



MacLeanTM
POWER SYSTEMS

MSO MOTORIZED SWITCH OPERATOR

Troubleshooting Guide, Version A, Rev. 00

Reciprocating Control Modules

This Guide Applies to the Following CMR#s:

MSO-CMR-86
(S.E.L. 3505 R-TAC)

MSO-CMR-69
(G.E. i-BOX)

MacLean Power Systems

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Introduction

This manual provides a troubleshooting guide for diagnosing and correcting issues with the MPS Motorized Switch Operator (MSO). If there are any items within the manual that are unclear to the user, it is advised that the user contact the **Engineering Department** at (209) 931-1670 for assistance in troubleshooting the MSO and/or overhead switch.

Where to Begin

This manual covers the most common MSO issues; however, not all sections may be required to diagnose a specific problem. Before beginning any troubleshooting, review the General Safety Information located on the lower half of this page and continuing onto page 3.

In all cases, the first diagnostic step is to perform the "**Preliminary Lamp Test Check**" to verify that the MSO is powered ON and that all status indicator lamps are functioning properly. Refer to page 3, Chart 1 for this procedure.

To ensure personnel safety and preventing damage to the MSO and or switch, the "Preliminary Lamp Test Check" MUST be performed prior to moving forward with any troubleshooting procedures.

After completing the Preliminary Lamp Test Check, refer to the Table of Contents and select the troubleshooting chart that matches the observed symptom. Each chart provides step-by-step diagnostic procedures and identifies recommended replacement components, where applicable. If any step is unclear or cannot be performed as written, contact the Engineering Department for technical support before proceeding. Use the Notes pages to document symptoms, test results, and diagnostic actions prior to contacting the factory.

Tools Required/Recommended

A true RMS digital multimeter (DMM) is **required**. The meter shall measure 24 VDC or greater with a minimum resolution of two decimal places for accurate verification of voltage sensors and battery or power supply readings. An audible continuity function is also recommended for required continuity checks.

A clamp meter capable of measuring DC current is **highly recommended**. Measuring current at the battery source terminals provides immediate confirmation of MSO operating status, including system energization, power supply operation, battery charging, or a stalled Battery Test condition. Use of a DC clamp meter significantly improves troubleshooting speed and fault isolation.

Other items that may be needed:


1. Flat head screwdriver, 1/8" width blade (for main terminal block, TB1-1)
2. Flat head screwdriver, 3/16" width blade (for AC terminal block, TB-2)
3. Phillips screwdriver for #8-32 machine screws
4. A PC or Laptop with the appropriate RTU software (SEL / GE-iBOX) for sending remote control commands to an RTU when communication devices are not available.
5. Appropriate communication cable for connecting to a RTU.

General Safety Information

This manual is not a substitute for proper training or adequate experience in the safe operation and maintenance of the equipment described herein. The MSO shall be serviced and maintained only by qualified technicians or electricians who are trained and experienced with this type of equipment. The following are suggested minimum qualifications:

- Knowledge and familiarity of these instructions.
- Trained in Electric Utility accepted high and low-voltage safe operating practices and procedures.
- Trained and authorized to energize, de-energize, clear, and ground electrical distribution equipment.
- Trained in the care and use of protective equipment such as flash clothing, safety glasses, face shield, hardhat, rubber gloves, hot stick, etc.

 **DANGER: Hazardous Voltage. Contact with hazardous voltage may cause severe personal injury and/or death. Follow all locally approved procedures and safety practices when working on or around high and low voltage lines and equipment.**

 **WARNING: Before installing, operating, maintaining, or testing this equipment, carefully read and understand the contents of the operation manual. Improper operation or maintenance may result in severe personal injury and or death.**

Troubleshooting Chart Safety Notes

! WARNING NOTE 1: Decoupling the MSO Motor

For the MSO, the "Motor Decoupler Handle" disengages the linkage from the motor. If the MSO is not in the fully closed (over-toggled) position, the switch may "fall" open due to the weight of the control rod, and switch blades.

The user must verify the following before proceeding to decouple the motor for energized switches.

- **If MSO is ON...** Either open status or closed status LED lamps are on, and the overhead switch is fully open, or fully closed.
- **If MSO is OFF...** The MSO is in the fully "over-toggled" linkage position and the overhead switch is fully open, or fully closed.

The user must verify the following before proceeding to decouple the motor for un-energized switches.

- Line crew is not in close proximity of moving switch components (switch blade, interrupters, reciprocating control rod, etc.) if MSO is decoupled and switch "falls" open.

Failure to comply to the above procedures may result in damage or fire to equipment, and/or injury or death to personnel.

! WARNING NOTE 2: Verify Proper System Grounding.

Refer to the "Grounding" section under "Installation wiring diagrams for 115 VAC, 15A maximum primary MSO power supply" on page 15 of the MSO Technical Manual

Chart 1: Preliminary Lamp Test & Battery Load Check (Sheet 1 of 2)

CHART 1 SHEET 1 OF 2

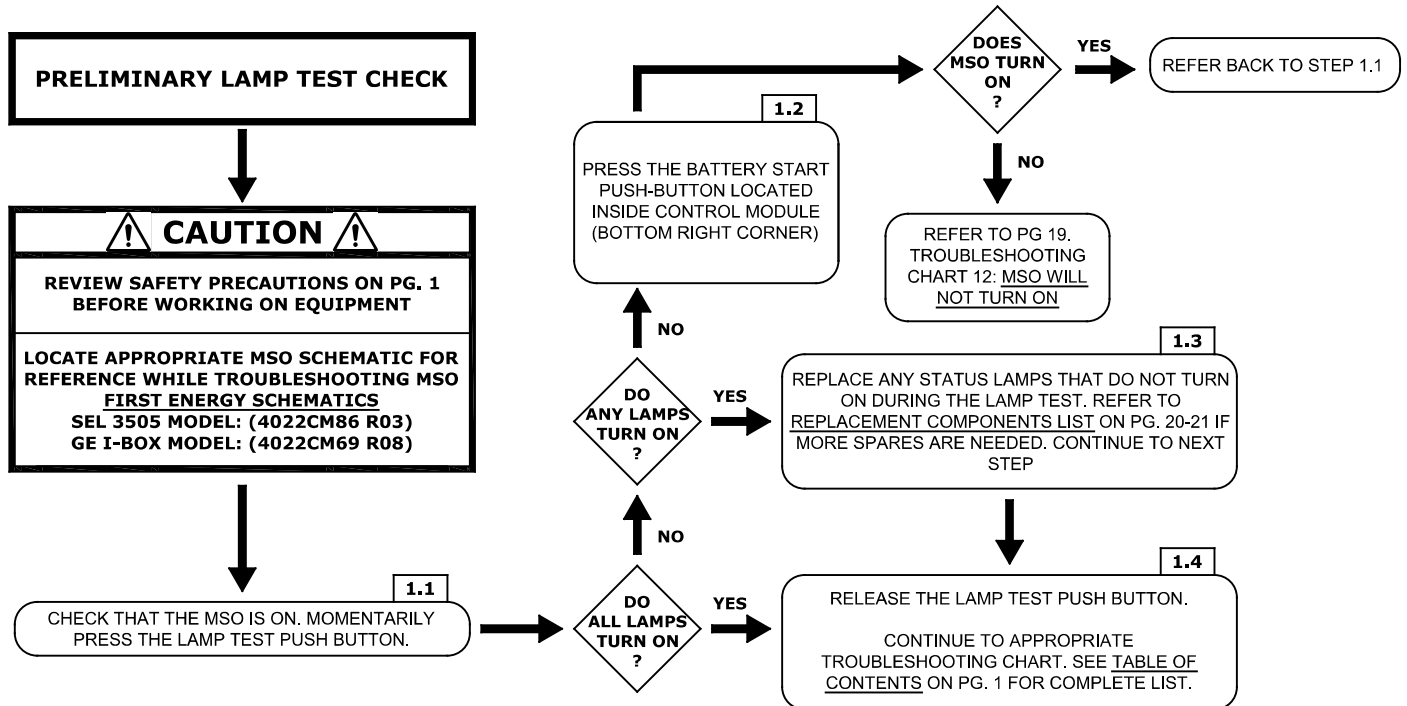


Chart 1: Preliminary Lamp Test & Battery Load Check (Sheet 2 of 2)

CHART 1 SHEET 2 OF 2

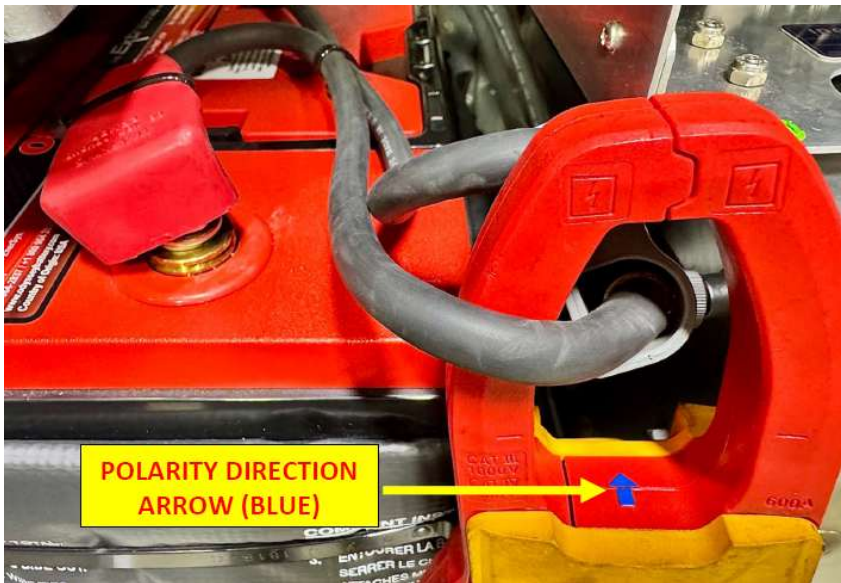
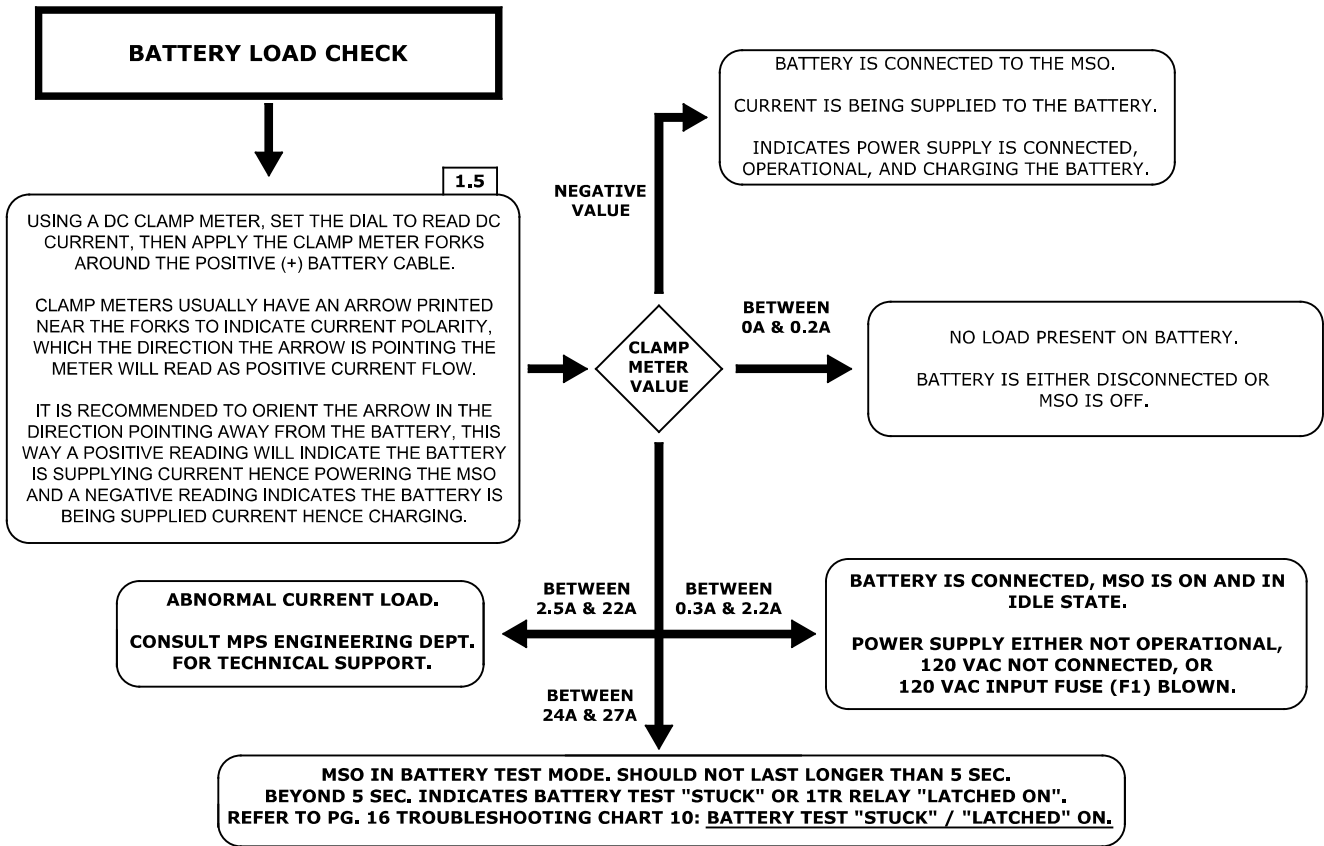


FIG. 1



FIG. 2



FIG. 3

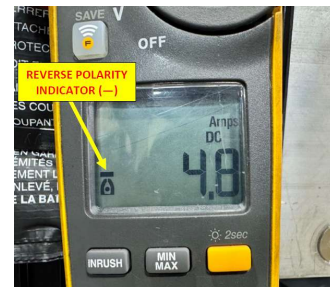


FIG. 4

- FIG.1** DEMONSTRATES THE BEST WAY TO POSITION A CLAMP METER ON THE 12VDC BATTERY IN ORDER TO OBTAIN DC CURRENT MEASUREMENTS. THE BLUE ARROW ON THE CLAMP METER INDICATES THE DIRECTION THE METER WILL READ POSITIVE CURRENT FLOW.
- FIG.2** DEMONSTRATES DC CURRENT VALUE FROM BATTERY INTO THE MSO WHILE THE MSO IS AT IDLE STATE AND 120 VAC DISCONNECTED BY OPENING FUSE (F1).
- FIG.3** DEMONSTRATES THE DC CURRENT VALUE WHILE THE MSO IS IN "BATTERY TEST MODE".
- FIG.4** DEMONSTRATES THE CURRENT FLOW WHEN (F1) FUSE IS CONNECTED, ALLOWING THE POWER SUPPLY TO CHARGE THE BATTERY. THE YELLOW ARROW POINTS TO THE REVERSE POLARITY SYMBOL WHICH INDICATES CURRENT IS FLOWING IN THE OPPOSITE DIRECTION IN REFERENCE TO THE BLUE ARROW IN FIG.1.

Chart 2: MSO Will Not Operate Using Open / Close Push Buttons (Sheet 1 of 2)

CHART 2 SHEET 1 OF 2

- TYPICAL ISSUES:**
- BATTERY LOCKOUT.
 - REMOTE / LOCAL SWITCH IN REMOTE POSITION.
 - INTERLOCK PIN REMOVED.
 - MODULE PLUGS NOT MATING.
 - FAULTY OPEN / CLOSE PUSH BUTTONS.
 - LOOSE RELAYS.

MSO WILL NOT OPERATE USING OPEN / CLOSE PUSH BUTTONS

CAUTION

REVIEW SAFETY PRECAUTIONS ON PG. 2 BEFORE WORKING ON EQUIPMENT

LOCATE APPROPRIATE MSO SCHEMATIC FOR REFERENCE WHILE TROUBLESHOOTING MSO FIRST ENERGY SCHEMATICS
SEL 3505 MODEL: (4022CM86 R03)
GE I-BOX MODEL: (4022CM69 R08)

COMPLETE TROUBLESHOOTING CHART 1: PRELIMINARY LAMP TEST CHECK ON PG. 3 BEFORE BEGINNING TROUBLESHOOTING.

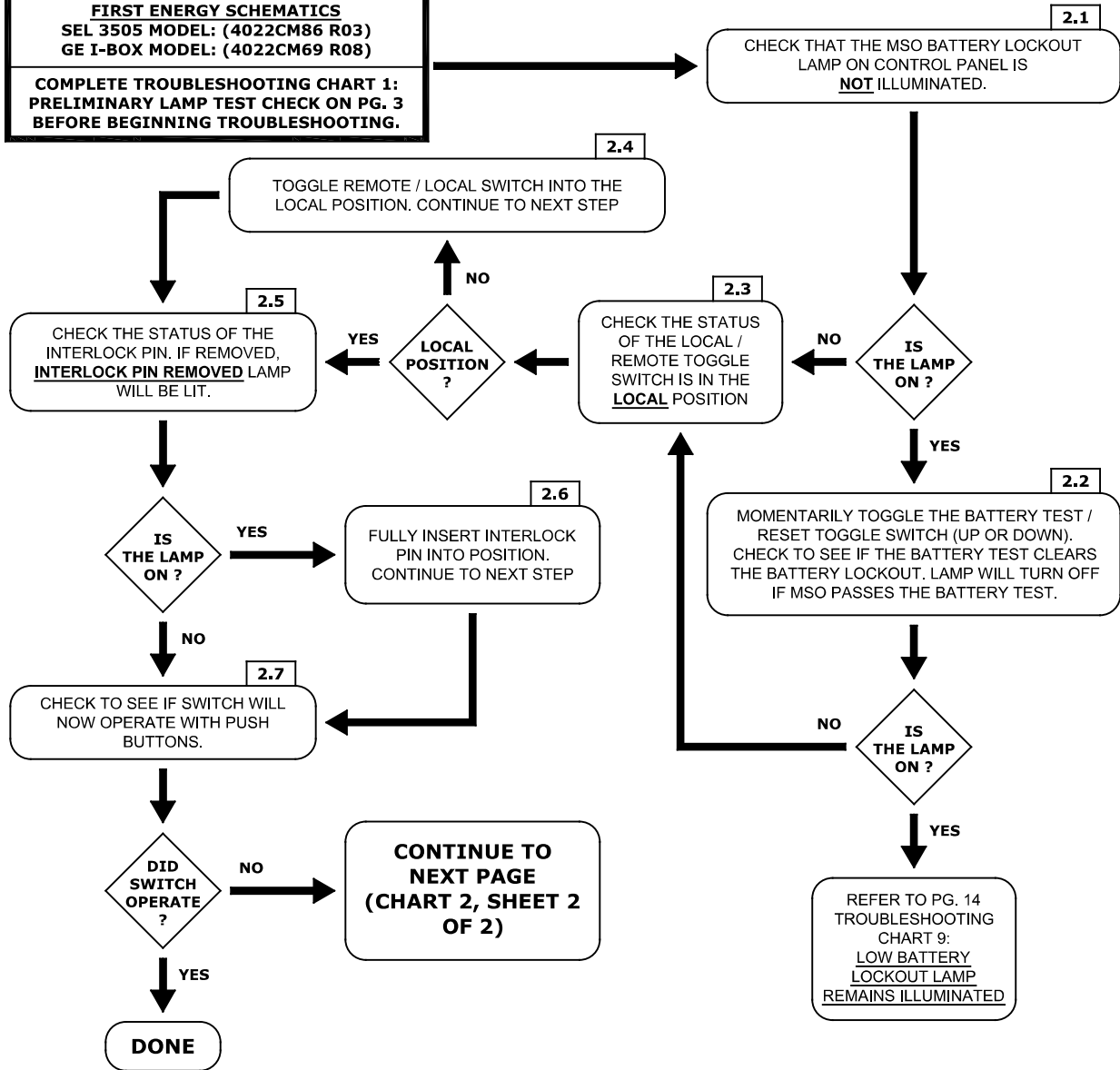


Chart 2: MSO Will Not Operate Using Open / Close Push Buttons (Sheet 2 of 2)

CHART 2 SHEET 2 OF 2

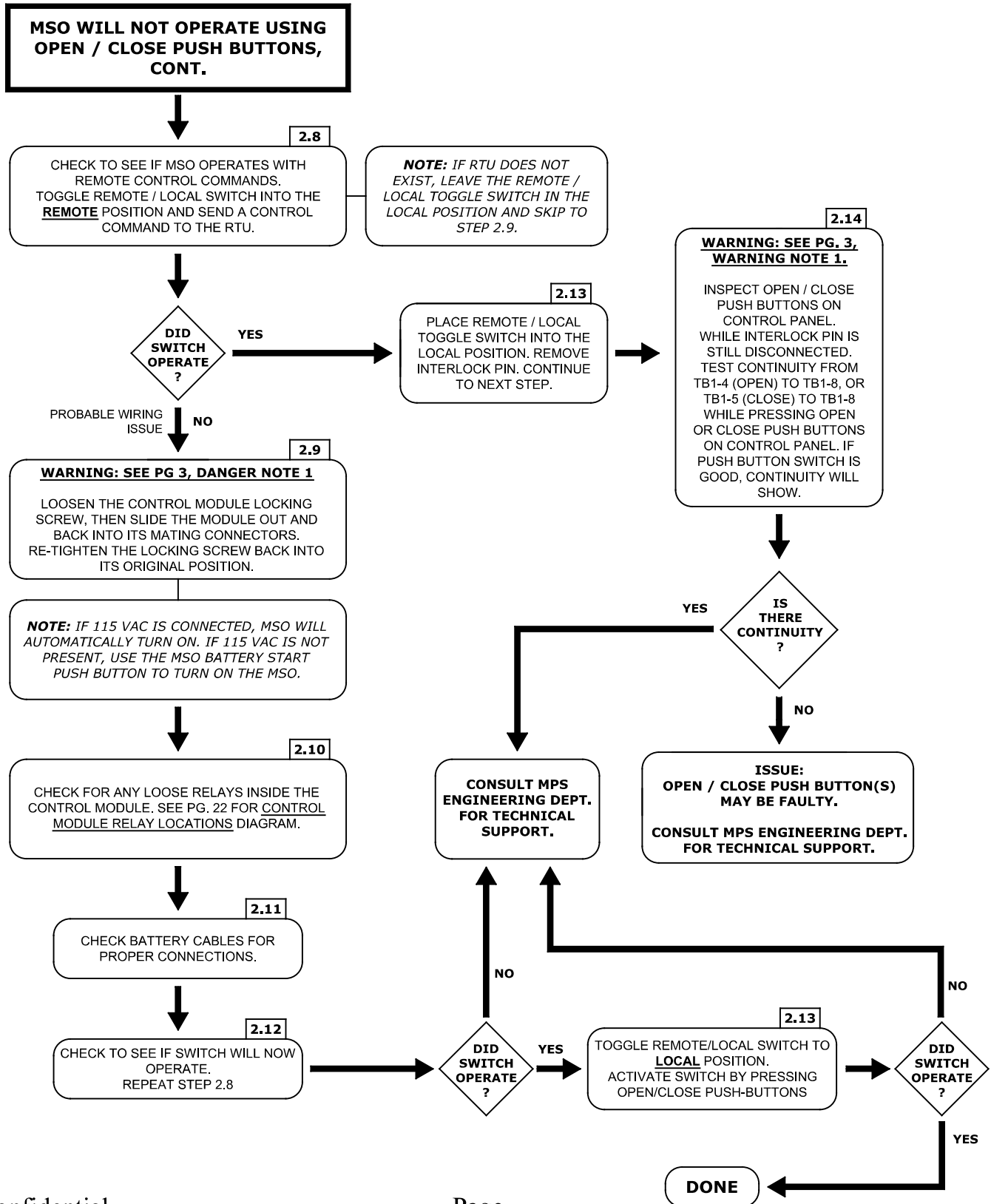


Chart 3: MSO Will Not Operate Using Remote Commands (Sheet 1 of 2)

CHART 3 SHEET 1 OF 2

- TYPICAL ISSUES:**
- BATTERY LOCKOUT.
 - REMOTE / LOCAL SWITCH IN LOCAL POSITION.
 - INTERLOCK PIN REMOVED.
 - MODULE PLUGS NOT MATING.
 - RTU / RADIO ERRORS.
 - LOOSE RELAYS.

MSO WILL NOT OPERATE USING REMOTE COMMANDS

CAUTION

REVIEW SAFETY PRECAUTIONS ON PG. 2 BEFORE WORKING ON EQUIPMENT

LOCATE APPROPRIATE MSO SCHEMATIC FOR REFERENCE WHILE TROUBLESHOOTING MSO
FIRST ENERGY SCHEMATICS
 SEL 3505 MODEL: (4022CM86 R03)
 GE I-BOX MODEL: (4022CM69 R08)

COMPLETE TROUBLESHOOTING CHART 1: PRELIMINARY LAMP TEST CHECK ON PG. 3 BEFORE BEGINNING TROUBLESHOOTING.

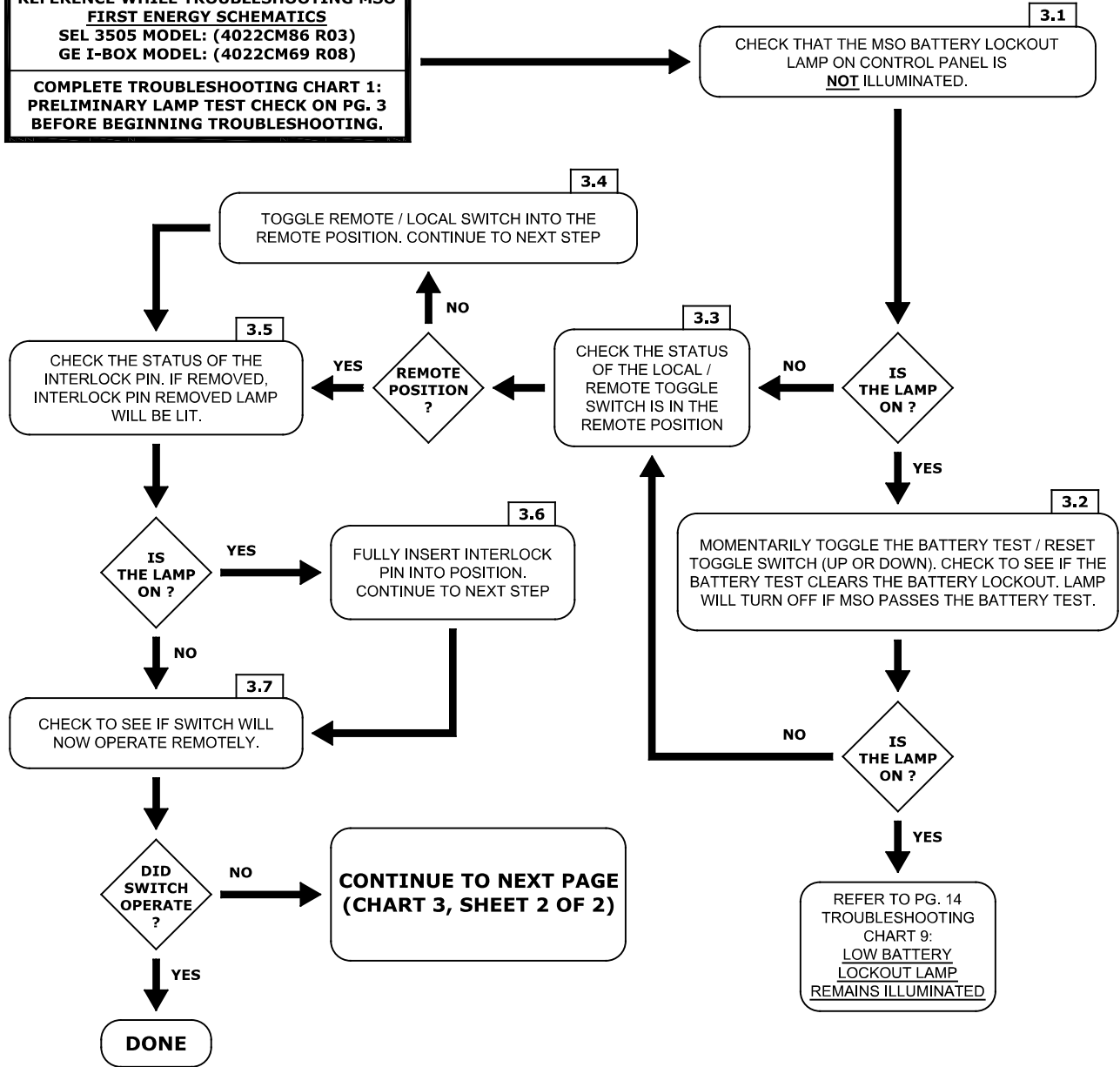


Chart 3: MSO Will Not Operate Using Remote Commands (Sheet 2 of 2)

CHART 3 SHEET 2 OF 2

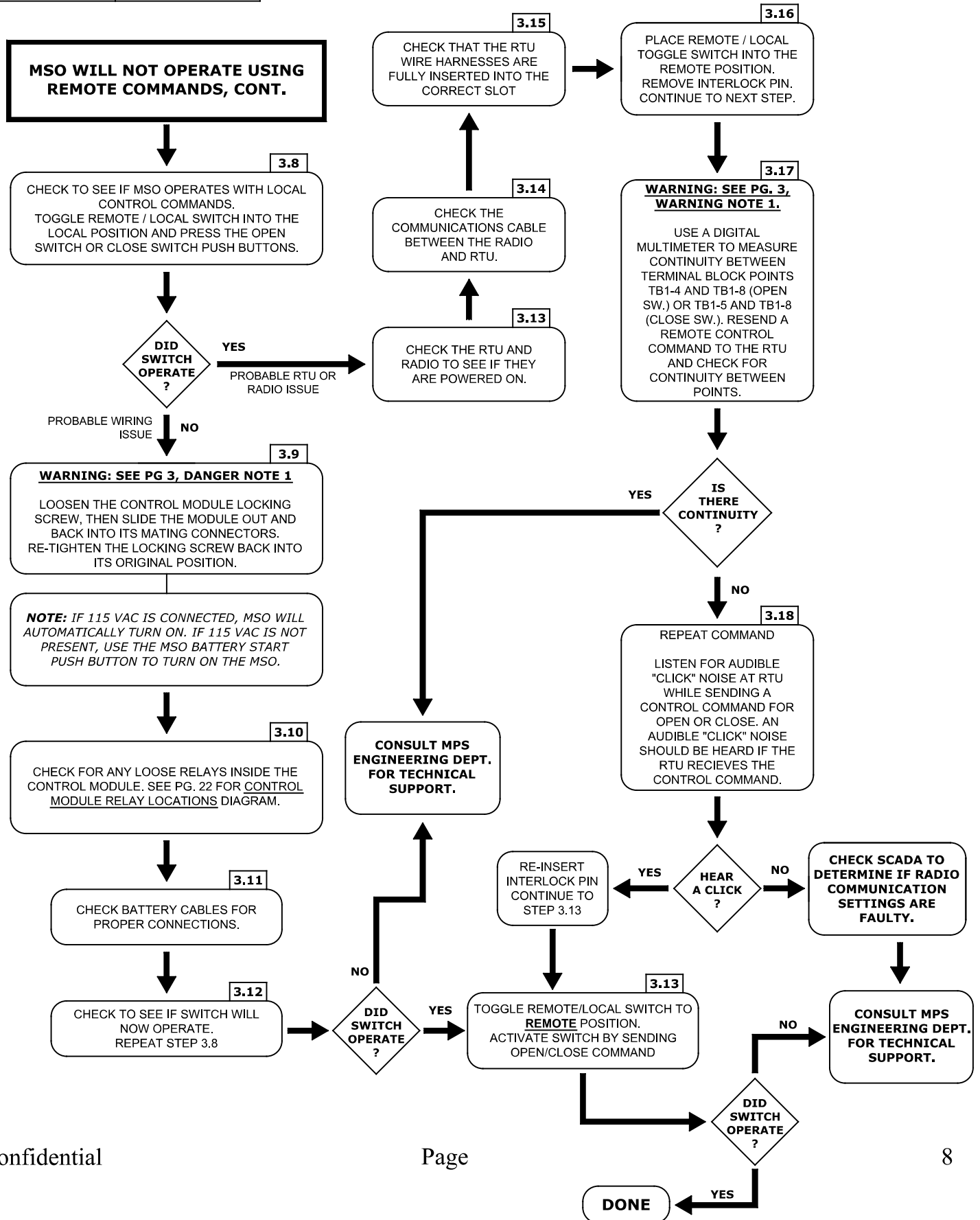


Chart 4: MSO has Stalled While Performing a Switch Operation (Sheet 1 of 1)

CHART 4 SHEET 1 OF 1

- TYPICAL ISSUES:**
- BAD BATTERY
 - BAD VR RELAY
 - COLD TEMPERATURES
 - SWITCH NEEDS MAINTENANCE
 - SWITCH ADJUSTMENT NEEDED

MSO HAS STALLED WHILE PERFORMING A SWITCH OPERATION

CAUTION

REVIEW SAFETY PRECAUTIONS ON PG. 2 BEFORE WORKING ON EQUIPMENT

LOCATE APPROPRIATE MSO SCHEMATIC FOR REFERENCE WHILE TROUBLESHOOTING MSO FIRST ENERGY SCHEMATICS
 SEL 3505 MODEL: (4022CM86 R03)
 GE I-BOX MODEL: (4022CM69 R08)

COMPLETE TROUBLESHOOTING CHART 1: PRELIMINARY LAMP TEST CHECK ON PG. 3 BEFORE BEGINNING TROUBLESHOOTING.

4.1

CHECK AND NOTE THE STATUS OF ALL INDICATOR LAMPS (POWER SUPPLY ON, BATTERY LOCKOUT, MOTOR DECOUPLED, INTERLOCK PIN, OPEN / CLOSE).

4.2

WARNING: THESE TROUBLESHOOTING INSTRUCTIONS FROM THIS POINT ON ASSUMES THE OVERHEAD SWITCH HAS BEEN DE-ENERGIZED OR A SWITCHING CLEARANCE HAS BEEN ESTABLISHED.

WARNING: SEE PG. 3, WARNING NOTE 1.

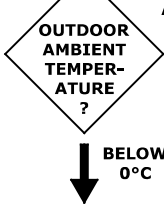
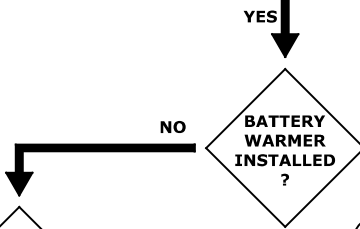
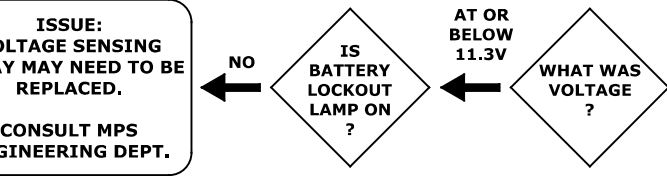
USING A DMM, MEASURE AND NOTE BATTERY VOLTAGE AT THE TERMINAL BLOCK POINTS TB1-17 (+) AND TB1-18 (-).
 DMM SHOULD READ BETWEEN 13.0 - 13.7 VDC

ALSO, MEASURE AND NOTE THE POWER SUPPLY OUTPUT VOLTAGE OF THE POWER SUPPLY AT TERMINAL BLOCK POINTS TB1-16 (+) AND TB1-18 (-).
 DMM SHOULD READ BETWEEN 14.0 -14.3 VDC

4.3

MOMENTARILY TOGGLE THE BATTERY TEST / RESET TOGGLE SWITCH (UP OR DOWN) WHILE USING A DMM TO MEASURE BATTERY VOLTAGE AT THE TERMINAL BLOCK, TB1-17 (+) AND TB1-18 (-).
 A GOOD BATTERY WILL MAINTAIN A VOLTAGE ABOVE 12.3 VDC DURING A BATTERY TEST.

ISSUE: VOLTAGE SENSING RELAY MAY NEED TO BE REPLACED.
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ISSUE: REPLACE THE 12V BATTERY PACK.
 CONSULT MPS ENGINEERING DEPT.

ISSUE: VOLTAGE SENSING RELAY MAY NEED TO BE REPLACED.
 CONSULT MPS ENGINEERING DEPT.

ISSUE: INSTALL A BATTERY WARMER KIT.
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CONSULT ENGINEERING DEPT. FOR FURTHER MSO TECHNICAL SUPPORT.

A STALLED SWITCH UP TO THIS POINT MAY BE A PRODUCT OF INADEQUATE SWITCH MAINTENANCE, MISADJUSTMENT OF THE SWITCH, MSO, CONTROL ROD, OR ANY COMBINATION OF THE THESE ITEMS.

Chart 5: Power Supply Lamp Does Not Illuminate (Sheet 1 of 1)

CHART 5 SHEET 1 OF 1

TYPICAL ISSUES:

- BAD BULB
- POWER SUPPLY OUTPUT VOLTAGE DRIFT.
- BLOWN F1 FUSE.
- NO VOLTAGE FROM 120 VAC SOURCE

POWER SUPPLY LAMP DOES NOT ILLUMINATE

CAUTION

REVIEW SAFETY PRECAUTIONS ON PG. 2 BEFORE WORKING ON EQUIPMENT

LOCATE APPROPRIATE MSO SCHEMATIC FOR REFERENCE WHILE TROUBLESHOOTING MSO FIRST ENERGY SCHEMATICS
SEL 3505 MODEL: (4022CM86 R03)
GE I-BOX MODEL: (4022CM69 R08)

COMPLETE TROUBLESHOOTING CHART 1: PRELIMINARY LAMP TEST CHECK ON PG. 3 BEFORE BEGINNING TROUBLESHOOTING.

5.1

WARNING: SEE PG. 3, WARNING NOTE 1.

USING A DMM, MEASURE POWER SUPPLY OUTPUT DC VOLTAGE AT THE TERMINAL BLOCK POINTS TB1-16 (+) AND TB1-18 (-).

DMM SHOULD READ BETWEEN 14.0 - 14.3 VDCM

5.4

LOOSEN THE CONTROL MODULE LOCKING SCREW, THEN SLIDE THE MODULE OUT THEN BACK INTO ITS MATING CONNECTORS. RE-TIGHTEN THE LOCKING SCREW BACK INTO ITS ORIGINAL POSITION. MSO SHOULD TURN ON AUTOMATICALLY, AND POWER SUPPLY LAMP SHOULD BE ILLUMINATED.

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ISSUE: POWER SUPPLY OUTPUT VOLTAGE HAS DRIFTED. POWER SUPPLY MAY NEED TO BE REPLACED.

CONSULT MPS ENGINEERING DEPT. FOR TECHNICAL SUPPORT

5.2

USING A DMM, MEASURE THE POWER SUPPLY 120 VAC INPUT VOLTAGE AT TERMINAL BLOCK 2, POINTS TB2-1(LINE) AND TB2-2(GND). VOLTAGE SHOULD BE BETWEEN 85V AND 140V

IS THERE CONTINUITY ?

5.3

REMOVE AND CHECK 120 VAC INPUT FUSE FOR CONTINUITY. FUSE LOCATED IN FUSE BLOCK POS (F1). (FUSE RATING 240V 15A)

ISSUE: REPLACE F1 15A FUSE.

REFER TO: REPLACEMENT COMPONENTS LIST ON PG. 20-21 FOR SPARES.

ISSUE: VERIFY 120 VAC SOURCE DEVICE STATUS

POSSIBLE CONDITIONS:

1. DEVICE CONNECTED & OPERATIONAL --> NO VOLTAGE AT TB-2
2. DEVICE CONNECTED, BUT NOT OPERATIONAL
3. DEVICE IMPROPERLY CONNECTED/DISCONNECTED

IN EITHER CONDITION, DISCONTINUE TROUBLESHOOTING AND CONTACT MPS ENGINEERING DEPT. FOR TECHNICAL ASSISTANCE

Chart 6: Interlock Pin Removed Lamp Remains Illuminated (Sheet 1 of 1)

CHART 6 SHEET 1 OF 1

TYPICAL ISSUES:

- FAULTY DIODE.
- INTERLOCK PIN NOT FULLY INSERTED INTO POSITION.
- BAD LIMIT SWITCH.

INTERLOCK PIN REMOVED LAMP REMAINS ILLUMINATED

CAUTION

REVIEW SAFETY PRECAUTIONS ON PG. 2 BEFORE WORKING ON EQUIPMENT

LOCATE APPROPRIATE MSO SCHEMATIC FOR REFERENCE WHILE TROUBLESHOOTING MSO FIRST ENERGY SCHEMATICS
 SEL 3505 MODEL: (4022CM86 R03)
 GE I-BOX MODEL: (4022CM69 R08)

COMPLETE TROUBLESHOOTING CHART 1: PRELIMINARY LAMP TEST CHECK ON PG. 3 BEFORE BEGINNING TROUBLESHOOTING.

6.1

CHECK THAT THE INTERLOCK PIN IS FULLY INSERTED INTO THE MOTOR BOX SLOT.

FULLY INSERTED ?

6.2

FULLY INSERT INTERLOCK PIN INTO MOTOR BOX. INTERLOCK PIN LAMP SHOULD TURN OFF.

DID LAMP TURN OFF ?

ISSUE: INTERLOCK PIN NOT FULLY INSERTED

ISSUE: DIODE IN DIODE BLOCK MAY BE FAULTY.

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6.3

AUDIBLE LIMIT SWITCH CHECK

SLOWLY INSERT INTERLOCK PIN AND LISTEN FOR AUDIBLE "CLICKING" NOISES. (UP TO 2 CLICKS) MAY BE HEARD WHILE THE INTERLOCK PIN IS BEING INSERTED. THE CLICK NOISE(S) SHOULD BE HEARD WHEN THE LIMIT SWITCH MECHANISM HAS BEEN FULLY SWITCHED.

HEAR CLICKS ?

DID LAMP TURN OFF ?

ISSUE: INTERLOCK PIN MOTOR LOCKOUT NOT FUNCTIONING

SAFETY RISK

IS THERE CONTINUITY ?

ISSUE: PROBLEM MAY BE FAULTY LIMIT SWITCH

CONSULT MPS ENGINEERING DEPT. FOR TECHNICAL HELP AND CONTINUED TROUBLESHOOTING.

6.4

LIMIT SWITCH CONTINUITY CHECK

MAKE SURE BATTERY LOCKOUT LAMP IS OFF. IF LAMP IS ON, PERFORM BATTERY TEST TO CLEAR LAMP. WITH THE INTERLOCK PIN FULLY INSERTED, CHECK CONTINUITY BETWEEN CONTROL MODULE POWER SOURCE (TB1-1) AND OPEN/CLOSE PUSH-BUTTONS

TB1-1 AND TB1-4 (OPEN SW.)
 TB1-1 AND TB1-5 (CLOSE SW.)

EXISTENCE OF CONTINUITY IN EITHER CHECK MEANS THE INTERLOCK PIN LIMIT SWITCH CURRENTLY SUPPLIES POWER TO OPEN/CLOSE PUSHBUTTONS AS DESIGNED. THIS MEANS THE MOTOR CAN BE OPERATED REGARDLESS IF INTERLOCK PIN REMOVED LAMP IS ON

Chart 7: Motor Decoupled Lamp Remains Illuminated (Sheet 1 of 1)

CHART 7 SHEET 1 OF 1

TYPICAL ISSUES:

- FAULTY DIODE.
- MOTOR DECOUPLER HANDLE NOT FULLY ROTATED INTO POSITION.
- BAD LIMIT SWITCH.

MOTOR DECOUPLER LAMP REMAINS ILLUMINATED

CAUTION

REVIEW SAFETY PRECAUTIONS ON PG. 2 BEFORE WORKING ON EQUIPMENT

LOCATE APPROPRIATE MSO SCHEMATIC FOR REFERENCE WHILE TROUBLESHOOTING MSO **FIRST ENERGY SCHEMATICS**
 SEL 3505 MODEL: (4022CM86 R03)
 GE I-BOX MODEL: (4022CM69 R08)

COMPLETE TROUBLESHOOTING CHART 1: PRELIMINARY LAMP TEST CHECK ON PG. 3 BEFORE BEGINNING TROUBLESHOOTING.

7.1

CHECK THAT THE MOTOR DECOUPLER HANDLE IS FULLY ROTATED CLOCKWISE INTO THE VERTICAL (COUPLED) POSITION

FULLY ROTATED ?

7.2

FULLY ROTATE MOTOR DECOUPLER HANDLE CLOCKWISE INTO THE VERTICAL (COUPLED) POSITION. MOTOR DECOUPLER LAMP SHOULD TURN OFF.

DID LAMP TURN OFF ?

ISSUE:
MOTOR DECOUPLER HANDLE NOT FULLY ROTATED INTO COUPLED POSITION

ARE ALL LAMPS ON ?

ISSUE:
DIODE IN DIODE BLOCK MAY BE FAULTY.

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7.3

WARNING: SEE PG. 3, WARNING NOTE 1.

REMOVE MOTOR BOX TOP COVER. LOCATE MOTOR DECOUPLER LIMIT SWITCH. LISTEN FOR AUDIBLE "CLICKING" NOISES (UP TO 2 CLICKS) WHEN THE DECOUPLER HANDLE IS ROTATED. THE CLICK NOISE(S) SHOULD BE HEARD WHEN THE LIMIT SWITCH HAS BEEN SWITCHED.

HEAR CLICKS ?

ISSUE:
LIMIT SWITCH MAY NEED REPLACEMENT.

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DID LAMP TURN OFF ?

ISSUE:
DIODE IN DIODE BLOCK MAY BE FAULTY.

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Chart 8: Open Switch and Closed Switch Lamps are BOTH Not Illuminated (Sheet 1 of 1)

CHART 8 SHEET 1 OF 1

OPEN SWITCH AND CLOSED SWITCH LAMPS ARE BOTH NOT ILLUMINATED

CAUTION

REVIEW SAFETY PRECAUTIONS ON PG. 2 BEFORE WORKING ON EQUIPMENT

LOCATE APPROPRIATE MSO SCHEMATIC FOR REFERENCE WHILE TROUBLESHOOTING MSO FIRST ENERGY SCHEMATICS
 SEL 3505 MODEL: (4022CM86 R03)
 GE I-BOX MODEL: (4022CM69 R08)

COMPLETE TROUBLESHOOTING CHART 1: PRELIMINARY LAMP TEST CHECK ON PG. 3 BEFORE BEGINNING TROUBLESHOOTING.

- TYPICAL ISSUES:
- MSO IN "TRAVELLING" POSITION
 - OPEN / CLOSE PUSH BUTTON(S) NEED TO BE REPLACED.
 - SWITCH / MSO NEEDS ADJUSTMENT.
 - BAD LIMIT SWITCHES.

8.1

WARNING: DO NOT ROTATE THE MOTOR DECOUPLER HANDLE INTO THE DECOUPLED POSITION.

DUE TO BOTH OPEN AND CLOSE STATUS LED'S BEING OFF, THE OVERHEAD SWITCH MAY BE IN A "TRAVELING" POSITION AND A NON-TOGGLED POSITION AT THE MSO.

8.2

CHECK THE POSITION OF THE OVERHEAD SWITCH. (DO NOT REFER TO MSO OPEN / CLOSE PUSH BUTTON STATUS LIGHTS) FOR CONFIRMATION.

IF UNABLE TO OBTAIN VISUAL CONFIRMATION OF OVERHEAD SWITCH POSITION, THIS CAN BE ACHIEVED BY VISUAL INSPECTION OF THE MSO CABINET.

REFER TO PG 23. VISUAL CONFIRMATION SWITCH CLOSED. LOCATE THE CONTROL ROD AND ROD COUPLER ON THE TOP-BACKSIDE OF THE MSO CABINET. IF ROD COUPLER APPEARS RAISED MORE THAN 2ft ABOVE THE MSO CABINET, THEN THE OVERHEAD SWITCH IS IN THE **CLOSED POSITION**.

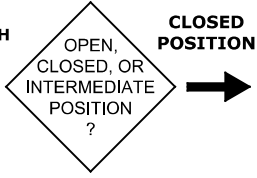
REFER TO PG 24. VISUAL CONFIRMATION SWITCH OPEN. IF THE ROD COUPLER APPEARS TO BE POSITIONED JUST ABOVE THE TOP OF THE CABINET APPROXIMATELY LEVEL WITH MSO POLE MOUNTING BRACKET, THEN THE OVERHEAD SWITCH IS IN THE **OPEN POSITION**.

8.4

IF THE OVERHEAD SWITCH IS OPEN, AND IS A NORMALLY OPEN SWITCH, PLACE THE REMOTE / LOCAL TOGGLE SWITCH INTO THE LOCAL POSITION, VERIFY THAT THE INTERLOCK PIN IS INSERTED, AND PRESS THE OPEN PUSH BUTTON. THIS WILL RUN THE MSO MOTOR TO ATTEMPT TO FULLY OPEN THE SWITCH / MSO.

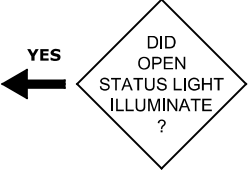
8.3

IF THE OVERHEAD SWITCH IS CLOSED, AND IS A NORMALLY CLOSED SWITCH, PLACE THE REMOTE / LOCAL TOGGLE SWITCH INTO THE LOCAL POSITION, VERIFY THAT THE INTERLOCK PIN IS INSERTED, AND PRESS THE CLOSED PUSH BUTTON. THIS WILL RUN THE MSO MOTOR TO ATTEMPT TO FULLY CLOSE THE SWITCH / MSO.

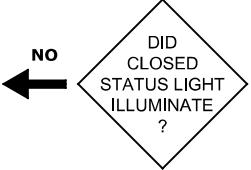


ISSUE: SWITCH AND / OR MSO NOT FULLY OPEN.

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CONSULT MPS ENGINEERING DEPT. FOR TECHNICAL HELP AND CONTINUED TROUBLESHOOTING.



ISSUE: SWITCH AND / OR MSO NOT FULLY CLOSED.

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Chart 9: Low Battery Lockout Lamp Remains Illuminated (Sheet 1 of 2)

CHART 9 SHEET 1 OF 2

TYPICAL ISSUES:

- FAULTY DIODE.
- BATTERY NEEDS TO BE CHARGED.
- OLD BATTERY.
- BATTERY TEST RELAY "LATCHED" ON.

LOW BATTERY LOCKOUT LAMP REMAINS ILLUMINATED

CAUTION

REVIEW SAFETY PRECAUTIONS ON PG. 2 BEFORE WORKING ON EQUIPMENT

LOCATE APPROPRIATE MSO SCHEMATIC FOR REFERENCE WHILE TROUBLESHOOTING MSO **FIRST ENERGY SCHEMATICS**
 SEL 3505 MODEL: (4022CM86 R03)
 GE I-BOX MODEL: (4022CM69 R08)

COMPLETE TROUBLESHOOTING CHART 1: PRELIMINARY LAMP TEST CHECK ON PG. 3 BEFORE BEGINNING TROUBLESHOOTING.

9.1

WARNING: SEE PG. 3, WARNING NOTE 1.

USING A DMM, MEASURE VOLTAGE AT TERMINAL BLOCK 1, POINTS TB1-13 (+) AND TB1-18 (-). VOLTAGE SHOULD EXIST, AND BE APPROXIMATELY VDC.

9.2

CHECK THE LEFT SIDE OF THE MSO CABINET. IF THE CABINET FEELS UNUSUALLY WARM, THE BATTERY TEST MAY BE LATCHED ON.

REFER TO PG. 16 TROUBLESHOOTING CHART 10: **BATTERY TEST "STUCK" OR "LATCHED" ON.**

WARM ?

YES → [Refer to Chart 10]

NO → [Issue: Faulty Diode]

DOES VOLTAGE EXIST ?

NO → [Check for Warm Cabinet]

YES → [Step 9.3]

ISSUE: FAULTY DIODE IN DIODE BLOCK.

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9.3

IF THE POWER SUPPLY IS ON (AND 120 VAC CONNECTED), DISCONNECT FUSE F1 AND WAIT 1 MINUTE BEFORE PROCEEDING.

USING A DMM, MEASURE BATTERY VOLTAGE AT TERMINAL BLOCK 1, POINTS TB1-17 (+) AND TB1-18 (-). READING SHOULD BE BETWEEN 12 VDC AND 14 VDC.

9.5

RECONNECT THE F1 FUSE TO TURN THE POWER SUPPLY BACK ON.

BATTERY VOLTAGE ?

ABOVE 12 VDC → [Step 9.5]

BELOW 11.7 VDC → [Step 9.4]

CONTINUE TO NEXT PAGE (CHART 9, SHEET 2 OF 2)

9.4

RECONNECT THE F1 FUSE TO TURN THE POWER SUPPLY BACK ON.

ALLOW THE MSO TO RECHARGE THE 12V BATTERY PACK FOR AT LEAST 6 HOURS BEFORE PROCEEDING TO NEXT STEP.

ISSUE: BATTERY UNABLE TO HOLD CHARGE. REPLACE THE 12V BATTERY PACK.

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UNDER 11.7V AFTER CHARGE → [Continue to Next Page]

AFTER 6 HOURS HAVE PASSED REPEAT STEP 9.3

UNDER 11.7V AFTER CHARGE → [Issue: Battery Unable to Hold Charge]

Chart 9: Low Battery Lockout Lamp Remains Illuminated (Sheet 2 of 2)

CHART 9 SHEET 2 OF 2

LOW BATTERY LOCKOUT LAMP REMAINS ILLUMINATED, CONT.

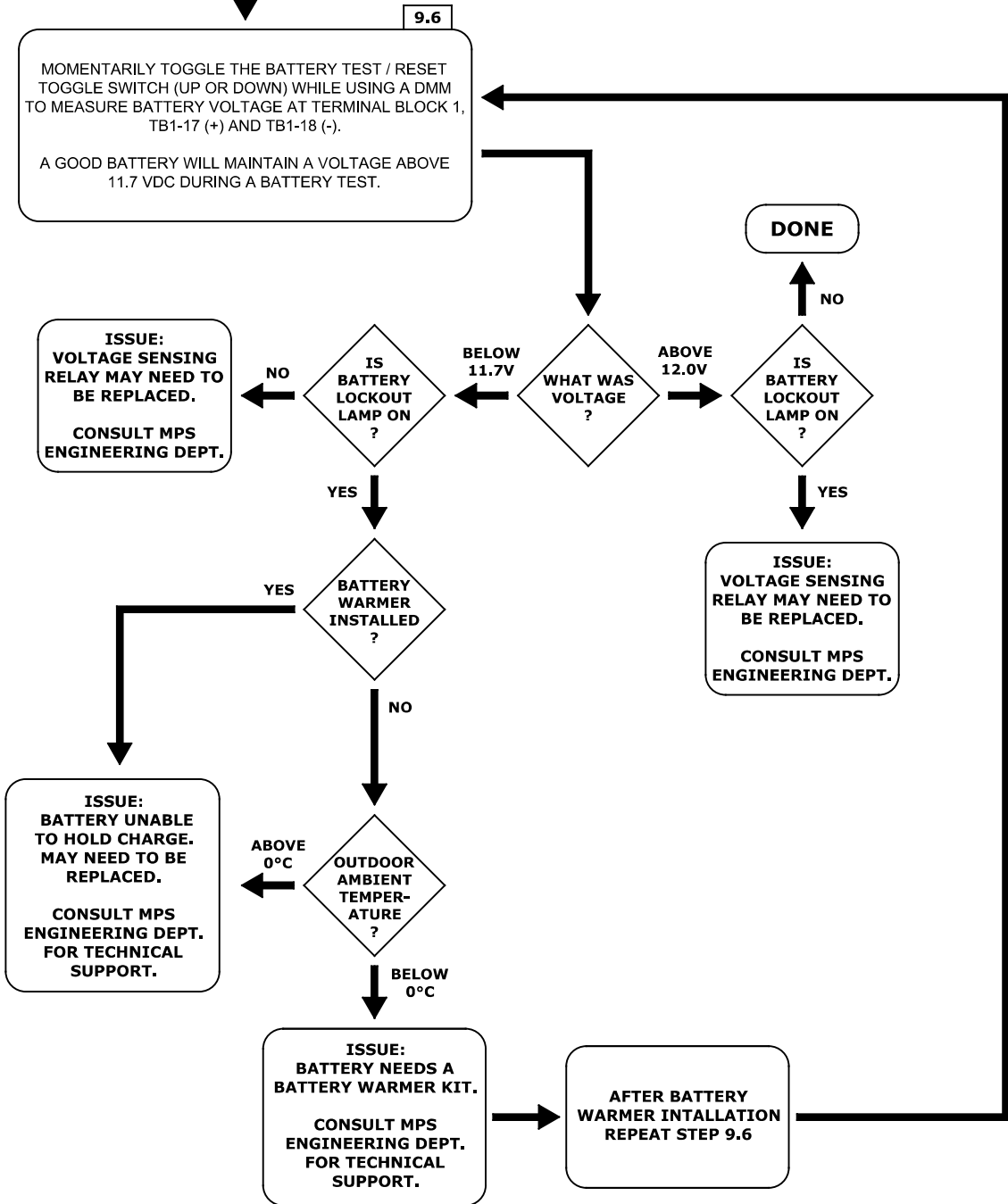


Chart 10: Battery Test "Stuck" or "Latched" On (Sheet 1 of 1)

CHART 10 SHEET 1 OF 1

- TYPICAL ISSUES:**
- LEFT SIDE OF MSO CABINET FEELS UNUSUALLY WARM.
 - MELTED WIRE LOOM OVER "CONTACTOR PANEL" ASSEMBLY.
 - BAD "1TR" TIMER RELAY.
 - BAD "BTC" RELAY.
 - LATCHED RTU CONTROL RELAY.

BATTERY TEST "STUCK" OR "LATCHED" ON

CAUTION

REVIEW SAFETY PRECAUTIONS ON PG. 2 BEFORE WORKING ON EQUIPMENT

LOCATE APPROPRIATE MSO SCHEMATIC FOR REFERENCE WHILE TROUBLESHOOTING MSO FIRST ENERGY SCHEMATICS
SEL 3505 MODEL: (4022CM86 R03)
GE I-BOX MODEL: (4022CM69 R08)

COMPLETE TROUBLESHOOTING CHART 1: PRELIMINARY LAMP TEST CHECK ON PG. 3 BEFORE BEGINNING TROUBLESHOOTING.

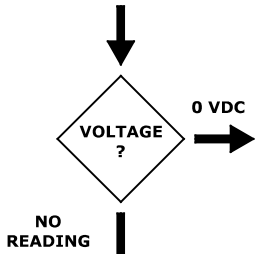
10.2

WARNING: SEE PG. 3, WARNING NOTE 1.

CHECK THAT A LATCHING CONTROL COMMAND FROM A RTU IS NOT KEEPING THE BATTERY TEST ACTIVATED. VERIFY BY PLACING REMOTE / LOCAL SWITCH INTO THE LOCAL POSITION AND MEASURING DC VOLTAGE FROM TB1-6 (+) TO TB1-8 (-).

10.1

USER NOTE: WHEN OPERATED FROM THE CONTROL PANEL, VERIFY THAT THE USER IS MOMENTARILY (<1 SEC.) HOLDING THE BATTERY TEST TOGGLE SWITCH TO PERFORM BATTERY TESTING. **DO NOT HOLD BATTERY TEST TOGGLE SWITCH FOR ANY EXTENDED PERIOD OF TIME.**



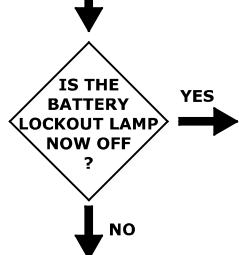
ISSUE:
LATCHED RTU CONTROL RELAY. CONTACT SCADA TO FIX STATUS OF RTU CONTROL COMMANDS.

RTU & CONTACT
RTAC 3505: CONTACT S.E.L.
i-BOX: CONTACT G.E. CO.
(ALL i-BOX CONTROL COMMANDS SHOULD BE PULSES (200-400mS))

10.3

VERIFY WHICH RELAYS ARE KEEPING THE BATTERY TEST "STUCK" OR "LATCHED" ON. WHILE MSO IS ON, DISCONNECT THE "1TR" AND "2TR" RELAYS FOR 30sec. THEN REINSTALL AND RUN A BATTERY TEST. SEE RELAY LAYOUT DIAGRAM ON PG 21.

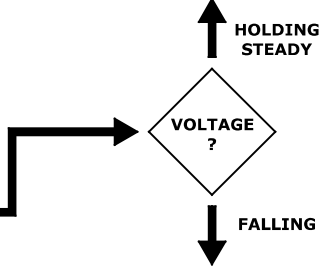
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10.4

EVEN WITH LAMP OFF, CHECK THAT BATTERY TEST IS NOT ACTIVE. IF THE BATTERY TEST IS STILL ACTIVE, THE BATTERY VOLTAGE WILL FALL.

OPEN (F1 FUSE), THEN USING A DMM, MEASURE BATTERY VOLTAGE AT TB1-17 (+) AND TB1-18 (-).



ISSUE:
1TR TIMER RELAY MAY NEED REPLACEMENT.

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ISSUE:
BTC RELAY LOCATED INSIDE THE CONTACTOR PANEL MAY BE LATCHED/FAULTY.

REFER TO:
REPLACEMENT COMPONENTS LIST,
ON PG. 20-21.

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Chart 11: MSO Battery Not Charging (Sheet 1 of 2)

CHART 11 SHEET 1 OF 2

- TYPICAL ISSUES:**
- BAD "1TR" TIMER RELAY.
 - FAULTY DIODES.
 - POWER SUPPLY OUTPUT VOLTAGE DRIFT.
 - BAD BATTERIES.

BATTERY NOT CHARGING

CAUTION

REVIEW SAFETY PRECAUTIONS ON PG. 2 BEFORE WORKING ON EQUIPMENT

LOCATE APPROPRIATE MSO SCHEMATIC FOR REFERENCE WHILE TROUBLESHOOTING MSO FIRST ENERGY SCHEMATICS
SEL 3505 MODEL: (4022CM86 R03)
GE I-BOX MODEL: (4022CM69 R08)

COMPLETE TROUBLESHOOTING CHART 1: PRELIMINARY LAMP TEST CHECK ON PG. 3 BEFORE BEGINNING TROUBLESHOOTING.

11.1 CHECK THAT THE MSO POWER SUPPLY ON LAMP IS ILLUMINATED.

ISSUE:
REPLACE 1TR TIMER RELAY LOCATED INSIDE THE CONTROL MODULE.

REFER TO:
REPLACEMENT COMPONENTS LIST
ON PG. 20-21.

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REFER TO PG. 10 TROUBLESHOOTING CHART 5: POWER SUPPLY LAMP DOES NOT ILLUMINATE

IS THE LAMP ON?

11.2 **WARNING: SEE PG. 3, WARNING NOTE 1.**

USING A DVM, MEASURE POWER SUPPLY OUTPUT VOLTAGE AT TERMINAL BLOCK 1 TB1-16 (+) AND TB1-18 (-).

VOLTAGE ?

ABOVE 13.2V

BELOW 13.2V

11.4 DISCONNECT THE 24V BATTERY FROM THE MSO AT THE GRAY BATTERY CONNECTORS. USING A DVM, MEASURE VOLTAGE ON THE "MSO" SIDE OF THE GRAY CONNECTORS. THIS SHOULD SHOW THE CHARGE VOLTAGE GETTING DIRECTLY TO THE BATTERY.

11.3 USING A DMM, MEASURE VOLTAGE AT TERMINAL BLOCK TB1-17 (+) AND TB1-18 (-).

VDC BETWEEN 14.0V AND 14.3V ?

VDC BETWEEN 13.2V AND 13.7V ?

ISSUE:
POWER SUPPLY OUTPUT VOLTAGE HAS DRIFTED.

CONSULT MPS ENGINEERING DEPT. FOR POWER SUPPLY TROUBLESHOOT

WHAT IS VOLTAGE ?

ABOVE 14.3V OR BETWEEN 14.0V AND 0.1V

ISSUE:
12V BATTERY PACK MAY NEED REPLACEMENT.

REFER TO:
REPLACEMENT COMPONENTS LIST
ON PG. 20-21.

ISSUE:
FAULTY DIODE IN BATTERY CHARGING CIRCUIT.

CONSULT MPS ENGINEERING DEPT. FOR TECHNICAL SUPPORT & CONTINUED TROUBLESHOOTING.

CONTINUE TO NEXT PAGE

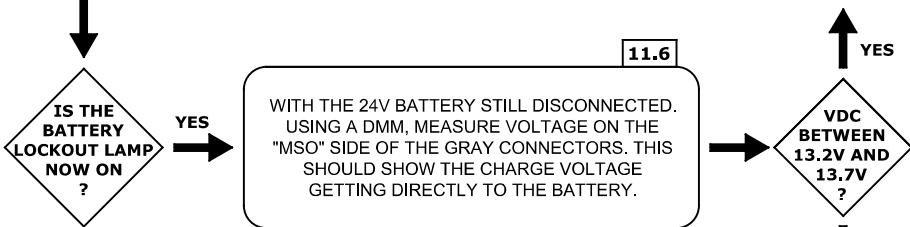
Chart 11: MSO Battery Not Charging (Sheet 2 of 2)

CHART 11 SHEET 2 OF 2

BATTERY NOT CHARGING, CONT.

11.5
 LOOSEN THE CONTROL MODULE LOCKING SCREW, AND SLIDE THE MODULE OUT AND BACK INTO ITS MATING CONNECTORS. RETIGHTEN THE LOCATING SCREW BACK INTO ITS ORIGINAL POSITION. MSO SHOULD TURN ON AUTOMATICALLY, AND POWER SUPPLY LAMP SHOULD BE ILLUMINATED AS WELL AS THE BATTERY LOCKOUT LIGHT.

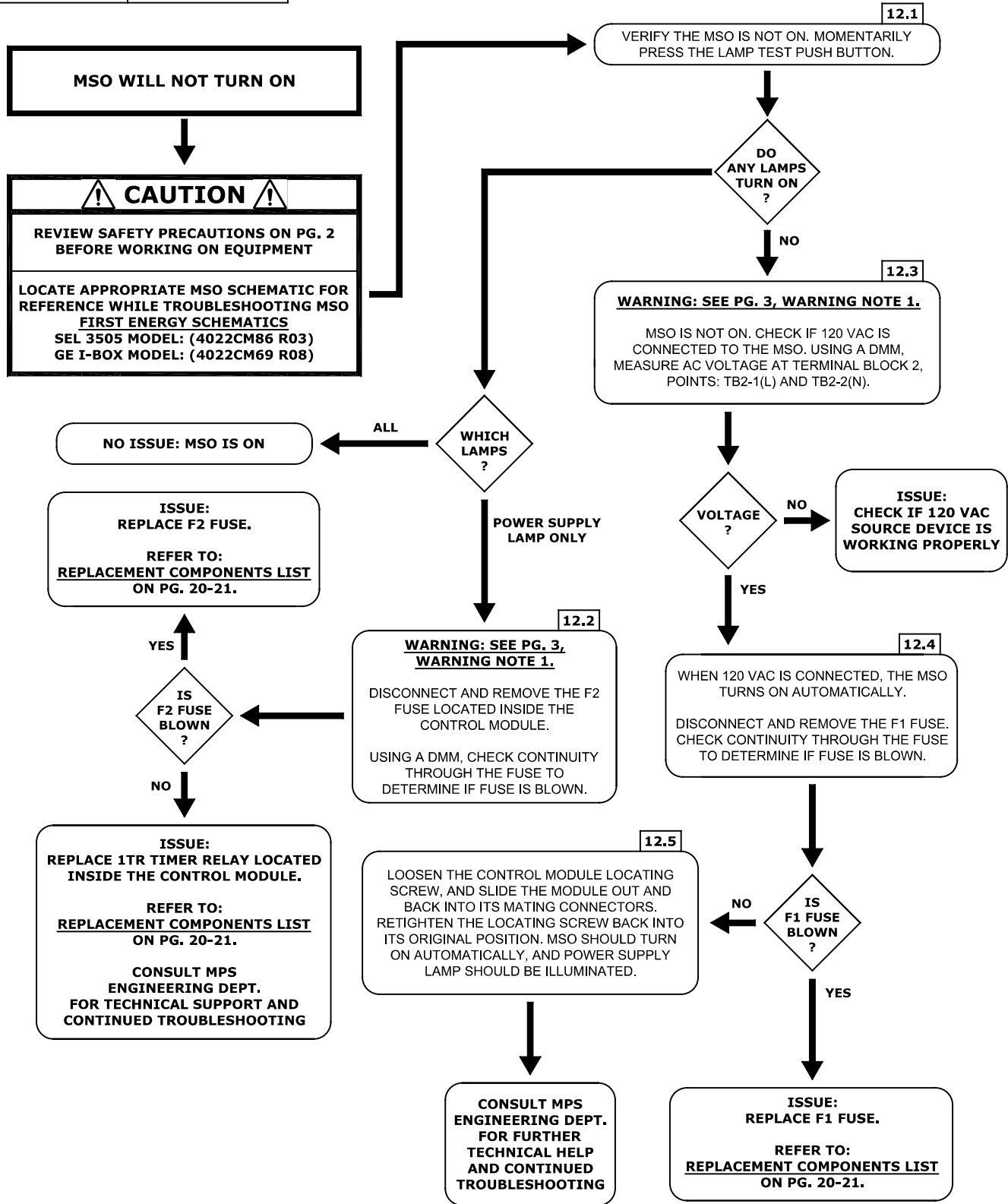
ISSUE:
 REPLACE THE 12V BATTERY PACK.
REFER TO:
REPLACEMENT COMPONENTS LIST
 ON PG. 20-21.
CONSULT MPS ENGINEERING DEPT. FOR FURTHER SUPPORT.



CONSULT MPS ENGINEERING DEPT. FOR TECHNICAL HELP AND CONTINUED TROUBLESHOOTING

Chart 12: MSO Will Not Turn On (Sheet 1 of 1)

CHART 12 SHEET 1 OF 1



**Replacement Components List
(Sheet 1 of 2)**

CONTROL MODULE

Catalog Number	Schematic Symbol	Description
4-102A	VR	VOLTAGE SENSING RELAY W/ TIME DELAY (12-30)VDC
412-30-0-028-00	1TR	TIME DELAY RELAY, <u>OFF DELAY</u> , 5 SEC. (12V, OPTOCOUPLER)
412-20-0-010-00	2TR	TIME DELAY RELAY, <u>ON DELAY</u> , 0.5 — 100 HR (12-125)VDC
4-223-12B	1CR, 2CR	TIME DELAY RELAY, <u>INTERVAL ON</u> , MOTOR RUN (12-125)VDC
4-95	3CR	RELAY, 4PDT (24V)
3-017	4CR	RELAY, SPDT (12V)
404-20-0-023-00	5CR/6CR	RELAY, DPDT (12V)
404-20-0-025-00	8CR	RELAY, SPDT (24V)
404-20-0-017-00	F1	FUSE, 15A 250V
404-20-0-019-00	F2/F3	FUSE, 10A 250V
404-20-0-018-00	F4	FUSE, 5A 250V
404-20-0-021-00	-	4CR / 8CR HOLDING CLIP
404-20-0-022-00	-	3CR / 5CR / 6CR HOLDING CLIP
404-20-0-115-00	-	POWER SUPPLY, 15V, 15A, 225W (MEANWELL HEP-240-15A)
4-459-12B	-	DC/DC BOOST CONVERTER, 12V TO 24V
4-392-8-1	-	RTU, SEL-3505 RTAC
4-98-15V225W-K	-	POWER SUPPLY <u>RETROFIT ASSEMBLY KIT</u> , (MEANWELL HEP-240-15A)

CONTROL PANEL

Catalog Number	Schematic Symbol	Description
406-20-0-010-00	IL1, IL2, IL3, IL4, IL6, IL7	28V LAMP (757)
4-448-12	IL5	12V LAMP (756)
4-293	PB1/PB2	(OPEN/CLOSE) PUSHBUTTON SWITCH, DPDT, RED LED
406-20-0-013-01	PB3	LAMP TEST PUSHBUTTON SWITCH, DPDT, NO LED
4-139	TM1/TM2	BATT. TEST/RESET TOGGLE SWITCH, MOMENTARY, SPDT
406-20-0-015-00	L/R	LOCAL/REMOTE TOGGLE SWITCH, DPDT
408-50-0-001-00	DS	DOOR SWITCH BRACKET/SPDT
4-292-1B	CO	OPEN/CLOSE CYCLE COUNTER
406-20-0-016-00	VAC	120VAC, SINGLE OUTLET, 3-PRONG RECEPTACLE
406-20-0-046-00	-	LAMP SOCKET COVER, RED
406-20-0-012-00	-	LAMP SOCKET COVER, AMBER
4-294	-	PUSHBUTTON CAP RED
4-295	-	PUSHBUTTON CAP GREEN
406-20-0-014-00	-	PUSHBUTTON CAP WHITE
4-53	-	(OPEN/CLOSE) PUSHBUTTON GUARD, CLEAR

Note: Consult factory for items not listed in the above table

**Replacement Components List
(Sheet 2 of 2)**

CONTACTOR PANEL

Catalog Number	Schematic Symbol	Description
405-20-0-010-00	7CR/BTC	RELAY, SPDT, 30A (12V)
405-20-0-001-01	CAP BANK	SUPER CAPACITOR MODULE, 16V, 58F
405-20-0-008-00	CCR	CAPACITOR CHARGING RESISTOR, 100W, 2Ω
4-93-1	BTR1/BTR2	BATTERY TEST RESISTORS #1 & #2, 200W, 1Ω (EACH)
405-20-0-011-00	MC	MOTOR CONTACTOR RELAY, SPDT, 12V
405-30-0-004-00	CB1/CB2	CIRCUIT BREAKER ASSEMBLY, 12V, 40A
407-30-0-008-00	BW	BATTERY WARMER ASSEMBLY
MSO-BAT-OD12100	BATTERY	BATTERY PACK W/ CABLE ASSEMBLY, 12V, 100AH

MOTOR-BOX

Catalog Number	Schematic Symbol	Description
401-20-0-018-00	LSDI, LSIP, LSOP, LSCL	LIMIT SWITCH, DPDT
401-20-0-001-00	CH	STRIP HEATER 120VAC, 150W
401-20-0-016-00	TS1	STRIP HEATER THERMOSTAT
401-30-0-025-00	TB2	3 POS TERMINAL BLOCK ASSEMBLY, 120VAC INPUT
401-20-0-002-00	SP	SURGE PILLS
401-30-0-006-00	-	DECOUPLER HANDLE
M9-382F	-	INTERLOCK PIN W/ TAG ASSEMBLY

SUB-PLATE

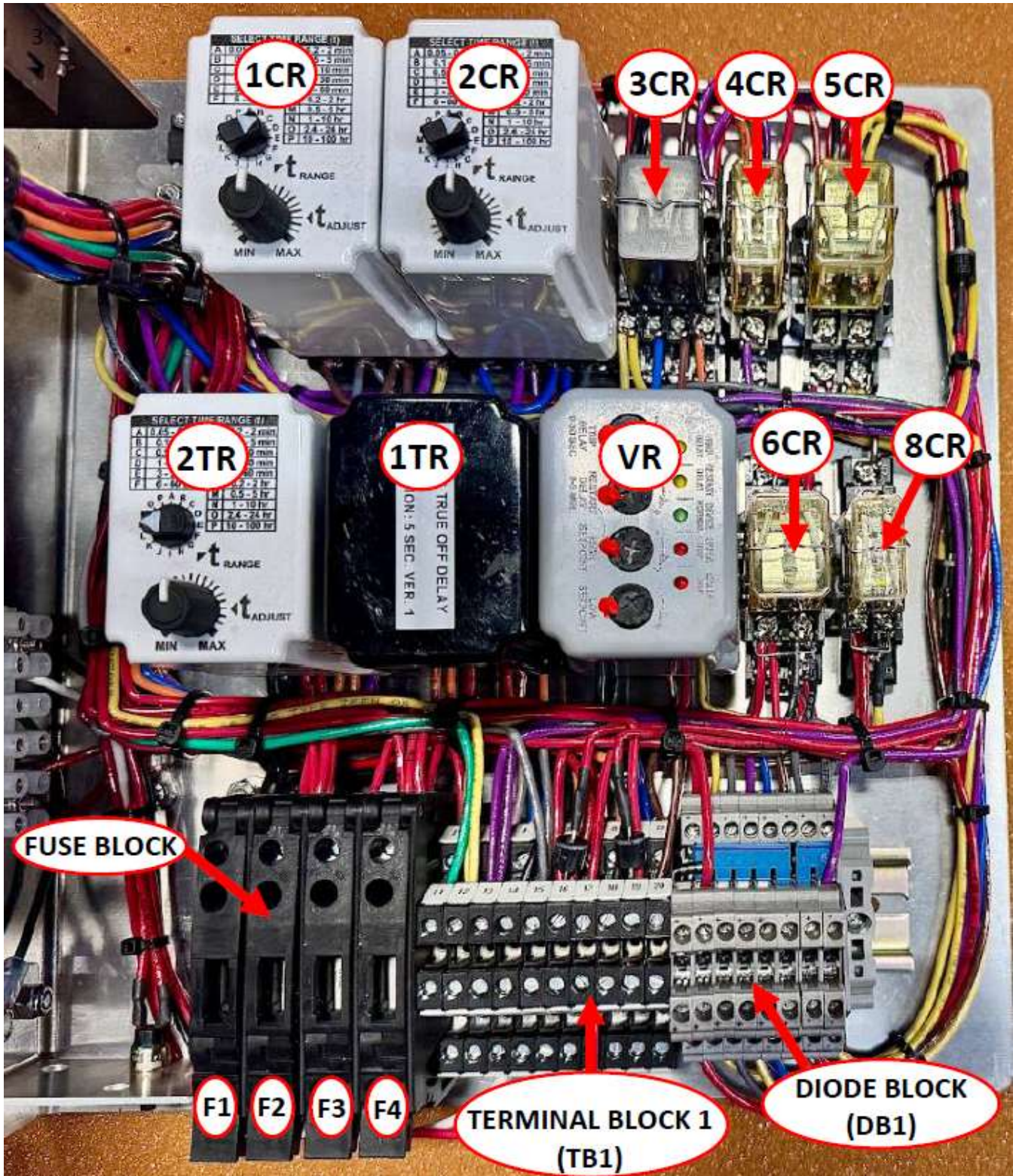
Catalog Number	Schematic Symbol	Description
4-648	F5/F6/F7/F8	FUSE, 250V, 2A, TIME DELAY

EXTERIOR

Catalog Number	Schematic Symbol	Description
50-4024BP	-	MSO MANUAL HANDLE, TRANSMISSION, 24" D-RING
MSO9-333SQ	-	CONTROL ROD ADJUSTER SCREW ASSY, 1.75" SQUARE F.G. 1" IPS COUPLER
408-20-0-001-00	-	MSO CABINET DOOR HANDLE, SS

Note: Consult factory for items not listed in the above table

Relay Layout Diagram



Notes:

1. If your control module relays do not look like what is shown in this picture, contact the factory.
2. Refer to the MSO Schematic supplied with your MSO for full relay names.

VISUAL CONFIRMATION SWITCH (OPEN)



