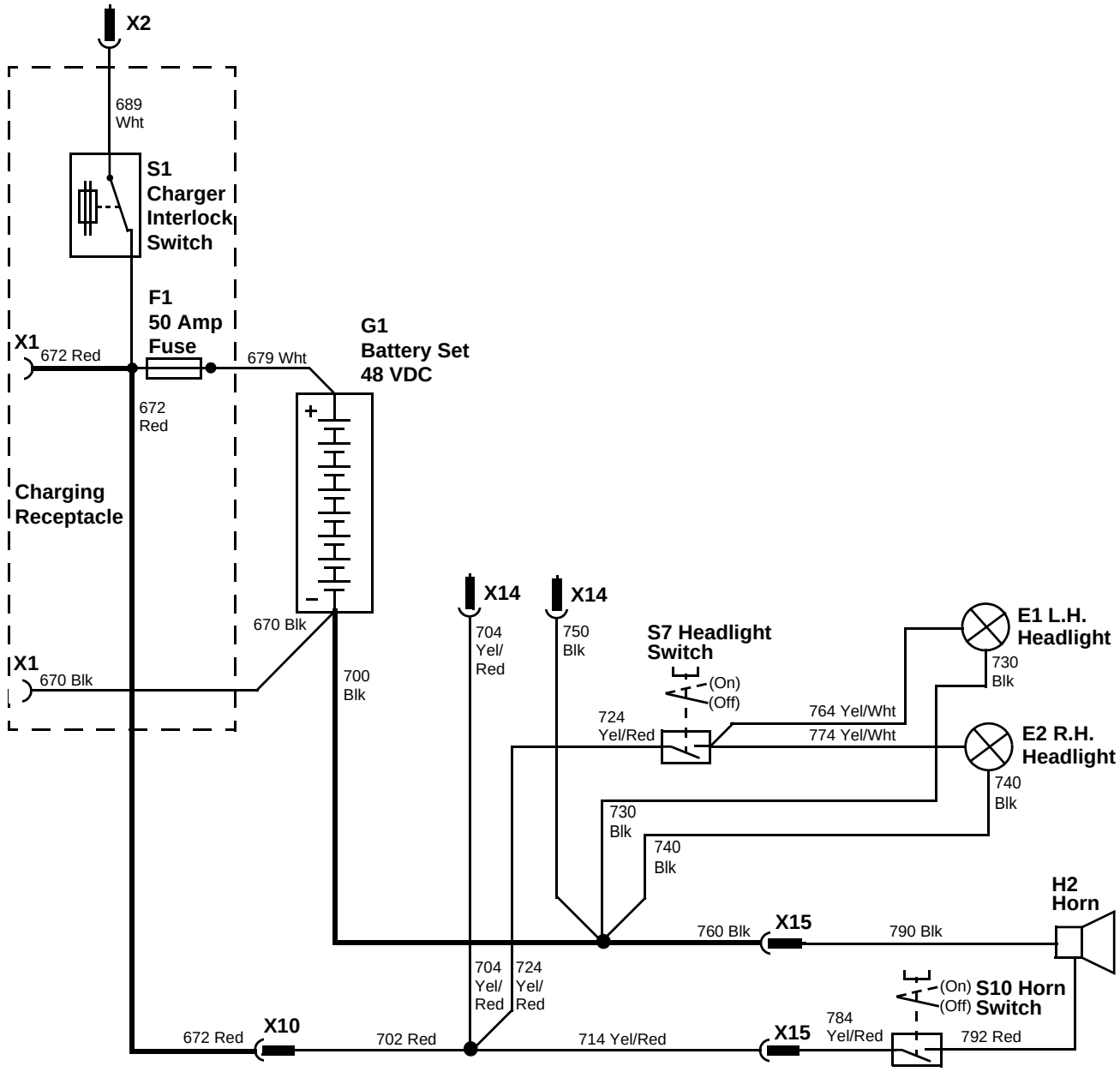
Power for the horn is provided by the battery set positive (B+) through the 679 Wht wire, F1 50 amp fuse, 672 Red wire, X10 connector, 702 Red and 714 Yel/Red wire, X15 connector, 784 Yel/Red wire, S10 horn switch, 792 Red wire to the horn.



The battery negative for the horn is provided from the battery set negative (B-) through the 700 Blk and 760 Blk wire, X15 connector, 790 Blk wire to the horn.

IMPORTANT: This is not a standard horn. If horn replacement is required, use only a 48 volt horn. Using a 12 volt horn could cause a blown vehicle fuse.

HORN CIRCUIT SCHEMATIC



HORN CIRCUIT DIAGNOSIS

Test Conditions:

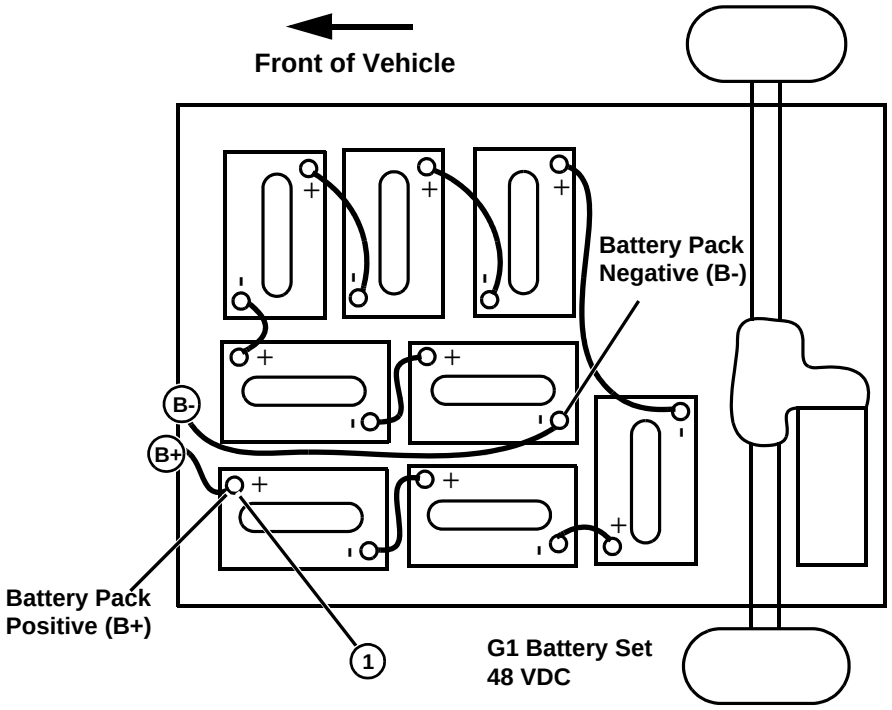
- Horn switch ON
- Key switch OFF
- Drive/Service switch in the SERVICE position
- Park Brake ON
- Battery Set FULLY charged

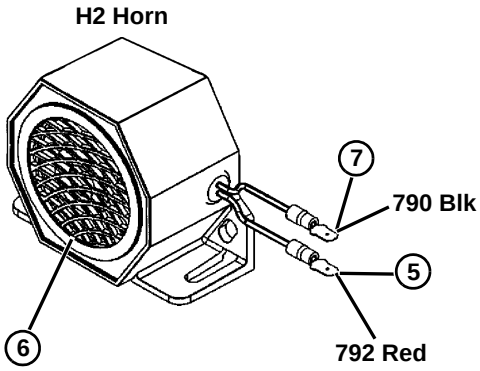
Test/Check Point	Normal	If Not Normal
1. Battery set	48 volts DC or higher	Test batteries. See Battery Section
2. X10 connector	48 volts DC or higher	Check 679 Wht and 672 Red wires and connections. Check F1 50 amp fuse.
3. X15 connector	48 volts DC or higher	Check 702 Red and 714 Yel/Red wires and connections.
4. S10 Horn switch	48 volts DC or higher	Check 784 Yel/Red wire and connections
5. Horn Red wire	48 volts DC or higher	Check 792 Red wire and connections. If OK, replace horn switch.
6. Horn	Audible sound	Check horn battery negative. If OK, replace horn.

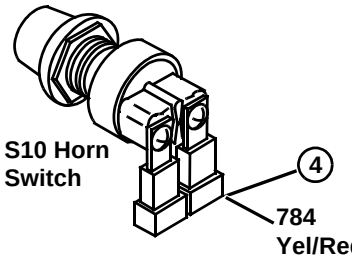
Test Conditions:

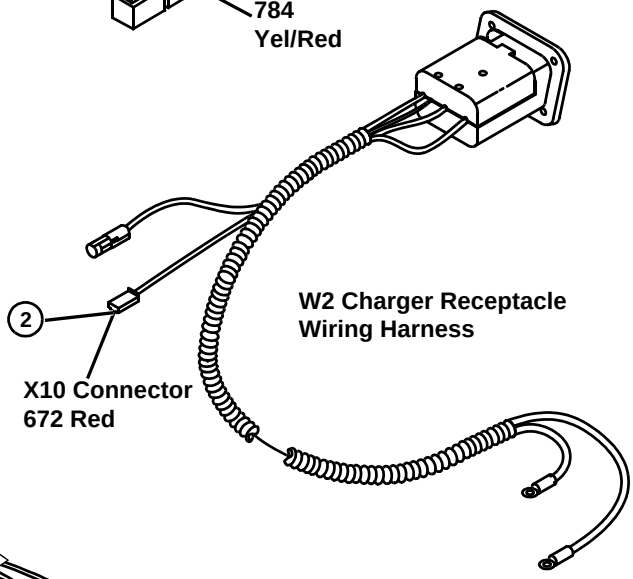
- Horn switch OFF
- Key switch OFF
- Drive/Service switch in the SERVICE position
- Park Brake ON
- Battery Set FULLY charged

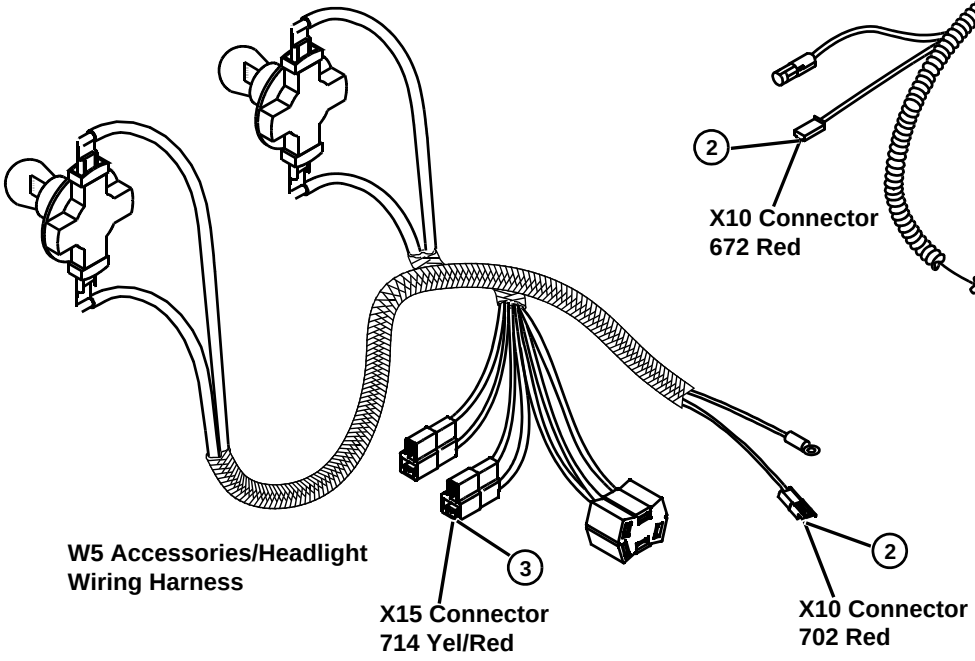
7. Horn Blk wire	Continuity to battery negative (B-)	Check 790, 760 and 700 Blk wires and connections.


Front of Vehicle
Battery Pack
Negative (B-)
B-
B+
Battery Pack
Positive (B+)
1
G1 Battery Set
48 VDC


H2 Horn
7
790 Blk
5
6
792 Red


S10 Horn
Switch
4
784
Yel/Red


2
W2 Charger Receptacle
Wiring Harness
X10 Connector
672 Red


W5 Accessories/Headlight
Wiring Harness
3
X15 Connector
714 Yel/Red
2
X10 Connector
702 Red

CARGO BOX LIFT CIRCUIT OPERATION

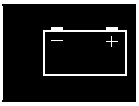
Function:

To provide power to the cargo box lift actuator to lift and lower the cargo box as desired by the operator.

The cargo box lift system is a linear actuator. It is a electromechanical, ball-bearing screw type actuator and consists of a electric motor, gear train, drive screw and ram.

The electric motor turns the drive screw that extends and retracts the stainless steel ram from the ram tube. The direction in which the motor turns is determined by which way current flows through it. Current flow is controlled by the cargo box lift switch.

Operating Conditions:



- Key switch ON
- Cargo Box Lift switch toggled to either the lift or lower position

Power is available to the cargo box lift circuit whenever the battery set is properly connected to the vehicle. To activate the lift circuit the key switch must be in the ON position and the operator must press the cargo box lift switch to either lift or lower the cargo box.

The cargo box lift switch will feed current into the lift circuit in one direction during a lift function and will reverse the current flow to the motor during a lowering function.

When the cargo box lift switch is activated for a lift, power is supplied to the cargo box relay coil and one terminal of the relay contacts. If the key switch is in the ON position then the battery negative circuit for the relay coil will be completed back to the cargo box lift switch and allow the relay to close its normally open contacts. This will then supply power to the cargo box lift motor causing the cargo box to be raised. The battery negative path for the cargo box lift motor will be provided through the cargo box lift switch along with the cargo box relay battery negative.

When lowering the cargo box the cargo box lift switch will reverse the current flow through the circuit. Because the motor is supplied current in the opposite direction it will reverse its direction of rotation and cause the cargo box to be lowered.

System Operation, Lift:

Power for the cargo box lift actuator is provided by the battery set positive (B+) through the 679 Wht wire, F1 50 amp fuse, 672 Red wire, X10 connector, 702 Red and 704 Yel/Red wire, X14 connector, 804 Yel/Red wire, S6 cargo box lift switch.

During a lift function the 804 Yel/Red wire supplies power through the S6 cargo box lift switch to the 812 Red/Wht wire, K2 cargo box lift relay contact terminal, and 832 Red/Wht wire to the relay coil. When the K2 cargo box lift relay contacts close power is then supplied to the 842 Red wire and the M2 cargo box lift motor.

With power to the cargo box lift relay 812 and 832 Red/Wht wires, the battery negative path is from the K2 relay 830 Blk wire, S3 key switch, 824 and 820 Blk/Yel wires, S6 cargo box lift switch, 810 Blk wire. X14 connector, 750 and 700 Blk wires back to the battery set negative (B-) terminal.

The battery negative for the cargo box lift motor is provided through the 821 Blk/Yel wire, 820 Blk/Yel wire, S6 cargo box lift switch, 810 Blk wire, X14 connector, 750 and 700 Blk wires back to the battery set negative (B-) terminal.

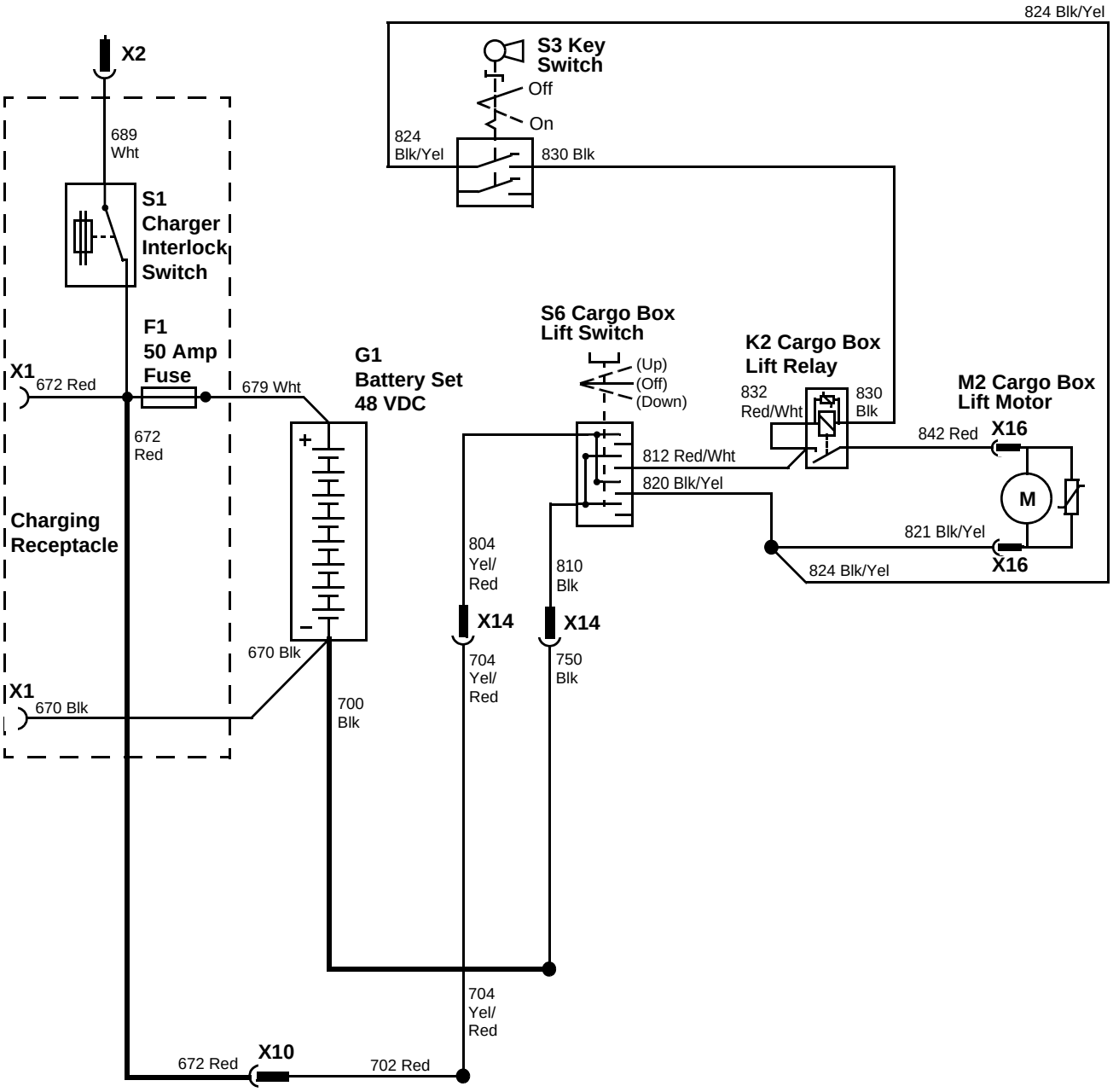
System Operation, Lower:

Power for the cargo box lift actuator is provided by the battery set positive (B+) through the 679 Wht wire, F1 50 amp fuse, 672 Red wire, X10 connector, 702 Red and 704 Yel/Red wire, X14 connector, 804 Yel/Red wire, S6 cargo box lift switch.

During a lowering function the 804 Yel/Red wire supplies power through the S6 cargo box lift switch to the 820, 824 and 821 Blk/Yel wires. The 821 Blk/Yel wire supplies power to the M2 cargo box lift motor while the 824 Blk/Yel wire supplies power to the S3 key switch, 830 Blk wire, K2 cargo box lift relay coil. The K2 cargo box lift relay coil is then connected back to the negative circuit by the 832 and 812 Red/Wht wire, S6 cargo box lift switch, 810 Blk wire, X14 connector, 750 and 700 Blk wires back to the battery set negative (B-) terminal.

The battery negative for the cargo box lift motor is provided through the 812 Red wire, 842 Red wire, S6 cargo box lift switch, 810 Blk wire, X14 connector, 750 and 700 Blk wires back to the battery set negative (B-) terminal.

CARGO BOX LIFT CIRCUIT SCHEMATIC



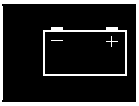
CARGO BOX LIFT CIRCUIT DIAGNOSIS

Test Conditions:

- Key switch OFF
- Cargo Box Lift switch OFF
- Park Brake ON
- Drive/Service switch in the SERVICE position
- Battery Set FULLY charged

NOTE: No load in cargo box for all tests

Test/Check Point	Normal	If Not Normal
1. Battery set	48 volts DC or higher	Test batteries. See Battery Section
2. S6 Cargo Box Lift switch	48 volts DC or higher	Check 679 Wht, 672 Red, 702 Red, 704 Yel/Red and 804 Yel/Red wires and connections. If OK, check F1 50 amp fuse.
3. S6 Cargo Box Lift switch	Continuity to battery negative	Check 700, 750 and 810 Blk wires and connections



Test Conditions:

- Key switch OFF
- Cargo Box Lift switch in LIFT position
- Drive/Service switch in the SERVICE position
- Park Brake ON
- Battery Set FULLY charged

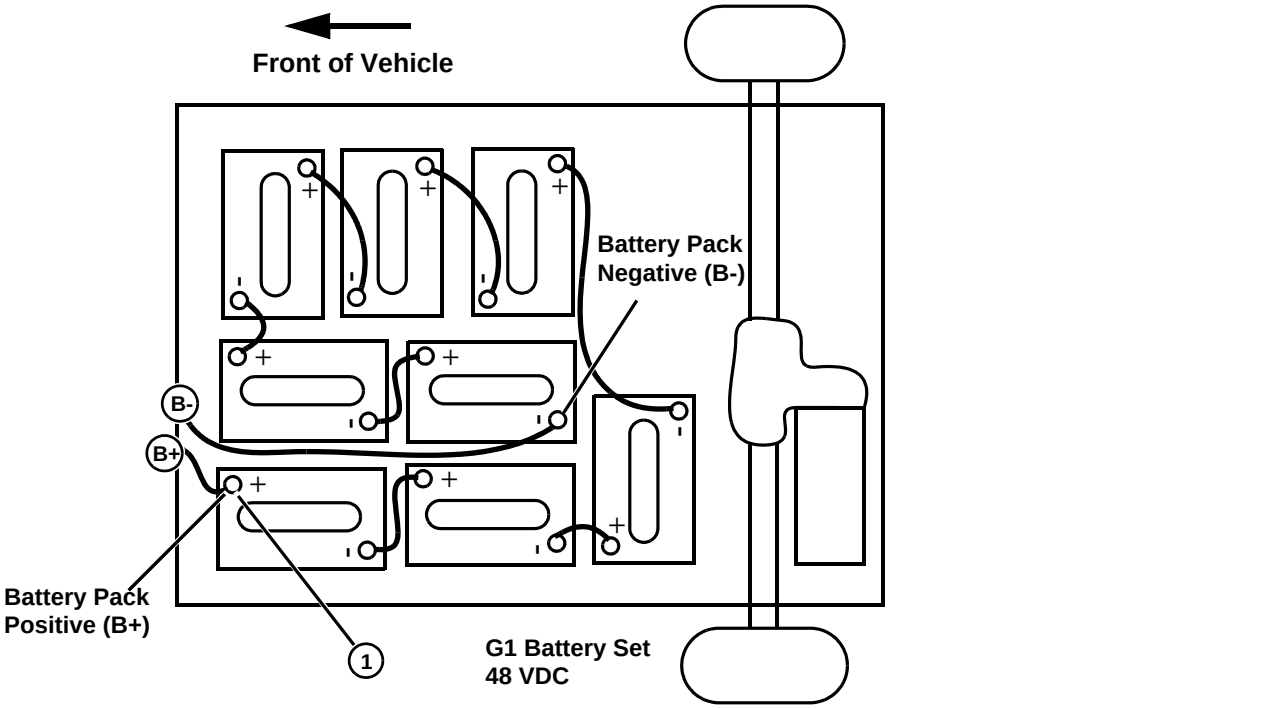
4. S6 Cargo Box Lift switch	48 volts DC or higher	Check cargo box lift switch. Replace if not OK.
5. K2 Cargo Box Lift Relay	48 volts DC or higher	Check 812 and 832 Red/Wht wires and connections.
6. K2 Cargo Box Lift Relay	Less than 1 volt DC	Check that key switch is OFF. Check K2 relay for welded contacts. Replace component if not OK.
7. S3 Key switch	48 volts DC or higher	Check 830 Blk wire and connections. If OK, replace cargo box lift relay.
8. S6 Cargo Box Lift switch	Continuity to battery negative (B-)	Check cargo box lift switch. Replace if not OK.
9. S3 Key switch	Continuity to battery negative (B-)	Check 820 and 824 Blk/Yel wire and connections.
10. X16 Connector on M2 Cargo Box Lift Motor	Continuity to battery negative (B-)	Check 821 Blk/Yel wire and connections.

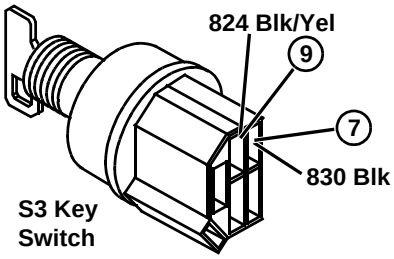
Test Conditions:

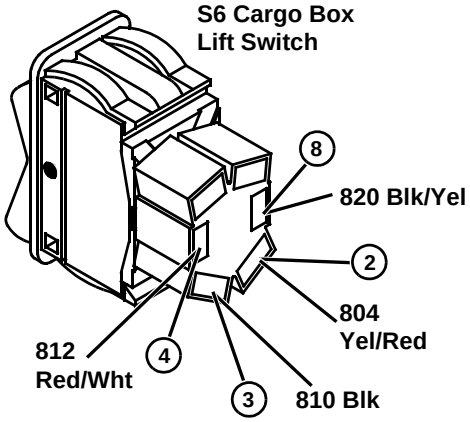
- Key switch ON
- Cargo Box Lift switch in LIFT position
- Park Brake ON
- Battery Set FULLY charged
- Drive/Service switch in the SERVICE position

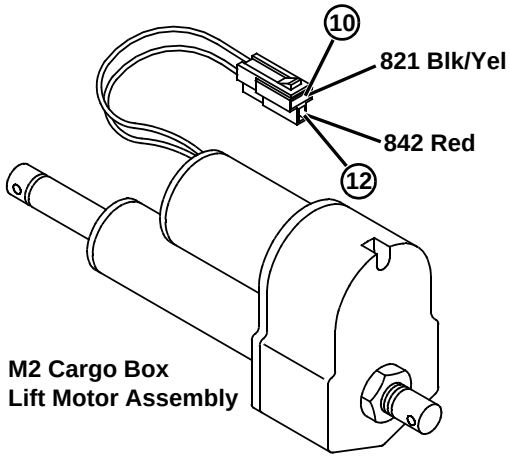
NOTE: Motor should be running and lifting cargo box. If the following test show normal operation, repair or place cargo box lift actuator assembly.

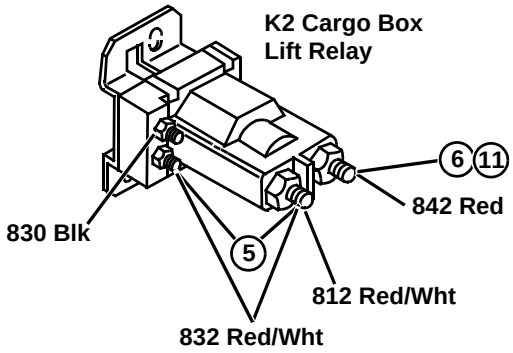
11. K2 Cargo Box Lift Relay	48 volts DC or higher	Check that key switch is OFF. Check K2 relay for welded contacts. Replace component if not OK.
12. X16 Connector on M2 Cargo Box Lift Motor	Continuity to battery negative (B-)	Check 842 Red wire and connections.


Front of Vehicle
Battery Pack
Negative (B-)
B-
B+
Battery Pack
Positive (B+)
1
G1 Battery Set
48 VDC


824 Blk/Yel
9
7
830 Blk
S3 Key
Switch


S6 Cargo Box
Lift Switch
8
820 Blk/Yel
2
804
Yel/Red
812
Red/Wht
4
3
810 Blk


10
821 Blk/Yel
842 Red
12
M2 Cargo Box
Lift Motor Assembly


K2 Cargo Box
Lift Relay
6
11
842 Red
830 Blk
5
812 Red/Wht
832 Red/Wht

TESTS AND ADJUSTMENTS

BATTERY SET TEST

See BATTERIES SECTION “BATTERY TEST” on page 7.

ELECTRIC DRIVE MOTOR TEST

See ELECTRIC MOTOR SECTION “INSPECTING AND TESTING ELECTRIC MOTOR” on page 7.

DRIVE/SERVICE SWITCH TEST

Reason:

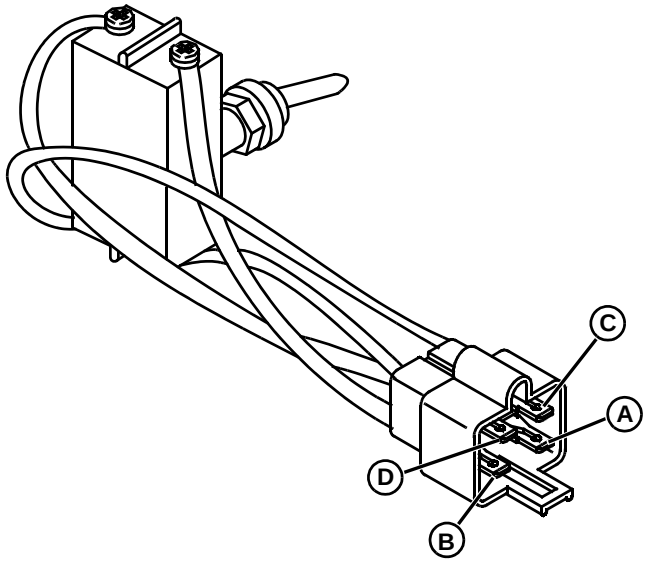
To verify drive/service switch functions are operating properly.

Equipment:

- JT05791 Multimeter

Procedure:

1. Park machine on level surface.
2. Turn key switch to OFF position.
3. Move directional lever to NEUTRAL position.
4. Engage park brake.
5. Place the Drive/Service switch in the SERVICE position.
6. Note the location of both the positive (B+) and negative (B-) terminals of the battery set.
7. Using insulated tools and care not to touch wrench to other terminals or the frame of the vehicle, disconnect the battery pack positive wires.
8. Remove seat base cover under seat. See “SEAT BASE COVER REMOVAL & INSTALLATION” on page 5 in the MISC. SECTION.
9. Remove capscrew securing motor controller cover and lift cover off of motor controller and tip cover over to expose the drive/service switch.
10. Mark and disconnect the wires connected to the drive/service switch.



11. Measure continuity across each combination of terminals with the switch in each position.

Results:

Switch in Service Position
. . . . . No Continuity across any terminals
Switch in Drive Position
. . . . . Continuity across A and C
. . . . . Continuity across B and D
No Continuity across any other combination of terminals

12. Connect wires to the drive/service switch as marked in step 10.
13. Place motor controller cover over motor controller and secure in place.
14. Verify battery wires and connect to their proper terminals using the battery connection diagram. See BATTERIES SECTION “BATTERY POSITION/CONNECTION DIAGRAM” on page 5.

MOTOR RELAY TEST

Reason:

To determine if motor relay is functioning properly.

Equipment:

- JT05791 Multimeter

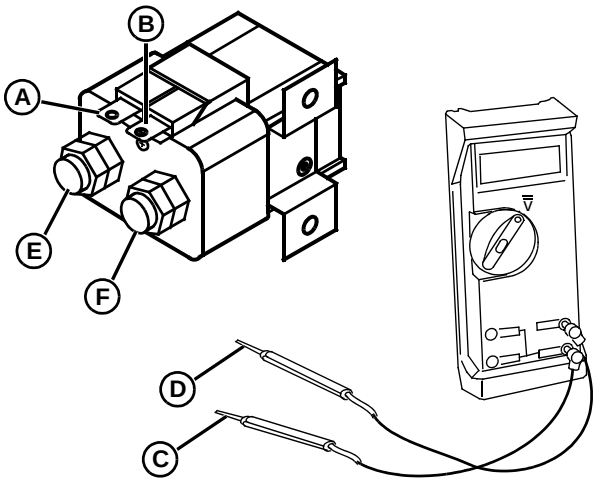
Procedure:

1. Park machine on level surface.
2. Turn key switch to OFF position.
3. Move directional lever to NEUTRAL position.
4. Engage park brake.
5. Place the Drive/Service switch in the SERVICE position.

CAUTION

Help prevent serious injury or death from an electrical shock or electrocution. This utility vehicle is equipped with a 48 volt electrical system which is capable of passing a high voltage electrical current. Always use extreme caution when servicing the battery set in this vehicle.

6. Note the location of both the positive (B+) and negative (B-) terminals of the battery set.
7. Using insulated tools and care not to touch wrench to other terminals or the frame of the vehicle, disconnect the battery pack positive wires.
8. Remove seat base cover under seat. See MISC. SECTION “SEAT BASE COVER REMOVAL & INSTALLATION” on page 5.



9. Mark and remove the wires connected to terminals (A) and (B).
10. Set the multimeter to the ohms setting.
11. Connect black lead (C) to terminal (A) and the red lead (D) to terminal (B) and note the resistance.
12. Connect black lead (C) to terminal (E) and the red lead (D) to terminal (F) and note the resistance.

Results:

Coil Resistance (terminals A to B) . .190 - 233 ohms
Contacts (terminals E to F) . . . . . NO Continuity

- If resistance is not within the range indicated at **25°C (77°F)**, the coil is defective, replace motor relay.
- If continuity is present, contacts are welded, replace motor relay.

13. Connect a jumper wire from battery positive (B+) terminal to relay terminal (B). Connect a jumper wire from battery negative (B-) to relay terminal (A).
14. Connect black lead (C) to terminal (E) and the red lead (D) to terminal (F) and note the resistance.

Results:

Contacts (terminals E to F) . . . . . .Continuity

- If NO continuity is present, contacts are not closing properly, replace motor relay.

KEY SWITCH TEST

Reason:

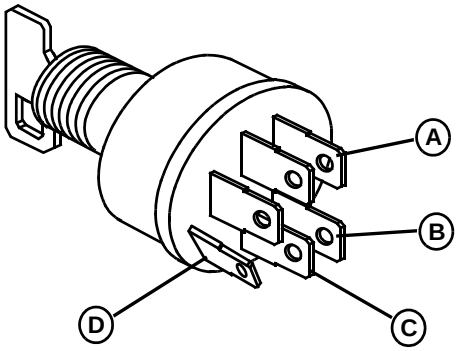
To verify key switch functions are operating properly.

Equipment:

- JT05791 Multimeter

Procedure:

1. Park machine on level surface.
2. Turn key switch to OFF position.
3. Move directional lever to NEUTRAL position.
4. Engage park brake.
5. Place the Drive/Service switch in the Service position.
6. Remove hood. See MISC. SECTION “HOOD INSTALLATION & ADJUSTMENT” on page 3.
7. Disconnect key switch connector.



8. Use an ohmmeter to test switch continuity in OFF and RUN positions.

Key Switch Continuity:

Switch Position . . . . . .Terminal Continuity

OFF . . . . . .A and B

RUN . . . . . .C and D

Results:

- If continuity is NOT found in any of these positions, or continuity is found in any other position, replace switch.

THROTTLE POTENTIOMETER TEST

Reason:

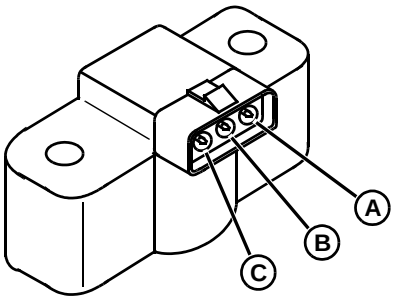
To verify the electrical integrity of the throttle potentiometer.

Equipment:

- JT05791 Multimeter

Procedure:

1. Park machine on level surface.
2. Turn key switch to OFF position.
3. Move directional lever to NEUTRAL position.
4. Engage park brake.
5. Place the Drive/Service switch in the SERVICE position.
6. Remove hood. See MISC. SECTION “HOOD INSTALLATION & ADJUSTMENT” on page 3.



7. Disconnect the throttle potentiometer from the main wiring harness.
8. Measure and record the resistance across each combination of terminals as listed below. Keep the throttle potentiometer in the OFF position while performing the tests.

The red lead position of the VOM is listed across the top and the black lead position of the VOM is listed down the side.

	Red A	Red B	Red C
Black A		640	4.7 k
Black B	640		5.4 k
Black C	4.7 k	5.4 k	

Results:

If any readings are incorrect, replace the throttle potentiometer.

REVERSE/WARNING ALARM TEST

Reason:

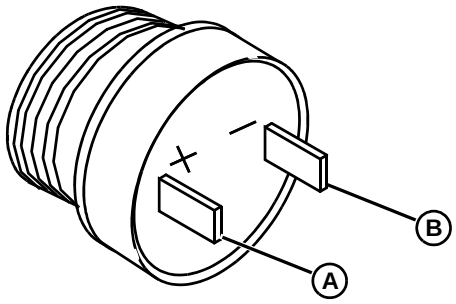
To make sure the reverse/warning alarm functions properly to warn the operator if the vehicle is in reverse or is moving unintentionally.

Equipment:

- JT05791 Multimeter
- JT05792 Shunt

Procedure:

1. Park machine on level surface.
2. Turn key switch to OFF position.
3. Move directional lever to NEUTRAL position.
4. Engage park brake.
5. Place the Drive/Service switch in the SERVICE position.
6. Remove seat base cover under seat. See MISC. SECTION “SEAT BASE COVER REMOVAL & INSTALLATION” on page 5.



7. Disconnect the 433 Org wire from the positive (+) terminal (A) of the reverse/warning alarm and the 268 Gry wire from the negative (-) terminal (B) of the reverse/warning alarm.
8. Place the red lead of the VOM on the positive (+) terminal (A) of the reverse/warning alarm and the black lead of the VOM on the negative (-) terminal (B) of the reverse/warning alarm and record the resistance value.
9. Reverse the leads and record that resistance value.

Specification:

Red to Positive (+) . . . . . .7.6 ohms
Black to Positive (+) . . . . . O.L.
If either reading is incorrect, replace the reverse/warning alarm.

FUNCTIONAL SWITCHES TEST

Reason:

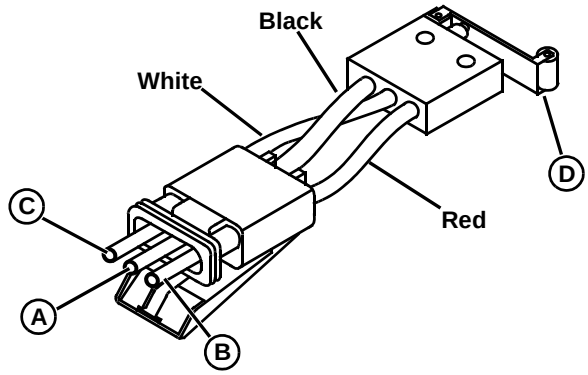
To verify the electrical integrity of the functional switches. This switch is used for the throttle, park brake, forward and reverse functions.

Equipment:

- JT05791 Multimeter

Procedure:

1. Park machine on level surface.
2. Turn key switch to OFF position.
3. Move directional lever to NEUTRAL position.
4. Engage park brake.
5. Place the Drive/Service switch in the SERVICE position.



6. Disconnect the connector from the functional switch to be tested.
7. With the switch in its normal (static) position, place the red lead of the VOM on the black wire (A) of the switch connector and measure the continuity to the red (B) and white (C) wires.

Results:

A to B. . . . . .Continuity
A to C. . . . . .No Continuity

8. Press and hold the switch arm (D) in and place the red lead of the VOM on the black wire (A) of the switch connector and measure the continuity to the red (B) and white (C) wires.

Results:

A to B. . . . . .No Continuity
A to C. . . . . .Continuity
If any of the readings are incorrect, replace the functional switch being tested.

HEADLIGHT SWITCH TEST

Reason:

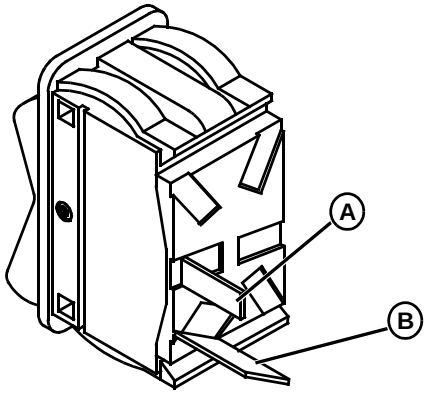
To make sure the light switch terminals have continuity when the light switch is **ON**.

Equipment:

- JT05791 Multimeter

Procedure:

1. Park machine on level surface.
2. Turn key switch to OFF position.
3. Move directional lever to NEUTRAL position.
4. Engage park brake.
5. Place the Drive/Service switch in the SERVICE position.
6. Remove hood. See MISC. SECTION “HOOD INSTALLATION & ADJUSTMENT” on page 3.
7. Disconnect light switch connector.



8. Move light switch to the ON and then the OFF position. Check continuity between terminals (A and B).

Results:

- Terminals should have continuity with switch ON.
- Terminals should NOT have continuity with switch OFF.

If continuity is NOT correct, replace headlight switch.

MOTOR SPEED SENSOR TEST

Reason:

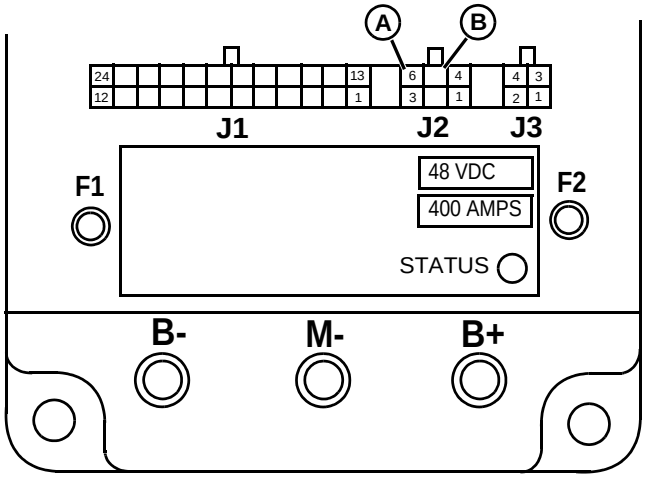
To verify the electrical integrity of the speed sensor.

Equipment:

- JT05791 Multimeter

Procedure with Speed Sensor Installed:

1. Park machine on level surface.
2. Turn key switch to OFF position.
3. Move directional lever to NEUTRAL position.
4. Disengage park brake.
5. Place the Drive/Service switch in the DRIVE position.
6. Raise the cargo box and secure the prop rod.



7. Connect the black test lead of the VOM to the battery set negative terminal.
8. Check terminal J2-6 (A) with the red lead of the VOM for a voltage of 13 to 15 volts.
9. Connect the red lead of the VOM to terminal J2-5 (B).
10. Push the vehicle slowly forward or reverse in **2.5 cm (1.0 in.)** increments and note the voltage readings on the J2-5 terminal.
11. The voltage should change from 0 volts to 5 volts then 0 volts and so on. This voltage should change at approximately each **2.5 cm (1.0 in.)** of travel.

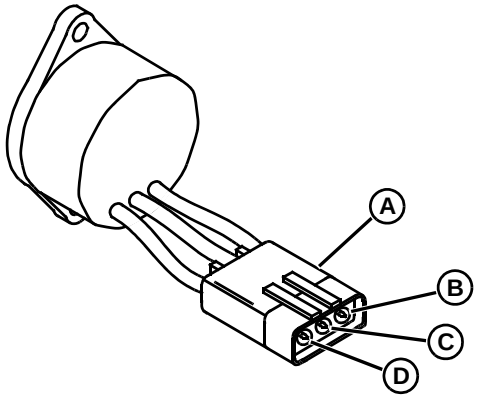
Results:

If the readings are incorrect, test the speed sensor removed from the vehicle. If the speed sensor test OK, replace the magnet.

Procedure with Speed Sensor Removed:

1. Park machine on level surface.

2. Turn key switch to OFF position.
3. Move directional lever to NEUTRAL position.
4. Engage park brake.
5. Place the Drive/Service switch in the SERVICE position.
6. Raise the cargo box and secure the prop rod.



7. Disconnect the motor speed sensor connector (A) from the speed sensor wiring harness.
8. Measure and record the resistance across each combination of terminals as listed below.

The red lead position of the VOM is listed across the top and the black lead position of the VOM is listed down the side.

	Red B	Red C	Red D
Black B		O.L.	4.9
Black C	3.8 m		14.4
Black D	4.6	O.L.	

Results:

If any readings are incorrect, replace the motor speed sensor.

CHARGER INTERLOCK SWITCH TEST

Reason:

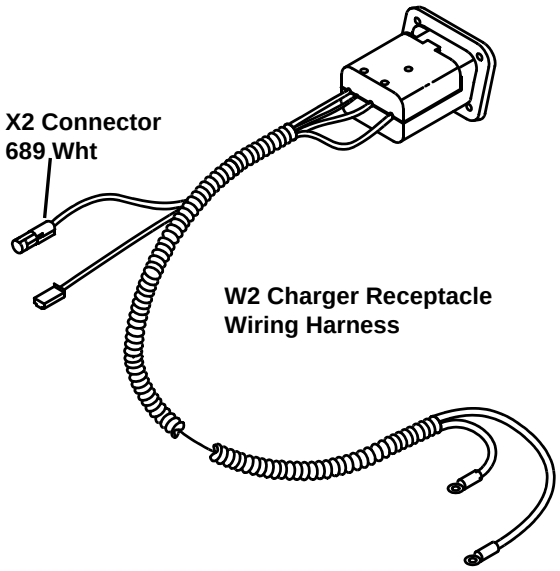
To verify the electrical integrity of the charger interlock switch.

Equipment:

- JT05791 Multimeter

Procedure:

1. Park machine on level surface.
2. Turn key switch to OFF position.
3. Move directional lever to NEUTRAL position.
4. Engage park brake.
5. Place the Drive/Service switch in the SERVICE position.
6. Remove seat base cover under seat. See MISC. SECTION “SEAT BASE COVER REMOVAL & INSTALLATION” on page 5.



7. Locate and disconnect the X2 connector from the charger receptacle under the motor controller.
8. With the battery charger unplugged from the vehicle, measure the voltage present at the X2 connector.
9. Plug the battery charger DC output plug into the charger receptacle and measure the voltage present at the X2 connector. The battery charger does not need to be plugged into the AC outlet to perform this test.

Results:

Battery Charger UNPLUGGED . . 48 volts or higher
Battery Charger PLUGGED . . . . . Less than 0.1 volt

If there is no voltage present at the X2 connector when the battery charger is unplugged, turn the headlights on. If the headlights illuminate, the 50 amp fuse and battery connections are OK. Replace the charger interlock switch. See Battery Charger Section, “BATTERY CHARGER RECEPTACLE DISASSEMBLY & ASSEMBLY” on page 30.

If voltage IS present when the battery charge is plugged in to the vehicle, check the plug to be sure it is plugged in to the engagement mark. If voltage is still present, replace the charger interlock switch. See Battery Charger Section, “BATTERY CHARGER RECEPTACLE DISASSEMBLY & ASSEMBLY” on page 30.

HOUR METER/BATTERY FUEL GAUGE TEST

Reason:

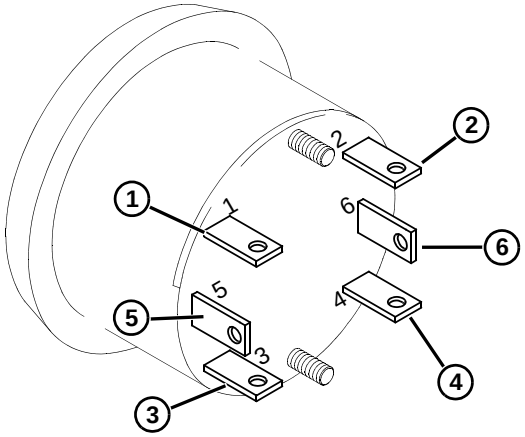
To verify terminal continuity is correct.

Equipment:

- JT05791 Multimeter

Procedure:

1. Park machine on level surface and engage parking brake.
2. Turn key switch OFF.
3. Move Forward/Reverse lever to NEUTRAL position.
4. Place the Drive/Service switch in the Service position.
5. Remove hood. See MISC. SECTION “HOOD INSTALLATION & ADJUSTMENT” on page 3.
6. Mark the four wires connected to the back of the hour meter/battery fuel gauge and remove the wires.
7. Remove the two thumb nuts and retainer bracket from the gauge and pull gauge out the front of the dash panel.



8. Set the multimeter to measure ohms, use the chart to sequentially test continuity across each terminal combination.

The red lead position of the meter is listed across the top and the black lead position of the meter is listed down the side.

Continuity:

	Red Lead on 1	Red Lead on 2	Red Lead on 3	Red Lead on 4	Red Lead on 5	Red Lead on 6
Black Lead on 1		18.45 k	131.0 k	29.8 k	36.0 k	130.4 k
Black Lead on 2	18.45 k		112.2 k	39.0 k	45.0 k	111.9 k
Black Lead on 3	131.0 k	112.2 k		151.1 k	157.5 k	224.2 k
Black Lead on 4	29.8 k	39.0 k	151.1 k		63.4 k	150.8 k
Black Lead on 5	36.0 k	45.0 k	157.5 k	63.4 k		157.2 k
Black Lead on 6	130.4 k	111.9 k	224.2 k	150.8 k	157.2 k	

Results:

- If any continuity is NOT correct, replace hour meter/ battery fuel gauge.

SHIFTER ASSEMBLY ADJUSTMENT

Reason:

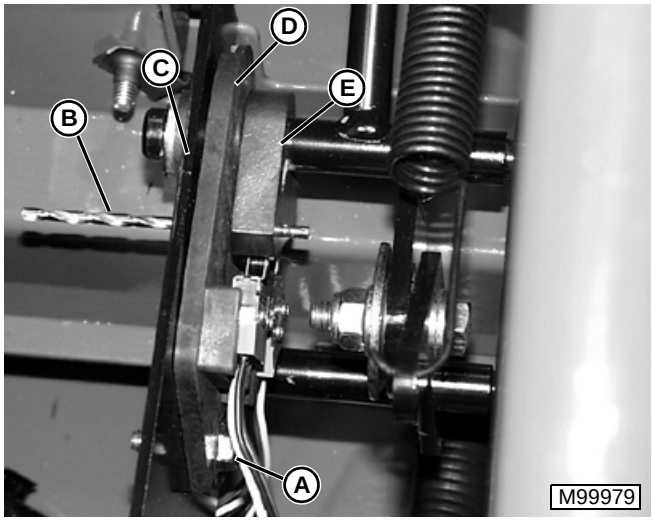
To center the shift cam between the forward and reverse switches in the neutral position and making sure that the switches are not activated.

Equipment:

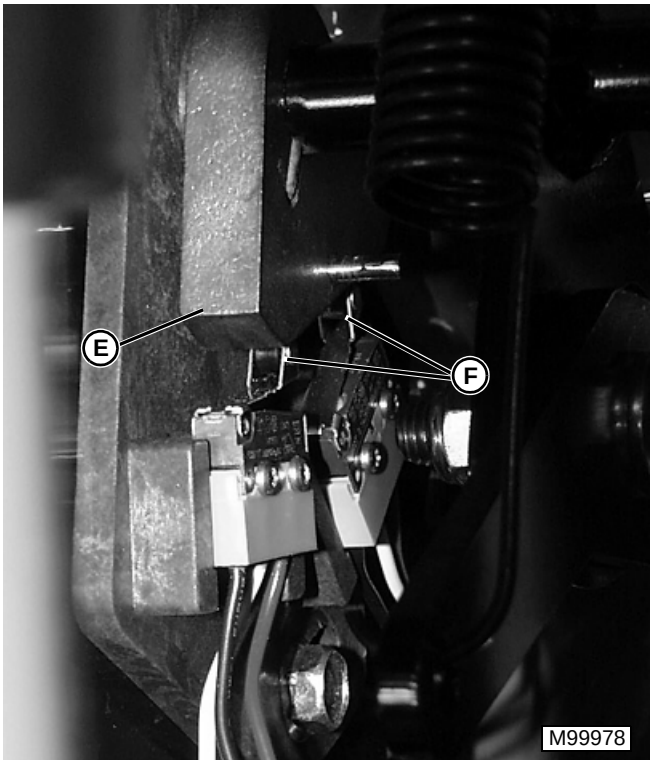
- 3.2 mm (0.125 in.) drill bit

Procedure:

1. Park machine on level surface and engage parking brake.
2. Turn key switch OFF.
3. Move Forward/Reverse lever to NEUTRAL position.
4. Place the Drive/Service switch in the Service position.
5. Remove both seats. See MISC. SECTION “SEAT REMOVAL & INSTALLATION” on page 4.
6. Remove seat base cover under seat. See MISC. SECTION “SEAT BASE COVER REMOVAL & INSTALLATION” on page 5.



7. Loosen the switch support mounting capscrew (A).
8. Insert a 3.2 mm (0.125 in.) drill bit (B) through the left side shift support (C) the shift switch support (D) and the shift cam (E).



9. Verify that the shift lever is centered in the neutral detent and that the switch rollers (F) have approximately the same visual clearance and are not touching the shift cam (E).
10. Tighten the mounting capscrew to **6 N•m (54 lb-in.)**.

Specifications:

Shift Support Mounting Capscrew . 6 N•m (54 lb-in.)

THROTTLE STOP & LINKAGE ADJUSTMENT

Reason:

To set the throttle pedal travel limit and the throttle linkage free play.

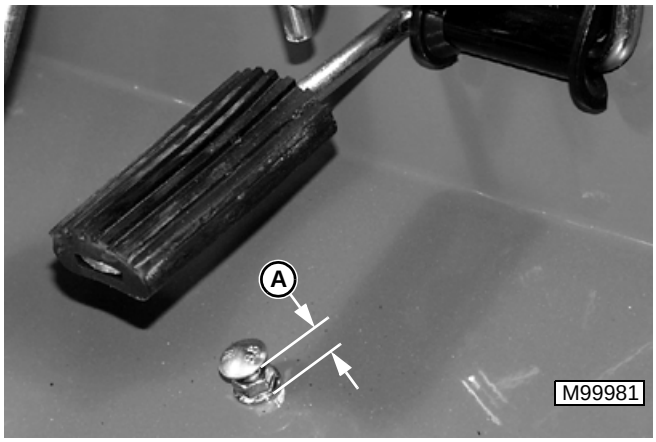
Equipment:

- M6 x 30 capscrew

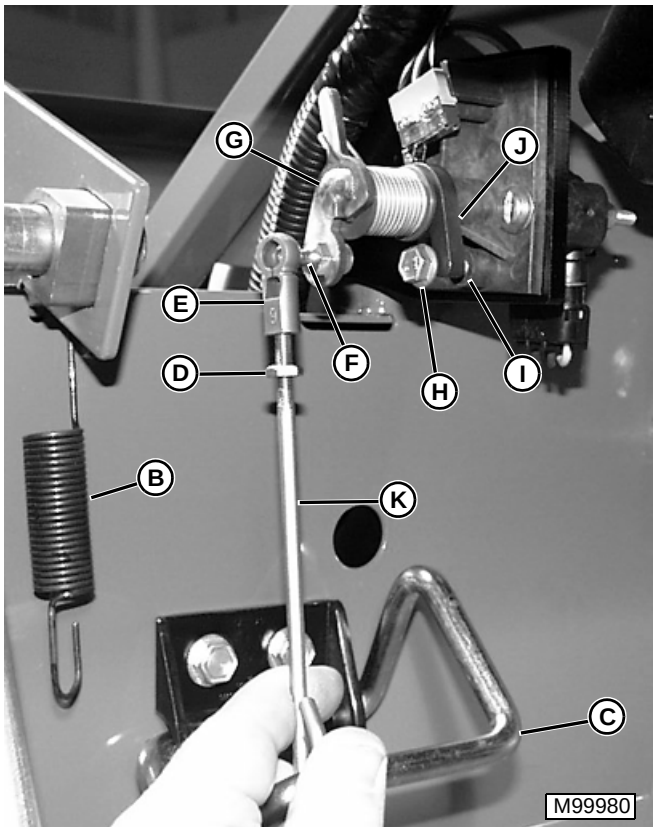
Procedure:

1. Park machine on level surface and engage parking brake.
2. Turn key switch OFF.
3. Move Forward/Reverse lever to NEUTRAL position.
4. Place the Drive/Service switch in the Service position.

5. Remove hood. See MISC. SECTION “HOOD INSTALLATION & ADJUSTMENT” on page 3.



6. Set the travel stop for the throttle pedal.
7. Measure the distance from the bottom of the bolt head to the top of the floor (A).
8. Set this dimension to **12.7 ± 1.6 mm (0.5 ± 0.062 in.)** and tighten the bottom nut to **6 N•m (54 lb-in.)**.



9. Unhook the throttle pedal return spring (B) from the throttle pedal (C).
10. Loosen the jam nut (D).
11. Snap the throttle link rod end (E) off of the pivot ball (F).
12. Rotate the throttle shaft (G) so that a M6 x 30 capscrew (H) can be inserted into the adjustment stop hole (I).
13. Release the throttle shaft so that the throttle cam (J) rest against the threads of the M6 capscrew.

NOTE: DO NOT let the throttle cam rest against the head of the capscrew or the linkage will be misadjusted.

14. Press the throttle pedal (C) down while lifting the throttle link (K) up to align the rod end (E) with the pivot ball (F).
15. Adjust the rod end (E) up or down until the rod end is centered over the pivot ball (F). This should remove all free play between throttle pedal, throttle link and throttle shaft.
16. Snap the rod end (E) over the pivot ball (F).
17. Keeping the throttle pedal pressed down to the throttle stop, check the throttle link to be sure there is no free play.
18. Keeping the rod end (E) in line with the throttle link (K), tighten the jam nut (D) to the rod end until it is snug.

IMPORTANT: DO NOT place vehicle in service until the throttle has been returned to the OFF position by removing the M6 capscrew and attaching the throttle pedal return spring.

19. Remove the M6 x 30 capscrew (H) and allow the throttle shaft (G) to return to the OFF position.
20. Connect the throttle pedal return spring (B) to the throttle pedal (C).

Specifications:

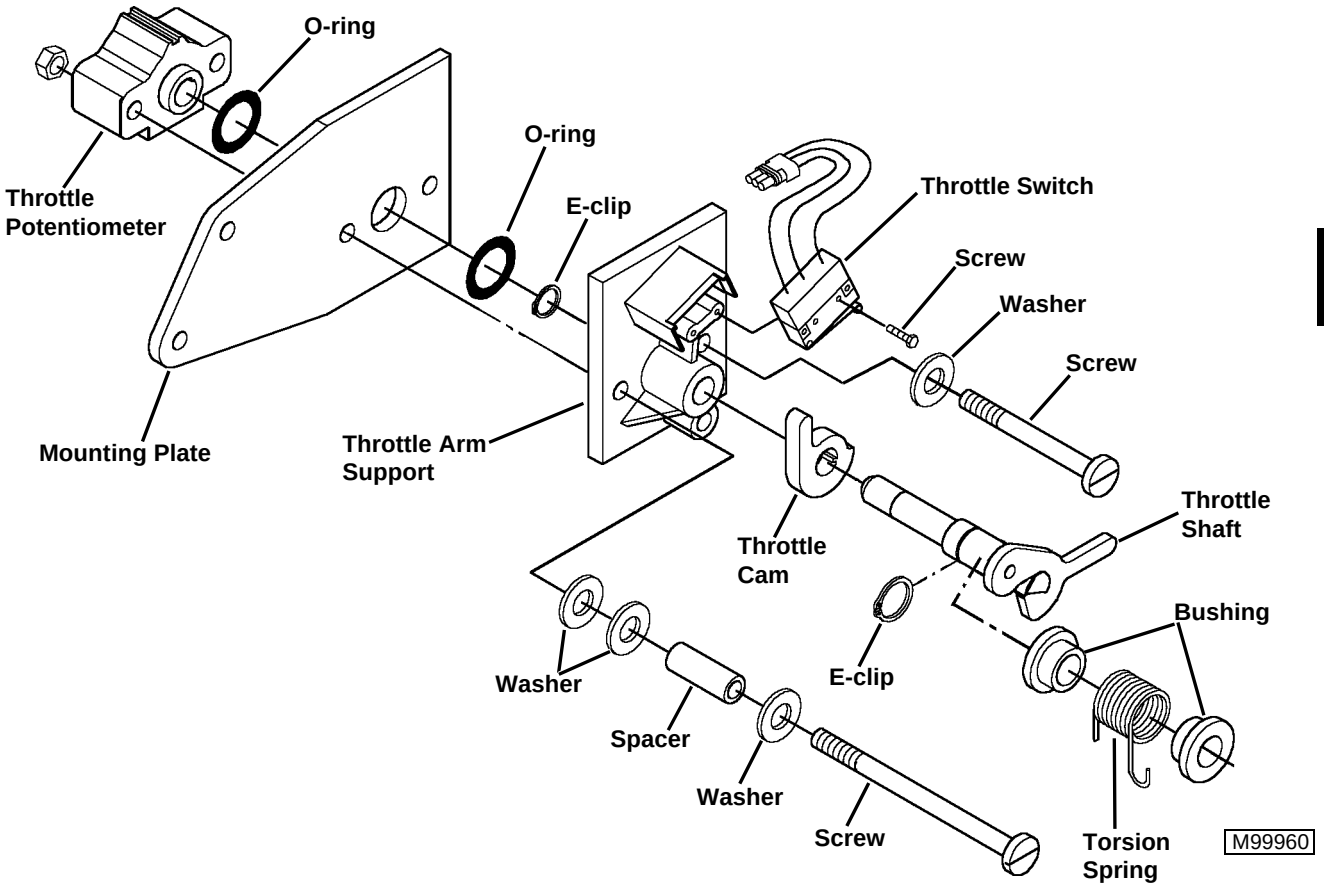
Jam Nut . . . . . Snug Only
Throttle Pedal Nuts . . . . . 6 N•m (54 lb-in.)

REPAIR

THROTTLE COMPONENTS DISASSEMBLY & ASSEMBLY

Disassembly:

1. Park machine on level surface and engage parking brake.
2. Turn key switch OFF.
3. Move Forward/Reverse lever to NEUTRAL position.
4. Place the Drive/Service switch in the Service position.
5. Remove hood. See MISC. SECTION “HOOD INSTALLATION & ADJUSTMENT” on page 3.



6. Disconnect the connector plugged into the throttle switch and the throttle potentiometer.
7. Remove the two capscrews securing the throttle assembly to the frame.
8. Lower the throttle assembly towards the floor and carefully snap the pivot ball out of the rod end.
9. Unhook the torsion spring from the throttle shaft to relieve the spring pressure.
10. Remove the two screws securing the throttle potentiometer to the throttle assembly and slide the throttle potentiometer and mounting plate off of and away from the throttle arm support and throttle shaft.
11. Remove the e-clip from the throttle shaft and slide the throttle shaft out of the throttle arm support.
12. Slide the throttle cam off of the throttle shaft, remove the inner e-clip and slide the bushings and torsion spring off of the throttle shaft.

Assembly is done in reverse order of disassembly.

IMPORTANT: Use care when assembling throttle cam and throttle shaft to throttle arm support to avoid damage to the throttle switch.

Specifications:

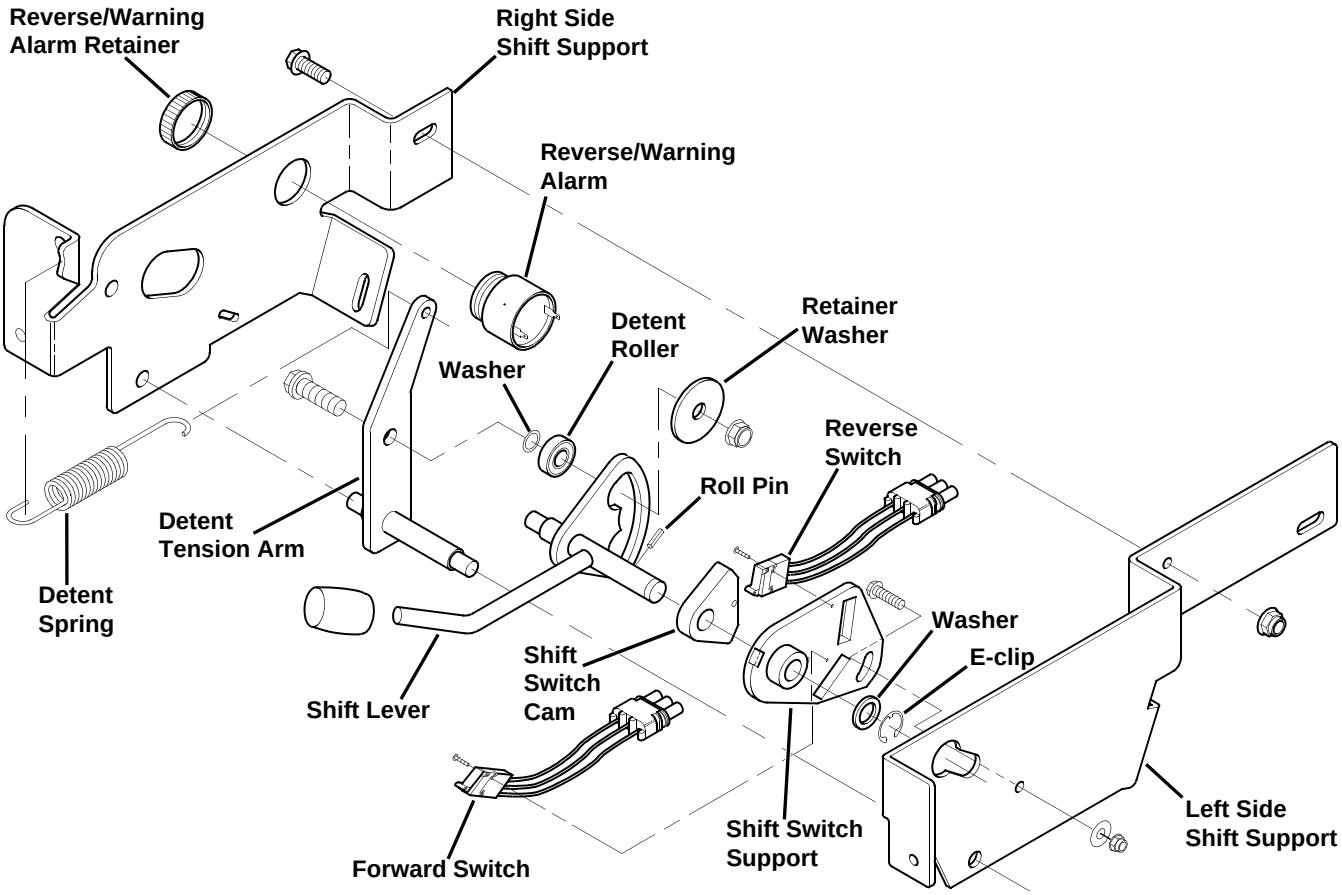
Throttle Potentiometer Screws . . . . 4 N•m (34 lb-in.)
Mounting Plate to Frame . . . . . 6 N•m (54 lb-in.)

1. Adjust the throttle stop and throttle linkage. See “THROTTLE STOP & LINKAGE ADJUSTMENT” on page 79.

SHIFTER COMPONENTS DISASSEMBLY & ASSEMBLY

Disassembly:

1. Park machine on level surface and engage parking brake.
2. Turn key switch OFF.
3. Move Forward/Reverse lever to NEUTRAL position.
4. Place the Drive/Service switch in the Service position.
5. Remove both seats. See MISC. SECTION “SEAT REMOVAL & INSTALLATION” on page 4.
6. Remove seat base cover under seat. See MISC. SECTION “SEAT BASE COVER REMOVAL & INSTALLATION” on page 5.



7. Disconnect the connector plugged into the forward and reverse switch and the two wires to the reverse/warning alarm.
8. Remove the three capscrews securing the shifter assembly to the frame and lift the assembly out of the vehicle.
9. Unscrew the reverse/warning alarm retainer and pull the reverse/warning alarm out of the right side shift support.
10. Unhook the detent spring.
11. Remove the two capscrews holding the left and right shift supports together.
12. Lift the right side shift support off of the shift assembly.
13. Remove the e-clip from the end of the shift lever and remove the shift lever and detent tension arm as an assembly.
14. Remove the capscrew and nut mounting the detent roller to the detent tension arm and separate the detent tension arm from the shift lever.
15. Remove the screws holding the forward and reverse switches to the shift switch support and remove the switches.

Assembly is done in reverse order of disassembly.

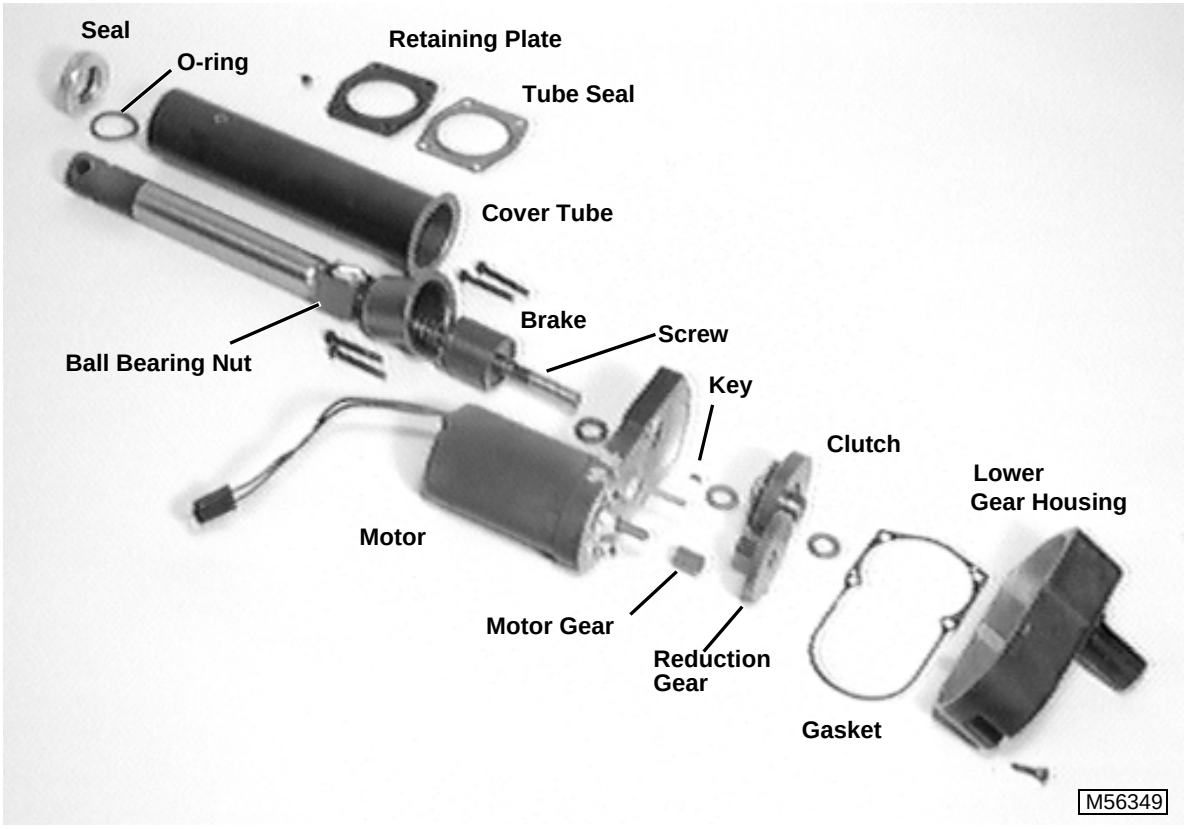
IMPORTANT: Use care when assembling shift cam to shift switch support to avoid damage to the shift switches.

Specifications:

Detent Nut and Capscrew . . . . . 4 N•m (34 lb-in.)
Mounting Capscrews . . . . . 6 N•m (54 lb-in.)

1. Adjust the shift lever position. See “SHIFTER ASSEMBLY ADJUSTMENT” on page 79.

ACTUATOR COMPONENTS

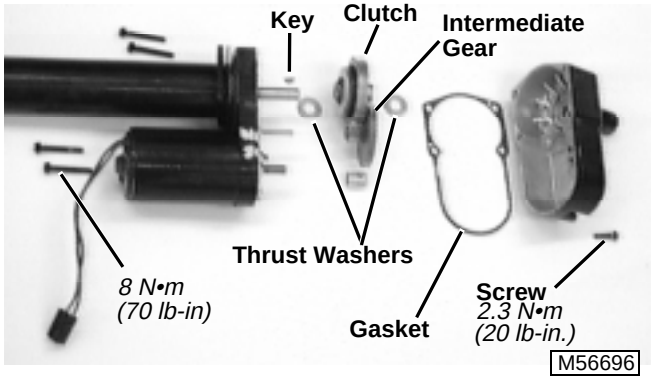


ACTUATOR REPAIR KITS

- Clutch Kit
- Seal Kit
- Motor

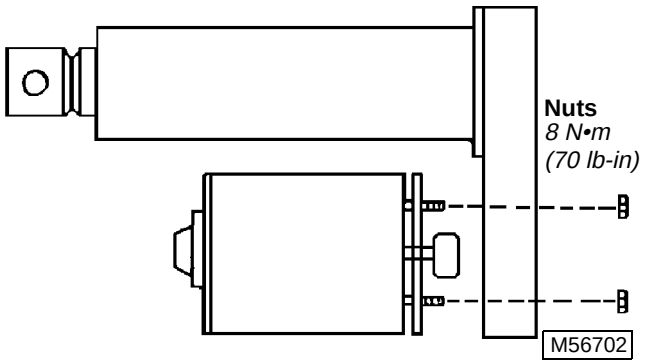
REPLACE ACTUATOR CLUTCH

1. Remove gear case housing, intermediate gear, clutch and thrust washers.
2. Install new clutch.
3. Install new gear case housing gasket.
4. Tighten capscrews evenly to **8 N•m (70 lb-in.)**.
5. Tighten screws evenly to **2.3 N•m (20 lb-in.)**.



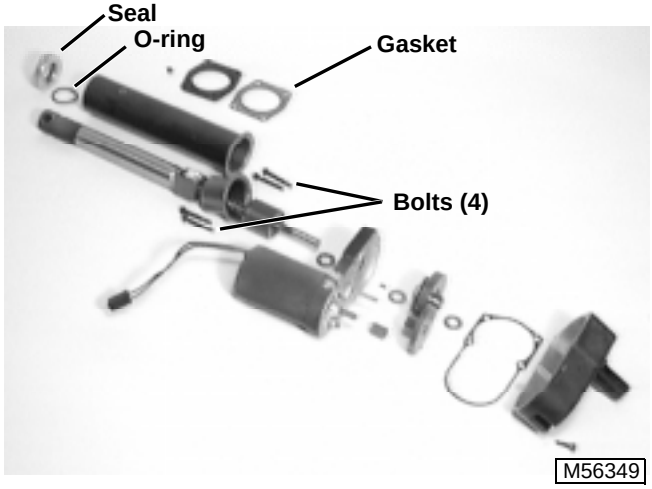
REPLACE MOTOR

IMPORTANT: When replacing motor, note direction that motor gear is installed. Intermediate gear teeth should ride close to the center of motor gear.



1. Remove gear case housing.
2. Remove nuts from motor.
3. Replace motor and seal.
4. Tighten nuts evenly to **8 N•m (70 lb-in.)**.

COVER TUBE SEAL

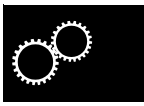


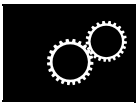
If tube is removed or leaking, replace the upper o-ring and lip seal. Drive seal and o-ring from end of tube using a disk and driver.

1. Install new seal and o-ring flush with end of tube.
2. Install new tube retaining gasket.
3. Install thrust tabbed thrust washer and thicker thrust washer.
4. Tighten hardware evenly.

CONTENTS

Page





SPECIFICATIONS

GENERAL SPECIFICATIONS

TRANSAXLE

Nominal Travel Speed-Forward . . . . . 25 km/h (15.5 mph)
Nominal Travel Speed-Reverse . . . . . 14.5 km/h (9 mph)
Transaxle Capacity . . . . . 0.4 L (15 oz)

TORQUE SPECIFICATIONS

Brake Bolts . . . . . 23 N•m (17 lb-ft)
Cover Plate Screws . . . . . 28 N•m (20 lb-ft)
Differential Bearing Cap . . . . . 55 N•m (40 lb-ft)
Fill Plug . . . . . 47 N•m (35 lb-ft)
Final Drive Gear Bolts . . . . . 55 N•m (40 lb-ft)
Spindle Nut . . . . . 140 N•m (105 lb-ft)
Transaxle Mounting Carriage Bolts . . . . . 90 N•m (70 lb-ft)

OTHER MATERIALS

HYDRAULIC OIL JDM J20C Hy-GARD

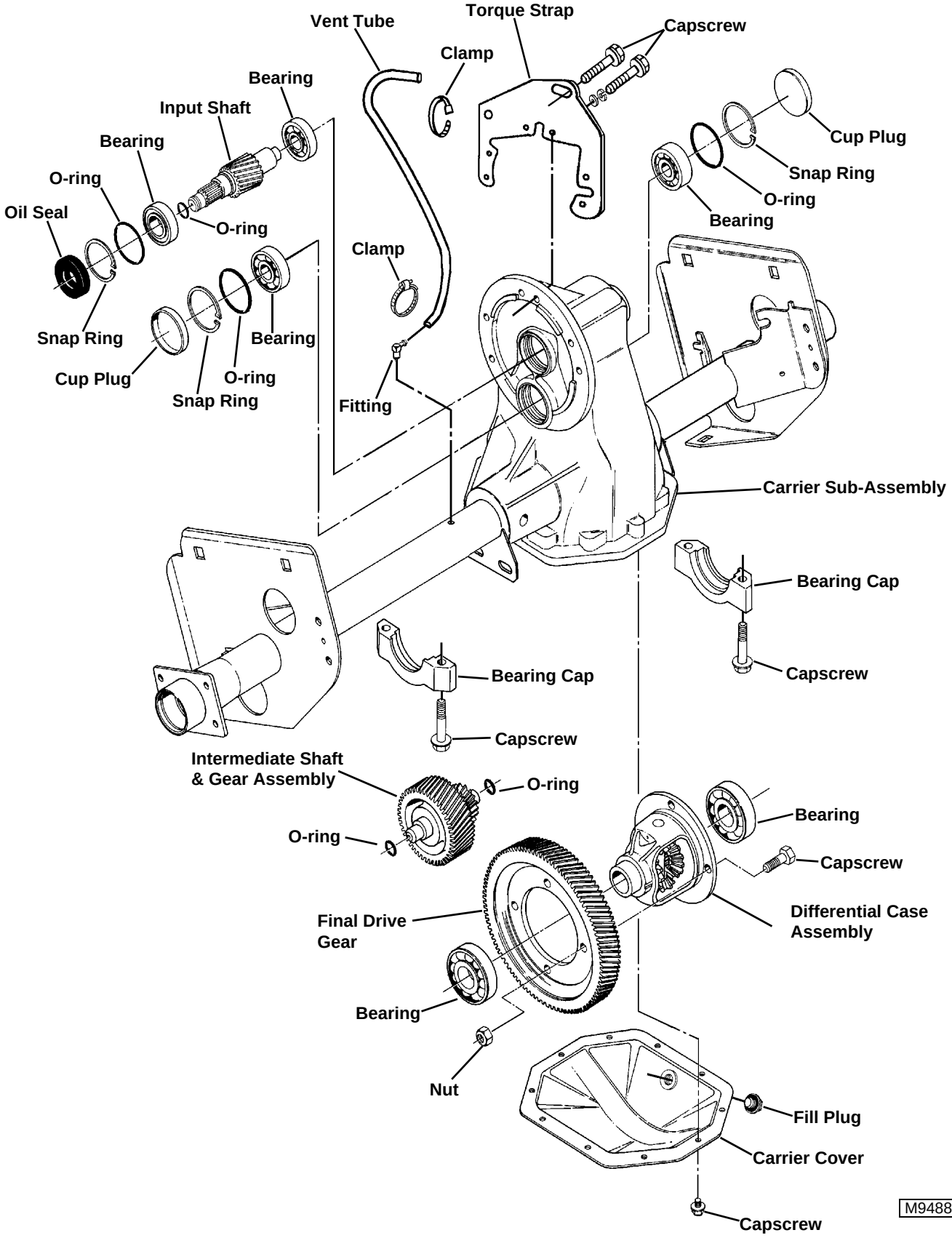
LOCTITE® PRODUCTS

U.S./ Canadian/ LOCTITE No. Number	Name	Use
TY6333/ TY6333/	Moly High Temperature EP Grease	Apply to splines of axle.
TY6305/ TY9485/ 764	Clean and Cure Primer	Clean transaxle case mating surfaces.
TY16135/ TY15705/ 518	Flexible Sealant	Seal transaxle case.

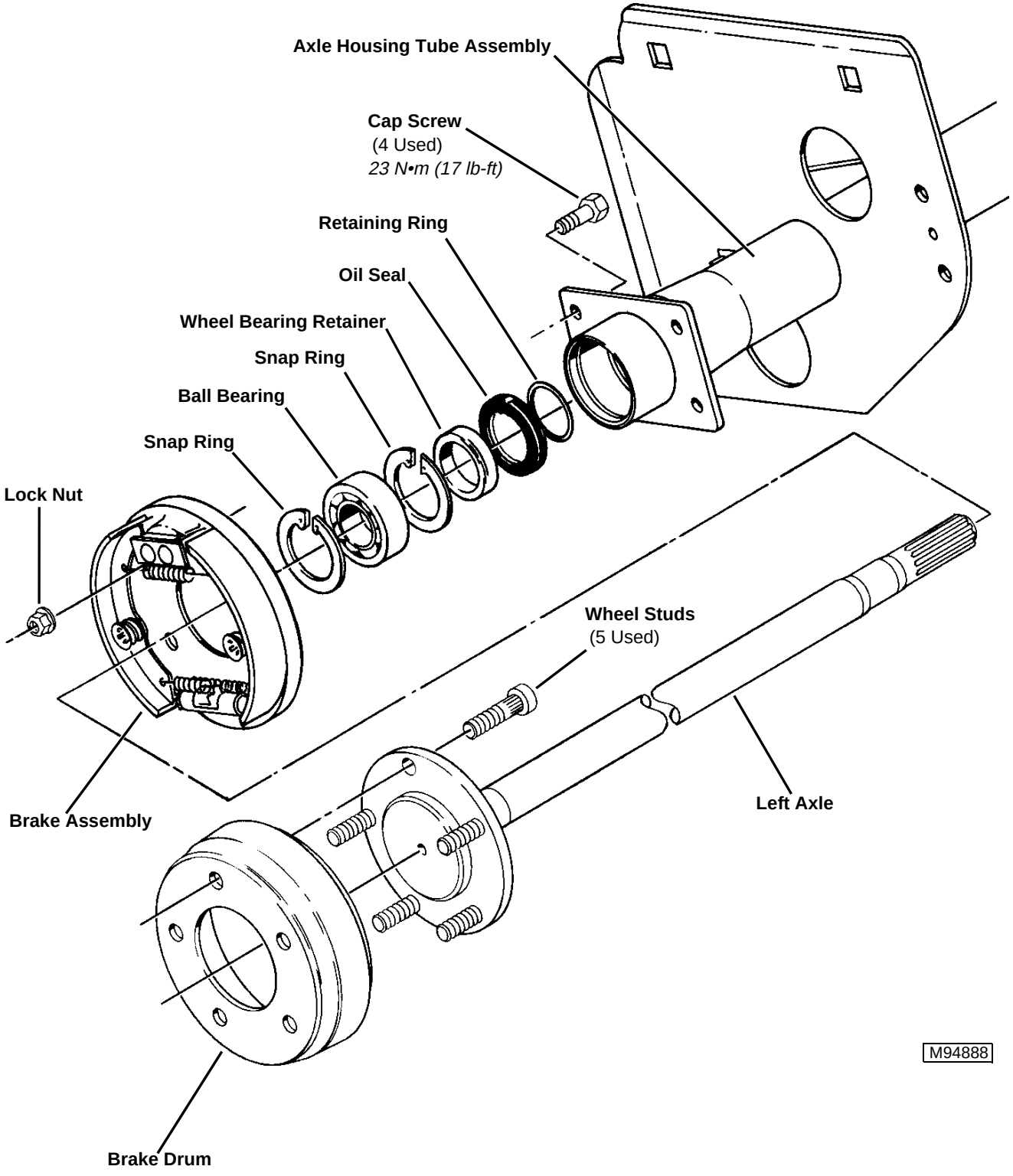
LOCTITE® is a registered trademark of the Loctite Corp.

COMPONENT LOCATION

TRANSAXLE COMPONENTS



AXLE COMPONENTS

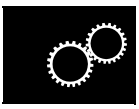


THEORY OF OPERATION

Function:

The transaxle provides a means of transferring power from the electric motor to the input shaft to the gear drive components of the transaxle and ultimately the drive wheels.

Speed and directional control is provided by the electric motor.

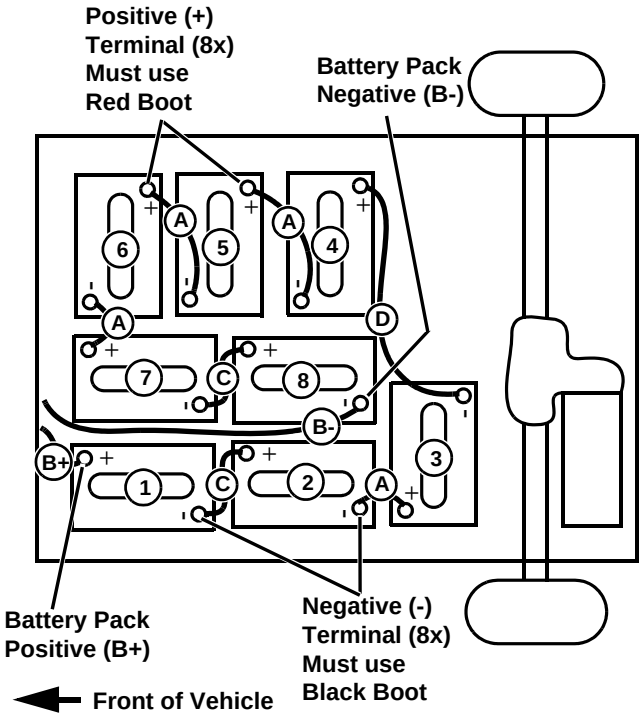


REPAIR

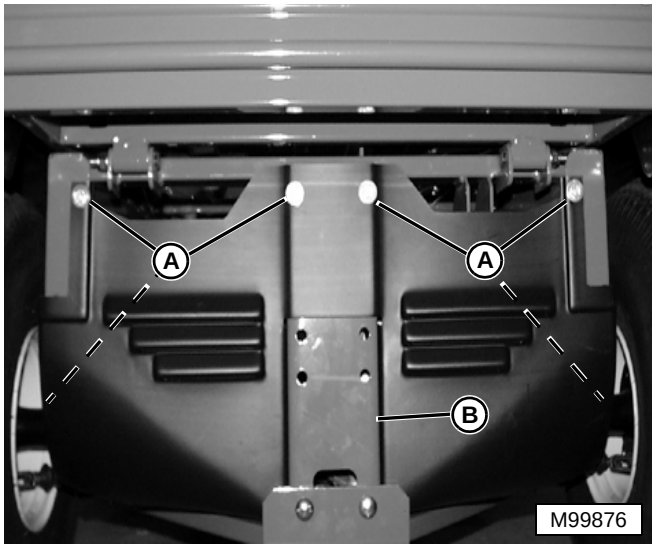
TRANSAXLE REMOVAL & INSTALLATION

Removal:

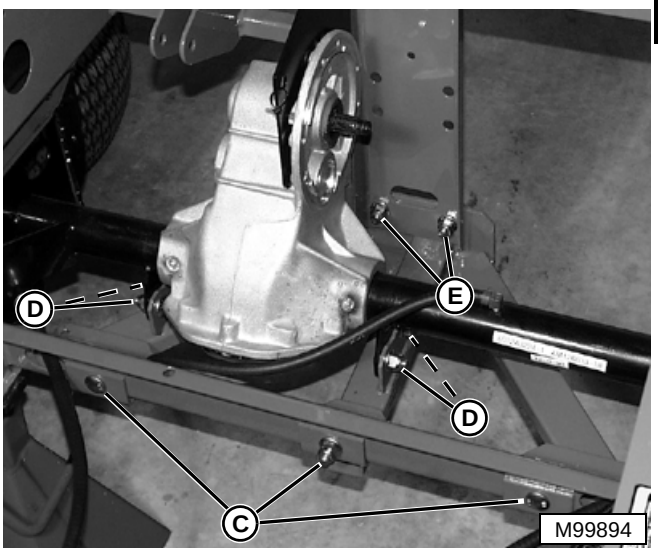
1. Park vehicle on a hard level surface.
2. Turn key switch to the OFF position.
3. Move the directional control lever to the NEUTRAL position.
4. Block the front wheels to prevent the vehicle from rolling when the rear axle is raised off of the ground.
5. Raise and tilt operators seat up and forward to gain access to the service/drive switch.
6. Place the service/drive switch in the service position.
7. Raise the cargo bed and secure the prop rod.



8. Note the position of each battery and the location of both the positive and negative terminals.
9. Using insulated tools and care not to touch wrench to other terminals or the frame of the vehicle, disconnect the battery pack positive wires.
10. Remove the batteries. See BATTERIES SECTION “BATTERY REPLACEMENT” on page 17. Steps 1 through 11.
11. Remove the cargo bed. See MISC. SECTION “CARGO BOX REMOVAL & INSTALLATION” on page 8.

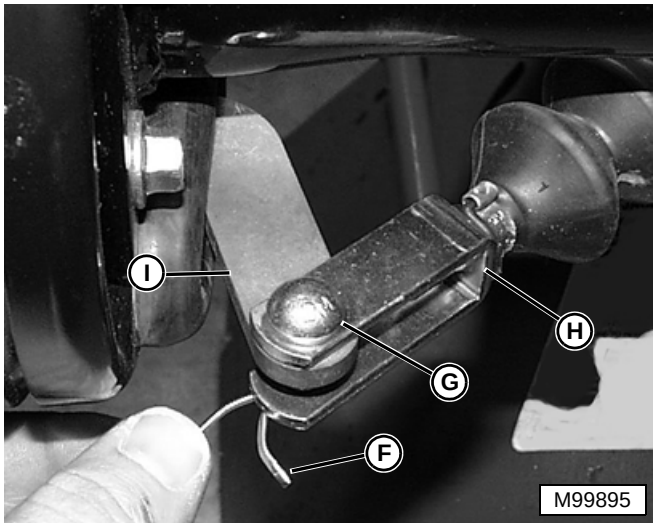


12. Remove the six capscrews (A) securing the cover to the frame.
13. Tip the top of the cover down to unhook the cover from the center bracket (B) and pull the cover out and away from the vehicle.
14. Remove the electric motor. See ELECTRIC MOTOR SECTION “MOTOR REMOVAL & INSTALLATION” on page 9.

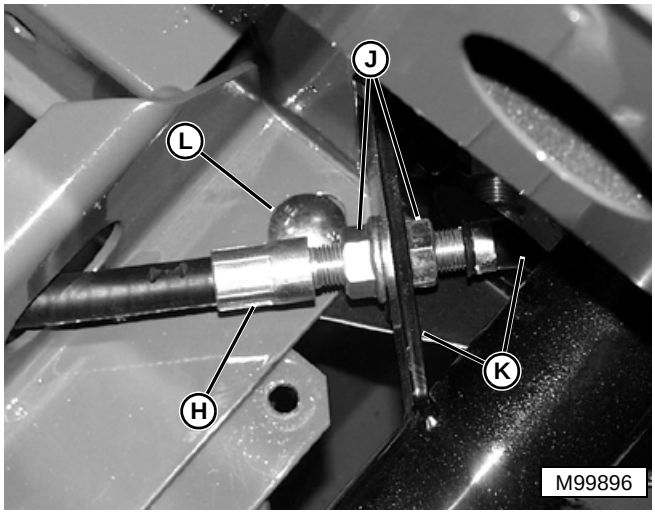


15. Remove the nine carriage bolts securing the hitch to the vehicle. There are three (C) bolts through the frame cross member, four (D) bolts fastening the hitch to the axle, and two (E) fastening the hitch to the rear support bracket.
16. Pull the hitch assembly down and out the rear of the vehicle.
17. Raise and support machine so that the rear wheels are just off the ground. Place the support under the frame rails just in front of the rear axle mounting plates.

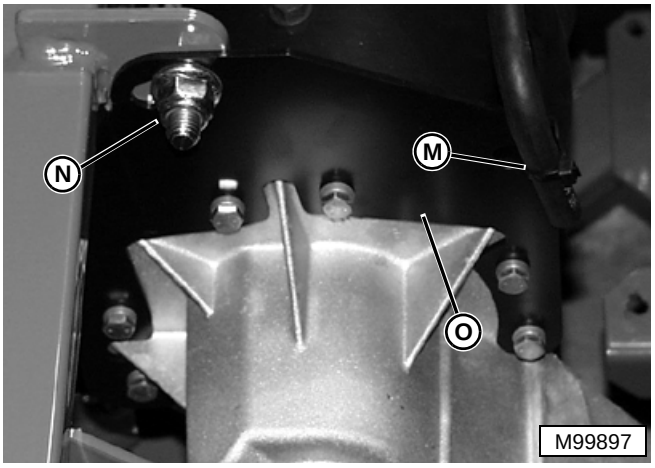
18. Remove five lug nuts on each wheel and remove the wheels.



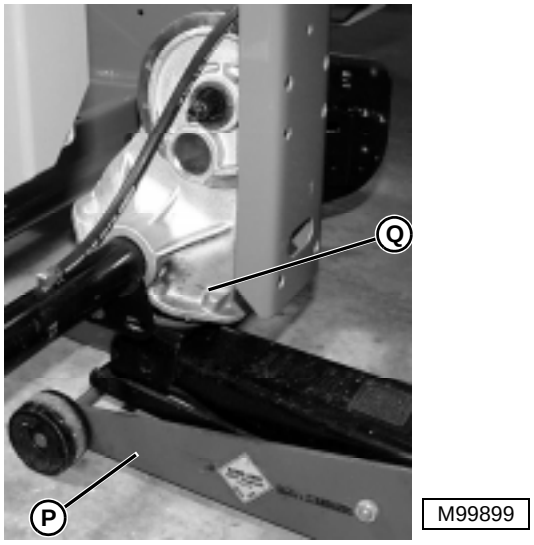
19. On each brake drum assembly, remove the cotter pin (F) and clevis pin (G) the fasten the brake cable (H) to the brake actuator arm (I).



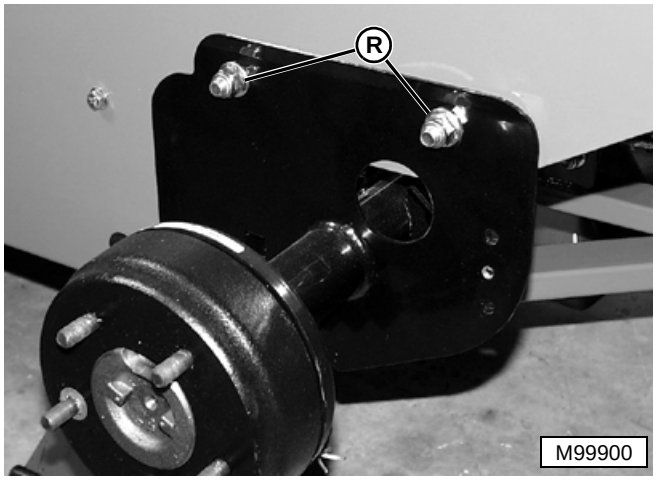
20. Loosen the brake cable retainer nuts (J) and pull the brake cable (H) out of the axle mounting bracket (K).
21. Remove the lower mounting carriage bolt (L) on each side.



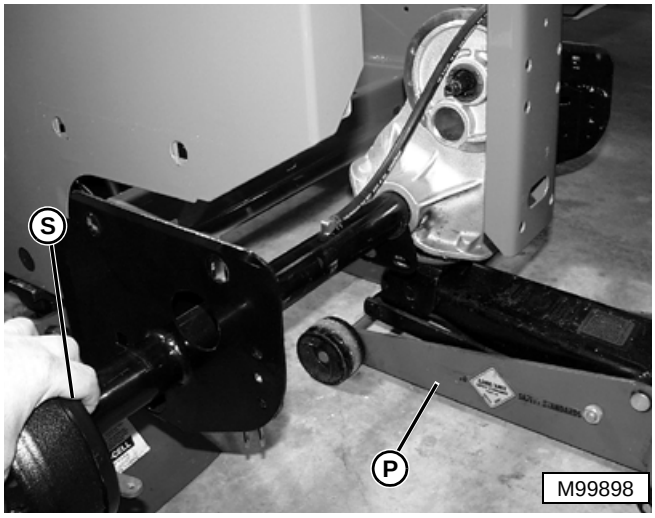
22. Remove the vent tube from the torque plate by cutting the tie wrap (M).
23. Remove the carriage bolt (N) securing the torque plate (O) to the frame.



24. Place a floor jack (P) under the differential case (Q) to support the transaxle when the last carriage bolts are removed.



25. Remove the remaining four (two on each side) carriage bolts (R) that secure the transaxle to the frame rails.



26. Support the axle out at the brake drums (S) and slowly lower the floor jack (P) until the transaxle can be pulled out from under the frame.

Installation is done in reverse order.

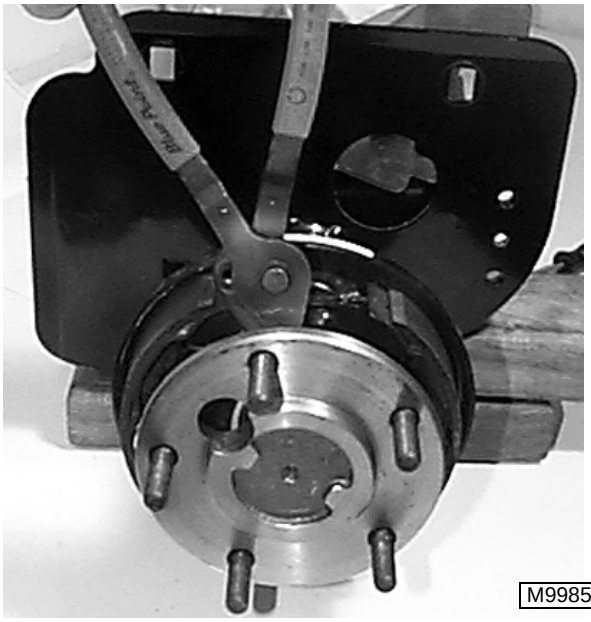
Specification:

Carriage Bolts . . . . . 90 N•m (70 lb-ft)

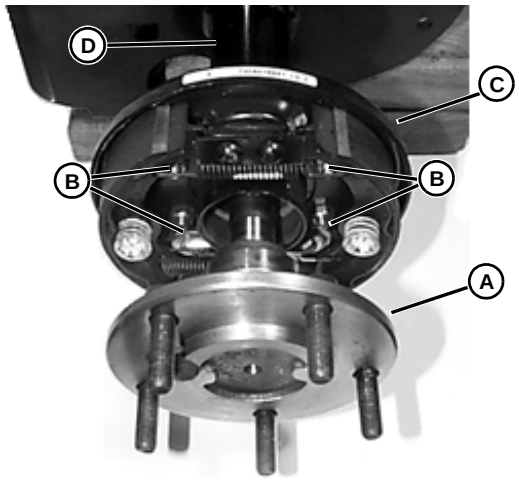
AXLE SHAFT REMOVAL & INSTALLATION

Removal:

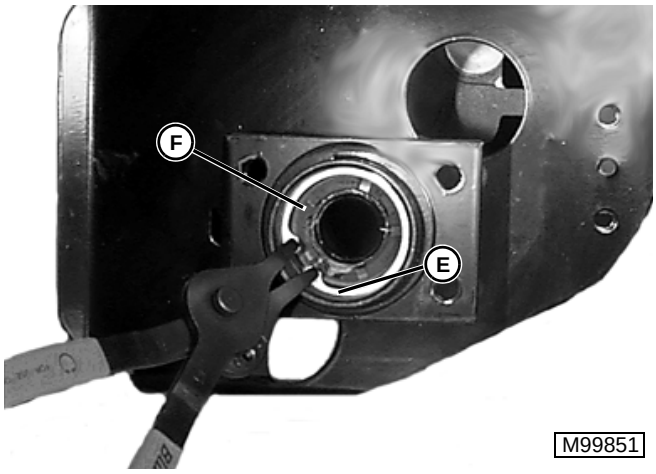
1. Remove fill plug on bottom of differential cover and drain oil. Capacity is 0.4 L (15 oz).



2. Remove snap ring from end of tube.

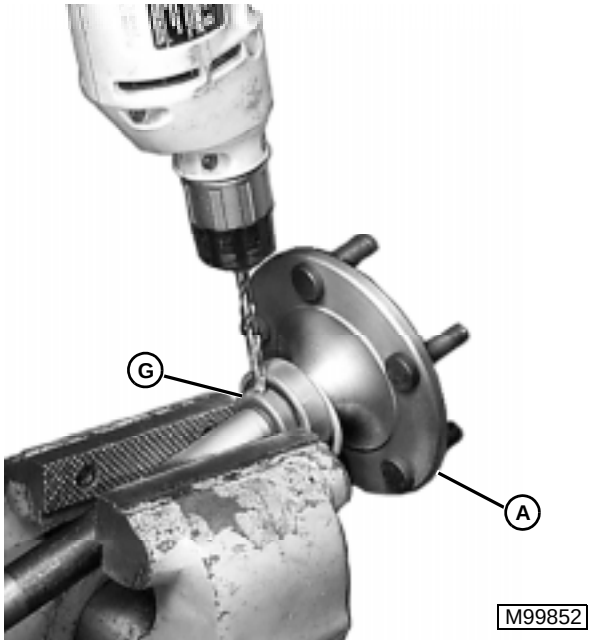


3. Using a slide hammer if needed, remove the axle shaft (A) from the axle tube.
4. Remove four bolts (B) holding brake assembly (C) on axle tube (D).
5. Remove brake assembly (C) from the axle tube (D).



6. Remove the inner snap ring (E).
7. Use a slide hammer to remove the oil seal (F).

IMPORTANT: Use caution as not to damage the seal seating surface.



8. Place the axle shaft (A) in a vise and center punch the outside of the retaining ring (G) on the axle shaft.
9. Drill the retaining ring (G) with a 1/4” drill, approximately 3/4 of the depth of the retaining ring.

IMPORTANT: Drilling completely through the retaining ring will damage the shaft.

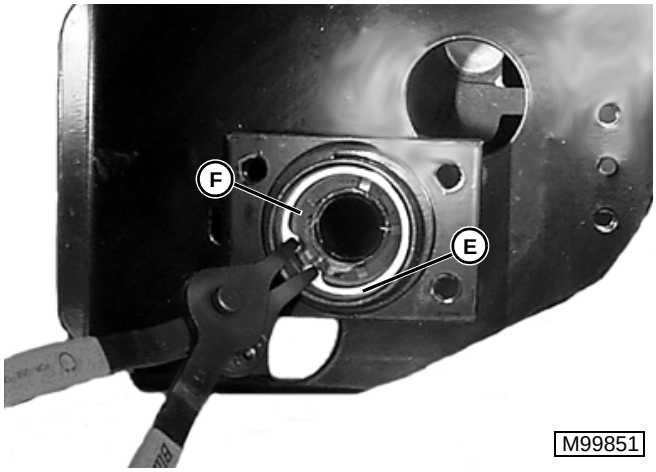
10. Position a chisel across the hole and strike sharply to break the retaining ring (G).
11. Support the axle shaft in a suitable press. Press on the end of the shaft until the wheel bearing (H) is removed. Use caution as not to damage the shaft splines.
12. Inspect the axle shafts for worn splines, bends, or cracks.
13. Replace these parts if they show signs of damage or wear.

Installation:

1. Place the snap ring over the shaft and the press the bearing onto the shaft.

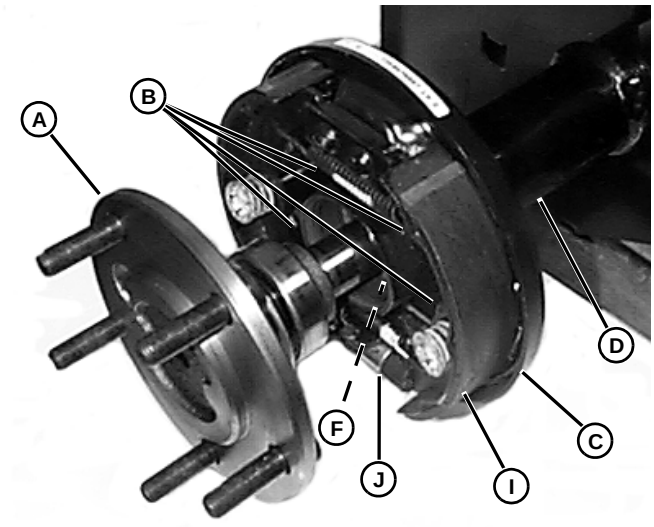
IMPORTANT: Use caution as not to damage the shaft splines.

2. Support the axle shaft in a suitable press. Support the bearing (H) on the inner ring to avoid damage to the bearing. Press shaft into bearing until the bearing is firmly seated against the shoulder. Use caution as not to damage the shaft splines.
3. Press a new retaining ring (G) firmly against the bearing.



M99851

4. Press a new oil seal (F) into the axle shaft tube to a depth of **28.5 mm (1.125 in.)**.
5. Install inner snap ring (E).
6. Grease the lip of the seal (F) with a light coating of Moly EP grease.
7. Check the axle shaft including the splines for any nicks or burrs. Using emory cloth, lightly sand any minor defects smooth.
8. Position brake assembly (C) on axle tube (D) with the brake shoes (I) facing out and the brake adjuster (J) to the bottom. Secure to the axle tube with four capscrews (B) and tighten to **23 N•m (17 lb-ft)**.



M99854

9. Install the axle shaft (A) into the axle tube (D), being careful not to damage the oil seal (F) when sliding the shaft into the carrier.
10. Install the snap ring into the groove in the tube to secure the axle shaft into the axle tube.
11. Refill the differential gear case with **0.4 L (15 oz)** of JDM J20C Hy-Gard oil.

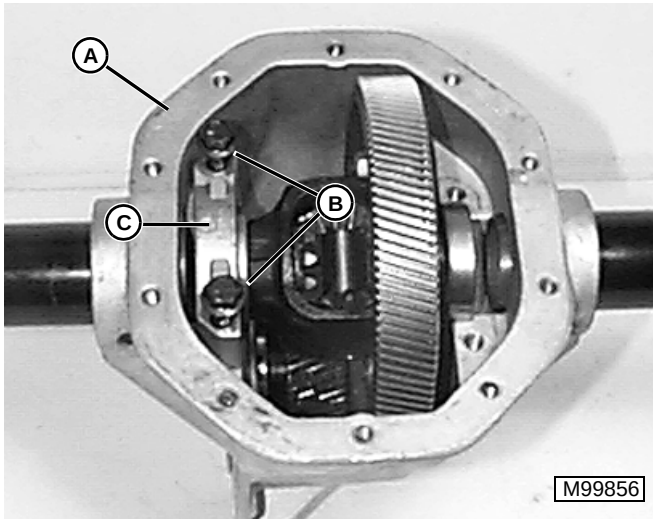
Specification:

Brake Assembly Capscrews . . . . . 23 N•m (17 lb-ft)
Transaxle Oil Capacity . . . . . 0.4 L (15 oz)

DIFFERENTIAL CASE DISASSEMBLY & ASSEMBLY

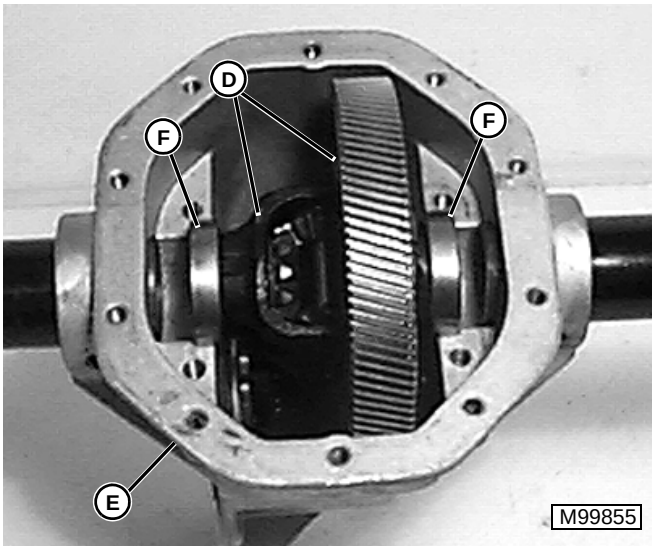
Disassembly:

1. Remove fill plug on bottom of differential cover and drain oil. Capacity is 0.4 L (15 oz).
2. Remove both the left and right axle shafts.
3. Remove the ten capscrews holding the cover plate to the gear case.
4. Using a putty knife, separate the cover from the housing. Use caution as not to damage the housing sealing surface (A) or deform the cover plate.

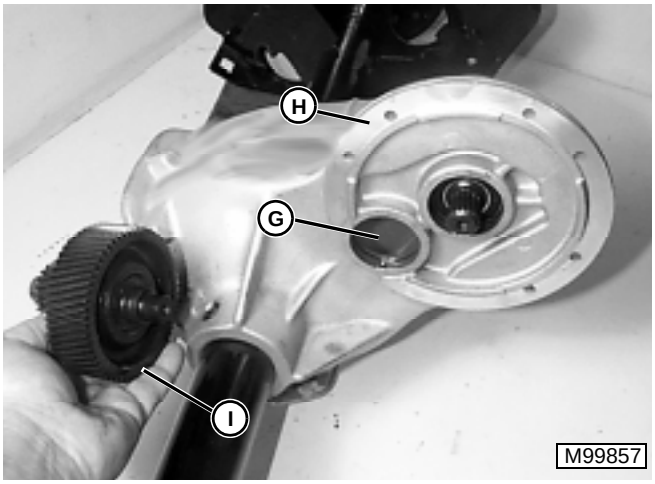


5. Remove the four bearing cap capscrews (B) and remove the bearing caps (C).

NOTE: Bearing caps are marked for identification. Letters or numbers are stamped in horizontal and vertical position. During reassembly, place them back in their original positions.



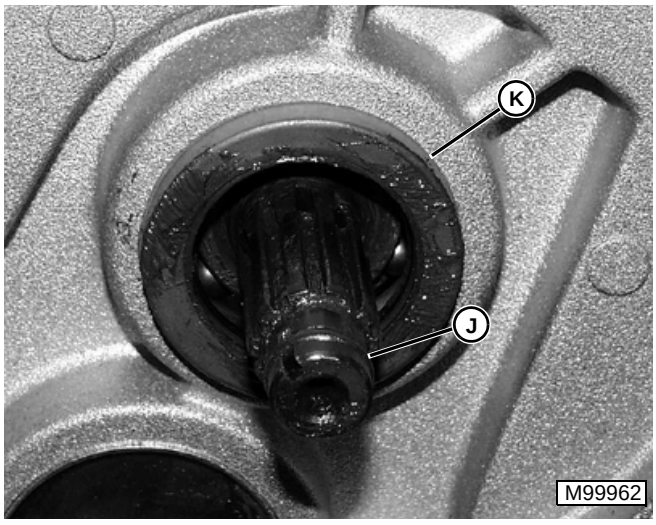
6. Lift the differential gear assembly (D) out of the gear case (E).
7. Using a bearing puller, remove the differential bearings (F) from each side of the differential gear assembly.
8. Remove the four capscrews and nuts from the final drive gear. Remove gear from differential gear assembly, using caution not to damage gear teeth.



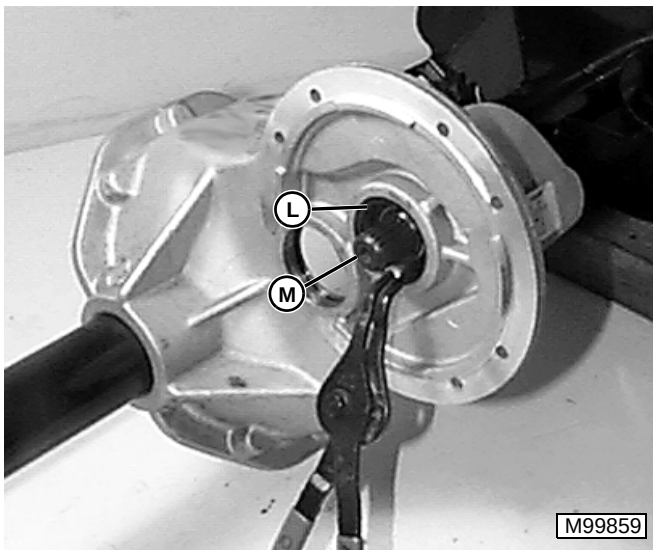
9. Punch or drill approximately a 1/8” diameter hole near the center of each intermediate bore plug (G).
10. Insert a suitably sized sheet metal screw into the plug to force the plug out of the bore.
11. Remove the snap ring from each side of the intermediate bore.
12. From the flange side (H) of the differential housing, push the intermediate shaft (I) over far enough to engage an ID bearing puller into bearing. Use a brass drift pin if needed.
13. Using a ID bearing puller attached to a slide hammer, remove intermediate bearing from flange side of housing.

14. Remove the bearing on the opposite side of the housing as in the previous step.

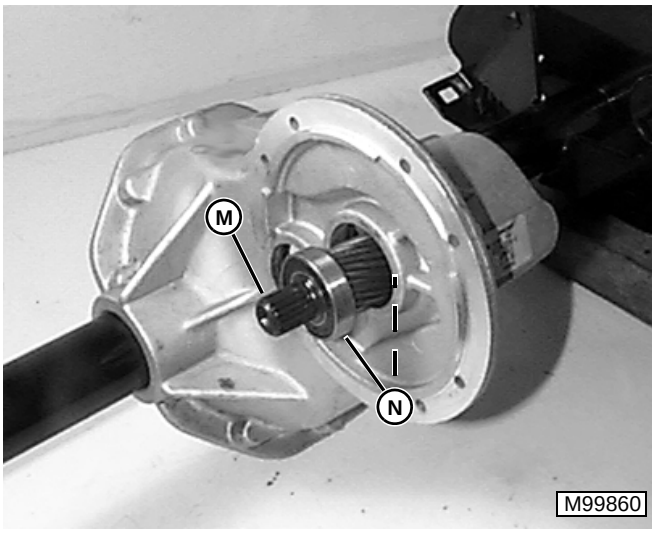
IMPORTANT: Shaft and gear assembly must be supported by hand as not to damage gear teeth. Small end of intermediate shaft and gear assembly must be tilted toward opening in bottom of housing for removal. Use caution not to damage gear teeth.



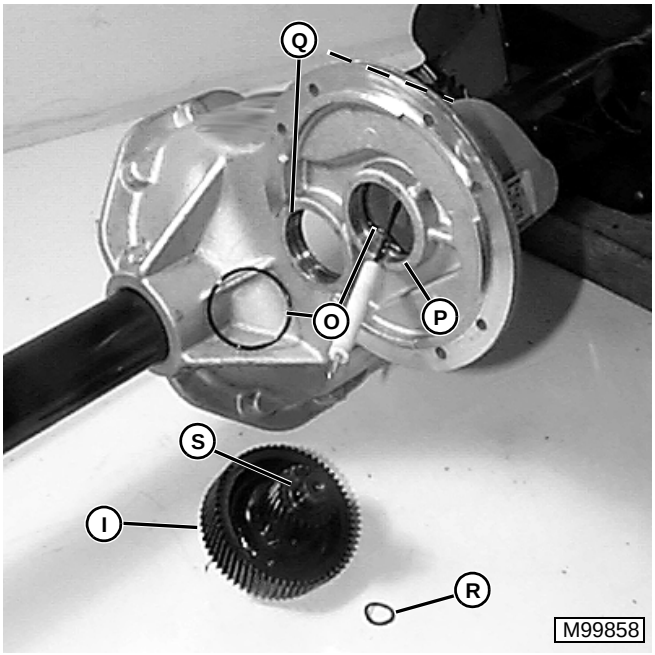
15. Remove the O-ring (J) from the end of the input shaft.
16. Remove the oil seal (K) from the bore of the input shaft and replace with a new seal during reassembly.



17. Remove snap ring (L) from input shaft (M) bore.



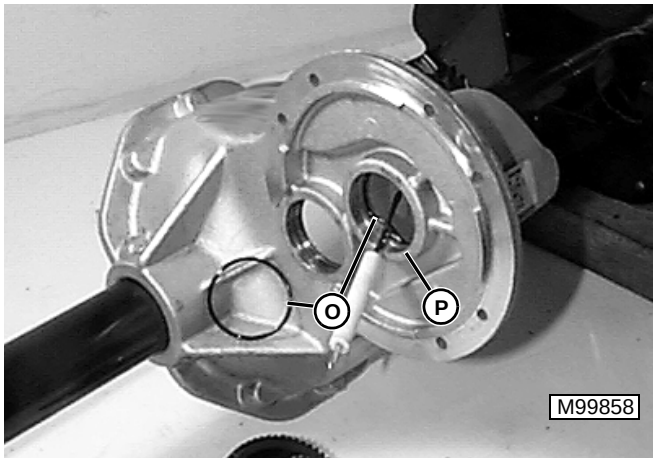
18. Pull input shaft (M) assembly from housing. The input shaft assembly should slide out of the housing easily. If resistance is encountered, a slide hammer may be required. Use caution as not to damage gear.
19. Using a bearing puller, remove the bearings (N) from the input shaft (M). Use caution as not to damage gear.



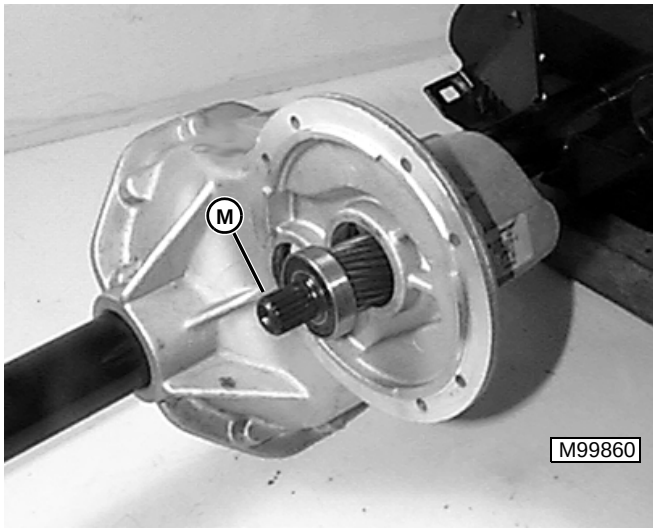
20. Remove the O-rings (O) from the outer input bearing bore (P) , and both intermediate bearing bores (Q).
21. Remove the O-rings (R) at each end of intermediate shaft (I) on the bearing shoulders (S).

22. Clean all parts with a petroleum based cleaner.
23. Dry parts using a soft, lintless towel or rag after cleaning. Bearings should NOT be dried by spinning with compressed air. This can damage mating surfaces due to lack of lubrication.
24. After drying, parts should be coated with a light coat of lubricant or rust preventative to prevent damage from corrosion. If parts are to be stored for a prolonged period they should be wrapped.
25. Inspect parts for signs of wear of damage. Bearing and seal surfaces should be inspected for pitting, wear, or overheating.
    Inspect gears for pitting, wear or scoring.
26. Replace any parts that show signs of damage or wear.

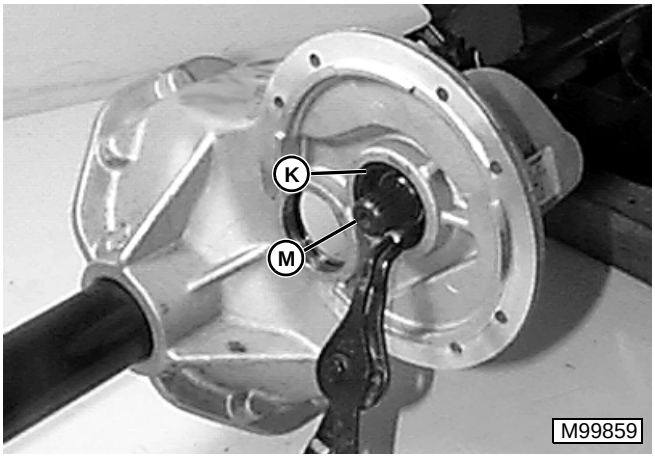
Installation:



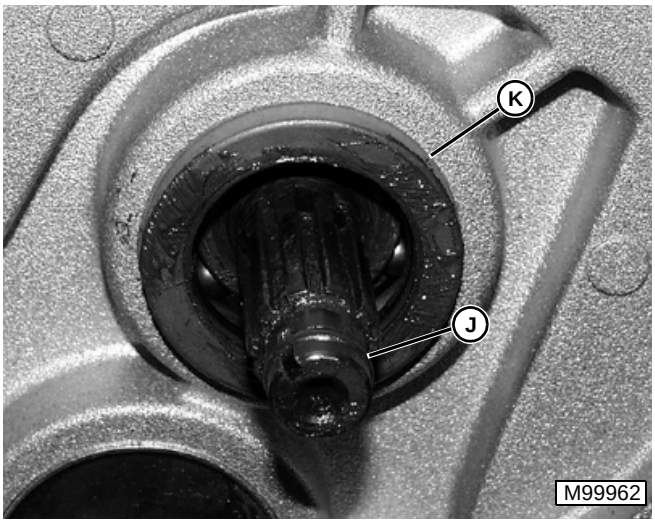
1. Wipe new O-rings (O) with a light coating of oil.
2. Install new O-rings into the outer input bearing bore (P).
3. Press new bearing onto input shaft until seated against bearing shoulder.



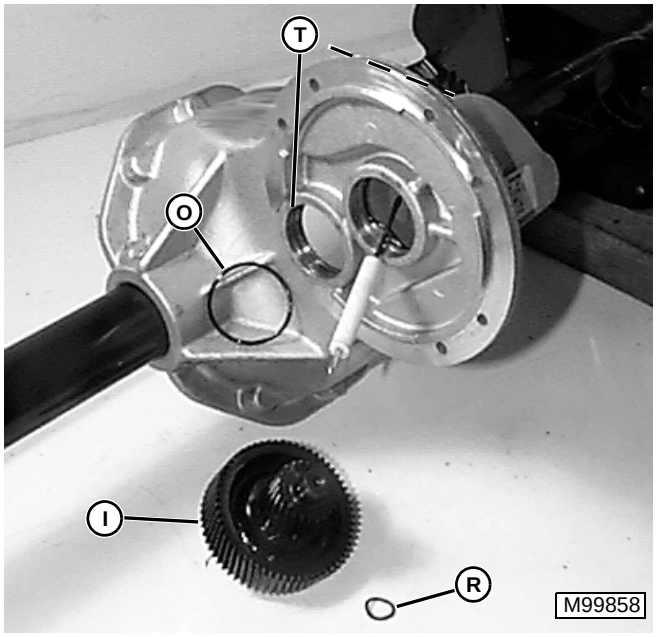
4. Install input shaft (M). Bearings and shaft should slide easily into housing. If resistance is encountered, the bearing and shaft assembly may be cocked slightly in the bore. Try to reposition the assembly with gentle rocking of the bearing and shaft assembly. If resistance is still encountered, a plastic or leather mallet could be used to gentle tap the shaft into its correct position.



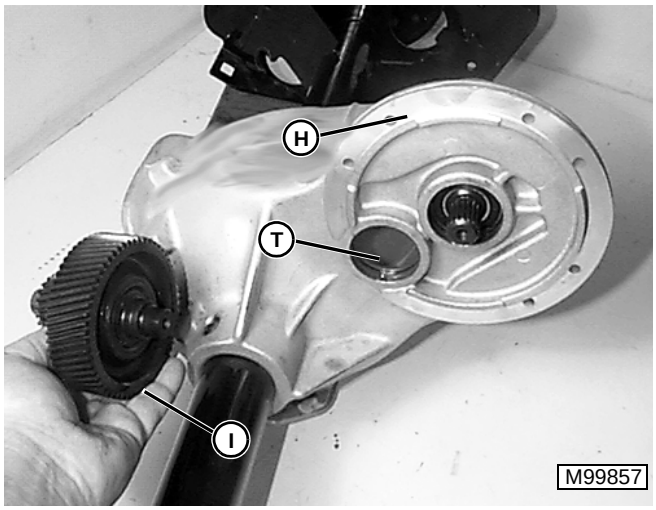
5. Install snap ring (K) into the input shaft bore (L).



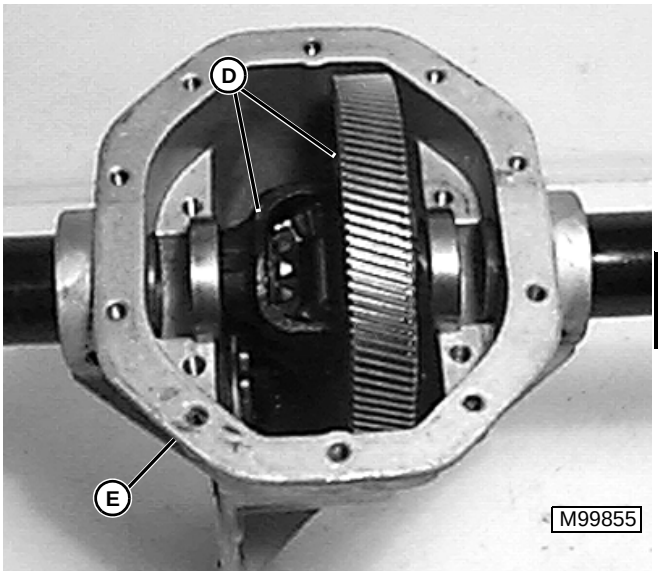
6. Install new O-ring (J) onto the end of the input shaft.
7. Install a new oil seal (K) into the bore of the input shaft until it is lightly seated against the shoulder in the bore.



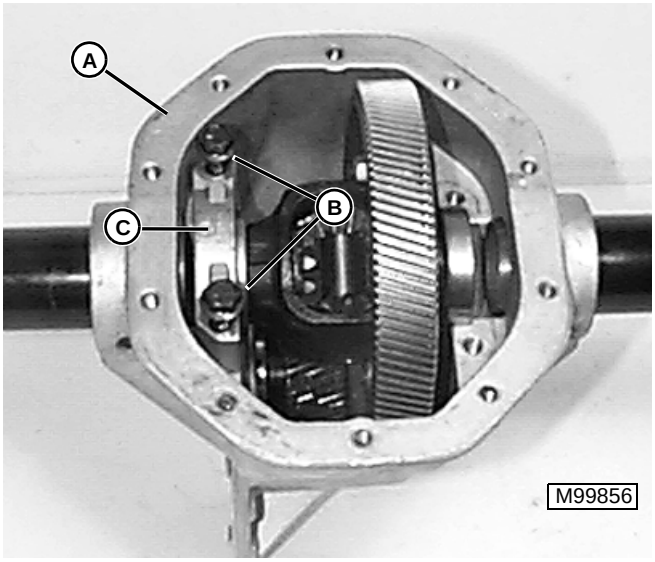
8. Install new O-ring (N) into both intermediate bearing bores (T).
9. Install new O-rings (Q) on both sides of the intermediate shaft (I).



10. Install intermediate shaft (I). Tip small end of intermediate shaft and gear assembly toward bottom opening until bearing trunnion visually engages intermediate bores (T).
11. Align both bearing trunnions with intermediate bore.
12. Continue supporting intermediate shaft and gear assembly with one hand and insert the flanged side (H) bearing into opening. To seat the bearing past O-ring, a leather or plastic mallet may be required.
13. After the bearing is seated past the snap ring groove, install the snap ring.
14. Repeat this procedure for the opposite side bearing and install snap ring.
15. Clean the housing and new bore plugs surfaces using TY6305 or TY9485 Clean and Cure Primer. (LOCTITE® 764)
16. Place a small film of TY16135 or TY15705 Flexible Sealant, (LOCTITE® 518), to bore plug sealing surface.
17. Using a properly sized driver and hammer, install bore plugs into housings until plug bottoms in bore.
18. Install the final drive gear onto the differential gear assembly.
19. Install the four capscrews from the flanged side of the differential gear. Tighten using the four nuts to **55 N•m (40 lb-ft)**.
20. Install the differential bearings on the differential gear assembly until firmly seated against bearing shoulder.



21. Insert differential gear assembly (D) into housing (E).



22. Install the differential bearing caps (C).

NOTE: Bearing caps are marked for identification. Letters or numbers are stamped in horizontal and vertical position. During reassembly, place them back in their original positions.

23. Install the four bearing cap capscrews (B) and tighten to **55 N•m (40 lb-ft)**.
24. Clean the housing (A) and cover sealing surfaces using TY6305 or TY9485 Clean and Cure Primer. (LOCTITE® 764)
25. Place a small, **1.5 mm (0.062 in.)**, bead of TY16135 or TY15705 Flexible Sealant, (LOCTITE® 518), to flange of cover plate. Sealant should be applied inside of the cover plate mounting holes.
26. Install the ten cover plate mounting capscrews and tighten to **28 N•m (20 lb-ft)**.
27. Install both axle shafts. See “AXLE SHAFT REMOVAL & INSTALLATION” on page 9 .
28. Refill the differential gear case with **0.4 L (15 oz)** of JDM J20C Hy-Gard oil.

Specification:

Final Drive Gear Capscrews . . . . . 55 N•m (40 lb-ft)
Bearing Cap Capscrews . . . . . 55 N•m (40 lb-ft)
Cover Plate Capscrews . . . . . 28 N•m (20 lb-ft)
Transaxle Oil Capacity. . . . . 0.4 L (15 oz)

CONTENTS

Page

SPECIFICATIONS

Torque Specifications:

Shock absorber lock nuts . . . . . 70 N•m (52 lb-ft)
Spindle assembly lock nuts . . . . . 60 N•m (40 lb-ft)
A-Arm assembly lock nuts . . . . . 90 N•m (70 lb-ft)
Rack and Pinion assembly lock nuts . . . . . 70 N•m (52 lb-ft)
Rubber boot assembly tie straps
. . . . . Snug Only — boot must not turn with tie rod when tie rod is adjusted
Front wheel bolts . . . . . 88 ± 10 N•m (65 ±7 lb-ft)
Tie rod
Lock nuts . . . . . 45 N•m (33 lb-ft)
Jam nuts . . . . . 60 N•m (44 lb-ft)
Steering shaft U-joint assembly cap screw . . . . . 40 N•m (30 lb-ft)
Steering wheel nut . . . . . Snug Only

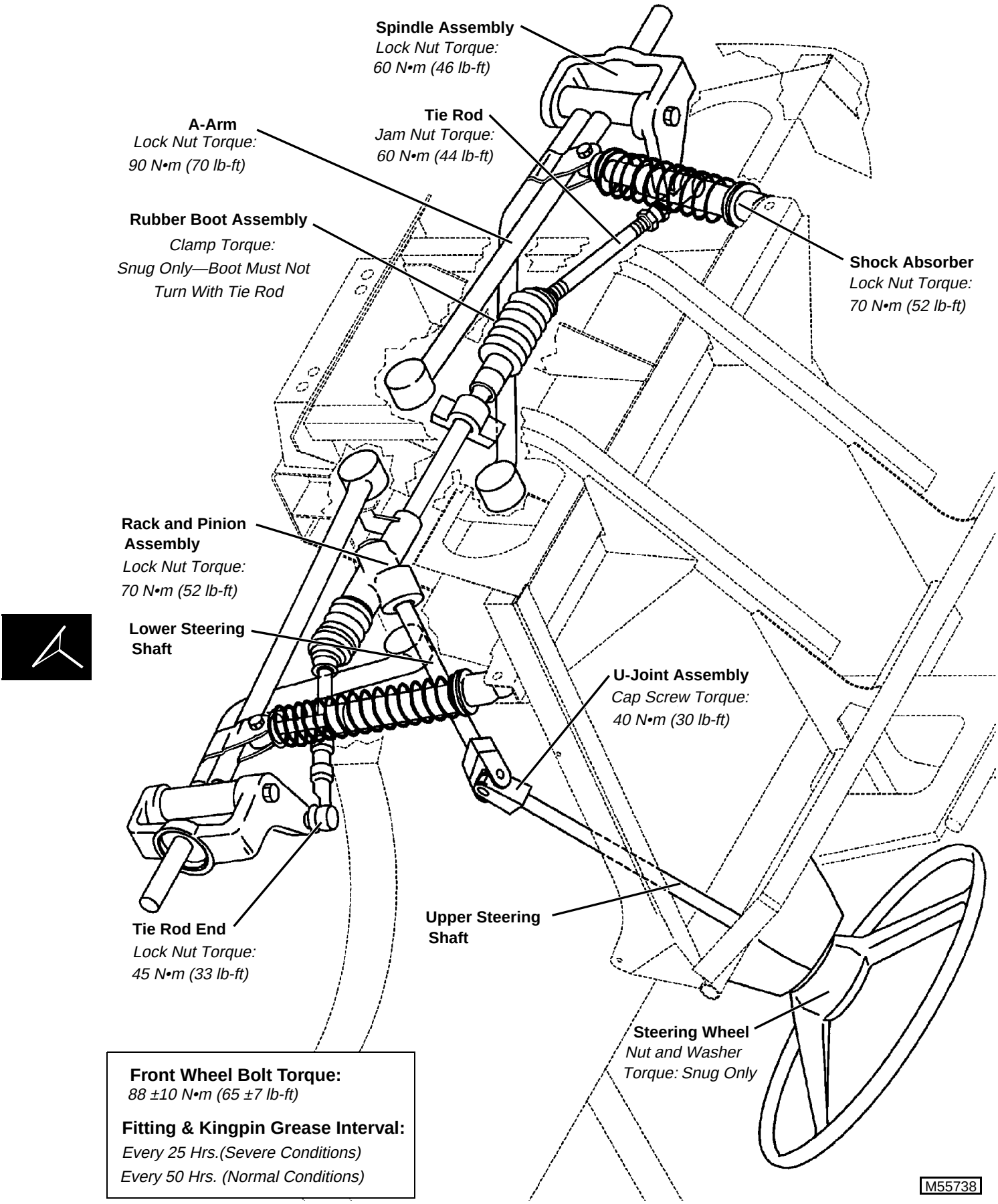
Lubrication Interval:

Spindle grease fitting and kingpin . . . . . Every 25 hours (severe conditions)
. . . . . Every 50 hours (normal conditions)

Toe-In Adjustment:

Front-to-rear difference . . . . . front is 4 ± 3 mm (0.16 ± 0.12 in.) less than rear

COMPONENTS LOCATION



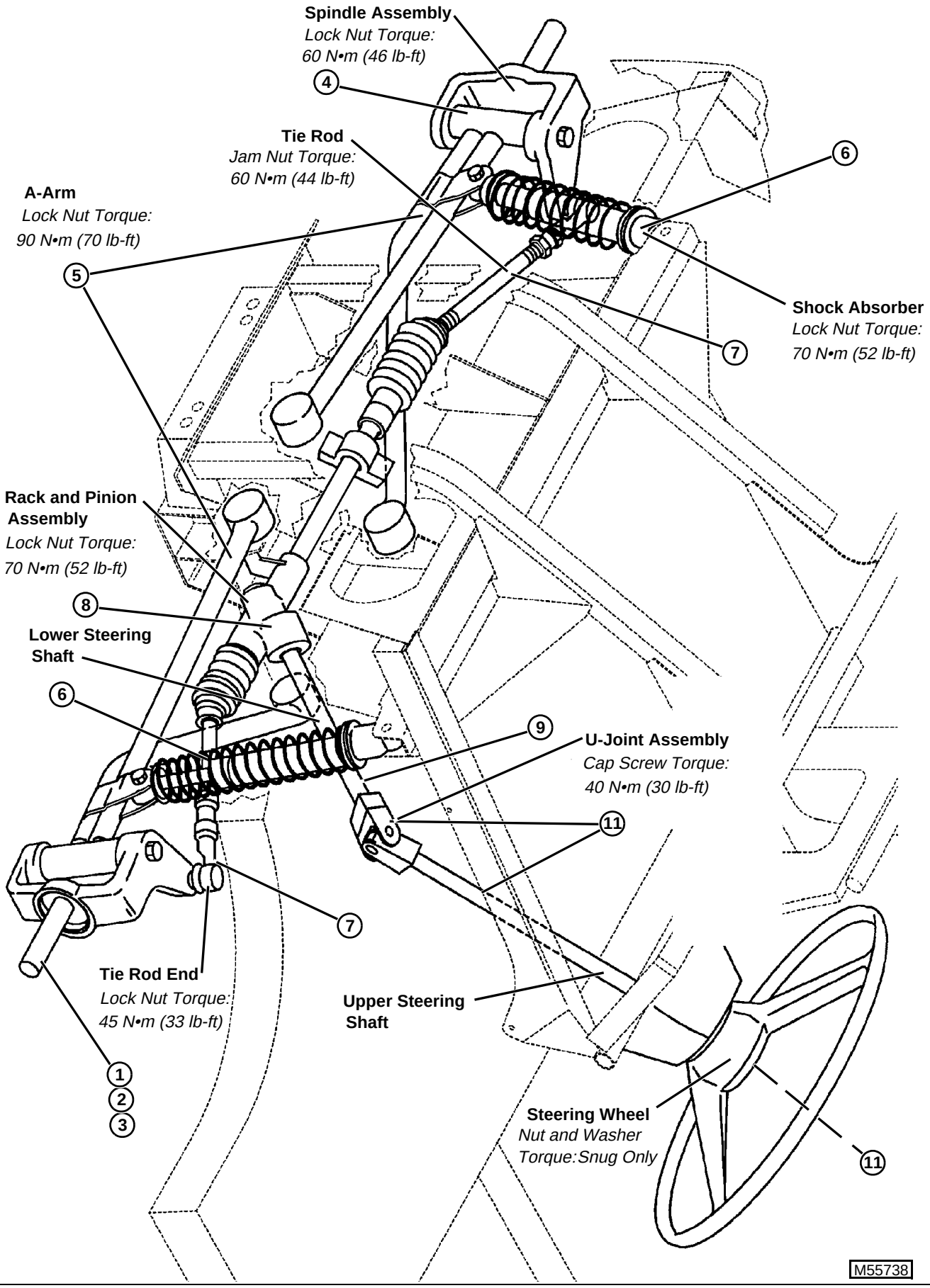
TROUBLESHOOTING

TROUBLESHOOTING CHART

Problem or Symptom / Check or Solution	Steering pulls in one direction	Steering wanders	Steering shimmies or vibrates	Wheel bearing noise	Steers hard left or right or both	Steering locks in hard left or right turns	Steering wheel pulls upward	Steering wheel spins freely	Noise during turns or over rough terrain	Front steering suspension weak or unstable
Spindles, king pins, or king pins A-frame bearings worn or not lubricated sufficiently	●	●	●		●	●			●	
Rack and pinion assembly worn or broken	●	●	●		●	●		●	●	
Tie rods bent, loose, or toe-in incorrect	●	●	●		●	●			●	
Steering shaft u-joint worn or cap screw loose		●					●	●	●	
Wheel bearings worn or lost lubricating properties	●	●	●	●	●				●	
Tire size incorrect, out-of-round, or air pressure incorrect	●	●	●		●					
Shock absorbers leaking or springs broken			●						●	●
Steering wheel and/or shaft splines worn or stripped		●			●			●		
Steering wheel nut loose, stripped, or fallen off		●					●	●		
Steering shaft-to-rack and pinion assembly snap ring dislodged or broken	●	●	●		●	●	●	●		
Rubber boots cracked or torn					●	●			●	
A-arm bent, pivot bushings worn or lost lubricating properties	●	●	●						●	●
Shock absorbers mounts bent or hardware worn, loose, or broken	●	●	●						●	●
Shock absorbers installed upside down									●	●

DIAGNOSIS/TEST/CHECK POINTS

Test/Check Point	Normal	If Not Normal
1. Rims	Runout less than 3 mm (0.12 in.) Wheel bolts tight	Replace rims. Tighten to specification.
2. Tires	Runout less than 10 mm (0.4 in.)	Remount or replace tires.
	Tires properly inflated	Inflate tires to proper pressure.
3. Wheel bearings and bushings	Wheels rotate freely without rough spots	Replace bearings.
4. Spindle and kingpin assemblies	Assemblies tight and turn smoothly	Tighten assemblies. Replace assemblies.
	King pins properly greased	Grease.
5. A-arm assemblies	Fastened securely	Tighten lock nuts to specification.
	Assemblies not bent	Replace A-arm assemblies.
	Pivot bushing not worn or binding	Replace bushings.
6. Shock absorbers	Installed and tightened properly	Tighten lock nuts to specification.
	Operate smoothly and not leaking	Replace shock absorbers.
7. Tie rods and tie rod ends	Jam nuts tight, tie rod ends tight, and toe-in adjusted properly	Adjust toe-in and tighten jam nuts and lock nuts.
	Tie rods straight, not worn	Replace components as necessary.
8. Rack and pinion assembly	Assembly fastened securely	Tighten assembly.
	Operates from stop-to-stop smoothly with little effort	Replace assembly.
9. Lower steering shaft	Fastened securely to rack and pinion assembly	Fasten securely.
	Straight	Replace shaft.
10. Upper steering shaft and U-joint	U-joint fastened securely	Tighten U-joint cap screw to specification.
	Operates smoothly. Shaft splines good	Replace upper steering shaft and U-joint.
11. Steering wheel and leaping deer emblem	Installed properly, nut snug	Install and tighten properly.
	No cracks or breaks, splines good	Replace components as necessary.


Spindle Assembly
Lock Nut Torque:
60 N•m (46 lb-ft)
4
Tie Rod
Jam Nut Torque:
60 N•m (44 lb-ft)
6
A-Arm
Lock Nut Torque:
90 N•m (70 lb-ft)
5
7
Shock Absorber
Lock Nut Torque:
70 N•m (52 lb-ft)
Rack and Pinion
Assembly
Lock Nut Torque:
70 N•m (52 lb-ft)
8
Lower Steering
Shaft
6
9
U-Joint Assembly
Cap Screw Torque:
40 N•m (30 lb-ft)
11
7
Tie Rod End
Lock Nut Torque:
45 N•m (33 lb-ft)
Upper Steering
Shaft
1
2
3
Steering Wheel
Nut and Washer
Torque:Snug Only
11
M55738

TESTS AND ADJUSTMENTS

TOE-IN ADJUSTMENT

Reason:

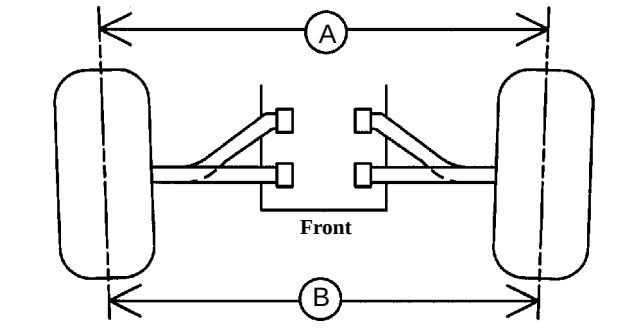
To prevent tire wear and steering wander.

Procedure:

1. Park machine on level surface, turn key switch OFF and LOCK park brake.

NOTE: Toe-in cannot be adjusted with:
- wheels off surface
- on an uneven surface
- any weight or load on machine.

2. Turn steering wheel until front drivers-side tire aligns with drivers-side rear tire(s). Use straight 2 x 4 or piece of angle iron for guide.

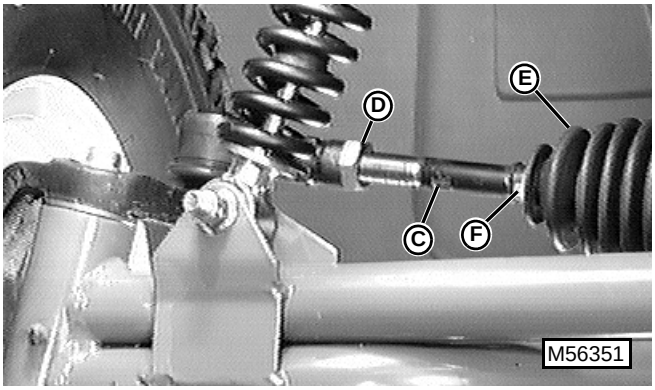


Front Toe-In Adjustment (B) = (A) - 4 ± 3 mm (0.16 ± 0.12 in.)

M55739

3. At hub height and center of tire tread, measure rear distance (A) and front distance (B).

IMPORTANT: The rubber boot (E) may turn with the tie rod if boot clamp (F) is too tight. DO NOT allow this to happen. Loosen clamp enough to allow the rubber boot to remain stationary.



4. At right side tie rod (C), loosen jam nut (D) and turn tie rod until front distance (B) is 4 ± 3 mm (0.16 ± 0.12 in.) less than rear distance (A).
5. Turn steering wheel fully clockwise and measure distance between tie rod end and lower shock mounting bolt. Turn steering wheel fully counterclockwise and measure distance between tie rod end and lower shock mounting bolt. The measured distances should be equal (approximately 4-6mm).
6. Tighten jam nut (D).

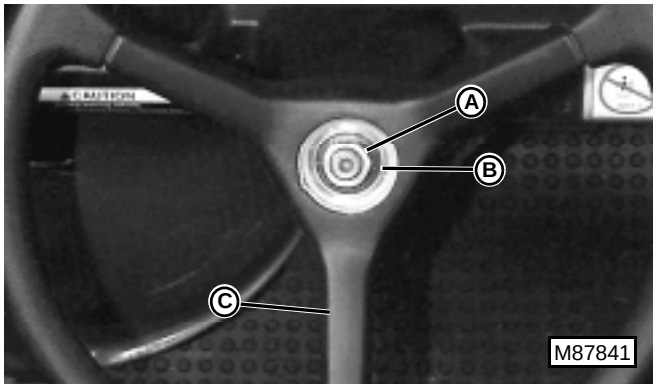
STEERING WHEEL ADJUSTMENT

Reason:

To position steering wheel properly.

Procedure:

1. Park machine on level surface, turn key switch OFF and LOCK park brake.
2. Turn steering wheel to right or left steering stop.
3. Turn wheel to other stop while counting number of turns.
4. Turn wheel back half of total turns counted.

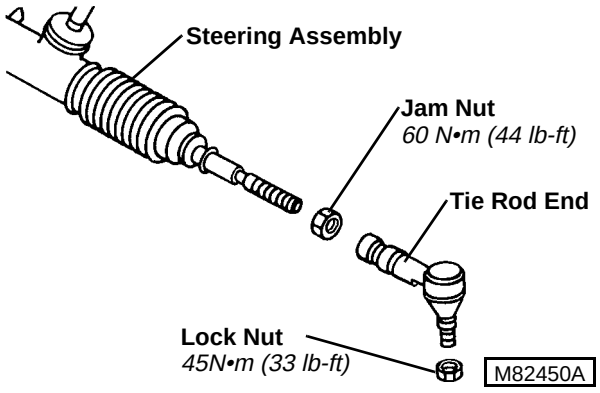


NOTE: Proper position of steering wheel is as shown with one spoke pointing down or rearward.

5. If wheel is not correct, remove leaping deer emblem, nut (A), and washer.
6. Without moving steering shaft, remove steering wheel and align on splines (B) so bottom spoke (C) points down or rearward.
7. Install washer and nut (A), tighten until snug only
8. Install leaping deer emblem.

REPAIR

TIE ROD END REPLACEMENT

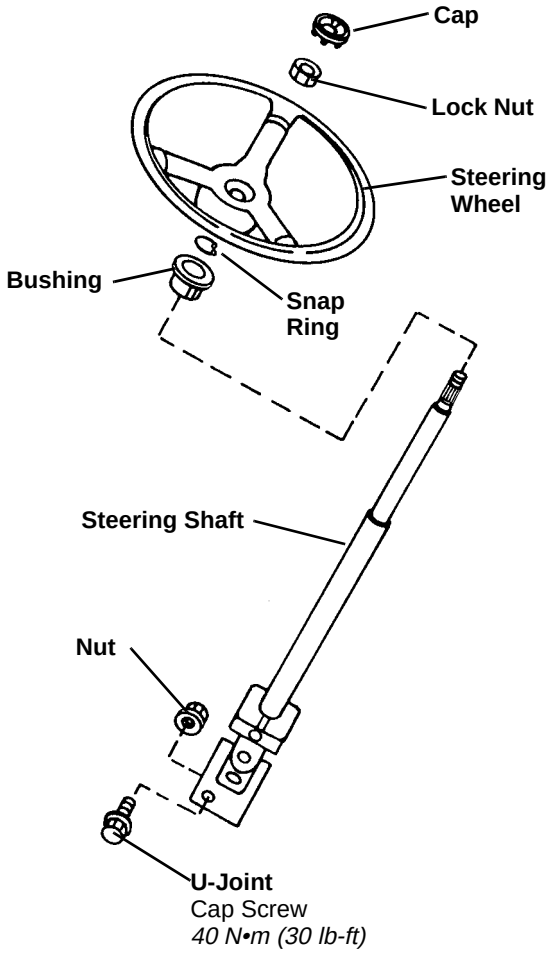


1. Remove front wheel.

NOTE: Tie rod end is a tapered bore fit. Use a ball joint fork or puller to ease removal.

2. Install new tie rod end. Position spindle shaft 90° to machine and turn wheel on other side to straight position.
3. Turn tie rod end until tapered end fits into arm of spindle. Tighten jam nut.
4. Adjust toe-in.

STEERING WHEEL & SHAFT REMOVAL & INSTALLATION



1. Remove cap, lock nut and wheel.
2. Remove U-joint cap screw and nut.

NOTE: Be sure to properly index the "flat" on the lower steering pinion shaft with the "U" joint.

3. Pull up on steering shaft and remove snap ring.
4. Remove shaft and bushing.
5. Inspect all parts for wear or damage. Replace as necessary.

Installation is done in the reverse order of removal.

STEERING ASSEMBLY REMOVAL & INSTALLATION

1. Remove front wheels.
2. Remove U-joint cap screw and nut.
3. Pull up on steering wheel to disconnect U-joint from lower steering shaft.

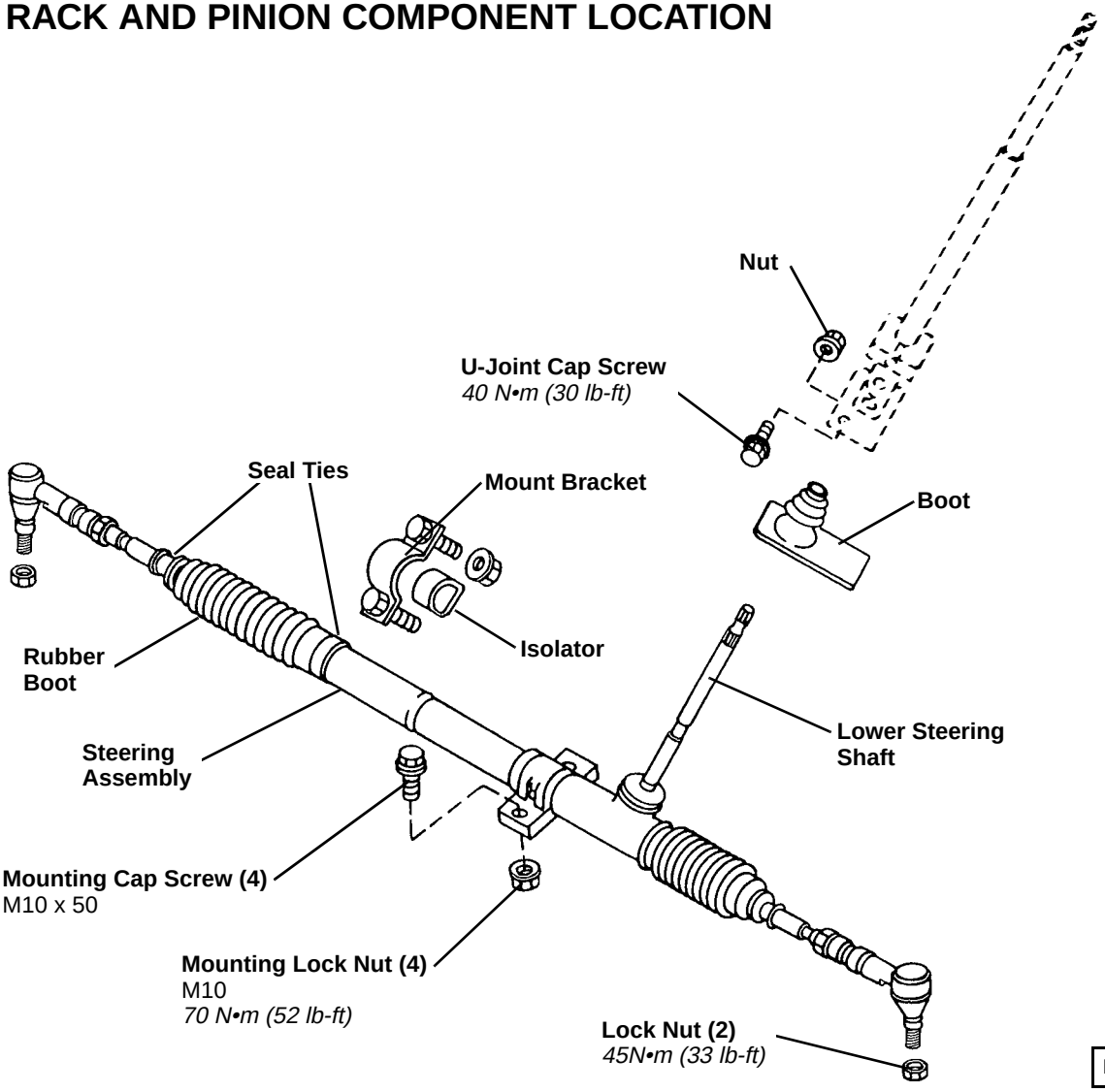
NOTE: Tie rod end is a tapered bore fit. Use a ball joint fork or puller to ease removal.

4. Remove tie rod end lock nuts and disconnect tie rod ends from spindles.
5. Remove mounting cap screws and lock nuts.
6. Remove nine mounting screws and washers from left-hand fender.
7. Remove steering assembly from left-hand side of machine.
8. Inspect the rubber boots and seal ties on each end of the steering assembly for any signs of damage such as cracking, tearing or holes that could cause leaks to allow dirt or moisture to get into the steering rack and cause damage to the inner and outer races. Replace as necessary.
9. Inspect all other parts for wear or damage. Replace as necessary.

Installation is done in the reverse order of removal.

Adjust toe-in.

RACK AND PINION COMPONENT LOCATION



SPINDLE SHAFT AND BUSHING REPLACEMENT

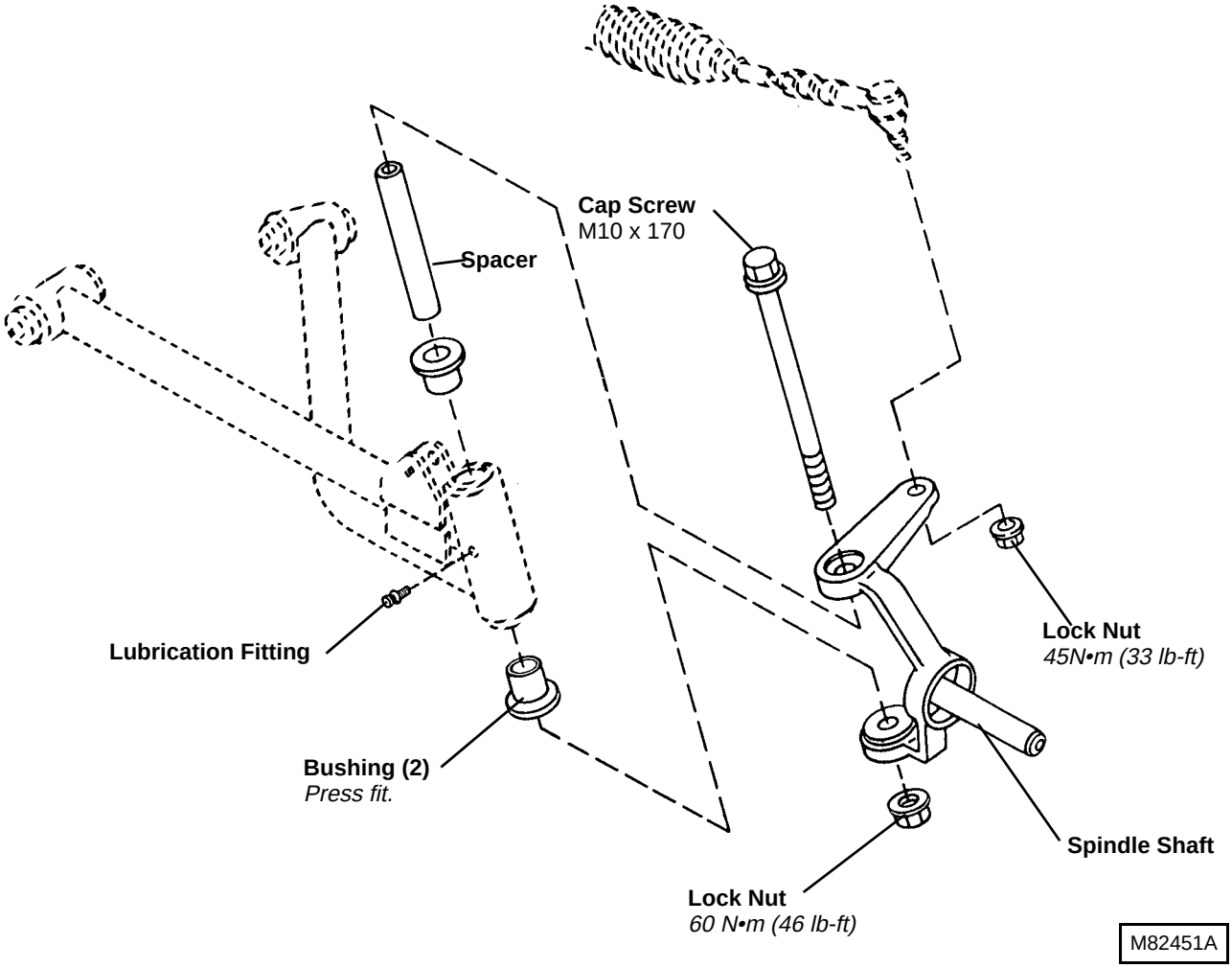
- Remove front wheel.

NOTE: Tie rod end is a tapered bore fit. Use a ball joint fork or puller to ease removal.

Bushings are press-fit in A-arm. Use an inside puller set to remove and a driver set to install.

- Apply multipurpose grease to lubrication fitting.

SPINDLE COMPONENT LOCATION



A-ARM REMOVAL & INSTALLATION

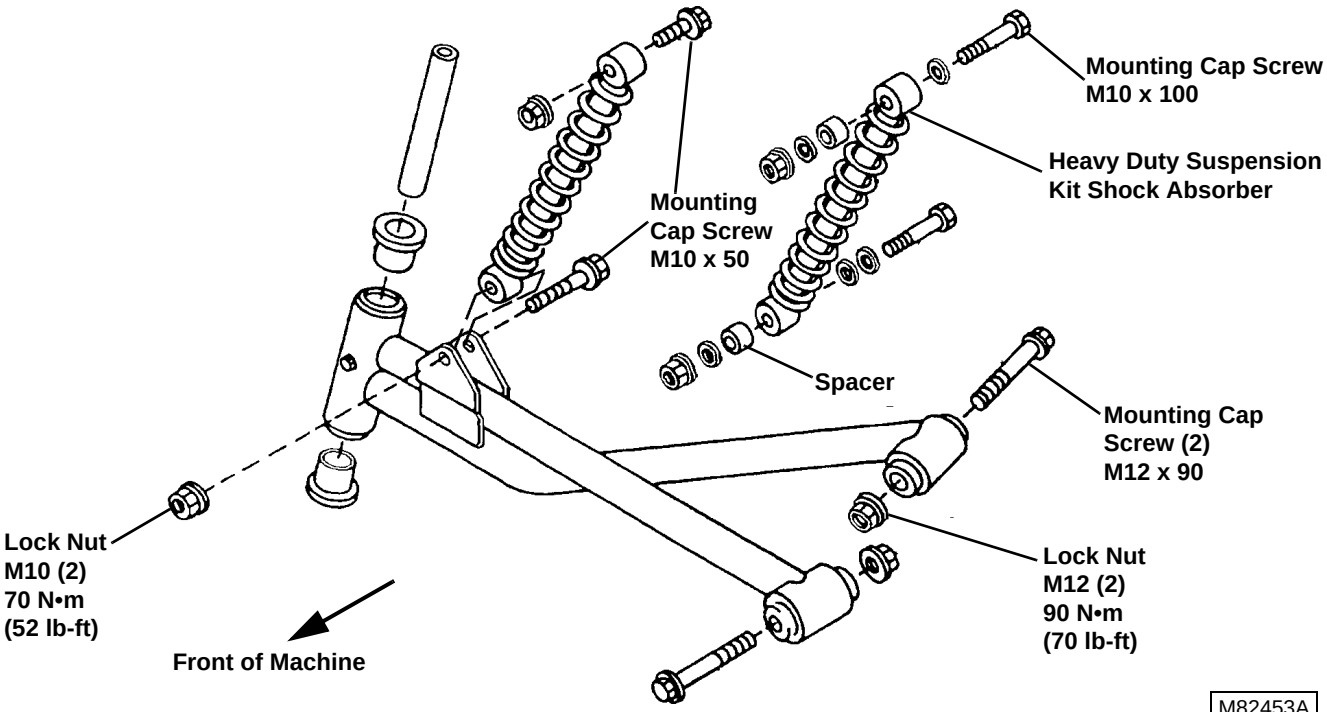
NOTE: If replacing A-arm, remove spindle shaft and bushings.

1. Remove front wheel. See MISC. SECTION "FRONT WHEEL REMOVAL & INSTALLATION" on page 6.
2. Remove shock absorber mounting cap screw and lock nut.
3. Remove mounting cap screws, lock nuts and A-arm.

Installation is done in the reverse order of removal.

NOTE: Shock Absorber should be in place to provide proper orientation of A-arm when tightening mounting hardware.
Double shock absorber kit may be installed for improved handling.

A-Arm Component Location



Right Hand Side A-Arm Shown

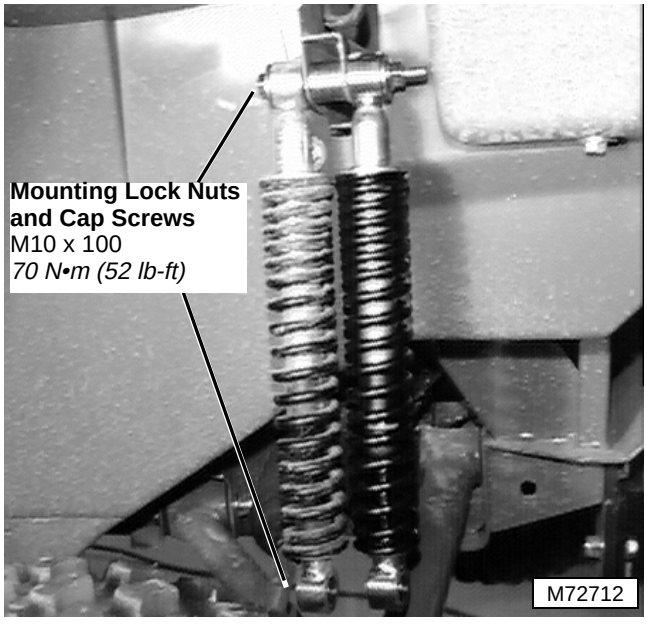
SHOCK ABSORBER REPLACEMENT

1. Park machine on level surface, turn key switch OFF, place shift lever in NEUTRAL, and lock park brake.
2. Remove front wheel. (See “FRONT WHEEL REMOVAL/INSTALLATION” on this page.)
3. Remove top and bottom mounting lock nuts and cap screws.
4. Remove shock absorber.

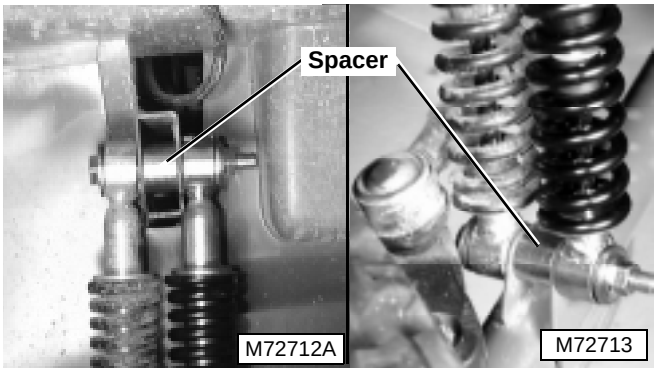
Installation is done in the reverse order of removal.

- Tighten mounting lock nuts to **70 N•m (52 lb-ft)**.

Standard Shock Absorber Mounting



Heavy Duty Suspension Kit Mounting



Heavy Duty Suspension Kit Mounting

NOTES:

CONTENTS

Page

SPECIFICATIONS

TORQUE SPECIFICATIONS:

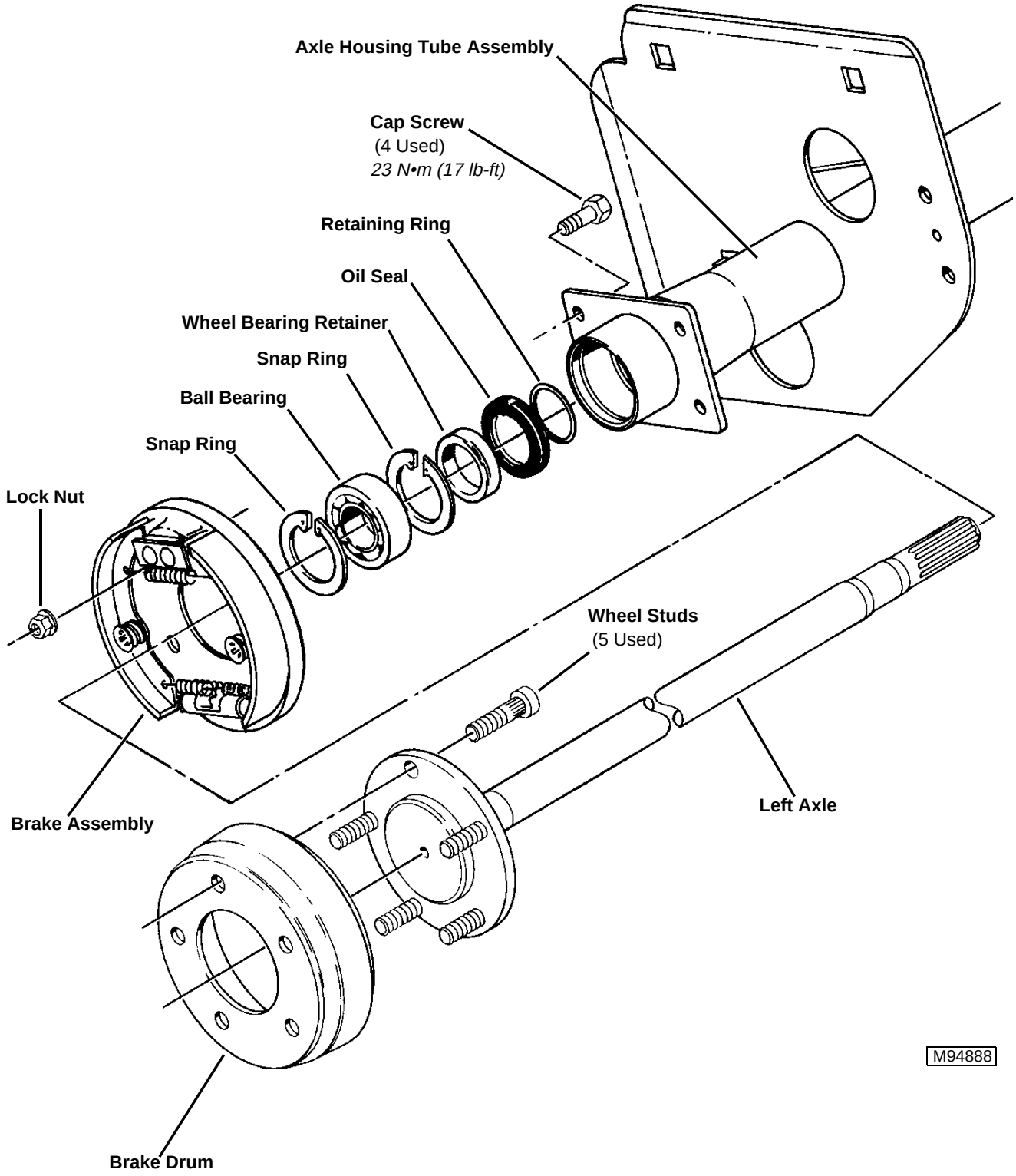
Brake Pedal Freeplay Adjustment (maximum) . . . . . 4 mm (0.16 in.)
Axle to Frame & Hitch Carriage Bolt Torque . . . . . 90 N•m (70 lb-ft)
Drum Brake Assembly to Axle Case . . . . . 23 N•m (17 lb-ft)
Rear Wheel to Axle Case . . . . . 100 N•m (75 lb-ft)
Brake Lining Thickness (Minimum) . . . . . 1 mm (0.04 in.)

OTHER MATERIALS

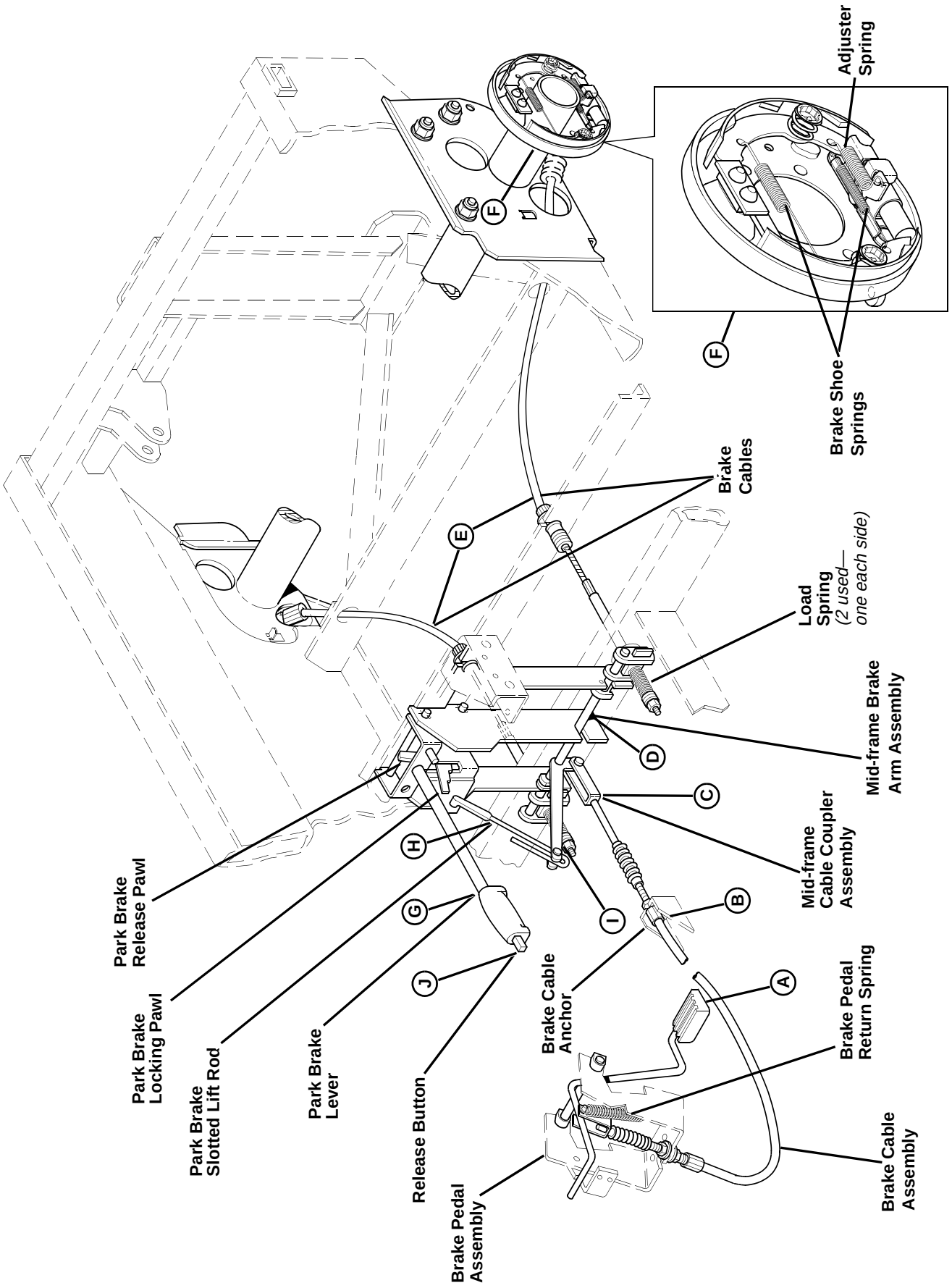
Number	Name	Use
TY6305	John Deere Clean and Cure Primer	Cleans parts and speeds cure of sealant.
TY15130 or TY15443	John Deere Sealant	Seals transaxle case halves.
TY6333	Moly High Temperature EP Grease	Apply to splines of transaxle input shaft.

COMPONENT LOCATION

REAR AXLE



BRAKE SYSTEM



THEORY OF OPERATION

Function:

To provide a means of stopping the unit and also prevent movement when not in use.

Theory Of Operation:

When the brake pedal (A) is depressed, the brake cable anchor (B) pulls U-bracket (C) and mid-frame brake arms (D) forward. Mid-frame brake arms pull left and right side brake cables (E) which pull brake arms (F) forward. When brake arms are pulled forward the brake shoes are forced against the inside of the brake drum.

The friction between the brake shoes and brake drums slows or stops rear wheel rotation.

When the park brake lever (G) is raised into its locked position, the slotted rod (H) pulls the park brake arm (I) up and the mid-frame brake arms (D) forward. From hereon, everything works the same as action from the brake pedal. To release the park brake lever, first raise the lever slightly, then depress the release button (J) and lower lever all-the-way.

TROUBLESHOOTING

TROUBLESHOOTING CHART

Problem or Symptom / Check or Solution	Brakes will not engage or show poor response	Brakes binding or brake effort excessive	Brake engagement too aggressive	Brakes will not release	Park brake will not engage	Park brake will not release	Park brake will not hold	Brakes noisy or chattering	Excessive brake wear	Brake pedal travel excessive
Brake pedal bent, binding, or worn.	●	●		●				●	●	
Brake pedal return spring stretched or broken.				●				●	●	
Brake pedal stop plate worn or misadjusted.	●	●	●	●				●	●	●
Brake cable misadjusted, stretched, worn, or binding.	●	●	●	●	●	●			●	●
Brake linkage freeplay adjustment incorrect.	●	●	●	●	●	●	●		●	●
Mid-frame brake springs misadjusted, collapsed or broken.	●	●	●	●	●		●	●		
Mid-frame brake arm linkage loose, misadjusted, binding, worn, or broken.	●	●		●	●	●	●	●	●	●
Park brake lever, locking pawl, slotted rod, or park brake arm bent, binding, worn, or broken.					●	●	●		●	
Mid-frame -to-wheel brake cables misadjusted, stretched, worn, or binding.	●	●	●	●	●	●	●	●	●	●

DIAGNOSIS

Test Conditions:

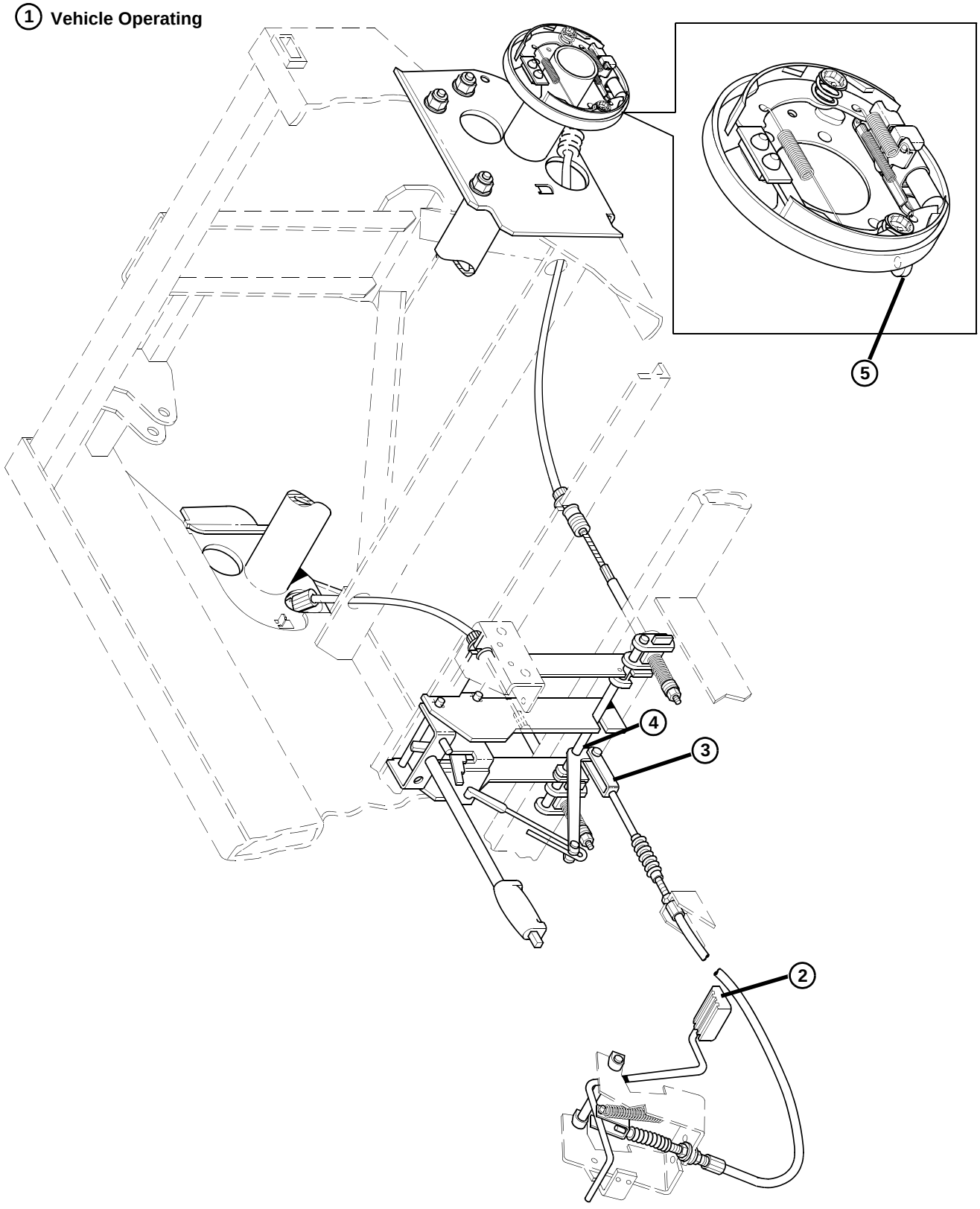
- Key switch in ON position
- Operator in seat
- Service/Drive switch in DRIVE position
- Shift lever in forward or reverse
- Minimum of 50 feet of open and flat pavement away from any people

Test/Check Point	Normal	If Not Normal
1. Vehicle operating to full speed and then brakes applied both smoothly and aggressively	When brakes applied, machine stops aggressively with rear wheels locking.	Check linkage and brake components for adjustment, binding, wear or damage
	Brake pedal should depress smoothly and with little effort.	Check linkage and brake components for binding, wear or damage.

Test Conditions:

- Key switch in OFF
- Shift lever in NEUTRAL
- Service/Drive switch in SERVICE

2. Brake pedal	Components not worn or damaged.	Repair or replace as necessary.
	Hardware not worn or loose.	Repair or replace as necessary.
	Springs not broken or stretched.	Repair or replace as necessary.
3. Mid-frame	Cable not binding, mount and jam nut good.	Repair or replace as necessary.
	Rubber boot and clamps good.	Repair or replace as necessary.
	Load springs not broken or compressed.	Repair or replace as necessary.
4. Rear wheel drum brakes	Linkage adjusted properly and not damaged or worn.	Adjust linkage and brake adjuster pawl. Repair or replace as necessary.
	Internal components not worn or damaged.	Repair or replace as necessary
5. Park brake	Properly adjusted.	Adjust cables and linkage.
	Linkage not worn or damaged	Repair or replace as necessary.


1 Vehicle Operating
5
4
3
2

TESTS AND ADJUSTMENTS

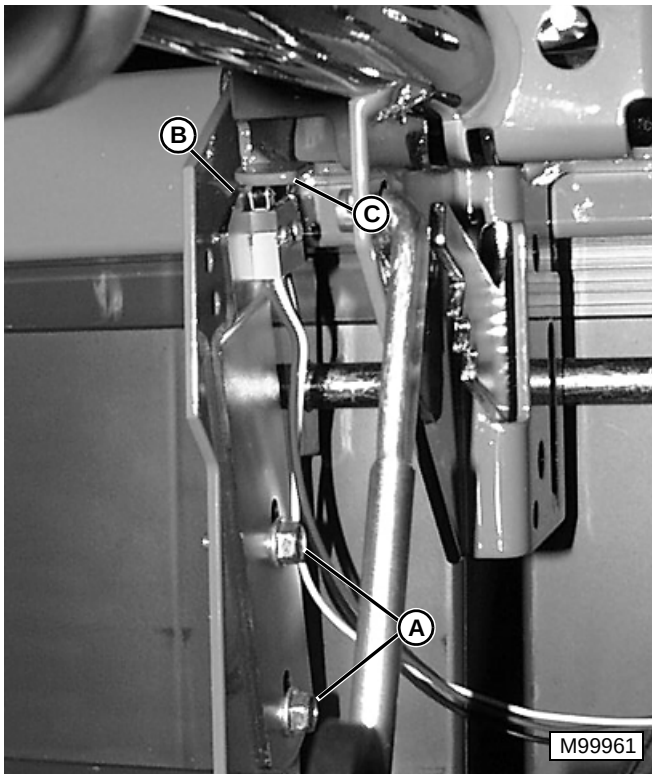
PARK BRAKE SWITCH ADJUSTMENT

Reason:

To ensure that the park brake switch is adjusted properly.

Procedure

1. Position the vehicle on a level surface.
2. Turn the key switch to the OFF position, and place the shift lever in the NEUTRAL position.
3. Set Service/Drive switch to Service position.
4. Place park brake lever in released position, and BLOCK front wheels.
5. Remove both seats. See MISC. SECTION “SEAT REMOVAL & INSTALLATION” on page 4.
6. Remove seat base cover under seat. See MISC. SECTION “SEAT BASE COVER REMOVAL & INSTALLATION” on page 5.



7. Loosen the two capscrews (A) securing the park brake switch mounting bracket (B) to the vehicle frame until the mounting bracket can be slid down as far as it will go.
8. Press down lightly on the park brake lever to be sure it is has reached the brake released stop point.
9. Holding down on the park brake lever, slide the park brake switch mounting bracket up until the mounting bracket has contacted the park brake lever (C).
10. Hold the switch and bracket assembly in the position and tighten the two capscrews (A) to **6 N•m (54 lb-in.)**.
11. Install seat base cover under seat. See MISC. SECTION “SEAT BASE COVER REMOVAL & INSTALLATION” on page 5.
12. Install both seats. See MISC. SECTION “SEAT REMOVAL & INSTALLATION” on page 4.

REAR BRAKE CABLE ADJUSTMENT

Reason:

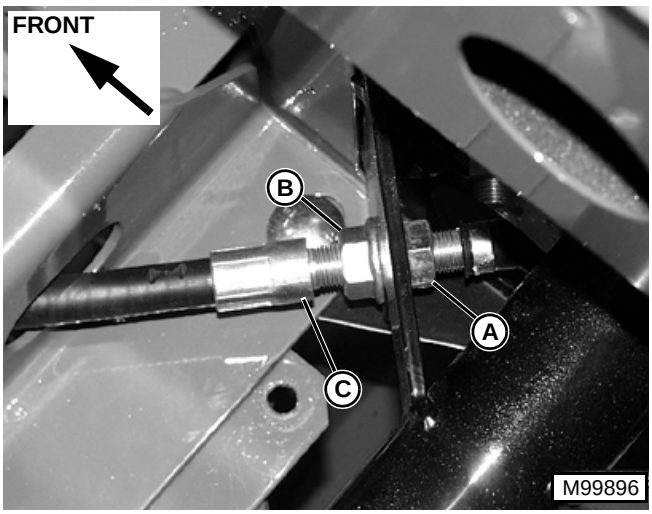
To ensure that the park brake cable is adjusted properly.

IMPORTANT: Always adjust brake cable in sequence starting at the axle working forward to the brake pedal.

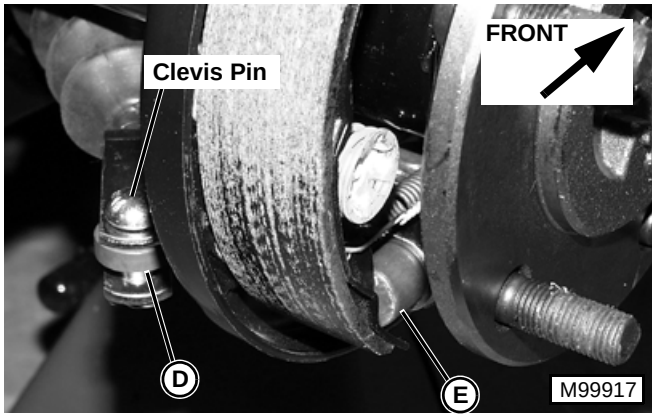
Procedure

1. Position the vehicle on a level surface.
2. Turn the key switch to the OFF position, and place the shift lever in the NEUTRAL position.
3. Set Service/Drive switch to Service position.
4. Place park brake lever in released position, and BLOCK front wheels.
5. Use jack stands or hoist to raise rear wheels at least **25 mm (1.0 in.)** off ground.
6. Remove rear wheel and brake drum. Clean out brake drum and brake mechanism with air (30–40 psi).

NOTE: If brake cable is being replaced, DO NOT attach cable to brake pedal at this time. Attach cable only at mid-frame mounting and rear brake arm clevis pin.



7. Loosen flange nuts (A) and (B) on brake cable housing (C).



Brake Drum Assembly Shown from Bottom

8. Move brake cable housing (C) until free play is removed from brake arm (D), but before there is movement of brake piston (E).
9. Tighten flange nuts (A and B).
10. Install brake drum and wheel.
11. Repeat procedure for opposite rear wheel.

FRONT BRAKE CABLE ADJUSTMENT

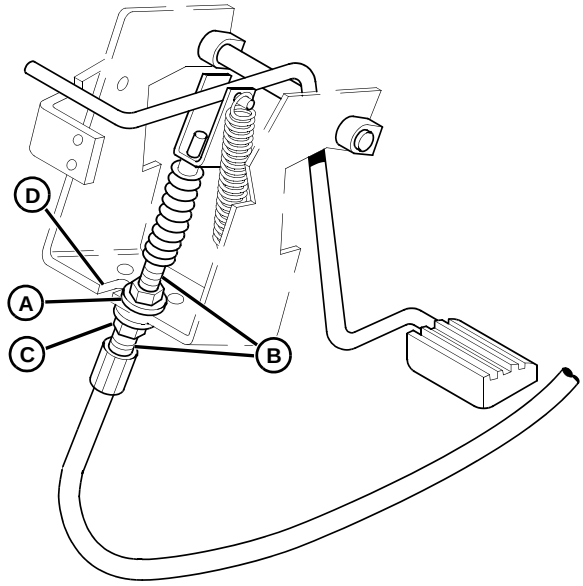
Reason:

To ensure that the brake control cable is adjusted properly.

IMPORTANT: Always adjust brake cable in sequence starting at the axle working forward to the brake pedal.

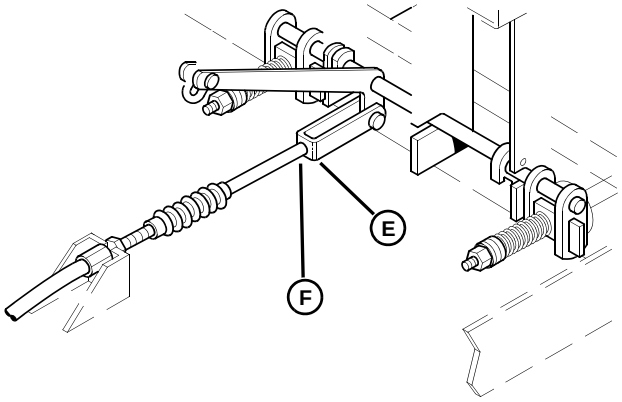
Procedure

1. Position the vehicle on a level surface.
2. Turn the key switch to the OFF position, and place the shift lever in the NEUTRAL position.
3. Set Service/Drive switch to Service position.
4. Place park brake lever in released position, and BLOCK front wheels.
5. Remove the hood, seats and seat base cover. See MISC. SECTION.



6. The brake control cable is adjusted by moving the top nut (A) up or down on the cable sheath (B) and tighten the lower nut (C) to it.

IMPORTANT: DO NOT allow brake control cable to slip out of slot (D) or cable may become kinked. Hold cable in slot by holding cable below lower nut (C) when loosening top nut (A).



7. Adjust the nuts (A & C at the brake pedal bracket) on the brake control cable until the slack in the control cable slide rod (E) and clevis (F) has been removed. Do not overtighten the cable or the brakes will be preloaded.
8. Perform brake pedal adjustment.

BRAKE PEDAL ADJUSTMENT

Reason:

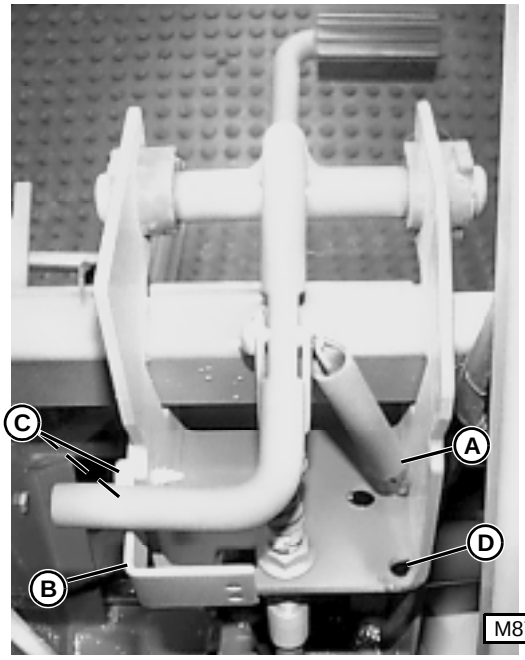
To ensure brake pedal is adjusted properly.

IMPORTANT: Always adjust brake cable in sequence starting at the axle working forward to the brake pedal.

Procedure

1. Position the vehicle on a level surface.
2. Turn the key switch to the OFF position, and place the shift lever in the NEUTRAL position.
3. Set Service/Drive switch to Service position.
4. Place park brake lever in released position, and BLOCK front wheels.

5. Remove the brake pedal return spring (A) to allow the pedal to travel freely during the adjustment procedure.



NOTE: Brake pedal freeplay is necessary to prevent any preload of brake linkage. If stop plate (B) is adjusted too high, brakes will be preloaded. If stop plate (B) is adjusted too low, return spring (A) pressure, will kink brake cable.

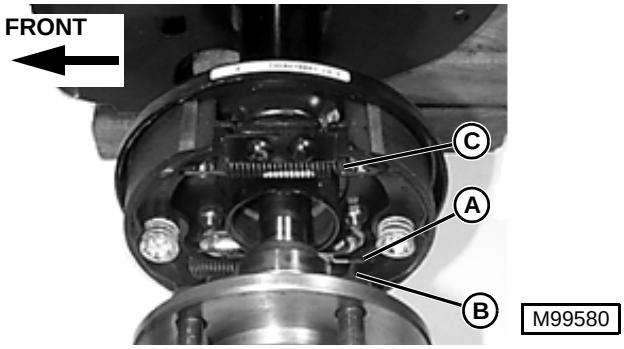
6. Loosen screws (C) of stop plate (B). Adjust stop plate up to reduce amount of freeplay in brake pedal. *Apply only enough up force to stop plate to take up freeplay. Do not start actuating brake. There should be maximum freeplay travel of **4 mm (0.16 in.)**.*
7. Hold stop plate (B) while tightening screws (C).
8. Install brake pedal return spring (A) in hole (D).

REPAIR

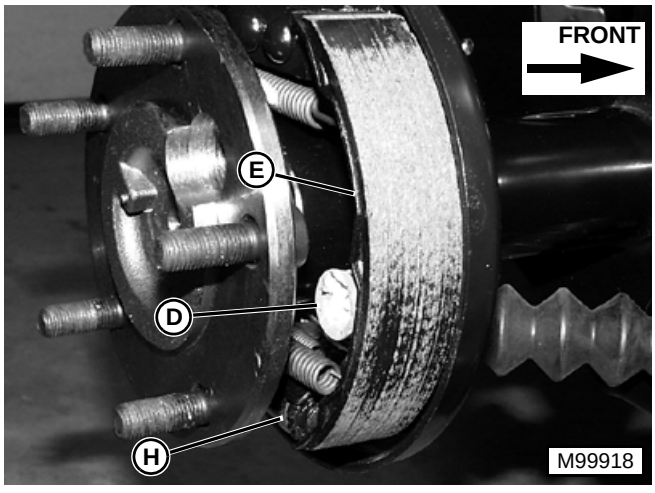
BRAKE SHOE REMOVAL & INSTALLATION

Removal:

1. Position the vehicle on a level surface.
2. Turn the key switch to the OFF position, and place the shift lever in the NEUTRAL position.
3. Set Service/Drive switch to Service position.
4. Place park brake lever in released position, and BLOCK front wheels.
5. Use jack stands or hoist to raise rear wheels at least **25 mm (1.0 in.)** off ground.
6. Remove 5 lug nuts, rear wheel and brake drum.

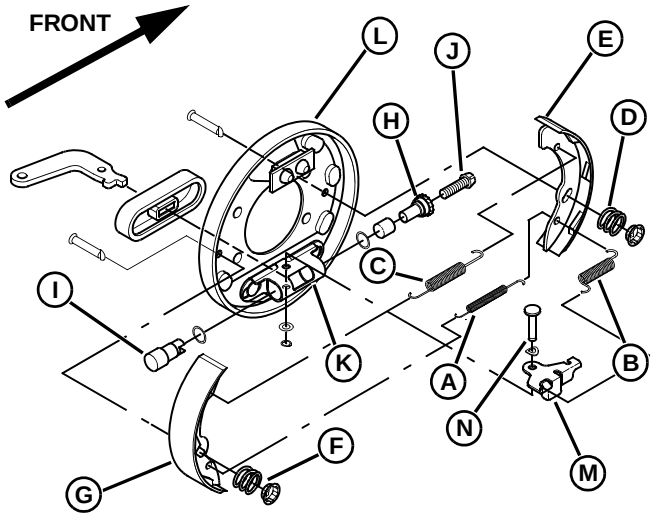


7. Disconnect back end of lower brake shoe spring (A).
8. Disconnect back end of adjuster spring (B).
9. Disconnect top brake shoe spring (C).



10. Remove front brake shoe hold down clip and spring (D). Remove front brake shoe (E).
11. Remove rear brake shoe hold down clip and spring (F). Remove rear brake shoe (G) and springs if still attached.
12. Service and inspect self adjuster (H) and plungers (I).

NOTE: Self adjuster housing (K) is not removable. Brake plate (L) must be removed from axle housing to remove brake adjustment arm (M) and pin (N).



Installation:

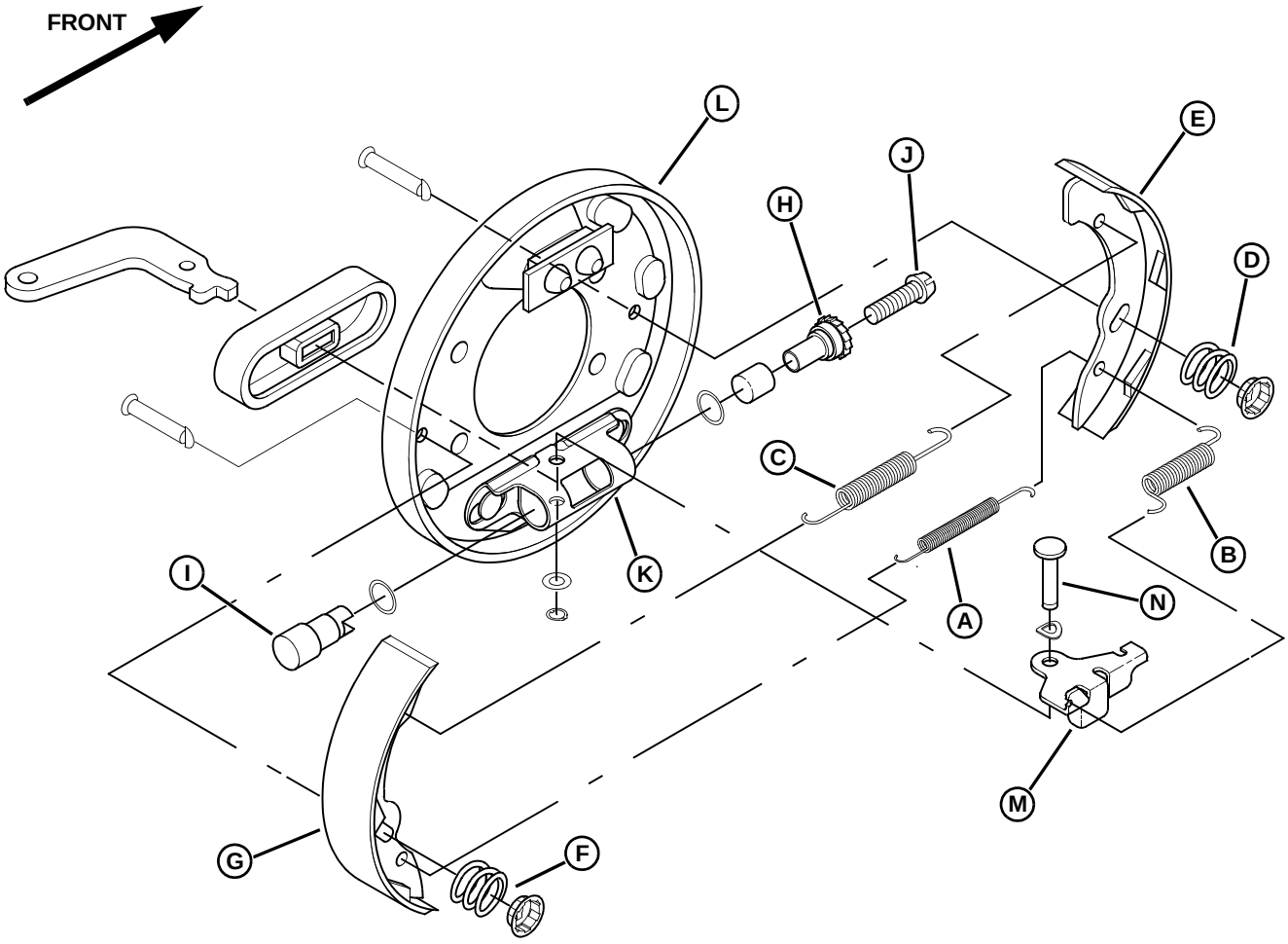
1. Install front and rear plungers (I). Front plunger is flat faced and slotted. Slot must be oriented horizontally.

NOTE: Ensure front plunger slot is fully seated.

2. Install rear brake shoe (G), hold down spring (F) and clip. Ensure clip is rotated 90° during installation and fully seated.
3. Slide lower brake shoe spring (A) under self adjuster housing (K) and connect end to rear brake shoe.
4. Place front brake shoe (E) in position.
5. Install hold down spring (D) and clip. Ensure clip is rotated 90° during installation and fully seated.

NOTE: Ensure brake shoes are in correct position with bottom of rear brake shoe seated in slot of self adjuster screw (J).

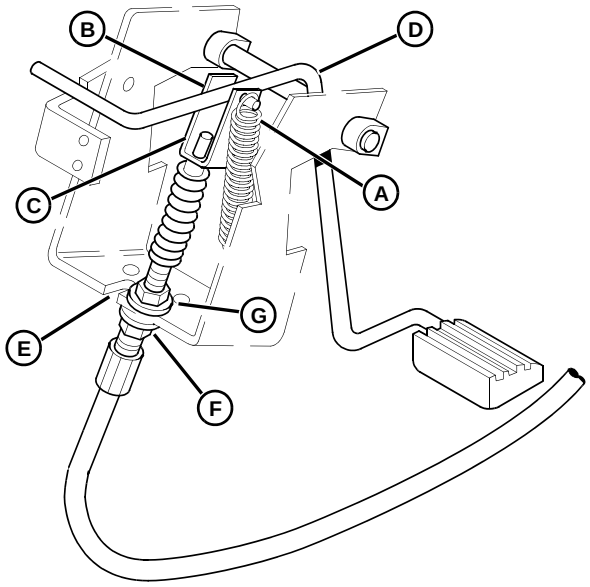
6. Connect both ends of lower brake shoe spring (A).
7. Install top brake shoe spring (C).
8. Connect front end of adjuster spring (B) to front brake shoe, position spring above and behind self adjuster housing (K) , and connect adjuster spring (B) to brake adjustment arm (M).
9. Check brake shoes for correct positioning, freedom of movement and seating against self adjustor plungers.
10. Install brake drum, wheel and lug nuts.
11. Lower vehicle to ground and tighten lug nuts to **100 N•m (75 lb-ft)**.
12. Adjust brakes. See “REAR BRAKE CABLE ADJUSTMENT” on page 10.



BRAKE CONTROL CABLE REMOVAL & INSTALLATION

Removal:

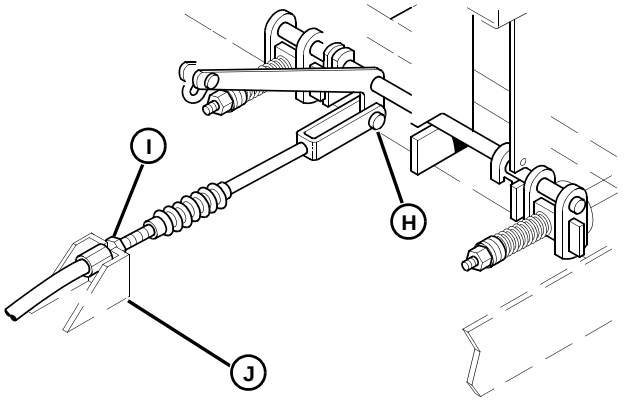
1. Position the vehicle on a level surface.
2. Turn the key switch to the OFF position, and place the shift lever in the NEUTRAL position.
3. Set Service/Drive switch to Service position.
4. Place park brake lever in released position, and BLOCK front wheels.
5. Remove the hood, seats and controls cover. See MISC. SECTION starting on page 3.



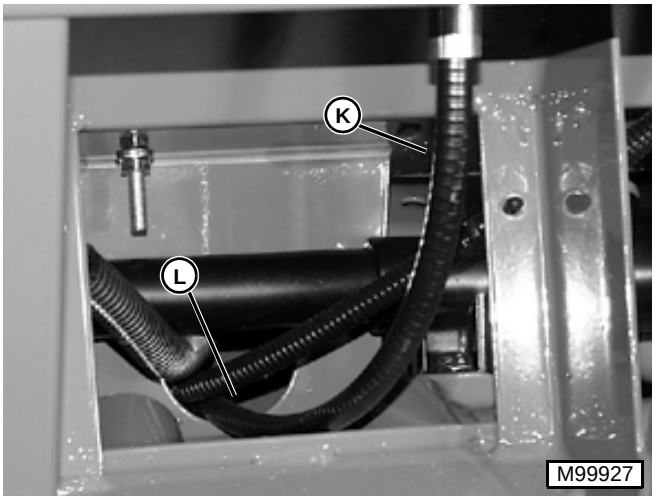
6. Unhook the return spring (A) securing the clevis pin (B) that is holding the cable clevis (C) to the pedal rod (D).

IMPORTANT: DO NOT allow brake control cable to slip out of slot (E) or cable may become kinked. Hold cable in slot by holding cable below lower nut (F) when loosening top nut (G).

7. Using two wrenches to prevent the cable from twisting and slipping out of slot, loosen the top nut (G) and remove cable from slot in bracket.



8. In the controls area under the seats, remove the cotter pin and clevis pin (H) holding the brake control cable to the actuator shaft assembly.
9. Loosen the nut (I) and slide the control cable out of the bracket (J).



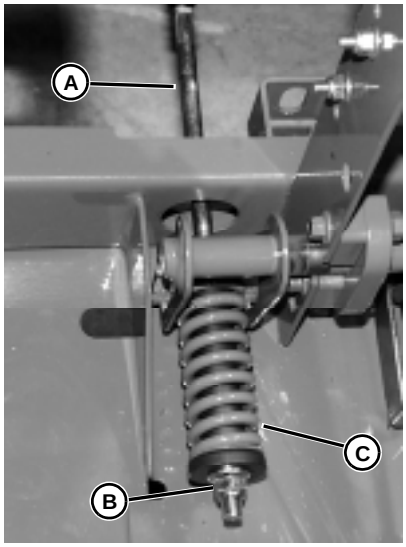
10. With the cable loose and removed from the slots on each end, pull the cable (K) down away from the brake pedal bracket and out the front of the vehicle through the opening (L) under the floor panel.

Installation is in reverse of removal.

REAR BRAKE CABLE REMOVAL & INSTALLATION

Removal:

1. Position the vehicle on a level surface.
2. Turn the key switch to the OFF position, and place the shift lever in the NEUTRAL position.
3. Set Service/Drive switch to Service position.
4. Place park brake lever in released position, and BLOCK front wheels.
5. Remove the seats, seat base cover and rear cover. See MISC. SECTION.
6. Remove batteries and battery tray. See BATTERIES SECTION “BATTERY REPLACEMENT” on page 17 and “BATTERY TRAY & SUPPORT REMOVAL & INSTALLATION” on page 19.



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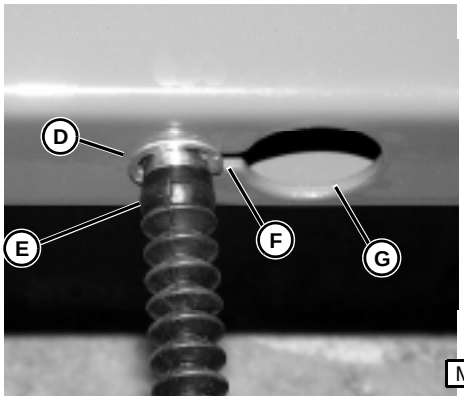
7. Using a locking pliers, clamp on to the cable rod at the flattened surfaces (A) and remove nut (B). This will release the tension on the brake spring (C).



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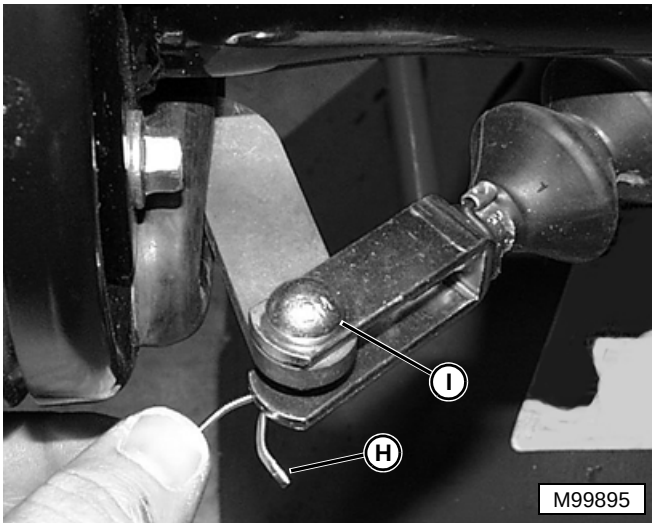
8. Remove the e-clip (D) holding the brake cable to the frame cross channel.
9. Pull the rubber boot (E) forward enough to expose the wire cable so that the brake cable can be pulled back enough to allow the wire cable to slide through the slot (F) and out the hole (G).



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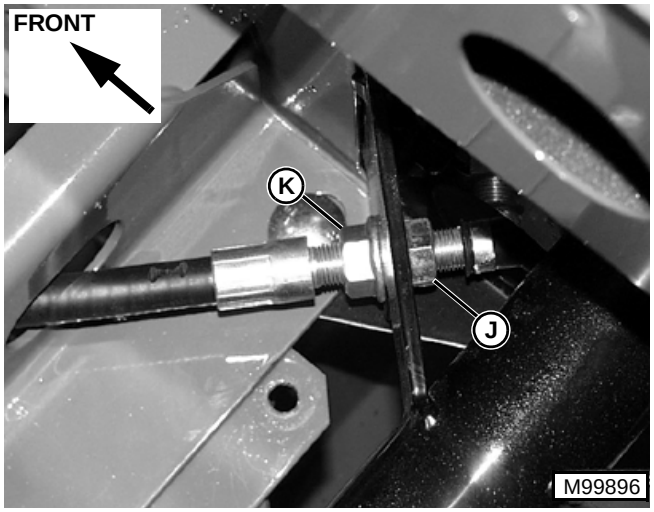
10. At the rear of the vehicle, remove the cotter pin (H) and clevis pin (I).



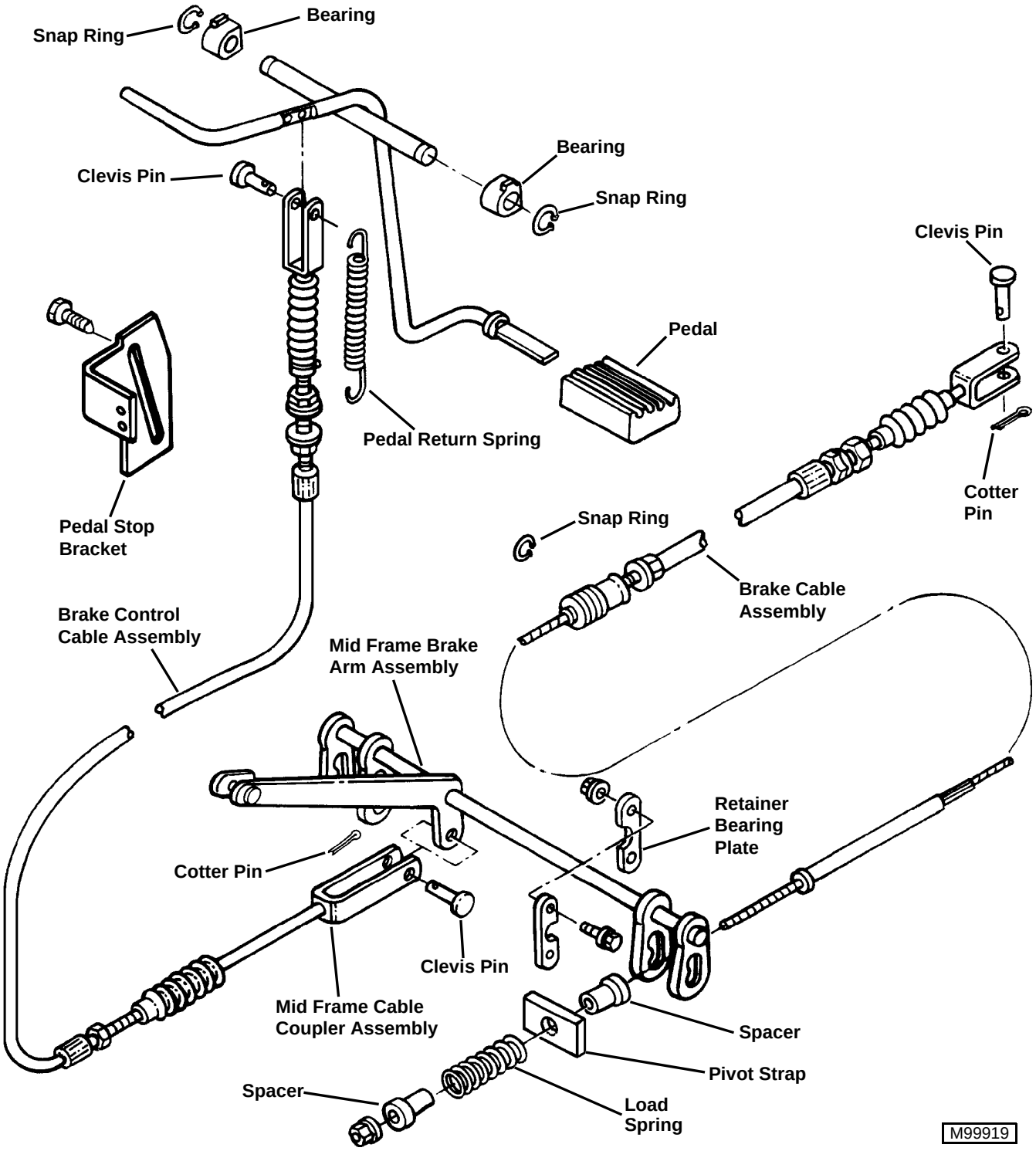
M99896

11. Using two wrenches, hold nut (J) and loosen nut (K).
12. Unhook the cable from the axle bracket and pull the cable forward out of the vehicle.

Installation is in reverse of removal.

1. Install a new brake cable in the reverse order from removal and the adjust the brake cable. See “REAR BRAKE CABLE ADJUSTMENT” on page 10 .

BRAKE CABLE COMPONENT LOCATION



NOTES:

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SPECIFICATIONS

TORQUE SPECIFICATIONS:

Front Wheel Mounting Cap Screw Torque	90 N•m (70 lb-ft)
Rear Wheel Mounting Lug Nut Torque	88 N•m (65 lb-ft)
Seat Mounting Cap Screw Torque	17 N•m (140 lb-in.)
Hood Mounting Cap Screw Torque	6 N•m (54 lb-in.)
Control Covers Mounting Cap Screw Torque	6 N•m (54 lb-in.)
Rear Covers Mounting Cap Screw Torque	9 N•m (78 lb-in.)
Hitch to Frame Lock Nut Torque	90 N•m (70 lb-ft)

REPAIR

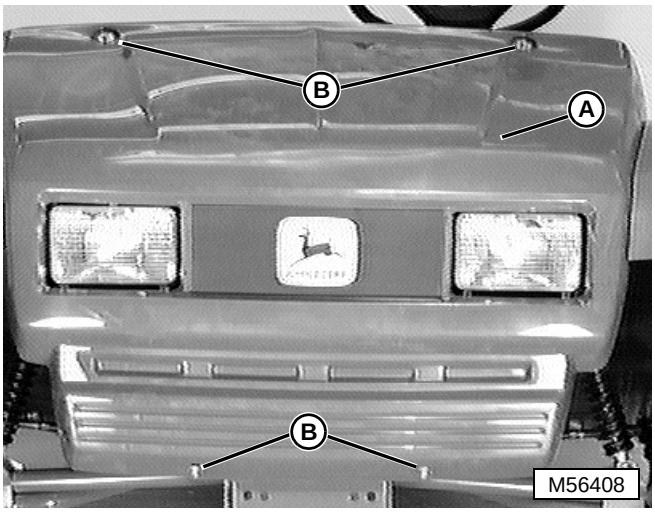
HOOD INSTALLATION & ADJUSTMENT

Reason:

To position hood so openings for the headlights are centered around headlights.

Procedure:

1. Park machine on level surface, turn key switch OFF, place shift lever in NEUTRAL, and lock park brake.



2. To remove the hood (A) remove the cap screws (B).

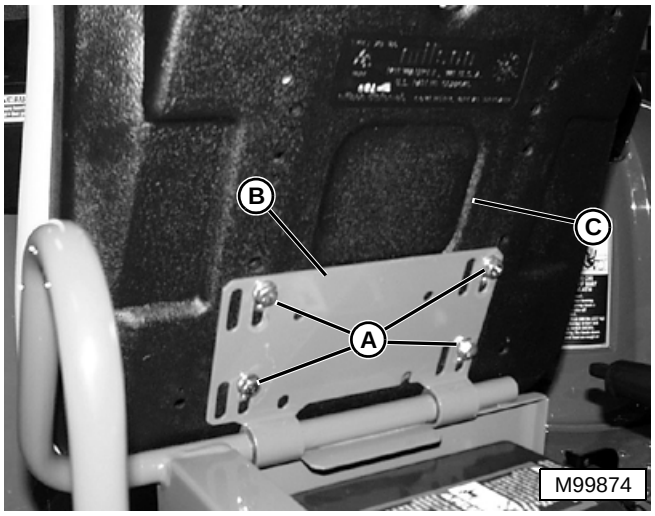
IMPORTANT: Hood MUST NOT touch headlights or vibration may cause headlights to fail.

3. Adjust hood so openings around headlights are equal.
4. Tighten bottom cap screws (B), then tighten top cap screws to **6 N•m (54 lb-in.)**.
5. Make sure hood has not shifted during tightening. Adjust again, if necessary.

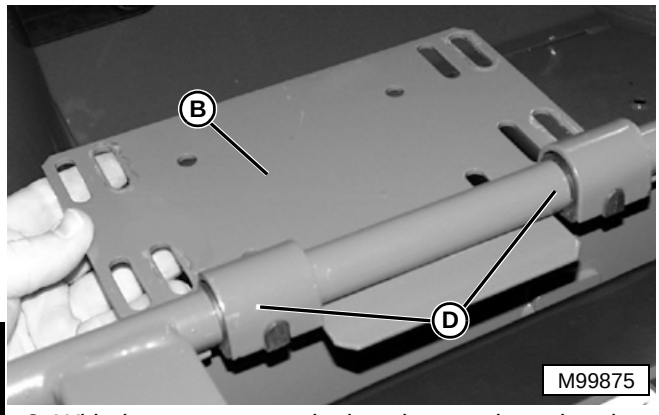
SEAT REMOVAL & INSTALLATION

Removal:

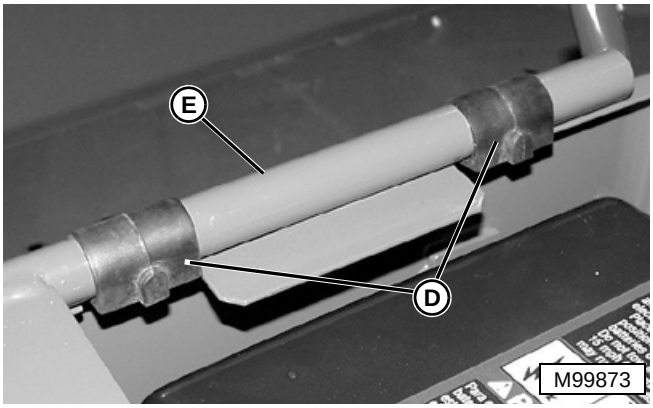
1. Park vehicle on a hard level surface.
2. Turn key switch to the OFF position.
3. Move the directional control lever to the NEUTRAL position.
4. Engage park brake.
5. Raise and tilt operators seat up and forward to gain access to the service/drive switch.
6. Place the service/drive switch in the service position.



7. With the seat to be removed in the raised position, remove the seat by removing the four capscrews (A) securing the seat base bracket (B) to the seat (C).

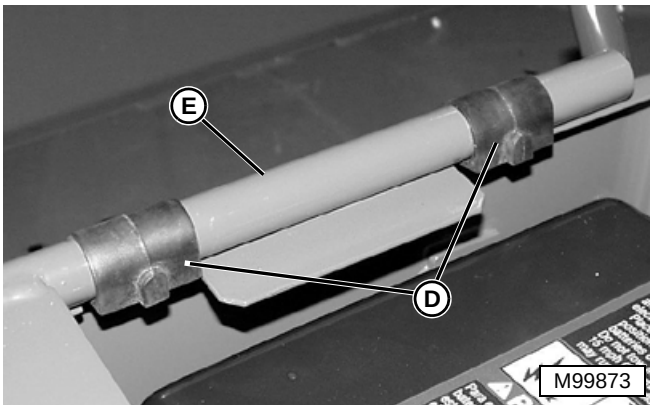


8. With the seat removed, pivot the seat base bracket (B) forward until it is in a horizontal position. Then lift it up and off of the rubber seat bushings (D).

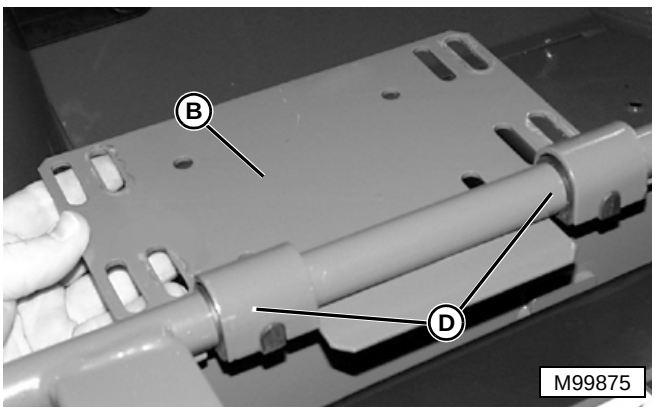


9. Remove the rubber seat bushings (D) from the seat frame rail (E).

Installation:



1. Position the rubber seat bushings (D) onto the seat frame rail (E) with the tabs facing to the rear of the vehicle.



2. Position the seat base bracket (B) onto the rubber seat bushings (D) so that the tabs from the rubber seat bushings engage the notches from the seat base bracket pivots.

NOTE: There is only one correct position laterally for each seat. Use the inboard slots when installing the seats.

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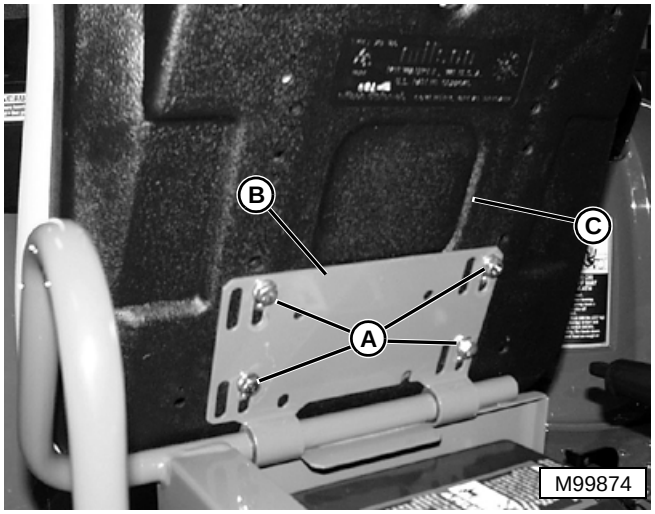
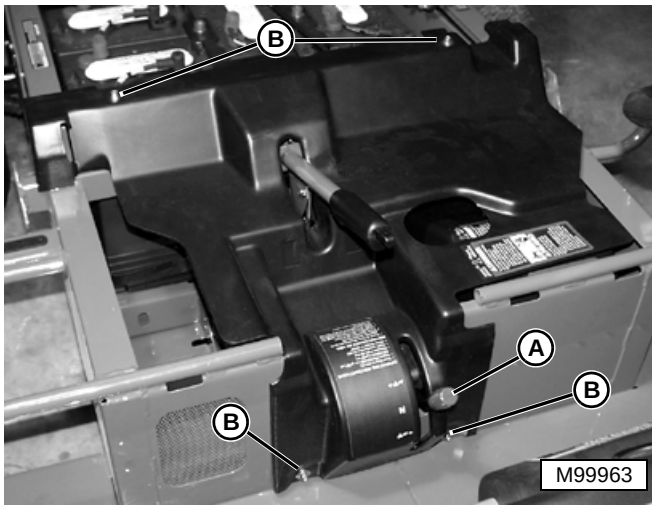


3. Rotate the seat base bracket (B) into an upward position and attach the seat (C) to the seat base bracket using the inboard set of slots.
4. Position the seat up or down in the slots to the desired position and tighten to **17 N•m (140 lb-in.)**.

SEAT BASE COVER REMOVAL & INSTALLATION

Removal:

1. Park vehicle on a hard level surface.
2. Turn key switch to the OFF position.
3. Move the directional control lever to the NEUTRAL position.
4. Engage park brake.
5. Raise and tilt operators seat up and forward to gain access to the service/drive switch.
6. Place the service/drive switch in the service position.
7. Remove both seats. See “SEAT REMOVAL & INSTALLATION” on page 4.



8. Remove the shift lever knob (A) by pulling it off of the shift lever.
9. Remove the four capscrews (B) securing the cover to the frame and lift the cover up and off of the vehicle.

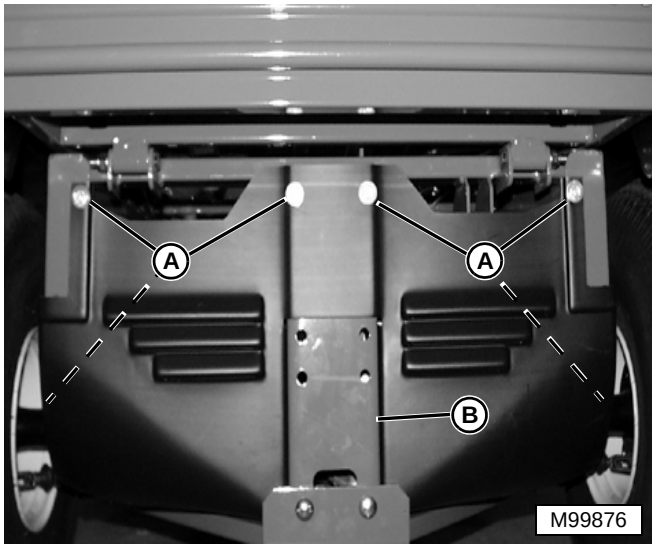
Installation is done in the reverse order of removal.

1. With the cover properly in place tighten the four capscrews to **6 N•m (54 lb-in.)**.

REAR COVER REMOVAL & INSTALLATION

Removal:

1. Park vehicle on a hard level surface.
2. Turn key switch to the OFF position.
3. Move the directional control lever to the NEUTRAL position.
4. Engage park brake.
5. Raise and tilt operators seat up and forward to gain access to the service/drive switch.
6. Place the service/drive switch in the service position.



7. Remove the six capscrews (A) securing the cover to the frame.
8. Tip the top of the cover down to unhook the cover from the center bracket (B) and pull the cover out and away from the vehicle.

Installation is done in the reverse order of removal.

1. With the cover properly in place tighten the six capscrews to **9 N•m (78 lb-in.)**.

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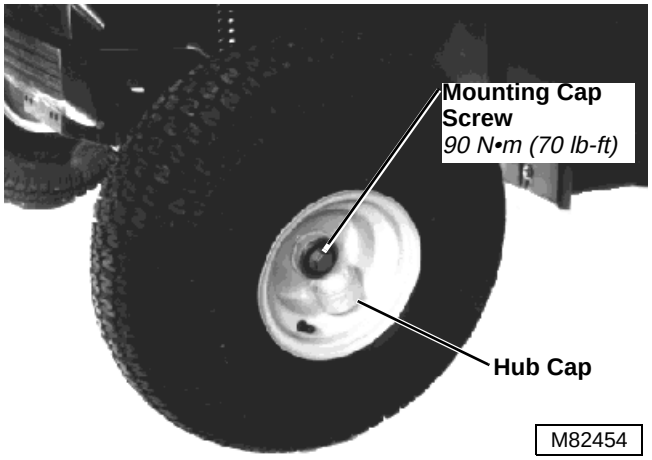
FRONT WHEEL REMOVAL & INSTALLATION

1. Park vehicle on a hard level surface.
2. Turn key switch to the OFF position.
3. Move the directional control lever to the NEUTRAL position.
4. Engage park brake.
5. Raise and support machine so that the front wheel are just off the ground.
6. Remove mounting cap screw.
7. Tap on backside of wheel rim with a soft-faced mallet to remove wheel.
8. Inspect and replace bearings, if necessary.



Installation is done in the reverse order of removal.

- Apply multipurpose grease to spindle shaft before installing wheel.
- Install front wheels with stems toward outside of machine.
- Tighten mounting capscrew to **90 N•m (70 lb-ft)**.

REAR WHEEL REMOVAL & INSTALLATION

1. Park vehicle on a hard level surface.
2. Turn key switch to the OFF position.
3. Move the directional control lever to the NEUTRAL position.
4. Engage park brake.
5. Raise and support machine so that the rear wheels are just off the ground.
6. Remove five lug nuts.
7. Remove wheel.

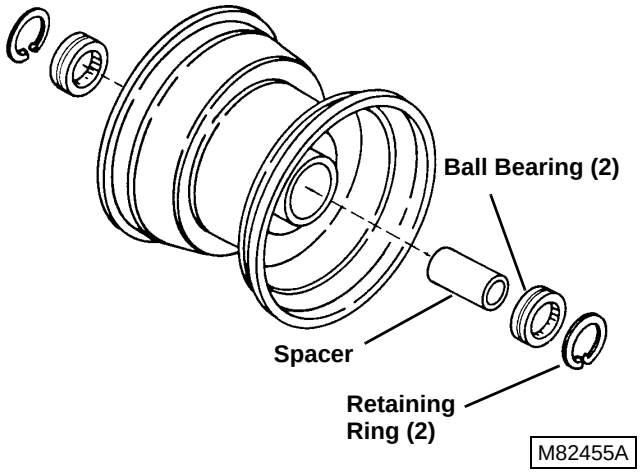
Installation is done in the reverse order of removal.

- Tighten lug nuts to **88 N•m (65 lb-ft)**.

FRONT WHEEL BEARING REPLACEMENT

NOTE: Bearings are press fit in wheel rim.

1. Remove bearing on one side using an inside puller and slide hammer.
2. Remove bearing on opposite end using a driver set.
3. Pack inside of rim with multipurpose grease before installing spacer and bearings.



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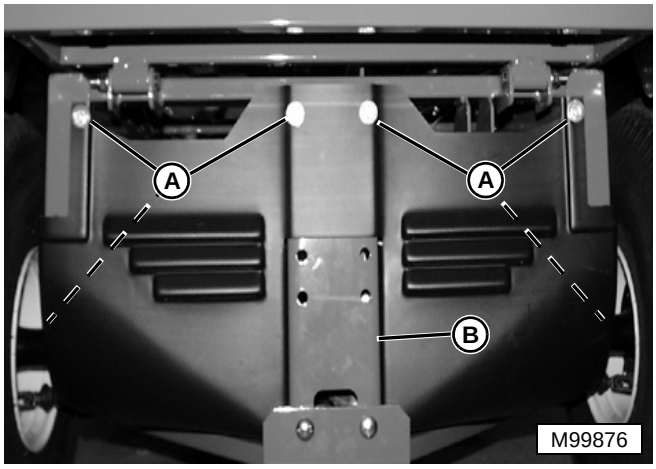
HITCH ASSEMBLY REMOVAL & INSTALLATION

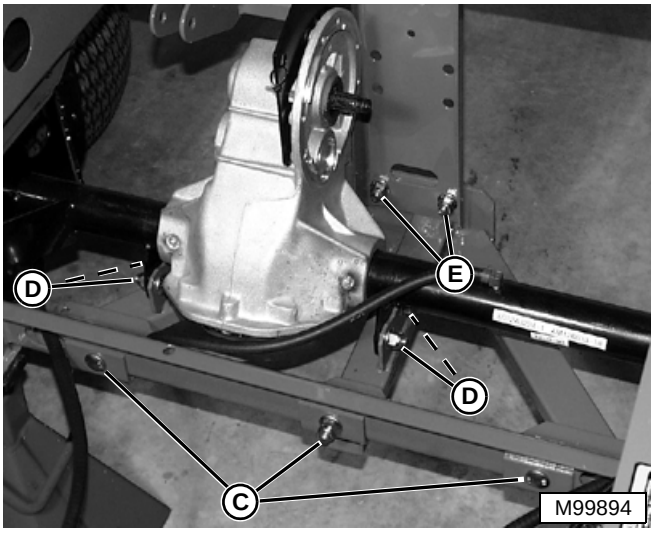
Removal:

1. Park vehicle on a hard level surface.
2. Turn key switch to the OFF position.
3. Move the directional control lever to the NEUTRAL position.
4. Block the front wheels to prevent the vehicle from rolling when the rear axle is raised off of the ground.
5. Raise and tilt operators seat up and forward to gain access to the service/drive switch.
6. Place the service/drive switch in the service position.
7. Raise the cargo box and secure the prop rod.
8. Note the position of each battery and the location of both the positive and negative terminals.
9. Using insulated tools and care not to touch wrench to other terminals or the frame of the vehicle, disconnect the battery pack positive wires.
10. Remove the batteries and battery tray. See BATTERIES SECTION “BATTERY REPLACEMENT” on page 17.



11. Remove the six capscrews (A) securing the cover to the frame.
12. Tip the top of the cover down to unhook the cover from the rear support bracket (B) and pull the cover out and away from the vehicle.

NOTE: Electric motor has been removed for clarity. It is not necessary to remove the electric motor.



13. Remove the nine carriage bolts securing the hitch to the vehicle. There are three (C) bolts through the frame cross member, four (D) bolts fastening the hitch to the rear support bracket, and two (E) fastening the hitch to the rear support bracket.
14. Pull the hitch assembly down and out the rear of the vehicle.

Installation is done in the reverse order of removal.

1. Install the nine carriage bolts securing the hitch assembly to the frame, axle and rear support bracket. Tighten to **90 N•m (70 lb-ft)**.

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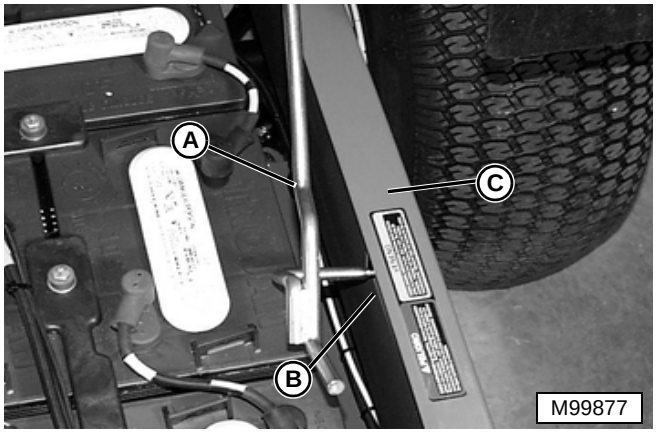
CARGO BOX REMOVAL & INSTALLATION

Removal:

1. Park vehicle on a hard level surface.
2. Turn key switch to the OFF position.
3. Move the directional control lever to the NEUTRAL position.
4. Engage park brake.
5. Raise and tilt operators seat up and forward to gain access to the service/drive switch.
6. Place the service/drive switch in the service position.
7. Raise and secure the cargo box.

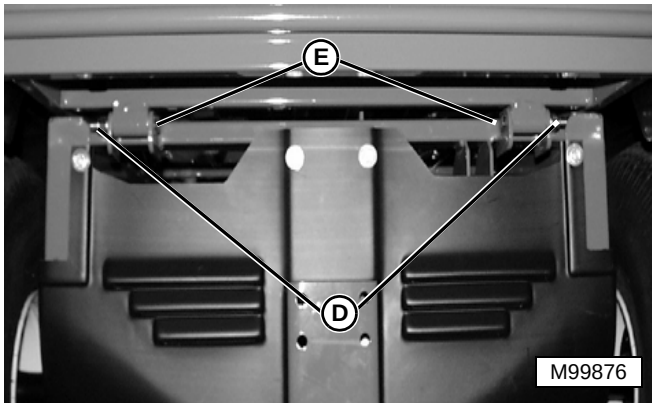
Manual Lift System:

1. Using a hoist, support the cargo box so that the prop rod can be disconnected from the slide channel.



NOTE: DO NOT over flex the prop rod and cause it to have a permanent bend.

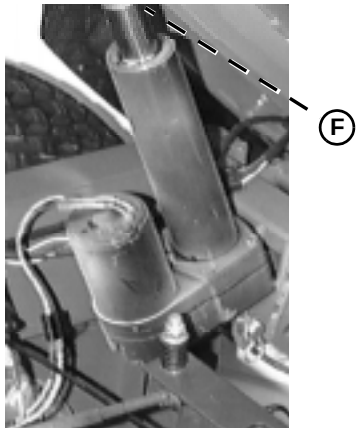
2. Flex the prop rod (A) inward until it has cleared the slide channel (B) and frame rail (C).
3. Raise the prop rod and hook the rod into the latch plate.
4. Lower the box to its stowed position.



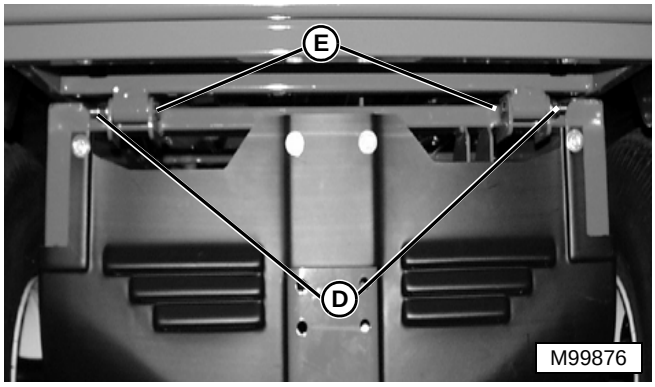
5. At the rear of the vehicle remove both cargo box pivot lock nuts (D) and capscrews (E).
6. Using a lifting device or an assistant, carefully lift the box off of the vehicle and set out of the way.

Power Lift System:

1. Using a hoist, support the cargo box so that the lift actuator can be disconnected.



2. Carefully remove the upper (F) actuator pin and retract the actuator rod.
3. Lower the box to its stowed position.



4. At the rear of the vehicle remove both cargo box pivot lock nuts (D) and capscrews (E).

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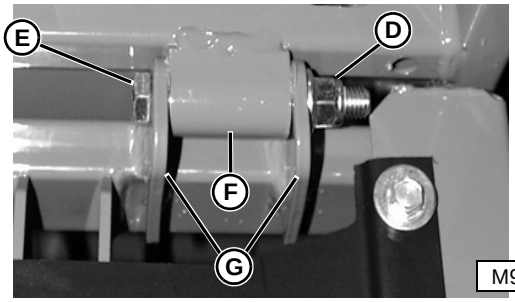
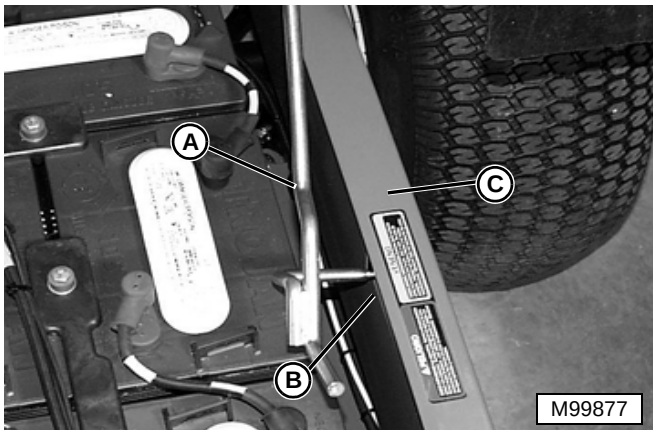
5. Using a lifting device or an assistant, carefully lift the box off of the vehicle and set out of the way.

Installation:



1. Set the cargo box on the vehicle frame so that the pivot bushings (F) on the box engage the pivot blocks (G) on the frame.
2. Install the two capscrews (E) and lock nuts (D) and tighten enough so that box pivots freely.
3. Raise the cargo box and support with a hoist so that the prop rod or lift actuator can be installed.

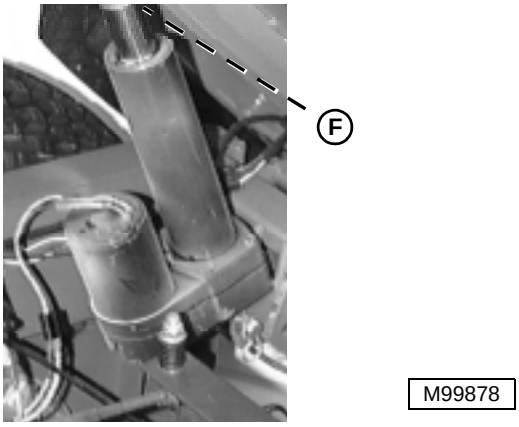
Manual Lift System:



NOTE: DO NOT over flex the prop rod and cause it to have a permanent bend.

1. Flex the prop rod (A) inward until it clears the frame rail (C) and is allowed to snap back into the slide channel (B).
2. Lock the prop rod in place and remove the hoist being used to support the box.

Power Lift System:



1. Carefully extend the lift actuator rod positioning the top end of the lift actuator into place and install the upper connecting pin (F).

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NOTES:

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