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WARNING: Read this manual and any attachment owner’s manuals before using this equipment. Failure to do so can result in serious injury or death. Call your dealer if you have any questions.

HAZARD DEFINITIONS
For your safety, and to assure the long life of your equipment, be sure you understand the following signal words which will be seen throughout this manual:

• DANGER: Alerts you to an immediate hazard, which will always result in severe personal injury and possible death if it is not avoided.
• WARNING: Alerts you to a hazard which will result in a serious personal injury or possible death in some cases, if not avoided.
• CAUTION: Alerts you to a potential hazard which may result in a serious personal injury if not avoided. It also alerts against an unsafe practice that will permanently damage equipment or property.
• IMPORTANT: Points out a proper use that will avoid damage to the machine, and/or will extend the life of its parts.
• NOTE: Suggests how to use or adjust the equipment for best product results.

IDENTIFICATION OF SAFETY LABELS
Safety labels are strategically located around the vehicle to prevent potential hazards. The labels are a permanent part of the equipment. If they become separated from the product or illegible, contact M-B Companies Inc. for no-cost replacements. Understand the information the labels are communicating before operating or maintaining the equipment.

WARNING: HIGHER ROLLOVER RISK
Avoid Abrupt Maneuvers and Excessive Speed
Travel at Low Speed When Turning
Always Wear Safety Belt

DANGER: HOT FLUID UNDER PRESSURE

DANGER: CUTTING/SEVERING OF FINGERS OR HAND - FAN

DANGER: ROTATING DRIVELINE HAZARD
To prevent serious injury or death from pinching:
• Keep all guards in place when operating.
• Keep hands, feet, hair and clothing away from moving parts.

DANGER: DO NOT GO NEAR HYDRAULIC OIL LEAKS
• When checking for hydraulic system leaks, observe only.
• Never use your hands to check for leaks.
• Hydraulic oil from a pin hole leak can puncture your skin and cause serious injury, gangrene, or death.
• If injured by hydraulic oil under pressure, seek medical attention immediately.
• Oil can be hot and can cause severe burns.

WARNING: Uneven terrain at higher speeds may cause vehicle to become unstable

WARNING: HOT SURFACE

WARNING: NO RIDERS OR HANGERS ON

WARNING: EMERGENCY PUSH TO STOP PULL TO RUN

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GENERAL SAFETY

• This manual should be available during operation.
• Extra copies of this manual are available for purchase through the M-B Customer Service Department.
• To avoid serious injury or death, do not modify equipment. Any modifications made to equipment can be dangerous and can void equipment warranty.
• Never defeat a safety device to make a task easier.
• Never deface or remove factory-installed safety labels. If a label ever becomes lost, damaged, or illegible, report this condition to a supervisor and obtain a replacement label from the Customer Service department of M-B Companies, Inc.
• Always wear proper apparel when operating equipment; safety glasses, face shield or goggles, ear protection, and dust mask. Tie hair back. Never wear loose clothing or jewelry that could get caught in moving parts.
• Never operate equipment with covers or guards removed. Rotating parts can cause severe injury. Keep hands, feet, hair, jewelry and clothing away from all moving parts.
• Understand the operation of hydraulic and pneumatic controls.
• Understand which adjustments are operator and which are maintenance adjustments.
• Always shut OFF equipment when left unattended.
• Never operate or work around equipment if under the influence of alcohol, drugs or medications.

PRE-START-UP SAFETY

• Install any covers or guards which may have been removed for shipping purposes or maintenance.
• Before starting equipment, walk around equipment, making a visual inspection that all safety devices are properly installed and secured.
• Check that all hardware, fasteners, hydraulic fittings, etc. are in good condition and properly fastened. Replace any fatigued or damaged items with proper replacements.
• Personnel who are not required to be in the work area should be kept away. Never start the equipment unless you are absolutely certain that everyone in the area is clear of the machine and aware it is being started.
• Follow the manufacturer’s recommended start-up procedure.

PRESSURIZED SYSTEMS SAFETY

• Do not disassemble a pressurized system unless properly trained and equipped with adequate tooling.
• Familiarize yourself with the proper method of relieving pressure from pneumatic or hydraulic systems. Never perform maintenance on, or disassemble, pressurized systems without first locking out power to these systems and then relieving pressure to them.
• Oils and fluids can be very hot under pressure. Use caution and allow the system to cool before beginning maintenance work.
• Never operate or pressurize one of these systems with worn or damaged components. Replace hoses, fittings, valves or other components which appear defective.
• Never adjust pressurized systems beyond recommended levels to achieve higher operating pressures.

THE MANUAL

It is the purpose of this manual to provide complete instructions for service, maintenance disassembly, repair, and installation of the mechanical components for the M-B Multi-Service Vehicle.

Directional Reference

All reference to left, right, front, or rear are given from the operator in the operator position and facing the direction of your unit.

REQUIRED OPERATOR TRAINING

Original purchaser of this unit was instructed by the seller on safe and proper operation. If unit is to be used by someone other than original purchaser; loaned, rented or sold, ALWAYS provide this manual and any needed safety training before operation.

The Operator Must Understand:

• How to operate all controls
• The functions of all controls
• How to STOP in an Emergency
• Speed Ranges
WORK AREA

• ALWAYS check overhead and side clearances carefully before operation. ALWAYS be aware of traffic when operating along streets and curbs.
• Keep area of operation clear. Stay alert for hidden hazards.
• DO NOT run engine in an enclosed area. Always provide good ventilation.
• Abnormal Vibrations are a warning of trouble. Striking a foreign object can damage unit. Stop unit and engine. Wait for all moving parts to stop. Inspect unit and make any necessary repairs before restart.
• Protect eyes, face, and head from objects that may be thrown from unit. Wear appropriate hearing protection.
• Avoid Sharp Edges. Sharp edges can cause serious injury. Wear gloves to service unit when handling sharp edges.
• ALWAYS keep hands and feet away from all moving parts during operation. Moving parts can cause serious injury or death.
• Be aware of the surroundings. Look for blind spots from which pedestrians or vehicles may suddenly appear.
• Locate the emergency stop on the vehicle.
• Do not operate in crowded pedestrian areas. This equipment may cause serious injury or death if safety rules are not followed.
• The M-B Multiple Service Vehicle (M-B MSV) uses a level gauge. The gauge helps the operator determine the angle or slope of the surface being driven on. The gauge shows percent of grade.

WARNING:

During normal operation the M-B MSV must not exceed 30% grade to either side. Adding any attachment to the M-B MSV will affect the safe maximum grade.

SLOPE INDICATOR (INCLINOMETER)

Figure 1

MAINTENANCE SAFETY

• Do not remove guards while operating. After maintenance work, be sure all guards and other safety devices are installed and in proper working order.
• Never clean, lubricate, or adjust equipment while it is moving, has the potential to move or when engine is running.
• Always release pressure from pressurized systems before disassembling.
• Allow ample time for heated components to cool before working on or working close to them. Use temperature sticks or other appropriate devices to test temperatures.
• ALWAYS maintain unit in safe operation condition.
• Check the conditions of the unit at the end of each day and repair any damage or defects.
• Keep all fasteners properly torqued and in safe operating condition.
• Before maintenance, adjustments, or service (except where specifically recommended), shut off engine, and secure from moving.

Storage

ALWAYS clean and lubricate equipment before extended storage. Clean and lubricate equipment every 6 months during prolonged storage.

WELDING

Before welding on a machine/unit equipped with an electronic engine, the following precautions should be observed:

• Turn the engine control switch to the OFF position.
• Disconnect the negative battery cable at the battery. If a better disconnect switch is provided, open the switch.
• Connect the welder ground cable directly to the member to be welded. Place the ground cable clamp as close as possible to the weld to reduce the possibility of welding current damage to bearings, hydraulic components, electrical components and ground straps. Do not use electrical components, the ECM, or electronics ground stud for grounding of the welder.
• Protect wiring from welding debris or splatter.
INTRODUCTION
Thank you for choosing M-B Companies, Inc. as your equipment manufacturer and supplier. As part of our commitment to total customer satisfaction, we have strived to ensure that the information contained within this manual is complete and representative of the equipment you have purchased. The manual cannot, however, anticipate every possible contingency to be met in the installation, operation and maintenance for your equipment. If you require additional information not included in this manual, please contact our Service Department at:

Customer Service Department
C/o M-B Companies, Inc.
1615 Wisconsin Ave.
PO Box 200
New Holstein, WI 53061
Phone: 1-888-558-5801 or 1-800-558-5800
Fax: 920-898-4588

CUSTOMER SERVICE
The serial number on your equipment is essential for proper service support. When contacting M-B Companies regarding service support, always provide the product serial number. This number is located on the identification plate mounted on your equipment, and should also have been recorded in the Machine Identification section.

Customer Service Department
C/o M-B Companies, Inc.
1615 Wisconsin Ave.
PO Box 200
New Holstein, WI 53061
Phone: 1-888-558-5801 or 1-800-558-5800
Fax: 920-898-4588

MACHINE IDENTIFICATION
Each machine manufactured by M-B Companies, Inc. has an identification plate mounted to it as shown in Figure 2. This plate contains the serial number of your M-B equipment. This information is important to have available when communicating with M-B.

Figure 2
Manufacturer’s Limited Warranty

The M-B Companies, Inc. warrants all its M-B MSV products to be free from defects in materials and workmanship for 12 months, to begin with the delivery of said product to its original owner. This warranty is not transferable without the written consent of M-B.

M-B will, at its own expense and without expense to the owner, replace all failed parts for and make all repairs that may be required by reason of workmanship or material in any part of the assembly of the product and associated components.

Upon notice in writing, M-B will promptly repair or replace all defective or damaged items delivered under the contract. The batteries, tires, rubber materials, brushes and material normally consumed in operation, and major components such as engines, air compressors, and hydraulic pumps and motors are excluded from this warranty but shall, in any event, be guaranteed by M-B to the extent of any warranty received from its supplier.

Any components replaced under warranty will be warrantied for the remainder of the original warranty. Replaced components do not restart the warranty period.

If requested by M-B, products or parts for which a warranty claim is made are to be returned, transportation prepaid, to M-B’s factory. Any improper use, operation beyond capacity, or substitution of parts not approved by M-B, or alteration or repair by others in such a manner as in M-B’s judgement materially and/or adversely affects the product shall void this warranty.

This warranty does not apply to defects caused by damage or unreasonable use while in the possession of the owner, including but not limited to: failure to provide reasonable and necessary maintenance, normal wear, routine tune-ups or adjustments, improper handling or accidents, operation at speed or load conditions contrary to published specifications, improper or insufficient lubrication, or improper storage.

The M-B Companies, Inc. shall not be liable for consequential damages of any kind, including, but not limited to, consequential labor costs or transportation charges in connection with the replacement or repair of defective parts, or lost time or expense which may have accrued because of said defect.

THE M-B COMPANIES DO NOT MAKE ANY WARRANTY OF MERCHANTABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE. THE ONLY WARRANTY MADE BY M-B COMPANIES IS AS SET FORTH HEREIN. THIS WARRANTY CANNOT BE EXTENDED, BROADENED OR CHANGED EXCEPT IN WRITING BY AN AUTHORIZED OFFICER OF M-B COMPANIES, INC.

(M-B’s total liability hereunder in no event shall exceed the purchase price of the product.)
INTRODUCTION

This section provides information that is specific to the M-B MSV. Each sub-section describes a component or system to give the reader a reasonable understanding of the topic. If a more in-depth knowledge is needed, contact M-B Companies Customer Support.

SPECIFICATIONS

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<tr>
<th>Engine</th>
<th>Type</th>
<th>Cummins QSB4.5 Teir 3 Turbo Diesel</th>
</tr>
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<tr>
<td></td>
<td>Displacement</td>
<td>275 cu-in (4.5 L)</td>
</tr>
<tr>
<td></td>
<td>Rated Horsepower</td>
<td>110 @ 2500 RPM, 115 @ 2300 RPM</td>
</tr>
<tr>
<td></td>
<td>Battery Size</td>
<td>1125 CCA</td>
</tr>
<tr>
<td></td>
<td>Charging System</td>
<td>Delco Remy, 3 phase, 12 volt, 95 Amp, 1125 CCA Battery</td>
</tr>
<tr>
<td></td>
<td>Compression Ratio</td>
<td>17.2 to 1</td>
</tr>
<tr>
<td></td>
<td>Cooling</td>
<td>Suction Fan Cooled Radiator</td>
</tr>
<tr>
<td></td>
<td>Cooling System Capacity</td>
<td>3 gallons (11.3 L)</td>
</tr>
<tr>
<td></td>
<td>Fuel Tank Capacity</td>
<td>19 gallons (71.9 L)</td>
</tr>
<tr>
<td></td>
<td>Cab</td>
<td>ROPS certified to ISO 3471 and SAE J1040C at 12,000 lbs</td>
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<table>
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<tr>
<th>Chassis</th>
<th>Type</th>
<th>Custom Fabricated Steel Construction Reinforced Wheel Motor Design</th>
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<tbody>
<tr>
<td></td>
<td>Articulation</td>
<td>45 degrees</td>
</tr>
<tr>
<td></td>
<td>Oscillation</td>
<td>15 degrees</td>
</tr>
<tr>
<td></td>
<td>Caster/Camber</td>
<td>0.5 degrees / 1.0 degrees</td>
</tr>
<tr>
<td></td>
<td>Overall Length</td>
<td>157&quot; (398 cm)</td>
</tr>
<tr>
<td></td>
<td>Ground Clearance</td>
<td>13&quot; (33 cm) winter, 11&quot; (28 cm) summer</td>
</tr>
<tr>
<td></td>
<td>Track Width</td>
<td>50&quot; (127 cm) winter, 60&quot; (152 cm) summer</td>
</tr>
<tr>
<td></td>
<td>Wheel Base</td>
<td>83&quot; (210.8 cm)</td>
</tr>
<tr>
<td></td>
<td>Height</td>
<td>Winter 82&quot; (208 cm) top of cab and 89&quot; (226 cm) top of beacon, Summer 80&quot; (203 cm) top of cab and 87&quot; (221 cm) top of beacon</td>
</tr>
<tr>
<td></td>
<td>Cab Width</td>
<td>48&quot; (121.9 cm)</td>
</tr>
<tr>
<td></td>
<td>Curb Weight</td>
<td>6680 lbs (3330 kg)</td>
</tr>
<tr>
<td></td>
<td>Front or Rear Axle Rating</td>
<td>8000 lbs (3635 kg)</td>
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<tr>
<td></td>
<td>Gross Combined Weight Rating (GCWR)</td>
<td>12,000 lbs (5436 kg)</td>
</tr>
<tr>
<td></td>
<td>Gross Vehicle Weight Rating (GVWR)</td>
<td>12,000 lbs (5436 kg)</td>
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<tr>
<th>Radial Snow Tire</th>
<th>LT275-70R18</th>
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<tr>
<td>Lug Tires</td>
<td>10.5/80-18 10 Ply Rating</td>
</tr>
<tr>
<td>Turf Tires</td>
<td>33/16LL500 10 Ply Rating</td>
</tr>
<tr>
<td>Outside Turning Radius</td>
<td>116&quot; (294 cm) Radial Snow Tire, 126&quot; (320 cm) Turf Tire</td>
</tr>
<tr>
<td>Inside Turning Radius</td>
<td>66&quot; (168 cm) Radial Snow Tire, 76&quot; (193 cm) Turf Tire</td>
</tr>
<tr>
<td>Front Three Point Hitch</td>
<td>CAT 1 or CAT 2</td>
</tr>
<tr>
<td>Electronic Controls</td>
<td>Sauer Danfoss MC50-20, MC38-10</td>
</tr>
<tr>
<td>Front Module Type</td>
<td>Sauer Danfoss MC50-22, MC24-10</td>
</tr>
<tr>
<td>Rear Module Type</td>
<td>Sauer Danfoss DP 610 LX</td>
</tr>
<tr>
<td>Display Type</td>
<td>Sauer Danfoss</td>
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<tr>
<td>Power Output Module</td>
<td>(2) Copper Bussman MVEC Modules 31M-000-0J</td>
</tr>
<tr>
<td>Joystick Type</td>
<td>Suregrip LGGM-UUbUbUGGRG-02-B2/J-MP 2-J19-02</td>
</tr>
<tr>
<td>(1) 4 Position joystick w/ dual trigger</td>
<td></td>
</tr>
<tr>
<td>(4) 3 Position momentary toggle switches</td>
<td></td>
</tr>
<tr>
<td>(4) Momentary push buttons</td>
<td></td>
</tr>
<tr>
<td>2 Way Radio</td>
<td>12V power and memory quick hook up</td>
</tr>
<tr>
<td>Auxiliary Lighting (Optional)</td>
<td>10A front, 10A rear</td>
</tr>
<tr>
<td>Front End Connector</td>
<td>6 outputs, (4) 4A and 2 (15A)</td>
</tr>
<tr>
<td>Rear End Connector</td>
<td>6 outputs, (4) 4A and 2 (15A)</td>
</tr>
<tr>
<td>Ground Drive</td>
<td>Poclain MS05, 2-speed, Hydraulic Wheel Motors</td>
</tr>
<tr>
<td>Drive Motors</td>
<td>All Wheel Drive with Pressure Locking Differential</td>
</tr>
<tr>
<td>Traction Control</td>
<td>0 to 10 MPH Work Mode, 0 to 21 MPH Transport Mode</td>
</tr>
<tr>
<td>Ground Speed</td>
<td>Sauer Danfoss Series 90 75cc Axial Piston Pump Electronic Displacement Control</td>
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<tr>
<td>Pressure</td>
<td>5600 psi (386 bar)</td>
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## Hydraulic System

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
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<tbody>
<tr>
<td>Tank Capacity</td>
<td>18 gal (68L)</td>
</tr>
<tr>
<td>Total Fluid Capacity</td>
<td>Approximately 28 gal (106 L)</td>
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## Auxiliary Hydraulics

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<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auxiliary Pump Make/Model</td>
<td>Eaton Model 70423 (Standard)</td>
</tr>
<tr>
<td>Hydraulic Volume</td>
<td>31 GPM (117.4 Lpm) adjustable, standard</td>
</tr>
<tr>
<td>Operating Pressure</td>
<td>2800 psi (193 bar) maximum</td>
</tr>
<tr>
<td>Front Quick Couplers</td>
<td>Low Flow (5 gpm 18.9 Lpm max)</td>
</tr>
<tr>
<td></td>
<td>- 2 pairs of 9/16&quot; quick couplers</td>
</tr>
<tr>
<td></td>
<td>High Flow (31 gpm 117 Lpm max)</td>
</tr>
<tr>
<td></td>
<td>- 1 pair of 1-1/16&quot; quick couplers</td>
</tr>
<tr>
<td></td>
<td>Case Drain - 1-9/16&quot; male quick coupler</td>
</tr>
<tr>
<td>Chassis Manifold (optional) (Rear)</td>
<td>Low Flow (5 gpm 18.9 Lpm max)</td>
</tr>
<tr>
<td></td>
<td>- 2 pairs of 9/16&quot; orb fittings</td>
</tr>
</tbody>
</table>

## Power Take Off

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clutch</td>
<td>Dry type, electronic-over-hydraulic</td>
</tr>
<tr>
<td>Spline</td>
<td>6 spline 1-3/8&quot; diameter</td>
</tr>
<tr>
<td>RPM Front PTO</td>
<td>540 @ 2200 RPM</td>
</tr>
</tbody>
</table>

## Hitch Capacities

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Towing Capacity</td>
<td>6000 lbs (2721 kg)</td>
</tr>
<tr>
<td>Tongue Weight Capacity</td>
<td>2000 lbs (907 kg)</td>
</tr>
<tr>
<td>Front Lift Capacity</td>
<td>6000 lbs (2721 kg)</td>
</tr>
<tr>
<td>Accumulator</td>
<td>Nitrogen filled to 650 psi (44.8 bar)</td>
</tr>
</tbody>
</table>

## Cooling System

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fan Size</td>
<td>20&quot; (51 cm) Rear Mounted - Suction</td>
</tr>
<tr>
<td>Eng Radiator</td>
<td>35 x 24&quot; x 4&quot; - Suction</td>
</tr>
</tbody>
</table>

## AC System

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refrigerant Charge</td>
<td>R-134a, 1 lb 2 oz</td>
</tr>
<tr>
<td>Lubricant Charge</td>
<td>8 oz PAG oil</td>
</tr>
</tbody>
</table>
NOTE: Overall height and ground clearance is dependant on the radius of the tires. Dimensions given are based on 32 inch radial tires.
<table>
<thead>
<tr>
<th>Layout Callouts</th>
<th>Parts Manual Reference Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Exterior CAB</td>
<td>12</td>
</tr>
<tr>
<td>2 Auxiliary Manifold</td>
<td>14</td>
</tr>
<tr>
<td>3 Windshield</td>
<td>16</td>
</tr>
<tr>
<td>4 Door</td>
<td>18</td>
</tr>
<tr>
<td>5 Right Console</td>
<td>20</td>
</tr>
<tr>
<td>6 Joystick</td>
<td>22</td>
</tr>
<tr>
<td>7 Brake Assembly/Throttle</td>
<td>24</td>
</tr>
<tr>
<td>8 HVAC</td>
<td>26</td>
</tr>
<tr>
<td>9 Steering</td>
<td>28</td>
</tr>
<tr>
<td>10 Cab Interior</td>
<td>30</td>
</tr>
<tr>
<td>11 Rear Compartment</td>
<td>32</td>
</tr>
<tr>
<td>12 Exterior</td>
<td>34</td>
</tr>
<tr>
<td>13 Cooling Assembly</td>
<td>36</td>
</tr>
<tr>
<td>14 Fuel and Hydraulic Tanks</td>
<td>38</td>
</tr>
<tr>
<td>15 Chassis</td>
<td>40</td>
</tr>
<tr>
<td>16 Front Frame</td>
<td>42</td>
</tr>
<tr>
<td>17 Front Drive</td>
<td>44</td>
</tr>
<tr>
<td>18 Hitch</td>
<td>46</td>
</tr>
<tr>
<td>19 Midsection</td>
<td>48</td>
</tr>
<tr>
<td>20 Rear Frame</td>
<td>50</td>
</tr>
<tr>
<td>21 Left Rear Ground Drive</td>
<td>52</td>
</tr>
<tr>
<td>22 Right Rear Ground Drive</td>
<td>54</td>
</tr>
<tr>
<td>23 Rear Manifolds</td>
<td>56</td>
</tr>
<tr>
<td>24 Engine</td>
<td>58</td>
</tr>
<tr>
<td>25 Fuel, Air Intake and Exhaust Side Two</td>
<td>60</td>
</tr>
<tr>
<td>26 Engine Electrical Side One</td>
<td>62</td>
</tr>
<tr>
<td>27 Engine Electrical Side Two</td>
<td>64</td>
</tr>
<tr>
<td>28 Harness and Cable</td>
<td>66</td>
</tr>
<tr>
<td>29 PTO</td>
<td>68</td>
</tr>
<tr>
<td>30 Clutch</td>
<td>70</td>
</tr>
</tbody>
</table>
VEHICLE IDENTIFICATION

The Vehicle Certification Label attached to the vehicle contains specifications and capacities for this unit. Do not operate the M-B MSV outside these specifications. Figure 5 shows an example of the label.

<table>
<thead>
<tr>
<th>VEHICLE CERTIFICATION LABEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>TYPE: MULTI PURPOSE VEHICLE</td>
</tr>
<tr>
<td>M-B S/N:</td>
</tr>
<tr>
<td>VIN #</td>
</tr>
<tr>
<td>DATE: (MM/YYYY)</td>
</tr>
<tr>
<td>Manufactured By</td>
</tr>
<tr>
<td>M-B Companies, Inc</td>
</tr>
<tr>
<td>New Holstein, WI 53061</td>
</tr>
<tr>
<td>Winter Tire Cold Inflation Pressure</td>
</tr>
<tr>
<td>Summer Tire Cold Inflation Pressure</td>
</tr>
<tr>
<td>Tire Size (Winter Type)</td>
</tr>
<tr>
<td>Tire Size (Summer Type)</td>
</tr>
<tr>
<td>Rim Size (Winter Type)</td>
</tr>
<tr>
<td>Rim Size (Summer Type)</td>
</tr>
<tr>
<td>Front Gross Axle Weight Rating</td>
</tr>
<tr>
<td>Rear Gross Axle Weight Rating</td>
</tr>
<tr>
<td>Curb Weight</td>
</tr>
<tr>
<td>Gross Combined Weight Rating (GCWR)</td>
</tr>
<tr>
<td>Gross Vehicle Weight Rating (GVWR)</td>
</tr>
<tr>
<td>Towing Capacity</td>
</tr>
<tr>
<td>Tongue Weight Capacity</td>
</tr>
<tr>
<td>Front Hitch Capacity</td>
</tr>
<tr>
<td>Wing Hitch Capacity</td>
</tr>
<tr>
<td>Rear Hitch Capacity</td>
</tr>
<tr>
<td>Dump Box Capacity</td>
</tr>
</tbody>
</table>

See Owners Manual For Additional Information.

Figure 5

SYSTEM POWER

The M-B MSV system uses 12-volt power from a single battery pack. The alternator and voltage regulator maintain battery charge and voltage.

CAN NETWORK

A Controller Area Network (CAN) is used on the M-B Multi Service Vehicle to control all hydraulic and engine functions. The CAN is designed with software switches that compliment other switches and the joystick. Together, this system activates electric solenoids that control hydraulic valves. The main interface to the system is the Sauer Danfoss Plus+1 (SDC+1).

FUSE PROTECTION

The electrical system is protected by fuses of various sizes located in the rear control panel in the engine enclosure and under armrest of the cab.

ATTACHMENT CONTROLS

All attachment hydraulic functions, PTO engagement, and some vehicle control selections are controlled by the SDC+1 joystick and Sauer Danfoss Control System.

SPEED CONTROLS

Vehicle controls include the engine throttle and a foot pedal. Each of these are set using the SDC+1 screens and the joystick to deliver a controlled variable voltage to an actuator.

Engine speed is controlled by an electronic control module provided by the engine manufacturer. The operator in the cab uses SDC+1 screens and joystick which are networked to the Electronic Control Module (ECM) to set desired engine operating speed.

The auxiliary hydraulic flow rate is controlled from the operators position in the cab by means of the SDC+1. The ground drive speed is controlled by means of the foot pedal. A variable current is delivered to an electronic displacement control (EDC) on each hydraulic pump for the particular function. The variable current determines the angle of the pump swash plate which in turn determines pump displacement.

WIRING

Wiring in the system is color and number coded for ease of tracing, maintenance, and troubleshooting.
ADVANCED ENGINE DIAGNOSTICS
The engine has diagnostic information that can be viewed using the SDC+1 displays. The engine manufacturer provides a second level of diagnostic information. Refer to the engine documentation for hardware requirements and access to that level. The communication port is located below the right side arm rest.

Cummins Diagnostic Port

Figure 6
OPERATION
HOW TO START
• Sit in seat, fasten seatbelt and insert key.
• Turn key to ON. Wait for screen to display STARTUP (10 seconds).
• Place foot on brake and turn key to START position.
• Hold key in START position for a couple of seconds to start the engine.

If key is turned to START too soon, the tractor will not start.
The key must then be reset by turning it to OFF - leave off for 5 seconds and then back to ON.

SHUTDOWN
• Turn off PTO.
• Turn off hydraulics.
• Turn key to OFF and release seatbelt to exit tractor.

PARKING BRAKE
• Engages/Disengages automatically when pressing and releasing accelerator pedal.

FORWARD/REVERSE
• Using the joystick, push the 3rd toggle switch from the left UP for forward or DOWN for reverse.

THROTTLE (Work Mode)
• Use the 2nd toggle switch from the left on joystick to throttle UP (push upward) or to throttle DOWN (pull downward).

RAISE/LOWER FRONT ATTACHMENT
• While tractor is running, pull back on joystick to raise front attachment.
• Lower attachment by pushing forward on joystick.

ON/OFF REAR ELECTRICAL/ HYDRAULIC ATTACHMENTS
• Turn rear electrical attachment (IE Sprayer) ON and OFF with 1st toggle switch on left.
• Turn rear hydraulic ON and OFF with 1st toggle switch on right.
Open Screen

“Quality You Can See. People You Can Trust”

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<table>
<thead>
<tr>
<th>Button</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Access Transport Mode (Refer to Page 19)</td>
</tr>
<tr>
<td>2</td>
<td>Access Work Mode (Refer to Page 21)</td>
</tr>
<tr>
<td>3</td>
<td>Access Joystick Setup (Refer to Page 23)</td>
</tr>
<tr>
<td>4</td>
<td>Access Front Inputs, Outputs, and MVEC Status Screens - Use Up and Down arrows to access each section (Refer to Pages 24-26)</td>
</tr>
<tr>
<td>5</td>
<td>Access Calibration Screen (Refer to Page 27)</td>
</tr>
<tr>
<td>6</td>
<td>Access Attachment Selection Screen (Refer to Pages 28-29)</td>
</tr>
<tr>
<td>7</td>
<td>Access Password Screen - If showing “PW OK” Password access has be granted (Refer to Page 30)</td>
</tr>
<tr>
<td>8</td>
<td>Access Rear Inputs, Outputs, and MVEC Status Screens - Use Up and Down arrows to access each section (Refer to Page 31-33)</td>
</tr>
</tbody>
</table>

Up and Down arrow keys will cycle through the screen functions as well.
Transport Mode Screen

<table>
<thead>
<tr>
<th>Button</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Turns on cruise control function of MSV. To engage cruise control press “OK”. To disengage press brake pedal or “OK” button again. To return to foot pedal throttle (FP Throttle) arrow down. Pressing okay will activate joystick throttle control.</td>
</tr>
<tr>
<td>3</td>
<td>Activates low speed, pressing again will return to high speed mode</td>
</tr>
<tr>
<td>4</td>
<td>Access to faults screens (Refer to page #)</td>
</tr>
<tr>
<td>5</td>
<td>Brings MSV to idle. Pressing again brings MSV back to last RPM level</td>
</tr>
<tr>
<td>6</td>
<td>Access to work screen mode – may have to reduce speed</td>
</tr>
<tr>
<td>7</td>
<td>NOT USED</td>
</tr>
<tr>
<td>8</td>
<td>Returns to Main Menu</td>
</tr>
<tr>
<td></td>
<td>Activates beacon light controls. Pressing “OK” turn on/off beacon light. Arrow down again to access rear work light controls. Pressing “OK” will turn on/off the rear work lights, if equipped.</td>
</tr>
</tbody>
</table>

Icons in uppers left corner of screen will light up red when a warning has occurred. A beep with occur every minute when a warning light is illuminated.
## Transport Screen Icons

<table>
<thead>
<tr>
<th>Icon</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>🔄</td>
<td>Left Signal Indicator</td>
</tr>
<tr>
<td>🔄</td>
<td>Right Signal Indicator</td>
</tr>
<tr>
<td>🚗</td>
<td>Vehicle Drive Status</td>
</tr>
<tr>
<td>💡</td>
<td>Headlight High Beam Indicator</td>
</tr>
<tr>
<td>🕒</td>
<td>Hour Meter</td>
</tr>
<tr>
<td>🎉</td>
<td>Alarms Display</td>
</tr>
<tr>
<td>⬠</td>
<td>Engine RPM</td>
</tr>
<tr>
<td>🎫</td>
<td>Vehicle Speed</td>
</tr>
<tr>
<td>🎨</td>
<td>Glow Plugs</td>
</tr>
<tr>
<td>🏠</td>
<td>Main Menu</td>
</tr>
<tr>
<td>🚙</td>
<td>Cruise</td>
</tr>
<tr>
<td>🔝</td>
<td>Foot Pedal Throttle</td>
</tr>
<tr>
<td>🛡️</td>
<td>Hi/Low Range Selection</td>
</tr>
<tr>
<td>⚡️</td>
<td>Lights - select to turn on</td>
</tr>
<tr>
<td>🇳intosh</td>
<td>Indicates when in High Speed</td>
</tr>
<tr>
<td>⚡️</td>
<td>Quick Stop - Quick Idle</td>
</tr>
<tr>
<td>🏛️</td>
<td>Vehicle Ground Drive</td>
</tr>
</tbody>
</table>

### Coolant Low

<table>
<thead>
<tr>
<th>Icon</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>🚗</td>
<td>Alarms Display</td>
</tr>
<tr>
<td>💥</td>
<td>Engine RPM</td>
</tr>
<tr>
<td>🏫</td>
<td>Vehicle Speed</td>
</tr>
<tr>
<td>🎨</td>
<td>Glow Plugs</td>
</tr>
<tr>
<td>🏠</td>
<td>Main Menu</td>
</tr>
<tr>
<td>🚙</td>
<td>Cruise</td>
</tr>
<tr>
<td>🔝</td>
<td>Foot Pedal Throttle</td>
</tr>
<tr>
<td>🛡️</td>
<td>Hi/Low Range Selection</td>
</tr>
<tr>
<td>⚡️</td>
<td>Lights - select to turn on</td>
</tr>
<tr>
<td>🇳intosh</td>
<td>Indicates when in High Speed</td>
</tr>
<tr>
<td>⚡️</td>
<td>Quick Stop - Quick Idle</td>
</tr>
<tr>
<td>🏛️</td>
<td>Vehicle Ground Drive</td>
</tr>
</tbody>
</table>

### M-B Multi-Service Vehicle

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### Work Mode Screen

#### Button Function

<table>
<thead>
<tr>
<th>Button</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Press to select creep mode, press “OK” to engage creep mode. Utilize creep mode to connect attachments. Press again to select diff lock mode, press “OK” to engage. Diff lock is used to reduce wheel slippage, use only under 7 MPH.</td>
</tr>
<tr>
<td>2</td>
<td>Turns on cruise control function of MSV. To engage cruise control press “OK”. To disengage press brake pedal or “OK” button again. Press again to activate foot pedal throttle, press “OK” to engage.</td>
</tr>
<tr>
<td>3</td>
<td>Energizes PTO icon. Press “OK” to activate PTO icon. MSV must be under 1200 RPM to activate.</td>
</tr>
<tr>
<td>4</td>
<td>Access to faults screens (Refer to pages 35-36)</td>
</tr>
<tr>
<td>5</td>
<td>Brings MSV to idle. Turns off any attachment. Pressing again will return MSV to previous RPM and turn back on the attachments that were previously on.</td>
</tr>
<tr>
<td>6</td>
<td>Access to transportation screen mode</td>
</tr>
<tr>
<td>7</td>
<td>Access to weight transfer setup screen. Must have weight transfer function selected. (Refer to page 34)</td>
</tr>
<tr>
<td>8</td>
<td>Returns to Main Menu</td>
</tr>
</tbody>
</table>

Activates beacon light controls. Pressing “OK” turn on/off beacon light. Arrow down again to access rear work light controls. Pressing “OK” will turn on/off the rear work lights, if equipped. Arrow down again to activate weight transfer function (Refer to page 34)
Work Screen Icons

Left Signal Indicator
Right Signal Indicator
Vehicle Drive Status
Headlight High Beam Indicator

Coolant Low
Alarms Display
Seat Belt connected (green)
Seat Belt not connected
Parking Break Engaged
Current horsepower load being used by engine

Seat Belt
Engine RPM
Vehicle Speed
Creep Mode ON (green)
Diff lock engaged (green)
Cruise engaged (green)
Foot Pedal Throttle active (green)
PTO RPM
PTO engaged (green)
Amount of weight on front hitch

System Faults

Quick Stop - Quick Idle
Vehicle Ground Drive
Speed too high. Switch to Work Mode. Must stop to switch modes.
Spray/Spreader on (green) Spreader Speed 0-6
Setup Weight Transfer
Aux 3A on (green)
Hitch in Float Mode (green)
Voltage
Fuel Level
Main Menu
Pressure level to ground drive
Lights - select to turn on (green)
Weight Transfer engaged (green)
Adjustment for Weight Transfer
Function being operated by joystick
Current front and rear attachment selection

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Joystick Setup Screen

<table>
<thead>
<tr>
<th>Button</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>🕹️</td>
<td>Returns to Main Menu</td>
</tr>
<tr>
<td>📐</td>
<td>Cycle through each function. Press “OK” to select function. Press up/down again to place the position of the function. Function must not be active on other selections. Place NA on the functions you do not want to use. Functions 3, 4, 5 and 6 cannot be moved.</td>
</tr>
</tbody>
</table>

The numbers on the left side of each function are the default numbers. Place the number in the right to set back factory default. Functions 19, 20, and 21 are bonus functions that must be assigned an unused number.
Front Input Screen

<table>
<thead>
<tr>
<th>Button</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>Returns to Main Menu</td>
</tr>
<tr>
<td>4</td>
<td>Press to highlight Front Inputs</td>
</tr>
<tr>
<td>⬇️</td>
<td>Cycle through Front Inputs, Outputs and MVEC</td>
</tr>
<tr>
<td>OK</td>
<td>Press to access highlighted option</td>
</tr>
</tbody>
</table>

Displays the status of the front inputs.
Front Output Screen

<table>
<thead>
<tr>
<th>Button</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>Returns to Main Menu</td>
</tr>
<tr>
<td>4</td>
<td>Press to highlight Front Inputs</td>
</tr>
<tr>
<td>📚</td>
<td>Cycle through Front Inputs, Outputs and MVEC</td>
</tr>
<tr>
<td>🟢</td>
<td>Press to access highlighted option</td>
</tr>
</tbody>
</table>

Displays the status of the front outputs and what voltage or current it is modulating.
### Front MVEC Screen

**Button Function**

<table>
<thead>
<tr>
<th>Button</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>Returns to Main Menu</td>
</tr>
<tr>
<td>4</td>
<td>Press to highlight Front Inputs</td>
</tr>
<tr>
<td></td>
<td>Cycle through Front Inputs, Outputs and MVEC</td>
</tr>
<tr>
<td></td>
<td>Press to access highlighted option</td>
</tr>
</tbody>
</table>

Displays the status of the front MVEC.
### Button Function

<table>
<thead>
<tr>
<th></th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Resets foot pedal settings. Allows you to recalibrate foot pedal</td>
</tr>
<tr>
<td>2</td>
<td>Resets hydraulic filter notice</td>
</tr>
<tr>
<td>3</td>
<td>Cycles between slow, medium and high ground drive ramping</td>
</tr>
<tr>
<td>4</td>
<td>Cycles between slow, medium and high ground drive ramping</td>
</tr>
<tr>
<td>5</td>
<td>Resets steering cylinders</td>
</tr>
<tr>
<td>6</td>
<td>Returns to Main Menu</td>
</tr>
<tr>
<td>7</td>
<td>Change screen brightness</td>
</tr>
<tr>
<td>8</td>
<td>Change tire size</td>
</tr>
</tbody>
</table>
## Attachment Selection Screen

### Button Function

<table>
<thead>
<tr>
<th>Button</th>
<th>Function</th>
</tr>
</thead>
</table>
| 1      | Front attachment selection  
        Arrow up/down to cycle through attachments. Press and hold “OK” for three seconds to select attachment |
| 2      | Press and hold to reset front attachment |
| 3      | Rear attachments selection  
        Arrow up/down to cycle through attachments. Press and hold “OK” for three seconds to select attachment |
| 6      | Press and hold to reset rear attachment |
| 7      | Access attachment setup screen. This function is only accessible with password clearance from the main menu screen. |
| 8      | Returns to Main Menu |

Each selection illuminate in red when a fault is registered.
Attachment Selection Screen

Once you have your attachment selected on the attachment selection screen you can access the attachment setup screen only with password clearance from the main menu screen.
### Password Screen

**Main Menu**
- TRANSPORT
- CALIBRATION
- WORK
- ATTACH
- SELECT

**Password Screen**

**Enable Password:**
- Enter Password
- Press OK

**Cancel PW:**
- Press LT & RT ARROWS

**Password OK:**
- Password:
- Press "ESC" To Exit Page

<table>
<thead>
<tr>
<th>Button</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>#1</td>
</tr>
<tr>
<td>2</td>
<td>#2</td>
</tr>
<tr>
<td>3</td>
<td>#3</td>
</tr>
<tr>
<td>4</td>
<td>#4</td>
</tr>
<tr>
<td>5</td>
<td>#5</td>
</tr>
<tr>
<td>6</td>
<td>#6</td>
</tr>
<tr>
<td>7</td>
<td>#7</td>
</tr>
<tr>
<td>8</td>
<td>#8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Button</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>#9</td>
</tr>
<tr>
<td>0</td>
<td>#0</td>
</tr>
<tr>
<td>OK</td>
<td>Submit Password</td>
</tr>
<tr>
<td>ESC</td>
<td>Returns to Main Menu</td>
</tr>
</tbody>
</table>
Rear Input Screen

<table>
<thead>
<tr>
<th>Button</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>Returns to Main Menu</td>
</tr>
<tr>
<td>4</td>
<td>Press to highlight Rear Inputs</td>
</tr>
<tr>
<td></td>
<td>Cycle through Rear Inputs, Outputs and MVEC</td>
</tr>
<tr>
<td>OK</td>
<td>Press to access highlighted option</td>
</tr>
</tbody>
</table>

Displays the status of the rear input and frequency.
### Rear Output Screen

#### Button Function

<table>
<thead>
<tr>
<th>Button</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>Returns to Main Menu</td>
</tr>
<tr>
<td>4</td>
<td>Press to highlight Rear Inputs</td>
</tr>
<tr>
<td>+</td>
<td>Cycle through Rear Inputs, Outputs and MVEC</td>
</tr>
<tr>
<td>OK</td>
<td>Press to access highlighted option</td>
</tr>
</tbody>
</table>

Displays the status of the rear output and frequency.
Rear MVEC Screen

<table>
<thead>
<tr>
<th>Button</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>Returns to Main Menu</td>
</tr>
<tr>
<td>4</td>
<td>Press to highlight Rear Inputs</td>
</tr>
<tr>
<td></td>
<td>Cycle through Rear Inputs, Outputs and MVEC</td>
</tr>
<tr>
<td>OK</td>
<td>Press to access highlighted option</td>
</tr>
</tbody>
</table>

Displays the status of the rear MVEC.
## Weight Transfer Screen

### Button Function

<table>
<thead>
<tr>
<th>Button</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Reset weight transfer configuration by holding for two seconds</td>
</tr>
<tr>
<td>2</td>
<td>Save settings</td>
</tr>
<tr>
<td>3</td>
<td>Return to work mode screen</td>
</tr>
<tr>
<td>4</td>
<td>Decrease weight transfer</td>
</tr>
<tr>
<td>5</td>
<td>Increase weight transfer</td>
</tr>
</tbody>
</table>

**HOLD FOR 2 SECONDS TO RESET**

1. Reset by holding button 1 for 2 seconds
2. Push joystick forward to activate weight transfer
3. Press the right arrow key until attachment begins to raise
4. Press button 2 to save setting
5. Press button 3 to return to work screen

**WEIGHT TRANSFER OFF**

0 %
<table>
<thead>
<tr>
<th>Button</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Access to Engine Faults</td>
</tr>
<tr>
<td>2</td>
<td>Access to Front MVEC Faults</td>
</tr>
<tr>
<td>3</td>
<td>Access to Front Control Faults</td>
</tr>
<tr>
<td>6</td>
<td>Access to Rear MVEC Faults</td>
</tr>
<tr>
<td>7</td>
<td>Access to Rear Control Faults</td>
</tr>
<tr>
<td>8</td>
<td>Access to Return to Main Menu</td>
</tr>
</tbody>
</table>
Faults Screens

Front MVEC Faults Screen
When highlighted in RED shows an active fault

Rear MVEC Faults Screen
When highlighted in RED shows an active fault

Front Control Faults Screen
When highlighted in RED shows an active fault

Rear Control Faults Screen
When highlighted in RED shows an active fault

Faults Screens

M-B Multi-Service Vehicle
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The following examples apply once the initial attachment setup has been performed by M-B or a factory trained MSV dealer. This setup includes adjusting outputs to the optimum levels.

### Selecting the Ribbon Snow Blower Attachment
Connect the Ribbon Snow Blower and the hydraulic hoses to the desired auxiliary hydraulics.

#### Button Function

<table>
<thead>
<tr>
<th>Button</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Attachment Selection screen</td>
</tr>
</tbody>
</table>

#### Operation - Attachment Selection Examples

<table>
<thead>
<tr>
<th>Button</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Press and hold for two seconds to reset front attachment</td>
</tr>
<tr>
<td>1</td>
<td>Front attachment selection</td>
</tr>
<tr>
<td></td>
<td>Press two times to highlight MSV PTO Ribbon Blower</td>
</tr>
<tr>
<td>OK</td>
<td>Press and hold for three seconds to set attachment</td>
</tr>
<tr>
<td>8</td>
<td>Return to Main Menu</td>
</tr>
</tbody>
</table>
## Selecting the Ribbon Snow Blower attachment (continued)

<table>
<thead>
<tr>
<th>Button</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Enter Work Mode</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Button</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Select PTO. Engine RPM must be below 1200 RPM to activate PTO.</td>
</tr>
<tr>
<td>OK</td>
<td>Press “OK” to use PTO (engages Impeller), PTO RPM shows above PTO icon. Increase PTO RPM’s by increasing engine RPM’s.</td>
</tr>
<tr>
<td>User Defined</td>
<td>Press user defined button on joystick to turn on Aux 3A function to engage ribbon.</td>
</tr>
</tbody>
</table>

Increase engine RPM to desired speeds and begin using attachments.
The following examples apply once the initial attachment setup has been performed by M-B or a factory trained MSV dealer. This setup includes adjusting outputs to the optimum levels.

Selecting the Rear Spreader Attachment

Connect the Rear Spreader and the hydraulic hoses.

### Operation - Attachment Selection Examples

<table>
<thead>
<tr>
<th>Button</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Attachment Selection screen</td>
</tr>
</tbody>
</table>

### Rear Attachment Selection

<table>
<thead>
<tr>
<th>Button</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Press and hold for two seconds to reset rear attachment</td>
</tr>
<tr>
<td>5</td>
<td>Rear attachment selection</td>
</tr>
<tr>
<td></td>
<td>Press three times to highlight MSV Spreader</td>
</tr>
<tr>
<td>OK</td>
<td>Press and hold for three seconds to set attachment</td>
</tr>
<tr>
<td>8</td>
<td>Return to Main Menu</td>
</tr>
</tbody>
</table>
Selecting the Rear Spreader Attachment (continued)

<table>
<thead>
<tr>
<th>Button</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Enter Work Mode</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Button</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>User Defined</td>
<td>Press user defined button to engage Aux 4A to turn on rear spreader.</td>
</tr>
</tbody>
</table>

Increase engine RPM to desired speeds and begin using attachments.
The following examples apply once the initial attachment setup has been performed by M-B or a factory trained MSV dealer. This setup includes adjusting outputs to the optimum levels.

**Initial set up of the Weight Transfer feature**

After your attachments are connected and set up follow these steps. Steps need to be done when switching between attachments.

### Button Function

<table>
<thead>
<tr>
<th>Button</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Work mode screen</td>
</tr>
</tbody>
</table>

### Button Function

<table>
<thead>
<tr>
<th>Button</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Arrow down three times</td>
</tr>
<tr>
<td></td>
<td>Press “OK” to turn on Weight Transfer</td>
</tr>
<tr>
<td>7</td>
<td>Access Weight Transfer setup screen</td>
</tr>
</tbody>
</table>
Initial set up of the Weight Transfer feature (continued)

<table>
<thead>
<tr>
<th>Button</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Hold for two seconds to reset weight transfer</td>
</tr>
<tr>
<td>Joystick Forward</td>
<td>Push joystick forward to activate weight transfer</td>
</tr>
<tr>
<td></td>
<td>Press multiple times until attachment begins to raise</td>
</tr>
<tr>
<td></td>
<td>Press until attachment stops rising. This sets 100% of the attachment weight on the hitch.</td>
</tr>
<tr>
<td>2</td>
<td>Press to save settings</td>
</tr>
<tr>
<td>3</td>
<td>Return to Work Mode screen</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Button</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decrease weight transfer (decreases weight on front wheels)</td>
<td></td>
</tr>
<tr>
<td>Increase weight transfer (increases weight on front wheels)</td>
<td></td>
</tr>
</tbody>
</table>

Increase engine RPM to desired speeds and begin using attachments.
IMPORTANT: The engine will not start unless Plus+1® is ready. Turn the key to ON and wait for Plus+1® to start up (approximately 15 seconds). If the key is turned to START before Plus+1® is ready, the key must be reset. Turn the key to OFF for 10 seconds and back to ON. When Plus+1® is ready the engine preheater will be ready. The engine can then be started.

NOTE: If temperature is below 10°, turn key ON for 10 seconds, turn key OFF for 10 seconds and then back ON. This will help with starting.

**PRE-START UP**

**WARNING:**
Before performing any of the following inspections, make sure that the vehicle engine is shut down, the ignition key is removed, and all personnel in the work area are aware that the equipment is being inspected and must not be started.

Never check for hydraulic leaks by hand. Hydraulic fluid under pressure can penetrate skin.

- Inspect all hydraulic lines for evidence of leaking, loose fittings, and frayed or damaged hoses.
- Check hydraulic cylinders for broken or loose parts, especially cotter pins on the hydraulic cylinders.
- Check the hydraulic oil level. A sight gauge is located on the side of the reservoir for this purpose. Add fluid as necessary.
- All access doors are secured in place.
- Visually inspect for fluid leaks under the vehicle.
- Check engine fluids.
- Check for faults on screen.
- Inspect attachments for damage and proper connection.

**START-UP PROCEDURE**

**Key Switch**
The key switch on the steering column is used to initialize Plus+1® controller and start the engine. The engine will not start until Plus+1® has booted up and the intake manifold heater has properly warmed.

To start the MSV the operator must be seated. Turn the key switch to the on position. Watch the screen of Plus+1®. After an M-B splash screen the start up screen will appear. Turn the key to start the engine.
COLD WEATHER STARTING

Before Starting the Engine
NOTE: Do not use a torch to heat a compartment. This causes fires, burns wiring, gaskets and seals, or melts protective plastic. When using canvas covers, do not install them near exhaust systems. This helps to prevent fires.

Manually Sprayed Ether Starting Aids

⚠️ DANGER:
Do not use manually sprayed Ether starting aids. Using a spray type starting aid may cause the air intake to explode and cause personal injury.

Intake Air Heater
The engine has a grid heater in the air intake tube just before the intake manifold. This heater is controlled as needed by the engine electronics. Do not bypass or force the heater on.
AFTER STARTING ENGINE
Whenever a machine has been parked for a long period of time, some of the systems will cool to below normal operating temperatures. Always warm the machine systems before operating the machine at full operation. Damage to engine valve control components can result from engine operation for short intervals during operation in very cold weather conditions. If the engine is not allowed to warm completely, the engine can be damaged by repeated starting and stopping.
To avoid damage, always run the engine until the coolant temperature is at least 180°F (82°C).
After the engine is warm, warm up the other systems. Start with the hydraulics. Run the engine at less than one-third throttle, and slowly move the control lever to lift the attachment. Initially, lift the control lever for a few inches (centimeters). Lower the attachment slowly. Continue the sequence: raising, lowering, extending, and retracting. Extend the travel during each cycle. Perform this operation for all hydraulic circuits. Alternate between all of the attachments.
Exercise the transmission and the power train. If you cannot move the control for the transmission, perform the following steps:
• Engage the parking brake or apply the brake pedal.
• Run the engine slightly above LOW IDLE.
• Shift the transmission several times from FORWARD to REVERSE.
Release the brake. Move the equipment forward and backward for several feet (meters). Exercise the machine for several minutes.
To reduce the total warm up time, start exercising the entire machine before you complete the hydraulic warm up time.
Operate under light load until the systems reach normal operating temperatures.
If the engine temperature is not high enough enclose the engine and block the radiator. A thermostat that opens at a higher temperature will not increase the engine temperature if the engine is not under load.
To prevent seal damage and gasket damage, keep the engine crankcase breather pipe clear of blockage.
In extreme conditions, use a canvas over the engine compartment. Heat the engine area with a space heater. This will aid in starting the engine. Extending the canvas over the hydraulic components will provide initial warming of the components.

SAFETY LINK
The chassis for the MSV articulates or pivots in the middle. This is used to help maneuver the MSV and provides a smaller turning radius.
During maintenance it is advisable to lock-out the articulation of the chassis.
To lock the Chassis:
1. Pull straight ahead to align the chassis.
2. Locate the safety link on the frame behind the cab (Figure 7 Safety Link Open).
3. Pull out the removable pin (Figure 8).
4. Swing the link to meet the back half and insert the pin.
When the safety link is not in use, it should be stored against the front frame.
FRONT ATTACHMENT CONNECTIONS

Front Hitch Connections

IMPORTANT: For best performance each attachment must be setup by M-B or your authorized MSV dealer prior to use.

The attachment hitch has two hooks with hitch clamps. Up and down movement is supplied by two hydraulic cylinders.

The hitch hooks will slide side-to-side to align with various attachments.

CAUTION:

If the attachment is not centered on the vehicle damage may occur. Keep the hitch hooks tightened in place. The hydraulic hoses must be kept clear from all interference points. Make sure to install hitch plate at each end of hitch.

Part #401-162657

To connect an attachment:

1. Pull the MSV close to the attachment.
2. Adjust the hooks side-to-side as needed using the locking bolt on the back side. Pull the handle forward to open the clamp locks.
3. Drive the MSV forward with the hooks lowered. Putting the MSV in Creep Mode will assist in this.
4. The hooks should fit into the arms of the attachment. Lift the hitch in position so the hooks engage and lift the attachment.
5. Push the clamp locks back completely.
6. Insert the safety pins. Most attachments will have a top link as a third connecting point. This link is normally used to level the attachment.

Some attachments may be different. Review the instructions with each attachment. Hydraulic, PTO, and electrical connections may also be needed for proper attachment use.
Front Power Take Off (PTO)
The front attachment PTO is accessed thru a panel under the operators feet (Figure 10).

**WARNING:**
Turn the engine off before opening the access panel.

Remove the panel.

![PTO Access Panel](image)

Figure 10

The drive spline is visible

**NOTE:** The spline (Figure 11) should have a coating of grease before attaching the PTO shaft.

![Drive Spline](image)

Figure 11

The PTO shaft is inserted from the front of the MSV (Figure 12).

Line the universal joint up with the spline and push together. Make sure the locking device or universal joint has compressed in groove of PTO shaft (Figure 13).

![PTO Shaft](image)

Figure 12

**Hydraulic Connections**

At the front of the MSV there are three pair of connections. Each pair has a line out and a line in. The connections are matched for each pair. Attachments are connected and Plus+1© controls are set to control the proper auxiliary ports. See Attachment Manual for proper connections. Also refer to Plus+1© Controls section in this manual.

![Hydraulic Connections](image)

Figure 14
Rear Hydraulic Connections (Optional)
The rear of the MSV may have two pair of optional hydraulic connections (Figure 15). Each pair has a line out and a line in. Attachments are connected and Plus+1® controls are set to control the proper auxiliary ports (See Plus+1®).

NOTE: Some attachments will require these connections to make them operational.

Figure 15
MAINTENANCE
### DAILY OR REFUELING

<table>
<thead>
<tr>
<th>Preventative Maintenance</th>
<th>Procedure</th>
<th>Type/Specification</th>
<th>Reference Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine Oil Level</td>
<td>Check Level/Correct As Needed</td>
<td>Valvoline Premium Blue 15W-40 or equivalent API CH-4/SJ Rated Level must read between the dipstick high and low markings.</td>
<td></td>
</tr>
<tr>
<td>Engine Coolant Level</td>
<td>Check Level/Correct As Needed</td>
<td>Fleetguard Complete™ or equivalent Heavy Duty All Season Meets GM6038M Chemical Composition</td>
<td></td>
</tr>
<tr>
<td>Hydraulic Fluid Level</td>
<td>Check Level/Correct As Needed</td>
<td>Total Dynatrans MP - Hydraulic Tractor Fluid (Product Code 1-14100) or equivalent 28.3 API Gravity (weight)</td>
<td></td>
</tr>
<tr>
<td>Grease Fittings</td>
<td>Grease</td>
<td>Chevron Texaco Multifak® MEP 2 or equivalent NLGI Grade 2, Ambient Temp. 29.2°F (-34°C) to 360°F (121°C)</td>
<td></td>
</tr>
<tr>
<td>Fuel Filter - Water Separator</td>
<td>Drain</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hydraulic Cylinders</td>
<td>Inspect for broken or loose parts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hydraulic Hoses</td>
<td>Inspect for leaking, loose fittings, frayed or damaged hoses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electrical Wires/Cables</td>
<td>Inspect for loose or damaged wires</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crankcase Breather Tube</td>
<td>Inspect</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air Intake Piping</td>
<td>Inspect</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Radiator Screen</td>
<td>Inspect/Clean</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Access Doors and Panels</td>
<td>Secured/In Place</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leaks Under the Vehicle</td>
<td>Inspect</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Active Alarms on SDC+1</td>
<td>Check/Correct</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### FIRST 50 HOURS

<table>
<thead>
<tr>
<th>Preventative Maintenance</th>
<th>Procedure</th>
<th>Type/Specification</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine Oil</td>
<td>Replace</td>
<td>Valvoline Premium Blue 15W-40 or equivalent API CH-4/SJ Rated Dip Stick High to Low Mark Difference</td>
<td></td>
</tr>
<tr>
<td>Engine Oil Filter</td>
<td>Replace</td>
<td>209-157677</td>
<td></td>
</tr>
<tr>
<td>Hydraulic Oil Return Filter</td>
<td>Replace</td>
<td>MB Part 209-163192</td>
<td></td>
</tr>
</tbody>
</table>
### EVERY 50 HOURS OR MONTHLY

<table>
<thead>
<tr>
<th>Preventative Maintenance</th>
<th>Procedure</th>
<th>Type/Specification</th>
<th>Reference Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>PTO Gear Box Lubricant Level</td>
<td>Check/Correct</td>
<td>SAE 80W 90 or 75W 90 with synthetic anti-foaming agent</td>
<td></td>
</tr>
<tr>
<td>Tire Pressure</td>
<td>Check/Correct</td>
<td>Summer - 38 psi (262kPa) Max</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Winter - 55 psi (379kPa) Max</td>
<td></td>
</tr>
<tr>
<td>Brake Fluid Level</td>
<td>Check/Correct</td>
<td>3 DOT Must comply to Federal Standard #116 and SAE J1703</td>
<td></td>
</tr>
<tr>
<td>Engine Air Filter</td>
<td>Inspect/Clean</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cab Air Filter</td>
<td>Inspect/Clean</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bearings, Yokes and Shafts</td>
<td>Inspect</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engine Drive Belts</td>
<td>Check/Correct</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Radiator Hoses</td>
<td>Check</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooling Fan</td>
<td>Check</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Battery Terminal Corrosion</td>
<td>Inspect/Clean</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electrical Guards in Place</td>
<td>Check</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hydraulic Oil Return Filter</td>
<td>Inspect</td>
<td>MB Part 209-163192</td>
<td></td>
</tr>
<tr>
<td>Radiator</td>
<td>Inspect/Clean</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AC Cooler</td>
<td>Inspect/Clean</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Charge Air</td>
<td>Inspect/Clean</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oil Cooler</td>
<td>Inspect/Clean</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### EVERY 500 HOURS OR 6 MONTHS

<table>
<thead>
<tr>
<th>Preventative Maintenance</th>
<th>Procedure</th>
<th>Type/Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine Oil</td>
<td>Drain/Replace</td>
<td>Valvoline Premium Blue 15W-40 or equivalent API CH-4/SJ Rated Total Oil System Volume Approximately 11.6 QT (11.0 L)</td>
</tr>
<tr>
<td>Engine Oil Filter</td>
<td>Replace</td>
<td>M-B Part 209-157677</td>
</tr>
<tr>
<td>Engine Coolant - Antifreeze</td>
<td>Hydrometer Check/Correct</td>
<td>Fleetguard Complete™ or equivalent Heavy Duty All Season meets GM6038M chemical composition Minimum of -25°F (-32°C)</td>
</tr>
<tr>
<td>Fuel Filter - Primary</td>
<td>Replace</td>
<td>MB Part 209-157678</td>
</tr>
<tr>
<td>Fuel Filter - Water Separator</td>
<td>Replace</td>
<td>MB Part 209-157679</td>
</tr>
<tr>
<td>Engine Air Filter - Main Element</td>
<td>Replace</td>
<td>MB Part 209-157680</td>
</tr>
<tr>
<td>Cab Air Filter</td>
<td>Replace</td>
<td>MB Part 209-163257</td>
</tr>
<tr>
<td>PTO Gear Box Lubricant</td>
<td>Drain/Replace</td>
<td>SAE 80W 90 or 75W 90 with synthetic anti-foaming agent</td>
</tr>
<tr>
<td>Gear Box &amp; Clutch Splines</td>
<td>Grease Splines (See Service Bulletin 2011-2)</td>
<td>Type Moly Super HV Red 228 Must use spline grease to prevent fretting</td>
</tr>
<tr>
<td>Brake Pads</td>
<td>Inspect</td>
<td></td>
</tr>
</tbody>
</table>
### EVERY 1000 HOURS OR 1 YEAR

<table>
<thead>
<tr>
<th>Preventative Maintenance</th>
<th>Procedure</th>
<th>Type/Specification</th>
<th>Reference Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ground Drive Filter - Charge Pressure</td>
<td>Replace</td>
<td>Single Pump 209-157683, Dual Pump 209-186012</td>
<td></td>
</tr>
<tr>
<td>Ground Drive Filter - Return</td>
<td>Replace</td>
<td>209-163192</td>
<td></td>
</tr>
<tr>
<td>Hydraulic Tank Strainers (Ground Drive and Auxiliary Outlet Lines)</td>
<td>Check/Clean</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooling Fan Belt Tensioner</td>
<td>Check/Clean</td>
<td></td>
<td></td>
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<tr>
<td>Fan Hub, Belt Driven</td>
<td>Check/Clean</td>
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### EVERY 2000 HOURS OR 2 YEARS

<table>
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<th>Preventative Maintenance</th>
<th>Procedure</th>
<th>Type/Specification</th>
<th>Reference Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydraulic Fluid</td>
<td>Drain/Replace</td>
<td>Total Dynatrans MP - Hydraulic Tractor Fluid (Product Code 1-14100) or equivalent 28.3 API Gravity (weight)</td>
<td></td>
</tr>
<tr>
<td>Engine Coolant - Antifreeze</td>
<td>Drain/Replace</td>
<td>Fleetguard Complete™ or equivalent</td>
<td></td>
</tr>
<tr>
<td>Engine Vibration Damper - Rubber Condition</td>
<td>Check</td>
<td>Heavy Duty All Season meets GM6038M chemical composition Minimum of -25°F (-32°C)</td>
<td></td>
</tr>
<tr>
<td>Engine Vibration Damper - Viscous</td>
<td>Check/Correct</td>
<td>Silicon Fluid</td>
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</table>

### EVERY 5000 HOURS OR 4 YEARS

<table>
<thead>
<tr>
<th>Preventative Maintenance</th>
<th>Procedure</th>
<th>Type/Specification</th>
<th>Reference Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine - Overhead Set</td>
<td>Adjust</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brake Fluid</td>
<td>Drain/Replace/Bleed</td>
<td>3 DOT Must comply to Federal Standard #116 and SAE J1703</td>
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</tbody>
</table>

### LUBRICATION CHART

<table>
<thead>
<tr>
<th>Locations Refer to Figure 38</th>
<th>Number of Locations</th>
<th>Refer to Figure #</th>
<th>Frequency</th>
<th>Lubrication Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Daily</td>
<td>Weekly (50 Hrs)</td>
<td>6 Months</td>
</tr>
<tr>
<td>1. PTO Gearbox</td>
<td>1</td>
<td>Figure 16</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>2. Door Hinge</td>
<td>2</td>
<td>Figure 25</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>3. Front PTO Drive Assembly</td>
<td>3</td>
<td>Figure 17</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>4. Gear Box &amp; Clutch Splines</td>
<td>1</td>
<td>Figure 24</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>5. Engine</td>
<td>1</td>
<td>Figure 21</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>6. Ground Drive Yoke</td>
<td>2</td>
<td>Figure 22</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>7. Front Hitch</td>
<td>2</td>
<td>Figure 18</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>8. Engine Coolant</td>
<td>1</td>
<td>Figure 19</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>9. Hydraulic Reservoir</td>
<td>1</td>
<td>Figure 19</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>10. Master Cylinder</td>
<td>1</td>
<td>Figure 20</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>
**OIL AND FILTER REQUIREMENTS**

<table>
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<tr>
<th>Oil and Filter Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Engine Oil Type</strong></td>
</tr>
<tr>
<td><strong>Engine Oil Capacity</strong></td>
</tr>
<tr>
<td><strong>Engine Oil Filter Part Number</strong></td>
</tr>
<tr>
<td><strong>Primary Fuel Filter Part Number</strong></td>
</tr>
<tr>
<td><strong>Fuel Prefilter Part Number</strong></td>
</tr>
<tr>
<td><strong>Air Filter Main Element Part Number</strong></td>
</tr>
<tr>
<td><strong>Air Filter Safety</strong></td>
</tr>
<tr>
<td><strong>Engine Coolant Type</strong></td>
</tr>
<tr>
<td><strong>Engine Cooler Capacity</strong></td>
</tr>
<tr>
<td><strong>AC Charge Oil</strong></td>
</tr>
<tr>
<td><strong>AC Charge</strong></td>
</tr>
<tr>
<td><strong>Hydraulic Fluid Type</strong></td>
</tr>
<tr>
<td><strong>Hydraulic Fluid Capacity</strong></td>
</tr>
<tr>
<td><strong>Hydraulic Return Filter Part Number</strong></td>
</tr>
<tr>
<td><strong>Hydraulic Charge Filter Part Number</strong></td>
</tr>
<tr>
<td><strong>Gearbox Fluid Type</strong></td>
</tr>
<tr>
<td><strong>Gearbox Fluid Capacity</strong></td>
</tr>
<tr>
<td><strong>Cab Fresh Air Filter</strong></td>
</tr>
</tbody>
</table>

**MAINTENANCE**

**WARNING:**

Never service the M-B MSV unless the vehicle is completely shut down. Remove ignition key to prevent starting of the equipment. Failure to do so can result in serious injury or death.

Cleaning the Cooler Intake

The cooler intake must be periodically cleaned to keep the intake free of debris.

1. Remove the guard covering the cooler intake. This is located at the rear of the vehicle (Figure 26).

2. Using low pressure forced air (30 psi nozzle), clean the cooler intake (Figure 19) by blowing the area out thoroughly from inside the engine compartment. Forcing air or flowing water from the inside will force debris out of the coolers.

3. Replace the guard.

**NOTE:** If necessary, the cooler intake can be washed if forced air cleaning is unsuccessful.

**CAUTION:**

High air or water pressure can bend the cooler fins reducing the cooling ability.
1. Engine Intake From Cooler
2. Hyd Tank Cooling
3. Turbo Air Cooling
4. Engine Cooling
5. Screen
6. Backup Alarm
7. Turbo Discharge to Cooler
8. Coolant to Engine
9. AC Cooling
ENGINE COOLANT

Engine coolant levels should be checked frequently. Whenever the engine hood is raised, look at the overflow tank and check the level. Add coolant as needed. See maintenance charts for coolant type.

To change the air filter:
1. Unscrew the air filter screw clamp and remove the cover (Figure 31).
2. Slide the filter out of the housing and dispose of properly (Figure 32).

NOTE: The inside of the housing may need cleaning.
3. Insert a new filter.
4. Replace the cover and hand tighten the screw clamp (Figure 31).

INTAKE MAINTENANCE

WARNING:
The engine must be off.

Air Filter
The air filter should be replaced on a regular basis. Dusty conditions will require more frequent replacement. The air filter has a sensor that will send a warning to the MDC if the filter requires service (Figure 30).
FUEL SYSTEM MAINTENANCE

WARNING:
Make certain the engine is off. Use a catch pan large enough to hold the contents of the separator. Some fuel will drain out. The fuel is flammable. Do not open the valve or separator near fire or heat source. Use appropriate storage containers and dispose of fuel properly.

Fuel/Water Separator
The separator is located on the left side of the engine toward the cab (Figure 33). Water can be drained from the bottom by unscrewing the drain.

NOTE: Drain water from the separator more often in cooler temperatures.

Fuel Filter

WARNING:
Make certain the engine is off. Use a catch pan large enough to hold the contents of the separator. Some fuel will drain out. The fuel is flammable. Do remove the housing near fire or heat source. Use appropriate storage containers and dispose of fuel properly.

The fuel filter is located on the right side of the engine (Figure 34).

To change the fuel filter:
1. Unscrew the outer housing.
2. Remove the filter and insert a new one.
3. Replace the housing.
4. Tighten firmly by hand.

When a filter is replaced or when fuel system runs dry, the fuel primer is used to prime or pressurize the fuel line to the engine (Figure 35).
To prime:
1. Unscrew the knob on the fuel water separator.
2. Pump in/out until pressure is felt.
3. Push in and screw knob in to tighten.
CAB LIFT

The operators cab pivots at the front. Lifting the cab will allow access to several items for maintenance (Figure 36):

- Battery
- Wiring Harness
- PTO Shaft
- Several Lube Points

To lift the cab:
1. Remove the two hold-down bolts (Figure 37).
2. Locate the up/down toggle switch and push up (Figure 38).

The switch runs an electric motor with a screw extension mechanism that will lift/lower the cab.

When lowering the cab:
- Be certain all wiring and hoses are secure and will not be pinched.
- Stay clear when the cab is lowering.
- Be certain the cab is completely down before tightening the hold-down bolts.

GROUND DRIVE MAINTENANCE

WARNING:

Never service the M-B MSV unless the vehicle is completely shut down. Remove the ignition key to prevent starting of the equipment. Failure to follow this instruction can result in serious injury or death.

The hydraulic fluids for the Ground Drive and the Attachments use the same reservoir. See Hydraulic Reservoir.

The ground drive system is comprised of the pump, several manifolds and four wheel motors.

The front wheel motors have a parking brake.

The parking brake engages whenever the drive pump is off or when the operator controls call for it to be on. To disengage the parking brake push the brake button on the MDC.

NOTE: The rear wheel motors do not have parking brakes. It may be easier to access the front wheel motors by lifting the cab.

The ground drive system is powered by a single pump driven by the engine. The pump is a variable displacement type. The foot pedal controls a rheostat that sends a PWM signal to the pump.

Engine RPM does not change the performance of the pump under normal circumstances. It is possible for the engine RPM to be so low that the pump does not reach maximum. In this case the M-B MSV simply will not reach top speed.

Maintenance of the drive system includes checking for leaks and maintenance of the hydraulic reservoir.
GROUND DRIVE FILTER

To replace the pump filter:

1. Swing open the fuel tank door.
2. Remove the screws that hold the pump cover in place.
3. Lift the close end of the cover and pull to release the two tabs at the back of the enclosure.
4. Tilt the cover so the side near the radiators is up, and pull the cover out.
5. Locate the pump filter (Figure 39).
6. Screw the old filter off. Be careful to catch any fluid that may drip.
7. Lubricate the gasket on the new filter and screw it in place. Tighten by hand.
8. Start the engine and check for leaks. Tighten filter as needed.
9. Dispose of the old filter properly.
10. Replace the cover.

POWER TAKE OFF (PTO) MAINTENANCE

PTO Case Fluid Change

The power take off case should have the fluid changed periodically.

To drain the case fluid:

1. Place a catch pan below the plug at the bottom of the case.
2. Remove the plugs (Figure 40).
3. Remove the case fill plug (Figure 41).
4. When the fluid has stopped draining, replace the drain plug.

CAUTION:

Dispose of the fluid properly.

5. Put new fluid in through one of the fill holes (Figure 41) until it begins to run out the maximum level hole (Figure 42).
6. Replace the plugs and wipe up any spillage.
To maintain the PTO system:
- Change the case fluids.
- Grease the driveshaft at the universal joints.
- Grease the driveshaft at the spline thru the access panel in the operators cab.

If the clutch and gear box have been removed from the engine, a tool is available to aid with reassembly. Contact MB Technical Support for instructions on the use of Tool Fix-163891 (Figure 43).

**Power Take Off, Front**

The PTO is driven by the engine through a gear reduction transfer case (Figure 43). A drive shaft from the front of the case goes to the front of the M-B MSV. Two universal joints on the driveshaft accommodate the articulating chassis of the M-B MSV.

The PTO is engaged using the joystick. The main screen of the MDC will show the drive shaft is engaged. The engine RPM controls the RPM of the PTO.

**CAUTION:**

The PTO cannot be engaged when the engine RPM is higher than 1250 RPM.
POWER TAKE OFF DRIVESHAFT

Some maintenance procedures will require the removal of the PTO shaft. This section describes the removal and installation of the PTO.

Remove
To remove the PTO shaft:
1. Place two jack stands under rear engine frame of MSV and two jack stands under rear cab frame. Use hydraulic floor jack between the two jack stands supporting the frame under the cab as shown. Jack stands and floor jack should be snug against the frame, do not lift at this time.

2. Remove the two rear cab mount bolts and lift cab using electric lift.
3. Remove PTO U-joint bolt using a 3/4" box-end wrench. PTO shaft may have to be supported so it doesn't spin.

4. Remove the two PTO U-joint set screws using a 3/16" Allen wrench.

5. Loosen the front and rear bearing collars on PTO shaft under the cab by first loosening the set screw using 3/16" Allen wrench. Position bearing collar punch hole as shown (Figure 47). The collars will move to the left (counterclockwise). Use a 3/16" punch in collar's punch hole and strike with hammer. Collar should now be loose. Collar is off-set and was installed using a hammer in the opposite direction.

6. Once both collars are loosened, support the PTO U-joint and slide the PTO shaft forward far enough to get at the front articulation pin. Remove PTO U-joint assembly.
Install
To install the PTO shaft:
1. Install PTO U-joint to engine and finger start the bolt.
2. Slide PTO shaft through rear bearing and attach to PTO U-joint. Shaft has a groove that will align with set screw in U-joint. When in place, tighten set screws with red loctite on the threads.
3. Remove U-joint bolt to apply red loctite and then install and tighten using a 3/4" box-end wrench.
4. Position U-joint within 1/8" from the frame.

5. Once positioned, slide the rear bearing collar onto the bearing and turn counterclockwise until the collar gets snug. Insert a 3/16" punch in the punch hole as shown (Figure 49) and strike punch with hammer forcefully. Bearing collar should now be tight.

6. Apply red loctite to set screw and tighten.

7. Slide front bearing collar onto the bearing and turn counterclockwise until the collar gets snug. Insert a 3/16" punch in the punch hole as shown (Figure 50) and strike punch with hammer forcefully. Bearing collar should now be tight.

8. Apply red loctite to set screw and tighten.
9. Grease all points on the U-joints and PTO bearings.
10. Lower cab and install cab bolts.
11. Remove hydraulic jacks and jack stands.
HYDRAULIC CONNECTIONS

At the front of the MSV there are three pair of connections. Each pair has a line out and a line in. The connections are matched for each pair. Attachments are connected and the SDC+1 controls are set to control the proper auxiliary ports. See Attatchment Manual for proper connections. Also refer to SDC+1 Controls section in this manual.

![HYDRAULIC CONNECTIONS Diagram](image)

Figure 51

Attachments connected to the front of the MSV may have hydraulic hoses that need to attach to the MSV. The following table lists the size and manufacturer of the quick couplers.

<table>
<thead>
<tr>
<th>Brand Name of Quick Coupler - TEMA IB Series</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>9/16 ORB Female, 1/4 NPT</td>
<td>TIB 2511 N</td>
</tr>
<tr>
<td>9/16 ORB Male, 1/4 NPT</td>
<td>TIB 2521 N</td>
</tr>
<tr>
<td>1-1/16 ORB Female, 3/4 NPT</td>
<td>TIB 7511 U</td>
</tr>
<tr>
<td>1-1/16 ORB Male, 3/4 NPT</td>
<td>TIB 7521 U</td>
</tr>
</tbody>
</table>

HYDRAULIC SYSTEM MAINTENANCE

**WARNING:**

Never service the M-B MSV unless the vehicle is completely shut down. Remove the ignition key to prevent starting of the equipment. Failure to follow this can result in serious injury or death.

**System Description**

All of the functions of the M-B MSV receive power through hydraulic systems driven by the engine. This engine drives two independent closed loop hydrostatic systems, one for ground drive and one for the attachment hydraulics. These systems use a common hydraulic reservoir and cooler.

![HYDRAULIC SYSTEM MAINTENANCE Diagram](image)

Figure 52

1. Return Filter
2. Low Level Float Switch
3. Sight Glass
4. Attachments Suction Strainer
5. Ground Drive Suction Strainer
6. Temperature Sensor
7. Engine Coolant Overflow
8. Access Panel
9. Fill Point
Checking and Adding Hydraulic Fluid
Hydraulic fluid level is monitored by the SDC+1 controls. An alarm will be displayed on the SDC+1 screen if the fluid level becomes low. A sight glass is also available to visually check the fluid level (Figure 52, Item #3).

<table>
<thead>
<tr>
<th>WARNING:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turn engine off to view the sight glass.</td>
</tr>
</tbody>
</table>

1. Remove the engine cover to gain access.
2. Observe the sight glass (Figure 53). The arrow indicates the proper hydraulic fluid level.
3. If below level, add hydraulic fluid through the fill cap (Figure 52) on the hydraulic filter housing until the level shown in the sight glass is to the “full” arrow indicator.
4. Replace the cap.

**NOTE:** The sight glass is best viewed from the left side of the vehicle looking over the cooling fan.

![Figure 53](image)

Filter
Filtering of the hydraulic fluid uses a return filter at the top of the tank. The filter can be removed by unbolting the top and lifting.

Suction strainers protect the drive and attachment hydraulic systems. They are located near the bottom of the tank. Notice that the intake for the attachments is higher than the ground drive. This will help ensure the ground drive will continue to function if the fluid level gets low.

Draining and Filling the Tank
To completely drain the hydraulic tank remove the drain plug. The drain plug is located on the underside of the tank (Figure 54). The access panel on the top of the tank can be removed to allow cleaning of the tank. The tank should be filled to the full reading on the sight glass.

Cooling System
A hydraulic reservoir is a poor cooling system. To prevent oil temperatures from reaching levels not recommended by the component manufacturer’s, an oil cooling radiator is mounted at the rear of the M-B MSV.
BRAKE MAINTENANCE

Master Cylinder
The master cylinder fluid reservoir is located in a compartment behind the SDC+1 controller (Figure 55).

To access the reservoir:
1. Remove SDC+1 display by loosening center mounting turn buckle.
2. Pull the display out of the way
3. The two screw-off caps are visible (Figure 56).
Disc Brake
The disc brakes are accessed by removing the wheel (Figure 58). The maintenance and repair is the same as an automobile. The pads should wear evenly. If an inspection shows uneven wear or the pads have less than 1/16 inch of material then they should be replaced.

**WARNING:**
Use jack stands with a suitable load capacity when removing a wheel. The engine should be off and at least one of the remaining wheels should be blocked. The articulation safety link should be locked to the rear frame to prevent movement.

Refer to the Service section for replacement.

---

**BATTERY**
Remove the battery from the unit before charging it.

**WARNING:**
- ELECTRIC SHOCK may result in injury and/or damage to the unit.
- DO NOT allow objects to come into contact with both terminals at the same time.
- REVERSE CONNECTIONS may result in sparks which can cause death or serious injury. ALWAYS connect positive (+) lead of charger to positive (+) terminal, and negative (-) lead to negative (-) terminals.
- ALWAYS connect the positive (+) cable FIRST, and the negative (-) cable SECOND.

**WARNING:**
- EXPLOSIVE GASES from battery can cause death or serious injury. ALWAYS keep open flames, sparks, or smoking materials away from batteries.
- POISONOUS BATTERY FLUID contains sulfuric acid and its contact with skin, eyes or clothing can cause severe chemical burns. ALWAYS wear safety glasses and protective gear near battery.
- DO NOT TIP any battery beyond 45° angle in any direction.

**Battery Electrolyte First Aid**
- Follow First Aid directions for contact with battery fluid.
- External Contact: Flush with water.
- Eyes: Flush with water for at least 15 minutes and get medical attention immediately!
- Internal Contact: Drink large quantities of water. Follow with Milk of Magnesia, beaten egg, or vegetable oil. Get medical attention immediately!

**IMPORTANT:** In case of internal contact, DO NOT induce vomiting!
Cleaning Terminals
Keep battery and its terminals clean. Inspect monthly to maintain best performance.
Remove corrosion from battery terminals and cable connections with a wire brush, then wash with a weak baking soda/water solution. After cleaning, apply a thin coat of grease or petroleum jelly to terminals and cable ends to retard corrosion.

Charging
Always follow information provided on the battery by the battery manufacturer. Contact battery manufacturer for extensive instructions to charge battery.
IMPORTANT: DO NOT fast charge. Charging at high rates will damage or destroy battery.
Place unit on a level surface, shut off engine and raise the cab to gain access to battery.
1. Disconnect negative (-) cable first, then positive (+) cable.
2. Loosen strap and remove battery.
3. Place battery on bench or other well-ventilated place where electrolyte spill will not create damage.
4. Connect positive (+) lead of charger to positive (+) terminal, and negative (-) lead to negative (-) terminal.
5. Charge the battery at 2-1/2 amps for 10 hours.
6. Reinstall battery into unit and connect positive (+) cable first, then negative (-) cable.

Battery Charger
Under normal conditions the engine alternator will have no problem keeping the battery charged. When unit has been idle for an extended period of time without operation and the battery has been completely discharged, a battery charger will be required for recharging.
Before using a charger, you can attempt to recharge the battery by jump starting the unit and allowing the engine to run.

---

ELECTRICAL SYSTEM

Protecting Electrical Terminals
There are several electrical terminals on the M-B MSV that have no corrosion protection. A liquid tape should be applied to these terminals to prevent corrosion. The front-end and rear-end electrical connectors have rubber boots. If these boots do not have a drain hole and the connections are not protected by a liquid tape, they will most likely corrode.
Service Bulletin MSV-2010-2 describes “Protecting Unsealed Electrical Terminals”. Whenever a terminal is exposed it should be cleaned and the liquid tape protection reapplied. Follow instructions on liquid tape product.
Connections of main concern are:
• Starter Motor - Located behind left rear fender
• Alternator - Located behind left rear fender
• Solenoids for starter, Grid Heater and Rear MVEC - Located in the rear electrical compartment.
• Hydraulic Fluid Temperature Sender - Located partway down on hydraulic tank between the fan and fan shroud, swing fuel tank out to locate sender.
Front Electronic Controller

The Front Electronic Controller (front MVEC) is mounted inside the operators cab under the right armrest (Figure 59). Lift the armrest to gain access. A 5 Amp ATC (automotive type) fuse protects the power wire to the front MVEC.

Figure 84 shows the components and their locations.
Remove the cover of the MVEC to expose the relays and fuses (Figure 61). To replace a relay or fuse pull the old one straight out and plug in a new one.

NOTE: When replacing relays observe the pin locations.
Part of the front MVEC are the push-to-reset breakers. If one of the breakers becomes "tripped" it can be pressed to reset (Figure 63).

![Rear Electronic Controller](image)

**CAUTION:**
Do not repeatedly press breakers to reset them. A breaker that trips out is an indication of a fault in that circuit. Troubleshoot the circuit and correct the problem.

**Figure 63**

<table>
<thead>
<tr>
<th>Label</th>
<th>Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2W MEM</td>
<td>CB11</td>
<td>Continuous power on Auxiliary power supply.</td>
</tr>
<tr>
<td>2W RADIO</td>
<td>CB10</td>
<td>Switched power on Auxiliary power supply.</td>
</tr>
<tr>
<td>WORK LT</td>
<td>CB9</td>
<td>Spare circuit breaker, extra #0070 supply wire is located in harness.</td>
</tr>
<tr>
<td>WIPER PARK</td>
<td>CB8</td>
<td>Power for wiper.</td>
</tr>
<tr>
<td>STB PWR</td>
<td>CB5</td>
<td>Power for Hazards MC38 PIN 37</td>
</tr>
<tr>
<td>RADIO MEM</td>
<td>CB3</td>
<td>Memory power for AM/FM radio.</td>
</tr>
<tr>
<td>HORN</td>
<td>CB2</td>
<td>Washer and Horn Power</td>
</tr>
<tr>
<td>IGNITION</td>
<td>CB1</td>
<td>Ignition Power</td>
</tr>
</tbody>
</table>

**Bladed Fuse and Holders**

<table>
<thead>
<tr>
<th>Amp</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Power to MVEC Controller</td>
</tr>
<tr>
<td>20</td>
<td>Power to PIN 36 MC38</td>
</tr>
<tr>
<td>20</td>
<td>Power to PIN 38 MC 38</td>
</tr>
<tr>
<td>20</td>
<td>Front Hitch Up/Down Option</td>
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</tbody>
</table>

**Alaska Option (Bladed Fuse and Holders)**

<table>
<thead>
<tr>
<th>Amp</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>Low Beam Lights</td>
</tr>
<tr>
<td>15</td>
<td>High Beam Lights</td>
</tr>
<tr>
<td>15</td>
<td>Work Lights</td>
</tr>
</tbody>
</table>

**Rear Electronic Controller**

The Rear Electronic Controller (rear MVEC) is mounted inside the engine compartment in front of the hydraulic reservoir tank.

A 5 Amp ATC (automotive type) fuse protects the power wire to the rear MVEC.

Figure 64 shows the components and their locations. Remove the cover to expose the relays and fuses (Figure 65).

To replace pull the old one straight out and plug in the new one.

**NOTE:** When replacing a relay observe the pin locations.

**Figure 64**

**Figure 65**
**ACCESSORY TERMINAL STRIP**

The top right side of the operators cab dashboard has a three pole terminal block. The terminal screws are labeled as to their function (Figure 68).

- Two way radio memory (+) - provides low amperage 12 Vdc uninterrupted power for memory functions
- Two way radio power (+) - Provides 15 amp 12 Vdc power for the radio. Turns off when key switch is off.
- Two way radio common (-) - goes to ground terminal on battery.

![Figure 68](image)

**MSV REAR MVEC FUSES AND RELAY**

<table>
<thead>
<tr>
<th>Fuse</th>
<th>Size</th>
<th>Relay</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>15 A</td>
<td>R1</td>
<td>AC CLUTCH</td>
</tr>
<tr>
<td>P2</td>
<td>20 A</td>
<td>R4</td>
<td>BACK-UP ALARM</td>
</tr>
<tr>
<td>P3</td>
<td>20 A</td>
<td>R7</td>
<td>REAR PLUG PIN 3</td>
</tr>
<tr>
<td>P4</td>
<td>5 A</td>
<td>R2</td>
<td>REAR CLEAR</td>
</tr>
<tr>
<td>P5</td>
<td>5 A</td>
<td>R8</td>
<td>ENGINE START</td>
</tr>
<tr>
<td>P6</td>
<td>5 A</td>
<td>R6</td>
<td>REAR PLUG PIN 2</td>
</tr>
<tr>
<td>P7</td>
<td>5 A</td>
<td>R3</td>
<td>FLOW DIVIDER</td>
</tr>
<tr>
<td>P8</td>
<td>5 A</td>
<td>R5</td>
<td>REAR CONNECTOR / PIN 6</td>
</tr>
<tr>
<td>P9</td>
<td>5 A</td>
<td>-</td>
<td>KEYON</td>
</tr>
<tr>
<td>P10</td>
<td>5 A</td>
<td>-</td>
<td>STEER SENSOR POWER</td>
</tr>
<tr>
<td>P11</td>
<td>15 A</td>
<td>-</td>
<td>SC50-22 POWER</td>
</tr>
<tr>
<td>P12</td>
<td>15 A</td>
<td>-</td>
<td>SC50-22</td>
</tr>
<tr>
<td>P13</td>
<td>15 A</td>
<td>-</td>
<td>SC50-22</td>
</tr>
<tr>
<td>P14</td>
<td>5 A</td>
<td>-</td>
<td>FUEL SENDER PWR</td>
</tr>
<tr>
<td>P15</td>
<td>20 A</td>
<td>-</td>
<td>REAR PLUG PIN 1</td>
</tr>
<tr>
<td>P16</td>
<td>15 A</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Spare</td>
<td>5 A</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Spare</td>
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<td>-</td>
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</tr>
<tr>
<td>Spare</td>
<td>20 A</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

- 5 A - MVEC POWER FUSE - STANDARD AUTOMOTIVE

All fuses Mini Automotive ATM Type unless specified.

![Figure 67](image)
CAB VENTILATION

Fresh air is drawn into the cab from the vent at the top rear of the cab. A cartridge type air filter is used to remove dust and debris. The filter should be inspected and changed as needed.

To replace the air filter:

1. Remove vent by unscrewing the two nuts. Notice that the top of the window is held in place by the vent (Figure 69).

![Figure 69](image1.png)

Remove Nuts  Bottom Edge Holds Window In

2. After the cover is removed the filter cartridge can be pulled out.

![Figure 70](image2.png)

3. Replace with clean/new cartridge and install the cover.
4. Tighten both nuts.
SERVICE
TOWING THE MSV

The MSV is driven by a ground drive hydraulic pump. All four wheels have hydraulic motors. Only the two front wheels have parking brakes.

To tow the vehicle the brakes must be released and the drive bypass valve is opened.

WARNING:
Do not operate the MSV with the manual brake release installed.

If the vehicle is running, the parking brake will be released when you press the accelerator. Using a manual brake release will override the emergency and the parking brake systems (Figure 71).

Towing the MSV with a manual brake release installed must be kept below 2 mph and less than 500 ft. Exceeding these limits will damage the wheel motors. The damage can be identified and it will void all warranties from the manufacturer.

Before starting this procedure the vehicle must be on level ground with the wheels chocked.

The engine must be off with the key removed.

To override the parking brakes use the manual brake release kit. This kit will install in the hydraulic lines.

Release the parking brakes by pumping the red handle on the manual disconnect. Pump until the gauge reads 300 psi.

WARNING:
The pressure in the parking brake system must be 300 psi. Under pressure will result in the brakes overheating and damage to the emergency brake system. Over pressure will damage O-rings in the brake system.

With the gauge reading 300 psi, tow the MSV as needed. Keep speed below 2 mph and the distance should be less than 500 ft. The regular brake system will continue to operate while towing.

When finished the bypass valve(s) must be closed and the manual brake release kit will be removed.

Reconnect the hydraulic lines. Replace the plastic cable tie on the connection. This will prevent the couplers from accidently pulling apart.

The brake systems will operate normally.

BRAKE RELEASE INSTALL

Refer to Work Instructions, WIAS 0083 in back of this book.
TROUBLESHOOTING BRAKES

WARNING:
An operator must be properly seated with unobstructed ability to use the foot brakes.

1. Refer to Work Instruction , Checking Parking Brake Relief Pressure.
2. To check coil, start machine.
4. Slightly place foot on accelerator until brake light goes out.
5. Exit to Main Menu.
7. Use arrow Down Keys go to Rear Outputs. Press OK.
8. Verify park brake release is on. If unit still does not work:
9. Remove park brake coil from cartridge by removing 1/2 nut on top of coil. Install screwdriver in the inside of coil. Repeat steps, 2, 3, and 4. The coil should magnetize and you should feel resistance pulling the screwdriver out of coil. If no resistance is felt, the coil should be replaced. If resistance is felt the cartridge could be bad. Replace cartridge and recheck.

Replacement Part Numbers

<table>
<thead>
<tr>
<th>Part</th>
<th>Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cartridge</td>
<td>202-144080</td>
</tr>
<tr>
<td>Coil</td>
<td>702-133633</td>
</tr>
<tr>
<td>Pressure Relief Valve 200psi</td>
<td>202-144858</td>
</tr>
</tbody>
</table>

TESTING THE GROUND DRIVE PUMP

The ground drive pump produces the hydraulic pressure and flow to drive the wheel motors. The pump is driven through a universal joint powered from the front of the engine. Electrical signals control a solenoid on the pump that directs fluid flow.

To test the pump:
1. Engage the articulation safety link to prevent movement of the chassis.
2. Jack all four wheels off the ground and support the vehicle with jack stands. The jack stands should be located under the main frame at the four corners.
3. An operator must sit in the operators seat with the seatbelt fastened.
4. Start the vehicle and run at low RPM. Shift to forward with no pressure on the brake pedal. The wheels should move in a forward rotation when foot pedal is pushed.
5. Shift to neutral then reverse. The wheels should move in a reverse rotation when foot pedal is pushed. If the wheels do not rotate or only drive in one direction check the fluid level in the hydraulic tank. Check the fuses for the solenoid. If those are not blown remove the cover over the ground drive pump.
To remove the ground drive pump cover:

1. Open the fuel tank door.
2. Remove the screws that hold the cover in position.
3. Lift the close edge of the cover and pull back. This will pull two tabs out of slots at the rear of the enclosure.

![Image of Pump Cover and Tabs]

4. Tip the edge toward the radiators up and pull the cover out.

![Image of Person Tip Pump Cover](Figure 74)

**WARNING:**

All four wheels should rotate during this test. The operator must be in the seat and ready to apply the brakes. All four wheels must be off the ground and clear of all objects. Use as low an RPM as possible for this test.

The top of the ground drive has an electrical connector and a mechanical switch to activate the solenoid.

Test the mechanical switch first. With an operator in the seat and the seatbelt fastened, start the engine. Stay clear of the wheel because it should rotate. Locate the manual lever on the top of the pump.

![Image of Electrical Connector and Manual Lever](Figure 75)

Push the lever one way and the wheels should rotate. Release the lever and it will return to the center. Push the lever in the other direction and the wheels should rotate in the other direction.

If the wheels rotate in both directions, then the hydraulic system is functioning properly. The problem is likely in the electrical signal.

If the wheels do not rotate, the ground drive pump is not producing pressure and should be replaced.

Test the electrical signals by unplugging the connector to the pump.
By disconnecting pump plug, a fault should come on. Reconnect plug. Sit in seat with seat belt on. Start unit. Place unit in Forward, open Rear Outputs screen. Accelerate to get wheels turning. Propel forward. FWD EDC should display voltage reading. If wheels are not turning, pump needs to be replaced.

**IMPORTANT:** If hydraulic fluid level becomes low, the attachments will stop functioning before the ground drive pump starves for fluid.

**GROUND DRIVE PUMP REPLACEMENT**

**Location**
The ground drive pump is driven directly by the engine through a universal joint. The pump is located at the rear of the vehicle between the engine fan and the cooling radiators. Access to the pump requires removing the pump cover.

**Removal**
To access the ground drive pump start by supporting the frame with a jackstand. The jackstand should be located under the frame.

The basic steps to remove the ground drive pump are:
- Remove engine covers, wheel well and air cleaner.
- Remove fuel tank.
- Drain hydraulic tank.
- Remove ground drive pump cover.
- Remove engine fan and spacer.
- Remove fan shroud.
- Disconnect electrical, mechanical and hydraulic connections.
- Remove ground drive pump.

To remove the engine covers, wheel well and air cleaner:
1. Remove the engine cover front and rear and set them aside.
2. Then remove the wheel.
3. Pull out the electrical connector to the air filter sensor.
To remove the fuel tank:

**WARNING:**
You may drain the fuel tank to remove weight. The fuel is extremely flammable. Keep fuel in approved containers. Handle only in open vented areas. Clean up any spilled fuel immediately.

1. Open the fuel tank door.  
   **NOTE:** The fuel lines are long enough to move the fuel tank out of the way without disconnecting them.

2. To move the fuel tank without removing the fuel lines, cut all the cable tie clamps and remove the metal guide bolted to the radiator frame.

3. Disconnect the fuel sensor electrical connector.

4. Support the weight of the fuel tank. Remove the two hinge bolts. Each bolt has a bushing that must be present to allow proper hinge movement.

**NOTE:** The wheel well can be removed without removing the wheel. Removing the wheel is not required but it will provide better access to the front of the engine.
5. Move the fuel tank out of your way.
To drain the hydraulic tank:
When removing the drive pump, hydraulic lines will be
disconnected. To minimize spills drain the hydraulic tank.

**WARNING:**
The hydraulic fluid is flammable. When
draining the fluid only use approved
containers. Handle only in open vented areas.
Clean up any spilled fluid immediately.

1. Place a catch pan under the hydraulic tank drain plug.
2. Remove the drain plug and allow fluid to drain.
3. Remove the large vent plug on top of the return filter.

4. Replace the drain plug when empty.
To remove the ground drive pump cover:
1. Remove the screws that hold the cover in place.
2. Lift the close edge of the cover and pull back.
   This will pull two tabs out of slots at the rear of the enclosure.

To remove the engine fan and spacer:
1. Note or write down the path of the engine serpentine belt.
2. Release tension on the belt by pulling the tension pulley against the spring action. A 1/2-inch drive
   socket wrench can be used in the square hole to assist.
3. Pull the belt off of a pulley and release the tension pulley.
4. Remove the bolts that hold the fan in place. Then remove the fan and the spacer from the motor.

**NOTE:** The pulley on the engine will be held in place by a second fan belt. Leave the
pulley in place. Also, notice the spacer is held in place by a pilot shaft.

To remove the fan shroud:
The fan shroud has a number of hoses and tubes that
lay on top and are fastened in place. Some of these will
be removed.
1. Start by removing the two metal air tubes for the turbo. Unscrew the clamps at the radiator and slide the rubber couplers onto the tube. Unscrew the clamp at the other end. Remove the tubes.

**IMPORTANT:** The openings for the turbo cannot have foreign material inside. Cover the openings.

2. The fuel lines are held in place with cable tie and a metal guide. These should have been removed when the fuel tank was moved.

3. The top radiator hose can be left in place.

4. The radiator sensor wire at the top corner must be unplugged. The wires will pull through the hole in the fan shroud.

5. Remove the five bolts that hold the fan shroud at the rear of the cavity.

6. Remove the remaining bolt above the coolant sensor.

7. Remove the two bolts at the lower left.

8. The shroud should be loose. The shroud must be forced over the coolant sensor before it will pull out.

9. Pull the shroud out. The coolant hose can be lifted up to help with clearance.

**NOTE:** The fan shroud has two edge pieces that must be kept in place for proper air flow and noise reduction.

To disconnect electrical, mechanical and hydraulic connections:

The ground drive pump should be completely accessible.

1. Disconnect the electrical connection.

2. Four hydraulic connections must be removed. Catch any fluid spills in a pan for proper disposal.
To remove the ground drive pump:

1. A mounting bracket with four bolts must be unbolted. Hold the nut from the bottom and unscrew the bolts.
2. Remove the four bolts from the universal joint to the engine.
3. Use a lifting bracket (Figure 89) and the mounting bracket as lift points. The pump can be pulled up.

**CAUTION:**
The radiator is easily damaged. Protect the cooling fins with heavy cardboard or a wooden panel.

4. When the universal joint is clear of the motor the pump can be completely removed.

**Installation**
The basic steps to install the ground drive pump are:
- Prepare the pump.
- Make connections for hydraulics and electrical.
- Install fan shroud.
- Install spacer, fan and belt.
- Mount fuel tank.
- Fill hydraulic tank.
- Mount wheel well and air cleaner.
- Replace engine covers.

To prepare the pump:
1. The new pump will have plugs in the hydraulic line ports that must be removed.
2. Attach the lifting bracket and mounting bracket from the old pump.

**NOTE:** The mounting bracket is a tight fit over a ring. Pry the bracket off of the old pump and press it onto the new one.

3. Tighten the bolts.
4. Use a heavy spline grease to cover the splined shaft of the pump. Use the universal joint from the old pump and slide it over the new pump flange. Lubricate the two grease fittings in the U-Joint.

To make connections for hydraulic and electrical:
1. Lift the pump over the mounting area.
2. Connect the three hydraulic lines on the side of the pump. The center line connects directly to the hydraulic tank.
3. Set the pump in position and attach the fourth hydraulic line to the top port.
4. Insert the bolts for the mounting bracket. Start the nuts from below.
5. Position the U-Joint to match with the engine puly. Insert the bolts and tighten.
6. Tighten the mounting bracket bolts.
7. Make the electrical connection to the pump.
To install fan shroud:

1. The two edging strips must be in place.

2. Move the shroud into position between the radiators and the engine. It will fit under the upper radiator hose.

3. The coolant sensor wires must be guided through the hole. Moving the shroud over the coolant sensor will be a tight fit. Be careful to avoid cutting the wires.

4. Once the shroud is in place finger start the five bolts at the rear, the two bolts at the lower left and the bolts by the coolant sensor.

5. Tighten all the bolts except the outside bolt at the coolant sensor.

6. Replace the two metal tubes for the turbo cooling.

**CAUTION:**
Inspect the turbo tubes, the inlets and outlets for debris. Clean all dirt from the tubes. Foreign material in the turbo tubing will damage the engine.

7. Slide the rubber couplers in place. Tighten all the clamps.

To install spacer, fan and belt:

1. Hold the spacer in place with the fan. Insert a bolt into one of the holes.

2. Hold the spacer with fan in position. Finger start the bolt into the flange on the engine.

3. Insert and finger start the remaining three bolts.

4. Tighten the bolts.

5. The belt is a serpentine style that will contact pulleys from either side.

6. One pulley is a spring loaded idler pulley. Use a 1/2-inch drive socket wrench in the square hole to push against the spring pressure.

7. Follow the diagram and place the belt in position.

8. Release the spring loaded pulley to complete the installation.

To mount fuel tank:

**WARNING:**
The fuel tank may contain fuel. Be prepared to clean up spilled fuel during this activity.

1. Move the fuel tank into position lining up the top and bottom hinge points. The hinge bolts have a bushing that fits inside the pivot holes of the hinge.

2. Insert the bolt through one of the hinges and the bushing. Finger start the nut. Repeat for the second bolt.

3. Tighten the bolts. The fuel tank should move freely. The hoses and wire harness can be connected and put in place.
4. The guide for the fuel lines is placed around the hoses. Bolt the guide in place using the bolt above and outside the coolant sensor. When the guide is tight the hoses must move freely as the fuel tank door is opened and closed.

5. Use cable tie on all hoses and harnesses to hold them neatly in position.

To fill hydraulic tank:
All hydraulic connections should be secure.

1. Check that the drain plug is in place and tight.
2. Fluid can be added through the vent plug on top of the tank.

**NOTE:** The ground drive pump and attached hydraulic lines are likely filled with air. When the pump is started up the fluid level in the tank will drop.

To mount wheel well and air cleaner:

1. Lift the wheel well into position. If the air cleaner is mounted you should insert the air cleaner tube into place at this time.

2. Use the clamp at the lower right and the bolt inside the wheel area to secure the wheel well.

3. Move the hose clamps in place and tighten.

4. Connect the electrical plug to the air sensor.

5. Clamp the engine dipstick to the bracket below the air cleaner.

Replace engine covers. The assembly should be complete. Before starting the engine, read through the following section for pump start-up.

**Testing**

The installation of the pump is complete. To test the operation of the pump and set the relief valves refer to the Sauer Danfoss Service Manual for Series 90 Pumps, Publication 520L0818.

To adjust working pressures:

When the start-up procedure is complete attach the charge pressure gauge, 0-1,000 psi (0-50 bar), to the filter head. Attach gauges, 0-10,000 psi (0-1,000 bar), to the two gauge ports (forward and reverse). See Figure 93.
DISC BRAKE

To replace the brake rotor or brake pads, the wheel must be removed. Jack the frame up to lift the wheel off the ground. Use a jackstand under the frame for support.

**WARNING:**

Use jack stands with a suitable load capacity when removing a wheel. The engine should be off and at least one of the remaining wheels should be blocked.

![Diagram of DISC BRAKE components: Rotor, Caliper, Caliper Mounting Bracket](Image)

To replace brake pads:

1. Jack the wheel off the ground and support the M-B MSV with a jackstand.
2. Remove the lug nuts and the wheel. Inspect the pads for wear. If replacement is needed, continue to step 3.

**NOTE:** If removing the calipers and brake pads, screw one lug nut on a stud. This will hold the brake rotor in position to help with assembly.

3. Remove both caliper bolts (Figure 94).
4. Using a prybar work the caliper out of the support. Note the two spacers and their position.
5. Remove both brake pads.
6. To put in new brake pads, the piston must be pushed back. A C-clamp can be used to slowly force it back to the start position.
7. Replace the pads and place the caliper assembly back into position.

**NOTE:** The caliper bolts should be clean when inserting into the caliper and protective boot.

8. Tighten the caliper bolts.

**NOTE:** Remember when stepping on the brakes for the first time the pedal must be pumped up. If the brake line was removed from the caliper the brakes need to be bled to remove air.

When bleeding the brakes, gain access to the master cylinder in the cab. Remove fill caps.

**NOTE:** Bleeding brake lines will consume a large amount of brake fluid. Have at least a quart of new approved brake fluid available (reference Every 50 Hours page)

To bleed the brakes:

Use two people, one to step on the brake pedal and one person to open/close the bleeder valve.

1. With the master cylinder full, open the bleeder valve.
2. Push the brake pedal slowly to the floor.

**WARNING:**

Brake fluid will exit the bleeder valve. Be prepared to catch the fluid in a container. Be prepared to clean up any spills.

**CAUTION:**

Do not re-use contaminated brake fluid in the master cylinder. Small debris can clog openings.

3. When the pedal is down hold it and close the bleeder valve.
4. Let the pedal return to the top. Check the fluid level in the master cylinder.
5. Repeat steps 1 thru 4 until all the exiting fluid is free of air bubbles.
6. Repeat for the remaining wheels if needed.
7. Replace the wheel and tighten the lug nuts.
WHEEL MOTORS
Please refer to Work Instructions WIAS 0084 for Series 2 & 3 machines.

AUXILIARY PUMP
The auxiliary pump is located behind the right side of the engine in front of the wheel well.
The auxiliary pump provides hydraulic fluid pressure and flow to the attachment connections. If the attachments are not working properly check the fluid level in the hydraulic tank. If hydraulic fluid runs low the attachments will be the first items to be affected. A low hydraulic oil warning should also be flashing on the screen.
To test the auxiliary pump:
1. Connect a flow meter to the front Aux 3 connections.
2. Start the engine. Enter Work Screen. Set engine RPMs to 2500.
3. Energize Aux 3A button on joystick. The flow meter should read 31gpm. If flow is not at 31gpm (5% margin of error for flow divider). Enter Password screen. Type in password (500).
4. Enter Attachment Selection screen. Energize Button 1. Make sure Item 2 - MSU PTO Snow Blower or 3 - MSU PTO Ribbon Blower, is selected.
5. Enter Attachment Setup screen.
Verify that Aux 3A is at 100 percent. Repeat step 3 again. If flow is not 31gpm, enter Main Menu, select Button 4. Select Front Output screen.
NOTE: Before replacing the auxiliary pump, check for obstruction in hydraulic tank, intank, suction stainer, pinched hose to front manifold block and hydraulic fluid level.

To replace the auxiliary pump:
1. Engage the chassis safety link to prevent unexpected chassis movement.
2. Drain the hydraulic fluid from the hydraulic tank. Replace the plug.

WARNING:
Hydraulic fluid is flammable. Drain fluid into a proper container for reuse or disposal.

3. Jack the right rear wheel off the ground. Use a jackstand under the frame to support the vehicle.
4. Remove the wheel.
5. Unscrew the bolt inside the wheel well and lift the wheel well up and out.

6. Place a drip pan below the auxiliary pump and remove the three visable hydraulic lines.
7. Locate the forth hose behind the frame. This hose must be removed but it may be easier if the auxiliary pump is loose.
To finish the installation:
1. Install the wheel well. Be careful to insert the lower edge into the two support brackets. Insert the bolt and tighten.
2. Mount the wheel.

WINDSHIELD WIPER

Location
the windshield wiper motor and fluid reservoir are located inside the cab. They are mounted on the front floor by the operators left foot.

To test the auxiliary pump:
1. With an operator in the seat with the seatbelt fastened. Start the engine.
2. The test procedure can be used to test the new pump.
3. A pressure gage or an attachment can be connected to an auxiliary port to provide a test device.

To remove the wiper arm:
1. The wiper arm is held on by two nuts and the washer tube. Remove the two nuts. The small arm will pull off. Remove the main arm by tilting the wiper away from the windshield until it stays out. With spring pressure removed the arm should easily pull off.
2. The tube for the washer fluid runs through the arm tension spring and onto a barbed connection. Pull the tube off of the connection and pull out through the spring.

NOTE: If the washer reservoir contains fluid it will siphon out through the tubing. Empty the reservoir or catch the fluid in a container.
3. Remove the flange by prying off the wedge. Then unscrew the main nut. Remove the remaining two bolts. The flange should separate.

Main Nut
Wedge

Figure 106

To remove the covers, reservoir and motor:
Three covers need to be removed; the reservoir cover, the motor cover and the cover panel to the side and in the front of the steering wheel.

1. Remove the cover panel by removing the plate along the bottom of the windshield. Then the cover panel will lift out. The bottom edge has a lip that pulls free from behind the windshield frame.

Remove Plate
Cover Panel

Figure 107

To remove the windshield:

1. Unscrew all of the outside nuts that hold the windshield in place. Then remove the frame. The lights do not need to be removed.

2. Set the frame aside.

3. The windshield glass has a rubber seal that covers the outside edge. The glass will rest on the seal at the bottom. Pull the windshield away from the frame of the vehicle. Leave the rubber edge in place. Set the windshield aside.

Figure 108

2. The cover over the reservoir has four screws that hold it in. Remove the screws.

3. Lift the cover. Disconnect the electrical plug and pull the reservoir with the tube outward.

4. The cover over the motor has side screws that are then removed. Lift the cover.

5. Disconnect the wiring to the wiper motor and remove the motor.
STEERING COLUMN

Removal
The basic steps to remove the steering column are:
- Remove wiper arm.
- Remove windshield.
- Remove cover panel.
- Disconnect electric connectors and hydraulic lines.
- Unbolt steering column.

To remove the wiper arm:
1. The wiper arm is held on by two nuts and the washer tube. Remove the two nuts. The small arm will pull off. Remove the main arm by tilting the wiper away from the windshield until it stays out. With spring pressure removed the arm should easily pull off.
2. The tube for the washer fluid runs through the arm tension spring and onto a barbed connection. Pull the tube off of the connection and pull out through the spring.

NOTE: If the washer reservoir contains fluid it will siphon out through the tubing. Empty the reservoir or catch the fluid in a container.

3. Remove the flange by prying off the wedge. Then unscrew the main nut. Remove the remaining two bolts. The flange should separate.

Main Nut    
Wedge

To remove the windshield:
1. Unscrew all of the outside nuts that hold the windshield in place. Then remove the frame. The lights do not need to be removed.
2. Set the frame aside.
3. The windshield glass has a rubber seal that covers the outside edge. The glass will rest on the seal at the bottom. Pull the windshield away from the frame of the vehicle. Leave the rubber edge in place. Set the windshield aside.

To remove the cover panel:
1. Remove the cover panel by removing the plate along the bottom of the windshield. Then the cover panel will lift out. The bottom edge has a lip that pulls free from behind the windshield frame.

Remove Plate    Cover Panel

When the cover panel is removed the hydraulic connections and the electrical plugs are accessible.

Electrical Connectors    Hydraulic Connections

To disconnect the electrical connectors:
1. Pull the electrical harnesses outward.
2. Push the two halves together and twist apart.
3. Move the harnesses out of the way.

To disconnect the hydraulic lines:
NOTE: You may want to mark the connections as to their location.

CAUTION:
When the hydraulic connections are opened it is likely that fluid will leak out. Use a catch pan and be prepared to clean up any spills.

The hydraulic connections must be completely removed at the motor housing to allow removal of the steering column. Remove all five connections. Plug hose ends and cap adapters.

To unbolt the steering column:
1. Remove the four bolts from the flange under the flexible rubber boot.
2. Pull the steering column up and out.

Installation
The basic steps to install the steering column are:
• Install the steering orbital pump.
• Bolt the steering column in place.
• Connect the hydraulic lines and electrical connectors.

To install the steering orbital pump:
The side of the steering orbital pump with the four connections will face to the right side of the vehicle.
1. Position the steering orbital pump against the connecting flange. The mounting bracket should be in place.
2. Start the four bolts with lock washers. Tighten the bolts.

To bolt the steering column in place:
The electrical wiring should be routed through the mounting bracket and the notch in the mounting flange.
1. Feed the wires through the opening.
2. Place the steering orbital pump and the mounting flange through the opening. The hydraulic connections will face to the right.
3. Place bolts through the mounting bracket and secure to the mounting flange. Tighten the bolts.
4. Before connecting the hydraulic lines be certain the transducers are plugged in.
Refer to the hydraulic diagrams in the back of this manual. To connect the hydraulic lines and electrical connectors:

1. Connect the two back hydraulic lines first. The top line will fit best routed around the front of the bottom line. Tighten both lines.

2. Connect the front bottom line, then the front top line. Tighten both lines.

3. Connect the hydraulic line at the front of the steering orbital pump.

4. Position the two electrical harnesses and complete the two connections.

5. Route the electrical harness inside the opening to allow the cover panel to be bolted in place.

Figure 114

Finish the assembly by installing the cover panel. Position the windshield with the trim seal in place. Place the frame (retainer) over the studs and bolt evenly in place.

Figure 116
MAIN HYDRAULIC TANK

Location
The hydraulic tank is located at the right rear of the MSV. It has several connections and holds the hydraulic fluid filter.

Inspection of the tank
The main component of the tank is the filter, it is changed on a regular interval and should not present operation problems. If the fluid becomes contaminated the tank is drained and the filter will be changed. An inspection panel is located on the top surface.

Removal
In the event where the hydraulic tank must be removed, the basic steps are:
- Remove cover over the ground drive pump.
- Drain the tank.
- Remove top fan shroud.
- Remove the front half of the wheel well.
- Disconnect the oil level sensor.
- Disconnect the tubes to the cooling radiator.
- Remove filter.
- Disconnect the two suction lines.
- Disconnect the three hydraulic lines.
- Unbolt the tank and lift out.
To remove the ground drive pump cover:
1. Open the fuel tank door.
2. Remove the screws that hold the cover in position.
3. Lift the close edge of the cover and pull back. This will pull two tabs out of slots at the rear of the enclosure.

To drain the tank:
1. Place a catch pan under the tank.

**WARNING:**

| ! | Hydraulic fluid is flammable and must be disposed of properly. Be prepared to clean up any spills. |

---

2. Remove the drain plug. Allow fluid to drain. The hydraulic lines of the MSV will drain for an extended period of time. If you wish to remove connections immediately be prepared to plug or elevate the hoses.

To remove the fan shroud:
1. Remove the bolts from the top of the shroud.
2. Lift the shroud and set it aside.

---

Remove the front half of the wheel well:
1. Jack the right rear wheel off the ground. Use a jackstand under the frame to support the vehicle.
2. Remove the wheel.
3. Unscrew the bolt inside the wheel well and lift the wheel well up and out.
To disconnect the oil level sensor:
The oil level sensor is located on the top surface of the tank, toward the cooling radiators. Disconnect the wires and secure them.

To disconnect the tubes to the cooling radiator:
1. Locate the top connection. Hold the inside fitting in place. Unscrew the outer nut.
2. Loosen the tube connection at the filter head.

![Figure 123](image)

Loosen Connections
Remove Nuts

The tubes will be removed later in the procedure.

To remove the filter:
1. Remove the four nuts at the base of the filter head.
2. Lift the head and pull the tube free.

NOTE: The mating surface of the filter head has an O-ring that must be reused.
3. Lift the filter out and place in a pan to drain.

![Figure 124](image)

Loosen Clamps

CAUTION:
If the filter is to be replaced, dispose of the old one properly. The oil soaked filter is flammable.

To disconnect the suction lines:
1. Locate the two lines at the bottom of the tank.
2. Unscrew the two clamps shown. The bottom hose has a third clamp that does not need to be loosened.

![Figure 125](image)

To disconnect the three hydraulic lines:
1. Locate the connections by the sight gage.
2. Hold the inside fitting and unscrew the outside nuts.
To lift the tank out:
1. Remove the three bolts at the top rear by the cooling radiator.
2. Remove the two bolts at the lower center inside the engine compartment.
3. Remove two bolts at the very bottom to the frame.
4. Remove the two bolts on the flange by the overflow reservoir.
5. Unscrew the three mounting nuts and remove the overflow reservoir.
6. Lift the tank out. When the tank is removed the supply hose to the ground drive pump will be pulled free.

Installation
The installation of the hydraulic tank is the reverse of the removal. The basic steps are:
• Mount the tank in position.
• Connect the hydraulic lines and two suction lines.
• Connect tubes to the cooling radiator.
• Install the filter.
• Connect the oil level sensor.
• Remount the wheel well.
• Attach the top shroud.
• Fill the tank.
• Replace ground drive pump cover.

To place the tank in position:
1. Move the tank into position. The bottom suction connection should have a piece of hose clamped at the tank. A second clamp should be on the tube for the ground drive pump. This connection will be completed as the tank is positioned.

2. Insert mounting bolts in four locations and finger start the fasteners for all four locations.
   • Top rear by the radiator - 3 bolts/nuts/washers
   • Bottom studs - 2 bolts/nuts
   • Bracket on frame near suction line connections - 2 bolts/nuts
   • Flange next to the fluid reservoir - 2 bolts/nuts

3. Tighten all the mounting bolts/nuts.

To connect the hydraulic lines:
1. Position and tighten both clamps on the bottom suction hose.
2. Push the hose for the aux pump over the fitting and tighten the clamp.

3. Connect the three hyd lines next to the sight gage. Tighten the fittings by holding the inside fitting and tighten the outside nut.

4. Check the connection for the lower radiator. Be certain it is connected and tight (Figure 185).
5. Insert the top tube into the connection at the top of the radiator (Figure 130). Position the nut but do not tighten. The other end is connected when installing the filter head.

![Figure 129](image1)

![Figure 130](image2)

To install the filter:

1. Clean the gasket around the filter opening. Place the gasket over the studs.
2. Place the filter onto the opening with the filter opening facing up.

![Figure 131](image3)

3. Place the shaft and sping into the center opening of the filter.

![Figure 132](image4)

4. The filter cover has an O-ring that must be cleaned then covered with clean silicone. Check that the two plugs are installed and tight.

![Figure 133](image5)

5. Be certain the nuts are in place on the tube to the radiator. Place the filter head over the studs while inserting the tube into the fitting.

6. Start the four nuts that hold the head down. Check
that the tube is in place. Tighten the four nuts evenly. Then tighten both tube connections.

To connect the oil level sensor:
1. Locate the wires from the sensor on the top surface of the tank.
2. Make the connection into the wiring harness.
3. Position the wheel well in place. Be certain the wheel well is behind the bottom support brackets. Insert the bolt and tighten.
4. Attach the top cooling shroud using the bolts that were removed earlier.

To mount the overflow reservoir:
1. Connect the hose to the reservoir.
2. Slide the reservoir over the studs.
3. Finger start the nuts with washers. Tighten evenly.

To install the ground drive pump cover:
1. Insert the two tabs at the back of the enclosure.
2. Bolt the cover in place.
3. Close the fuel tank door.

To fill the tank:
1. Be certain the drain plug is screwed in and tight.
2. Check all connections for tightness.
3. The tank has an inspection plate that can be removed for access to the inside of the tank. This opening should not be used for filling the tank. If this plate is removed be certain the gasket is clean before replacing the plate.
4. Fill the tank with hydraulic fluid.
5. Close the fill point cover.

To check for hydraulic leaks the ground drive pump cover can be left off. After running the engine for a few minutes, turn it off and check for leaks. The system should be ready to use. When first starting the MSV, check for leaks.

ARTICULATION JOINT

See Work Instruction, WI AS 0081 in back of book.

LOW PRESSURE MANIFOLD

Location
The hydraulic coils and manifold for the low pressure hydraulic system are located on the right side of the MSV. It is in front of the rear wheel and below the exhaust muffler.

The manifold controls pressure for the PTO clutch, the parking brakes in the front wheel motors and the HI/LO transport speed.
Testing
The working pressure should be between 200-225 psi.

1. Locate and remove the connection to the PTO clutch (Figure 136).
2. Install a pressure gauge capable of reading 300 psi on the hose.
3. Start the engine and engage the PTO. The gauge should read 200-225 psi.
4. Use the pressure valve to adjust (Figure 137). Rotate the valve until the gauge reading is within range.

**NOTE:** If the gauge is reading zero for one (not all) of the controlled units, the operation of the coil should be checked.
Low Pressure Manifold Series 3
If one of the three systems is not working the coils can be checked for operation.
To check Hi Lo Shift
1. Start machine.
2. Go into Transport screen. Verify High Speed is on (high speed is yellow when on).
3. Go to Main Menu. Select Rear (push button #8).

4. Use Arrow Down key, go to Rear Outputs, press OK.

Verify High Speed Value is on. If unit still doesn’t work:
5. Remove transport coil from cartridge by removing 1/2 nut from top of coil. Install screwdriver in the inside of coil. Repeat steps 1 and 2. The coil should magnetize and you should feel resistance pulling the screwdriver out of the coil. If no resistance, the cartridge could be bad. Replace cartridge and recheck.
To Check PTO

1. Start machine.
2. Go to Work screen. Press button #3.

5. Remove PTO coil from cartridge by removing 1/2 nut from top of coil. Install screwdriver inside of coil. Repeat steps 1 and 2. The coil should magnetize and you should feel resistance when pulling screwdriver out of coil. If no resistance is felt the coil should be replaced. If resistance is felt, the cartridge could be bad. Replace cartridge and recheck.

PTO should turn green. Press OK to turn on.
3. Go to Main Menu, select button #8.

4. Use Arrow Down key, go to Rear Outputs. Press OK.

Verify PTO clutch valve is ON. If unit still does not work.
RADIO AND 12 VDC CONNECTIONS

Location
The radio is a standard automotive style. It is located to the right of the steering wheel. Just below the radio is a standard 12 VDC accessory outlet.
A 12 VDC fused terminal strip is just to the right of the radio. To make connections, follow the polarity as shown on the decal.
To remove the radio, unscrew the four screws. The radio and bracket will lift up.

AC Component Testing

<table>
<thead>
<tr>
<th>Component</th>
<th>Operation</th>
<th>Testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fan Switch</td>
<td>3 speeds, located on steering console.</td>
<td>Check switch function by listening for the heater fan and electrically using Vehicle Diagnostics/Front Input #4 Main Menu.</td>
</tr>
<tr>
<td>AC Switch</td>
<td>On/Off, located on steering console.</td>
<td>Will luminate when switch is on. Use Vehicle Diagnostics/Front Diagnostic/Front MVEC.</td>
</tr>
<tr>
<td>Heater Control</td>
<td>Warm or Cold position, located by Joystick.</td>
<td>Control has a cable running to a valve in engine coolant line for heater. Manually check valve and cable by removing side panel next to seat.</td>
</tr>
<tr>
<td>Heater Fan</td>
<td>3 speed fan located behind seat in a heater box.</td>
<td>If fan switch operates incorrectly, heater fan wires need to be tested for power. If power is correct replace fan motor.</td>
</tr>
<tr>
<td>Thermo Switch</td>
<td>On/Off located behind seat in a heater box.</td>
<td>Check switch for operation. Switch will be open if to cool (checking in cold weather). If switch is not operating, test the wires for power. Use Vehicle Diagnostics/Input MC38-10 AC Thermal Switch.</td>
</tr>
<tr>
<td>AC Dryer</td>
<td>On/Off located on front frame under cab.</td>
<td>Check switch for operation. Switch will not function with low refrigerant charge. If switch is not operating, test the wires for power. Use Vehicle Diagnostics/Rear/ Rear MVEC AC Clutch Relay.</td>
</tr>
<tr>
<td>Compressor Clutch</td>
<td>Belt driven On/Off, located on rear of engine.</td>
<td>Check for power on red wire. Test by providing 12 volts directly to compressor. If clutch does not turn on, it is likely the clutch is bad. Use Vehicle Diagnostics/Rear/ Rear MVEC AC Clutch Relay.</td>
</tr>
<tr>
<td>AC Belt</td>
<td>Drives the compressor from engine.</td>
<td>Make sure belt is not slipping. Belt should have 1/4&quot; to 1/2&quot; deflection.</td>
</tr>
<tr>
<td>Condensor</td>
<td>Cools refrigerant, located on rear of engine radiator.</td>
<td>Look for physical damage or signs of leaks.</td>
</tr>
<tr>
<td>Refrigerant and Oil</td>
<td>Used in cooling system. Lubricates for proper cooling.</td>
<td>If all components check good, have refrigerant checked by authorized installer.</td>
</tr>
</tbody>
</table>

AC SYSTEM

![Figure 145](image1)

CAUTION: Always have system charged and maintained by a certified refrigeration installer.

NOTE: For fastest cooling the fresh air vent should be closed.

![Figure 146](image2)
TO RGVC
SPECIFICATIONS
### Table 1: For 37° & 45° (Machined or Flared) and MegaSeal®

<table>
<thead>
<tr>
<th>Size</th>
<th>Steel</th>
<th>Brass</th>
</tr>
</thead>
<tbody>
<tr>
<td>-4</td>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td>-5</td>
<td>13</td>
<td>15</td>
</tr>
<tr>
<td>-6</td>
<td>17</td>
<td>19</td>
</tr>
<tr>
<td>-8</td>
<td>34</td>
<td>38</td>
</tr>
<tr>
<td>-10</td>
<td>50</td>
<td>56</td>
</tr>
<tr>
<td>-12</td>
<td>70</td>
<td>78</td>
</tr>
<tr>
<td>-16</td>
<td>94</td>
<td>104</td>
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<td>-20</td>
<td>124</td>
<td>138</td>
</tr>
<tr>
<td>-24</td>
<td>156</td>
<td>173</td>
</tr>
<tr>
<td>-32</td>
<td>219</td>
<td>243</td>
</tr>
</tbody>
</table>

### Table 2: For Flat-Face “O” Ring Seal (Steel)

<table>
<thead>
<tr>
<th>Size</th>
<th>Ft-Lbs.</th>
<th>Newton-Meters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dash Fractional (In.)</td>
<td>Min.</td>
<td>Max.</td>
</tr>
<tr>
<td>-4</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>-6</td>
<td>18</td>
<td>20</td>
</tr>
<tr>
<td>-8</td>
<td>32</td>
<td>40</td>
</tr>
<tr>
<td>-10</td>
<td>46</td>
<td>56</td>
</tr>
<tr>
<td>-12</td>
<td>65</td>
<td>80</td>
</tr>
<tr>
<td>-14</td>
<td>65</td>
<td>80</td>
</tr>
<tr>
<td>-16</td>
<td>92</td>
<td>105</td>
</tr>
<tr>
<td>-20</td>
<td>125</td>
<td>140</td>
</tr>
<tr>
<td>-24</td>
<td>150</td>
<td>180</td>
</tr>
</tbody>
</table>
Table 3: For SAE O-Ring Boss (Steel) & Gates Adapterless

<table>
<thead>
<tr>
<th>Size</th>
<th>Ft-Lbs. Working Pressures 4,000 psi (27.5 Mpa) and below</th>
<th>Newton-Meters Working Pressures 4,000 psi (27.5 Mpa) and below</th>
<th>Ft-Lbs. Working Pressures Above 4,000 psi (27.5 Mpa)</th>
<th>Newton-Meters Working Pressures Above 4,000 psi (27.5 Mpa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-3</td>
<td>3/16</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>-4</td>
<td>1/4</td>
<td>14</td>
<td>16</td>
<td>20</td>
</tr>
<tr>
<td>-5</td>
<td>5/16</td>
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<td>—</td>
<td>—</td>
</tr>
<tr>
<td>-6</td>
<td>3/8</td>
<td>24</td>
<td>26</td>
<td>33</td>
</tr>
<tr>
<td>-8</td>
<td>1/2</td>
<td>37</td>
<td>44</td>
<td>50</td>
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<tr>
<td>-10</td>
<td>5/8</td>
<td>50</td>
<td>60</td>
<td>68</td>
</tr>
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<td>3/4</td>
<td>75</td>
<td>83</td>
<td>101-1/2</td>
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<tr>
<td>-14</td>
<td>7/8</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>-16</td>
<td>1</td>
<td>111</td>
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<td>150</td>
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<td>-20</td>
<td>1-1/4</td>
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<td>152</td>
<td>180</td>
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<tr>
<td>-24</td>
<td>1-1/2</td>
<td>156</td>
<td>184</td>
<td>212</td>
</tr>
</tbody>
</table>

Table 4: Maximum Recommended Torque for dry NPTF (Tapered) Pipe Threads*

<table>
<thead>
<tr>
<th>Size</th>
<th>Ft-Lbs.</th>
<th>Newton-Meters</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2</td>
<td>20</td>
<td>25</td>
</tr>
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<td>-4</td>
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<td>-20</td>
<td>80</td>
<td>110</td>
</tr>
<tr>
<td>-24</td>
<td>95</td>
<td>130</td>
</tr>
<tr>
<td>-32</td>
<td>120</td>
<td>160</td>
</tr>
</tbody>
</table>

*NOTES:*
1. The torque values obtained from tightening pipe threads can vary considerably depending on thread condition. Adequate sealing can occur at values much lower than the maximum values listed above. Only enough torque to achieve adequate sealing should be used.
2. When using a male tapered pipe thread with a female straight or parallel pipe thread, maximum values are 50% of those listed in the table.
3. If threaded sealant is used, maximum values shown should be decreased by 25%
# FASTENER TORQUE RECOMMENDATION

## Table 5: Torque for Standard Fasteners

| Nominal Dia. (in.) | Threads per inch | Grade 2 | | Grade 5 | | Grade 8 | | Grade 9 |
|-------------------|-----------------|---------|---------|---------|---------|---------|---------|
|                   | Tightening Torque | Tightening Torque | Tightening Torque | Tightening Torque |
|                   | Lubed K = 0.15 | Dry K = 0.17 | Dry K = 0.20 | Lubed K = 0.15 | Dry K = 0.17 | Dry K = 0.20 | Lubed K = 0.15 | Dry K = 0.17 | Dry K = 0.20 |
| 1/4               | 20 | 49 in-lbs | 59 in-lbs | 66 in-lbs | 76 in-lbs | 86 in-lbs | 101 in-lbs | 122 in-lbs | 143 in-lbs | 126 in-lbs | 143 in-lbs | 168 in-lbs |
| 5/16              | 18 | 101 | 122 | 135 | 157 | 178 | 209 | 221 | 251 | 295 | 259 | 294 | 346 |
| 3/8               | 16 | 15 ft-lbs | 18 ft-lbs | 20 ft-lbs | 23 ft-lbs | 26 ft-lbs | 31 ft-lbs | 33 ft-lbs | 37 ft-lbs | 44 ft-lbs | 38 ft-lbs | 43 ft-lbs | 51 ft-lbs |
| 7/16              | 14 | 24 | 29 | 32 | 37 | 42 | 49 | 52 | 59 | 70 | 61 | 70 | 82 |
| 1/2               | 13 | 37 | 44 | 49 | 57 | 64 | 75 | 80 | 90 | 106 | 94 | 106 | 125 |
| 9/16              | 12 | 53 | 63 | 70 | 82 | 92 | 109 | 115 | 130 | 154 | 135 | 153 | 180 |
| 5/8               | 11 | 73 | 87 | 97 | 113 | 126 | 150 | 159 | 180 | 212 | 186 | 211 | 248 |
| 3/4               | 10 | 129 | 155 | 172 | 200 | 227 | 267 | 282 | 320 | 376 | 331 | 375 | 441 |
| 7/8               | 9 | 125 | 160 | 167 | 322 | 365 | 429 | 455 | 615 | 606 | 633 | 604 | 710 |
| 1                 | 8 | 187 | 225 | 250 | 483 | 547 | 644 | 681 | 722 | 909 | 799 | 905 | 1065 |
| 1-1/8             | 7 | 266 | 319 | 354 | 596 | 675 | 794 | 966 | 1095 | 1288 | 1132 | 1283 | 1510 |
| 1-1/4             | 7 | 375 | 450 | 500 | 840 | 952 | 1121 | 1363 | 1545 | 1817 | 1597 | 1810 | 2130 |
| 1-1/2             | 6 | 652 | 783 | 869 | 1462 | 1625 | 1950 | 2371 | 2688 | 3162 | 2779 | 3150 | 3706 |
|                   | Fine Thread Series | | | | | | | | |
| 1/4               | 28 | 56 in-lbs | 68 in-lbs | 75 in-lbs | 87 in-lbs | 99 in-lbs | 116 in-lbs | 123 in-lbs | 139 in-lbs | 164 in-lbs | 144 in-lbs | 163 in-lbs | 192 in-lbs |
| 5/16              | 24 | 112 | 135 | 150 | 174 | 197 | 231 | 245 | 278 | 327 | 287 | 325 | 383 |
| 3/8               | 24 | 17 ft-lbs | 20 ft-lbs | 23 ft-lbs | 26 ft-lbs | 30 ft-lbs | 35 ft-lbs | 37 ft-lbs | 42 ft-lbs | 49 ft-lbs | 43 ft-lbs | 49 ft-lbs | 58 ft-lbs |
| 7/16              | 20 | 27 | 32 | 36 | 41 | 47 | 55 | 58 | 66 | 78 | 68 | 78 | 91 |
| 1/2               | 20 | 41 | 49 | 55 | 64 | 72 | 85 | 90 | 102 | 120 | 105 | 120 | 141 |
| 9/16              | 18 | 59 | 71 | 78 | 91 | 103 | 121 | 126 | 146 | 171 | 151 | 171 | 201 |
| 5/8               | 18 | 82 | 99 | 110 | 127 | 144 | 170 | 180 | 204 | 240 | 211 | 239 | 281 |
| 3/4               | 16 | 144 | 173 | 192 | 223 | 253 | 297 | 315 | 357 | 420 | 369 | 418 | 492 |
| 7/8               | 14 | 138 | 165 | 184 | 355 | 403 | 474 | 502 | 568 | 669 | 588 | 666 | 784 |
| 1                 | 14 | 210 | 252 | 280 | 542 | 614 | 722 | 765 | 867 | 1020 | 896 | 1016 | 1195 |
| 1-1/8             | 12 | 298 | 357 | 397 | 668 | 757 | 890 | 1083 | 1227 | 1444 | 1269 | 1439 | 1693 |
| 1-1/4             | 12 | 415 | 493 | 553 | 930 | 1055 | 1241 | 1509 | 1710 | 2012 | 1768 | 2004 | 2358 |
| 1-1/2             | 12 | 734 | 880 | 978 | 1645 | 1865 | 2194 | 2668 | 3024 | 3557 | 3127 | 3544 | 4169 |

Torque values for 1/4 and 5/16-in series are in inch-pounds. All other torque values are in foot-pounds.

Torque values calculated from formulas:

\[ T = KDF \]

- \( K = 0.15 \) for "lubricated" conditions
- \( K = 0.17 \) for zinc plated and dry conditions
- \( K = 0.20 \) for plain and dry conditions

D = Nominal Diameter
F = Clamp Load

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Table 6: Torque-Tension Relationship for Metric Fasteners

<table>
<thead>
<tr>
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Clamp load calculated as 75% of the proof load for specified bolts.
All Torque values are listed in foot-pounds.
Torque values calculated from formulas T = KD, where
K = 0.15 for "lubricated" conditions
K = 0.17 for zinc plated and dry conditions
K = 0.20 for plain and dry conditions
D = Nominal Diameter
F = Clamp Load
Torque wrenches may have an adapter attached to help reach a bolt or nut. Use the following formula to recalculate the reading of the torque wrench.

\[
\text{Y} = \frac{\text{T} \times \text{L}}{\text{L} + \text{E}}
\]

Example: (with "E" as plus dimension)

- Desired Torque \( T \) = 135 lb. In.
- Original Length \( L \) = 10.0 In.
- Extension \( E \) = 1.5 In.
- \( Y \) = Unknown

\[
Y = \frac{135 \times 10}{10 + 1.5} = \frac{1350}{11.5} = 117.39
\]

\( Y \) = 117 lb. In.
Final reading on torque wrench

Figure 147
Replacement Parts

For a complete listing of replacement parts, refer to the
Parts Manual 904-163124 Rev. C for Series 1 Units
Parts Manual 904-162429 Rev. F for Series 3 Units
APPENDIX
Hydraulics

MSV SERIAL NUMBERS
9-2052 -- 9-2084
9-2086 AND UP
GEN 2 AND 3 SINGLE PUMP DIAGRAMS
210-162303 DIAGRAM STEERING
210-162304 DIAGRAM TANK AND COOLING
210-162305 DIAGRAM FRONT HITCH
210-162306 DIAGRAM AUX HYDRAULICS
210-162307 DIAGRAM AUX PUMP
210-162601 DIAGRAM GROUND DRIVE
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WHEEL MOTION INTAKE - LEFT FRONT
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MSV 3.5 DUAL PUMP
HYDRAULIC SCHEMATICS

210-162306 DIAGRAM, HYD AUX, STD MSV
210-162305 DIAGRAM HYD, FRONT HITCH MSV
210-162303 DIAGRAM STEERING CYLINDER
210-186561 DIAGRAM TANK AND COOLING
210-186560 DIAGRAM MSV3 GROUND DRIVE DP
213-183935K HOSE KIT DUAL PUMP
DUAL PUMP AV22 MANUAL
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REV A - CHANGED 213-183962, WAS 10" X 2 STs
REV B - CHANGED 213-183968, WAS 1 1/4
REV C - ADDED SLEEVES, LENGTHEND ACCUMULATOR HOSES, SHORTENED 213-183967 & 213-183969
REV D - CORRECTED HOSE END MB PART NUMBERS TO REFLECT HIGH PRESSURE FITTINGS ON HIGH PRESSURE HOSE
REV E - LENGTHEND 213-183963, WAS 8"
Axial Piston Variable Double Pump A22VG

Series 40
The data specified above serve to describe the product. Should information be provided on use, these are only examples of applications and suggestions. Information from the catalog are not assured properties. The information given does not release the user from the obligation of own judgment and verification. Our products are subject to a natural wear and aging process.

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The cover shows an example application. The product delivered may differ from the image on the cover.

The original instruction manual was created in the German language.
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1 About this documentation

1.1 Validity of the documentation

This documentation applies to the following products:
• Axial piston variable double pump A22VG series 40

This documentation is intended for machine/system manufacturers, fitters and service technicians.
This documentation contains important information on the safe and appropriate transport, installation, commissioning, operation, maintenance, removal and simple troubleshooting of the axial piston unit.

▶ Read this documentation completely and in particular the chapter 2 “Safety instructions” on page 8 and chapter 3 “General instructions on damage to equipment and the product” on page 13 before you start work with the axial piston unit.

1.2 Required and supplementary documentation

▶ Only commission the axial piston unit if the documentation marked with the book symbol ❀ is available to you and you have understood and observed it.

Table 1: Required and supplementary documentation

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<td>Environmentally acceptable hydraulic fluids</td>
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1.3 Display of information
Standardized safety instructions, symbols, terms and abbreviations are used so that you can use this documentation to work quickly and safely with your product. To give you a better understanding they are explained in the sections below.

1.3.1 Safety instructions
This documentation includes safety instructions in chapter 2.6 “Product-specific safety instructions” on page 49 and in chapter 3 “General instructions on damage to equipment and the product” on page 13 and before a sequence of actions or an instruction for action involving a risk of personal injury or damage to equipment. The described danger prevention measures must be observed.

Safety instructions are set out as follows:

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<td>Type and source of danger!</td>
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<td>Consequences in case of noncompliance</td>
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<td>▶ Measure for danger prevention</td>
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<td>▶ &lt;List&gt;</td>
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- **Warning sign**: draws attention to the danger
- **Signal word**: identifies the degree of the danger
- **Type and source of danger**: identifies the type and source of the danger
- **Consequences**: describes what occurs if the safety instructions are not complied with
- **Precautions**: states how the danger can be avoided

Table 2: Danger classes in accordance with ANSI Z535.6-2006

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<td>Identifies a dangerous situation that will result in death or serious injuries if it is not avoided.</td>
</tr>
<tr>
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<td>Identifies a dangerous situation that may result in death or serious injuries if it is not avoided.</td>
</tr>
<tr>
<td>![CAUTION]</td>
<td>Identifies a dangerous situation that may result in minor to moderate injuries if it is not avoided.</td>
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</table>

**NOTE**
Damage to equipment: the product or the environment may be damaged.

1.3.2 Symbols
The following symbols mark notes that are not safety-relevant but which increase the understanding of the documentation.
Table 3: Meaning of the symbols

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>▶</td>
<td>Single, independent step</td>
</tr>
<tr>
<td>1.</td>
<td>Numbered instruction: The numbers specify that the steps are completed one after the other.</td>
</tr>
<tr>
<td>2.</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
</tr>
</tbody>
</table>

1.3.3 Designations

This documentation uses the following designations:

Table 4: Designations

<table>
<thead>
<tr>
<th>Designation</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>A22VG</td>
<td>Axial piston variable double pump, closed circuit</td>
</tr>
<tr>
<td>Threaded plug</td>
<td>Metal screw, pressure-resistant</td>
</tr>
<tr>
<td>Protection plug</td>
<td>Made out of plastic, not pressure-resistant, only for transportation</td>
</tr>
</tbody>
</table>

As umbrella term for “A22VG axial piston variable double pump” the designation “axial piston unit” will be used in the following.

1.3.4 Abbreviations

This documentation uses the following abbreviations:

Table 5: Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATEX</td>
<td>EU directive for explosion protection (Atmosphère explosible)</td>
</tr>
<tr>
<td>DIN</td>
<td>Deutsche Industrie Norm (German Institute for Standardization)</td>
</tr>
<tr>
<td>EP</td>
<td>Proportional control electric</td>
</tr>
<tr>
<td>ET</td>
<td>Electric control, direct controlled</td>
</tr>
<tr>
<td>HT</td>
<td>Hydraulic control, direct controlled</td>
</tr>
<tr>
<td>HW</td>
<td>Proportional control, hydraulic, mechanical servo</td>
</tr>
<tr>
<td>ISO</td>
<td>International Organization for Standardization</td>
</tr>
<tr>
<td>JIS</td>
<td>Japan Industrial Standard</td>
</tr>
<tr>
<td>RE</td>
<td>Rexroth document in the English language</td>
</tr>
<tr>
<td>VDI 2230</td>
<td>Directive for the systematic calculation of high duty bolted joints and joints with one cylindrical bolt from the VDI (Verein Deutscher Ingenieure – Association of German Engineers)</td>
</tr>
</tbody>
</table>
2 Safety instructions

2.1 About this chapter
The axial piston unit has been manufactured according to the generally accepted rules of current technology. There is, however, still a danger of personal injury or damage to equipment if this chapter and the safety instructions in this documentation are not complied with.

▶ Read this documentation completely and thoroughly before working with the axial piston unit.
▶ Keep this documentation in a location where it is accessible to all users at all times.
▶ Always include the required documentation when you pass the axial piston unit on to third parties.

2.2 Intended use
Axial piston units are hydraulic components, meaning that in their application area they are classified neither as complete nor as incomplete machines in the sense of the EU machine directive 2006/42/EC. A component is exclusively intended to form an incomplete or a complete machine together with other components. The component may only be commissioned after it has been installed in the machine/system for which it is intended and the safety of the entire system has been established in accordance with the machine directive.

The product is intended for the following use:

The axial piston unit is only approved as a pump for hydrostatic drives in closed circuit.

▶ Observe the technical data, application and operating conditions and performance limits as specified in data sheet 93221 and in the order confirmation. Information about approved hydraulic fluids can be found in data sheet 93221.

The axial piston unit is only intended for professional use and not for private use. Intended use includes having read and understood the complete documentation, especially the chapter 2 “Safety instructions” on page 8.

2.3 Improper use
Any use other than that described as intended use shall be considered as improper and is therefore impermissible.

Bosch Rexroth AG shall accept no liability whatsoever for damage resulting from improper use. The user shall bear all risks arising from improper use.

Similarly, the following foreseeable faulty usages are also considered to be improper:

▶ Use outside the operating parameters approved in the data sheet or in the order confirmation (unless customer-specific approval has been granted)
▶ Use for non-approved fluids, e.g. water or polyurethane components
▶ Modification of factory settings by non-authorized persons
▶ Use of add-on parts (e.g. control unit, valves) that are not specified Rexroth components
▶ Using the axial piston unit under water at a depth of more than 10 meters without necessary additional measures, e.g. pressure equalization
• Using the axial piston unit when the exterior pressure is greater than the interior pressure (case pressure)
• Using the axial piston unit in explosive environments unless the component or machine/system has been certified as compliant with the ATEX directive 94/9/EC
• Using the axial piston unit in an aggressive atmosphere
• Using the axial piston unit in aircraft or space craft

2.4 Personnel qualifications
The activities described in this documentation require basic mechanical, electrical and hydraulic knowledge, as well as knowledge of the associated technical terms. For transporting and handling the product, additional knowledge is necessary with regard to working with a lifting device and the corresponding attachment equipment. In order to ensure safe use, these activities may therefore only be carried out by appropriate qualified personnel or an instructed person under the direction and supervision of qualified personnel. Qualified personnel are those who can recognize possible hazards and institute the appropriate safety measures due to their professional training, knowledge, and experience, as well as their understanding of the relevant regulations pertaining to the work to be done. Qualified personnel must observe the rules relevant to the subject area and have the necessary hydraulic knowledge.
Hydraulic knowledge means, for instance:
• reading and fully understanding hydraulic plans,
• fully understanding in particular the interrelationships regarding safety devices, and
• having knowledge on the function and assembly of hydraulic components.

Bosch Rexroth offers training support for special fields. You can find an overview of the training contents on the internet at: [http://www.boschrexroth.de/didactic](http://www.boschrexroth.de/didactic).

2.5 General safety instructions
• Observe the applicable accident prevention and environmental protection regulations.
• Observe the safety regulations and provisions of the country in which the product is used/operated.
• Use Rexroth products only when they are in good technical order and condition.
• Observe all notes on the product.
• Persons who install, operate, remove or maintain Rexroth products must not consume any alcohol, drugs or pharmaceuticals that may affect their ability to respond.
• Only use Rexroth original accessories and spare parts to ensure there is no risk to persons from unsuitable spare parts.
• Conform to the technical data and ambient conditions specified in the product documentation.
• If unsuitable products are installed or used in applications that are of relevance to safety, unexpected operating conditions may occur in the application which could result in injury to persons or property damage. For this reason, only use the product in a safety-relevant application if this use is expressly specified and
permitted in the product documentation, for example in ex-protection applications or in safety-related parts of a control system (functional safety).
• You may only commission the product if it has been determined that the end product (e.g. machinery or a system) into which the Rexroth products are installed complies with the country-specific provisions, safety regulations and standards of the application.

2.6 Product-specific safety instructions
The following safety instructions apply for chapters 6 to 14.

**WARNING**

Danger from excessively high pressure!
Danger to life or risk of injury, damage to equipment!
Incorrectly changing the factory pressure setting can cause pressure to increase beyond the permissible maximum pressure.
Operating the unit above the permissible maximum pressure can cause components to burst and hydraulic fluid to escape under high pressure.
▶ Changes to the factory settings must only be made by Bosch Rexroth specialist personnel.
▶ In addition, a pressure-relief valve is needed as back-up in the hydraulic system.
If the axial piston unit is equipped with a pressure cut-off and/or a pressure controller, this is not an adequate back-up against pressure overload.
WARNING

Danger from suspended loads!
Danger to life or risk of injury, damage to equipment!
Improper transportation may cause the axial piston unit to fall down lead to injuries e.g. crushing or broken bones or damage to the product.
▶ Make certain that the forklift truck or lifting device has adequate lifting capacity.
▶ Never stand under or put you hands under suspended loads.
▶ Ensure your position is stable during transportation.
▶ Use your personal protection equipment (e.g. safety glasses, safety gloves, suitable working clothes, safety shoes).
▶ Use suitable lifting devices for transportation.
▶ Observe the prescribed position of the lifting strap.
▶ Observe the national laws and regulations on work and health protection and transportation.

Pressurized machine/system!
Danger to life or risk of injury, serious injuries when working on machines/systems not shutdown! Damage to equipment!
▶ Protect the complete system against being energized.
▶ Make sure that the machine/system is depressurized. Please follow the machine/system manufacturer’s instructions.
▶ Do not disconnect any line connections, ports and components when the machine/system is pressurized.
▶ Switch off all power-transmitting components and connections (electric, pneumatic, hydraulic, mechanical) in accordance with the manufacturer’s instruction and secure them against being switched back on.

Escaping oil mist!
Risk of explosion, fire, health hazard, environmental pollution!
▶ Depressurize the machine/system and repair the leak.
▶ Only perform welding work then the machine/system is depressurized.
▶ Keep open flames and ignition sources away from the axial piston unit.
▶ If axial piston units are to be situated in the vicinity of ignition sources or powerful thermal radiators, a shield must be erected to ensure that any escaped hydraulic fluid can not ignite, and to protect hose lines from premature aging.

Electrical voltage!
Risk of injury due to electric shock or damage to equipment!
▶ Always set up the relevant part of the machine/system so that it is free of electrical voltage before you install the product or when connecting and disconnecting plugs. Protect the machine/system against being energized.
2.7 Personal protection equipment

The personal protection equipment is the responsibility of the user of the axial piston unit. Observe the safety regulations and provisions of your country. All components of the personal protection equipment must be intact.
3 General instructions on damage to equipment and the product

The following instructions apply for chapters 6 to 14.

**NOTE**

**Danger from improper handling!**

Product can be damaged!

- Do not expose the product to an impermissible mechanical load.
- Never use the product as a handle or step.
- Do not place/lay any objects on the product.
- Do not strike the drive shaft of the axial piston unit.
- Do not set/place the axial piston unit on the drive shaft or fittings.
- Do not strike fittings (e.g. sensors or valves).
- Do not strike sealing surfaces (e.g. service line ports).
- Leave the protection covers on the axial piston unit until shortly before the lines are connected.
- Disconnect all electrical connectors before performing electro-welding or painting operations.
- Make certain that the electronic components (e.g., sensors) do not become electrostatically charged (e.g., during painting operations).

**Damage to equipment due to improper lubrication!**

Product can be damaged or destroyed!

- Never operate the axial piston unit with insufficient hydraulic fluid. Make sure in particular that the rotary group has sufficient lubrication.
- When commissioning a machine/system, make sure that the housing and the service lines of the axial piston unit are filled with hydraulic fluid and remain filled during operation.
- Check the hydraulic fluid level in the housing regularly; if necessary, recommission. With above-reservoir installation, the housing may drain via the reservoir line after longer standstill periods (air enters via the shaft seal) or via the service line (gap leakage). The bearings are thus insufficiently lubricated at switch on.
- Make sure that the suction line is always filled with hydraulic fluid during commissioning and operation.
### NOTE

**Mixing of hydraulic fluids!**
Product can be damaged!
- Before installation, remove all fluids from the axial piston unit to prevent mixing with the hydraulic fluid used in the machine/system.
- Any mixing of hydraulic fluids of different manufacturers or different types of the same manufacturer is not permissible in general.

**Contamination of the hydraulic fluid!**
The cleanliness of the hydraulic fluid has a considerable impact on the cleanliness and service life of the hydraulic system. Contamination of the hydraulic fluid could cause premature wear and malfunctions!
- Make sure that the working environment at the installation site is fully free of dust and foreign substances in order to prevent contaminants, such as welding beads or metal cuttings, from getting into the hydraulic lines and causing product wear or malfunctions. The axial piston unit must be installed in a clean condition.
- Use only clean ports, hydraulic lines and attachments (e.g. measuring devices).
- No contaminants may enter the ports when they are plugged.
- Before commissioning, make sure that all hydraulic connections are tight and that all of the connection seals and plugs are installed correctly to ensure that they are leakproof and fluids and contaminants are prevented from penetrating the product.
- Use a suitable filter system to filter hydraulic fluid during filling to minimize solid impurities and water in the hydraulic system.

**Improper cleaning!**
Product can be damaged!
- Plug all openings with the appropriate protection equipment in order to prevent detergents from entering the hydraulic system.
- Never use solvents or aggressive detergents. Use only water and, if necessary, a mild detergent to clean the axial piston unit.
- Do not point the high-pressure cleaner at sensitive components, e.g. shaft seal, electrical connections and components.
- Use lint-free cloths for cleaning.

**Environmental pollution due to incorrect disposal!**
Careless disposal of the axial piston unit and its fittings, the hydraulic fluid and the packaging material could lead to pollution of the environment!
- Dispose of the axial piston unit, hydraulic fluid and packaging in accordance with the national regulations in your country.
- Dispose of the hydraulic fluid in accordance with the applicable safety data sheet for the hydraulic fluid.
NOTE

Escaping or spilling hydraulic fluid!
Environmental pollution and contamination of the ground water!
▶ Always place a drip tray under the axial piston unit when filling and draining the hydraulic fluid.
▶ Use an oil binding agent if hydraulic fluid is spilled.
▶ Observe the information in the safety data sheet for the hydraulic fluid and the specifications provided by the system manufacturer.

The warranty applies only to the delivered configuration.
The entitlement to warranty cover will be rendered void if the product is incorrectly installed, commissioned or operated, or if it is used or handled improperly.
4 Scope of supply

Included in the scope of supply are:
• Axial piston unit as per order confirmation

The following parts are also installed on delivery:
• Protection plug/threaded plug (1)
• For version with through drive, metallic protection cover and mounting bolts (2)
5  Product description

5.1 Performance description
The axial piston variable double pump generates, controls and regulates a hydraulic-fluid flow. It is designed for mobile applications such as construction machinery. Refer to data sheet 93221 and the order confirmation for the technical data, operating conditions and operating limits of the axial piston unit.

5.2 Product description
The A22VG is a variable double pump with two axial piston rotary groups in swashplate design for hydrostatic drives in closed circuits. The two flows are proportional to the drive speed and the displacement. The flow can be steplessly changed by controlling the cradle (11). Both circuits can be adjusted independent of one another. For axial piston units with swashplate design, the pistons are arranged axially with respect to the drive shaft.

Closed circuit
In the closed circuit, the hydraulic fluid flows from the hydraulic pump to the consumer (e.g. the hydraulic motor) and from there directly back to the hydraulic pump.
There is a high-pressure side and a low-pressure side which alternate depending on which side is under load.

5.2.1 Assembly of the axial piston unit

![Fig. 2: Assembly of the A22VG](image)

1  Drive shaft  
2  Retainer plate  
3  Controller (using the EP as an example here)  
4  Stroking piston  
5  High-pressure side  
6  Low-pressure side  
7  Control plate  
8  Cylinder  
9  Piston  
10  Slipper pad  
11  Cradle
5.2.2 Functional description

**Pump**
Torque and rotational speed are applied to the drive shaft (1) by an diesel engine. The drive shaft is connected by splines to the cylinder (8) to set this in motion. With every revolution, the pistons (9) in the cylinder bores execute one stroke whose magnitude depends on the setting of the cradle (11). The pistons hold the slipper pads (10) onto the glide surface of the cradle with the retainer plate (2) and guide them along. The swashplate setting during a rotation causes each piston to move over the bottom and top dead centers and back to its initial position. Here, hydraulic fluid is fed in and drained out through the two control slots in the control plate (7) according to the stroke displacement. On the high-pressure side (5) the hydraulic fluid is pushed out of the cylinder chamber and into the hydraulic system by the pistons. At the same time, hydraulic fluid flows into the growing piston chamber on the low-pressure side (6). In a closed circuit, supported by the return and boost pressure.

**High-pressure safeguarding**
The four high-pressure relief valves protect the hydrostatic transmission (pump and engine) against overloading. They limit the maximum pressure in the relevant high-pressure line and at the same time act as boost valves. High-pressure relief valves are not working valves and are only suitable for pressure spikes or high rates of pressure change.

**Version without boost pump**
In order to replenish internal leakage in the variable double pump and consumers, port G must be connected to an external source of boost pressure. The boost pressure-relief valve is integrated.

**Version with boost pump (optional)**
The boost pump continuously supplies a volume of fluid (boost volume) from a reservoir to the low-pressure side of the closed circuit via a check valve to replenish the internal leakage of the variable double pump and consumers. The boost pump is an internal gear pump, driven directly via the drive shaft.

Pressure port G₁ on the boost pump must be externally piped up by the customer to port G (or G₂ on the version with DA control valve). Suction or pressure filtration must be provided by the customer.

**Control**
The swivel angle of the cradle (11) is steplessly varied. Controlling the swivel angle of the swashplate changes the piston stroke and therefore the displacement. Adjusting the swashplate through the neutral position will change the direction of flow (making reversing operation possible). The swivel angle is controlled hydraulically by means of the stroking piston. The cradle is mounted in swivel bearings for easy motion and the neutral position is spring-centered. Increasing the swivel angle increases the displacement; reducing the angle results in a corresponding reduction in displacement.

Various control devices are available depending on requirements. Information about this can be found in data sheet 93221.
CAUTION

The spring feedback feature in the control module is not a safety device

The control module can stick in an undefined position due to internal contamination (contaminated hydraulic fluid, abrasion or residual contamination from system components). As a result, the volume flow of the axial piston unit will no longer respond correctly to the operator’s commands.

- Check whether the application on your machine requires additional safety measures, in order to bring the driven consumer into a safe position (immediate stop). If necessary, make sure that these are properly implemented.

5.3 Product identification

The axial piston unit can be identified from the name plate. The following example shows an A4VG A22VG name plate:

![Name plate A22VG](image)

Fig. 3: Name plate A22VG

1 Manufacturer
2 Sample category (optional)
3 Internal plant designation
4 Specified area for inspection stamp
5 Direction of rotation (viewed on drive shaft) – here: clockwise
6 Weight (optional)
7 Power
8 Bar code
9 Rotational speed
10 Manufacturing date
11 Serial number
12 Material number of the axial piston unit
13 Ordering code
14 Customer material number
6 Transport and storage

- Always observe the required ambient conditions for transport and storage, see chapter 6.2 “Storing the axial piston unit” on page 22.

Notes on unpacking can be found in chapter 7.1 “Unpacking” on page 24.

6.1 Transporting the axial piston unit

The transportation options below exist depending on the weight and duration of the transport:
- Transport by hand (chapter not relevant for this axial piston unit)
- Transporting with lifting device (eye bolt or lifting strap)

Table 6: Dimensions and weights

<table>
<thead>
<tr>
<th>Size</th>
<th>Width mm</th>
<th>Height mm</th>
<th>Depth mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>45</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>The dimensions vary with the unit type. The values applicable for your axial piston unit can be found in the installation drawing (request if necessary).</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>53(^1)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^1\) With HT control without boost pump.

The weight specifications may vary depending on the unit type.

6.1.1 Transporting by hand

Axial piston units with a weight of up to 15 kg can be transported manually for a short time if necessary.

**CAUTION!** Danger from heavy loads!
There is a danger of health damage when carrying axial piston units.
- Use suitable lifting, placement and relocation equipment.
- Use your personal protection equipment (e.g. safety glasses, safety gloves, suitable working clothes, safety shoes).
- Do not transport the axial piston unit at sensitive attachment parts (e.g. sensors or valves).
- Carefully place the axial piston unit on the seating to prevent it from being damaged.

6.1.2 Transporting with lifting device

For transporting, the axial piston unit can be connected to a lifting device via a eye bolt or a lifting strap.

**Transport with eye bolt**
The axial piston unit can be transported suspended from an eye bolt screwed into the drive shaft as long as only outward (pulling) axial forces are applied.
- For all female threads, use a threaded plug from the same system of units and of the correct size.
- To do this, screw an eye bolt completely into the female thread on the drive shaft. The thread size is stated in the installation drawing.
- Make sure that the eye bolt can bear the total weight of the axial piston unit plus 20%.
You can hoist the axial piston unit as shown in Fig. 4 with the eye bolt screwed into the drive shaft.

**WARNING!** Danger from suspended loads!
During transport with a lifting device, the axial piston unit can fall out of the lifting strap and cause injuries.

▶ Use the widest possible lifting strap.
▶ Make sure that the axial piston unit is securely fixated with the lifting strap.
▶ Only guide the axial piston unit by hand for fine positioning and to avoid oscillations.
▶ Never stand under or put your hands under suspended loads.

▶ Place the lifting strap around the axial piston unit in such a way that it neither passes over the attachment parts (e.g., valves) nor that the axial piston unit is hung from attachment parts (see Fig. 5).
6.2 Storing the axial piston unit

**Requirement**

- The storage areas must be free from corrosive materials and gases.
- To prevent damage to the seals, ozone-forming equipment (e.g. mercury-vapor lamps, high voltage equipment, electric motors, sources of electrical sparks or electrical discharges) must not be operated in storage areas.
- The storage areas must be dry.
- Ideal storage temperature: +5 °C to +20 °C.
- Minimum storage temperature: −50 °C (exception: units with on-board-electronics).
- Maximum storage temperature: +60 °C.
- Avoid high light irradiation (e.g. bright windows or direct fluorescent lighting).
- Do not stack axial piston units and store them shock-proof.
- Do not store the axial piston unit on the drive shaft or fitting, e.g. sensors or valves.
- For further storage conditions, see Table 7.

▶ Check the axial piston unit monthly to ensure proper storage.

**After delivery**

The axial piston units are provided ex-works with corrosion protection packaging (corrosion protection film).

Table 7 lists the maximum permissible storage times for an originally packed axial piston unit as per data sheet 90312.

<table>
<thead>
<tr>
<th>Storage conditions</th>
<th>Standard corrosion protection</th>
<th>Long-term corrosion protection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closed, dry room, uniform temperature between +5 °C and +20 °C. Undamaged and closed corrosion protection film.</td>
<td>Maximum 12 months</td>
<td>Maximum 24 months</td>
</tr>
</tbody>
</table>

Entitlement to warranty will be rendered void if the requirements and storage conditions are not adhered to or after expiration of the maximum storage time (see Table 7).

Procedure after expiry of the maximum storage time:

1. Check the entire axial piston unit for damage and corrosion prior to installation.
2. Check the axial piston unit for proper function and leaks during a test run.
3. If the storage time exceeds 24 months, the shaft seal ring must be replaced.

After expiry of the maximum storage time, we recommend that you have the axial piston unit inspected by your responsible Bosch Rexroth Service partner.

In the event of questions regarding repair and spare parts, contact your responsible Bosch Rexroth Service partner or the service department of the manufacture’s plant for the axial piston unit, see chapter 10.5 “Spare parts” on page 45.
After removal

If a removed axial piston unit is to be stored, it must be preserved against corrosion for the duration of storage.

The following instructions only refer to axial piston units which are operated with a mineral-oil based hydraulic fluid. Other hydraulic fluids require preservation methods that are specifically designed for them. In such cases, consult with Bosch Rexroth Service, see chapter 10.5 “Spare parts” on page 45.

Bosch Rexroth recommends the following procedure:

1. Clean the axial piston unit, see chapter 10.1 “Cleaning and care” on page 43.
2. Empty the axial piston unit.
3. For storage time up to 12 months: Moisten the inside of the axial piston unit with mineral oil and fill with approx. 100 ml mineral oil.
   For storage time up to 24 months: Fill the axial piston unit with corrosion protection medium VCI 329 (20 ml).
   Filling is performed via the reservoir port T, see chapter 7.4 “Installing the axial piston unit”, Fig. 13 and 14 on page 35.
4. Seal all ports airproof.
5. Moisten the unpainted surfaces of the axial piston unit with mineral oil or a suitable, easily removed corrosion protection agent, e.g. acid-free grease.
6. Package the axial piston unit airproof together with desiccant in corrosion protection film.
7. Store the axial piston unit so that it is protected against jolts, see “Requirement” on page 22 in this chapter.
7 Installation

Prior to installation, the following documents must be ready at hand:

- Installation drawing for axial piston unit (can be obtained from your responsible contact person at Bosch Rexroth)
- Hydraulic schematic for the axial piston unit (in the installation drawing)
- Hydraulic schematic for the machine/system (available from the machine/system manufacturer)
- Order confirmation (contains the order-related technical data for your axial piston unit)
- Data sheet of the axial piston unit (contains the permissible values of technical data)

7.1 Unpacking
The axial piston unit is delivered in a corrosion protection film made of polyethylene material (PE).

CAUTION! Danger from parts falling out!
If the packaging is not opened correctly, parts may fall out and damage the parts or even cause injuries!

- Place the packaging on a flat and solid surface.
- Only open the packaging from the top.
- Remove the packaging from the axial piston unit.
- Check the axial piston unit for transport damage and completeness, see chapter 4 “Scope of supply” on page 16.
- Dispose of the packaging according to the environmental regulations of your country.

7.2 Installation conditions
The installation location and position of the axial piston unit essentially determine the procedures during installation and commissioning (such as when filling and air bleeding the axial piston unit).

- Fix the axial piston unit so that the expected forces and torques can be transferred without any danger. The machine/system manufacturer is responsible for dimensioning the fasteners.

The variable double pump A22VG is permissible without additional supports, providing a maximum dynamic mass acceleration of $10 \, \text{g} (= 98.1 \, \text{m/s}^2)$ is not exceeded. If an additional pump is to be fitted to the A22VG, the mounting flange must be calculated for the permissible moment of inertia.

- Observe the permissible radial forces on the drive shaft when transferring output drive with radial force loading (belt drives). If necessary, the belt pulley must be separately mounted.
- Make sure that the axial piston unit is air bled and filled with hydraulic fluid during commissioning and operation. This is also to be observed following relatively long standstill periods as the axial piston unit may empty via the hydraulic lines.
The case drain fluid in the housing must be directed to the reservoir via the highest case drain port. Use the line size which is appropriate for the port.

Avoid using a check valve in the reservoir line.

To achieve favorable noise values, decouple all connecting lines from all vibration-capable components (e.g. reservoir) using elastic elements.

Make sure that the suction, reservoir and return lines lead into the reservoir below the minimum fluid level in all operating conditions. This will prevent air from being drawn in and foam from being formed.

Make sure that a minimum suction pressure of 0.8 bar absolute is present at port S during operation (0.5 bar absolute for cold starts) in all installation positions and installation locations for the axial piston pump, see Fig. 6. Please refer to the data sheet for further pressure values.

![Fig. 6: Suction pressure](image)

1 Absolute pressure gauge
2 Standard pressure gauge (relative)

The suction conditions improve with below-reservoir installation.

Make sure that the working environment at the installation site is fully free of dust and foreign substances. The axial piston unit must be installed in a clean condition. Dirt contamination in the hydraulic fluid can seriously impair the function and service life of the axial piston unit.

Use lint-free cloths for cleaning.

Use suitable mild detergents to remove lubricants and other difficult-to-remove contamination. Cleaning agents must not enter the hydraulic system.
7.3 Installation position

The following installation positions are permissible. The shown piping layout illustrates the basic layout.

If it is not possible to fill the stroking chambers via $X_1$ to $X_6$ in the final installation position, this must be done prior to installation.

In order to prevent unexpected activation behavior and damage, the stroking chambers must be air bled via ports $X_1$, $X_2$ or $X_5$, $X_6$, or $X_3$, $X_4$, according to their installation position.

Please note that with HT control, port $X_1$, $X_2$ is omitted and is replaced by $X_5$, $X_6$.

7.3.1 Below-reservoir installation (standard)

Below-reservoir installation means that the axial piston unit is installed outside of the reservoir below the minimum fluid level.

Recommended installation position: 1 and 2 (without boost pump)
3 and 4 (with boost pump)

![Fig. 7: Below-reservoir installation A22VG without boost pump, installation position 1-2](image)

![Fig. 8: Below-reservoir installation: A22VG with boost pump, installation position 3-4](image)
Table 8: Below-reservoir installation

<table>
<thead>
<tr>
<th>Installation position</th>
<th>Air bleeding the housing</th>
<th>Air bleed Stroking chamber</th>
<th>Filling</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (drive shaft, horizontal)</td>
<td>R</td>
<td>$X_1, X_2$</td>
<td>$T + X_1 + X_2$</td>
</tr>
<tr>
<td>2 (drive shaft, horizontal)</td>
<td>–</td>
<td>–</td>
<td>$T$</td>
</tr>
<tr>
<td>3 (drive shaft, horizontal)</td>
<td>R</td>
<td>$X_1, X_2$</td>
<td>$S + T + X_1 + X_2$</td>
</tr>
<tr>
<td>4 (drive shaft, horizontal)</td>
<td>–</td>
<td>–</td>
<td>$S + T$</td>
</tr>
</tbody>
</table>

### 7.3.2 Above-reservoir installation

Above-reservoir installation means that the axial piston unit is installed above the minimum fluid level of the reservoir.

Observe the maximum permissible suction height $h_{S\text{ max}} = 800$ mm. The permissible suction height $h_S$ is derived from the total pressure loss.
Table 9: Above-reservoir installation

<table>
<thead>
<tr>
<th>Installation position</th>
<th>Air bleeding the housing</th>
<th>Air bleed Stroking chamber</th>
<th>Filling</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 (drive shaft, horizontal)</td>
<td>R</td>
<td>X1, X2</td>
<td>L1 + X1 + X2</td>
</tr>
<tr>
<td>6 (drive shaft, horizontal)</td>
<td>L1</td>
<td>-</td>
<td>L1</td>
</tr>
<tr>
<td>7 (drive shaft, horizontal)</td>
<td>R + L2 (S)</td>
<td>X1, X2</td>
<td>L1 + L2 (S) + X1 + X2</td>
</tr>
<tr>
<td>8 (drive shaft, horizontal)</td>
<td>L1 + L2 (S)</td>
<td>-</td>
<td>L1 + L2 (S)</td>
</tr>
</tbody>
</table>

7.4 Installing the axial piston unit

7.4.1 Preparation

1. Compare the material number and designation (ordering code) with the details in the order confirmation.

If the material number for the axial piston unit does not correspond to the one in the order confirmation, contact Bosch Rexroth Service for clarification, see chapter 10.5 “Spare parts” on page 45.

2. Before installing, completely empty the axial piston unit to prevent any mixing with the hydraulic fluid used in the machine/system.

3. Check the direction of rotation of the axial piston unit (on the name plate) and make sure that this corresponds to the direction of rotation of the output/drive shaft of the machine/system.
The direction of rotation as specified on the name plate determines the direction of rotation of the axial piston unit as viewed on the drive shaft, see chapter 5.3 “Product identification” on page 19.

### 7.4.2 Dimensions
The installation drawing contains the dimensions for all connections and ports on the axial piston unit. Also observe the instructions provided by the manufacturers of the other hydraulic components when selecting the required tools.

### 7.4.3 General instructions
Please keep in mind the following general instructions for installation of the axial piston unit:
- Note that you can expect certain installation positions to affect the control device. Gravity, dead weight and case pressure can cause minor shifts in control characteristics and changes in response time.
- Torsional vibrations and speed variations may cause leakages on the shaft seal and increased rotary angle accelerations of the rotary group of the axial piston unit. At risk are diesel drives with a small number of cylinders and low flywheel mass and toothed belt or V-belt drives. Belts can lose a large part of its tension after just a short time.
  
  An automatic clamping device can lessen the speed variations and vibrations and thus avoid consequential damage.
- Always use an automatic clamping device when using toothed belts or V-belts to transfer the input or output drive.
- On the input or output drive of an axial piston unit, a cardan shaft may cause vibrations and impermissible rotary angle accelerations. Depending on the frequency and temperature, they may result in leakage on the shaft seal and damage to the rotary group.
- For combinations of multiple units, make sure that the respective case pressure in each unit is not exceeded. In the event of differential pressures at the drain ports of the units, the shared drain line must be changed so that the minimum permissible case pressure of all connected units is not exceeded in any situation. If this is not possible, separate drain lines must be laid if necessary.

How to install the axial piston unit depends on the connecting elements to the drive side. The following descriptions explain the installation of the axial piston unit:
- with a coupling
- on a gearbox
7.4.4 Installation with coupling

The method for installing the axial piston unit with a coupling is described below:

**NOTE!** Danger from improper handling!
Product can be damaged!
- Do not install the coupling hub onto the drive shaft of the axial piston unit by striking it.

1. Install the specified coupling half onto the drive shaft of the axial piston unit according to the instructions of the coupling manufacturer.

   The drive shaft of the axial piston unit is equipped with a female thread. Use this female thread to pull the coupling element onto the drive shaft. The size of the female thread can be seen in the installation drawing.

2. Clamp the coupling hub onto the drive shaft or ensure permanent lubrication of the drive shaft. This prevents the formation of frictional corrosion and the associated wear.

3. Transport the axial piston unit to the installation location.

4. Remove dirt and contaminants from the installation location.

5. Install the coupling on the output shaft of the diesel engine in accordance with the specifications provided by the coupling manufacturer.

   The axial piston unit may not be bolted down until the coupling has been correctly installed.

6. Fix the axial piston unit at the installation location.

7. Align the drive shaft of the axial piston unit and the output shaft of the diesel engine so that there is no angular deviation.

8. Make sure that no impermissible axial and radial forces act on the drive shaft.

9. For bell housing installation, check the coupling axial play through the bell window according to the manufacturer’s instructions.

10. Details on the required tools and tightening torques for the mounting bolts are available from the machine/system manufacturer.

11. When using flexible couplings, check that the drive is free of resonance after completing the installation.

7.4.5 Installation on a gearbox

The installation layout for the axial piston unit on a gearbox is described below.

After installing on a gearbox, the axial piston unit is covered and is difficult to access:
- Therefore, before installing, make sure that the spigot diameter centers the axial piston unit (observe tolerances) and that no impermissible axial or radial forces act on the drive shaft of the axial piston unit (installation length).
- Protect the drive shaft against frictional corrosion by providing permanent lubrication.
- Fix the axial piston unit at the installation location.
No gearing forces higher than the permissible axial and radial forces are to act on the shaft, if necessary the gear wheel must be supported separately at the gearbox output.

### 7.4.6 Installation with cardan shaft

To connect the axial piston unit to the diesel engine via a cardan shaft:

1. Position the axial piston unit close to the specified installation location. It should allow enough space for the cardan shaft to fit through on both sides.
2. Position the cardan shaft on the output shaft of the diesel engine.
3. Push the axial piston unit to the cardan shaft and join the cardan shaft to the drive shaft of the axial piston unit.
4. Bring the axial piston unit to the installation position and secure. If necessary, details on the required tools and tightening torques for the mounting bolts can be obtained from the system manufacturer.

### 7.4.7 Completing installation

1. Remove any mounted transport screws.

**CAUTION!** Operation with protection plug!

Operating the axial piston unit with protection plugs may result in injuries or damage to the axial piston unit.

- Before commissioning, remove all protection plugs and replace them with suitable, pressure-proof, metal threaded plugs.

2. Remove the transport protection.

   The axial piston unit is delivered with protection plugs (1) and protection covers (2). They are not pressure-resistant, therefore they have to be removed prior to connection. Use a suitable tool for this to prevent damage to the sealing and functional surfaces. If sealing or functional surfaces are damaged, contact your responsible Bosch Rexroth Service partner or the service department of the manufacturer’s plant for the axial piston unit.
Fig. 12: Removing transport protection

1 Protection plug/threaded plug  
2 Protection cover

Ports intended for connecting lines are covered by protection plugs or threaded plugs, which serve as transport protection. All ports required for functional operation must be connected (see Table 10 “Ports A22VG series 40 series 40” on page 36). If this requirement is disregarded, malfunction or damage may result. If a port is not connected, it must be plugged with a threaded plug because protection plugs are not pressure-resistant.

The setting screws are protected against unauthorized resetting by means of protection caps. Removing the protection caps will void the warranty. If you need to change settings, contact your responsible Bosch Rexroth Service partner (for address, see chapter 10.5 “Spare parts” on page 45).

3. For versions with through drive, install the auxiliary pump according to the pump manufacturer’s instructions.
7.4.8 Hydraulically connecting the axial piston unit

**NOTE**

**Insufficient suction pressure!**

Generally, a minimum permissible suction pressure at port “S” is specified for axial piston pumps with boost pump in all installation positions. If the pressure at port “S” drops below the specified values, damage may occur which may lead to the axial piston pump being damaged beyond repair!

Make sure that the necessary suction pressure is not undercut. This is influenced by:

- the piping (e.g. suction cross-section, pipe diameter, length of suction line)
- the position of the reservoir
- the viscosity of the hydraulic fluid
- if fitted, a filter cartridge or check valve in the suction line (regularly check the level of soiling of the filter cartridge)

The machine/system manufacturer is responsible for dimensioning the lines. The axial piston unit must be connected to the rest of the hydraulic system in accordance with the hydraulic schematic of the machine/system manufacturer. The ports and fastening thread are designed for the maximum pressure specified in the data sheet. The machine/system manufacturer must ensure that the connecting elements and lines correspond to the specified application conditions (pressure, flow, hydraulic fluid, temperature) with the necessary safety factors.

Connect only hydraulic lines that are appropriate for the axial piston unit port (pressure level, size, system of units).

**Notes on routing the lines**

Observe the following notes when routing the suction, pressure and reservoir lines.

- Lines and hoses must be installed without pre-charge pressure, so that no further mechanical forces are applied during operation that will reduce the service life of the axial piston unit and, if applicable, the entire machine/system.
- Use suitable seals as sealing material.
- Suction line (pipe or hose)
  - The suction line should be as short and straight as possible.
  - Measure the line cross section of the suction line so that the pressure at the suction port does not drop below the minimum permissible pressure. Make sure that the maximum suction pressure is not exceeded (e.g. when pre-filling).
  - Make sure the connections and connecting elements are air-tight.
  - The hose must be pressure-resistant, also for external air pressure.
- Pressure line
  - For the pressure lines, use only pipes, hoses and connecting elements rated for the operating pressure range specified in data sheet 93221 (see Table 10).
• Drain line
  – Always route the reservoir lines so that the case is constantly filled with hydraulic fluid and to ensure that no air gets through the shaft seal even during extended standstill periods.
  – The case pressure must not exceed the limit values listed for the axial piston unit in the data sheet under any operating conditions.
  – The reservoir line joint in the reservoir must always be below the minimum fluid level under all conditions (see chapter 7.3 “Installation position” on page 26).
• If the axial piston unit is equipped with installed screw fittings, these must not be unscrewed. Screw the threaded plug of the fitting directly into the installed screw fitting.

Risk of mix-ups with threaded connections

Axial piston units are employed in regions using the metric measuring system, in regions using the Anglo-American (imperial) measuring system and in regions using the Japanese measuring system (JIS – Japan Industrial Standard). Moreover, various kinds of seal are used.
The system of units, the kind of seal and the size of female thread and threaded plugs (e.g. locking screw) must all match.
Due to the limited options for visually detecting differences, there is a risk of mix-ups.

WARNING! Leaky or popped-out threaded plugs!
If a threaded plug which is of a different measurement system, kind of seal and size with respect to the female thread is pressurized, the threaded plug may loosen itself or even be ejected from the hole in a projectile-like manner. This can result in serious injury and damage to equipment. Hydraulic fluid can be discharged from this leakage point.
▶ Use the drawings (installation drawing) to determine the required threaded plug for each fitting.
▶ Make certain that there are no mix-ups when installing fittings, mounting bolts and threaded plugs.
▶ For all female threads, use a threaded plug from the same system of units and of the correct size.
Port overview

Fig. 13: Port overview A22VG, EP control with boost pump

Fig. 14: Port overview A22VG, HT control with boost pump
Table 10: Ports A22VG series 40\textsuperscript{1)}

<table>
<thead>
<tr>
<th>Ports</th>
<th>$p_{max}$ [bar]\textsuperscript{2)}</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>A, B</td>
<td>Service line port</td>
<td>420</td>
</tr>
<tr>
<td>S</td>
<td>Suction port (only with boost pump)</td>
<td>5</td>
</tr>
<tr>
<td>T</td>
<td>Drain port</td>
<td>3</td>
</tr>
<tr>
<td>R</td>
<td>Air bleed</td>
<td>3</td>
</tr>
<tr>
<td>$X_1, X_2$</td>
<td>Control pressure (upstream of orifice, only HP, HW, EP and ET)</td>
<td>30</td>
</tr>
<tr>
<td>$X_3, X_4$</td>
<td>Stroking chamber pressure</td>
<td>30</td>
</tr>
<tr>
<td>$X_5, X_6$</td>
<td>Control pressure (upstream of orifice, HT only)</td>
<td>30</td>
</tr>
<tr>
<td>Y</td>
<td>Pilot pressure, outlet (only with DA control valve)</td>
<td>30</td>
</tr>
<tr>
<td>G</td>
<td>Boost pressure, inlet</td>
<td>30</td>
</tr>
<tr>
<td>$G_1$</td>
<td>Boost pressure, inlet (only with DA control valve)</td>
<td>30</td>
</tr>
<tr>
<td>$G_2$</td>
<td>Boost pressure, outlet (only with boost pump)</td>
<td>30</td>
</tr>
<tr>
<td>$M_A$, $M_B$</td>
<td>Measuring pressure A, B</td>
<td>420</td>
</tr>
</tbody>
</table>

\textsuperscript{1)} The measuring system and thread size can be taken from the installation drawing.

\textsuperscript{2)} Short-term pressure spikes may occur depending on the application. Keep this in mind when selecting measuring devices and fittings.

Optional

O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

Port G (or $G_1$ on the version with DA control valve) must be charged with boost pressure by the customer.

Tightening torques

The following tightening torques apply:

- Female threads hole of the axial piston unit:
  The maximum permissible tightening torques $M_{g_{\text{max}}}$ are maximum values of the for the female threads and must not be exceeded. Values, see Table 11.

- Fittings:
  Observe the manufacturer’s instruction regarding tightening torques for the used fittings.

- Mounting bolts:
  For mounting bolts with metric ISO thread according to DIN 13 or with thread according to ASME B1.1, we recommend checking the tightening torque in individual cases as per VDI 2230.

- Threaded plugs:
  For the metallic threaded plugs supplied with the axial piston unit, the required tightening torques of threaded plugs $M_v$ apply. Values, see Table 11.
Table 11: Tightening torques of the female threads and threaded plugs

<table>
<thead>
<tr>
<th>Ports Standard</th>
<th>Thread size</th>
<th>Maximum permissible tightening torque of the female threads $M_{\text{G, max}}$</th>
<th>Required tightening torque of the threaded plugs $M_v$</th>
<th>WAF hexagon socket of the threaded plugs</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISO 11926</td>
<td>5/16-24 UNF-2B</td>
<td>10 Nm</td>
<td>7 Nm</td>
<td>1/8 in</td>
</tr>
<tr>
<td></td>
<td>3/8-24 UNF-2B</td>
<td>20 Nm</td>
<td>10 Nm</td>
<td>5/32 in</td>
</tr>
<tr>
<td></td>
<td>7/16-20 UNF-2B</td>
<td>40 Nm</td>
<td>18 Nm</td>
<td>3/16 in</td>
</tr>
<tr>
<td></td>
<td>9/16-18 UNF-2B</td>
<td>80 Nm</td>
<td>35 Nm</td>
<td>1/4 in</td>
</tr>
<tr>
<td></td>
<td>3/4-16 UNF-2B</td>
<td>160 Nm</td>
<td>70 Nm</td>
<td>5/16 in</td>
</tr>
<tr>
<td></td>
<td>7/8-14 UNF-2B</td>
<td>240 Nm</td>
<td>110 Nm</td>
<td>3/8 in</td>
</tr>
<tr>
<td></td>
<td>1 1/16-12 UN-2B</td>
<td>360 Nm</td>
<td>170 Nm</td>
<td>9/16 in</td>
</tr>
<tr>
<td></td>
<td>1 5/16-12 UN-2B</td>
<td>540 Nm</td>
<td>270 Nm</td>
<td>5/8 in</td>
</tr>
<tr>
<td></td>
<td>1 5/8-12 UN-2B</td>
<td>960 Nm</td>
<td>320 Nm</td>
<td>3/4 in</td>
</tr>
<tr>
<td></td>
<td>1 7/8-12 UN-2B</td>
<td>1200 Nm</td>
<td>390 Nm</td>
<td>3/4 in</td>
</tr>
</tbody>
</table>

Procedure

1. Remove the protection plugs and threaded plugs at the ports at which the connections are to be made according to the hydraulic schematic.
2. Make sure that the sealing surfaces of the hydraulic ports and functional surfaces are not damaged.
3. Use only clean hydraulic lines or flush them before installation. (Note chapter 7.5 “Performing flushing cycle” on page 38 when you flush out the complete system.)
4. Connect the lines in accordance with the installation drawing and the machine or system schematic. Check whether all ports are connected or plugged with threaded plugs.
5. Tighten the fittings correctly (note tightening torques). Mark all correctly tightened fittings, e.g. with a permanent marker.
6. Check all pipes and hose lines and every combination of connecting pieces, couplings or connecting points with hoses or pipes to ensure they are in condition for safe working.

For relationship between direction of rotation and flow direction, please refer to data sheet 93221.
7.4.9 Electrically connecting the axial piston unit

**NOTE**

Short circuit in event of penetrating hydraulic fluid!
Fluid can penetrate the product and cause a short circuit!
- Do not install axial piston units with electric components (e.g. electric controls, sensors) in a reservoir below the fluid level (inside-reservoir installation).

The machine/system manufacturer is responsible for the layout of the electric control.
Electrically controlled axial piston units must be connected in accordance with the electrical circuit diagram for the machine/system.
For axial piston units with electrical control and/or mounted sensors, please comply with the details given in data sheet 93221, e.g.:
- the permissible voltage range
- the permissible current
- correct pin assignment
- the recommended electrical control units

Exact details on the connector, type of protection and matching mating connector can also be found in data sheet 93221. The mating connector is not included in the scope of supply.
1. Switch off power supply to the relevant system component.
2. Electrically connect the axial piston unit (12 or 24V). Before connecting, check that the connector including all seals are intact.

If necessary, you can change the connector orientation by turning the solenoid housing. This is dependent on the connector version.
To do this, proceed as follows:
1. Loosen the mounting nut (1) of the solenoid. To do this, turn the mounting nut (1) one turn counterclockwise.
2. Turn the solenoid body (2) to the desired position.
3. Retighten the mounting nut. Tightening torque of the mounting nut: 5+1 Nm.

7.5 Performing flushing cycle

In order to remove foreign particles from the system, Bosch Rexroth recommends a flushing cycle for the entire system before initial commissioning. To avoid internal contamination, the axial piston unit must not be included in the flushing cycle.

The flushing cycle must be performed with an additional flushing unit. Follow the instructions of the flushing unit’s manufacturer for the exact procedure during the flushing cycle.
8 Commissioning

WARNING

Danger while working in the danger zone of a machine/system!
Danger to life, risk of injury or serious injuries!
▶ Pay attention to and rectify potential danger sources before operating the axial piston unit.
▶ Nobody may stand in the danger zone of the machine/system.
▶ The emergency stop button for the machine/system must be within the operator’s reach.
▶ Always follow the instructions of the machine/system manufacturer during commissioning.

CAUTION

Commissioning of an incorrectly installed product!
Risk of injury and damage to equipment!
▶ Make sure that all electrical and hydraulic ports are connected or plugged.
▶ Only commission a completely installed fault-free product with original accessories from Bosch Rexroth.

8.1 Initial commissioning

During all work for commissioning the axial piston unit, observe the general safety instructions and intended use detailed in chapter 2 “Safety instructions” on page 8.

▶ Connect the gauge for the operating pressure, case pressure and suction pressure to the specified measuring points on the axial piston unit or in the hydraulic system, to check the technical data at first operation.
▶ During the commissioning process, monitor the temperature of the hydraulic fluid in the reservoir to ensure that it lies within the permissible viscosity limits.

8.1.1 Filling the axial piston unit

Professional filling and air bleeding is necessary to prevent damage to the axial piston unit and to maintain correct function.

The axial piston unit should be filled with a filling unit (10 μm filter grade). The axial piston unit must not be operated while it is being filled by the filling unit.

Use only a hydraulic fluid that conforms to the following requirements:
Details of minimum requirements for hydraulic fluid can be found in the Bosch Rexroth data sheets 90220, 90221 and 90222. The titles of the data sheets can be found in Table 1 “Required and supplementary documentation” on page 5. You can find details of permissible and optimal viscosity in data sheet 93221.
To ensure the functional reliability of the axial piston unit, cleanliness level 20/18/15 according to at least ISO 4406 is necessary for the hydraulic fluid.
Continuous suction or pressure filtration must be provided by the customer for the boost pressure fluid fed in at port G (or G₁ on the version with DA control valve).

At very high hydraulic fluid temperatures (+90 °C to maximum +115 °C), a cleanliness level of at least 19/17/14 according to ISO 4406 is necessary. For permissible temperatures, see the data sheet 93221.

1. Place a drip tray under the axial piston unit to collect any hydraulic fluid that may escape.

**NOTE!** Contaminated hydraulic fluid!
The cleanliness levels of hydraulic fluids on delivery do not normally conform to the requirements for our components.

- Use a suitable filter system to filter hydraulic fluids during filling to minimize solid impurities and water in the hydraulic system.

2. Fill and air bleed the axial piston unit via the appropriate ports, see chapter 7.3 “Installation position” on page 26. The hydraulic lines of the system must also be filled.

**NOTE!** Damage to equipment due to improper lubrication!
Product can be damaged or destroyed!

- When using a shut-off valve in the suction and/or reservoir line, make sure that the input of the axial piston unit can only be started when the shut-off valves are open.

3. When using a shut-off valve in the suction and/or reservoir line, only operate the axial piston unit when the shut-off valves are open.

4. Test the direction of rotation of the diesel engine. To do this, rotate the diesel engine briefly at the lowest rotational speed (inching). Make sure that the direction of rotation of the axial piston unit agrees with the details of the name plate, see chapter 5.3 “Product identification”, Fig. 3: Name plate A22VG on page 19.

5. Operate the axial piston pump at a lower speed (starter speed for internal combustion engines or inching operation for electric motors) until the hydraulic system is completely filled and air bled. To inspect, drain the hydraulic fluid at the reservoir port and wait until it drains without bubbles.
8.1.2 Testing the hydraulic fluid supply
The axial piston unit must always have a sufficient supply of hydraulic fluid. For this reason, the supply of hydraulic fluid must be ensured at the start of the commissioning process.
When you test the hydraulic fluid supply, constantly monitor the noise development and check the hydraulic fluid level in the reservoir. If the axial piston unit becomes louder (cavitation) or the case drain fluid is discharged with bubbles, this is an indication that the axial piston unit is not being sufficiently supplied with hydraulic fluid.
For information on troubleshooting, see chapter 14 “Troubleshooting” on page 48.
To test the hydraulic fluid supply:
1. Allow the diesel engine to run at the lowest speed. The axial piston unit must be operated without load. Pay attention to leakage and noise.
2. Check the axial piston unit’s reservoir line during the test. The case drain fluid should not contain any bubbles.
3. Increase the load and check whether the operating pressure rises as expected.
4. Carry out a leak test to ensure that the hydraulic system is sealed and can withstand the maximum pressure.
5. Check the suction pressure at port “S” of the axial piston pump at nominal speed and maximum swivel angle (only on the version with boost pump). Refer to data sheet 93221 for the permissible value.
6. At maximum pressure, check the case drain pressure at port T. Refer to data sheet 93221 for the permissible value.

8.1.3 Performing functional test

**WARNING**

Incorrectly connected axial piston unit!
Mixing up the ports will lead to malfunctions (e.g. lift instead of lower) and thus to corresponding danger to persons and equipment!
▶ Before the functional test, check whether the piping specified in the hydraulic schematic has been installed.

Once you have tested the hydraulic fluid supply, you must perform a functional test on the machine/system. The functional test should be performed according to the instructions of the machine/system manufacturer.
The axial piston unit is checked for functional capability before delivery according to the technical data. During commissioning, it must be ensured that the axial piston unit was installed properly in the machine/system.
▶ After starting the diesel engine, check in particular the specified pressures, e.g. system pressure, boost pressure and case pressure.
▶ If necessary, remove the pressure gauge and plug the ports with threaded plugs.
8.2 Running-in phase

**NOTE**

**Damage to equipment by insufficient viscosity!**
An increased hydraulic fluid temperature may reduce the viscosity values by too much and damage the product!
- Monitor the operating temperature during the running-in phase, e.g. by measuring the case drain temperature.
- Reduce the loading (pressure, rpm) of the axial piston unit if impermissible operating temperatures and/or viscosities occur.
- Operating temperatures that are too high indicate faults that have to be analyzed and cleared.

The bearings and sliding surfaces are subject to a running-in phase. The increased friction at the start of the running-in phase results in increased heat development which decreases with increasing operating hours. The volumetric and mechanical-hydraulic efficiency increases as well through the conclusion of the running-in phase of approx. 10 operating hours.

To ensure that contamination in the hydraulic system does not damage the axial piston unit, Bosch Rexroth recommends the following procedure after the running-in phase:
- After the running-in phase, have a hydraulic fluid specimen analyzed for the required cleanliness level.
- Change the hydraulic fluid if the required cleanliness level is not reached. If a laboratory test is not carried out after the running-in phase, Bosch Rexroth recommends the hydraulic fluid be changed.

8.3 Recommissioning after standstill

Depending on the installation conditions and ambient conditions, changes may occur in the hydraulic system which make recommissioning necessary.

Among others, the following criteria may make recommissioning necessary:
- Air and/or water in the hydraulic system
- Old hydraulic fluid
- Other contamination

- Before recommissioning, proceed as described in chapter 8.1 “Initial commissioning” on page 39.
9 Operation

The product is a component which requires no settings or changes during operation. For this reason, this chapter of the manual does not contain any information on adjustment options. Use the product only within the performance range provided in the technical data. The machine/system manufacturer is responsible for the proper project planning of the hydraulic system and its control.

10 Maintenance and repair

### NOTE

**Inspection and maintenance work carried out too late!**
Damage to equipment!
- Carry out the specified inspection and maintenance work at the intervals described in this manual.

10.1 Cleaning and care

### NOTE

**Damage to seals and electrical system by mechanical effects!**
The water jet of a high-pressure cleaner may damage the seals and electrical system of the axial piston unit!
- Do not point the high-pressure cleaner at sensitive components, e.g. shaft seal, electrical connections and components.

For cleaning and care of the axial piston unit, observe the following:
- Check whether all seals and fittings on the connections are securely seated to ensure that no moisture can penetrate into the axial piston unit during cleaning.
- Use only water and, if necessary, a mild detergent to clean the axial piston unit. Never use solvents or aggressive detergents.
- Remove external coarse dirt and keep sensitive and important components, such as solenoids, valves and sensors, clean.
10.2 Inspection
In order to enable long and reliable operation of the axial piston unit, Bosch Rexroth recommends testing the hydraulic system and axial piston unit on a regular basis, and documenting and archiving the following operating conditions:

Table 12: Inspection schedule

<table>
<thead>
<tr>
<th>Task to be carried out</th>
<th>Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hydraulic system</strong></td>
<td></td>
</tr>
<tr>
<td>Check level of hydraulic fluid in the reservoir.</td>
<td>Daily</td>
</tr>
<tr>
<td>Check the operating temperature at a comparable load condition at the reservoir port and in the reservoir.</td>
<td>Weekly</td>
</tr>
<tr>
<td>Conduct analysis of hydraulic fluid: viscosity, aging and dirt contamination</td>
<td>Yearly or every 2000 operating hours (whichever occurs first)</td>
</tr>
<tr>
<td><strong>Axial piston unit</strong></td>
<td></td>
</tr>
<tr>
<td>Check axial piston unit for leakage.</td>
<td>Daily</td>
</tr>
<tr>
<td>Early detection of hydraulic fluid loss can help to find faults on the machine/system and to rectify them. For this reason, Bosch Rexroth recommends that the axial piston unit and system are always kept in a clean condition.</td>
<td></td>
</tr>
<tr>
<td>Check axial piston unit for unusual noise development.</td>
<td>Daily</td>
</tr>
<tr>
<td>Check fastener elements for tight seating. All fasteners have to be checked when the hydraulic system is switched off, depressurized and cooled down.</td>
<td>Monthly</td>
</tr>
</tbody>
</table>

10.3 Maintenance
The axial piston unit is low maintenance when used properly.

The service life of the axial piston unit is heavily dependent on the quality of the hydraulic fluid. For this reason, we recommend changing the hydraulic fluid at least once per year or every 2000 operating hours (which ever occurs first) or having it analyzed by the hydraulic fluid manufacturer or a laboratory to determine its suitability for further use.

The service life of the axial piston unit is limited by the service life of the bearings fitted. The service life can be requested from the responsible Bosch Rexroth Service partner, see chapter 10.5 “Spare parts” on page 45. Based on these details, a maintenance interval is to be determined by the system manufacturer for the replacement of the bearings and included in the maintenance schedule of the hydraulic system.
10.4 Repair
Bosch Rexroth offers a comprehensive range of services for the repair of Rexroth axial piston units.

Repairs on the axial piston unit and its fittings may only be performed by service centers certified by Bosch Rexroth.

▶ Use exclusively original spare parts from Rexroth to repair the Rexroth axial piston units, otherwise the functional reliability of the axial piston unit can not be assured and you lose your entitlement under warranty.

In the event of questions regarding repairs, contact your responsible Bosch Rexroth Service partner or the service department of the manufacturer's plant for the axial piston unit, see chapter 10.5 “Spare parts” on page 45.

10.5 Spare parts

**CAUTION**

Use of unsuitable spare parts!
Spare parts that do not meet the technical requirements specified by Bosch Rexroth may cause personal injury or property damage!

▶ Only use Rexroth original spare parts to repair the Rexroth axial piston units, otherwise the functional reliability of the axial piston unit can not be assured and you lose your entitlement under warranty.

The spare parts lists for axial piston units are order specific. When ordering spare parts, quote the material and serial number of the axial piston unit as well as the material numbers of the spare parts.

Address all questions regarding spare parts to your responsible Bosch Rexroth Service partner or the service department of the manufacturer's plant for the axial piston unit.

Bosch Rexroth AG
Glockeraustraße 4
89275 Elchingen, Germany
Hotline +49-9352-405060
spares.elchingen@boschrexroth.de

Spare parts can be found in the internet at [www.boschrexroth.com/spc](http://www.boschrexroth.com/spc)

For general inquiries, please contact svm.support@boschrexroth.de

For the addresses of foreign subsidiaries, please refer to [www.boschrexroth.com/addresses](http://www.boschrexroth.com/addresses)
11 Removal and replacement

11.1 Required tools
Removal can be performed with standard tools. No special tools are necessary.

11.2 Preparing for removal
1. Decommission the entire system as described in the instruction manual for the machine or system.
   – Relieve pressure in the hydraulic system according to the instructions of the machine or system manufacturer.
   – Make sure that the relevant system components are not under pressure or voltage.
2. Protect the complete system against being energized.

11.3 Removal of the axial piston unit
Proceed as follows to remove the axial piston unit:
1. Check whether the hydraulic system is depressurized.
2. Allow the axial piston unit to cool down until it can be removed without danger.
3. For below-reservoir installation, before removing the axial piston unit from the complete system, seal the connection to the reservoir or drain the reservoir.
4. Place a drip tray under the axial piston unit to collect any hydraulic fluid that may escape.
5. Loosen the lines and collect the escaping hydraulic fluid in the drip tray.
6. Remove the axial piston unit. Use a suitable lifting device.
7. Completely empty the axial piston unit.
8. Plug all openings.

11.4 Preparing the components for storage or further use
▶ Proceed as described in chapter 6.2 “Storing the axial piston unit” on page 22.
12 Disposal

Careless disposal of the axial piston unit, the hydraulic fluid and the packaging material could lead to pollution of the environment.

Observe the following points when disposing of the axial piston unit:

1. Completely empty the axial piston unit.
2. Dispose of the axial piston unit and packaging material in accordance with the national regulations in your country.
3. Dispose of the hydraulic fluid according to the national regulations of your country. Also observe the applicable safety data sheet for the hydraulic fluid.
4. Remove the axial piston unit into its individual parts and properly recycle these parts.
5. Separate according to, for instance:
   - Castings
   - Steel
   - Aluminum
   - Non-ferrous metal
   - Electronic waste
   - Plastic
   - Seals

13 Extension and conversion

Do not modify the axial piston unit or its fittings. This includes changes to the setting screws or wiring.

The Bosch Rexroth warranty only applies for the delivered configuration. In case of conversion or extension, the entitlement under warranty will be rendered void.

The setting screws are protected against unauthorized resetting by means of protection caps. Removing the protection caps will void the warranty. If you need to change settings, contact your responsible Bosch Rexroth Service partner (for address, see chapter 10.5 “Spare parts” on page 45.
14 Troubleshooting

Table 13 and may help you when troubleshooting. The Table makes no claim for completeness.
In practical use, problems which are not listed here may also occur.

14.1 How to proceed for troubleshooting
▶ Always act systematically and purposefully, even under pressure of time. Random and imprudent removal and changing of settings could result in the inability to ascertain the original failure cause.
▶ First obtain a general overview of how your product works in conjunction with the entire system.
▶ Try to find out whether the product has worked properly in conjunction with the entire system before the fault occurred.
▶ Try to determine any changes of the entire system in which the product is integrated
  – Were there any changes to the product’s application conditions or operating range?
  – Has maintenance work recently been carried out? Is there an inspection or maintenance log?
  – Were changes (e.g. conversions) or repairs made to the complete system (machine/system, electrics, control) or on the product? If yes, which?
  – Has the hydraulic fluid been changed?
  – Was the product or machine operated as intended?
  – How did the malfunction appear?
▶ Try to get a clear idea of the error cause. Directly ask the (machine) operator.
▶ Document the work carried out.
▶ If you cannot rectify the error, contact one of the contact addresses which can be found at:
  www.boschrexroth.comaddresses.
## 14.2 Malfunction table

### Table 13: Axial piston unit malfunction table

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<tr>
<th>Malfunction</th>
<th>Possible cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unusual noises</td>
<td>Drive speed too high.</td>
<td>Machine/system manufacturer.</td>
</tr>
<tr>
<td></td>
<td>Wrong direction of rotation.</td>
<td>Ensure correct direction of rotation.</td>
</tr>
<tr>
<td></td>
<td>Insufficient suction conditions, e.g. air in the suction line, insufficient diameter of the suction line, viscosity of the hydraulic fluid too high, suction height too high, suction pressure too low, contaminants in the suction line (only relevant for the version with boost pump).</td>
<td>Machine or system manufacturer (e.g. optimize inlet conditions, use suitable hydraulic fluid).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Completely air bleed axial piston unit, fill suction line with hydraulic fluid.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Remove contaminants from the suction line.</td>
</tr>
<tr>
<td>Improper mounting of the axial piston unit.</td>
<td>Check the mounting of the axial piston unit according to the specifications of the machine/system manufacturer. Observe tightening torques.</td>
<td></td>
</tr>
<tr>
<td>Improper mounting of the attachment parts, e.g. coupling and hydraulic lines.</td>
<td>Fix attachment parts according to the information provided by the coupling or fitting manufacturer.</td>
<td></td>
</tr>
<tr>
<td>Pressure-relief valves on axial piston unit.</td>
<td>Air bleed the axial piston unit Check viscosity of the hydraulic fluid Contact Bosch Rexroth Service.</td>
<td></td>
</tr>
<tr>
<td>Pressure-relief valve of the axial piston unit (boost pressure, high pressure).</td>
<td>Air bleed the axial piston unit Check viscosity of the hydraulic fluid Contact Bosch Rexroth Service.</td>
<td></td>
</tr>
<tr>
<td>Mechanical damage to the axial piston unit (e.g. bearing damage).</td>
<td>Exchange axial piston unit, contact Bosch Rexroth Service.</td>
<td></td>
</tr>
<tr>
<td>No or insufficient flow</td>
<td>Faulty mechanical drive (e.g. defective coupling).</td>
<td>Machine/system manufacturer.</td>
</tr>
<tr>
<td></td>
<td>Drive speed too low.</td>
<td>Machine/system manufacturer.</td>
</tr>
<tr>
<td></td>
<td>Insufficient suction conditions, e.g. air in the suction line, insufficient diameter of the suction line, viscosity of the hydraulic fluid too high, suction height too high, suction pressure too low, contaminants in the suction line (only relevant for the version with boost pump).</td>
<td>Machine or system manufacturer (e.g. optimize inlet conditions, use suitable hydraulic fluid).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Completely air bleed axial piston unit, fill suction line with hydraulic fluid.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Remove contaminants from the suction line.</td>
</tr>
<tr>
<td></td>
<td>Hydraulic fluid not in optimum viscosity range.</td>
<td>Use suitable hydraulic fluid (machine/system manufacturer).</td>
</tr>
<tr>
<td></td>
<td>External control of the control device defective.</td>
<td>Check external control (machine/system manufacturer).</td>
</tr>
<tr>
<td></td>
<td>Insufficient pilot pressure or control pressure.</td>
<td>Check pilot pressure or control pressure, contact Bosch Rexroth Service.</td>
</tr>
<tr>
<td></td>
<td>Malfunction of the control device or controller of the axial piston unit.</td>
<td>Contact Bosch Rexroth Service.</td>
</tr>
<tr>
<td></td>
<td>Wear of axial piston unit.</td>
<td>Exchange axial piston unit, contact Bosch Rexroth Service.</td>
</tr>
<tr>
<td></td>
<td>Mechanical damage to the axial piston unit.</td>
<td>Exchange axial piston unit, contact Bosch Rexroth Service.</td>
</tr>
</tbody>
</table>
Table 13: Axial piston unit malfunction table

<table>
<thead>
<tr>
<th>Malfunction</th>
<th>Possible cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No or insufficient pressure</strong></td>
<td>Faulty mechanical drive (e.g. defective coupling).</td>
<td>Machine/system manufacturer.</td>
</tr>
<tr>
<td></td>
<td>Drive power too low.</td>
<td>Machine/system manufacturer.</td>
</tr>
<tr>
<td></td>
<td>Insufficient suction conditions, e.g. air in the suction line, insufficient</td>
<td>Machine or system manufacturer (e.g. optimize inlet conditions, use</td>
</tr>
<tr>
<td></td>
<td>diameter of the suction line, viscosity of the hydraulic fluid too high,</td>
<td>suitable hydraulic fluid).</td>
</tr>
<tr>
<td></td>
<td>suction height too high, suction pressure too low, contaminants in the suction</td>
<td>Completely air bleed axial piston unit, fill suction line with</td>
</tr>
<tr>
<td></td>
<td>line (only relevant for the version with boost pump).</td>
<td>hydraulic fluid.</td>
</tr>
<tr>
<td></td>
<td>Hydraulic fluid not in optimum viscosity range.</td>
<td>Remove contaminants from the suction line.</td>
</tr>
<tr>
<td></td>
<td>External control of the control device defective.</td>
<td>Check external control (machine/system manufacturer).</td>
</tr>
<tr>
<td></td>
<td>Insufficient pilot pressure or control pressure.</td>
<td>Check pilot pressure or control pressure, contact Bosch Rexroth Service.</td>
</tr>
<tr>
<td></td>
<td>Malfunction of the control device or controller of the axial piston unit.</td>
<td>Contact Bosch Rexroth Service.</td>
</tr>
<tr>
<td></td>
<td>Wear of axial piston unit.</td>
<td>Exchange axial piston unit, contact Bosch Rexroth Service.</td>
</tr>
<tr>
<td></td>
<td>Mechanical damage to the axial piston unit (e.g. bearing damage).</td>
<td>Exchange axial piston unit, contact Bosch Rexroth Service.</td>
</tr>
<tr>
<td></td>
<td>Output unit defective (e.g. hydraulic motor or cylinder).</td>
<td>Machine/system manufacturer.</td>
</tr>
<tr>
<td><strong>Pressure/flow fluctuations</strong></td>
<td>Axial piston unit not or insufficiently air bled.</td>
<td>Completely air bleed axial piston unit.</td>
</tr>
<tr>
<td></td>
<td>Insufficient suction conditions, e.g. air in the suction line, insufficient</td>
<td>Machine or system manufacturer (e.g. optimize inlet conditions, use</td>
</tr>
<tr>
<td></td>
<td>diameter of the suction line, viscosity of the hydraulic fluid too high,</td>
<td>suitable hydraulic fluid).</td>
</tr>
<tr>
<td></td>
<td>suction height too high, suction pressure too low, contaminants in the suction</td>
<td>Completely air bleed axial piston unit, fill suction line with</td>
</tr>
<tr>
<td></td>
<td>line (only relevant for the version with boost pump).</td>
<td>hydraulic fluid.</td>
</tr>
<tr>
<td></td>
<td>Excessive inlet temperature at the axial piston unit.</td>
<td>Machine or system manufacturer: inspect system, e.g malfunction of the</td>
</tr>
<tr>
<td></td>
<td>Malfunction of the pressure control valves (e.g. high-pressure relief valve,</td>
<td>cooler, insufficient hydraulic fluid in the reservoir.</td>
</tr>
<tr>
<td></td>
<td>pressure controller).</td>
<td>Contact Bosch Rexroth Service.</td>
</tr>
<tr>
<td></td>
<td>Wear of axial piston unit.</td>
<td>Exchange axial piston unit, contact Bosch Rexroth Service.</td>
</tr>
<tr>
<td><strong>Excessive hydraulic fluid temperature and case</strong></td>
<td>Excessive inlet temperature at the axial piston unit.</td>
<td>Machine or system manufacturer: inspect system, e.g malfunction of the</td>
</tr>
<tr>
<td><strong>temperature</strong></td>
<td></td>
<td>cooler, insufficient hydraulic fluid in the reservoir.</td>
</tr>
<tr>
<td></td>
<td>Malfunction of the pressure control valves (e.g. high-pressure relief valve,</td>
<td>Contact Bosch Rexroth Service.</td>
</tr>
<tr>
<td></td>
<td>pressure controller).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Wear of axial piston unit.</td>
<td>Exchange axial piston unit, contact Bosch Rexroth Service.</td>
</tr>
<tr>
<td><strong>Instability/vibrations</strong></td>
<td>Setpoint value not stable.</td>
<td>Machine/system manufacturer.</td>
</tr>
<tr>
<td></td>
<td>Resonance in the reservoir line.</td>
<td>Machine/system manufacturer.</td>
</tr>
<tr>
<td></td>
<td>Malfunction of the control devices or the controller.</td>
<td>Contact Bosch Rexroth Service.</td>
</tr>
</tbody>
</table>
15 Technical data

The permissible values of the technical data of your axial piston unit can be found in data sheet 93221.

The data sheet can be found on the Internet under
www.boschrexroth.com/various/utilities/mediadirectory/
index.jsp?&language=en-GB

Further information can be found in the online product catalog
Mobile Hydraulics: www.boschrexroth.com/axial-piston-pumps

The order-related technical data of your axial piston unit can be found in the order confirmation.
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MSV Wheel Motor Installation

Turn supplied studs into two of the bottom bolt holes.

Lift motor up to the frame, align the two studs with the corresponding holes in the motor and slide the motor into place. Then install bolts to hold the motor in and remove the installation studs. Finally complete that installation of the motor.

****** Note: Using these studs will protect the speed sensor from damage during the installation and removal of the wheel motors. ******
Replacing the frame link between front and rear frames.
Removing the frame link from front and rear frames.
If your machine is equipped with front frame weights, the under frame and right wing frame weights must be removed prior to any other step.
Jack machine up and place 8 jack stands under the machine so it is supported properly and won’t tip when the link is removed. There should be 4 stands under each piece of the frame, one under each corner.
-Loosen the set screw on the front bearing collar on the PTO shaft and slide out of the way.

-Loosen the set screw on the universal joint attached to the PTO shaft.
- Slide the PTO shaft forward towards the front of the machine.

- Separate the universal joint from the PTO shaft.
- Remove the bolt that holds the other end of the universal to the gearbox. Remove the universal joint / driveline combo from the machine.

- Remove the cotter pins, nuts, washers and bolts from the connecting link. Do this at each end of the link.
- Cut the grease line from the zerk closest to the middle of the frame. This zerk is no longer needed, as the new link is non-grease able.

- Remove the link through the side of the machine.
Preparing the new frame link
- Place nuts all the way onto the rod ends (2X).

- Thread rod ends into link arm (2X).
-Set the distance between the centers of the rod ends to 13.5”.

-Tighten the nuts against the link arm on both ends. While tightening nuts ensure that the rod end faces stay aligned to the wing tabs on the link arm.
- Grind the nuts on face sides of the rod ends until they are flush with the link arm tube. This only needs to be done on the end without the wing tabs.

- Tape the dust seals down flat on the rod end on the end of the link arm without the wing tabs. After taping completely down cut the center hole open. Do this to both sides of the same rod end.
Installing new link into frame
- Remove bushings from both link mounts on frame.

- Install new bushings into both link mounts on the frame. When installing new bushings keep the lower ones down an 1/8” and the upper ones up an 1/8”. This will make installing the link arm easier.
Insert the new link through the side of the frame.

Position the link arm into place.

Position the winged tabs end is towards the back of the machine.

Make sure the winged tabs end is towards the back of the machine.
-Align the link arm with the bushings in the frame at the front mount. Insert a bolt with a washer in from the bottom. Then place 3 washers on top with a nut and a cotter pin.

-Install the dust seals on the back end of the link arm. Place a washer in between the lower seal and the frame mount.
Install a bolt with a washer from the bottom side through the mount and rod end of the link arm. Place a washer, nut and cotter pin onto the bolt.

Reinstall the PTO drive shaft and universal joints to the gearbox.
Installing the brake release kit
- Raise the cab of the MSV

- Locate the brake line "T" fitting
-Disconnect all 3 hoses from the “T” fitting and discard the “T”.

-Locate the new “T”, the 90 degree elbow, and the male and female quick connect couplers from the kit.
-Apply pipe sealant to the fitting and assemble as shown.

-Apply pipe sealant and connect the other end of the 90 degree elbow to the brake line hose with the brown cable tie, that leads to the rear of the MSV.
- Apply pipe sealant and connect the remaining two brake lines that lead to the wheel motors to the remaining ports of the “T” fitting.

- Connect the male and female ends of the quick couplers together and place a cable tie around the female coupler to prevent accidental disconnection.
PARKING BRAKE
<table>
<thead>
<tr>
<th>M-B Companies</th>
<th>Work Instruction</th>
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<tbody>
<tr>
<td>Title:</td>
<td>Checking Parking Brake Relief Pressure MSV</td>
</tr>
<tr>
<td>Prepared By:</td>
<td>Sherri Schad</td>
</tr>
<tr>
<td>Approved By:</td>
<td></td>
</tr>
<tr>
<td>Revised By:</td>
<td></td>
</tr>
<tr>
<td>Document #:</td>
<td>WIAS 0086</td>
</tr>
</tbody>
</table>

904-200187
CHECKING PARKING BRAKE RELIEF PRESSURE MSV
• Tools need vop-100262 kit
• 1. REMOVE PTO DOOR
• 2. FIND TEE OR QUICK COUPLER GOING TO THE FRONT BRAKES.
3. REMOVE THE PLASTIC TIE THAT PREVENTS THE DISCONNECT FROM OPENING. THE CABLE TIE IS FOR SAFETY PURPOSES AND WILL NEED TO BE REPLACED WHEN THE JOB IS DONE.
• 4. INSTALL THE MALE CONNECTOR FROM THE PARKING BRAKE RELEASE KIT TO THE FEMALE CONNECTOR ON THE MSV.
5. DO NOT HOOK UP OTHER END. START THE MACHINE, PLACE MACHINE IN FORWARD, PUT SLIGHT PRESSURE ON FOOT PEDAL TO RELEASE BRAKE. RECORD WHAT THE PRESSURE READING IS ON THE GUAGE.
6. PRESSURE READING SHOULD BE BETWEEN 190 AND 220 PSI. IF PRESSURE IS BELOW OR ABOVE, REPLACE THE RELIEF CARTIDGE LOCATED ON THE REAR OF THE MACHINE IN THE LOW PRESSURE MANIFOLD.
7. THE CARTIDGE IS NONE ADJUSTABLE.
8. RECHECK PRESSURE TO SEE THAT THE PRESSURE FALLS INTO THE ALLOWABLE RANGE 185 TO 230 PSI.

9. DISCONNECT GAUGE AND REHOOK FEMALE CONNECTOR ON THE MSV WITH THE MALE CONNECTOR. SECURE WITH TIE STRAP TO PREVENT CONNECTORS FROM SEPARATING.
PLUS 1 MSV GEN 3
PLUS 1 MSV GEN 3

ENGINE CAN MESSAGES
FAULTS TROUBLE SHOOTING
SERVICE SECTION 2.3
CUMMINS
ENGINE FAULTS

SPN #: 0
FMI #: 0
OC #: 0
TOTAL #: 0

J1939 CAN FAULT

DELETE
INACTIVE

PREV
WARN
STOP
MAIN MENU
<table>
<thead>
<tr>
<th>FAULT CODE</th>
<th>PID (P)</th>
<th>SID (S)</th>
<th>REASON</th>
<th>EFFECT</th>
</tr>
</thead>
<tbody>
<tr>
<td>115 (Red)</td>
<td>P190</td>
<td>612</td>
<td>Engine Magnetic Speed/Position Lost Both of Two Signals - Data Erratic, Intermittent, or Incorrect. High signal voltage detected at the intake manifold pressure circuit.</td>
<td>None on performance.</td>
</tr>
<tr>
<td>122 (Amber)</td>
<td>P102</td>
<td>102</td>
<td>Intake Manifold 1 Pressure Sensor Circuit - Voltage Above Normal or Shorted to High Source. Low signal voltage detected at the intake manifold pressure circuit.</td>
<td>Derate in power output of the engine.</td>
</tr>
<tr>
<td>123 (Amber)</td>
<td>P102</td>
<td>102</td>
<td>Intake Manifold 1 Pressure Sensor Circuit - Voltage Below Normal or Shorted to Low Source. Low signal voltage or open circuit detected at the intake manifold pressure circuit.</td>
<td>Derate in power output of the engine.</td>
</tr>
<tr>
<td>131 (Red)</td>
<td>P091</td>
<td>91</td>
<td>Accelerator Pedal or Lever Position Sensor 1 Circuit - Voltage Above Normal or Shorted to High Source. High signal voltage detected at accelerator pedal position number 1.</td>
<td>Severe derate in power output of the engine. Limp home power only.</td>
</tr>
<tr>
<td>132 (Red)</td>
<td>P091</td>
<td>91</td>
<td>Accelerator Pedal or Lever Position Sensor 1 Circuit - Voltage Below Normal or Shorted to Low Source. Low signal voltage detected at accelerator pedal position number 1.</td>
<td>Severe derate in power output of the engine. Limp home power only.</td>
</tr>
<tr>
<td>133 (Red)</td>
<td>P372</td>
<td>974</td>
<td>Remote Accelerator Pedal or Lever Position Sensor 1 Circuit - Voltage Above Normal or Shorted to High Source. High signal voltage detected at accelerator position signal circuit.</td>
<td>Remote accelerators will not operate. Remote accelerator position will be set to 0 percent.</td>
</tr>
<tr>
<td>134 (Red)</td>
<td>P372</td>
<td>974</td>
<td>Remote Accelerator Pedal or Lever Position Sensor 1 Circuit - Voltage Below Normal or Shorted to Low Source. Low voltage detected at remote accelerator position signal circuit.</td>
<td>Remote accelerators will not operate. Remote accelerator position will be set to 0 percent.</td>
</tr>
<tr>
<td>144 (Amber)</td>
<td>P110</td>
<td>110</td>
<td>Engine Coolant Temperature 1 Sensor Circuit - Voltage Above Normal or Shorted to High Source. High signal voltage or open circuit detected at engine coolant temperature circuit.</td>
<td>Possible white smoke. Fan will stay ON if controlled by ECM. No engine protection for engine coolant temperature.</td>
</tr>
<tr>
<td>145 (Amber)</td>
<td>P110</td>
<td>110</td>
<td>Engine Coolant Temperature 1 Sensor Circuit - Voltage Below Normal or Shorted to Low Source. Low signal voltage detected at remote accelerator position signal circuit.</td>
<td>Possible white smoke. Fan will stay ON if controlled by ECM. No engine protection for engine coolant temperature.</td>
</tr>
<tr>
<td>146 (Amber)</td>
<td>P110</td>
<td>110</td>
<td>Engine Coolant Temperature 1 Data Valid but Above Normal Operational Range - Moderately Severe Level. Engine coolant temperature is above engine protection warning limit.</td>
<td>Power derate and possible engine shutdown if Engine Protection Shutdown feature is enabled.</td>
</tr>
<tr>
<td>151 (Red)</td>
<td>P110</td>
<td>110</td>
<td>Engine Coolant Temperature 1 Data Valid but Above Normal Operational Range - Most Severe Level. Engine coolant temperature signal indicates engine coolant temperature is above engine protection critical limit.</td>
<td>Progressive power and derate increasing in severity from time of alert. If Engine Protection Shutdown feature is enabled, engine will shut down 30 seconds after red SIDP lamp starts flashing.</td>
</tr>
<tr>
<td>153 (Amber)</td>
<td>P105</td>
<td>105</td>
<td>Intake Manifold 1 Temperature Sensor Circuit - Voltage Above Normal or Shorted to High Source. High signal voltage detected at intake manifold air temperature circuit.</td>
<td>Possible white smoke. Fan will stay ON if controlled by the ECM. No engine protection for intake manifold air temperature.</td>
</tr>
<tr>
<td>154 (Amber)</td>
<td>P105</td>
<td>105</td>
<td>Intake Manifold 1 Temperature Sensor Circuit - Voltage Below Normal or Shorted to Low Source. Low signal voltage detected at intake manifold air temperature circuit.</td>
<td>Possible white smoke. Fan will stay ON if controlled by the ECM. No engine protection for intake manifold air temperature.</td>
</tr>
<tr>
<td>155 (Red)</td>
<td>P105</td>
<td>105</td>
<td>Intake Manifold 1 Temperature - Data Valid but Above Normal Operational Range - Most Severe Level. Intake manifold air temperature signal indicates engine coolant temperature is above engine protection critical limit.</td>
<td>Progressive power and derate increasing in severity from time of alert. If Engine Protection Shutdown feature is enabled, engine will shut down 30 seconds after red SIDP lamp starts flashing.</td>
</tr>
<tr>
<td>195 (Amber)</td>
<td>P111</td>
<td>111</td>
<td>Coolant Level Sensor 1 Circuit - Voltage Above Normal or Shorted to High Source. High signal voltage detected at engine coolant level circuit.</td>
<td>None on performance.</td>
</tr>
<tr>
<td>196 (Amber)</td>
<td>P111</td>
<td>111</td>
<td>Coolant Level Sensor 1 Circuit - Voltage Below Normal or Shorted to Low Source. Low signal voltage detected at the engine coolant level circuit.</td>
<td>None on performance.</td>
</tr>
<tr>
<td>197 (Amber)</td>
<td>P111</td>
<td>111</td>
<td>Coolant Level - Data Valid but Below Normal Operational Range - Moderately Severe Level. Low engine coolant level detected.</td>
<td>None on performance.</td>
</tr>
<tr>
<td>FAUL CODE</td>
<td>PID(P)</td>
<td>SID(S)</td>
<td>SPN(S)</td>
<td>REASON</td>
</tr>
<tr>
<td>-----------</td>
<td>--------</td>
<td>--------</td>
<td>--------</td>
<td>--------</td>
</tr>
<tr>
<td>8211</td>
<td>3510</td>
<td>3510</td>
<td></td>
<td>Sensor Supply 2 Circuit - Voltage Above Normal or Shorted to High Source. High voltage detected at sensor supply number 2 circuit.</td>
</tr>
<tr>
<td>P190</td>
<td>190</td>
<td>190</td>
<td></td>
<td>Engine Crankshaft Speed/Position - Data Valid but Above Normal Operational Range - Most Severe Level. Engine speed signal indicates engine speed above engine protection limit.</td>
</tr>
<tr>
<td>8232</td>
<td>3511</td>
<td>3511</td>
<td></td>
<td>Sensor Supply 3 Circuit - Voltage Below Normal or Shorted to Low Source. Low voltage detected on the +5 volt sensor supply circuit to the engine speed sensor.</td>
</tr>
<tr>
<td>P084</td>
<td>84</td>
<td>84</td>
<td></td>
<td>Wheel-Based Vehicle Speed - Data Erratic, Intermittent, or Incorrect. The ECM lost the vehicle speed signal.</td>
</tr>
<tr>
<td>S033</td>
<td>647</td>
<td>647</td>
<td></td>
<td>Fan Control Circuit - Voltage Below Normal or Shorted to Low Source. Low signal voltage detected at the fan control circuit when commanded ON.</td>
</tr>
<tr>
<td>P171</td>
<td>171</td>
<td>171</td>
<td></td>
<td>Ambient Air Temperature Sensor 1 Circuit - Voltage Above Normal or Shorted to High Source. High signal voltage detected at ambient air temperature circuit.</td>
</tr>
<tr>
<td>P98</td>
<td>98</td>
<td>98</td>
<td></td>
<td>Engine Oil Level - Data Erratic, Intermittent, or Incorrect. An intermittent signal is being received from the oil level sensor.</td>
</tr>
<tr>
<td>S231</td>
<td>639</td>
<td>639</td>
<td></td>
<td>SAE J1939 Multiplexing PGN Timeout Error - Abnormal Update Rate. The ECM expected information from a multiplexed device but did not receive it soon enough or did not receive it at all.</td>
</tr>
<tr>
<td>S231</td>
<td>639</td>
<td>639</td>
<td></td>
<td>SAE J1939 Multiplexing Configuration Error - Out of Calibration. The CM expected information from a multiplexed device but only received a portion of the necessary information.</td>
</tr>
<tr>
<td>P091</td>
<td>91</td>
<td>91</td>
<td></td>
<td>SAE J1939 Multiplexed Accelerator Pedal or Lever Sensor System - Received Network Data In Error. The OEM vehicle electronic control unit (VECU) detected a fault with its accelerator pedal.</td>
</tr>
<tr>
<td>P372</td>
<td>974</td>
<td>974</td>
<td></td>
<td>SAE J1939 Multiplexing Remote Accelerator Pedal or Lever - Position Sensor System - Received Network Data In Error. The OEM vehicle electronic control unit (VECU) detected a fault with the remote accelerator.</td>
</tr>
<tr>
<td>P108</td>
<td>108</td>
<td>108</td>
<td></td>
<td>Barometric Pressure - Data Erratic, Intermittent, or Incorrect. The ambient air pressure sensor is reading an erratic value at initial key-on.</td>
</tr>
<tr>
<td>S001</td>
<td>651</td>
<td>651</td>
<td></td>
<td>Injector Solenoid Driver Cylinder 1 Circuit - Current Below Normal or Open Circuit. Current detected at injector Number 1 when the voltage is turned off.</td>
</tr>
<tr>
<td>FAULT CODE</td>
<td>FAULT CODE</td>
<td>J158</td>
<td>J1939</td>
<td>REASON</td>
</tr>
<tr>
<td>------------</td>
<td>------------</td>
<td>-------</td>
<td>-------</td>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td>323</td>
<td>(Amber)</td>
<td>655</td>
<td>(5)</td>
<td>Injector Solenoid Driver Cylinder 5 Circuit - Current Below Normal or Open Circuit. Current detected at injector Number 5 when voltage is turned off.</td>
</tr>
<tr>
<td>324</td>
<td>(Amber)</td>
<td>653</td>
<td>(5)</td>
<td>Injector Solenoid Driver Cylinder 3 Circuit - Current Below Normal or Open Circuit. Current detected at injector Number 3 when voltage is turned off.</td>
</tr>
<tr>
<td>325</td>
<td>(Amber)</td>
<td>656</td>
<td>(5)</td>
<td>Injector Solenoid Driver Cylinder 6 Circuit - Current Below Normal or Open Circuit. Current detected at injector Number 6 when voltage is turned off.</td>
</tr>
<tr>
<td>331</td>
<td>(Amber)</td>
<td>653</td>
<td>(5)</td>
<td>Injector Solenoid Driver Cylinder 2 Circuit - Current Below Normal or Open Circuit. Current detected at injector Number 2 when voltage is turned off.</td>
</tr>
<tr>
<td>332</td>
<td>(Amber)</td>
<td>654</td>
<td>(5)</td>
<td>Injector Solenoid Driver Cylinder 4 Circuit - Current Below Normal or Open Circuit. Current detected at injector Number 4 when voltage is turned off.</td>
</tr>
<tr>
<td>343</td>
<td>(Amber)</td>
<td>629</td>
<td>(12)</td>
<td>Electronic Control Module Warning Internal Hardware Failure - Bad Intelligent Device or Component. ECM power supply errors have been detected.</td>
</tr>
<tr>
<td>351</td>
<td>(Amber)</td>
<td>627</td>
<td>(12)</td>
<td>Injectors Power Supply - Bad Intelligent Device or Component. The ECM measured injector boost voltage is low.</td>
</tr>
<tr>
<td>386</td>
<td>(Amber)</td>
<td>3509</td>
<td>(4)</td>
<td>Sensor Supply 1 Circuit - Voltage Below Normal or Shorted to Low Source. Low voltage detected at sensor supply number 1 circuit.</td>
</tr>
<tr>
<td>415</td>
<td>(Red)</td>
<td>100</td>
<td>[1]</td>
<td>Engine Oil Rifle Pressure - Data Valid but Below Normal Operational Range - Most Severe Level. Oil pressure signal indicates oil pressure is below the engine protection critical limit.</td>
</tr>
<tr>
<td>418</td>
<td>(Maintenance)</td>
<td>97</td>
<td>[15]</td>
<td>Water-in-Fuel Indicator - Data Valid but Above Normal Operational Range - Least Severe Level. Water has been detected in the fuel filter.</td>
</tr>
<tr>
<td>427</td>
<td>(None)</td>
<td>639</td>
<td>(9)</td>
<td>J1939 Datalink - Abnormal Update Rate. Communication between the electronic control module (ECM) and another device on the SAE J1939 data link has been lost.</td>
</tr>
<tr>
<td>435</td>
<td>(Amber)</td>
<td>100</td>
<td>(2)</td>
<td>Engine Oil Rifle Pressure - Data Erratic, Incorrect, or Incorrect. The engine oil pressure sensor is reading an erratic value at key-on.</td>
</tr>
<tr>
<td>441</td>
<td>(Amber)</td>
<td>168</td>
<td>(18)</td>
<td>Battery 1 Voltage - Data Valid but Below Normal Operational Range - Moderately Severe Level. ECM supply voltage is below the minimum system voltage level.</td>
</tr>
<tr>
<td>442</td>
<td>(Amber)</td>
<td>168</td>
<td>(16)</td>
<td>Battery 1 Voltage - Data Valid but Above Normal Operational Range - Moderately Severe Level. ECM supply voltage is above the maximum system voltage level.</td>
</tr>
<tr>
<td>449</td>
<td>(Amber)</td>
<td>157</td>
<td>(0)</td>
<td>Injector Metering Rail 1 Pressure Sensor Circuit - Voltage Above Normal or Shorted to High Source. High signal voltage detected at rail fuel pressure sensor circuit.</td>
</tr>
<tr>
<td>451</td>
<td>(Amber)</td>
<td>157</td>
<td>(3)</td>
<td>Injector Metering Rail Number 1 Pressure Sensor Circuit - Voltage Above Normal or Shorted to High Source. High signal voltage detected at rail fuel pressure sensor circuit.</td>
</tr>
<tr>
<td>452</td>
<td>(Amber)</td>
<td>157</td>
<td>(4)</td>
<td>Injector Metering Rail Number 1 Pressure Sensor Circuit - Voltage Below Normal or Shorted to Low Source. Low signal voltage detected at the rail fuel pressure sensor circuit.</td>
</tr>
<tr>
<td>471</td>
<td>(Maintenance)</td>
<td>98</td>
<td>(17)</td>
<td>Engine Oil Level - Data Valid but Below Normal Operational Range - Least Severe Level. Low oil level has been detected by the oil level sensor.</td>
</tr>
<tr>
<td>FAULT CODE (LAMP)</td>
<td>J158 SPN(S) (FMI)</td>
<td>J1939 SPN(S) (FMI)</td>
<td>REASON</td>
<td>EFFECT</td>
</tr>
<tr>
<td>------------------</td>
<td>-----------------</td>
<td>------------------</td>
<td>--------</td>
<td>--------</td>
</tr>
<tr>
<td>499 (Amber)</td>
<td>P98 [4]</td>
<td>98</td>
<td>Engine Oil Level Sensor Circuit - Voltage Below Normal or Shorted to Low Source. The engine oil level sensor has detected an internal failure.</td>
<td>Oil level sensor operation will be disabled.</td>
</tr>
<tr>
<td>553 (Amber)</td>
<td>P157 [16]</td>
<td>157</td>
<td>Injector Metering Rail 1 Pressure - Data Valid but Above Normal Operational Range - Moderately Severe Level. The ECM has detected that fuel pressure is higher than commanded pressure.</td>
<td>None or possible engine noise associated with higher injection pressures (especially at idle or light load). Engine power is reduced.</td>
</tr>
<tr>
<td>554 (Amber)</td>
<td>P157 [2]</td>
<td>157</td>
<td>Injector Metering Rail 1 Pressure - Data Erratic, Intermittent, or Incorrect. The ECM has detected that the fuel pressure signal is not changing.</td>
<td>The ECM will estimate fuel pressure and power is reduced.</td>
</tr>
<tr>
<td>559 (Yellow)</td>
<td>P94 [18]</td>
<td>94</td>
<td>Injector Metering Rail 1 Pressure - Data Valid but Below Normal Operational Range - Moderately Severe Level. The ECM has detected that fuel pressure is lower than commanded pressure.</td>
<td>Possibly hard to start, low power, or engine smoke.</td>
</tr>
<tr>
<td>584 (Amber)</td>
<td>S39 [3]</td>
<td>677</td>
<td>Starter Relay Driver Circuit - Voltage Above Normal or Shorted to High Source. Open circuit or high voltage detected at starter lockout circuit.</td>
<td>Either the engine will not start or the engine will not have starter lockout protection.</td>
</tr>
<tr>
<td>596 (Amber)</td>
<td>P167 [16]</td>
<td>167</td>
<td>Electrical Charging System Voltage - Data Valid but Above Normal Operational Range - Moderately Severe Level. High battery voltage detected by the battery voltage monitor feature.</td>
<td>Amber warning lamp illuminated until high battery voltage condition is corrected.</td>
</tr>
<tr>
<td>597 (Amber)</td>
<td>P167 [18]</td>
<td>167</td>
<td>Electrical Charging System Voltage - Data Valid but Below Normal Operational Range - Most Severe Level. Low battery voltage detected by the battery voltage monitor feature.</td>
<td>Amber lamp will light until low battery voltage condition is corrected.</td>
</tr>
<tr>
<td>598 (Red)</td>
<td>P167 [1]</td>
<td>167</td>
<td>Electrical Charging System Voltage - Data Valid but Below Normal Operational Range - Most Severe Level. Very low battery voltage detected by the battery voltage monitor feature.</td>
<td>Red lamp illuminated until very low battery voltage condition is corrected.</td>
</tr>
<tr>
<td>656 (Amber)</td>
<td>P103 [2]</td>
<td>103</td>
<td>Turbocharger 1 Speed - Data Erratic, Intermittent, or Incorrect. An invalid turbocharger speed signal has been detected by the ECM.</td>
<td>None on performance. The ECM uses an estimated turbocharger speed.</td>
</tr>
<tr>
<td>686 (Amber)</td>
<td>P103 [18]</td>
<td>103</td>
<td>Turbocharger 1 Speed - Data Valid but Below Normal Operational Range - Moderately Severe Level. Low turbocharger speed detected by the ECM.</td>
<td>Engine power derate. The ECM uses an estimated turbocharger speed.</td>
</tr>
<tr>
<td>688 (Red)</td>
<td>P98 [1]</td>
<td>98</td>
<td>Engine Oil Level - Data Valid but Above Normal Operational Range - Most Severe Level. High oil level has been detected by the oil level sensor.</td>
<td>Possible low power, excessive smoke, oil dilution, contamination, or severe engine damage. The engine may derate.</td>
</tr>
<tr>
<td>FAULT CODE</td>
<td>J1587 SID(S)</td>
<td>J1939 SPN(S)</td>
<td>REASON</td>
<td>EFFECT</td>
</tr>
<tr>
<td>------------</td>
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<td>--------</td>
</tr>
<tr>
<td>778 (Amber)</td>
<td>S064 (2)</td>
<td>723 (2)</td>
<td>Engine Camshaft Speed/Position Sensor - Data Erratic, Intermittent, or Incorrect. The ECM has detected an error in the camshaft position sensor signal.</td>
<td>Engine can run rough. Possibly poor starting capability. Engine runs using primary engine position sensor.</td>
</tr>
<tr>
<td>784 (None)</td>
<td>S145 (2)</td>
<td>1590 (2)</td>
<td>Adaptive Cruise Control Mode - Data Erratic, Intermittent, or Incorrect. Loss of communication with adaptive cruise control.</td>
<td>Adaptive cruise control will not operate. Standard cruise control may not operate.</td>
</tr>
<tr>
<td>1117 (None)</td>
<td>S251 (2)</td>
<td>627 (2)</td>
<td>Power Supply Lost With Ignition On - Data Erratic, Intermittent, or Incorrect. Supply voltage to the ECM fell below 6.2 volts momentarily or the ECM was not allowed to power down correctly (retain battery voltage for 30 seconds after key OFF).</td>
<td>Possible no noticeable performance effects or engine dying or hard starting. Fault information, trip information, and maintenance monitor data can be inaccurate.</td>
</tr>
<tr>
<td>1239 (Amber)</td>
<td>None (3)</td>
<td>2623 (3)</td>
<td>Accelerator Pedal or Lever Position Sensor 2 Circuit - Voltage Above Normal or Shorted to High Source. High voltage detected at accelerator pedal position number 2 signal circuit.</td>
<td>Severe derate in power output of the engine. Limp home power only.</td>
</tr>
<tr>
<td>1241 (Amber)</td>
<td>None (41)</td>
<td>2623 (4)</td>
<td>Accelerator Pedal or Lever Position Sensor 2 Circuit - Voltage Below Normal or Shorted to Low Source. Low voltage detected at accelerator pedal position number 2 signal circuit.</td>
<td>Severe derate in power output of the engine. Limp home power only.</td>
</tr>
<tr>
<td>1242 (Red)</td>
<td>P091 (2)</td>
<td>91 (2)</td>
<td>Accelerator Pedal or Lever Position Sensor 1 and 2 - Data Erratic, Intermittent, or Incorrect; Accelerator position sensor number 1 and number 2 are read at different values.</td>
<td>The engine will only idle.</td>
</tr>
<tr>
<td>1063 (Amber)</td>
<td>S326 (111)</td>
<td>3241 (31)</td>
<td>Catalyst Inlet Temperature Sensor Swapped with Outlet Temperature Sensor Connections - Condition Exists. The inlet and outlet catalyst temperature sensor connections are swapped.</td>
<td>Active aftertreatment diesel particulate filter regeneration will be disabled.</td>
</tr>
<tr>
<td>1064 (Amber)</td>
<td>None (11)</td>
<td>3050 (31)</td>
<td>Catalyst Missing - Condition Exists. The aftertreatment catalyst in the exhaust system is not present.</td>
<td>Active aftertreatment diesel particulate filter regeneration will be disabled.</td>
</tr>
<tr>
<td>1065 (Amber)</td>
<td>S326 (4)</td>
<td>3241 (4)</td>
<td>Aftertreatment Exhaust Gas Temperature 1 Circuit - Active Aftertreatment Exhaust Gas Temperature 2 Circuit - Data Erratic, Intermittent, or Incorrect. The aftertreatment diesel particulate filter inlet temperature sensor is not changing with engine operating conditions.</td>
<td>Active aftertreatment diesel particulate filter regeneration will be disabled.</td>
</tr>
<tr>
<td>1066 (Amber)</td>
<td>S326 (3)</td>
<td>3241 (3)</td>
<td>Aftertreatment Exhaust Gas Temperature 2 Circuit - Voltage Above Normal or Shorted to High Source. High signal voltage detected at the aftertreatment diesel particulate filter inlet temperature sensor circuit.</td>
<td>Active aftertreatment diesel particulate filter regeneration will be disabled.</td>
</tr>
<tr>
<td>1067 (Amber)</td>
<td>S326 (2)</td>
<td>3241 (2)</td>
<td>Aftertreatment Exhaust Gas Temperature 1 Circuit - Data Erratic, Intermittent, or Incorrect. The aftertreatment diesel oxidaetion catalyst inlet temperature sensor is not changing with engine operating conditions.</td>
<td>Active aftertreatment diesel particulate filter regeneration will be disabled.</td>
</tr>
<tr>
<td>1068 (Amber)</td>
<td>S327 (4)</td>
<td>3249 (4)</td>
<td>Aftertreatment Exhaust Gas Temperature 2 Circuit - Voltage Above Normal or Shorted to Low Source. Low signal voltage detected at the aftertreatment diesel particulate filter inlet temperature sensor circuit.</td>
<td>Active aftertreatment diesel particulate filter regeneration will be disabled.</td>
</tr>
<tr>
<td>1069 (Amber)</td>
<td>S327 (3)</td>
<td>3249 (3)</td>
<td>Aftertreatment Exhaust Gas Temperature 2 Circuit - Data Erratic, Intermittent, or Incorrect. The aftertreatment diesel particulate filter inlet temperature sensor is not changing with engine operating conditions.</td>
<td>Active aftertreatment diesel particulate filter regeneration will be disabled.</td>
</tr>
<tr>
<td>1074 (Amber)</td>
<td>None (13)</td>
<td>3050 (13)</td>
<td>Catalyst Efficiency - Out of Calibration. The temperature increase across the aftertreatment diesel oxidation catalyst is lower than expected.</td>
<td>None on performance.</td>
</tr>
<tr>
<td>1075 (Amber)</td>
<td>S323 (3)</td>
<td>3513 (3)</td>
<td>Sensor Supply 5 - Voltage Above Normal or Shorted to Low Source. Low voltage detected at sensor supply number 5 circuit in the OEM harness.</td>
<td>Severe derate in power output of the engine. Limp home power only.</td>
</tr>
<tr>
<td>1076 (Amber)</td>
<td>S323 (4)</td>
<td>3513 (4)</td>
<td>Sensor Supply 5 - Voltage Below Normal or Shorted to Low Source. Low voltage detected at sensor supply number 5 circuit in the OEM harness.</td>
<td>Severe derate in power output of the engine. Limp home power only.</td>
</tr>
<tr>
<td>1843 (Amber)</td>
<td>P101 (3)</td>
<td>101 (3)</td>
<td>Crankcase Pressure Circuit - Voltage Above Normal or Shorted to High Source. High signal voltage detected at the crankcase pressure circuit.</td>
<td>No engine protection for high crankcase pressure.</td>
</tr>
<tr>
<td>1844 (Amber)</td>
<td>P101 (4)</td>
<td>101 (4)</td>
<td>Crankcase Pressure Circuit - Voltage Below Normal or Shorted to Low Source. Low signal voltage detected at the crankcase pressure circuit.</td>
<td>No engine protection for high crankcase pressure.</td>
</tr>
<tr>
<td>FAULT CODE (LAMP)</td>
<td>PID(P)</td>
<td>SID(S)</td>
<td>SPN(S)</td>
<td>REASON</td>
</tr>
<tr>
<td>------------------</td>
<td>--------</td>
<td>--------</td>
<td>--------</td>
<td>------------------------------------------------------------------------</td>
</tr>
<tr>
<td>1866 (Amber)</td>
<td>P411</td>
<td></td>
<td>401</td>
<td>Exhaust Gas Recirculation Valve Delta Pressure - Data Erratic, Intermittent, or Incorrect. An error in the EGA delta pressure signal was detected at initial key-on or the sensor failed the auto-zero test.</td>
</tr>
<tr>
<td>1876 (Amber)</td>
<td>S328</td>
<td></td>
<td>3245</td>
<td>Aftertreatment Exhaust Gas Temperature 3 Circuit - Voltage Below Normal or Shorted to Low Source. Low signal voltage detected at the aftertreatment diesel particulate filter outlet temperature sensor.</td>
</tr>
<tr>
<td>1877 (Amber)</td>
<td>S328</td>
<td></td>
<td>3245</td>
<td>Aftertreatment Exhaust Gas Temperature 3 Circuit - Voltage Above Normal or Shorted to High Source. High signal voltage detected at the catalyst inlet temperature sensor circuit.</td>
</tr>
<tr>
<td>1878 (Amber)</td>
<td>S328</td>
<td></td>
<td>3245</td>
<td>Aftertreatment Exhaust Gas Temperature 3 - Data Erratic, Intermittent, or Incorrect. The aftertreatment diesel oxidation catalyst inlet temperature sensor is not changing with engine operating conditions.</td>
</tr>
<tr>
<td>1879 (Amber)</td>
<td>S324</td>
<td></td>
<td>3251</td>
<td>Aftertreatment Particulate Filter Differential Pressure Sensor Circuit - Voltage Above Normal or Shorted to High Source. High signal voltage detected at the aftertreatment differential pressure sensor circuit.</td>
</tr>
<tr>
<td>1881 (Amber)</td>
<td>S324</td>
<td></td>
<td>3251</td>
<td>Aftertreatment Particulate Filter Differential Pressure Sensor Circuit - Voltage Below Normal or Shorted to Low Source. Low signal voltage or open circuit detected at the aftertreatment differential pressure sensor circuit.</td>
</tr>
<tr>
<td>1883 (Amber)</td>
<td>S324</td>
<td></td>
<td>3251</td>
<td>Aftertreatment Particulate Filter Differential Pressure Sensor - Data Erratic, Intermittent, or Incorrect. The aftertreatment diesel particulate filter differential pressure sensor is reading an erratic value at initial key-on or during engine operation.</td>
</tr>
<tr>
<td>1896 (Amber)</td>
<td>S146</td>
<td></td>
<td>2791</td>
<td>EGA Valve Controller - Out of Calibration. The EGA valve has failed the automatic calibration procedure at initial key-on.</td>
</tr>
<tr>
<td>1899 (Amber)</td>
<td>P411</td>
<td></td>
<td>411</td>
<td>Exhaust Gas Recirculation Valve Delta Pressure - Data Valid but Above Normal Operating Range - Moderately Severe Level. The EGR differential pressure sensor has detected low EGR gas flow or the EGR differential pressure reading is not valid for engine operating conditions.</td>
</tr>
<tr>
<td>1911 (Amber)</td>
<td>P157</td>
<td></td>
<td>157</td>
<td>Injector Metering Rail Number 1 Pressure - Data Valid but Above Normal Operating Range - Most Severe Level. Fuel pressure signal indicates that fuel pressure has exceeded the maximum limit for the given engine rating.</td>
</tr>
<tr>
<td>1921 (Amber)</td>
<td>S324</td>
<td></td>
<td>3251</td>
<td>Aftertreatment Particulate Filter Differential Pressure - Data Valid but Above Normal Operating Range - Moderately Severe Level. The soot load of the aftertreatment diesel particulate filter has exceeded the recommended limits.</td>
</tr>
<tr>
<td>1922 (Red)</td>
<td>S324</td>
<td></td>
<td>3251</td>
<td>Aftertreatment Particulate Filter Differential Pressure - Data Valid but Above Normal Operating Range - Most Severe Level. The soot load of the aftertreatment diesel particulate filter has exceeded the recommended limits.</td>
</tr>
<tr>
<td>1938 (Amber)</td>
<td>None</td>
<td></td>
<td>3597</td>
<td>ECU Power Output Supply Voltage 1 - Data Valid but Below Normal Operating Range - Moderately Severe Level. Low battery voltage detected by the VGT actuator.</td>
</tr>
<tr>
<td>1942 (Amber)</td>
<td>P101</td>
<td></td>
<td>101</td>
<td>Crankcase Pressure - Data Erratic, Intermittent, or Incorrect. The ECM has detected that the crankcase pressure signal is not changing with engine operating conditions.</td>
</tr>
<tr>
<td>1943 (None)</td>
<td>None</td>
<td></td>
<td>3555</td>
<td>Ambient Air Density - Data Valid but Below Normal Operating Range - Least Severe Level. Engine torque has been reduced because the vehicle was operating at a high altitude condition.</td>
</tr>
<tr>
<td>1962 (Amber)</td>
<td>S027</td>
<td></td>
<td>641</td>
<td>VGT Actuator Driver Over Temperature (Calculated) - Data Valid but Above Normal Operating Range - Least Severe Level. High internal VGT actuator temperature has been detected.</td>
</tr>
<tr>
<td>FAULT CODE</td>
<td>J1587 PID(P)</td>
<td>J1939 SPN(S)</td>
<td>REASON</td>
<td>EFFECT</td>
</tr>
<tr>
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<td>--------</td>
</tr>
<tr>
<td>1967 (Amber)</td>
<td>837</td>
<td>324</td>
<td>9</td>
<td>16</td>
</tr>
<tr>
<td>1969 (Red)</td>
<td>8327</td>
<td>324</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>1972 (Amber)</td>
<td>832</td>
<td>324</td>
<td>5</td>
<td>16</td>
</tr>
<tr>
<td>1973 (Red)</td>
<td>5</td>
<td>324</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>1974 (Maintenance)</td>
<td>P10</td>
<td>101</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>1981 (Amber)</td>
<td>8324</td>
<td>3251</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>1993 (Amber)</td>
<td>None</td>
<td>3064</td>
<td>31</td>
<td>31</td>
</tr>
<tr>
<td>2182 (Amber)</td>
<td>879</td>
<td>107</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>2183 (Amber)</td>
<td>879</td>
<td>1072</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>2185 (Amber)</td>
<td>523</td>
<td>351</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>2186 (Amber)</td>
<td>523</td>
<td>351</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>2198 (Amber)</td>
<td>8027</td>
<td>641</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>2265 (Amber)</td>
<td>812</td>
<td>1075</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>2266 (Amber)</td>
<td>812</td>
<td>107</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>2272 (Amber)</td>
<td>P027</td>
<td>27</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>2273 (Amber)</td>
<td>P41</td>
<td>411</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>2274 (Amber)</td>
<td>P41</td>
<td>411</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>FAULT CODE (LAMP)</td>
<td>J1587 PID(P) SID(S) (FMI)</td>
<td>J1939 SPN(S) (FMI)</td>
<td>REASON</td>
<td>EFFECT</td>
</tr>
<tr>
<td>-------------------</td>
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<td>--------</td>
</tr>
<tr>
<td>2288 (None)</td>
<td>P10 3 103 15</td>
<td></td>
<td>Turbocharger 1 Speed - Data Valid but Above Normal Operational Range - Least Severe Level. High turbocharger speed has been detected by the ECM.</td>
<td>Engine power derate to lower the turbocharger speed.</td>
</tr>
<tr>
<td>2311 (Amber)</td>
<td>S06 8 633 31</td>
<td></td>
<td>Electronic Fuel Injection Control Valve Circuit - Condition Exists. Fuel pump actuator circuit resistance too high or too low.</td>
<td>Possible low power.</td>
</tr>
<tr>
<td>2321 (None)</td>
<td>P19 19 0 (2)</td>
<td></td>
<td>Engine Crankshaft Speed/Position - Data Error, Intermittent, or Incorrect. Crankshaft engine speed sensor intermittent synchronization.</td>
<td>Engine can exhibit misfire as control switches from the primary to the backup speed sensor. Engine power is reduced while the engine operates on the backup speed sensor.</td>
</tr>
<tr>
<td>2322 (None)</td>
<td>S06 (2) 123 2</td>
<td></td>
<td>Engine Camshaft Speed/Position Sensor - Data Error, Intermittent, or Incorrect. Camshaft engine speed sensor intermittent synchronization.</td>
<td>None on performance.</td>
</tr>
<tr>
<td>2345 (Amber)</td>
<td>P10 3 103 10</td>
<td></td>
<td>Turbocharger 1 Speed - Abnormal Rate of Change. The turbocharger speed sensor has detected an erroneous speed value.</td>
<td>None on performance. The ECM uses an estimated turbocharger speed.</td>
</tr>
<tr>
<td>2346 (None)</td>
<td>None 2789 (15)</td>
<td></td>
<td>Turbocharger Turbine Inlet Temperature (Calculated) - Data Valid but Above Normal Operational Range - Least Severe Level. Turbocharger turbine inlet temperature has exceeded the engine protection limit.</td>
<td>Fuel is limited in an attempt to decrease the exhaust gas temperature entering the turbocharger.</td>
</tr>
<tr>
<td>2347 (None)</td>
<td>None 2790 (15)</td>
<td></td>
<td>Turbocharger Compressor Outlet Temperature (Calculated) - Data Valid but Above Normal Operational Range - Least Severe Level. High turbocharger compressor outlet air temperature has been calculated by the electronic control module (ECM).</td>
<td>Fuel is limited in an attempt to decrease the calculated turbocharger compressor outlet air temperature.</td>
</tr>
<tr>
<td>2349 (Amber)</td>
<td>S14 6 279 5</td>
<td></td>
<td>EGA Valve Control Circuit - Current Below Normal or Open Circuit. Motor terminal or motor coil open circuit has been detected by the smart EGA controller.</td>
<td>EGA valve actuation will be disabled.</td>
</tr>
<tr>
<td>2351 (Amber)</td>
<td>S14 6 279 4</td>
<td></td>
<td>EGA Valve Control Circuit - Voltage Below Normal or Shorted to Low Source. Motor terminal or motor coil short circuit to ground, or 3 power supply has not been detected by the smart EGA controller.</td>
<td>EGA valve actuation will be disabled.</td>
</tr>
<tr>
<td>2357 (Amber)</td>
<td>S14 6 279 7</td>
<td></td>
<td>EGA Valve Control Circuit - Mechanical System Not Responding Properly or Out of Adjustment. The EGA motor has exceeded the duty cycle limit, indicative of a stuck open EGA valve.</td>
<td>EGR valve actuation will be disabled.</td>
</tr>
<tr>
<td>2359 (Amber)</td>
<td>P41 1 411 16</td>
<td></td>
<td>Exhaust Gas Recirculation Valve Delta Pressure - Data Valid but Above Normal Operational Range - Moderately Severe Level. The EGA differential pressure sensor has detected high EGA gas flow or the EGA differential pressure reading is not valid for engine operating conditions.</td>
<td>EGA valve actuation will be disabled.</td>
</tr>
<tr>
<td>2363 (Amber)</td>
<td>S02 9 107 4</td>
<td></td>
<td>Engine Brake Actuator Driver Output 2 Circuit - Voltage Below Normal or Shorted to Low Source. Low voltage detected at the engine brake solenoid number 2 signal circuit.</td>
<td>Engine brake on cylinders 4, 5, and 6 can not be activated.</td>
</tr>
<tr>
<td>2367 (Amber)</td>
<td>S00 3 107 3</td>
<td></td>
<td>Engine Brake Actuator Driver Output 2 Circuit - Voltage Above Normal or Shorted to High Source. Open circuit or high voltage detected at the engine brake solenoid number 2 signal circuit.</td>
<td>Engine brake on cylinders 4, 5, and 6 can not be activated.</td>
</tr>
<tr>
<td>2373 (Amber)</td>
<td>P13 1 1209 3</td>
<td></td>
<td>Exhaust Gas Pressure Sensor Circuit - Voltage Above Normal or Shorted to Low Source. High signal voltage detected at the exhaust gas pressure circuit.</td>
<td>None on performance.</td>
</tr>
<tr>
<td>2374 (Amber)</td>
<td>P13 1 120 4</td>
<td></td>
<td>Exhaust Gas Pressure Sensor Circuit - Voltage Below Normal or Shorted to Low Source. Low signal voltage detected at the exhaust gas pressure circuit.</td>
<td>None on performance.</td>
</tr>
<tr>
<td>2375 (Amber)</td>
<td>P41 2 412 3</td>
<td></td>
<td>Exhaust Gas Recirculation Temperature Sensor Circuit - EGA valve actuation will be disabled.</td>
<td>EGA valve actuation will be disabled.</td>
</tr>
<tr>
<td>2376 (Amber)</td>
<td>P41 2 412 4</td>
<td></td>
<td>Exhaust Gas Recirculation Temperature Sensor Circuit - Voltage Below Normal or Shorted to Low Source. Low signal voltage detected at EGA temperature circuit.</td>
<td>EGA valve actuation will be disabled.</td>
</tr>
<tr>
<td>2377 (Amber)</td>
<td>S03 647 3</td>
<td></td>
<td>Fan Control Circuit - Voltage Above Normal or Shorted to High Source. Open circuit or high voltage detected at the fan control circuit.</td>
<td>The fan may stay on continuously or not run at all.</td>
</tr>
<tr>
<td>FAULT CODE</td>
<td>J158 SPN(F)</td>
<td>J1939 SPN(S)(FMI)</td>
<td>REASON</td>
<td>EFFECT</td>
</tr>
<tr>
<td>------------</td>
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<td>--------</td>
<td>--------</td>
</tr>
<tr>
<td>2448</td>
<td>S027</td>
<td>641</td>
<td>VGT Actuator Controller - Out of Calibration. The VGT has failed the automatic calibration procedure at initial key-on. VGT will be in the open position.</td>
<td>None on performance.</td>
</tr>
<tr>
<td>2448</td>
<td>None</td>
<td>111</td>
<td>Coolant Level - Data Valid but Below Normal Operational Range - Least Severe Level. Low engine coolant level detected.</td>
<td>None on performance.</td>
</tr>
<tr>
<td>2451</td>
<td>N/A</td>
<td>2789</td>
<td>Turbocharger Turbine Inlet Temperature (Calculated) - Data Valid but Above Normal Operational Range - Least Severe Level. Turbocharger turbine inlet charger temperature has exceeded the engine protection limit.</td>
<td>Low intake manifold pressure.</td>
</tr>
<tr>
<td>2554</td>
<td>P131</td>
<td>1209</td>
<td>Exhaust Gas Pressure - Data Erratic, Intermittent, or Incorrect. The exhaust gas pressure sensor is reading an erratic value at initial key-on.</td>
<td>The ECM will estimate the exhaust gas pressure.</td>
</tr>
<tr>
<td>2555</td>
<td>S070</td>
<td>729</td>
<td>Intake Air Heater 1 Circuit - Voltage Above Normal or Shorted to Hot Source. High voltage detected at the intake air heater signal circuit.</td>
<td>The intake air heaters may be ON or OFF all the time.</td>
</tr>
<tr>
<td>2556</td>
<td>S070</td>
<td>729</td>
<td>Intake Air Heater 1 Circuit - Voltage Below Normal or Shorted to Low Source. Low voltage detected at the intake air heater signal circuit.</td>
<td>The intake air heater may be ON or OFF all the time.</td>
</tr>
<tr>
<td>2634</td>
<td>S027</td>
<td>641</td>
<td>VGT Actuator Controller - Bad Intelligent Device or Component. An internal error has been detected by the smart VGT controller.</td>
<td>VGT actuation will be disabled.</td>
</tr>
<tr>
<td>2635</td>
<td>S027</td>
<td>641</td>
<td>VGT Actuator Driver Circuit - Condition Exists. A calibration mismatch between the VGT actuator and the ECM has been detected.</td>
<td>VGT actuation will be disabled.</td>
</tr>
<tr>
<td>2636</td>
<td>S027</td>
<td>641</td>
<td>VGT Actuator Driver Circuit - Abnormal Update Rate. No communications on the J1939 datalink between the engine ECM and the smart VGT controller.</td>
<td>VGT actuation will be disabled.</td>
</tr>
<tr>
<td>2637</td>
<td>None</td>
<td>3050</td>
<td>Catalyst Face Plugged - Root Cause Not Known. The front face of the aftertreatment diesel oxidation catalyst has been detected to be plugged with soot.</td>
<td>Active aftertreatment diesel particulate filter regeneration will be disabled.</td>
</tr>
<tr>
<td>2638</td>
<td>None</td>
<td>3050</td>
<td>Catalyst Efficiency - Out of Calibration. The temperature increase across the aftertreatment diesel oxidation catalyst is lower than expected.</td>
<td>None on performance.</td>
</tr>
<tr>
<td>2639</td>
<td>S324</td>
<td>3251</td>
<td>Aftertreatment Particulate Filter Differential Pressure - Data Valid but Above Normal Operational Range - Least Severe Level. The soot load of the aftertreatment diesel particulate filter has exceeded the recommended limits.</td>
<td>The aftertreatment dash lamp will be illuminated and will begin to flash as the severity of the soot load increases. Possible engine protection derate based on severity.</td>
</tr>
<tr>
<td>2646</td>
<td>P110</td>
<td>110</td>
<td>Engine Coolant Temperature - Condition Exists. The EGR valve was closed to reduce engine coolant temperature.</td>
<td>EGR valve actuation will be disabled.</td>
</tr>
<tr>
<td>2659</td>
<td>P110</td>
<td>110</td>
<td>Engine Coolant Temperature - Condition Exists. The EGA valve was closed to reduce engine coolant temperature.</td>
<td>EGA valve actuation will be disabled.</td>
</tr>
<tr>
<td>2728</td>
<td>None</td>
<td>3556</td>
<td>Aftertreatment Fuel Injector 1 - Data Valid but Above Normal Operational Range - Moderately Severe Level. Excessive fuel injection into the aftertreatment system has been detected.</td>
<td>None on performance.</td>
</tr>
<tr>
<td>2742</td>
<td>None</td>
<td>3249</td>
<td>Aftertreatment Exhaust Gas Temperature 2 - Data Valid but Below Normal Operating Range - Least Severe Level. The, temperatures in the aftertreatment system can not reach the required temperatures for stationary regeneration.</td>
<td>None on performance.</td>
</tr>
<tr>
<td>2743</td>
<td>None</td>
<td>3249</td>
<td>Aftertreatment Exhaust Gas Temperature 2 Data Valid but Below Normal Operating Range - Moderately Severe Level. Excessive black smoke has been detected exiting the engine and entering the aftertreatment diesel particulate filter.</td>
<td>None on performance.</td>
</tr>
<tr>
<td>2754</td>
<td>None</td>
<td>81</td>
<td>Engine Particulate Trap Inlet Pressure - Data Valid but Above Normal Operational Range - Moderately Severe Level. Excessive black smoke has been detected exiting the engine and entering the aftertreatment diesel particulate filter.</td>
<td>None on performance.</td>
</tr>
<tr>
<td>2777</td>
<td>N/A</td>
<td>3703</td>
<td>Particulate Trap Active Aggregation Inhibited Due to Inhibit Switch - Condition Exists. Regeneration of the diesel particulate filter has been prevented due to the inhibit switch being activated.</td>
<td>Active aftertreatment diesel particulate filter regeneration has been disabled.</td>
</tr>
<tr>
<td>FAULT CODE (LAMP)</td>
<td>J158 SPN(S) (FMI)</td>
<td>J1939 SPN(S) (FMI)</td>
<td>REASON</td>
<td>EFFECT</td>
</tr>
<tr>
<td>------------------</td>
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<td>--------</td>
</tr>
<tr>
<td>F1</td>
<td>3481 (16)</td>
<td>Aftertreatment Fuel Rate - Data Valid but Above Normal Operational Range - Moderately Severe Level</td>
<td>None on performance.</td>
<td></td>
</tr>
<tr>
<td>O</td>
<td>412 (15)</td>
<td>Exhaust Gas Recirculation Temperature - Data Valid but Above Normal Operational Range - Moderate Severe Level. EGA temperature has exceeded the engine protection limit.</td>
<td>None on performance.</td>
<td></td>
</tr>
<tr>
<td>Amber</td>
<td>412 (16)</td>
<td>Exhaust Gas Recirculation Temperature - Data Valid but Above Normal Operational Range - Moderate Severe Level. EGA temperature has exceeded the engine protection limit.</td>
<td>None on performance.</td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>110 (15)</td>
<td>Engine Coolant Temperature - Data Valid but Above Normal Operational Range - Least Severe Level. Engine coolant temperature is above the engine protection warning limit.</td>
<td>Power derate and possible engine shutdown if engine protection shutdown feature is enabled.</td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>105 (15)</td>
<td>Intake Manifold 1 Temperature - Data Valid but Above Normal Operational Range - Least Severe Level. Intake manifold air temperature signal indicates intake manifold air temperature is above engine protection warning limit.</td>
<td>Progressive power derate increasing in severity from time of alert.</td>
<td></td>
</tr>
<tr>
<td>Amber</td>
<td>102 (2)</td>
<td>Intake Manifold 1 Pressure - Data Erratic, Intermittent, or Incorrect. The ECM has detected an intake manifold pressure signal that is too high or low for current engine operating conditions.</td>
<td>Engine power derate.</td>
<td></td>
</tr>
</tbody>
</table>

Bulletin No. 4021572
PLUS 1 FRONT FAULTS
Plus 1 MSV Gen 3
Electrical Faults
Troubleshooting manual
07/18/16
Service Section 2.2
FRONT CONTROL MC50-20 AND MC38-10
# FRONT CONTROLS

## FRONT CONTROL FAULTS (MC050-020)

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TO Mc038-10 FAULTS

NEXT
FRONT CONTROL FAULTS (MC038-10)

MC038-010 CAN
HEAD LIGHT LOW BEAM
HEAD LIGHT HIGH BEAM
FRONT HITCH LOCKING VALVE
VALVE AUX 3B OUTPUT
WASHER PUMP VALVE
VALVE AUX 2B OUTPUT
FRONT CLEARANCE LIGHTS
VALVE AUX 1A OUTPUT
WORK LIGHTS
FRONT CONTROL FAULTS

FAULT: MC50-20 CAN

1. INSPECT CABLE FOR DAMAGE BETWEEN THE MC50-20, MC38-10 AND SCREEN
   - Y: REPAIR DAMAGED CABLE FAULT GONE
   - N: CHECK FOR GROUND

2. CHECK FOR GROUND
   - Y: REPAIR GROUND FAULT GONE
   - N: DOES MC50-20 HAVE POWER?

3. DOES MC50-20 HAVE POWER?
   - Y: IS FUSE BLOWN?
   - N: PLUG CABLE IN FAULT GONE

4. IS FUSE BLOWN?
   - Y: REPLACE FUSE FAULT GONE
   - N: IS CAN 0 CABLE PLUGGED INTO MC50-20?

5. IS CAN 0 CABLE PLUGGED INTO MC50-20?
   - Y: PLUG CABLE IN FAULT GONE
   - N: DOES CABLE OHM OUT?

6. DOES CABLE OHM OUT?
   - Y: RECONNECT CABLE FAULT GONE
   - N: DONT RESCURE ANY LOOSE WIRES

7. DONT RESCURE ANY LOOSE WIRES
   - Y: DONE
   - N: OHL CABLE FROM MC50-20 PIN 3 CAN HI WITH MC38-10 CAN PIN 3 CAN HI AND SCREEN PIN 6 CAN HI

8. OHL CABLE FROM MC50-20 PIN 3 CAN HI WITH MC38-10 CAN PIN 3 CAN HI AND SCREEN PIN 6 CAN HI
   - Y: DONE
   - N: OHL CABLE FROM MC50-20 PIN 3 CAN LO WITH MC38-10 CAN PIN 4 CAN LO AND SCREEN PIN 7 CAN LO

9. OHL CABLE FROM MC50-20 PIN 3 CAN LO WITH MC38-10 CAN PIN 4 CAN LO AND SCREEN PIN 7 CAN LO
   - Y: DONE
   - N: OHL CABLE FROM MC50-20 PIN 4 CAN LO WITH MC38-10 CAN PIN 4 CAN LO AND SCREEN PIN 7 CAN LO
FRONT CONTROL FAULTS

FAULT: JOYSTICK CAN

IS CAN 1 CABLE PLUGGED INTO JOYSTICK

Y

DOES JOYSTICK HAVE POWER

N

CHECK FOR GROUND

Y

INSPECT CABLE FOR DAMAGE BETWEEN THE JOYSTICK, MVEC AND MC 50-22 CAN 2 LINE

N

IS FUSE BLOWN

N

REPAIR GROUND FAULT GONE

N

REPAIR DAMAGED CABLE FAULT GONE

Y

REPLACE FUSE FAULT GONE

Y

DONE RESECURE ANY LOOSE WIRES

N

RECONNECT CABLE FAULT GONE

Y

DOES CABLE OHM OUT

N

OHM CABLE FROM MC50 20 PIN 21 CAN 1 LO WITH MVEC PIN 12 CAN 1 CAN LO AND JOYSTICK PIN 4 CAN 1 LO

N

OHM CABLE FROM MC50 20 PIN 20 CAN 1 HI WITH MVEC CAN 1 PIN 6 CAN HI AND JOYSTICK PIN 3 CAN 1 HI
FAULT: JOYSTICK X OR Y AXIS.

- **DOES JOYSTICK HAVE POWER?**
  - **Yes:** IS CAN LINE HOOK UP
  - **No:** CHECK FUSE 16 ON FRONT MVEC

- **IS CAN LINE HOOK UP?**
  - **Yes:** REPLACE JOYSTICK
  - **No:** HOOK UP CAN LINE

- **DONE RESECURE ANY LOOSE WIRES**
FAULT: FRONT HITCH PSI SENSOR

1. REMOVE J2 CABLE FROM FRONT INPUTS TURCK BLOCK INSPECT AND REINSTALL. DOES FAULT GO AWAY
   - Y
   - N

2. REPLACE CABLE 721-183119 FRONT HITCH PRESSURE DOES FAULT GO AWAY
   - Y
   - N

3. REPLACE TRANSDUCER DOES FAULT GO AWAY
   - Y
   - N

4. REPLACE FRONT INPUTS TURCK BLOCK

DONE, REINSTALL ANY CABLES, RESECURE ANY LOOSE WIRES
FAULT: FOOT PEDAL INPUT

- Replace front inputs turck block
  - Y: Replace foot pedal
    - Y: Replace cable 721-183120 foot pedal does fault go away
      - Y: Remove 11 cable from front inputs turck block inspect and reinstall does fault go away
    - Y: Replace front inputs turck block
  - N: Replace foot pedal
    - Y: Replace front inputs turck block
  - N: Replace front inputs turck block

DONE reinstall all cables, resecure any loose wires
FAULT: FOOT PEDAL NOT CALIBRATED

1. Replace foot pedal.
2. Does max turn green?
   - Yes: Go into calibration hold foot pedal to the floor.
   - No: Go to password screen, enter password 501, hit escape.
3. Resecure any loose cables.
FAULT: FRONT END CONNECTOR 4

- Inspect front end connector; if installed, proceed with step 2.
- Remove seven-way plug goes fault away.
- Inspect cable on attachment; if damaged, repair.
- Done; resecure any loose wires.
FAULT: FRONT END CONNECTOR 5

IS ANYTHING INSTALLED ON THE SEVEN WAY FRONT CONNECTOR

INSPECT FRONT RECEPTICLE AND CABLE REPAIR ANY DAMAGES

REMOVE SEVEN WAY PLUG DOES FAULT GO AWAY

DONE RESECURE ANY LOOSE WIRES

INSPECT CABLE ON THE ATTACHMENT REPAIR ANY DAMAGES
FAULT: FRONT END CONNECTOR 6

1. **Inspect front receptacle and cable, repair any damages**
   - **N**
2. **Is anything installed on the seven way front connector?**
   - **Y**
   - **N**
3. **Remove seven way plug; does fault go away?**
   - **Y**
   - **N**
4. **Inspect cable on the attachment; repair any damages**
   - **Y**

If any loose wires, **Done**.
FAULT: FRONT HITCH UP PWM

1. REMOVE J1 CABLE FROM FRONT OUTPUTS TURCK BLOCK TURN KEY ON DOES FAULT GO AWAY
   - Y: REINSTALL CABLE AND CYCLE KEY ENERGIZE FRONT HITCH UP DOES FAULT COME ON
   - N: REPLACE FRONT OUTPUTS TURCK BLOCK

2. REPLACE FRONT OUTPUTS TURCK BLOCK
   - Y: REPLACE CABLE 721-183722 FRONT HITCH UP REPEAT PREVIOUS STEP DOES FAULT GO AWAY
   - N: REPLACE COIL ON FRONT HITCH UP CARTIDGE

3. REPLACE COIL ON FRONT HITCH UP CARTIDGE
   - Y: DONE REINSTALL ALL CABLES AND RESECURE ANY LOOSE WIRES
   - N: RETURN TO REMOVING J1 CABLE FROM FRONT OUTPUTS TURCK BLOCK TURN KEY ON

DONE REINSTALL ALL CABLES AND RESECURE ANY LOOSE WIRES
FAULT: VALVE AUX 3A PWM

DONE REINSTALL ALL CABLES AND RESCURE ANY LOOSE WIRES

REPLACE COIL AUX 3A CARTRIDGE

REPLACE CABLE 722-183731 AUX 3A REPEAT PREVIOUS STEP DOES FAULT GO AWAY

REINSTALL CABLE AND CYCLE KEY 3A DOES FAULT COME ON

ENERGIZE AUX 3A DOES FAULT COME ON

Y

N

REPLACE FRONT OUTPUTS TURCK BLOCK

TURN KEY ON DOES FAULT GO AWAY

REMOVE 17 CABLE FROM FRONT OUTPUTS TURCK BLOCK

N

Y

Y

N
FAULT: MC38-10 CAN

- IS CAN 0 CABLE PLUGGED INTO MC38-10
  - Y: DOES MC38-10 HAVE POWER
    - Y: CHECK FOR GROUND
      - N: INSPECT CABLE FOR DAMAGE BETWEEN THE MC50-20, MC38-10 AND SCREEN
    - N: IS FUSE BLOWN
      - N: REPAIR GROUND FAULT GONE
      - N: REPAIR DAMAGED CABLE FAULT GONE
  - N: PLUG CABLE IN FAULT GONE
    - Y: D One RESECURE ANY LOOSE WIRES
    - Y: RECONNECT CABLE FAULT GONE
    - Y: DOES CABLE O H M OUT
      - Y: O H M CABLE FROM MC50 20 PIN 4 CAN LO WITH MC 38-10 CAN PIN 4 CAN LO AND SCREEN PIN 7 CAN LO
      - N: O H M CABLE FROM MC50 20 PIN 3 CAN HI WITH MC38-10 CAN PIN 3 CAN HI AND SCREEN PIN 6 CAN HI

- N: CHECK FOR GROUND
  - N: REPAIR GROUND FAULT GONE
  - N: REPAIR DAMAGED CABLE FAULT GONE
  - N: D One RESECURE ANY LOOSE WIRES
FAULT: HEAD LIGHT HIGH BEAM NEW (LIGHT PACKAGE)

- **Inspect wires going to high beam relay.**
  - Yes: Go to cycle key does fault go away.
  - No: Replace high beam relay does fault go away.
- **Replace MC38-10 module.**
  - Yes: Replace high beam relay does fault go away.
  - No: Inspect wires going to high beam relay.
- **Done reinstall all cables and resecure any loose wires.**
FAULT: HEAD LIGHT HIGH BEAM OLD (LIGHT PACKAGE)

1. **Inspect wires going to high beam lights.** Repair any damages. Does fault go away?
   - Yes: Go to next step.
   - No: Replace lights. Does fault go away?
     - Yes: Go to next step.
     - No: Replace MC38-10 module.

2. **Replace MC38-10 module.**
   - No: Inspect and repair any loose wires.
     - Yes: Reinstall all cables and resecure any loose wires.
FAULT: FRONT LOCKING VALVE

1. REMOVE J8 CABLE FROM FRONT INPUTS TURCK BLOCK TURN KEY ON DOES FAULT GO AWAY
   - Y
   - N
   - Y
2. REINSTALL CABLE AND CYCLE KEY ENERGIZE HITCH UP DOES FAULT COME ON
   - Y
   - N
   - Y
3. REPLACE CABLE 721-183722 FRONT LOCKING VALVE REPEAT PREVIOUS STEP DOES FAULT GO AWAY
   - Y
   - N
4. REPLACE COIL ON FRONT LOCKING VALVE CARTIDGE
5. DONE REINSTALL ALL CABLES AND RESECURE ANY LOOSE WIRES
FAULT: WASHER PUMP

REPLACE MC38-10 MODULE

DONE REINSTALL ALL CABLES AND RESECURE ANY LOOSE WIRES

INSPECT WIRES GOING TO WASHER PUMP TURN KEY ON DOES FAULT GO AWAY

REPLACE WASHER PUMP

Y

N

CYCLE KEY ENERGIZE WASHER PUMP DOES FAULT COME ON

Y

N
FAULT: AUX 2B PWM

DONE REINSTALL ALL CABLES AND RESCURE ANY LOOSE WIRES

REPLACE COIL ON AUX 2B CARTRIDGE

REPLACE CABLE 721-183730 AUX 2B

REPEAT PREVIOUS STEP IF FAULT DOES GO AWAY

REINSTALL CABLE AND CYCLE KEY TO AUX 2B

ENERGIZE AUX 2B DOES FAULT COME ON

REMOVE W6 CABLE FROM FRONT OUTPUTS TURCK BLOCK

TURCK ON DOES FAULT GO AWAY

Y

N

Y

N

Y

N
FAULT: FRONT CLEARANCE LIGHTS

1. Inspect cables going to clearance lights for any damages. Repair if necessary.
   - Z
   - Y

2. Replace MC38-10 module.
   - Z

3. Energize clearance lights. Does fault come on?
   - Y
   - Prev. step

4. Replace clearance one at a time. Repeat previous step.
   - N

5. Done. Reinstall all cables and resecure any loose wires.
FAULT: WORK LIGHTS (NEW)

- Inspect cables going to work lights; replace if damaged.
- Repair any damages to work light relay.
- If fault does not go away, energize work lights; does fault come on?
  - No: Replace MC38-10 module.
  - Yes: Replace clearance lights relay.

DONE: Reinstall all cables and resecure any loose wires.
FAULT: WORK LIGHTS (OLD)

1. Inspect cables going to work lights. Repair any damaged turns. Key on. Does fault go away?
   - No: Replace MC38-10 module
   - Yes: Energize work lights. Does fault come on?
     - Yes: Repeat previous step. Does fault go away?
       - Yes: Done. Reinstall all cables and reseal any loose wires.
       - No: Replace work lights. One at a time. Does fault go away?
         - Yes: Repeat previous step. Does fault go away?
           - Yes: Done. Reinstall all cables and reseal any loose wires.
           - No: Replace MC38-10 module.
         - No: Replace work lights. One at a time. Does fault go away?
           - Yes: Replace MC38-10 module.
           - No: Replace MC38-10 module.
PLUS 1 FRONT FAULTS
MVEC
FRONT MVEC
Service Section 2.2
07/18/16
Troubleshooting manual
Electrical Faults
Plus 1 MSV Gen 3
Fault screen

- ENGINE FAULTS
- FRONT MVEC
- FRONT CONTROL
- REAR MVEC
- REAR CONTROL
- MAIN MENU

**FAULTS**

- CONTROLLER CAN FAULTS
  - MC050-20 FRONT 50 PIN CAN
  - MC038-10 FRONT 38 PIN CAN
  - SC050-22 REAR 50 PIN CAN
  - MC024-020 REAR 24 PIN CAN
## FRONT MVEC FAULTS

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[BACK](#)
FAULT: FAN LOW FUSE 1

- REPLACE FAN MOTOR
- DOES FUSE BLOW
- REINSTALL RELAY 1
- REMOVE CONNECTOR ON FAN MOTOR
- REMOVE RELAY 1
- DOES THE FUSE BLOW
- REPLACE FUSE 1
- DOES FUSE BLOW
- IS FUSE BLOWN
- REPLACE MVEC
- IS FAULT GONE
- DONE
- RESecure ANY LOOSE WIRES
FAULT: FAN LOW RELAY 1

1. REPLACE MVEC
   - N → REPLACE RELAY WITH NEW RELAY
   - Y → INSPECT RELAY TO SEE THAT IT DID NOT GET MOVED FROM MVEC

2. INSPECT RELAY TO SEE THAT IT DID NOT GET MOVED FROM MVEC
   - Y → REMOVE AND REINSTALL RELAY DOVES FAULT GO AWAY
   - N → REPLACE RELAY WITH NEW RELAY

3. REMOVE AND REINSTALL RELAY DOVES FAULT GO AWAY
   - Y → DONE
   - N → REPLACE RELAY WITH NEW RELAY

4. DONE
FAULT: FAN MEDIUM FUSE 4

1. Is fuse blown? (Y/N)
   - N: Replace fan motor.
   - Y: REINSTALL RELAY 2, REMOVE RELAY CONNECTOR ON FAN MOTOR.

2. Does fuse blow? (Y/N)
   - N: Replace wire on the black MVUC connector pin B and fan motor connector pin D.
   - Y: REPLACE MVUC.

3. Is fault gone? (Y/N)
   - N: REINSTALL RELAY 2, REMOVE RELAY CONNECTOR ON FAN MOTOR.
   - Y: DONE, RESCURE ANY LOOSE WIRES.
FAULT: FAN MEDIUM RELAY 2

1. REPLACE MVEC
   - N
     - DOES FAULT GO AWAY
       - Y
         - DONE
       - N
         - REPLACE RELAY WITH NEW RELAY
           - Y
             - REMOVE AND REINSTALL RELAY DOES FAULT GO AWAY
               - Y
                 - DONE
               - N
                 - INSPECT RELAY TO SEE THAT IT DID NOT GET MOVED FROM MVEC
                   - Y
                     - REPLACE MVEC
                       - N
                         - DOES FAULT GO AWAY
                           - Y
                             - DONE
                           - N
                             - REPLACE RELAY WITH NEW RELAY
                               - Y
                                 - REMOVE AND REINSTALL RELAY DOES FAULT GO AWAY
                                   - Y
                                     - DONE
                                   - N
                                     - INSPECT RELAY TO SEE THAT IT DID NOT GET MOVED FROM MVEC
                                       - Y
                                         - REPLACE MVEC
                                           - N
FAULT: FAN HIGH FUSE 7

- **Replace Fan Motor**
  - **Does Fuse Blow?**
    - **Yes**
      - Replace Wire on the Black MVEC Connector Pin E and Fan Motor Connector Pin E
    - **No**
      - **Replace Relay 3**
        - **Does the Fuse Blow?**
          - **Yes**
            - **Replace MVEC**
          - **No**
            - **Is Fault Gone?**
              - **Yes**
                - Done: Resecure Any Loose Wires
              - **No**
                - **Is Fuse Blown?**
                  - **Yes**
                    - **Replace Fuse 7**
                  - **No**
                    - **Replace Relay 3**
FAULT: FAN HIGH RELAY 3

1. **REPLACE MVEC**
   - **N**
   - **Y**

2. **DOES FAULT GO AWAY**
   - **Y**
   - **N**

3. **REPLACE RELAY WITH NEW RELAY**
   - **Y**
   - **N**

4. **INSPECT RELAY TO SEE THAT IT DID NOT GET MOVED FROM MVEC**
   - **Y**
   - **N**

5. **REMOVE AND REINSTALL RELAY**
   - **N**
   - **Y**

6. **DONE**
FAULT: FRONT CONNECTOR 2 RELAY 5

1. REPLACE MVEC
   - N
   - Y

2. DOES FAULT GO AWAY
   - Y
   - N

3. REPLACE RELAY WITH NEW RELAY
   - Y
   - N

4. INSPECT RELAY TO SEE THAT IT DID NOT GET MOVED FROM MVEC
   - N
   - Y

5. REMOVE AND REINSTALL RELAY DOES FAULT GO AWAY
   - Y
   - N

DONE
FAULT: FRONT CONNECTOR 3 FUSE 6

1. IS FUSE BLOWN
   - Y: REPLACE FUSE 6 DOES FUSE BLOW
   - N: IS FAULT GONE

2. IS FAULT GONE
   - Y: DONE RESECURE ANY LOOSE WIRES
   - N: REPLACE MVEC

3. REPLACE MVEC
   - Y: Y
   - N: REINSTALL RELAY REMOVE FRONT CONNECTOR WIRE #3

4. REINSTALL RELAY REMOVE FRONT CONNECTOR WIRE #3
   - Y: REPLACE WIRE ON BLACK MVEC CONNECTOR PIN G AND FRONT CONNECTOR PIN 3
   - N: DOES FUSE BLOW

5. DOES FUSE BLOW
   - Y: REPLACE FRONT CONNECTOR
   - N: N
FAULT: WIPER LOW RELAY 7

1. REPLACE MVEC
   - N
2. DOES FAULT GO AWAY
   - Y
3. REPLACE RELAY WITH NEW RELAY
   - N
   - Y
4. INSPECT RELAY TO SEE THAT IT DID NOT GET MOVED FROM MVEC
   - Y
   - N
5. REMOVE AND REINSTALL RELAY DOES FAULT GO AWAY
   - N
   - Y
DONE
FAULT: WIPER HIGH FUSE 5

1. Replace wiper motor. If yes, go to step 2. If no, go to step 3.
2. Replace wire on black MVEC connector. Pin H and wiper motor connector Pin 3. If yes, go to step 4. If no, go to step 5.
3. Reinstall relay. If yes, go to step 6. If no, go to step 7.
4. Replace fuse 5. If yes, go to step 8. If no, go to step 9.
5. Replace MVEC. If yes, go to step 10. If no, go to step 11.
6. Is fault gone? If yes, go to step 12. If no, go to step 13.
7. Remove relay 8. If yes, go to step 14. If no, go to step 15.
8. Does the fuse blow? If yes, go to step 16. If no, go to step 17.
10. Is fuse blown? If yes, go to step 20. If no, go to step 21.
11. Replace relay. If yes, go to step 22. If no, go to step 23.
12. Resecure. Any loose wires. If yes, go to step 24. If no, go to step 25.
FAULT: **WIPER HIGH RELAY 8**

1. **Inspect relay to see that it did not get moved from MVEC**
   - If **Y**, go to next step.
   - If **N**, go to previous step.

2. **Replace relay with new relay**
   - If **Y**, go to next step.
   - If **N**, go to previous step.

3. **Does fault go away**
   - If **Y**, replace MVEC and done.
   - If **N**, remove and reinstall relay does fault go away.

4. **Remove and reinstall relay does fault go away**
   - If **Y**, go to previous step.
   - If **N**, go to previous step.

5. **Done**
FAULT: SCREEN DOES NOT POWER UP FUSE 9

1. IS FUSE BLOWN
   - Y: REPLACE FUSE 9 DOES FUSE BLOW
   - N: DOES THE SCREEN POWER UP

2. DOES THE SCREEN POWER UP
   - Y: DONE RESECURE ANY LOOSE WIRES
   - N: REMOVE WIRE CONNECTOR FROM BACK OF SCREEN

3. REMOVE WIRE CONNECTOR FROM BACK OF SCREEN
   - Y: DOES FUSE BLOW
   - N: REPLACE SCREEN

4. DOES FUSE BLOW
   - Y: REMOVE ALARM FROM HARNESS DOES FUSE BLOW
   - N: REPLACE ALARM

5. REMOVE ALARM FROM HARNESS DOES FUSE BLOW
   - Y: REPLACE WIRE ON GRAY MVEC CONNECTOR PIN D AND SCREEN CONNECTOR PIN 2 AND ALARM POWER WIRE
   - N: DONE RESECURE ANY LOOSE WIRES
FAULT: MC50-20 Pins 47 & 48 Fuse 10

1. **Is Fuse Blown?**
   - **Yes:** Go to Step 2
   - **No:** Go to Step 3

2. **Replace MC50 20 Controller**
   - **Yes:** End Procedure
   - **No:** Go to Step 4

3. **Does Fuse Blow?**
   - **Yes:** Go to Step 5
   - **No:** Go to Step 4

4. **Replace MVEC**
   - **Yes:** End Procedure
   - **No:** Go to Step 4

5. **Replace Wire on Grey MVEC Connector Pin C and MC50 -20 Connector Pins 47 and Pins 48 Does Fuse Blow?**
   - **Yes:** End Procedure
   - **No:** Go to Step 4

6. **Is Fault Gone?**
   - **Yes:** End Procedure
   - **No:** Go to Step 7

7. **Resecure Any Loose Wires**
   - **Yes:** End Procedure
   - **No:** Go to Step 3

8. **Remove MC50 Electrical Connector Does the Fuse Blow?**
   - **Yes:** Go to Step 6
   - **No:** Go to Step 3

9. **Reinstall MC50 MC 50 Electrical Connector**
   - **Yes:** Go to Step 4
   - **No:** Go to Step 3

10. **Replace Fuse 10 Does Fuse Blow?**
    - **Yes:** Go to Step 5
    - **No:** Go to Step 4

11. **Does Fault Go Away?**
    - **Yes:** End Procedure
    - **No:** Go to Step 7
FAULT: MC50-20 MAIN FUSE 11

1. **Is fuse blown?**
   - **Yes:** Replace fuse 11 does fuse blow.
   - **No:** Remove MC50 electrical connector does the fuse blow.

2. **Remove MC50 electrical connector does the fuse blow?**
   - **Yes:** Replace MC50 controller.
   - **No:** Reinstall MC50 electrical connector.

3. **Does fuse blow?**
   - **Yes:** Replace MC50 controller.
   - **No:** Replace wire on grey MVEC connector pin G and MC50 -20 connector pins 2 does fuse blow.

4. **Replace wire on grey MVEC connector pin G and MC50 -20 connector pins 2 does fuse blow?**
   - **Yes:** Replace MVEC.
   - **No:** Does the fuse blow?

5. **Does the fuse blow?**
   - **Yes:** Replace fuse 11 does fuse blow.
   - **No:** Is fault gone?

6. **Is fault gone?**
   - **Yes:** Done: resecure any loose wires.
   - **No:** Is fuse blown?
FAULT: SEAT AND CAB TILT FUSE 14

1. IS FUSE BLOWN
   - N: REINSTALL ELECTRICAL CONNECTOR ON SEAT PLUG
   - Y: DOES FUSE BLOW

2. DOES FUSE BLOW
   - Y: REPLACE JOINT
   - N: REPLACE JACR

3. REINSTALL ELECTRICAL CONNECTOR TO JACK
   - N: REMOVE ELECTRICAL CONNECTOR FROM AIR CAB JACK AND AIR RIDE SEAT SWITCH
     DOES THE FUSE BLOW
   - Y: REPLACE WIRE ON GREY MVEC CONNECTOR_PIN TO THE AIR RIDE SEAT SWITCH AND CAB JACK DOES FUSE BLOW

4. REPLACE FUSE 14 DOES FUSE BLOW
   - N: IS FAULT GONE
   - Y: DONE

5. IS FAULT GONE
   - N: RESECURE ANY LOOSE WIRES
   - Y: DONE

6. REPLACE WIRE ON GREY MVEC CONNECTOR_PIN TO THE AIR RIDE SEAT SWITCH AND CAB JACK DOES FUSE BLOW
   - N: REMOVE ELECTRICAL CONNECTOR FROM AIR CAB JACK AND AIR RIDE SEAT SWITCH
     DOES THE FUSE BLOW
   - Y: REPLACE WIRE ON GREY MVEC CONNECTOR_PIN TO THE AIR RIDE SEAT SWITCH AND CAB JACK DOES FUSE BLOW
FAULT: RADIO AND AC FUSE 15

1. IS FUSE BLOWN?
   - Y: IS FAULT GONE?
     - Y: DONE
     - N: REINSTALL AC SWITCH

2. REINSTALL CONNECTORS
   - N: REMOVE AC SWITCH

3. REMOVE HEATER CONNECTOR
   - N: DOES FUSE BLOW?

4. REPLACE WIRE FROM STEER COLUMN PIN 14 AND AC CONTROL PIN B
   - Y: REPLACE STEERING COLUMN

5. REPLACE column pin 22 connector
   - Y: REPLACE GREY PLUM/VEC PLUG PIN B AND WIRE ON 22 PIN STEER COLUMN PIN CONNECTOR PIN 13

6. UNPLUG POWER POINT
   - Y: REPLACE POWER POINT

7. REINSTALL FUSE 15
   - N: DOES FUSE BLOW?
FAULT: JOYSTICK POWER FUSE 16

1. Is fuse blown? [Y] [N]
   - Yes
     - Replace fuse 16 does fuse blow? [Y] [N]
       - Yes
         - Replace joystick
       - No
         - Is fault gone? [Y] [N]
           - Yes
             - Resecure any loose wires
           - No
             - Replace dome lights does fuse blow? [Y] [N]
               - Yes
                 - Replace wire from dome lights to fuse 16 on front MVEC
               - No
                 - Replace bad dome light

2. No
   - Replace joystick
PLUS 1 REAR FAULTS
Plus 1 MSV Gen 3

Electrical Faults

Troubleshooting manual

07/18/16

Service Section 2.2

REAR CONTROL SC50-22 AND

MC24-20
### REAR CONTROL FAULTS (SC050-022) PAGE 1

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PPU FAULT RESET
FAULT: SC50-22 CAN

- **IS CAN 0 CABLE PLUGGED INTO SC50-22**
  - Y: DOES SC50-22 HAVE POWER
  - N: PLUG CABLE IN FAULT GONE
  - N: INSPECT CABLE FOR DAMAGE BETWEEN THE SC50-22, MC24-10 AND SCREEN

- **DOES SC50-22 HAVE POWER**
  - Y: CHECK FOR GROUND
  - N: IS FUSE BLOWN

- **IS FUSE BLOWN**
  - Y: REPAIR GROUND FAULT GONE
  - N: REPAIR DAMAGED CABLE FAULT GONE

- **CHECK FOR GROUND**
  - Y: Y
  - N: NO

- **REPAIR GROUND FAULT GONE**
  - Y: Y
  - N: NO

- **REPAIR DAMAGED CABLE FAULT GONE**
  - Y: Y
  - N: NO

- **DONE RESECURE ANY LOOSE WIRES**
  - Y: RECONNECT CABLE FAULT GONE
  - N: Y

- **RECONNECT CABLE FAULT GONE**
  - Y: Y
  - N: N

- **DOES CABLE OHM OUT**
  - Y: OHM CABLE FROM SC50-22 PIN 4 CAN LO WITH MC 24-10 CAN PIN 4 CAN LO AND CABLE GOING TO THE FRONT
  - N: OHM CABLE FROM SC50-22 PIN 3 CAN HI WITH MC24-10 CAN PIN 3 CAN HI AND CABLE GOING TO THE FRONT
FAULT: SC50-22 SENSOR POWER.
FAULT: SC50-22 SENSOR POWER.

- Replace Turck Block
- Remove Cable J8 from Rear GD turck Block
- Replace Cables for FWD and Reverse PSI Sensor
- Replace Transducer one at a time check Fault
- Replace Steering Cylinder
- Remove Cables from Rear GD Inputs Turck Block
- Replace Cables 721-183183 Propel FWD Does Fault Go Away
- Replace Transducer
- Replace Cables 721-183184 Propel Rev Does Fault Go Away
- Replace Transducer
- Replace Cables 721-183185 Propel Forward Does Fault Go Away
- Replace Transducer
- Secure Loose Wires
- Reinstall All Cables

Y: Yes
N: No
FAULT: PROPEL REVERSE PSI

DONE, INSTALL ALL CABLES, RESECURE ANY LOOSE WIRES

REPLACE REAR GD INPUTS TURCK BLOCK

N

REPLACE TRANSDUCER DOES FAULT GO AWAY

Y

REPLACE CABLE FOR REVERSE PSI DOES FAULT GO AWAY

N

REMOVE J8 CABLE FROM REAR GD INPUTS TURCK Block INSPECT AND REINSTALL AND CABLE DOES FAULT GO AWAY

Y
FAULT: REAR PSI 1

- **REMOVE J5 CABLE FROM REAR GD INPUTS TURCK BLOCK INSPECT AND REINSTALL CABLE DOES FAULT GO AWAY**

  - **N**
    - **REPLACE CABLE 721-183184 REVERSE PSI DOES FAULT GO AWAY**
      - **N**
        - **REPLACE TRANSDUCER DOES FAULT GO AWAY**
          - **N**
            - **REPLACE REAR GD INPUTS TURCK BLOCK**

  - **Y**

    - **DONE, REINSTALL ALL CABLES, RESECURE ANY LOOSE WIRES**
FAULT: FUEL GUAGE SENSOR

1. **REMOVE J4 CABLE FROM LIGHTS SENSORS TURCK BLOCK**
   - Y: Inspect and re-install cable does fault go away
   - N: Replace cable 721-183166 fuel level does fault go away

2. **Replace cable 721-183166 fuel level does fault go away**
   - Y: Inspect and re-install sensor
   - N: Replace coil on fuel gauge does fault go away

3. **Replace coil on fuel gauge does fault go away**
   - Y: Inspect and re-install sensor
   - N: Replace lights sensor turck block

4. **Replace lights sensor turck block**
   - Y: Reinstall all cables and resecure any loose wires

DONE REINSTALL ALL CABLES AND RESECURE ANY LOOSE WIRES
FAULT: STEER SENSOR NOT CALIBRATED

1. **Replace Left Steer Cylinder**
   - If yes (Y), go to step 3.
   - If no (N), go to step 2.

2. **Does the Center Turn Green**
   - If yes (Y), go to step 4.
   - If no (N), go to step 1.

3. **Go into Calibration Screen Turn Machine to the Left Until Green Light Comes On Turn Machine to the Right Till Green Light Comes On Return the Machine to Center**
   - If yes (Y), go to step 5.
   - If no (N), go to step 1.

4. **Go to Password Screen Enter Password 501 Hit Enter Hit Escape**
   - If yes (Y), go to step 6.
   - If no (N), go to step 1.

5. **Done Secure Any Loose Cables**
Fault: Steer Sensor

- Replace GD inputs truck block

- Replace left steer cylinder, does fault go away?
  - Yes
  - No
    - Replace cable, 721-183185, steer sensor, does fault go away?
      - Yes
      - No
        - Remove J7 cable from inputs truck block, inspect and reinstall cable, does fault go away?
          - Yes
          - No
            - Done, reinstall all cables and resecure any loose wires
              - No
FAULT: FRONT LEFT PPU

PLACE MACHINE ON JACK STANDS

INSPECT CABLE FOR TIGHTNESS ON GD DRIVE INPUTS TURCK BLOCK AND FRONT LEFT WHEEL MOTOR

START MACHINE AND LEAVE IDLE IS FAULT PRESENT

PUT MACHINE IN GEAR AND ACCELERATE WITH FOOT PEDAL DOES THE FAULT COME BACK

Y

REPLACE GD DRIVE INPUTS BLOCK

REMOVE J2 FROM GD DRIVE INPUTS BLOCK REPEAT PREVIOUS STEP DOES FAULT GO AWAY

REPLACE CABLE J2 721-183179 LEFT FRONT DOES FAULT GO AWAY

REPLACE LEFT FRONT WHEEL SENSOR

DONE REINSTALL ALL CABLES AND RESECURE ANY LOOSE WIRES REMOVE MACHINE FROM JACK STANDS
FAULT: FRONT RIGHT PPU

1. Place machine on jack stands
2. Inspect cable for tightness on GD drive inputs Turck block and front right wheel motor
3. Start machine and leave idle is fault present
4. Put machine in gear and accelerate with foot pedal does the fault come back

   Y
   
   N
   
   N
   
   Y

   N
   

5. Replace GD drive inputs block
6. Remove J1 from GD drive inputs block repeat previous step does fault go away
7. Replace cable J1 721-183180 right front does fault go away
8. Replace right front wheel sensor
9. Done reinstall all cables and resecure any loose wires remove machine from jack stands
FAULT: PTO CLUTCH VALVE

1. Remove J4 cable from manifold. Outputs Turck block. Turn key on. Does fault go away?
   - Yes: Reinstall cable and cycle key. Energize PTO function. Does fault come on?
     - Yes: Replace cable 721-183188. PTO clutch. Repeat previous step. Does fault go away?
       - Yes: Replace coil on PTO clutch cartridge.
       - No: Done! Reinstall all cables and resecure any loose wires.
     - No: Replace manifolds outputs Turck block.
   - No: Replace manifolds outputs Turck block.
FAULT: GROUND DRIVE HIGH SPEED VALVE

1. **REPLACE COIL ON GD HIGH SPEED CARTIDGE**
   - Y: **REINSTALL CABLE AND CYCLE KEY ENERGIZE HIGH SPEED FUNCTION DOES FAULT COME ON**
   - N: **PREVIOUS STEP DOES FAULT GO AWAY**
   - Y: **REPLACE CABLE 723-183189**
   - N: **REPLACE MANIFOLDS OUTPUTS TURN 3 KEY BLOCK ON DOES GO AWAY**
   - N: **REPLACE MANIFOLDS OUTPUTS TURCK BLOCK**

2. **REMOVE 12 CABLE FROM MANIFOLD**
   - Y: **DONE REINSTALL ALL CABLES AND RESCURE ANY LOOSE WIRES**
   - N: **REINSTALL CABLE AND CYCLE KEY ENERGIZE HIGH SPEED FUNCTION DOES FAULT COME ON**
FAULT: REAR END CONNECTOR 5

1. **Is anything installed on the rear connector?**
   - **Yes:** Remove seven-way plug and any attachments that are selected on the screen. Does fault go away?
   - **No:** Inspect cable on the attachment. Repair any damages.

2. **Inspect rear, receptacle, and cable. Repair any damages.**
   - **Yes:** Done. Resecure any loose wires.
   - **No:** Repeat the process from step 1.
Fault: Park Brake Valve

1. Remove J6 cable from manifold. Outputs: Turck block turn key on. Does fault go away?
   - Yes: Reinstall cable and cycle key. Energize park brake function. Does fault come on?
     - Yes: Replace cable 721-183192 parking brake repeat previous step. Does fault go away?
       - Yes: Replace coil on parking brake cartridge.
       - No: Replace manifolds outputs: Turck block.
     - No: Replace manifolds outputs: Turck block.
   - No: Reinstall all cables and resecure any loose wires.

DONE
FAULT: REAR END CONNECTOR 4

1. IS ANYTHING INSTALLED ON THE SEVEN WAY REAR CONNECTOR
   - N: INSPECT REAR RECEPTICLE AND CABLE REPAIR ANY DAMAGES
   - Y: REMOVE SEVEN WAY PLUG AWAY AND ANY ATTACHMENTS THAT ARE SELECTED ON THE SCREEN DOES FAULT GO AWAY

2. REMOVE SEVEN WAY PLUG AWAY AND ANY ATTACHMENTS THAT ARE SELECTED ON THE SCREEN DOES FAULT GO AWAY
   - N: INSPECT CABLE ON THE ATTACHMENT REPAIR ANY DAMAGES
   - Y: DONE RESECURE ANY LOOSE WIRES
FAULT: FRONT RIGHT ASC VALVE

1. Place machine on jack stands
2. Remove J5 cable from GD outputs TURCK block turn key on does fault go away
3. Replace ground drive outputs TURCK block
4. Reinstall cable and start machine energize foot pedal does fault come on
5. Replace cable 721-183197 RF ASC valve repeat previous step does fault go away
6. Replace coil on RF ASC cartridge
7. Done reinstall all cables and resecure any loose wires remove machine from jack stands
FAULT: REAR LEFT ASC VALVE

- Replace ground drive outputs turnkey on does fault go away?
  - Yes → Reinstall cable and start machine; does fault come on?
    - Yes → Repeat previous step; does fault go away?
      - Yes → REPLACE CABLE 721-183196 LR ASC VALVE
      - No → Replace coil on LR ASC cartridge
    - No → Replace J3 cable from gun outputs turnkey off does fault go away?
      - Yes → Place machine on jack stands
      - No → Replace ground drive outputs turnkey on does fault go away?

- Remove J3 cable from gun outputs turnkey off does fault go away?
  - No → Place machine on jack stands

- Check all cables and resecure any loose wires; remove machine from jack stands

DONE
FAULT: REAR RIGHT ASC VALVE

1. PLACE MACHINE ON JACK STANDS
2. REMOVE J7 CABLE FROM GD OUTPUTS TURCK BLOCK TURN KEY ON DOES FAULT GO AWAY
3. REPLACE GROUND DRIVE OUTPUTS TURCK BLOCK
   - Y: REINSTALL CABLE AND START MACHINE ENERGIZE FOOT PEDAL DOES FAULT COME ON
   - N: REPLACE CABLE 721-183198 RR ASC VALVE REPEAT PREVIOUS STEP DOES FAULT GO AWAY
      - Y: REPLACE COIL ON RR ASC CARTIDGE
      - N: DONE REINSTALL ALL CABLES AND RESECURE ANY LOOSE WIRES REMOVE MACHINE FROM JACK STANDS
   - N: PLACE MACHINE ON JACK STANDS
FAULT: FLOAT LOCKING VALVE

1. REMOVE J8 CABLE FROM MANIFOLD OUTPUTS TURCK BLOCK TURN KEY ON DOES FAULT GO AWAY
   - N
   - Y REINSTALL CABLE AND CYCLE KEY ENERGIZE FLOAT FUNCTION DOES FAULT COME ON
   - N
   - Y REPLACE CABLE 721-183199 FLOAT REPEAT PREVIOUS STEP DOES FAULT GO AWAY
   - N
   - Y REPLACE COIL ON FLOAT CARTIDGE
2. REPLACE MANIFOLDS OUTPUTS TURCK BLOCK
   - N
   - Y DONE REINSTALL ALL CABLES AND RESECURE ANY LOOSE WIRES
FAULT: WEIGHT TRANSFER

- **REMOVE J6 CABLE FROM GD OUTPUTS TURCK BLOCK TURN KEY ON**
  - **YES:** REINSTALL CABLE AND CYCLE KEY ENERGIZE WEIGHT TRANSFER
  - **NO:** DOES FAULT COME ON
- **NO:** REPLACE GD OUTPUTS TURCK BLOCK
- **YES:** REPLACE CABLE 721-183192 WEIGHT TRANSFER REPEAT PREVIOUS STEP DOES FAULT GO AWAY
- **NO:** REPLACE COIL ON WEIGHT TRANSFER CARTIDGE
- **Done: REINSTALL ALL CABLES AND RESECURE ANY LOOSE WIRES**
FRONT CONTROL FAULTS

FAULT: MC24-20 CAN

- Inspect cable for damage between the SC50-22, MC24-SC50-22, and rear cable CAN 0.
- Check for ground.
- Repair damaged cable, fault gone.
- Yes: Does MG38-10 have power?
- No: Does MG38-10 cable plugged into MG38-10?
- Yes: Plug cable in, fault gone.
- No: Replace fuse, fault gone.
- Yes: Repair ground, fault gone.
- Yes: OHM cable from SC50-22 pin 3 can Hi with MC24-20 can pin 3 can Hi and rear cable CAN 0.
- No: OHM cable from SC50-22 pin 4 can Lo with MC24-20 can pin 4 can Lo and rear cable CAN 0.
- Yes: Does cable OHM out?
- Yes: Reconnect cable, fault gone.
- No: Yes: Secure loose wires.
- No: Yes: Secure loose wires.
- Yes: Yes: Secure loose wires.
FAULT: PUMP FWD PWM

PLACE MACHINE ON JACKSTANDS

REMOVE J2 CABLE FROM GD OUTPUTS TURCK BLOCK TURN KEY ON DOES FAULT GO AWAY

REPLACE GROUND DRIVE OUTPUTS TURCK BLOCK

Y

REINSTALL CABLE AND START MACHINE ENERGIZE FOOT PEDAL DOES FAULT COME ON

REPLACE CABLE 721-183193 PUMP FWD EDC REPEAT PREVIOUS STEP DOES FAULT GO AWAY

N

REPLACE COIL ON PUMP

Y

DONE REINSTALL ALL CABLES AND RESECURE ANY LOOSE WIRES

N
FAULT: PROPEL 2 FORWARD EDC

1. Place machine on jackstands
2. Replace cable from pump to turnkey. Does fault go away?
   - Yes: Go to next step
   - No: Replace MC24-20
3. Replace coil pump
4. Replace cable to pump. Repeat previous step. Does fault go away?
   - Yes: Reinstall cable and start machine. Does fault come on?
   - No: Remove cable from pump. Turn key on. Does fault go away?
5. Do replace all cables and resecure any loose wires.
FAULT: PROPEL 2 REVERSE PWM

PLACE MACHINE ON JACKSTANDS

REMOVE CABLE FROM PUMP TURN KEY ON DOES FAULT GO AWAY

REPLACE MC24-20

Y

REINSTALL CABLE AND START MACHINE ENERGIZE FOOT PEDAL DOES FAULT COME ON

Y

REPLACE CABLE GOING TO PUMP REPEAT PREVIOUS STEP DOES FAULT GO AWAY

N

REPLACE COIL PUMP

N

DONE REINSTALL ALL CABLES AND RESECURE ANY LOOSE WIRES
FAULT: VALVE AUX 4A PWM

- REMOVE J7 CABLE FROM MANIFOLD OUTPUTS TURCK BLOCK TURN KEY ON DOES FAULT GO AWAY
  - N
  - Y
  - Y
  - N

- REPLACE MANIFOLD OUTPUTS TURCK BLOCK
  - N

- REINSTALL CABLE AND CYCLE KEY ENERGIZE AUX 4A FUNCTION DOES FAULT COME ON
  - Y
  - N

- REPLACE CABLE 721-183206 AUX 4A REPEAT PREVIOUS STEP DOES FAULT GO AWAY
  - Y
  - N

- REPLACE COIL ON AUX 4A CARTIDGE
  - Y

DONE REINSTALL ALL CABLES AND RESECURE ANY LOOSE WIRES
FAULT: VALVE AUX 4B PWM

- **REMOVE J5 CABLE FROM MANIFOLD OUTPUTS TURCK BLOCK TURN KEY ON**
  - **DOES FAULT GO AWAY?**
    - **Y**: REINSTALL CABLE AND CYCLE KEY ENERGIZE AUX 4 B FUNCTION DOES FAULT COME ON
    - **N**: REPLACE CABLE 721-183205 AUX 4B REPEAT PREVIOUS STEP DOES FAULT GO AWAY
  - **N**: REPLACE MANIFOLD OUTPUTS TURCK BLOCK

- **Y**: REINSTALL ALL CABLES AND RESECURE ANY LOOSE WIRES
FAULT: VALVE AUX 5B PWM

DONE REINSTALL ALL CABLES AND RESECURE ANY LOOSE WIRES

REPLACE COIL ON AUX 5B CARTRIDGE

REPLACE CABLE 721-183203 AUX 5B TRADE MORE

REINSTALL CABLE AND CYCLE KEY 5B FUNCTION DOES FAULT COME ON

REPLACE MANIFOLD OUTPUTS TURCK BLOCK TURN KEY ON DOES FAULT GO AWAY

REMOVE 11 CABLE FROM MANIFOLD OUTPUTS TURCK BLOCK TURN KEY ON DOES FAULT GO AWAY
PLUS 1 REAR FAULTS
REAR MVEC FAULTS
REAR MVEC FAULTS

FAULT: REAR MVEC CAN

- IS CAN 1 CABLE PLUGGED INTO REAR MVEC
  - Y: DOES REAR MVEC HAVE POWER
  - N: INSPECT CABLE FOR DAMAGE BETWEEN THE SC50-20 CUMMINS ENGINE AND REAR MVEC
  - N: PLUG CABLE IN FAULT GONE
- IS FUSE BLOWN
  - N: REPAIR GROUND FAULT GONE
  - Y: REPAIR DAMAGED CABLE FAULT GONE
- REPLACE FUSE FAULT GONE
  - N: RECONNECT CABLE FAULT GONE
  - Y: DOES CABLE OHM OUT
- DOES CABLE OHM OUT
  - N: OHM CABLE FROM SC50 20 PIN 21 CAN LO WITH ENGINE CAN PIN 47 CAN LO AND MVEC PIN 12 CAN LO
  - Y: OHM CABLE FROM SC50 20 PIN 20 CAN HI WITH ENGINE CAN PIN 46 CAN HI AND MVEC PIN 6 CAN HI
- DONE RESECURE ANY LOOSE WIRES
  - Y: N: N: Y:
Fault: AC Clutch Fuse 1

1. Is fuse 1 blown? Y/N
   - Y: Replace fuse 1 does fuse blow? Y/N
     - Y: Replace relay 1 does the fuse blow? Y/N
       - Y: Reinstall relay 1 remove connector on AC clutch. Does fuse blow? Y/N
         - Y: Replace AC clutch.
         - N: Replace wire on the black MVEC connector pin D and AC clutch.
     - N: Is fault gone? Y/N
       - Y: Done resecure any loose wires.
       - N: Replace MVEC.
   - N: Is fault gone? Y/N
     - Y: Done resecure any loose wires.
     - N: Replace AC clutch.
FAULT: AC CLUTCH RELAY 1

1. Replace MVEC
   - N
   - Y

2. Does fault go away?
   - Y
   - N

   Replace relay with new relay
   - Y
   - N

   Inspect relay to see that it did not get moved from MVEC
   - Y
   - N

   Remove and reinstall relay - does fault go away?
   - Y
   - N

   Done
FAULT: OEM POWER FUSE 4

- **Is fuse blown?**
  - **Yes:**
    - **Replace fuse 4.**
    - **Does fuse blow?**
      - **Yes:**
        - **Replace MVEC.**
        - **If fault gone:**
          - **Yes:**
            - **Done.**
            - **Resecure any loose wires.**
          - **No:**
            - **Replace the black MVEC plug pin B and OEM connector.**
      - **No:**
        - **Replace relay 2.**
        - **Remove OEM power plug.**
        - **Does the fuse blow?**
          - **Yes:**
            - **Replace MVEC.**
            - **If fault gone:**
              - **Yes:**
                - **Done.**
                - **Resecure any loose wires.**
              - **No:**
                - **Replace on black MVEC plug pin B and OEM connector.**
          - **No:**
            - **Reinstall relay.**
            - **Remove OEM power plug.**
            - **Does the fuse blow?**
              - **Yes:**
                - **Replace MVEC.**
                - **If fault gone:**
                  - **Yes:**
                    - **Done.**
                    - **Resecure any loose wires.**
                  - **No:**
                    - **Replace on black MVEC plug pin B and OEM connector.**
              - **No:**
                - **Call Cummins.**
FAULT: OEM POWER RELAY 2

1. **Inspect Relay to See That It Did Not Get Moved From MVEC**
   - **Y**: Continue to next step
   - **N**: **Replace Relay With New Relay**

2. **Replace Relay With New Relay**
   - **Y**: Continue to next step
   - **N**: **Inspect Relay to See That It Did Not Get Moved From MVEC**

3. **Remove and Reinstall Relay Does Fault Go Away**
   - **Y**: **Done**
   - **N**: **Replace MVEC**
FAULT: OEM PLUG RELAY 3

1. **REPLACE MVEC**
   - **DOES FAULT GO AWAY?**
     - **Y**
       - **DONE**
     - **N**
       - **REPLACE RELAY WITH NEW RELAY**
       - **INSPECT RELAY TO SEE THAT IT DID NOT GET MOVED FROM MVEC**
         - **Y**
           - **REPLACE RELAY WITH NEW RELAY**
           - **DONE**
         - **N**
           - **REMOVE AND REINSTALL RELAY DOES FAULT GO AWAY**
             - **Y**
               - **DONE**
             - **N**
               - **REPLACE RELAY WITH NEW RELAY**
               - **DONE**
FAULT: BACK UP ALARM RELAY 4

1. **REPLACE MVEC**
   - N

2. **DOES FAULT GO AWAY**
   - Y

3. **REPLACE RELAY WITH NEW RELAY**
   - N
   - Y

4. **INSPECT RELAY TO SEE THAT IT DID NOT GET MOVED FROM MVEC**
   - Y
   - N

5. **REMOVE AND REINSTALL RELAY DOES FAULT GO AWAY**
   - N
   - Y

6. **DONE**
FAULT: REAR CONNECTOR 6 FUSE 8

1. IS FUSE BLOWN?
   - Y: DONE
   - N: REPLACE FUSE 8

2. DOES FUSE BLOW?
   - Y: REPLACE FUSE 8
   - N: REINSTALL RELAY 5

3. REMOVE RELAY 5
   - Y: REPLACE RELAY 5
   - N: DOES THE FUSE BLOW?

4. REPLACE RELAY 5
   - Y: REPLACE RELAY 5
   - N: REINSTALL RELAY

5. REPLACE WIRE ON BLACK MVEC CONNECTOR PIN A AND REAR CONNECTOR PIN 6 WIRE #6

6. IS FAULT GONE?
   - Y: DONE
   - N: RESecure ANY LOOSE WIRES
FAULT: REAR CONNECTOR 6 RELAY 5

1. Replace MVEC

2. Does fault go away?
   - Yes: Done
   - No: Replace relay 5 with new relay

3. Replace relay 5 with new relay

4. Inspect relay to see if it did not get moved from MVEC
   - Yes: Replace relay 5 with new relay
   - No: Remove and reinstall relay. Does fault go away?

5. Remove and reinstall relay. Does fault go away?
   - Yes: Done
   - No: Replace MVEC
FAULT: REAR CONNECTOR 2 FUSE 6


FAULT: REAR CONNECTOR PIN 2 RELAY 6

1. **REPLACE MVEC**
   - **N**
   - **Y**

2. **DOES FAULT GO AWAY**
   - **Y**
   - **N**

3. **REPLACE RELAY WITH NEW RELAY**
   - **N**
   - **Y**

4. **INSPECT RELAY TO SEE THAT IT DID NOT GET MOVED FROM MVEC**
   - **N**
   - **Y**

5. **REMOVE AND REINSTALL RELAY**
   - **Y**
   - **N**

6. **DONE**

Flowchart steps:
- **REPLACE MVEC** (Y/N)
- **DOES FAULT GO AWAY** (Y/N)
- **REPLACE RELAY WITH NEW RELAY** (N/Y)
- **INSPECT RELAY TO SEE THAT IT DID NOT GET MOVED FROM MVEC** (Y/N)
- **REMOVE AND REINSTALL RELAY** (Y/N)

The flowchart concludes with **DONE**.
FAULT: REAR CONNECTOR PIN 3 FUSE 3

- **IS FUSE BLOWN**
  - Y: REPLACE FUSE 3 DOES FUSE BLOW
  - N: REINSTALL RELAY REMOVE REAR CONNECTOR PIN 3

- **REPLACE FUSE 3 DOES FUSE BLOW**
  - Y: REMOVE RELAY 7 DOES THE FUSE BLOW
  - N: DOES FUSE BLOW

- **REPLACE RELAY 7 DOES THE FUSE BLOW**
  - Y: REPLACE MVEC
  - N: IS FAULT GONE

- **IS FAULT GONE**
  - N: REPLACE MVEC

- **REPLACE MVEC**
  - Y: REPLACE WIRE ON BLACK MVEC CONNECTOR PIN F AND REAR CONNECTOR PIN 3, WIRE #3
  - N: Y: DONE RESECURE ANY LOOSE WIRES

- **DOES FUSE BLOW**
  - N: REPLACE REAR CONNECTOR
FAULT: REAR CONNECTOR PIN 3 RELAY 7

- **Replace MVEC**
  - **Does fault go away**
    - **Yes**
      - **Remove and reinstall relay; does fault go away**
        - **Yes**
          - **Done**
        - **No**
          - **Inspect relay to see that it did not get moved from MVEC**
      - **No**
        - **Replace relay with new relay**
          - **Yes**
            - **Remove and reinstall relay; does fault go away**
              - **Yes**
                - **Done**
              - **No**
                - **Replace MVEC**
FAULT: ENGINE START RELAY FUSE 5

- IS FUSE BLOWN
  - Y: REPLACE FUSE 5 DOES FUSE BLOW
  - N: IS FAULT GONE
    - N: REPLACE MVEC
      - Y: DONE RESECURE ANY LOOSE WIRES
    - Y: REPLACE WIRE ON BLACK MVEC CONNECTOR PIN H AND STARTER SOLENOID CONNECTOR
  - N: REMOVE RELAY 8 DOES THE FUSE BLOW
    - Y: REINSTALL RELAY REMOVE WIRE CONNECTOR FROM STARTER SOLENOID
    - N: DOES FUSE BLOW
      - Y: REPLACE STARTER SOLENOID
FAULT: ENGINE START RELAY 8

- **REPLACE MVEC**
  - N
  - **DOES FAULT GO AWAY**
    - Y
    - **REPLACE RELAY WITH NEW RELAY**
      - Y
      - **INSPECT RELAY TO SEE THAT IT DID NOT GET MOVED FROM MVEC**
        - N
        - **REPLACE MVEC**
          - Y
          - **REMOVEL AND REINSTALL RELAY DOES FAULT GO AWAY**
            - N
            - **DONE**
            - Y
FAULT: KEY ON FUSE 9

1. IS FUSE BLOWN
   - Y: REPLACE FUSE 9
   - N: DOES THE ENGINE START

2. DOES THE ENGINE START
   - Y: DONE
   - N: RESECURE ANY LOOSE WIRES

3. REMOVE WIRE CONNECTOR FROM CUMMINS 50 PIN
   - Y: REPLACE WIRE ON GRAY MVEC CONNECTOR PIN D AND CUMMINS 50 PIN CONNECTOR PIN 39
   - N: DOES FUSE BLOW

4. DOES FUSE BLOW
   - Y: CALL CUMMINS 5 FOR MORE HELP
   - N: Y
FAULT: SC50-22 MAIN FUSE 11

IS FUSE BLOWN

REPLACE FUSE 11 DOES FUSE BLOW

IS FAULT GONE

REPLACE WIRE ON GREY MVEC CONNECTOR PIN G AND SC50 -20 CONNECTOR PINS 2 DOES FUSE BLOW

DONE RESECURE ANY LOOSE WIRES

REPLACE MVEC

REINSTALL SC 50 ELECTRICAL CONNECTOR

DOES FUSE BLOW

REPLACE SC50 20 CONTROLLER
FAULT: SC50-22 PINS 47 & 48 FUSE 12

1. IS FUSE BLOWN
   - Y: REPLACE FUSE 12 DOES FUSE BLOW
     - Y: REMOVE SC50 ELECTRICAL CONNECTOR DOES THE FUSE BLOW
       - N: REINSTALL SC 50 ELECTRICAL CONNECTOR
         - N: DOES FUSE BLOW
           - N: REPLACE SC 50-22 CONTROLLER
           - Y: REPLACE MVEC
     - N: IS FAULT GONE
       - N: REPLACE WIRE ON GREY MVEC CONNECTOR PIN H AND SC50-22 CONNECTOR PINS 47 AND PINS 48 DOES FUSE BLOW
         - Y: DONE RESECURE ANY LOOSE WIRES
   - N: Y: IS FAULT GONE
       - N: RESECURE ANY LOOSE WIRES
       - Y: DONE RESECURE ANY LOOSE WIRES
FAULT: MC50-20 PINS 49 & 50 FUSE 13

1. IS FUSE BLOWN
   - Y: REPLACE FUSE 12 DOES FUSE BLOW
     - Y: REMOVE SC50 ELECTRICAL CONNECTOR DOES THE FUSE BLOW
       - Y: DOES FUSE BLOW
         - Y: REPLACE SC50-22 CONTROLLER
         - N: REPLACE MVEC
       - N: REINSTALL SC 50 ELECTRICAL CONNECTOR
         - Y: DOES FUSE BLOW
         - N: REPLACE MVEC
     - N: IS FAULT GONE
       - Y: REPLACE WIRE ON GREY MVEC CONNECTOR PIN H AND SC50 -22 CONNECTOR PINS 49 AND PINS 50 DOES FUSE BLOW
       - N: REINSTALL SC50 ELECTRICAL CONNECTOR
         - Y: DOES FUSE BLOW
         - N: REPLACE MVEC
   - N: IS FAULT GONE
     - Y: REPLACE WIRE ON GREY MVEC CONNECTOR PIN H AND SC50 -22 CONNECTOR PINS 49 AND PINS 50 DOES FUSE BLOW
     - N: REINSTALL SC 50 ELECTRICAL CONNECTOR
       - Y: DOES FUSE BLOW
       - N: REPLACE MVEC
2. DONE RESECURE ANY LOOSE WIRES
FAULT: POWER TO SENSORS  LIGHTS SENSOR TURCK BLOCK FUSE 14

1. IS FUSE BLOWN
   - Y: REPLACE FUSE 14 DOES FUSE BLOW
   - N: IS FAULT GONE
     - N: IS FAULT GONE
       - N: DONE RESECURE ANY LOOSE WIRES
       - Y: REPLACE CABLE 721-183166 FUEL SENSOR
     - Y: REMOVE ELECTRICAL CONNECTOR FROM J4 ON TURCK BLOCK DOES THE FUSE BLOW
   - Y: REMOVE ELECTRICAL CONNECTOR FROM J3 ON TURCK BLOCK DOES THE FUSE BLOW

2. REMOVE ELECTRICAL CONNECTOR FROM J1 ON TURCK BLOCK DOES THE FUSE BLOW
   - Y: REPLACE GREY ELECTRICAL CONNECTOR FROM MVEC DOES THE FUSE BLOW
   - Y: REPLACE WIRE ON GREY MVEC CONNECTOR PIN F AND BROWN POWER WIRE TO THE TURCK BLOCK LIGHT SENSOR
   - N: REPLACE MVEC
FAULT: REAR CONNECTOR PIN 1 FUSE 15

1. REUSE REAR MVEC
   Y
   N
   REMOVE WIRE #1 FROM SEVEN WAY CONNECTOR DOES FUSE BLOW
   Y
   N
   REPLACE FUSE 15 DOES FUSE BLOW
   Y
   N
   IS FUSE BLOWN
   Y
   N
   IS FAULT GONE
   Y
   N
   DONE RESEURE ANY LOOSE WIRES
FAULT: MC2420 POWER FUSE 16

- Does fuse blow?
  - No: Reinstall electrical connections in pin connectors and reinstall.
  - Yes: Replace MC2420.

- Remove pin 11 and 12 on black plug of MC2420.
  - Does the fuse blow?
    - No: Replace MVEC.
    - Yes: Replace wire from grey plug pin A on MVEC and pin 11 and 12 black plug on MC2420.

- Remove pin 2 from grey plug on MC2420.
  - Does the fuse blow?
    - No: Replace wire from grey plug pin A on MVEC and pin 2 grey plug on MC2420.
    - Yes: Replace fuse 16.

- Is fuse blown?
  - Yes: Resecure any loose wires.
  - No: Replace fuse 16.

- Is fault gone?
  - Yes: Done.
  - No: Repeat process.
MSV FLOW DIAGRAM
MSV AUX
MSV 2,3,3.5 AUXILIARY HYDRAULIC FLOW SCHEMATIC 06/24/16
FRONT HITCH CARTIDGE ACTIVATED TO UP POSITION. LOAD SENSE SIGNAL FROM CHECK VALVE CK2 ACTIVATES AUXILIARY PUMP. FLOW LEAVES AUXILIARY PUMP AND GOES INTO LOW PRESSURE MANIFOLD. LEAVES LOW PRESSURE MANIFOLD AND ENTERS AUXILIARY MANIFOLD AT THE P PORT. FLOW GOES OVER CHECK VALVE CK 6. FLOW ENTERS PORT 5 ON FRONT HITCH CARTIDGE AND LEAVES PORT2 ON CARTIDGE. FLOW ENTERS SV4 (HOLDING CHECK VALVE ) AND LEAVES GOING TO THE ROD SIDE OF THE LIFT CYLINDERS. RETURN FLOW LEAVES BASE END OF THE CYLINDERS AND ENTERS FRONT HITCH CARTIDGE AT PORT 4. THE RETURN FLOW LEAVES PORT 3 FRONT HITCH CARTIDGE AND LEAVES AUXILIARY MANIFOLD PORT R TO HYDRAULIC COOLER. THE RETURN OIL GOES THROUGH THE RETURN FILTER BEFORE RETURNING TO TANK.

TROUBLE SHOOTING
FRONT HITCH WONT GO UP.
1. JOYSTICK NOT CALIBRATED
2. FAULT ON FRONT HITCH COIL
3. HITCH LOCKING VALVE SV4 STUCK
4. FRONT HITCH CARTIDGE BAD
5. FRONT HITCH UP COIL BAD
6. CYLINDER PISTON BYPASSING
7. BLOWN HOSE
8. NO LOAD SENSE SIGNAL
9. OTHER FAULTS ON SCREEN
FRONT HITCH CARTIDGE ACTIVATED TO DOWN POSITION. LOAD SENSE SIGNAL FROM CHECK VALVE CK2 ACTIVATES AUXILARY PUMP. FLOW LEAVES AUXILARY PUMP AND GOES INTO LOW PRESSURE MANIFOLD. LEAVES LOW PRESSURE MANIFOLD AND ENTERS AUXILARY MANIFOLD AT THE P PORT. FLOW GOES OVER CHECK VALVE CK 6. FLOW ENTERS PORT 5 ON FRONT HITCH CARTIDGE AND LEAVES PORT 4 ON CARTIDGE. FLOW ENTERS SV4 (HOLDING CHECK VALVE ) AND LEAVES GOING TO THE ROD SIDE OF THE LIFT CYLINDERS. RETURN FLOW LEAVES BASE END OF THE CYLINDERS AND ENTERS FRONT HITCH CARTIDGE AT PORT 2. THE RETURN FLOW LEAVES PORT 3 FRONT HITCH CARTIDGE AND LEAVES AUXILARY MANIFOLD PORT R TO HYDRAULIC COOLER. THE RETURN OIL GOES THROUGH THE RETURN FILTER BEFORE RETURNING TO TANK.

TROUBLE SHOOTING
FRONT HITCH WONT GO UP.
1. JOYSTICK NOT CALIBRATED
2. FAULT ON FRONT HITCH COIL
3. HITCH LOCKING VALVE SV4 STUCK
4. FRONT HITCH CARTIDGE BAD
5. FRONT HITCH DOWN COIL BAD
6. CYLINDER PISTON BYPASSING
7. BLOWN HOSE
8. NO LOAD SENSE SIGNAL
9. OTHER FAULTS ON SCREEN
AUX 1 CARTIDGE ACTIVATED TO A POSITION. LOAD SENSE SIGNAL FROM CHECK VALVE CK3 ACTIVATES AUXILARY PUMP. FLOW LEAVES AUXILARY PUMP AND GOES INTO LOW PRESSURE MANIFOLD. LEAVES LOW PRESSURE MANIFOLD AND ENTERS AUXILARY MANIFOLD AT THE P PORT. FLOW GOES OVER CHECK VALVE CK 7. FLOW ENTERS PORT 5 ON AUX 1 CARTIDGE AND LEAVES PORT 4 ON CARTIDGE. FLOW ENTERS ATTACHMENT. RETURN FLOW LEAVES ATTACHMENT ENTERING AUX 1B. FLOW ENTERS AUX 1 CARTIDGE AT PORT 2. THE RETURN FLOW LEAVES PORT 3 AUX 1 CARTIDGE AND LEAVES AUXILARY MANIFOLD PORT R TO HYDRAULIC COOLER. THE RETURN OIL GOES THROUGH THE RETURN FILTER BEFORE RETURNING TO TANK.

TROUBLE SHOOTING

AUX 1A WIL NOT ENERGIZE.

1. JOYSTICK NOT CALIBRATED
2. FAULT ON AUX 1
3. AUX 1 CARTIDGE BAD
4. AUX 1A COIL BAD
5. AUX 1A NOT ENERGIZED ON JOYSTICK SET UP SCREEN
6. BLOWN HOSE
7. NO LOAD SENSE SIGNAL
8. OTHER FAULTS ON SCREEN
9. ATTACHMENT SETUP SCREEN 1A SET AT 50% OR LOWER
AUX 1 CARTIDGE ACTIVATED TO B POSITION. LOAD SENSE SIGNAL FROM CHECK VALVE CK3 ACTIVATES AUXILIARY PUMP. FLOW LEAVES AUXILIARY PUMP AND GOES INTO LOW PRESSURE MANIFOLD. LEAVES LOW PRESSURE MANIFOLD AND ENTERS AUXILIARY MANIFOLD AT THE P PORT. FLOW GOES OVER CHECK VALVE CK 7. FLOW ENTERS PORT 5 ON AUX 1 CARTIDGE AND LEAVES PORT 2 ON CARTIDGE. FLOW ENTERS ATTACHMENT. RETURN FLOW LEAVES ATTACHMENT ENTERING AUX 1A. FLOW ENTERS AUX 1 CARTIDGE AT PORT 4. THE RETURN FLOW LEAVES PORT 3 AUX 1 CARTIDGE AND LEAVES AUXILIARY MANIFOLD PORT R TO HYDRAULIC COOLER. THE RETURN OIL GOES THROUGH THE RETURN FILTER BEFORE RETURNING TO TANK.

TROUBLE SHOOTING

AUX 1B WIL NOT ENERGIZE.

1. JOYSTICK NOT CALIBRATED
2. FAULT ON AUX 1
3. AUX 1 CARTIDGE BAD
4. AUX 1B COIL BAD
5. AUX 1B NOT ENERGIZED ON JOYSTICK SET UP SCREEN
6. BLOWN HOSE
7. NO LOAD SENSE SIGNAL
8. OTHER FAULTS ON SCREEN
9. ATTACHMENT SETUP FOR AUX 1B SET AT 50% OR LOWER
AUX 2 CARTIDGE ACTIVATED TO A POSITION. LOAD SENSE SIGNAL FROM CHECK VALVE CK1 ACTIVATES AUXILIARY PUMP. FLOW LEAVES AUXILIARY PUMP AND GOES INTO LOW PRESSURE MANIFOLD. LEAVES LOW PRESSURE MANIFOLD AND ENTERS AUXILIARY MANIFOLD AT THE P PORT. FLOW GOES OVER CHECK VALVE CK 5. FLOW ENTERS PORT 5 ON AUX 2 CARTIDGE AND LEAVES PORT 4 ON CARTIDGE. FLOW ENTERS ATTACHMENT. RETURN FLOW LEAVES ATTACHMENT ENTERING AUX 2B. FLOW ENTERS AUX 2 CARTIDGE AT PORT 4. THE RETURN FLOW LEAVES PORT 3 AUX 2 CARTIDGE AND LEAVES AUXILIARY MANIFOLD PORT R TO HYDRAULIC COOLER. THE RETURN OIL GOES THROUGH THE RETURN FILTER BEFORE RETURNING TO TANK.

TROUBLE SHOOTING

AUX 2A WIL NOT ENERGIZE.

1. JOYSTICK NOT CALIBRATED
2. FAULT ON AUX 2
3. AUX 2 CARTIDGE BAD
4. AUX 2A COIL BAD
5. AUX 2A NOT ENERGIZED ON JOYSTICK SET UP SCREEN
6. BLOWN HOSE
7. NO LOAD SENSE SIGNAL
8. OTHER FAULTS ON SCREEN
9. ATTACHMENT SETUP SCREEN AUX2 A SET AT 50 % OR LOWER.
AUX 2 CARTIDGE ACTIVATED TO B POSITION. LOAD SENSE SIGNAL FROM CHECK VALVE CK3 ACTIVATES AUXILARY PUMP. FLOW LEAVES AUXILARY PUMP AND GOES INTO LOW PRESSURE MANIFOLD. LEAVES LOW PRESSURE MANIFOLD AND ENTERS AUXILARY MANIFOLD AT THE P PORT. FLOW GOES OVER CHECK VALVE CK 5. FLOW ENTERS PORT 5 ON AUX 2 CARTIDGE AND LEAVES PORT 2 ON CARTIDGE. FLOW ENTERS ATTACHMENT. RETURN FLOW LEAVES ATTACHMENT ENTERING AUX 2A. FLOW ENTERS AUX 2 CARTIDGE AT PORT 4. THE RETURN FLOW LEAVES PORT 3 AUX 1 CARTIDGE AND LEAVES AUXILARY MANIFOLD PORT R TO HYDRAULIC COOLER. THE RETURN OIL GOES THROUGH THE RETURN FILTER BEFORE RETURNING TO TANK.

TROUBLE SHOOTING

AUX 2B WIL NOT ENERGIZE.

1. JOYSTICK NOT CALIBRATED
2. FAULT ON AUX 2
3. AUX 2 CARTIDGE BAD
4. AUX 2B COIL BAD
5. AUX 2B NOT ENERGIZED ON JOYSTICK SET UP SCREEN
6. BLOWN HOSE
7. NO LOAD SENSE SIGNAL
8. OTHER FAULTS ON SCREEN
9. ATTACHMENT SETUP SCREEN AUX 2B SET AT 50% OR LOWER
AUX 3 SPOOL ACTIVATED TO A POSITION. LOAD SENSE SIGNAL FROM CHECK VALVE CK29 ACTIVATES AUXILIARY PUMP. FLOW LEAVES AUXILIARY PUMP AND GOES INTO LOW PRESSURE MANIFOLD. LEAVES LOW PRESSURE MANIFOLD AND ENTERS AUXILIARY MANIFOLD AT THE P PORT. FLOW GOES OVER HDV-2. FLOW ENTERS PORT 3 ON AUX 3 CARTRIDGE AND LEAVES PORT 2 ON CARTRIDGE. FLOW ENTERS ATTACHMENT. RETURN FLOW LEAVES ATTACHMENT ENTERING AUX 3B. FLOW ENTERS AUX 3 SPOOL AT PORT 4. THE RETURN FLOW LEAVES PORT 5 AUX 3 SPOOL AND LEAVES AUXILIARY MANIFOLD PORT R TO HYDRAULIC COOLER. THE RETURN OIL GOES THROUGH THE RETURN FILTER BEFORE RETURNING TO TANK.

TROUBLESHOOTING

AUX 3A WIL NOT ENERGIZE.

1. JOYSTICK NOT CALIBRATED
2. FAULT ON AUX 3
3. AUX 3 SPOOL BAD
4. AUX 3A COIL BAD
5. AUX 3A NOT ENERGIZED ON JOYSTICK SET UP SCREEN
6. BLOWN HOSE
7. NO LOAD SENSE SIGNAL
8. OTHER FAULTS ON SCREEN
AUX 3 SPOOL ACTIVATED TO B POSITION. LOAD SENSE SIGNAL FROM CHECK VALVE CK31 ACTIVATES AUXILIARY PUMP. FLOW LEAVES AUXILIARY PUMP AND GOES INTO LOW PRESSURE MANIFOLD. LEAVES LOW PRESSURE MANIFOLD AND ENTERS AUXILIARY MANIFOLD AT THE P PORT. FLOW GOES OVER HDV-2. FLOW ENTERS PORT 3 ON AUX 3 CARTIDGE AND LEAVES PORT 4 ON CARTIDGE. FLOW ENTERS ATTACHMENT. RETURN FLOW LEAVES ATTACHMENT ENETERING AUX 3A. FLOW ENTERS AUX 3 SPOOL AT PORT 2. THE RETURN FLOW LEAVES PORT 5 AUX 3 SPOOL AND LEAVES AUXILIARY MANIFOLD PORT R TO HYDRAULIC COOLER. THE RETURN OIL GOES THROUGH THE RETURN FILTER BEFORE RETURNING TO TANK.

TROUBLE SHOOTING

AUX 3B WIL NOT ENERGIZE.

1. JOYSTICK NOT CALIBRATED
2. FAULT ON AUX 3
3. AUX 3 SPOOL BAD
4. AUX 3B COIL BAD
5. AUX 3B NOT ENERGIZED ON JOYSTICK SET UP SCREEN
6. BLOWN HOSE
7. NO LOAD SENSE SIGNAL
8. OTHER FAULTS ON SCREEN
AUX 4 CARTIDGE ACTIVATED TO A POSITION. LOAD SENSE SIGNAL FROM CHECK VALVE CK10 LEAVES REAR MANIFOLD. THE LOAD SENSE SIGNAL ENTERS AUXILIARY MANIFOLD THROUGH PORT GE AND LEAVES PORT GA. THIS ACTIVATES THE AUXILIARY PUMP. FLOW LEAVES AUXILIARY PUMP AND GOES INTO LOW PRESSURE MANIFOLD. LEAVES LOW PRESSURE MANIFOLD AND ENTERS AUXILIARY MANIFOLD AT THE P PORT. FLOW LEAVES AUXILIARY MANIFOLD AT PORT NP. FLOW ENTERS REAR MANIFOLD AT PORT NP. FLOW ENTERS PORT 5 ON AUX 4 CARTIDGE AND LEAVES PORT 4 ON CARTIDGE. FLOW ENTERS ATTACHMENT. RETURN FLOW LEAVES ATTACHMENT ENTERING AUX 4B. FLOW ENTERS AUX 4 CARTIDGE AT PORT 2. THE RETURN FLOW LEAVES PORT 3 AUX 4 CARTIDGE. FLOW LEAVES THE REAR MANIFOLD PORT R TO HYDRAULIC COOLER. THE RETURN OIL GOES THROUGH THE RETURN FILTER BEFORE RETURNING TO TANK.

TROUBLE SHOOTING

AUX 4A WIL NOT ENERGIZE.
1. JOYSTICK NOT CALIBRATED
2. FAULT ON AUX 4
3. AUX 4 CARTIDGE BAD
4. AUX 4A COIL BAD
5. AUX 4A NOT ENERGIZED ON JOYSTICK SET UP SCREEN
6. BLOWN HOSE
7. NO LOAD SENSE SIGNAL
8. OTHER FAULTS ON SCREEN
9. ATTACHMENT SETUP SCREEN 4A SET AT 50% OR LOWER
10. MACHINE NOT SET UP WITH REAR HYDRAULICS
AUX 4 CARTIDGE ACTIVATED TO B POSITION. LOAD SENSE SIGNAL FROM CHECK VALVE CK10 LEAVES REAR MANIFOLD. THE LOAD SENSE SIGNAL ENTERS AUXILIARY MANIFOLD THROUGH PORT GE AND LEAVES PORT GA. THIS ACTIVATES THE AUXILIARY PUMP. FLOW LEAVES AUXILIARY PUMP AND GOES INTO LOW PRESSURE MANIFOLD. LEAVES LOW PRESSURE MANIFOLD AND ENTERS AUXILIARY MANIFOLD AT THE P PORT. FLOW LEAVES AUXILIARY MANIFOLD AT PORT NP. FLOW ENTERS REAR MANIFOLD AT PORT NP. FLOW ENTERS PORT 5 ON AUX 4 CARTIDGE AND LEAVES PORT 2 ON CARTIDGE. FLOW ENTERS ATTACHMENT. RETURN FLOW LEAVES ATTACHMENT ENTERING AUX 4B. FLOW ENTERS AUX 4 CARTIDGE AT PORT 4. THE RETURN FLOW LEAVES PORT 3 AUX 4 CARTIDGE. FLOW LEAVES THE REAR MANIFOLD PORT R TO HYDRAULIC COOLER. THE RETURN OIL GOES THROUGH THE RETURN FILTER BEFORE RETURNING TO TANK.

TROUBLE SHOOTING

AUX 4A WIL NOT ENERGIZE.

1. JOYSTICK NOT CALIBRATED
2. FAULT ON AUX 4
3. AUX 4 CARTIDGE BAD
4. AUX 4A COIL BAD
5. AUX 4A NOT ENERGIZED ON JOYSTICK SET UP SCREEN
6. BLOWN HOSE
7. NO LOAD SENSE SIGNAL
8. OTHER FAULTS ON SCREEN
9. ATTACHMENT SETUP SCREEN 4A SET AT 50% OR LOWER
10. MACHINE NOT SET UP WITH REAR HYDRAULICS
AUX 5 CARTIDGE ACTIVATED TO A POSITION. LOAD SENSE SIGNAL FROM CHECK VALVE CK9 LEAVES REAR MANIFOLD. THE LOAD SENSE SIGNAL ENTERS AUXILIARY MANIFOLD THROUGH PORT GE AND LEAVES PORT GA. THIS ACTIVATES THE AUXILIARY PUMP. FLOW LEAVES AUXILIARY PUMP AND GOES INTO LOW PRESSURE MANIFOLD. LEAVES LOW PRESSURE MANIFOLD AND ENTERS AUXILIARY MANIFOLD AT THE P PORT. FLOW LEAVES AUXILIARY MANIFOLD AT PORT NP. FLOW EntERS REAR MANIFOLD AT PORT NP. FLOW EntERS PORT 5 ON AUX 5 CARTIDGE AND LEAVES PORT 2 ON CARTIDGE. FLOW EntERS ATTACHMENT. RETURN FLOW LEAVES ATTACHMENT ENTERS 5B AND ENTERS LOAD HOLDING CARTIDGE SV8. FLOW EntERS AUX 5 CARTIDGE AT PORT 4. THE RETURN FLOW LEAVES PORT 3 AUX 5 CARTIDGE. FLOW LEAVES THE REAR MANIFOLD PORT R TO HYDRAULIC COOLER. THE RETURN OIL GOES THREW THE RETURN FILTER BEFORE RETURNING TO TANK.

TROUBLE SHOOTING

AUX 5A WIL NOT ENERGIZE.

1. JOYSTICK NOT CALIBRATED
2. FAULT ON AUX 5
3. AUX 5 CARTIDGE BAD
4. AUX 5A COIL BAD
5. AUX 5A NOT ENERGIZED ON JOYSTICK SET UP SCREEN
6. BLOWN HOSE
7. NO LOAD SENSE SIGNAL
8. OTHER FAULTS ON SCREEN
9. ATTACHMENT SETUP SCREEN 5A SET AT 50% OR LOWER
10. MACHINE NOT SET UP WITH REAR HYDRAULICS
AUX 5 CARTIDGE ACTIVATED TO B POSITION. LOAD SENSE SIGNAL FROM CHECK VALVE CK9 LEAVES REAR MANIFOLD. THE LOAD SENSE SIGNAL ENTERS AUXILIARY MANIFOLD THROUGH PORT GE AND LEAVES PORT GA. THIS ACTIVATES THE AUXILIARY PUMP. FLOW LEAVES AUXILIARY PUMP AND GOES INTO LOW PRESSURE MANIFOLD. LEAVES LOW PRESSURE MANIFOLD AND ENTERS AUXILIARY MANIFOLD AT THE P PORT. FLOW LEAVES AUXILIARY MANIFOLD AT PORT NP. FLOW ENTERS REAR MANIFOLD AT PORT NP. FLOW ENTERS PORT 5 ON AUX 5 CARTIDGE AND LEAVES PORT 4 ON CARTIDGE. FLOW ENTERS LOAD HOLDING CARTIDGE SV8. LEAVES SV8 AND ENTERS ATTACHMENT. RETURN FLOW LEAVES ATTACHMENT ENTERS 5A. FLOW ENTERS AUX 5 CARTIDGE AT PORT 24. THE RETURN FLOW LEAVES PORT 3 AUX 5 CARTIDGE. FLOW LEAVES THE REAR MANIFOLD PORT R TO HYDRAULIC COOLER. THE RETURN OIL GOES THREW THE RETURN FILTER BEFORE RETURNING TO TANK.

TROUBLE SHOOTING

AUX 5B WILL NOT ENERGIZE.

1. JOYSTICK NOT CALIBRATED
2. FAULT ON AUX 5
3. AUX 5 CARTIDGE BAD
4. AUX 5B COIL BAD
5. AUX 5B NOT ENERGIZED ON JOYSTICK SET UP SCREEN
6. BLOWN HOSE
7. NO LOAD SENSE SIGNAL
8. OTHER FAULTS ON SCREEN
9. ATTACHMENT SETUP SCREEN 5B SET AT 50% OR LOWER
10. MACHINE NOT SET UP WITH REAR HYDRAULICS