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# **MSO** MOTORIZED SWITCH OPERATOR

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## **Troubleshooting Guide, Version A, Rev. 02**

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### **Reciprocating Control Modules**

This guide applies to the following CMR#s:

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MSO-CMR-2	MSO-CMR-53
MSO-CMR-22	MSO-CMR-54
MSO-CMR-25	MSO-CMR-55
MSO-CMR-30	MSO-CMR-56
MSO-CMR-31	MSO-CMR-57
MSO-CMR-32	MSO-CMR-62
MSO-CMR-36	MSO-CMR-LVA
MSO-CMR-38	MSO-CMR-R1
MSO-CMR-39	MSO-CMR-R2
MSO-CMR-45	MSO-CMR-R2PG&E
MSO-CMR-46	

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# Introduction

This manual provides a troubleshooting guide for diagnosing and repairing issues with the Inertia 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 factory for assistance in troubleshooting the MSO and/or overhead switch.

## Where to Begin

This manual covers some of the most common issues with MSO's, and although lengthy, portions of the manual may not be necessary to review in order to diagnose a problem with your specific MSO. Before beginning, it is important to review the "General Safety Information" listed on the lower half of this page, and on the next page as well.

In all cases, the first troubleshooting procedure to follow is a "Preliminary Lamp Test Check" to verify that the MSO is ON, and to verify that all the status indicator lamps are functioning properly. See page 3, Chart 1 for this troubleshooting guide.

After the "Preliminary Lamp Test Check" procedure has been completed, refer to the Table of Contents on the first page of this document, and locate the specific MSO troubleshooting chart that is needed in order to diagnose the problem with your MSO. Each chart should have specific instructions for diagnosing each issue, and recommendations for replacement components. If any part of the troubleshooting chart is not understood by the user, it is recommended that the user contact the factory for technical support with either troubleshooting a MSO or overhead switch. Use the "Notes" pages in the back of this manual to log diagnostics before consulting factory.

## Tools Required

Most items within this troubleshooting guide will only require a true RMS digital volt meter. For DC voltages, it is recommended (but not necessary) to have a meter that reads 10 VDC and greater with a precision of 2 decimal places or greater when verifying the accuracy of voltage sensors, and reading battery or power supply voltages.

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 for sending remote control commands with a RTU when communication devices are not available.
5. Appropriate communication cable for connecting to a RTU.

## General Safety Information

This manual is not intended as a substitute for proper training and adequate experience in the safe operation and maintenance of the equipment described herein. The MSO should be serviced and maintained by technicians or electricians that are familiar and have experience 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 will cause death or severe personal injury. 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 can result in death, or severe personal injury.

# Troubleshooting Chart Safety Notes

## **WARNING NOTE 1: Decoupling the MSO Motor**

For the MSO, the "Motor Decoupler Handle" must be rotated into the Motor Decoupled position in order to gain access to the control module, and main terminal block. Doing so, 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.

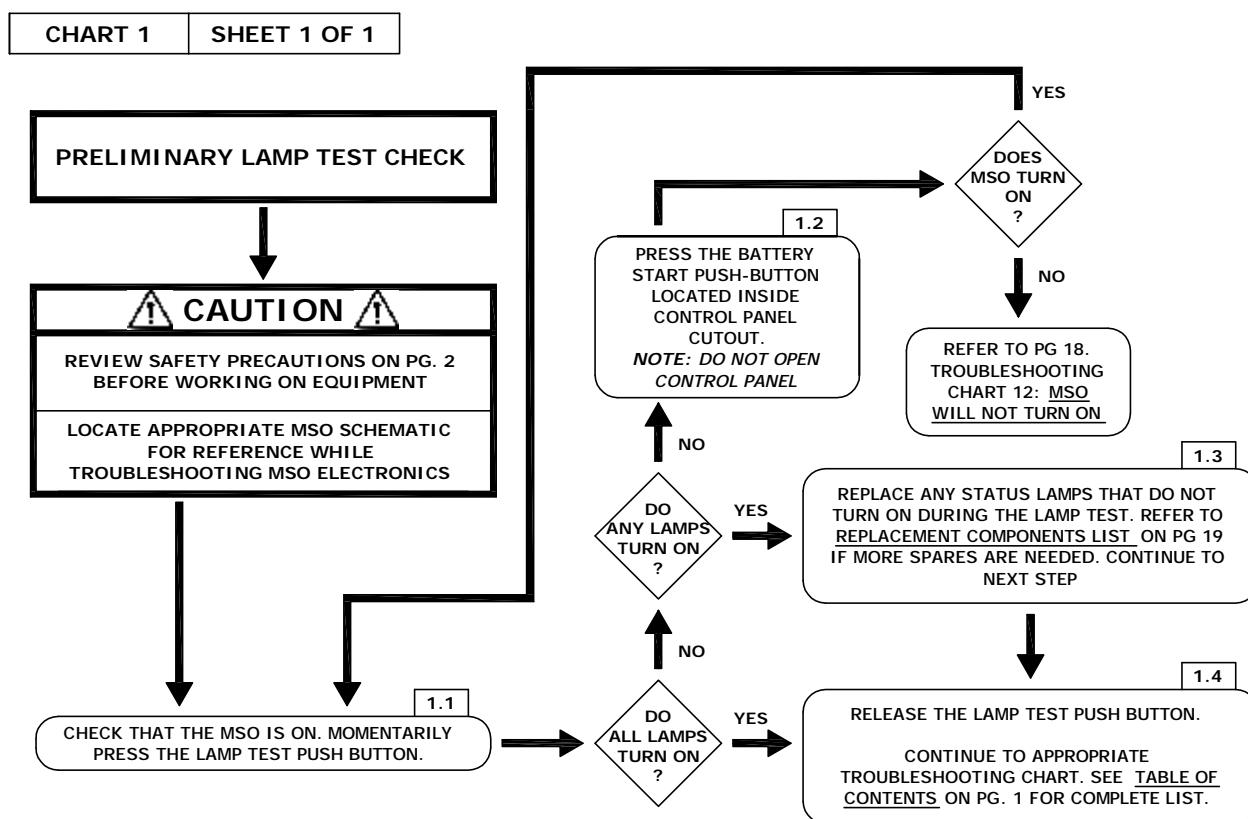
The user must verify the following before proceeding to decouple the motor for un-energized switches.

- 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.

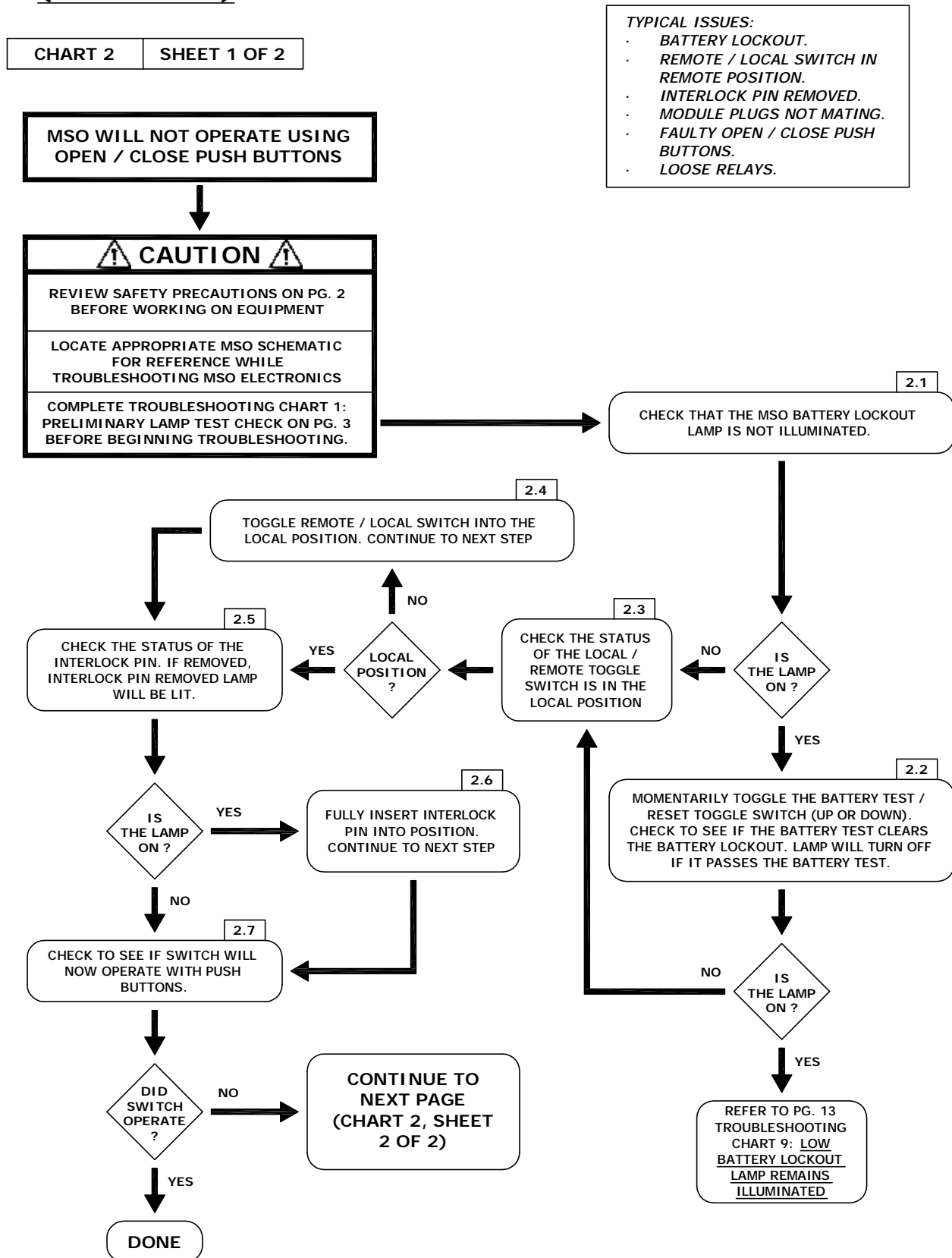
Failure to comply to the above danger may result in fire, injury, or death to equipment or troubleshooting personnel.

 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 Check (Sheet 1 of 1)

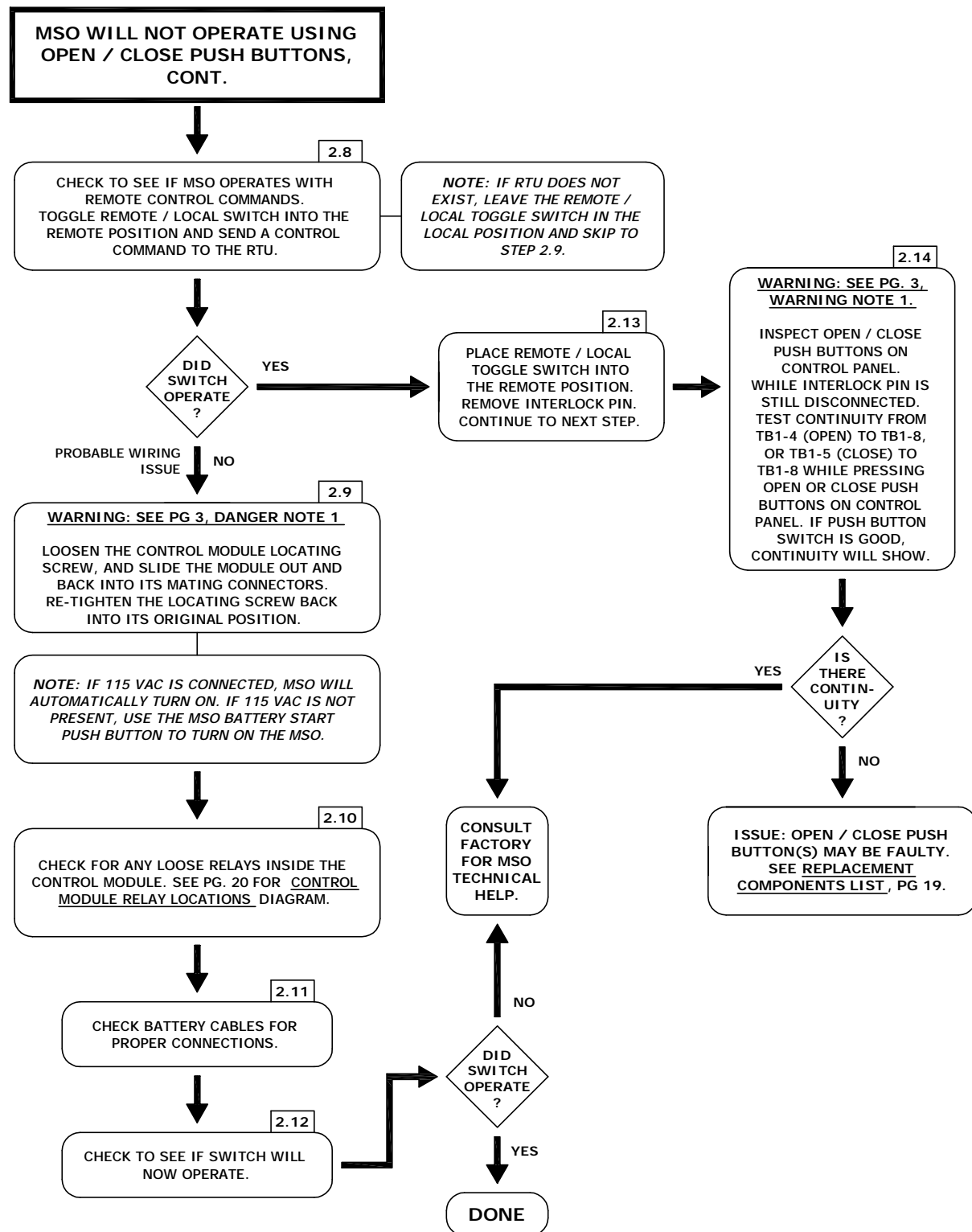


## Chart 2: MSO Will Not Operate Using Open / Close Push Buttons (Sheet 1 of 2)



## 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

**MSO WILL NOT OPERATE USING  
REMOTE COMMANDS**

**CAUTION**

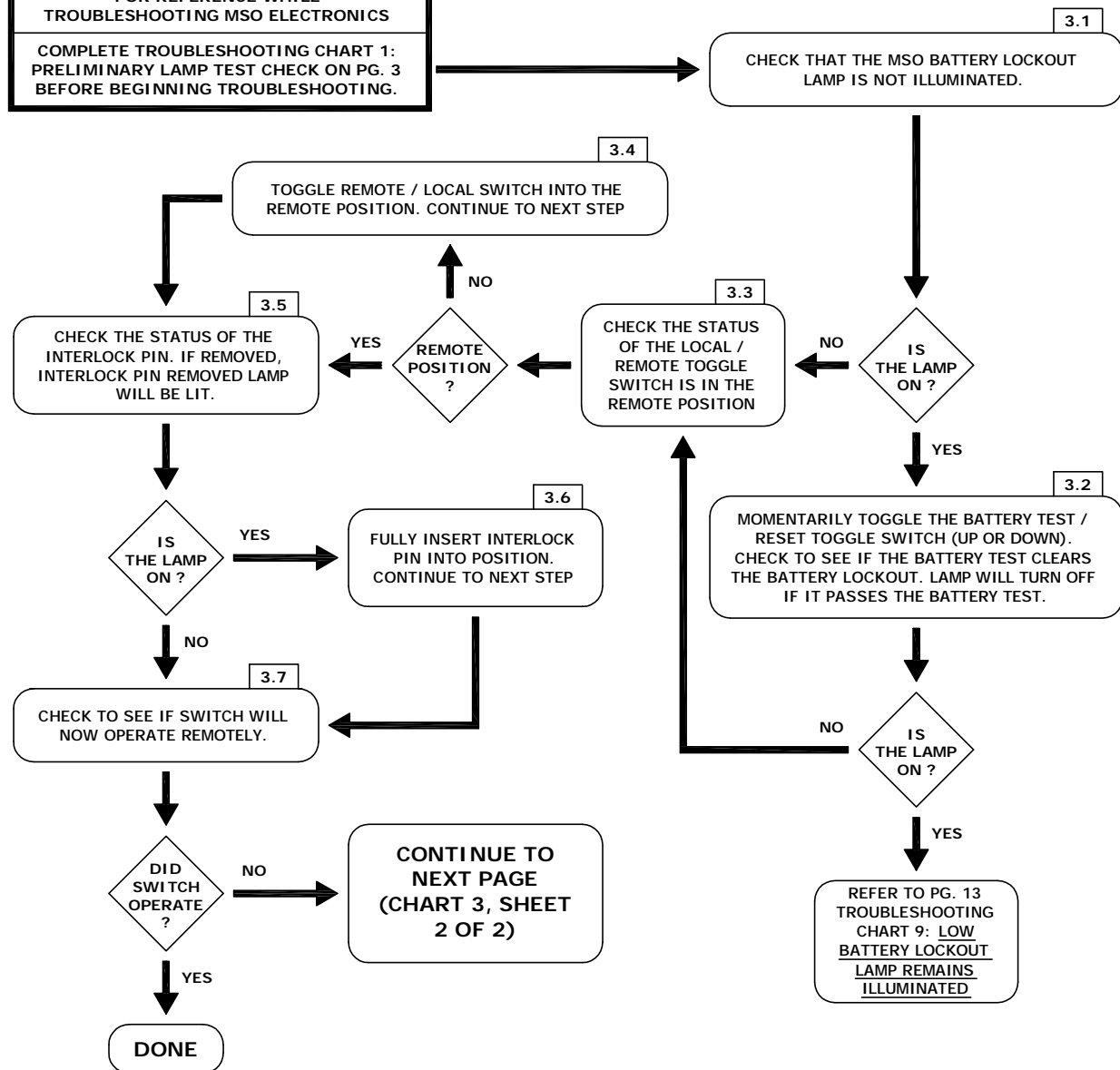
REVIEW SAFETY PRECAUTIONS ON PG. 2  
BEFORE WORKING ON EQUIPMENT

LOCATE APPROPRIATE MSO SCHEMATIC  
FOR REFERENCE WHILE  
TROUBLESHOOTING MSO ELECTRONICS

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

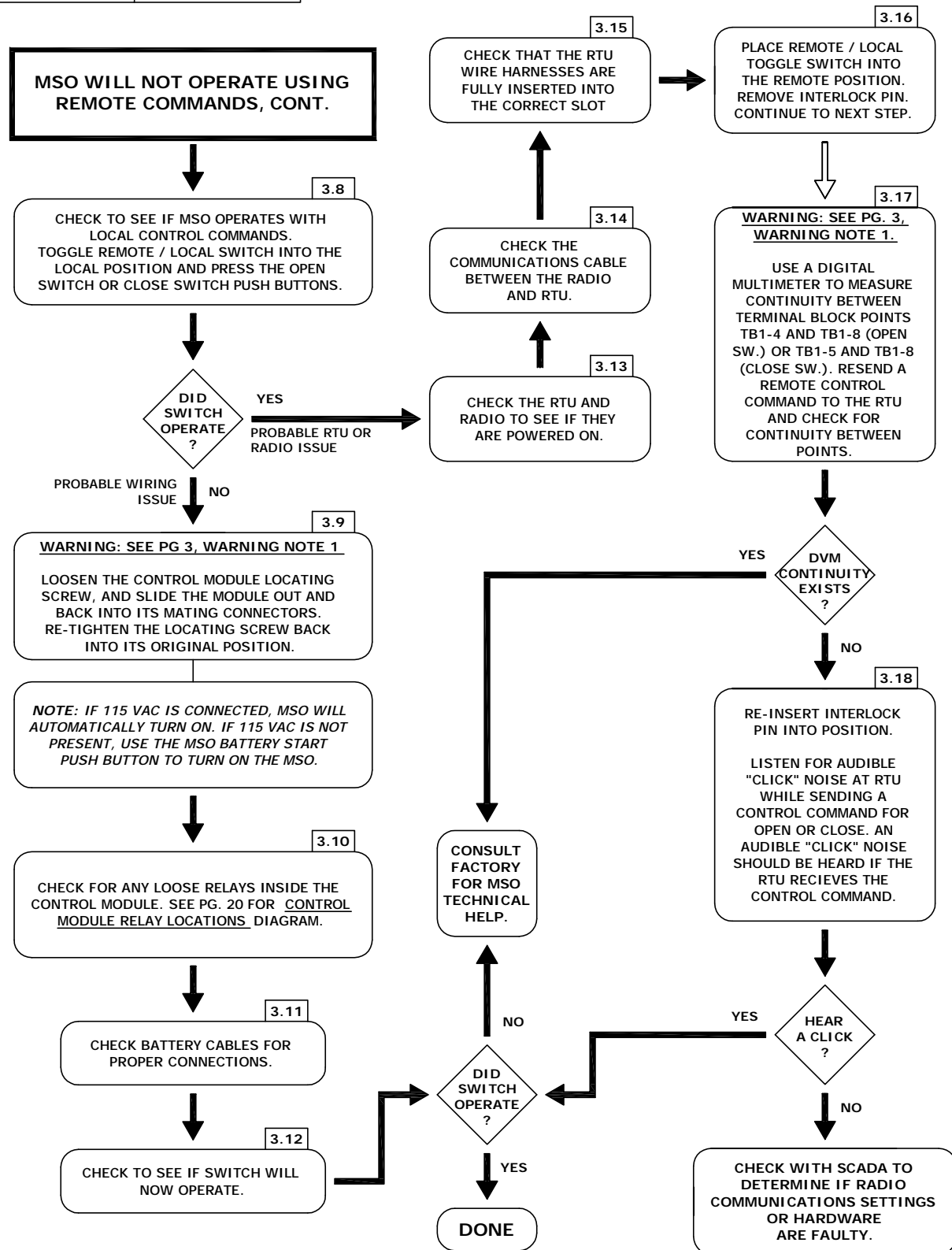
## TYPICAL ISSUES:

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



# 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

MSO HAS STALLED WHILE PERFORMING A SWITCH OPERATION



REVIEW SAFETY PRECAUTIONS ON PG. 2 BEFORE WORKING ON EQUIPMENT

LOCATE APPROPRIATE MSO SCHEMATIC FOR REFERENCE WHILE TROUBLESHOOTING MSO ELECTRONICS

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

### TYPICAL ISSUES:

- BAD BATTERY
- BAD VR RELAY
- COLD TEMPERATURES
- SWITCH NEEDS MAINTENANCE
- SWITCH ADJUSTMENT NEEDED

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 DVM, MEASURE AND NOTE BATTERY VOLTAGE AT THE TERMINAL BLOCK POINTS TB1-17 (+) AND TB1-18 (-). ALSO, MEASURE AND NOTE THE POWER SUPPLY OUTPUT VOLTAGE OF THE POWER SUPPLY AT TERMINAL BLOCK POINTS TB1-16 (+) AND TB1-18 (-).

4.3

MOMENTARILY TOGGLE THE BATTERY TEST / RESET TOGGLE SWITCH (UP OR DOWN) WHILE USING A DVM TO MEASURE BATTERY VOLTAGE AT THE TERMINAL BLOCK, TB1-17 (+) AND TB1-18 (-). A GOOD BATTERY WILL MAINTAIN A VOLTAGE ABOVE 22.8 VDC DURING A BATTERY TEST.

ISSUE: CONSULT FACTORY. VOLTAGE SENSING RELAY MAY NEED TO BE REPLACED.

BELOW 22.7V

IS BATTERY LOCKOUT LAMP ON ?

NO

YES

BATTERY WARMER INSTALLED ?

NO

YES

OUTDOOR AMBIENT TEMPERATURE ?

ABOVE 0°C

BELOW 0°C

ISSUE: INSTALL A BATTERY WARMER KIT. SEE REPLACEMENT COMPONENTS LIST ON PG. 19.

ISSUE: REPLACE THE 24V 18AH BATTERY PACK. SEE REPLACEMENT COMPONENTS LIST ON PG. 19.

ABOVE 22.9V

WHAT WAS VOLTAGE ?

IS BATTERY LOCKOUT LAMP ON ?

NO

ISSUE: CONSULT FACTORY. VOLTAGE SENSING RELAY MAY NEED TO BE REPLACED.

CONSULT FACTORY FOR FURTHER MSO TECHNICAL HELP.

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

POWER SUPPLY LAMP DOES NOT ILLUMINATE



REVIEW SAFETY PRECAUTIONS ON PG. 2 BEFORE WORKING ON EQUIPMENT

LOCATE APPROPRIATE MSO SCHEMATIC FOR REFERENCE WHILE TROUBLESHOOTING MSO ELECTRONICS

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

### TYPICAL ISSUES:

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

5.1

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

USING A DVM, MEASURE POWER SUPPLY OUTPUT DC VOLTAGE AT THE TERMINAL BLOCK POINTS TB1-16 (+) AND TB1-18 (-). VOLTAGE SHOULD BE BETWEEN 27.8 VDC AND 28.4 VDC.

5.4

LOOSEN THE CONTROL MODULE LOCATING 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.

CONSULT FACTORY FOR FURTHER MSO TECHNICAL HELP AND CONTINUED TROUBLESHOOTING

ISSUE: POWER SUPPLY OUTPUT VOLTAGE HAS DRIFTED. NEW POWER SUPPLY NEEDED. SEE REPLACEMENT COMPONENTS LIST ON PG. 19.

5.2

USING A DVM, MEASURE THE POWER SUPPLY 115 VAC INPUT VOLTAGE AT TERMINAL BLOCK 2, POINTS TB2-1 AND TB2-2. INPUT VOLTAGE SHOULD BE BETWEEN 85V AND 140V

5.3

REMOVE AND CHECK 120 VAC 15A F1 FUSE FOR CONTINUITY. FUSE MAY BE BLOWN.

IS FUSE BLOWN ?

ISSUE: REPLACE F1 15A FUSE. SEE REPLACEMENT COMPONENTS LIST ON PG. 19 FOR SPARES.

ALSO CHECK

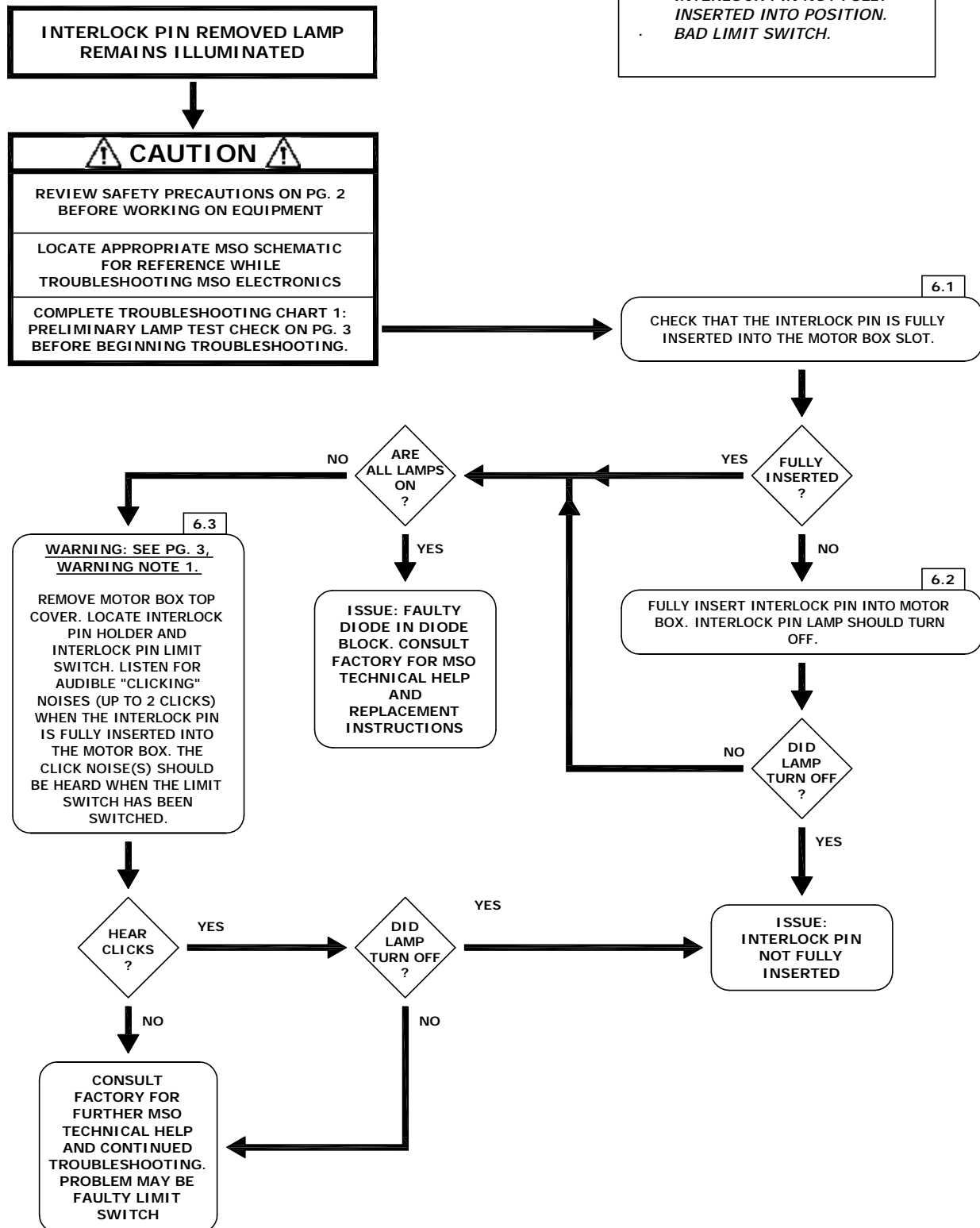
ISSUE: CHECK IF 120 VAC SOURCE DEVICE IS WORKING PROPERLY

## 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.



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

CHART 7 SHEET 1 OF 1

**MOTOR DECOUPLED LAMP REMAINS ILLUMINATED**



REVIEW SAFETY PRECAUTIONS ON PG. 2  
BEFORE WORKING ON EQUIPMENT

LOCATE APPROPRIATE MSO SCHEMATIC  
FOR REFERENCE WHILE  
TROUBLESHOOTING MSO ELECTRONICS

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

### TYPICAL ISSUES:

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

7.1

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

FULLY ROTATED ?

YES

NO

7.2

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

NO

DID LAMP TURN OFF ?

YES

ISSUE: MOTOR DECOUPLER HANDLE NOT FULLY ROTATED INTO COUPLED POSITION

NO

ARE ALL LAMPS ON ?

YES

ISSUE: FAULTY DIODE IN DIODE BLOCK. CONSULT FACTORY FOR MSO TECHNICAL HELP AND REPLACEMENT INSTRUCTIONS

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 ?

YES

NO

CONSULT FACTORY FOR FURTHER MSO TECHNICAL HELP AND CONTINUED TROUBLESHOOTING. PROBLEM MAY BE FAULTY LIMIT SWITCH OR ADJUSTMENT

DID LAMP TURN OFF ?

YES

NO

## 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



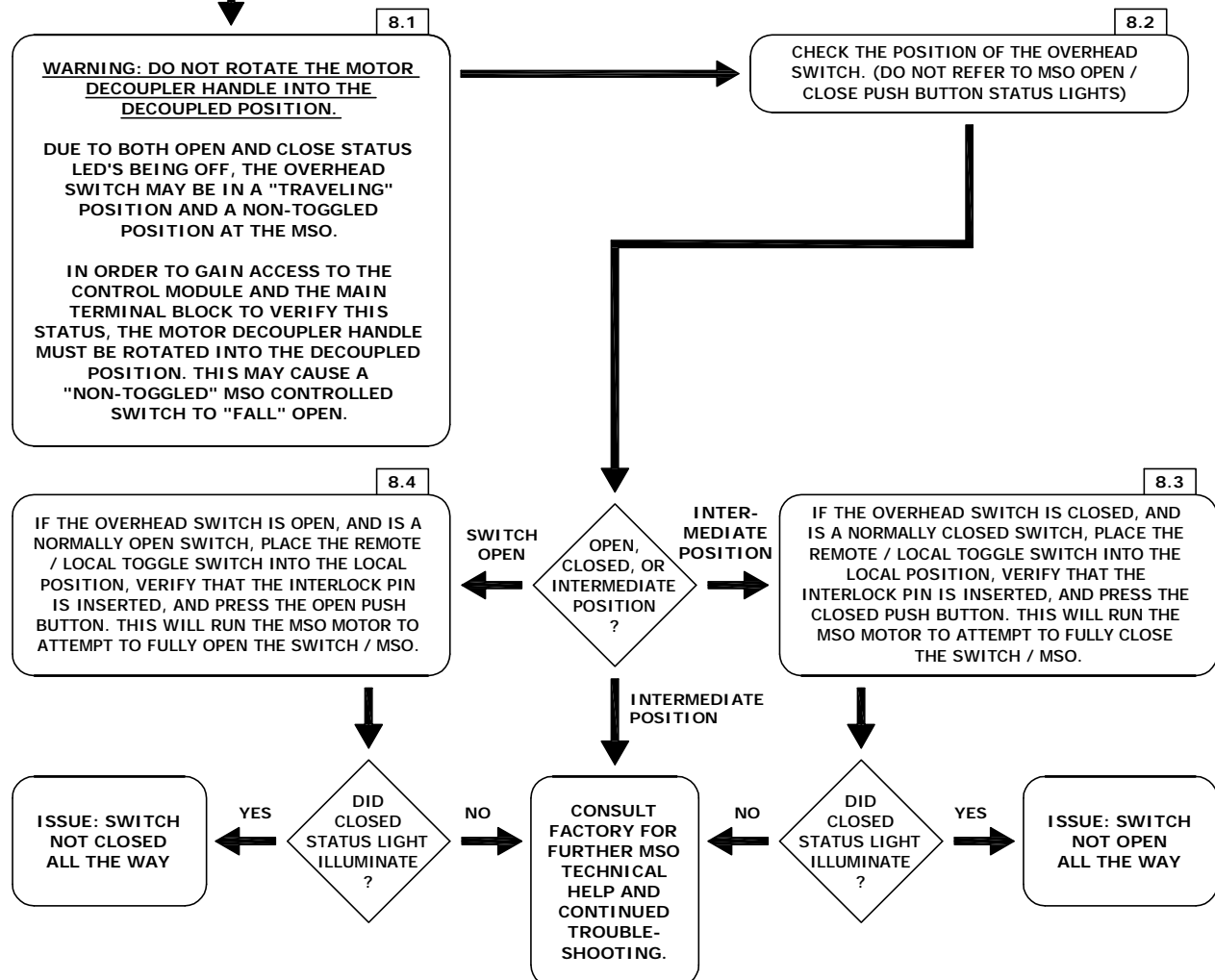
REVIEW SAFETY PRECAUTIONS ON PG. 2 BEFORE WORKING ON EQUIPMENT

LOCATE APPROPRIATE MSO SCHEMATIC FOR REFERENCE WHILE TROUBLESHOOTING MSO ELECTRONICS

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.



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

CHART 9 SHEET 1 OF 2

LOW BATTERY LOCKOUT LAMP  
REMAINS ILLUMINATED



REVIEW SAFETY PRECAUTIONS ON PG. 2  
BEFORE WORKING ON EQUIPMENT

LOCATE APPROPRIATE MSO SCHEMATIC  
FOR REFERENCE WHILE  
TROUBLESHOOTING MSO ELECTRONICS

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

### TYPICAL ISSUES:

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

9.1

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

USING A DVM, MEASURE VOLTAGE AT  
TERMINAL BLOCK 1, POINTS TB1-13 (+) AND  
TB1-18 (-). VOLTAGE SHOULD EXIST, AND BE  
APPROXIMATELY 24 VDC.

9.2

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

WARM ?

YES

REFER TO PG. 15  
TROUBLESHOOTING  
CHART 10:  
**BATTERY TEST**  
"STUCK" OR  
"LATCHED" ON.

NO

ISSUE: FAULTY  
DIODE IN DIODE  
BLOCK. CONSULT  
FACTORY FOR MSO  
TECHNICAL HELP  
AND  
REPLACEMENT  
INSTRUCTIONS

9.3

IF THE POWER SUPPLY IS ON (AND 115 VAC  
CONNECTED), DISCONNECT FUSE F1 AND  
WAIT 1 MINUTE BEFORE PROCEEDING.  
USING A DVM, MEASURE BATTERY VOLTAGE  
AT TERMINAL BLOCK 1, POINTS TB1-17 (+)  
AND TB1-18 (-). READING SHOULD BE  
BETWEEN 24 VDC AND 27 VDC.

BATTERY  
VOLTAGE ?

ABOVE  
24 VDC

9.5

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

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

BELOW  
23.3 VDC

9.4

RECONNECT THE F1 FUSE TO TURN THE  
POWER SUPPLY BACK ON. ALLOW THE MSO TO  
RECHARGE THE 24V BATTERY PACK FOR AT  
LEAST 6 HOURS BEFORE PROCEEDING TO  
NEXT STEP.

UNDER  
23.3V  
AFTER CHARGE

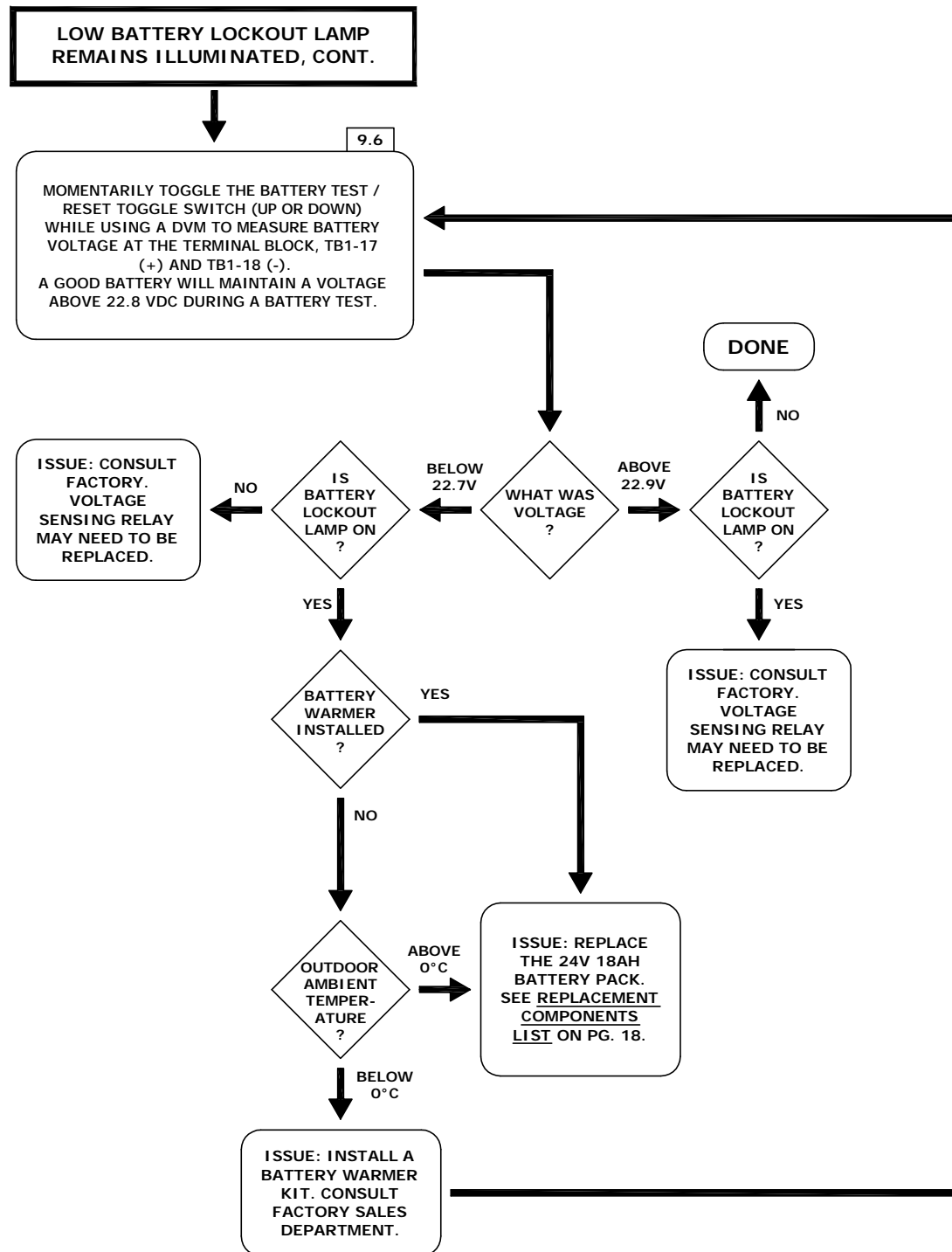
UNDER  
23.3V  
BEFORE CHARGE

ISSUE: REPLACE  
THE 24V 18AH  
BATTERY PACK.  
SEE **REPLACEMENT  
COMPONENTS  
LIST** ON PG. 19.

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

CHART 9

SHEET 2 OF 2



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

CHART 10 SHEET 1 OF 1

## BATTERY TEST "STUCK" OR "LATCHED" ON



REVIEW SAFETY PRECAUTIONS ON PG. 2 BEFORE WORKING ON EQUIPMENT

LOCATE APPROPRIATE MSO SCHEMATIC FOR REFERENCE WHILE TROUBLESHOOTING MSO ELECTRONICS

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

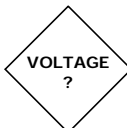
### TYPICAL ISSUES:

- 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.

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 (-).

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.



0 VDC

ISSUE: LATCHED RTU CONTROL RELAY. CONTACT SCADA TO FIX STATUS OF RTU CONTROL COMMANDS. ALL CONTROL COMMANDS SHOULD BE PULSES (200-400mS LENGTH)

NO READING

VERIFY WHICH RELAYS ARE KEEPING THE BATTERY TEST "STUCK" OR "LATCHED" ON. WHILE MSO IS ON, DISCONNECT THE "VR" RELAY AND THE "3CR" RELAY. SEE RELAY LAYOUT DIAGRAM ON PG 20.



YES

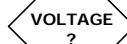
IF THE BATTERY TEST IS STILL ACTIVE ON THE BATTERIES, THE BATTERY VOLTAGE WILL FALL, EVEN WITH A NEW BATTERY. USING A DVM, MEASURE BATTERY VOLTAGE AT TB1-17 (+) AND TB1-18 (-).

NO

ISSUE: REPLACE 1TR TIMER RELAY LOCATED INSIDE THE CONTROL MODULE. SEE REPLACEMENT COMPONENTS LIST ON PG 19.

CONSULT FACTORY FOR FURTHER MSO TECHNICAL HELP AND CONTINUED TROUBLESHOOTING

HOLDING STEADY



FALLING

ISSUE: REPLACE BTC RELAY LOCATED INSIDE THE CONTACTOR PANEL. SEE REPLACEMENT COMPONENTS LIST, ON PG 19. CONSULT FACTORY FOR REPLACEMENT INSTRUCTIONS



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

CHART 11 SHEET 1 OF 2

BATTERY NOT CHARGING

**CAUTION**

REVIEW SAFETY PRECAUTIONS ON PG. 2 BEFORE WORKING ON EQUIPMENT

LOCATE APPROPRIATE MSO SCHEMATIC FOR REFERENCE WHILE TROUBLESHOOTING MSO ELECTRONICS

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

TYPICAL ISSUES:

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

CHECK THAT THE MSO POWER SUPPLY ON LAMP IS ILLUMINATED.

IS THE LAMP ON ?

NO

YES

ISSUE: REPLACE 1TR TIMER RELAY LOCATED INSIDE THE CONTROL MODULE. SEE REPLACEMENT COMPONENTS LIST ON PG 19.

REFER TO PG. 9 TROUBLESHOOTING CHART 5: POWER SUPPLY LAMP DOES NOT ILLUMINATE

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

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

VDC BETWEEN 27.8V AND 28.4V ?

YES

NO

WHAT IS VOLTAGE ?

0 V (OFF)

ISSUE: FAULTY DIODE IN DIODE BLOCK. CONSULT FACTORY FOR MSO TECHNICAL HELP AND REPLACEMENT INSTRUCTIONS

CONTINUE TO NEXT PAGE

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.

VDC BETWEEN 26.8V AND 27.4V ?

NO

YES

ISSUE: REPLACE THE 24V 18AH BATTERY PACK. SEE REPLACEMENT COMPONENTS LIST ON PG. 19.

VOLTAGE ?

ABOVE 26.8V

BELOW 26.8V

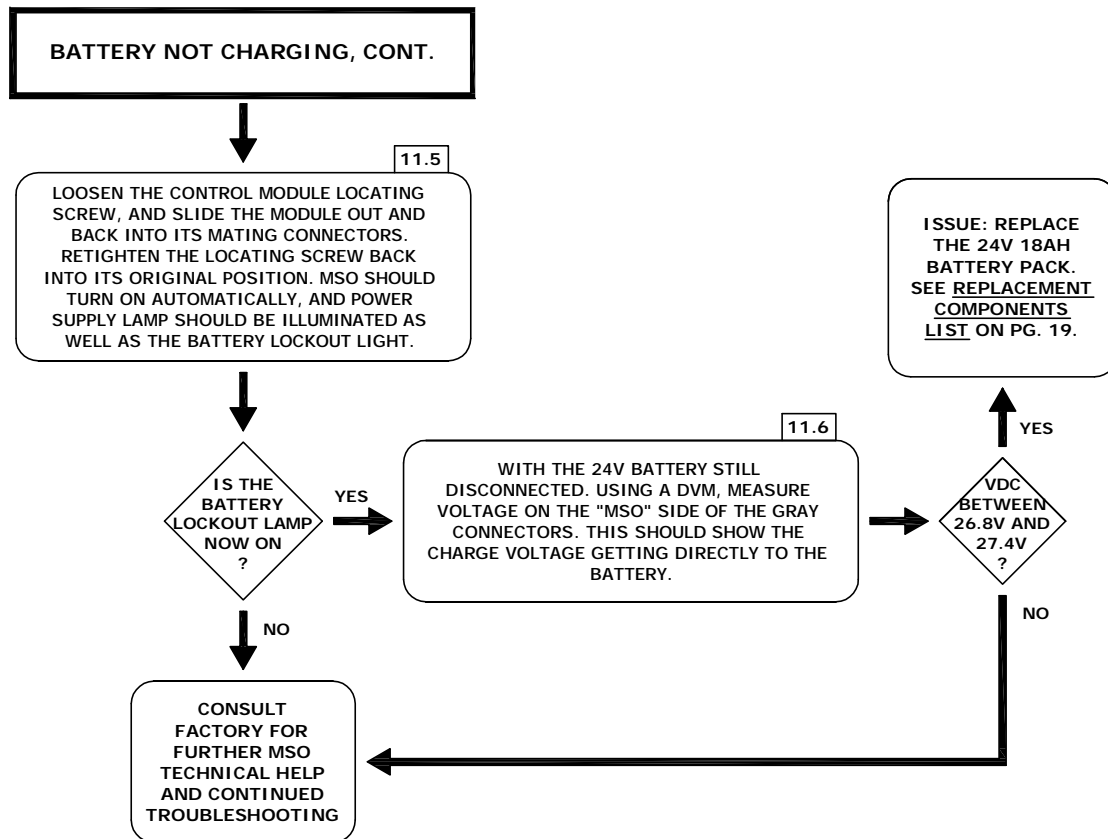
USING A DVM, MEASURE VOLTAGE AT TB1-17 (+) AND TB1-18 (-).

ISSUE: POWER SUPPLY OUTPUT VOLTAGE HAS DRIFTED. SEE REPLACEMENT PARTS LIST FOR NEW POWER SUPPLY PART NUMBER

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

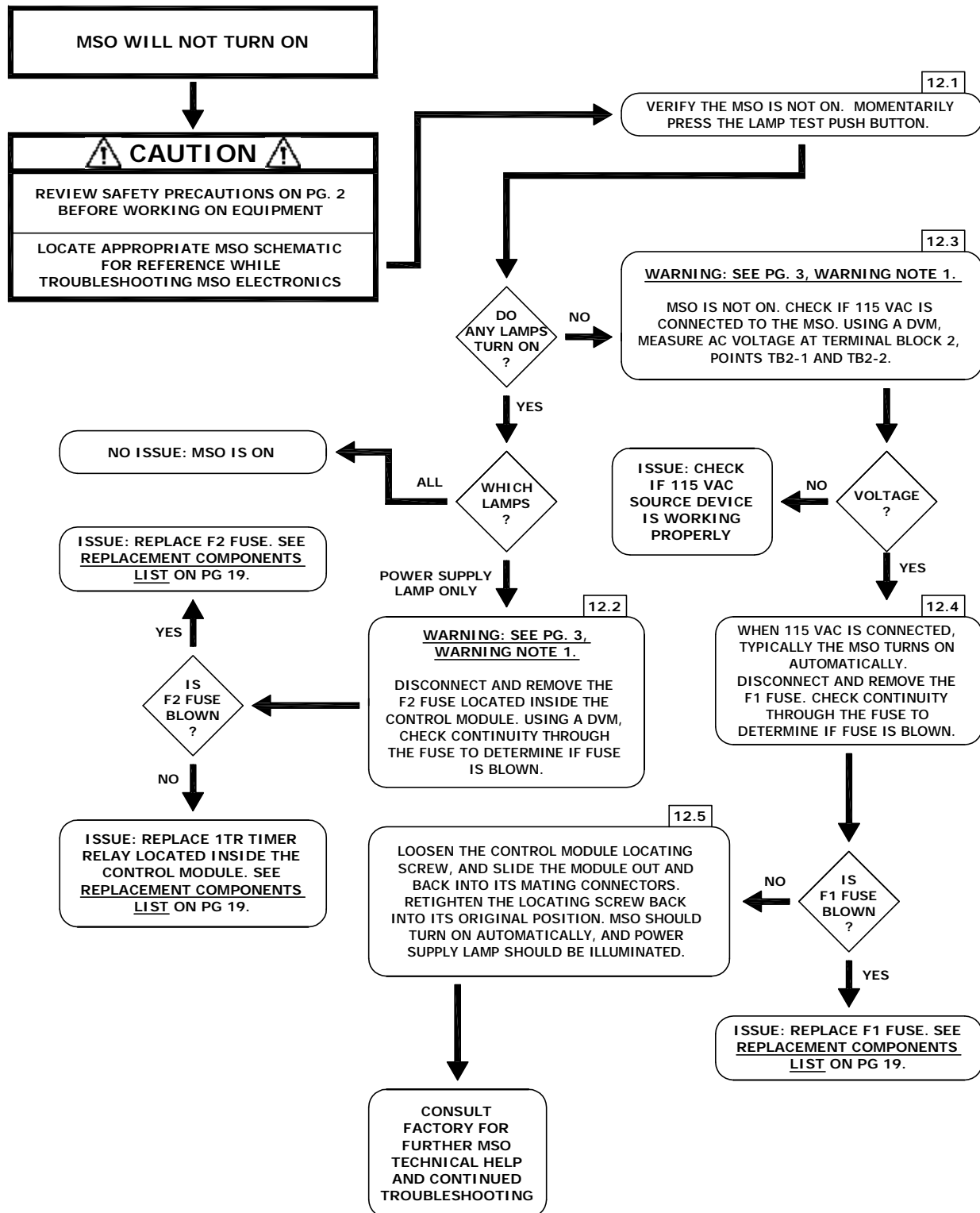
CHART 11

SHEET 2 OF 2



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

CHART 12 SHEET 1 OF 1



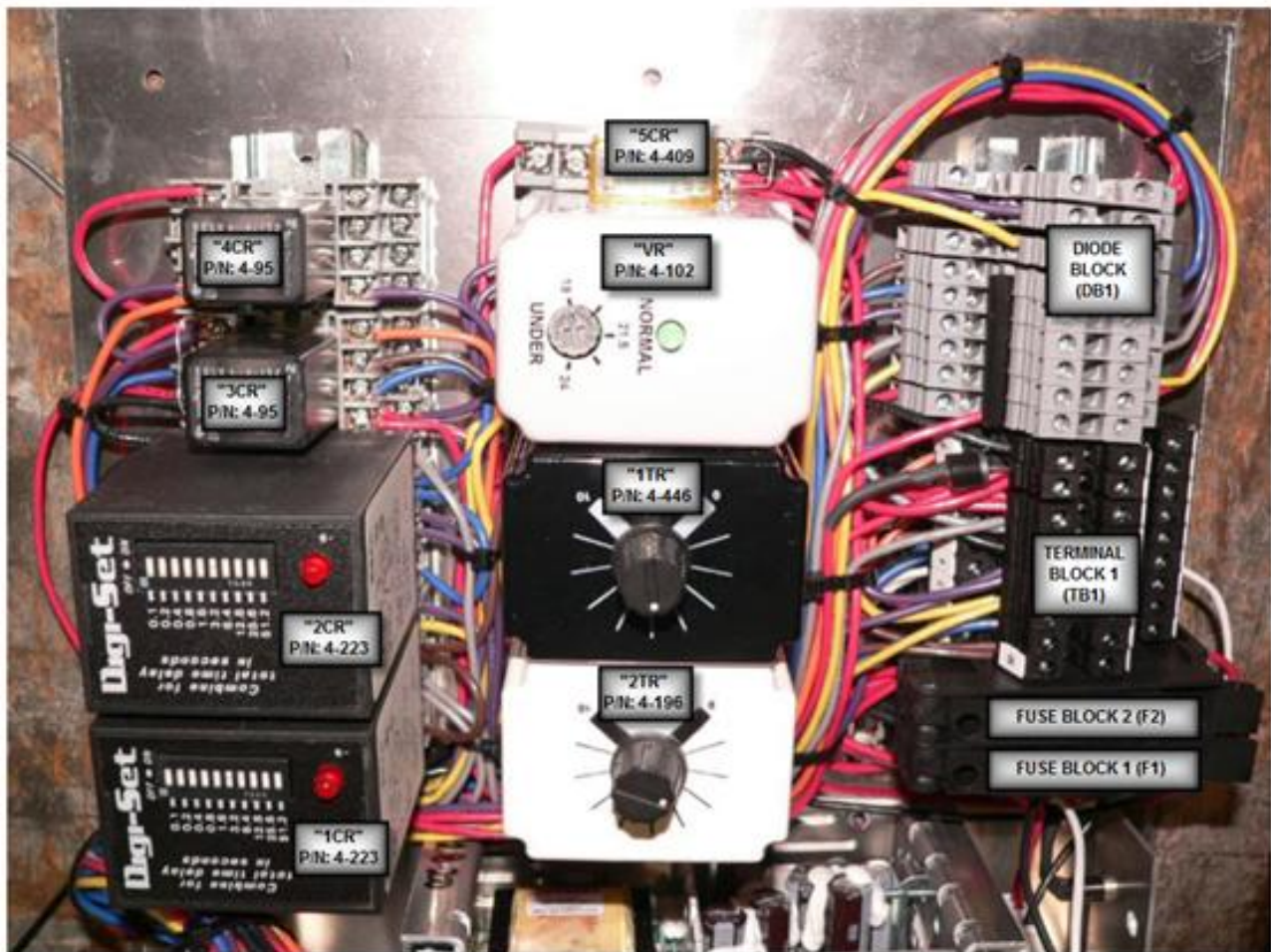
# Replacement Components List

Catalog Number	Schematic Symbol	Description
4-446	1TR	RELAY, DELAY ON DROPOUT, .1-10 SEC
4-196	2TR	RELAY, TIME DELAY, .5 TO 24 HR
4-102	VR	RELAY, VOLTAGE SENSOR
4-223	1CR, 2CR	RELAY, TIME DELAY, MOTOR RUN
4-95	3CR, 4CR	RELAY, 4PDT
4-409	5CR	RELAY, 1PDT
4-447	BTC	RELAY, 30A SPDT
4-65	F1	FUSE, 15A 250V
4-69	F2	FUSE, 5A 250V, TIME DELAY
4-98	-	24V, 6A POWER SUPPLY
MSO-BAT-R1	-	BATTERY PACK 24V, 18AH
CONSULT FACTORY	-	CONTROL MODULE ASSEMBLY
4-210	-	POLYPHASOR, IS-B50LN-C2
4-59	LSDI, LSIP, LSOP, LSCL	LIMIT SWITCH
4-448	IL1 THRU IL5	24V LAMP
4-46	-	LAMP SOCKET LENS, RED
4-47	-	LAMP SOCKET LENS, AMBER
4-293A-OP	IL6	PUSHBUTTON SW. W/ LED ASSEMBLY, OPEN, GRN
4-293A-CL	IL7	PUSHBUTTON SW. W/ LED ASSEMBLY, CLOSE, RED
M9-392	-	INTERLOCK PIN W/ TAG
4030P	-	MSO MANUAL HANDLE, DISTRIBUTION
50-4024P	-	MSO MANUAL HANDLE, TRANSMISSION
MSO9-333A	-	MSO CONTROL ROD ADJUSTING SCREW, 1" O.D. CONTROL ROD
MSO9-333SQ	-	MSO CONTROL ROD ADJUSTING SCREW, 1-3/4" SQ. F.G. CONTROL ROD
4-205	CH	STRIP HEATER 120VAC, 150W
4-204	TS1	STRIP HEATER THERMOSTAT

## Notes:

1. 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.

## Notes

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## Notes

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