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LVSM 7307

**STUDENT OUTLINE**

**MAINTAIN THE MK18A1 ELECTRICAL SYSTEM**

**LEARNING OBJECTIVES:**

1. Terminal Learning Objectives: Given a MK48/18, tools, test equipment, and references, repair a faulty MK18 electrical system, per the references. (3521.13.26)

2. Enabling Learning Objectives:

a. Given a MK48/18A1, tools, test equipment, TM 09470B-20/2, and TM 09470B-34/3, test the MK18A1 electrical system components for serviceability, per the references. (3521.13.26d)

b. Given TM 09470B-20/2, TM 09470B-34/3, and partial statements pertaining to the MK18A1 electrical system, complete the partial statements to describe the procedures used to diagnose a malfunctioning MK18A1 electrical system, per the reference. (3521.13.26e)

c. Given TM 09470B-20/2, TM 09470B-34/3, and partial statements pertaining to the MK18A1 remote control system, complete the partial statements to describe the procedures used to diagnose a malfunctioning MK18A1 remote control system, per the references. (3521.13.26f)

**OUTLINE**

1. **OVERVIEW OF THE MK18A1 ELECTRICAL SYSTEM**

a. The MK18A1 electrical system consists of a remote control unit (RCU), remote control receiver, hourmeter, pressure switch, proximity switches, solenoid valves wiring harness, and lights.

b. Voltage for the electrical system is 24 volts and is supplied by the MK48.

c. Maintenance for these components is primarily organizational level; however, there is limited third echelon maintenance involved.

## **2. IDENTIFICATION, LOCATION, AND FUNCTION OF THE MK18A1 ELECTRICAL SYSTEM COMPONENTS**

### a. Remote Control Unit(RCU)

(1) During normal operations, most of MK18A1 functions are controlled with the remote control unit (RCU). The RCU is located in a stowage box on the left hand side of the MK18A1.

(2) When either joystick is activated, an electrical signal is sent to electrical pilot valves on the manual control valves. The pilot valves convert this electrical signal into a hydraulic command to operate the particular valve or valves.

(3) The signal, in its various forms, however, goes to the remote control receiver first. In the receiver, a microprocessor analyzes the signal, along with other signals it receives. Only one wire is used to send out this signal in its various forms.

(4) The receiver requires electrical power to send out commands and the power is provided by the emergency stop switch. It is necessary to have the emergency stop switch in the "ON" position in order to use the RCU. The safety cover allows the operator to put the switch in the OFF position quickly, which stops all signals, including the power to the hydraulic safety valve.

(5) The MANUAL/AUTO switch modifies the signal that is being sent when a joystick is activated. If the switch is in MANUAL position, the signal being sent puts the load handling system (LHS) in MANUAL mode. In AUTO position, the signal being sent tells the LHS to work in auto mode.

(6) The high idle switch, when in the ON position, modifies the signal in another way to make the engine go to high idle, along with the other functions selected.

### b. Remote Control Receiver

(1) The remote control receiver receives, analyzes, and sends electrical signals. It is located behind the manual control valves.

(2) A microprocessor within the receiver processes all the input and output signals.

(3) With the cover removed, the circuit board can be seen. D17 is one of the many light emitting diodes (LED) used to troubleshoot the system.

(4) There are three (3) electrical connections to the receiver:

(a) one for the RCU,

(b) one for the MK48, proximity switches, and transit valves,

(c) one for the control valves.

c. RCU Cable

(1) An important part of the remote control unit (RCU) is the cable that connects the RCU to the receiver by means of a connector in the stowage box.

(2) The cable is 40 feet long with MS-type pin connectors at each end. The pins in each connector are identified with a letter corresponding to the harness wire colors as shown in the chart.

(3) The condition of the pins in each connector is very important. If they are damaged or corroded, they will not assure a good electrical connection and will weaken the signal.

d. Hourmeter Pressure Switch

(1) There is a normally-open pressure switch in the MK18A1 hydraulic system that sends electrical current to the hour meter whenever hydraulic pressure closes the switch contacts.

(2) The hourmeter records the time only when hydraulic fluid is sent to the MK18A1 from the MK48. Recall that hydraulic fluid goes to the MK18A1 only when the hydraulic selector valve on the MK48 is pulled out.

(3) The switch is mounted to the adapter block between the safety valve and main frame valve sections. The switch is activated by pilot oil pressure that is used for the pilot valves.

(4) Wires to the pressure switch are attached with connectors.

e. Proximity Switches

(1) Three proximity switches are used on the MK18A1 as part of the load handling system (LHS). The proximity switches control the automatic

operation of the LHS during container operation and the relief system hydraulic pressure during over-the-road (transit) operation.

(a) The switch at the front is called the "Hook Arm Down" proximity switch. This switch electronically senses when the hook arm is in the stowed position. When it's activated, the switch directs the remote control receiver to open the transit valves.

(b) The switch at the hook base is called the "Hook Arm Up" proximity switch. This switch electronically senses when the hook arm reaches the fully raised position during an unloading cycle. When it's activated, the switch directs the remote control receiver to switch the manual control valve from hook arm UNLOAD to main frame UNLOAD.

(c) The switch on the main frame is called the "Main Frame Down" proximity switch. This switch electronically senses when the main frame reaches the stowed position during a loading cycle. When it's activated, the switch directs the remote control receiver to operate both the hook arm and main frame manual control valves in the LOAD position.

(2) Each proximity switch is mounted to a block or plate and is retained with a nut on each side that provides for adjustment.

(3) When metal, such as a plate, comes close to the end of proximity switch, it activates the switch which then sends a signal to the remote control receiver. The switch and plate are mounted on two different members of the LHS. One member moves in relation to the other.

(4) Each proximity switch must be adjusted to have a small space between it and the metal that is activating it. This space is approximately 1/8 of an inch. Refer to the TM for the exact settings.

(5) At the end of the switch, where the electrical wires are, there is a small LED. This LED will illuminate whenever the switch is activated by the presence of metal, provided the switch is working properly. This LED is very useful for troubleshooting the switch.

#### f. Transit Valve Solenoids

(1) Solenoids are used for the transit valves, which are mounted in manifolds attached to each main frame cylinder. The solenoids open the valves when they are energized with 24 volts.

(2) The transit valves open to allow the oil pressure from each end of the main frame cylinders to be relieved and return to the reservoir. This happens when the hook arm is in the stowed position (down) for transit.

(3) The hook arm down proximity switch provides the signal to activate the solenoids. This signal goes to the remote control receiver that sends out 24V to the transit valve solenoids.

(4) It is necessary to relieve pressure in each end of the main frame cylinders to keep the cylinders from becoming structural support members in the MK18A1 frame. This is also necessary to retain off-road flexibility in the MK18A1 frame.

g. Pilot Valve Solenoids

(1) Each of the manual control valves is controlled by the RCU by means of electric-over-hydraulic pilot valves.

(2) Solenoids are used to open or close the pilot valves depending on the command or function sent by the RCU. The pilot valves will then activate the manual control valve for that function. It does this by directing pilot valve oil pressure to one end or the other on the main control valve spool.

(3) There are two types of pilot valves used. One type is used to open or close the safety valve. It gets one voltage signal to activate it. The other type, used for the three control valves, gets two voltage signals because they must meter the oil flow according to how the joystick is moved on the RCU.

(4) The pilot valves are not serviceable. If they are found to be defective, they are to be replaced.

h. Electrical System Schematic

(1) This symbolic diagram of the electrical components ties together the electrical system.

(a) The RCU receives electrical power and sends signals when a command is made.

(b) The receiver receives the signals commanded by the RCU along with signals from other sources such as a proximity switch. It then analyzes these signals and sends a command, or commands, to the control valves, transit valves, or MK48.

(c) The MK48 provides the electrical power signal for the receiver and RCU. A command, such as "go to high idle", goes back to the MK48.

(2) Next, we will work with the actual MK18A1 electrical schematic that will be modified to show various color-coded electrical circuits.

(a) Electrical circuits are color-coded according to a color key. For example, use red for the input circuit, blue for a proximity switch signal, and green for high idle.

(b) All multiple connectors have a number for identification; for example, MC29.

(c) Wire numbers appear on the actual wire in the MK18A1.

### **3. MAINTENANCE RESPONSIBILITIES RELATIVE TO THE MK18A1 ELECTRICAL SYSTEM**

a. Maintenance personnel are responsible for inspecting, troubleshooting, adjusting, and replacing all the electrical system components, including the chassis wiring harness, which is covered in TM 2320-34/13. Some of the maintenance responsibilities relative to the electrical system components involve third echelon maintenance.

b. The mechanic is also responsible for repairing the chassis wiring harness. However, refer to the MK14 maintenance procedures in TM 2320-20/2, paragraph 7-45.

### **4. INSPECTING THE MK18A1 ELECTRICAL SYSTEM FOR SERVICEABILITY**

a. Check the components for any visible damage such as distortion, wear, cracks, breaks, and loose or missing mounting hardware.

b. Check the wires and wiring harnesses for damaged insulation and assure they are clipped in place.

c. Check the terminal connectors for loose connections, broken wires, and corrosion on the pins.

d. Check the proximity switches for contamination and proper gap setting.

e. Check the receiver cover for tightness. If moisture is suspected, remove the cover and inspect the internal components for damage.

f. Inspect the RCU for damage to the switches or levers. Check the remote control cable connectors for damage and corrosion.

g. If discrepancies are found during the inspection process, make repairs or replace the unserviceable components within the scope of your

responsibility. Notify your supervisor if the vehicle should be evacuated to a higher echelon maintenance facility for repair.

## 5. DIAGNOSE A MALFUNCTIONING ELECTRICAL SYSTEM

### a. General Information on Troubleshooting

(1) Chapter 2, paragraph 2-8 of TM 09470B-20/2 contains the troubleshooting procedures, troubleshooting symptoms index, and malfunctions. For each malfunction, there is a test, or inspection, plus the corrective action.

(a) To quickly find the troubleshooting procedure you need, use the Troubleshooting Symptom Index. To use this index, first determine if the malfunction is present using the remote control unit (RCU) only, or if the malfunction also occurs using the manual controls. Then find the listed symptom which best matches your actual symptom. If the malfunction occurs using the RCU only, find a listed symptom with an X in the REMOTE column and nothing in the MANUAL column. If the malfunction occurs using the RCU and the manual controls, find a listed symptom with an X in both the REMOTE and MANUAL columns. To determine if the malfunction occurs using the RCU and using the manual controls, disconnect the RCU then check the system operation using the manual controls. For this lesson on the electrical system, only remote control-type malfunctions will be diagnosed.

(b) Follow each of the malfunction steps (tests). Do not skip steps because this can result in improper results.

### b. Troubleshooting

(1) There are several notes that are important in the troubleshooting tests. This list highlights those notes.

(a) As a "WARNING" to prevent yaw steering movement and personal injury, make sure that the shift selector is in NEUTRAL and the parking brake is set before performing any troubleshooting tests.

(b) The ignition switch must be in the ON position for all voltage and LED tests.

(c) Always connect the negative lead of the multimeter to the chassis ground for voltage tests unless told to do otherwise in the tests.

(d) Make sure the auxiliary steering valve is in the AUXILIARY position.

(e) Do not start the engine unless told to do so in the tests.

(f) Do not disconnect any plugs unless told to do so in the tests. If it is necessary to disconnect or connect any electrical connector, make certain the power is OFF.

c. Malfunction - Engine High Idle Does Not Work

(1) Using TM 09470B-20/2, paragraph 2-8, find this malfunction in the symptom index to locate what page the tests are on.

(2) The first check is the simple one which is to verify that the transmission was in NEUTRAL and the parking brake was on when high idle was attempted. Also check the cable connections.

(3) If the simple checks do not correct the problem, it is necessary to start the electrical tests.

(4) Clean the area and remove the remote control receiver cover to access the LED indicator lights.

(5) Follow each of the test steps in sequence to find the problem.

(6) Keep in mind, if everything checks out on the MK18A1, the problem could be forward of the electrical connections to the MK18A1. This involves troubleshooting the same system on the MK48.

d. Malfunction - Main Frame Does Not Move (Remote Only)

(1) Again, find the page for troubleshooting this malfunction in TM 09470B-20/2 symptom index.

(2) To verify the problem is electrical, check the main frame operations with the manual control. Also check other functions such as hook arm and winch operation from the RCU. If these do not work, the problem may be the connectors for the remote cable. These are the simple checks.

(3) If the problem exists after the simple checks, proceed with the tests that are in the TM. You will see there are many LED's in the receiver that are part of the tests for this malfunction.

(4) Remember the electrical schematic for this system. The RCU command signal must get to the control valve pilot valve and the pilot valve solenoids must work to get hydraulics for the main frame to function. Keeping this in mind will help understand the tests for this malfunction.

(5) Organizational maintenance troubleshoots this malfunction to the control valve. To troubleshoot further requires the 3rd echelon maintenance and TM 09470B-34/3. In this TM, find the troubleshooting symptom index in Chapter 2 for "Main Frame Does Not Move."

(6) Troubleshooting at the 3rd echelon maintenance level involves tests for the solenoids in the pilot valves, which are attached to the control valve. If replacement of the pilot valve is required, it involves hydraulics.

e. Malfunction - Hook Arm and Main Frame Do Not Load and/or Unload Properly In Auto Mode (Remote Only)

(1) Find the page for troubleshooting this malfunction in TM 09470B-20/2 symptom index.

(2) For this malfunction, we can direct our attention to components involved with the automatic portion of the system. AUTO mode involves the RCU and proximity switches.

(3) Follow each of the test steps, in sequence, to find the problem.

(4) For this malfunction, a quick check of the proximity switches to see if they look properly adjusted could save time. A proximity switch could also be damaged or obstructed with debris.

f. Replacement of Electrical Components

(1) Replacement of Remote Control Receiver

(a) Use TM 09470B-20/2 for the actual replacement procedures. In general, the replacement process is as follows:

(b) To assure there is no injury or electrical short, disconnect the main electrical connector MC18, which is located on a bracket forward of the MK18A1 controls. This is the main cable connection from the MK48.

(c) Remove the connectors from the receiver.

(d) Remove the nuts, lockwashers, and plain washers from the three studs holding the receiver to its mounting bracket.

(e) There are rubber isolators on each of the mounting studs and one on the bracket.

(f) Install the receiver in reverse manner.

(2) Replacement of "Main Frame Down" Proximity Switch

(a) Use TM 09470B-20/2 for actual replacement procedures. In general, the replacement process is as follows:

(b) Disconnect the electrical power to the MK18A1 from the MK48 at MC18 as before.

(c) Disconnect the proximity switch at MC34.

(d) By removing two screws, the proximity switch and holding clamps (item 6) are removed as an assembly.

(e) The locknuts are then loosened to remove the proximity switch assembly from the clamp halves.

(f) To assemble, reverse the process, but leave the locknuts and mounting screws loose to adjust the switch. The switch should be positioned in the clamps close to the position of the old one so it will not contact the metal activating plate before adjustment.

(g) The proximity switch is adjusted for the proper gap, using the locknuts. The TM directs us to use new locknuts. Refer to the TM for the proper gap, which is approximately .120 inch. The last step is to tighten the locknuts and mounting screws to secure the proximity switch.

(3) Replacement of Pilot Valves

(a) All of the pilot valves, (also called solenoid assemblies) are replaced as an assembly. The internal parts, such as the solenoids, are not serviced.

(b) The pilot valves for the main frame, hook arm, and winch control are the same. The pilot valve for the safety control is different internally.

(c) Cleanliness, to avoid getting contamination into the internal parts, is extremely important when replacing a pilot valve.

(d) Follow the procedures in TM 09470B-34/3 under "Manual Control Valve Repair" to replace the pilot valve. Notice that it is necessary to remove the remote control receiver, to provide clearance.

(e) After the preparations, the replacement basically involves disconnecting the electrical connector, removing the four bolts, and separating the pilot valve from the valve body. There are five O-ring seals

between the valve and valve body. It is not necessary to remove the lever end-cap.

(f) For assembly of the pilot valve, be sure to lubricate the O-rings and ensure they stay in place when mating the valve to the valve body. Again, cleanliness is very important.

(g) When connecting the electrical connector, check the pins for damage or corrosion, then assemble it carefully.

**REFERENCES:**

TM 09470B-20/2

TM 2320-20/12 Sup 1

TM 2320-34/13 Sup 1

TM 2320-34/13A