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PAT

LOAD MOMENT INDICATOR

DS 350 MODULAR/GRAPHIC

for Lattice Boom Cranes

SERVICE *MANUAL*

P/N 031-300-190-118 REV. -, 12/18/2000

NOTICE

MANUAL REVISIONS

REV	DATE	NAME	DESCRIPTION
-	12/18/00	CSH	Troubleshooting Manual created.

TABLE OF CONTENTS

1 GENERAL INFORMATION

The PAT Load Moment Indicator (LMI) DS 350 has been designed to provide the crane operator with the essential information required to operate the machine within its design parameters.

Using different sensing devices, the Load Moment Indicator monitors various crane functions and provides the operator with a continuous reading of the crane's capacity. The readings continuously change as the crane moves through the motions needed to make the lift.

The LMI provides the operator with information regarding the angle of the boom, working radius, rated load and the total calculated weight being lifted by the crane.

If non permitted conditions are approached, the DS 350 Load Moment Indicator will warn the operator by sounding an audible alarm, lighting a warning light and locking out those functions that may aggravate the crane's condition.

Refer to operator's manual 031-300-190-089 for console operating instructions.

2 WARNINGS

The LMI is an operational aid that warns a crane operator of approaching overload conditions and of over hoist conditions that could cause damage to equipment and personnel.

The device is not, and shall not, be a substitute for good operator judgment, experience and use of accepted safe crane operating procedures.

The responsibility for the safe crane operation shall remain with the crane operator who shall ensure that all warnings and instructions supplied are fully understood and observed.

Prior to operating the crane, the operator must carefully and thoroughly read and understand the information in this manual to ensure that he knows the operation and limitations of indicator and crane.

Proper functioning depends upon proper daily inspection and observance of the operating instructions set forth in this manual. Refer to Section *Pre-Operation Inspection and Calibration Verification* of the operator's manual.

⚠ WARNING

The LMI can only work correctly, if all adjustments have been properly set. For correct adjustment, the operator has to answer thoroughly and correctly all questions asked during the setup procedure in accordance with the real rigging state of the crane. To prevent material damage and serious or even fatal accidents, the correct adjustment of the LMI has to be ensured before starting the crane operation.

3 SYSTEM DESCRIPTION

The PAT Load Moment Indicator DS 350 consists of a central microprocessor unit, operating console, angle sensor, force transducer, and anti-two block switches.

The system operates on the principle of reference/real comparison. The real value, resulting from the load measurement is compared with the reference data, stored in the central processor memory and evaluated in the microprocessor. When limits are reached, an overload warning signal is generated at the operator's console. At the same time, the aggravating crane movements, such as hoist up and boom down, will be stopped.

The fixed data regarding the crane, such as capacity charts, boom weights, centers of gravity and dimensions are stored in memory chips in the central processor unit. This data is the reference information used to calculate the operating conditions.

The boom angle is measured by the angle sensor, mounted in the boom base. The cable reel cable serves as an electrical conductor for the anti two-block switches and force transducer signals.

The load on the boom is measured by force transducer mounted on top of the boom, close to the tip.

The interactive user guidance considerably simplifies the input of operating modes as well as the setting of geometry limit values. Please refer to the PAT DS350 operator's manual for the operation of the system.

The System consists of the following main components:

1. Central Unit
2. Cable for crane power
3. Cable to cable reel
4. Cable Reel
5. Junction box
6. A2B switch with weight
7. A2B bypass plug
8. Cable to force transducer
9. Force transducer
10. Cable to main boom angle sensor
11. Main boom angle sensor
12. Operator's console with cable assembly
13. Cable for area definition sensor
14. Area definition sensor

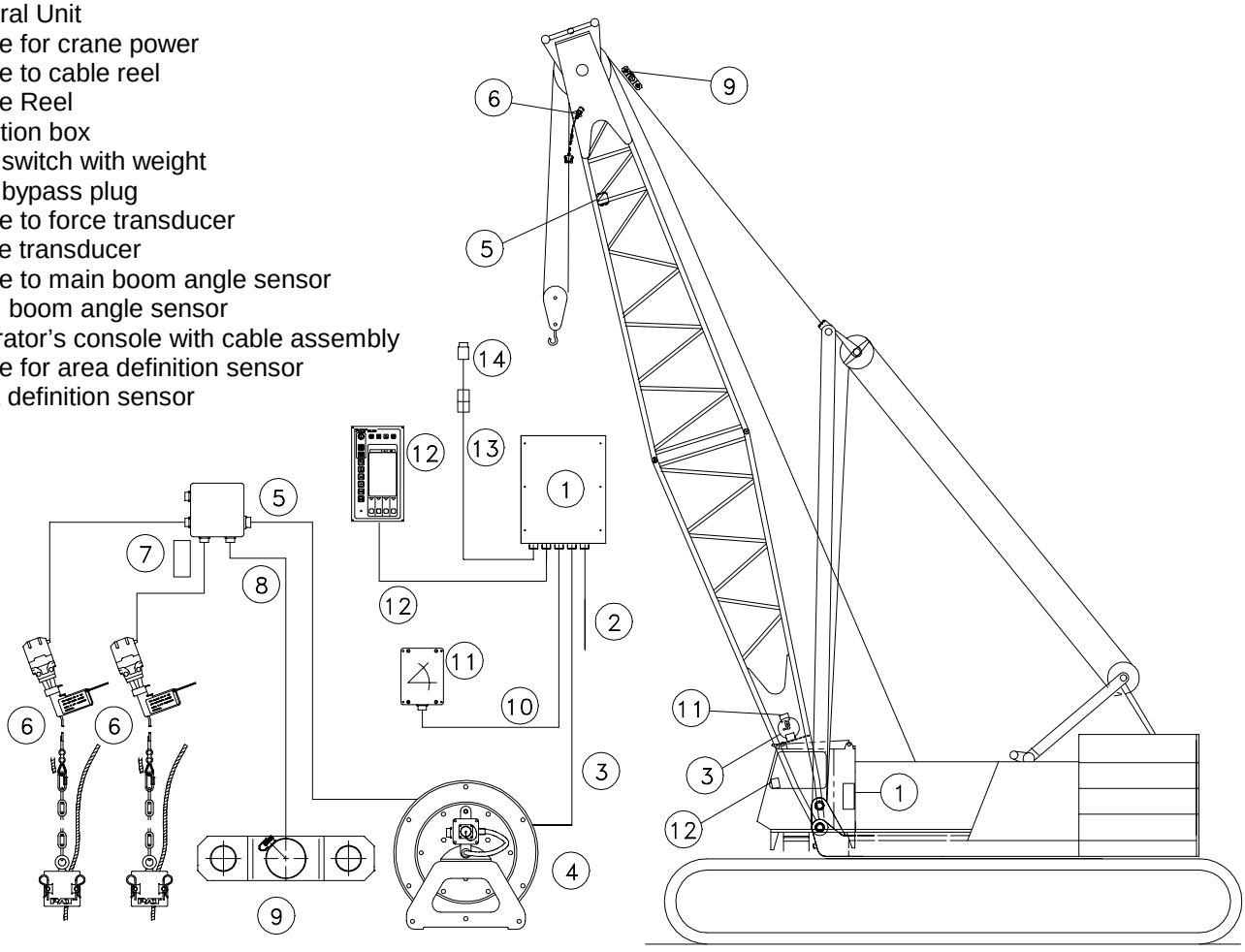
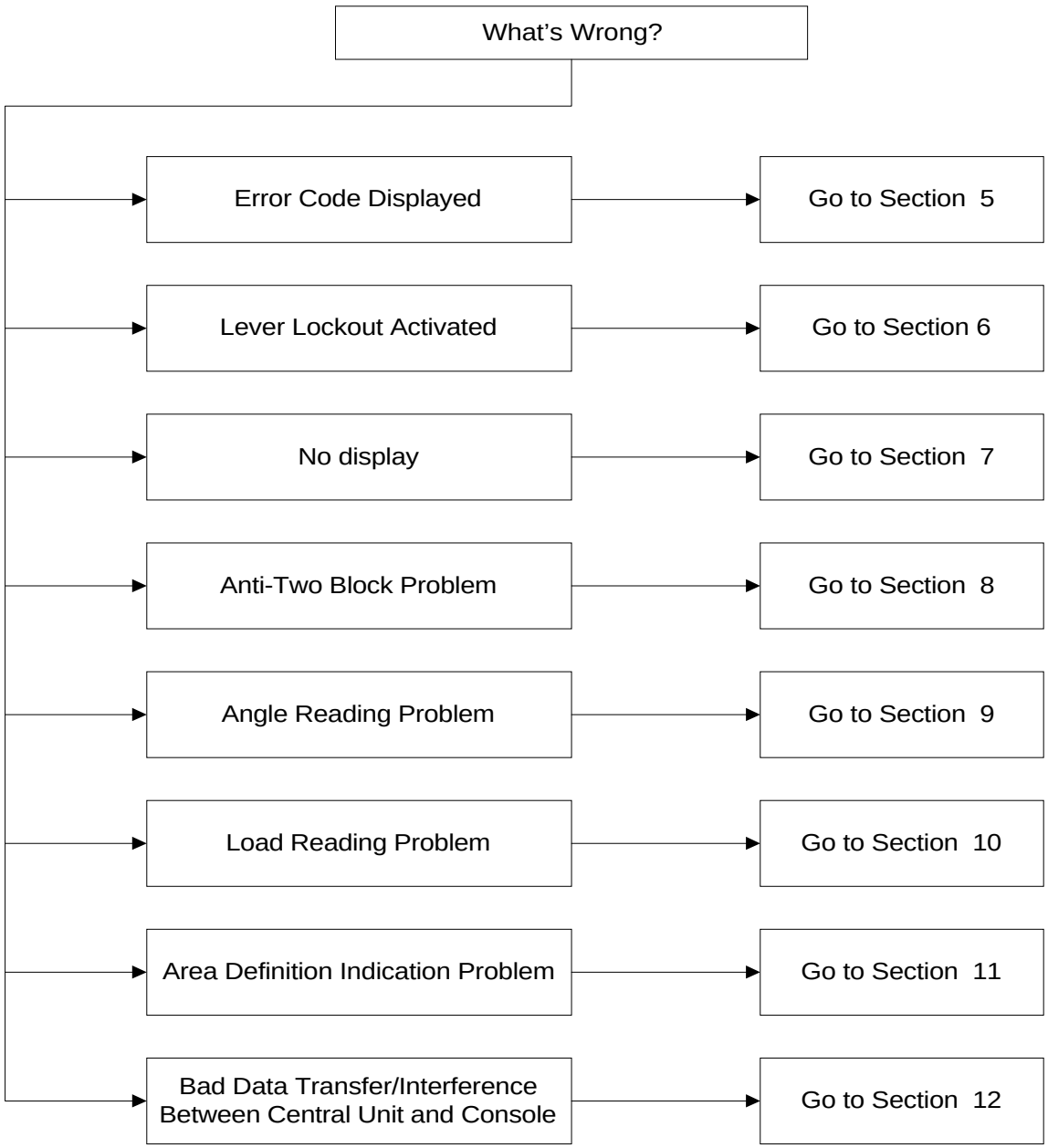


Fig. 1: Components of the LMI system PAT DS 350/Modular

4 GENERAL FLOW CHARTS

This section explains how to handle a problem that may arise with the PAT DS 350 Modular System. The procedures are given in flowchart format for the following sections. Start with the general flowchart below that will guide you to one of the detailed flowcharts shown in Sections 5 through 12. The drawings and procedures that are referenced in these sections can be found in Section 13 and 14.



5 ERROR CODES

5.1 Operating Errors E01 through E06

These errors are usually caused by operating in a way that is not allowed per the load charts.

Error Code	Error	Cause	Elimination
E01	Fallen below radius range or angle range exceeded	• Fallen below the minimum radius or gone past the maximum angle specified in the respective load chart due to hoisting up the boom too far	• Hoist the boom down to a radius or angle specified in the load chart.
E02	Radius range exceeded or fallen below angle range	• Gone past the maximum radius or fallen below the minimum angle specified in the respective load chart due to hoisting down the boom too far	• Hoist the boom up to a radius or angle specified in the load chart.
E04	Operating mode not existing or non permitted slewing zone	• A non existing operating mode has been selected • The selected operating mode is not available in the data EPROM or blocked. • The boom is in a non-permitted slewing zone	• Set the correct operating mode for the crane configuration in question • Check programming of the data EPROM • Slew the crane into a permitted area.
E05	Boom length not existing	• A non existing boom length has been selected • The selected boom length is not available in the data EPROM.	• Correctly enter the boom length according to the attribution of the operating state • Check programming of the data EPROM
E06	Radius range exceeded or fallen below angle range with luffing jib operation	• Maximum radius as specified in the load chart exceeded or fallen below minimum angle due to luffing down the luffing jib too far	• Luff the jib to a radius or angle specified in the load chart.

5.2 Lockout Function Errors 07 and 08

These errors are caused by defects around the function lockouts.

Error Code	Error	Cause	Elimination
E07	Faulty acknowledgment of the overload relay on the connection board. The relay should be energized, the 2nd contact however is indicated to be off, or the 2nd contact is indicated to be on while the relay should be de-energized.	• Overload relay or main board are defective • Processor board defective	• Replace main board • Replace processor board.
E08	No acknowledgment from the anti-two-block relay	• refer to E07	• refer to E07

5.3 Analog Input Channel Errors

These errors occur if the input signal of an analog input channel falls below (E1x) the minimum (4 mA) or exceeds (E2x) the maximum (20 mA).

The analog channels are used as follows:

Sensor	Pins Terminal X1	Lower Limit	Upper Limit
Main Force Transducer	36	E14	E24
Angle Sensor (Main Boom)	29	E15	E25

Each channel is constantly being monitored to be within 4 mA (1.1V resp.) and 20 mA (5.5V resp.). If it exceeds these limits, the following errors are triggered:

Error Code	Error	Cause	Elimination
E14	Fallen below the lower limit value in the main force channel	• Cable between the central unit and force transducer defective or water inside the plugs • Force transducer is defective. • Electronic component in the measuring channel is defective.	• Check cable as well as plugs, replace, if need be. • Replace force transducer • Replace LMI module(s).
E24	Upper limit value in main force transducer measuring channel has been exceeded	• refer to E14	• refer to E14
E15	Fallen below lower limit value in measuring channel "angle main boom"	• Cable between central unit and the angle sensor defective or loose. Water inside the plugs. • Angle sensor defective	• Check cable as well as plugs, replace, if need be. • Replace angle sensor

Error Code	Error	Cause	Elimination
		• Electronic component in the measuring channel defective.	• Replace LMI module(s).
E25	Upper limit value in measuring channel "main boom angle" has been exceeded.	• refer to E15	• refer to E15
E19	Reference and/or supply voltage defective	• The supply voltage is being dragged down by one of the sensors • Electronic component is defective • A/D converter defective.	• Check the voltages on the LMI main board (AGND = MP0). Check sensors, plugs and cable, replace, if need be. • Replace LMI main board • Replace analog board
E29	Reference and/or supply voltage defective.	• refer to E19	• refer to E19

5.4 Errors 31 and up

Miscellaneous Errors, most of them caused by electronics.

Error Code	Error	Cause	Elimination
E31	Error in the system program	• The system program PROM is defective.	• Replace system program PROM (PROM No. 0)
E38	System program and data EPROM do not match.	• The system program in the LMI does not match to the programming in the data EPROM	• Replace the system program PROM or the data EPROM (PROM No. 1)
E41	Error in the internal write/read memory (RAM) of the computer component 80C537	• Computer component 80C537 defective • CPU module defective • Processor board defective.	• Replace computer component 80C537. • Replace CPU module. • Replace processor board with CPU module.
E42	Error in the external write/read memory, 1st part (RAM)	• Write/read memory (CMOS RAM) or processor board defective.	• Replace processor board with CPU module.
E43	Error in the external write/read memory, 2nd part (RAM)	• refer to E42	• refer to E42
E45	Redundancy error in the A/D conversion	• The A/D converter on the processing board and the redundant A/D converter in the CPU 80C537 provide different results.	• Replace processor board.
E46	Error in the A/D converter uPD 7004 of the processor board.	• No acknowledgment of the A/D converter uPD 7004	• Replace processor board.

Error Code	Error	Cause	Elimination
E47	Error in the monitored write/ read memory. The CRC verification of the monitored write/read memory provides an incoherent result	• The CRC sign of the monitored write/read memory is wrong • The buffer battery is discharged (< 2V at 1kOhm). • Processor board defective.	• Restart the LMI • Replace buffer battery on the LMI main board • Replace processor board.
E48	Cyclic RAM test: error in the internal write/read memory (RAM) of the computer component 80C537	• Computer component 80C537 defective • CPU module defective • Processor board defective.	• Replace computer component 80C537. • Replace CPU module • Replace processor board with CPU module.
E51	Error in the data EPROM or EEPROM.	• No valid data in the data EEPROM. • Memory module wrongly bridged. • Crane data EPROM defective	• Load data EEPROM containing valid data. • Bridge memory module acc. to memory type • Replace crane data EPROM
E56	Error in the data EEPROM.	• Memory module wrongly bridged. • Crane data EEPROM defective	• Bridge memory module acc. to memory type • Replace crane data EEPROM
E57	Error in serial crane data EEPROM.	• Serial crane data EEPROM does not contain valid data. • Memory module defective	• Write data on the serial crane data EEPROM (by means of test program or on-line function), then restart the LMI • Replace memory module.
E58	Error in the serial analog data EEPROM.	• No valid data in the serial analog data EEPROM. • LMI module(s) defective.	• Write data on the serial analog data EEPROM by means of the test program, then, restart the LMI • Replace LMI module(s).
E60	The number of the selected EPROM base and the programmed value are not identical	• Load chart EPROM defective • Base number not programmed • Load chart EPROM wrongly programmed	• Replace load chart EPROM • Program the correct base number (1 for base 1, 2 for base 2) • Check base programming in the load chart EPROM.
E71	Faulty acknowledgment of relay K1 on the connection board	• Relay K1 or main board defective.	• Replace main board.

Error Code	Error	Cause	Elimination
	Relay should be energized but the 2nd contact is signaled to be off or the 2nd contact is signaled to be on whereas the relay should be de-energized.	• Main board is defective	• Replace main board.
E72 ... E77	Faulty acknowledgment of relays K2...K7 on the connection board.	• refer to E71	• refer to E71
E91	No data trans-mission form the console to the central unit	• 24 V supply of the console is interrupted • Interruption or accidental ground in the line between console electronics and central unit • Transmitter/receiver module is defective	• Check 24 V at terminal X1 of the console electronics • Check the connection console electronics - central unit. In case of an accidental ground, the transmitter module of the console electronics might be damaged. Therefore, replaces the console electronics. • Exchange console electronics or LMI main board resp.
E92	Error in the data transmission from console to central unit	• Loose connection in the line between console electronics and central unit • Transmitter/receiver module is defective	• Check the connection between console electronics and central unit • Exchange console electronics or LMI main board resp.
E93	Error in the data transmission from the central unit to the console	• refer to E92	• refer to E92
E94	No data trans-mission from the central unit to the console	• Interruption or accidental ground in the cable between central unit and console • 5 V supply of the computer in the central unit is missing • 5 V supply is too low	• Check wiring to the console (in case of accidental ground, replace console electronics, too). • Check connection to the power unit • Exchange the LMI main board

Error Code	Error	Cause	Elimination
		• Transmitter/receiver module is defective • Computer module is defective • Electro-magnetic interferences (e.g. when switching contactors or valves)	• Replace console electronics or LMI main board • Replace processor board. • Eliminate the source of interferences by inverse diodes or varistors.
E95	Error in the console EPROM	• The console EPROM is defective.	• Replace the console EPROM
E96	Error in the internal RAM of the console.	• The CPU of the console is defective. • The console main board is defective.	• Replace the CPU of the console • Replace the console main board.
E97	Error in the external RAM of the console	• The external RAM of the console is defective. • The console main board is defective.	• Replace the external RAM of the console. • Replace the console main board.
EAB	Short circuit in the A2B switch circuit	• Short circuit in the A2B switch • Short circuit in the cable to the A2B switch	• Replace A2B switch • Replace cable to the A2B switch

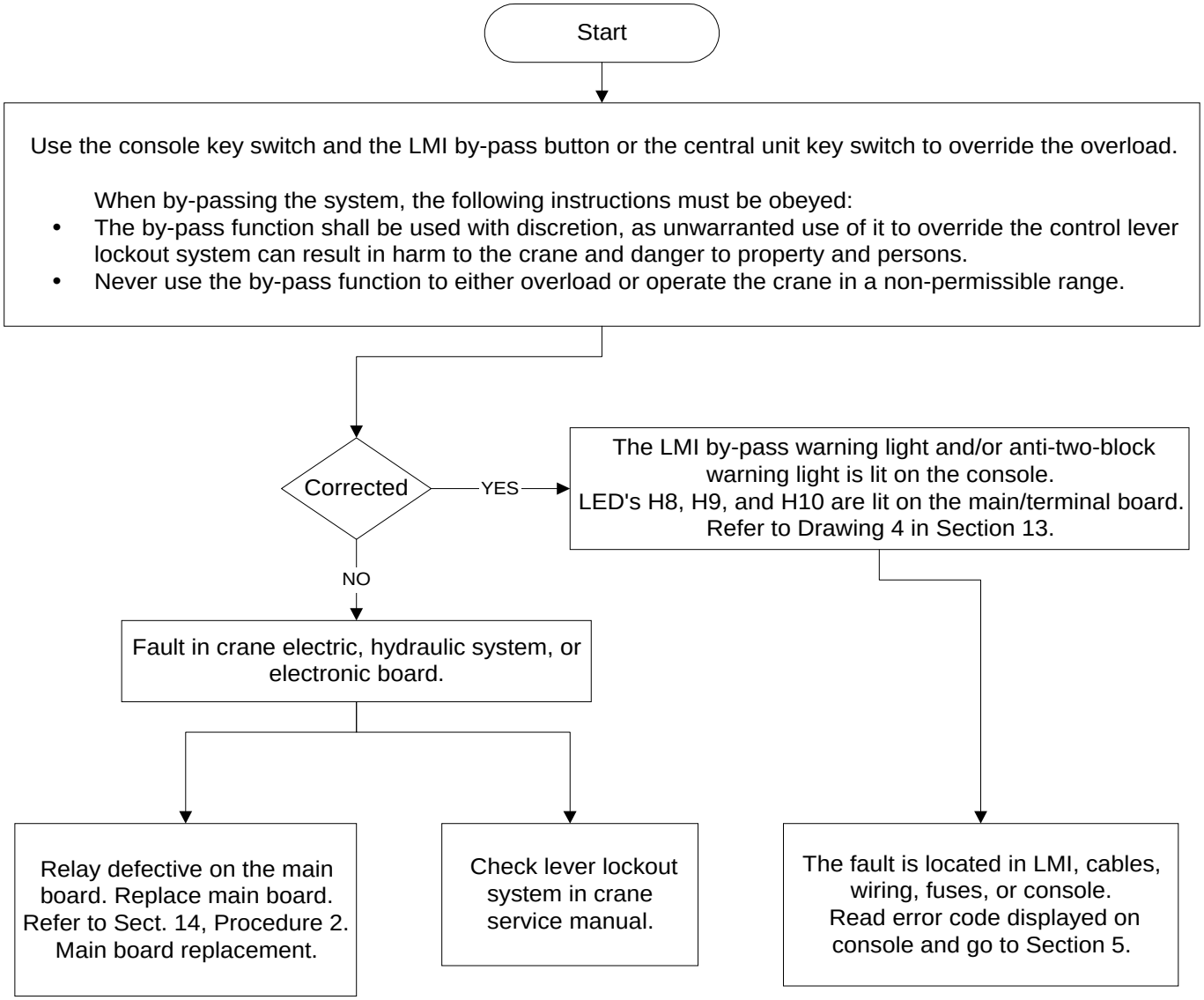
Note:
If an error message is displayed which is not contained in above list, please contact the PAT service department.

6 FUNCTION LOCKOUT

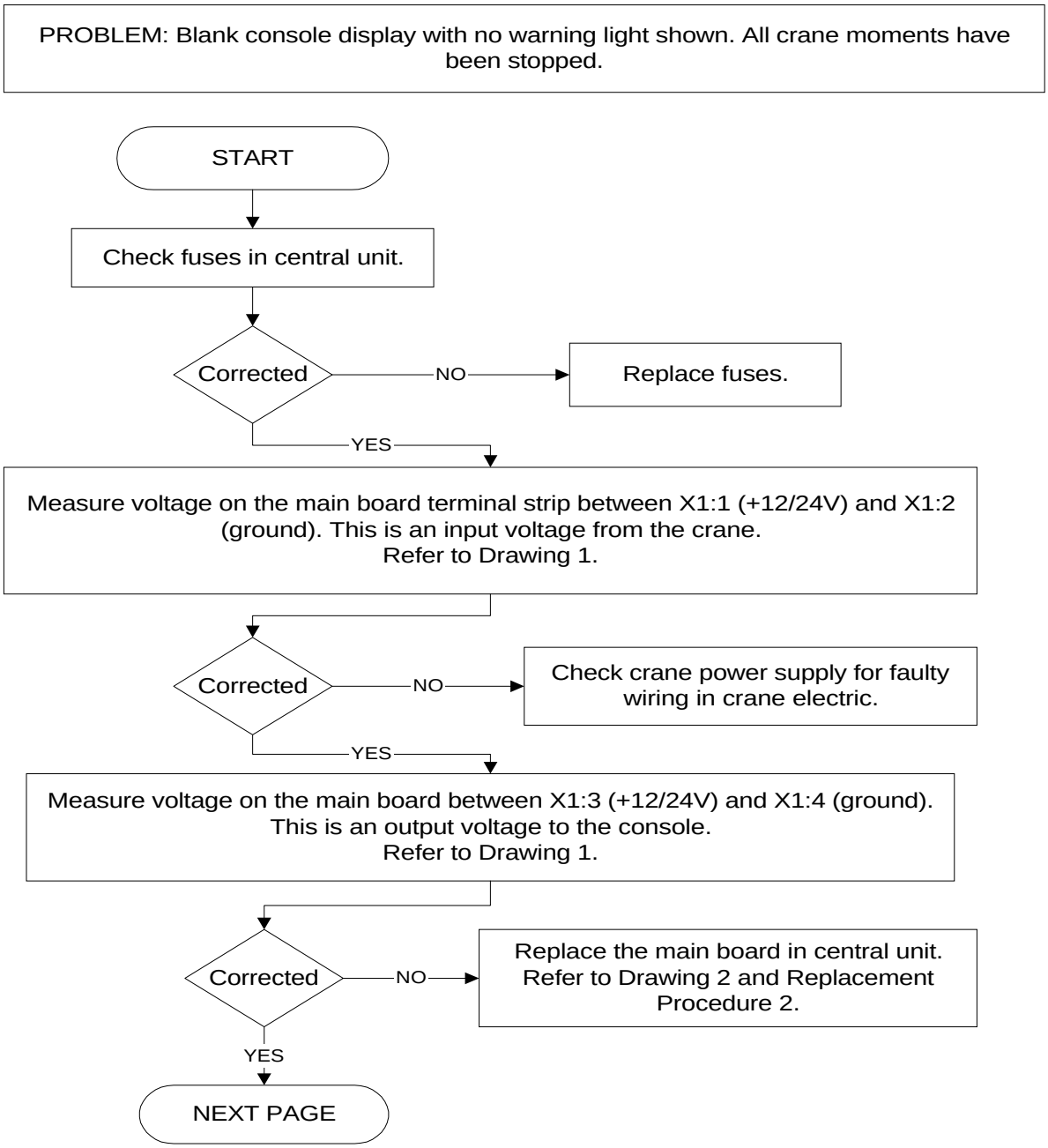
PROBLEM: The lever lockout system of the crane is activated. Crane movements “hoist up” and (optional) “boom down” are stopped. Only if the crane is not in overload or two-block condition continue with flow chart.

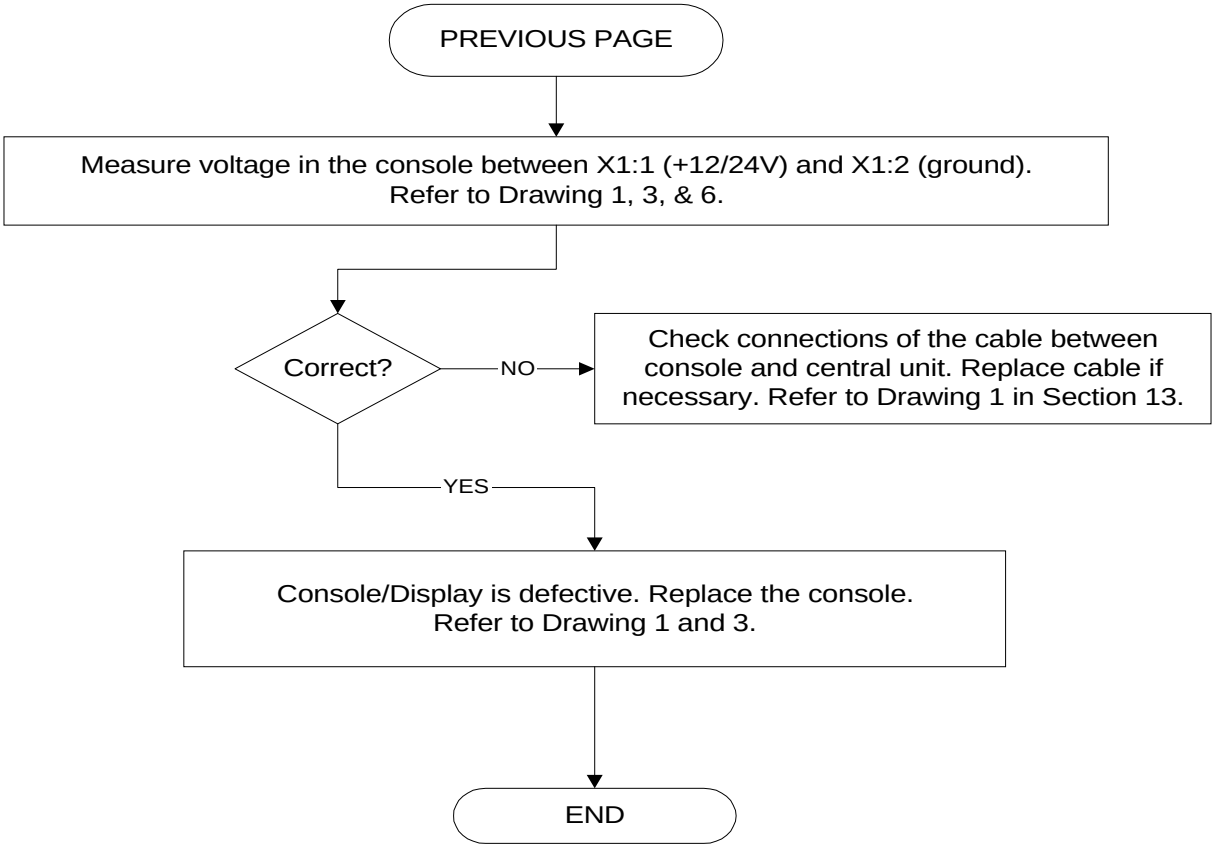
WARNING: If overload or A2B condition exists, use extreme caution and move the crane out of the condition.

If Error Code is displayed goto Section 5.

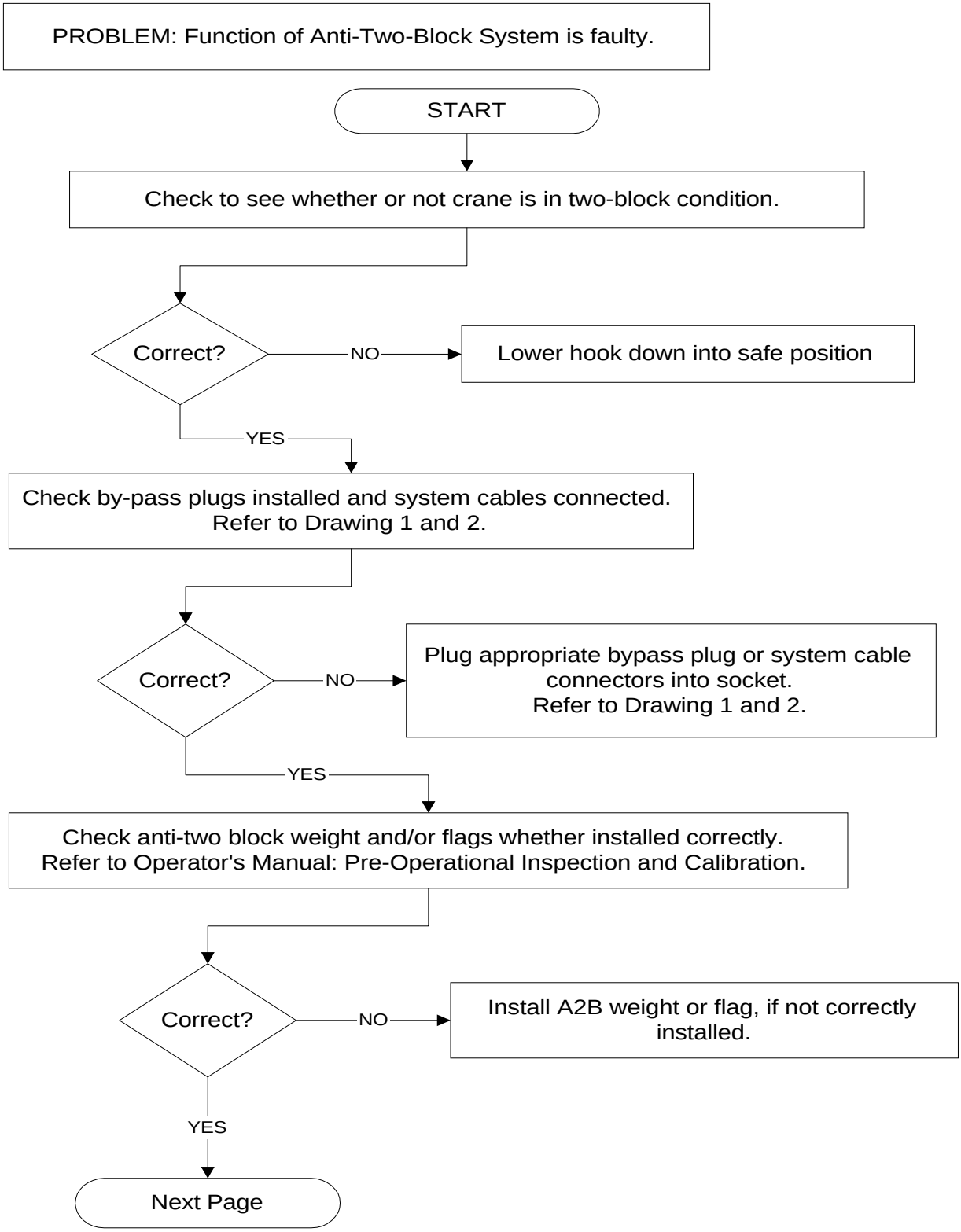


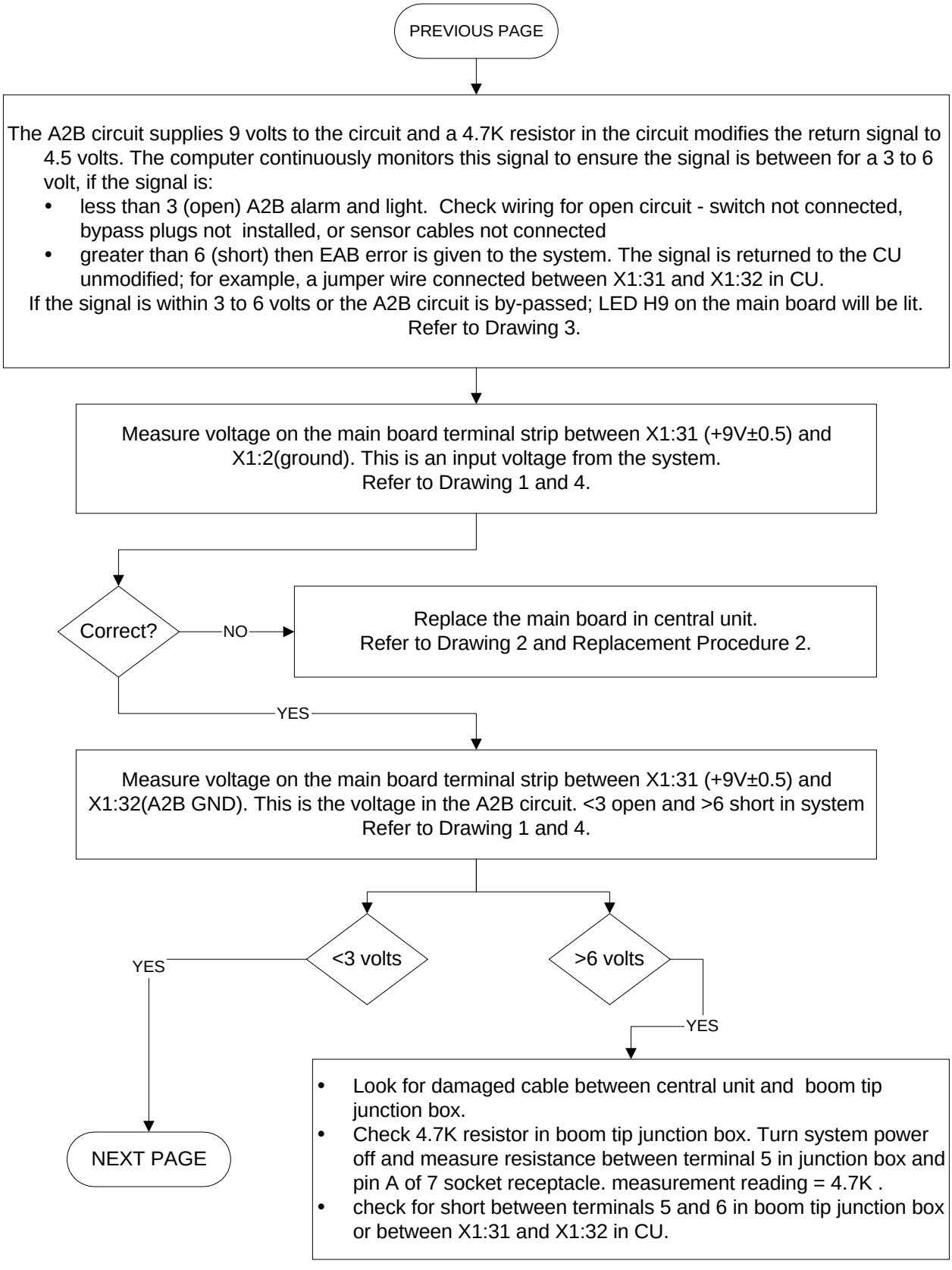
7 NO DISPLAY

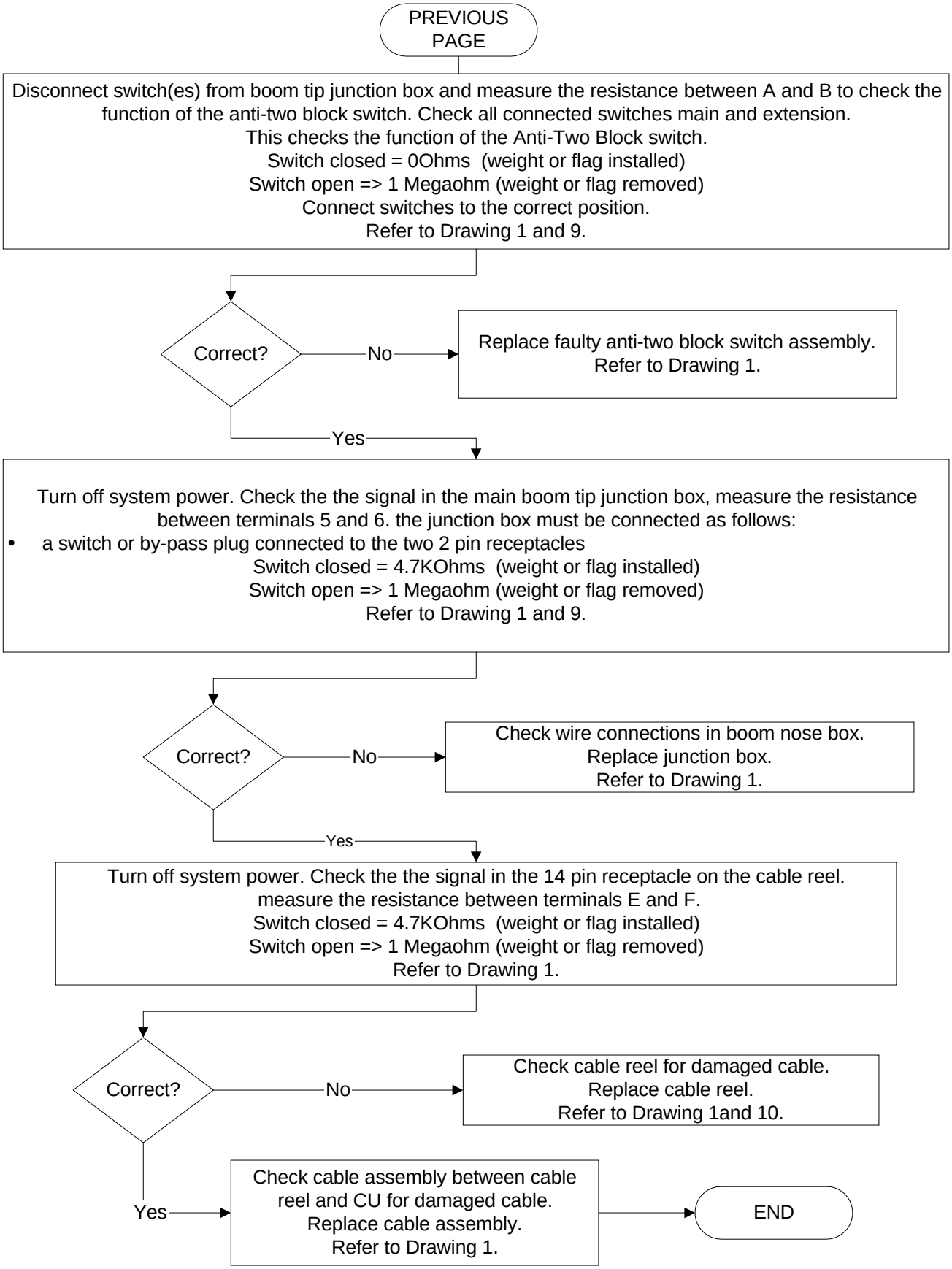

PROBLEM: Blank console display with no warning light shown. All crane moments have been stopped.
START
Check fuses in central unit.
Corrected
NO
Replace fuses.
YES
Measure voltage on the main board terminal strip between X1:1 (+12/24V) and X1:2 (ground). This is an input voltage from the crane.
Refer to Drawing 1.
Corrected
NO
Check crane power supply for faulty wiring in crane electric.
YES
Measure voltage on the main board between X1:3 (+12/24V) and X1:4 (ground).
This is an output voltage to the console.
Refer to Drawing 1.
Corrected
NO
Replace the main board in central unit.
Refer to Drawing 2 and Replacement Procedure 2.
YES
NEXT PAGE


PREVIOUS PAGE
Measure voltage in the console between X1:1 (+12/24V) and X1:2 (ground).
Refer to Drawing 1, 3, & 6.
Correct?
NO
Check connections of the cable between console and central unit. Replace cable if necessary. Refer to Drawing 1 in Section 13.
YES
Console/Display is defective. Replace the console.
Refer to Drawing 1 and 3.
END

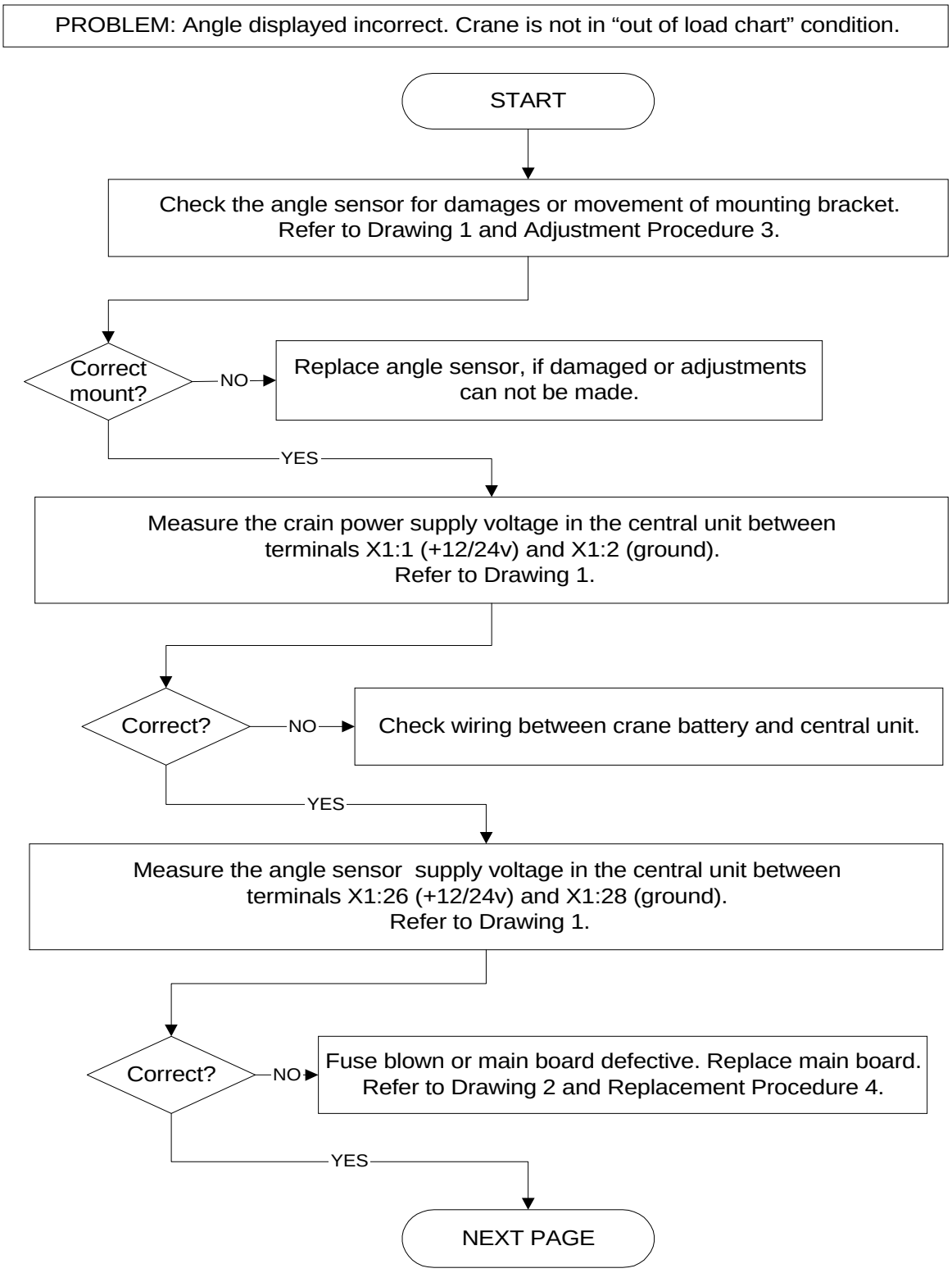
8 ANTI-TWO BLOCK PROBLEM

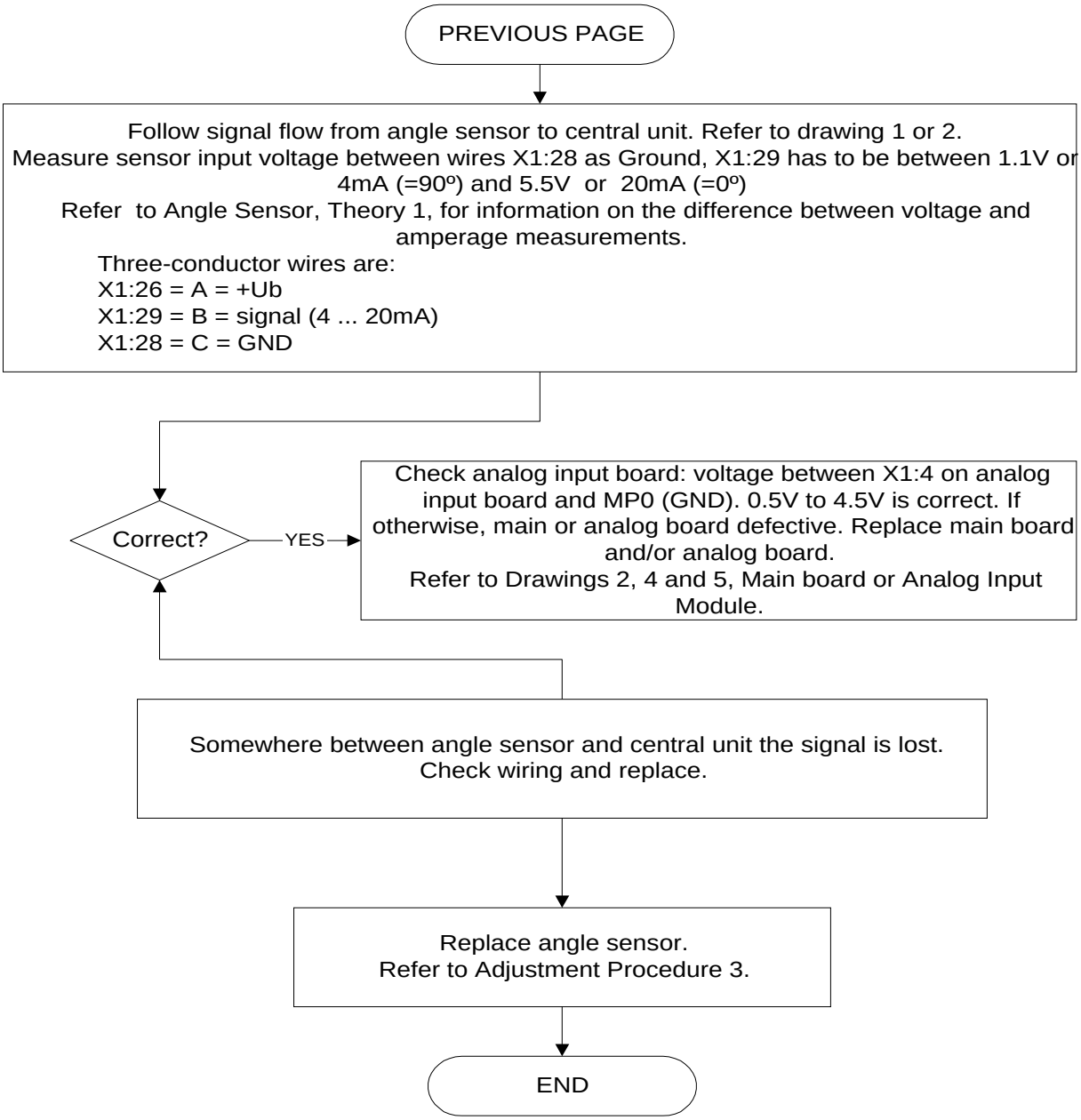



PREVIOUS PAGE
The A2B circuit supplies 9 volts to the circuit and a 4.7K resistor in the circuit modifies the return signal to 4.5 volts. The computer continuously monitors this signal to ensure the signal is between for a 3 to 6 volt, if the signal is:
• less than 3 (open) A2B alarm and light. Check wiring for open circuit - switch not connected, bypass plugs not installed, or sensor cables not connected
• greater than 6 (short) then EAB error is given to the system. The signal is returned to the CU unmodified; for example, a jumper wire connected between X1:31 and X1:32 in CU.
If the signal is within 3 to 6 volts or the A2B circuit is by-passed; LED H9 on the main board will be lit.
Refer to Drawing 3.
Measure voltage on the main board terminal strip between X1:31 (+9V±0.5) and X1:2(ground). This is an input voltage from the system.
Refer to Drawing 1 and 4.
Correct?
NO
Replace the main board in central unit.
Refer to Drawing 2 and Replacement Procedure 2.
YES
Measure voltage on the main board terminal strip between X1:31 (+9V±0.5) and X1:32(A2B GND). This is the voltage in the A2B circuit. <3 open and >6 short in system
Refer to Drawing 1 and 4.
<3 volts
YES
>6 volts
YES
NEXT PAGE
• Look for damaged cable between central unit and boom tip junction box.
• Check 4.7K resistor in boom tip junction box. Turn system power off and measure resistance between terminal 5 in junction box and pin A of 7 socket receptacle. measurement reading = 4.7K .
• check for short between terminals 5 and 6 in boom tip junction box or between X1:31 and X1:32 in CU.

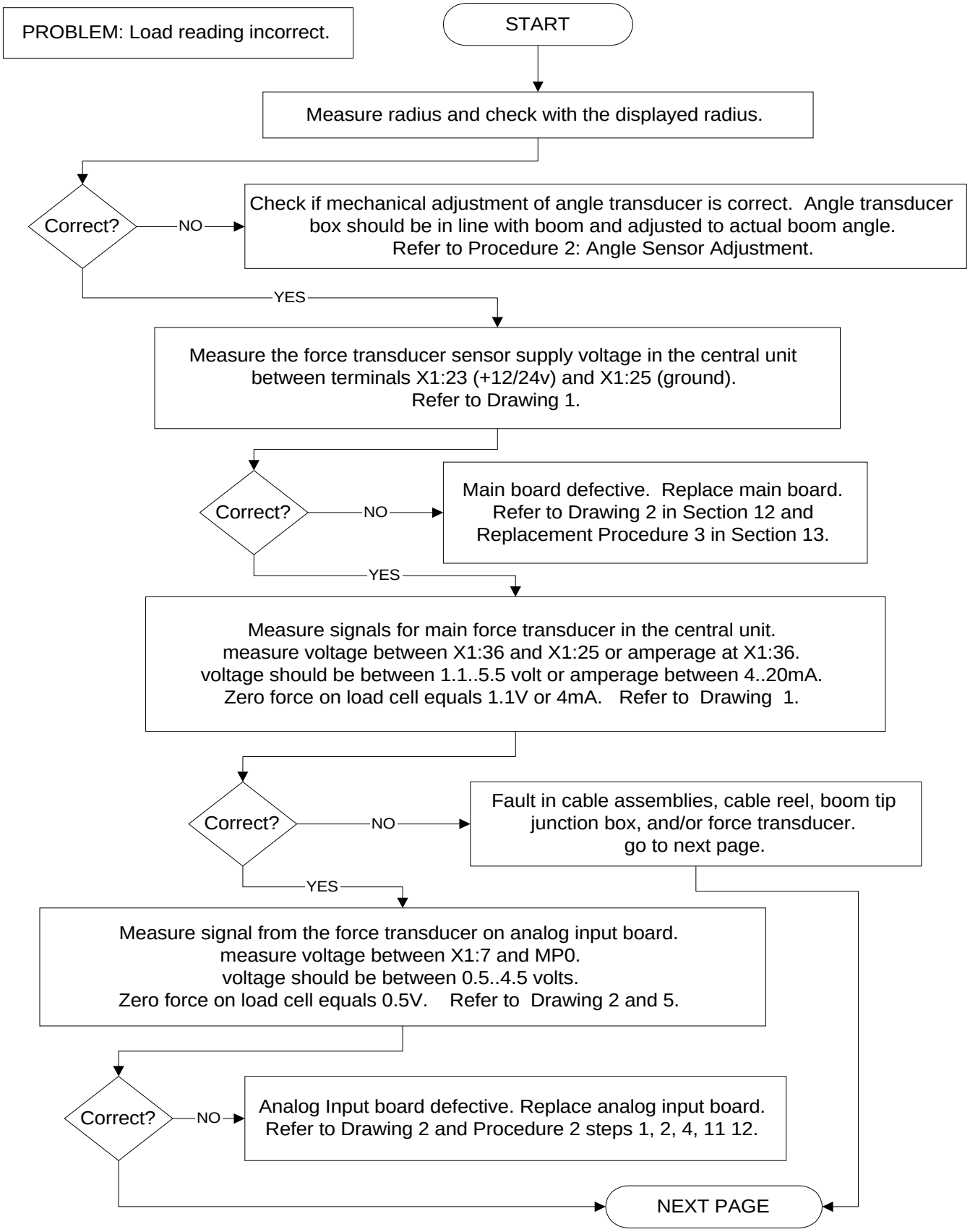

PREVIOUS PAGE
Disconnect switch(es) from boom tip junction box and measure the resistance between A and B to check the function of the anti-two block switch. Check all connected switches main and extension.
This checks the function of the Anti-Two Block switch.
Switch closed = 0Ohms (weight or flag installed)
Switch open => 1 Megaohm (weight or flag removed)
Connect switches to the correct position.
Refer to Drawing 1 and 9.
Correct?
No
Replace faulty anti-two block switch assembly.
Refer to Drawing 1.
Yes
Turn off system power. Check the the signal in the main boom tip junction box, measure the resistance between terminals 5 and 6. the junction box must be connected as follows:
• a switch or by-pass plug connected to the two 2 pin receptacles
Switch closed = 4.7KOhms (weight or flag installed)
Switch open => 1 Megaohm (weight or flag removed)
Refer to Drawing 1 and 9.
Correct?
No
Check wire connections in boom nose box.
Replace junction box.
Refer to Drawing 1.
Yes
Turn off system power. Check the the signal in the 14 pin receptacle on the cable reel.
measure the resistance between terminals E and F.
Switch closed = 4.7KOhms (weight or flag installed)
Switch open => 1 Megaohm (weight or flag removed)
Refer to Drawing 1.
Correct?
No
Check cable reel for damaged cable.
Replace cable reel.
Refer to Drawing 1and 10.
Yes
Check cable assembly between cable reel and CU for damaged cable.
Replace cable assembly.
Refer to Drawing 1.
END

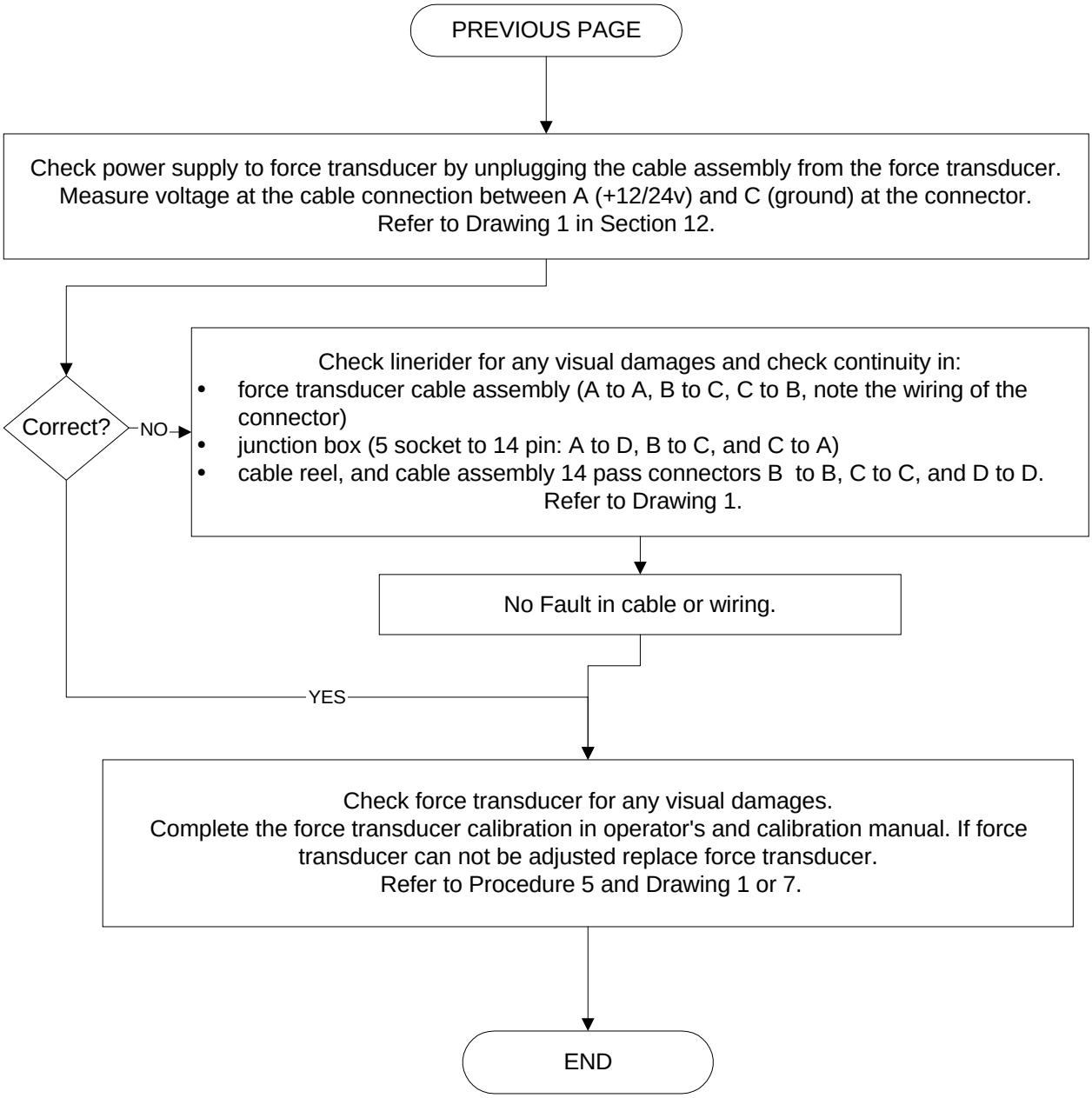
9 ANGLE SENSORS



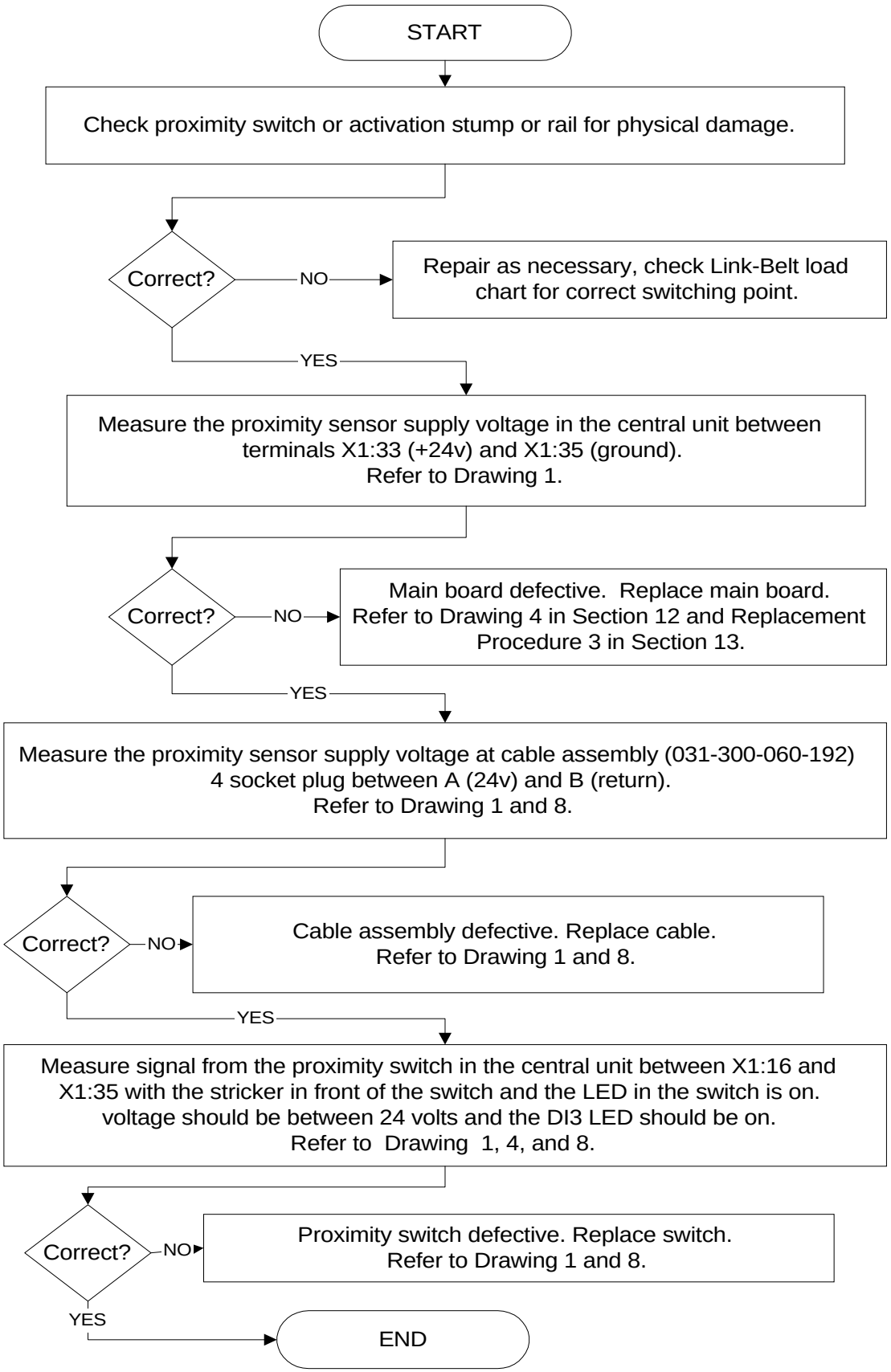

PREVIOUS PAGE
Follow signal flow from angle sensor to central unit. Refer to drawing 1 or 2.
Measure sensor input voltage between wires X1:28 as Ground, X1:29 has to be between 1.1V or 4mA (=90º) and 5.5V or 20mA (=0º)
Refer to Angle Sensor, Theory 1, for information on the difference between voltage and amperage measurements.
Three-conductor wires are:
X1:26 = A = +Ub
X1:29 = B = signal (4 ... 20mA)
X1:28 = C = GND
Correct?
YES
Check analog input board: voltage between X1:4 on analog input board and MP0 (GND). 0.5V to 4.5V is correct. If otherwise, main or analog board defective. Replace main board and/or analog board.
Refer to Drawings 2, 4 and 5, Main board or Analog Input Module.
Somewhere between angle sensor and central unit the signal is lost.
Check wiring and replace.
Replace angle sensor.
Refer to Adjustment Procedure 3.
END

10 LOAD READING

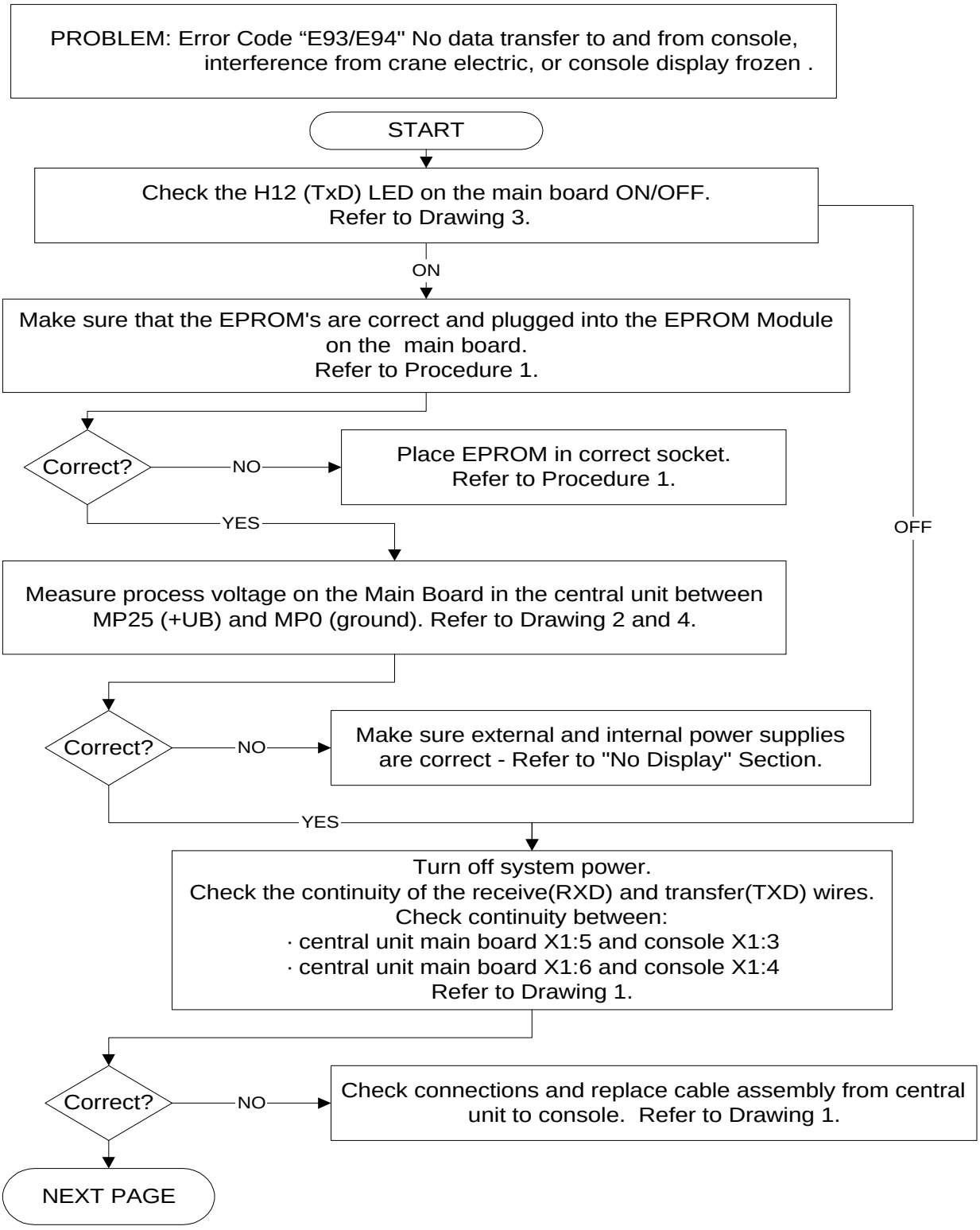


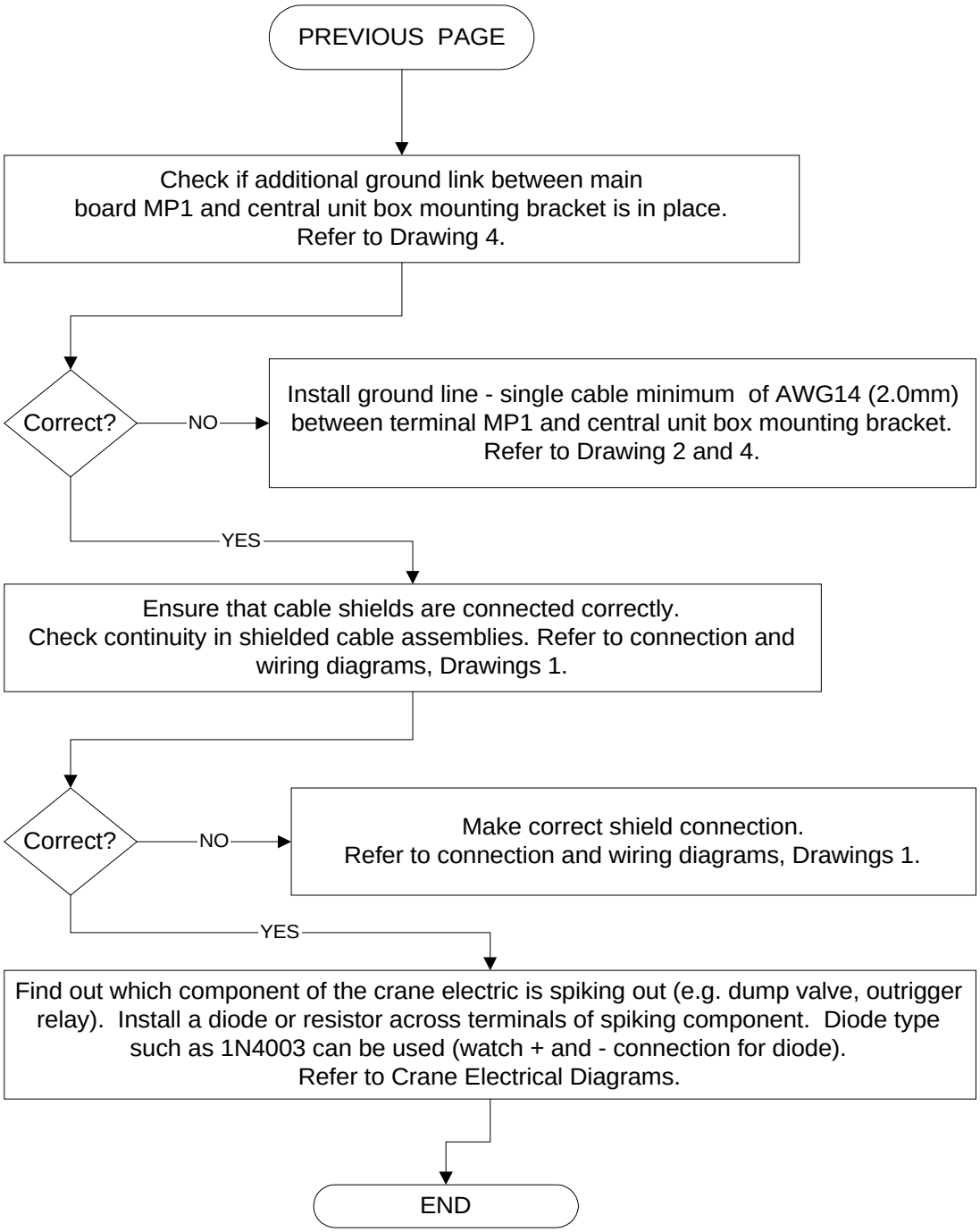

PREVIOUS PAGE
Check power supply to force transducer by unplugging the cable assembly from the force transducer.
Measure voltage at the cable connection between A (+12/24v) and C (ground) at the connector.
Refer to Drawing 1 in Section 12.
Correct?
NO
Check linerider for any visual damages and check continuity in:
• force transducer cable assembly (A to A, B to C, C to B, note the wiring of the connector)
• junction box (5 socket to 14 pin: A to D, B to C, and C to A)
• cable reel, and cable assembly 14 pass connectors B to B, C to C, and D to D.
Refer to Drawing 1.
No Fault in cable or wiring.
YES
Check force transducer for any visual damages.
Complete the force transducer calibration in operator's and calibration manual. If force transducer can not be adjusted replace force transducer.
Refer to Procedure 5 and Drawing 1 or 7.
END

11 AREA DEFINITION INDICATION PROBLEM



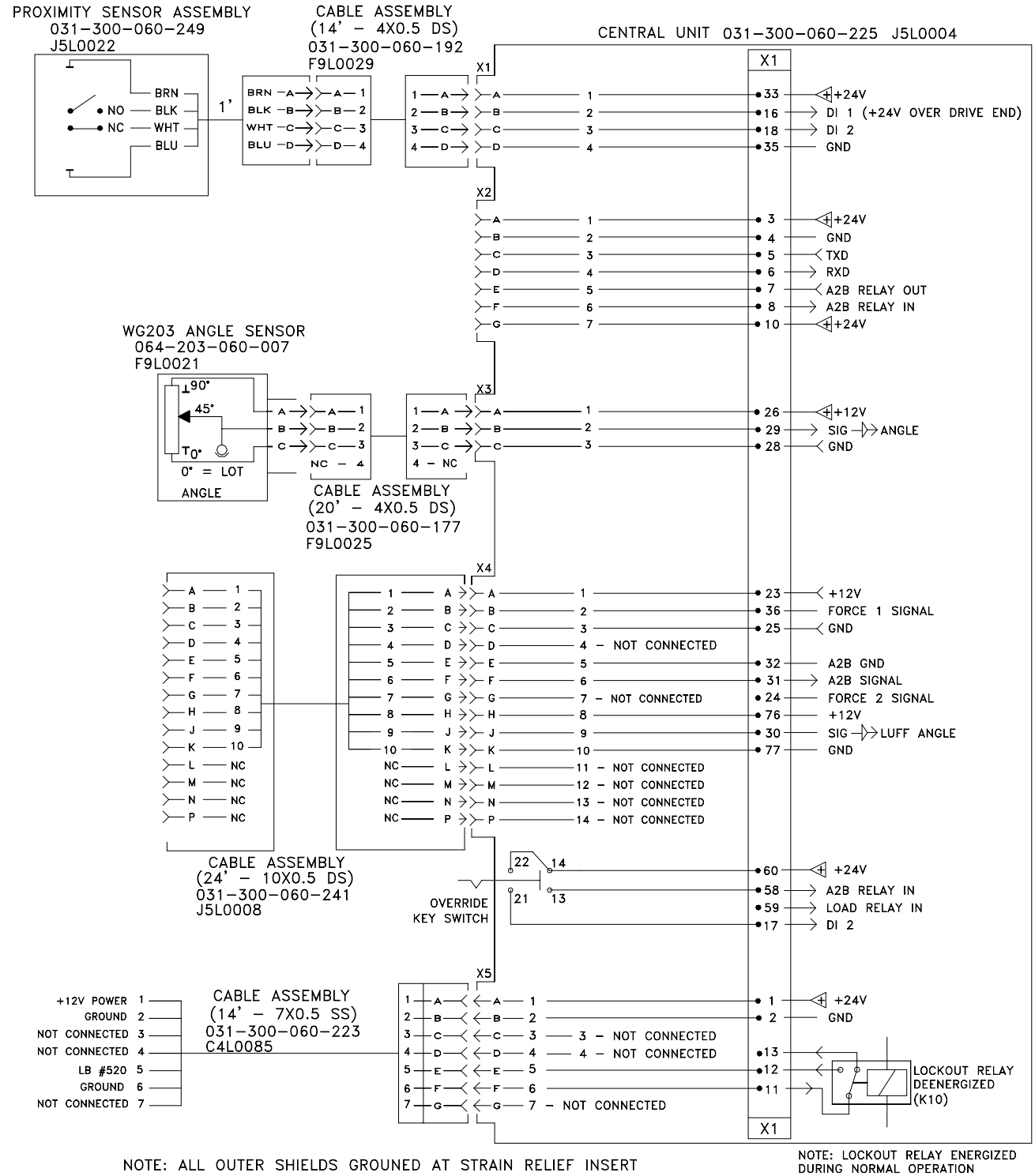
12 DATA TRANSFER CENTRAL UNIT <--> CONSOLE



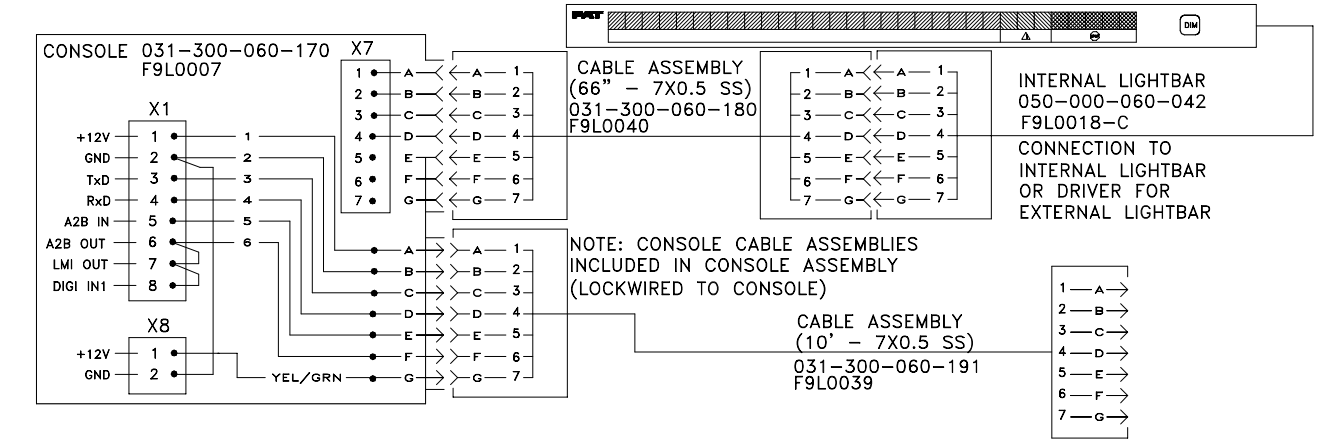

PREVIOUS PAGE
Check if additional ground link between main board MP1 and central unit box mounting bracket is in place. Refer to Drawing 4.
Correct?
NO
Install ground line - single cable minimum of AWG14 (2.0mm) between terminal MP1 and central unit box mounting bracket. Refer to Drawing 2 and 4.
YES
Ensure that cable shields are connected correctly. Check continuity in shielded cable assemblies. Refer to connection and wiring diagrams, Drawings 1.
Correct?
NO
Make correct shield connection. Refer to connection and wiring diagrams, Drawings 1.
YES
Find out which component of the crane electric is spiking out (e.g. dump valve, outrigger relay). Install a diode or resistor across terminals of spiking component. Diode type such as 1N4003 can be used (watch + and - connection for diode). Refer to Crane Electrical Diagrams.
END

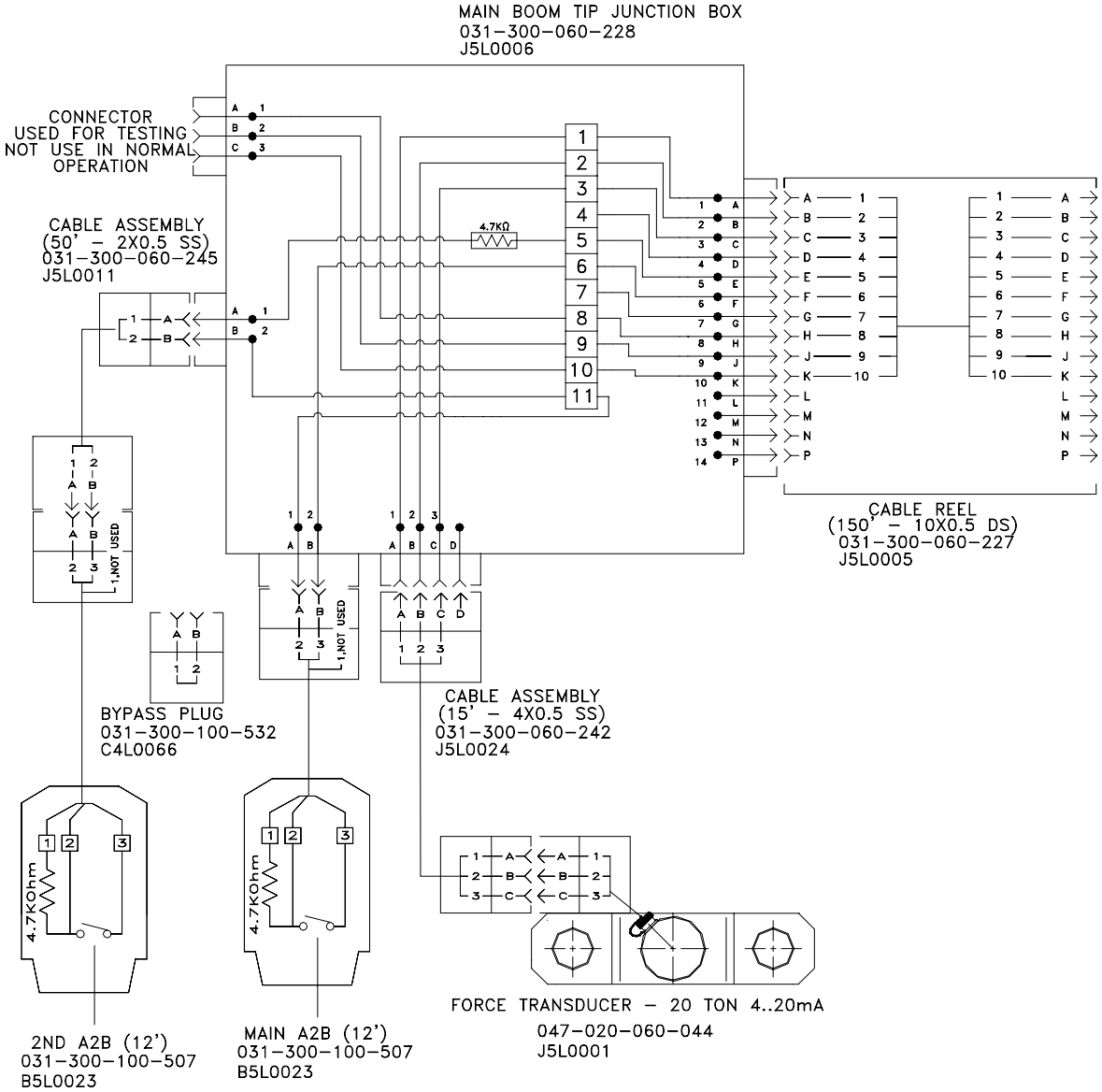
13 DRAWINGS

13.1 Electrical Wiring (Drawing 1) Part 1.



Electrical Wiring (Drawing 1) Part 2.



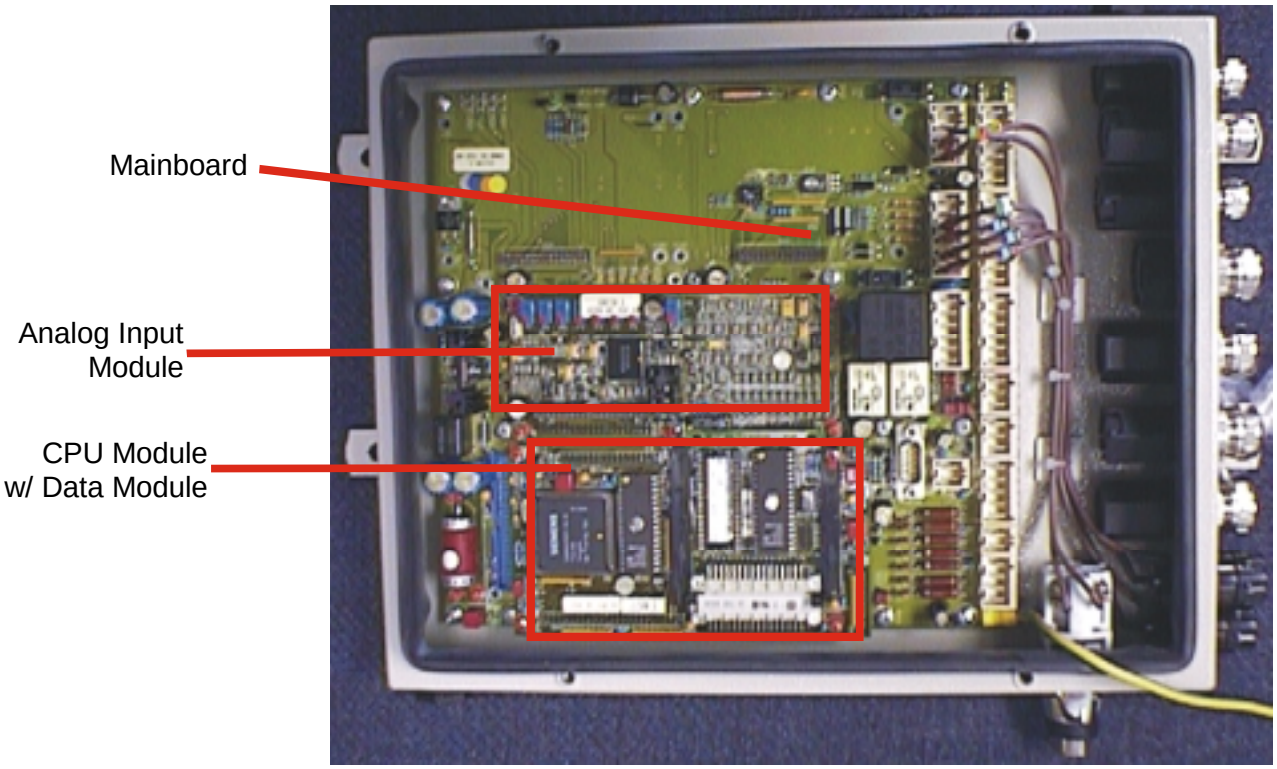


13.2 Central Unit Breakdown / Parts List (Drawing 2)

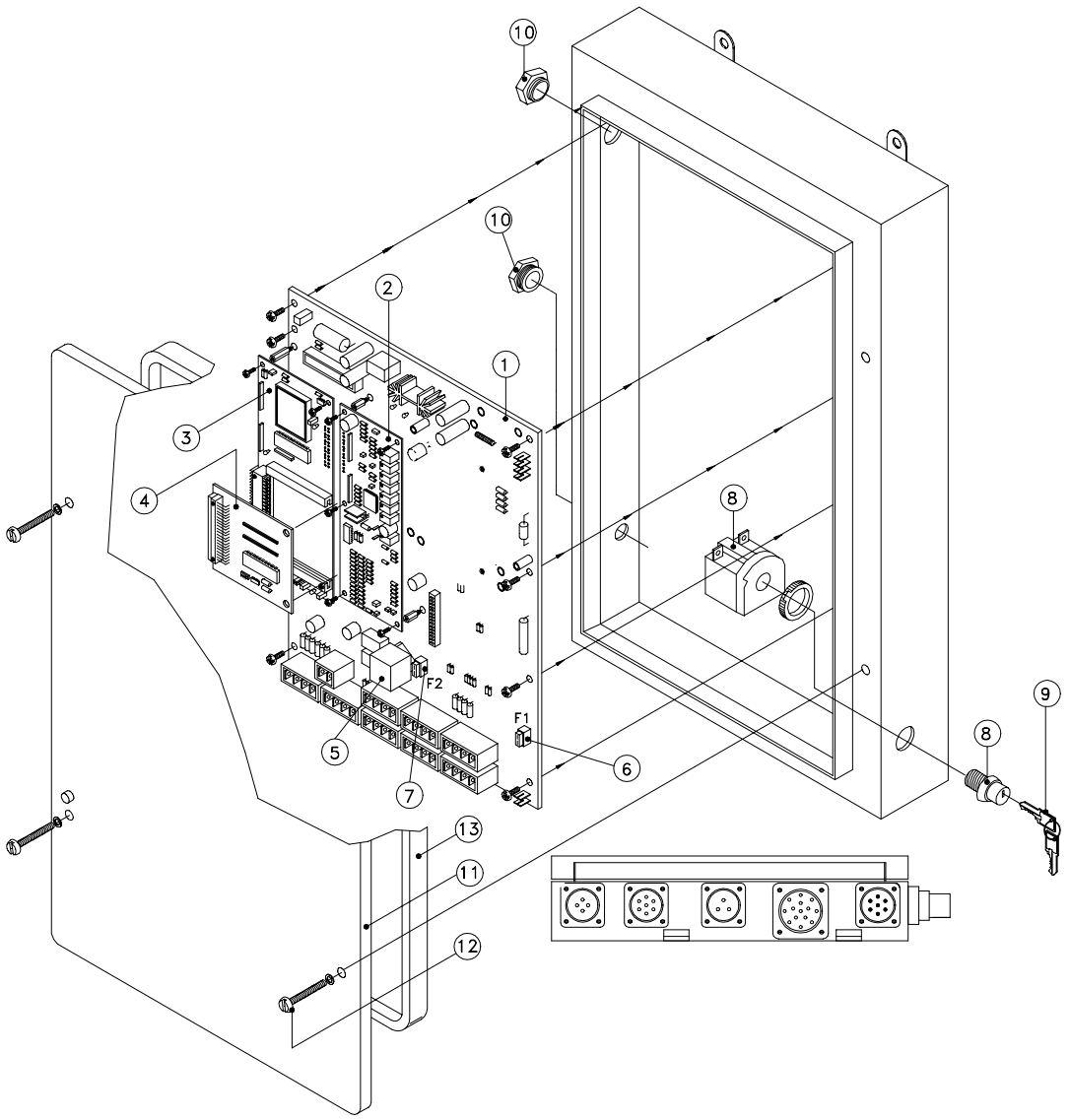
The central unit is located in the cabin, behind the operator's seat:

(shown with the lid removed).

The electronics consist of the mainboard with the following modules:



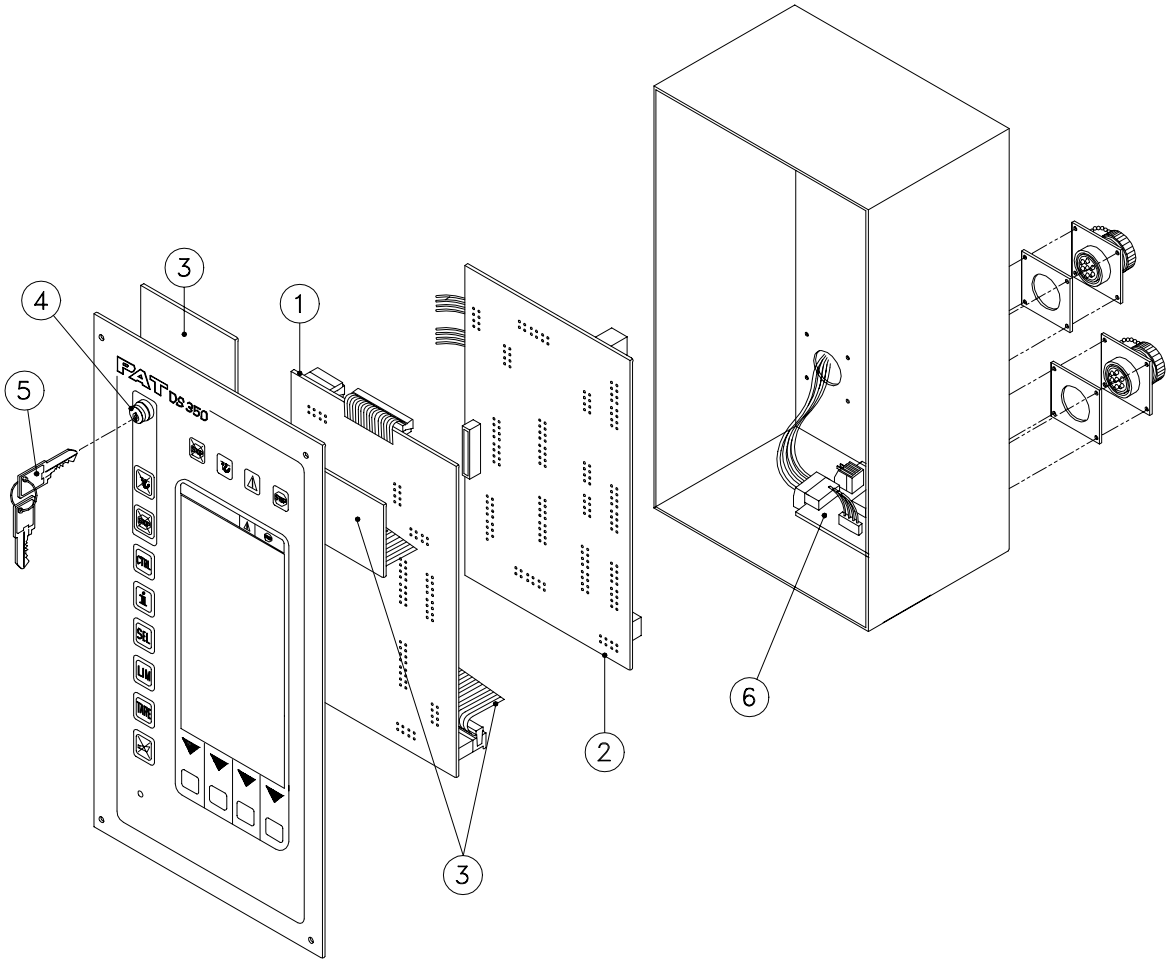
PART NO. 031-300-060-225



NO.	PART NO.	QTY	DESCRIPTION
01	024-352-300-001	1	MAIN, BOARD
02	024-352-300-020	1	ANALOG INPUT MODULE
03	024-351-300-007	1	CPU MODULE
04	024-351-300-016	1	EPROM MODULE
05A	000-304-140-112	1	RELAY 12V
05B	000-304-140-241	1	RELAY 24V
06	031-300-050-170	1	FUSE 4amp auto (F1)
07	031-300-050-171	1	FUSE 10amp auto (F2)
08	024-350-100-661	1	KEYSWITCH
09	031-300-101-131	1	SPARE KEY
10	024-000-100-095	2	MEMBRANE ELEMENT, BREATHER
11	24-350-050-292A	1	CENTRAL UNIT COVER
12	024-350-100-135	1	SCREW SET FOR COVER
13	024-350-110-067	1	GASKET

13.3 Console Ds350/1334 / Parts List (Drawing 3)

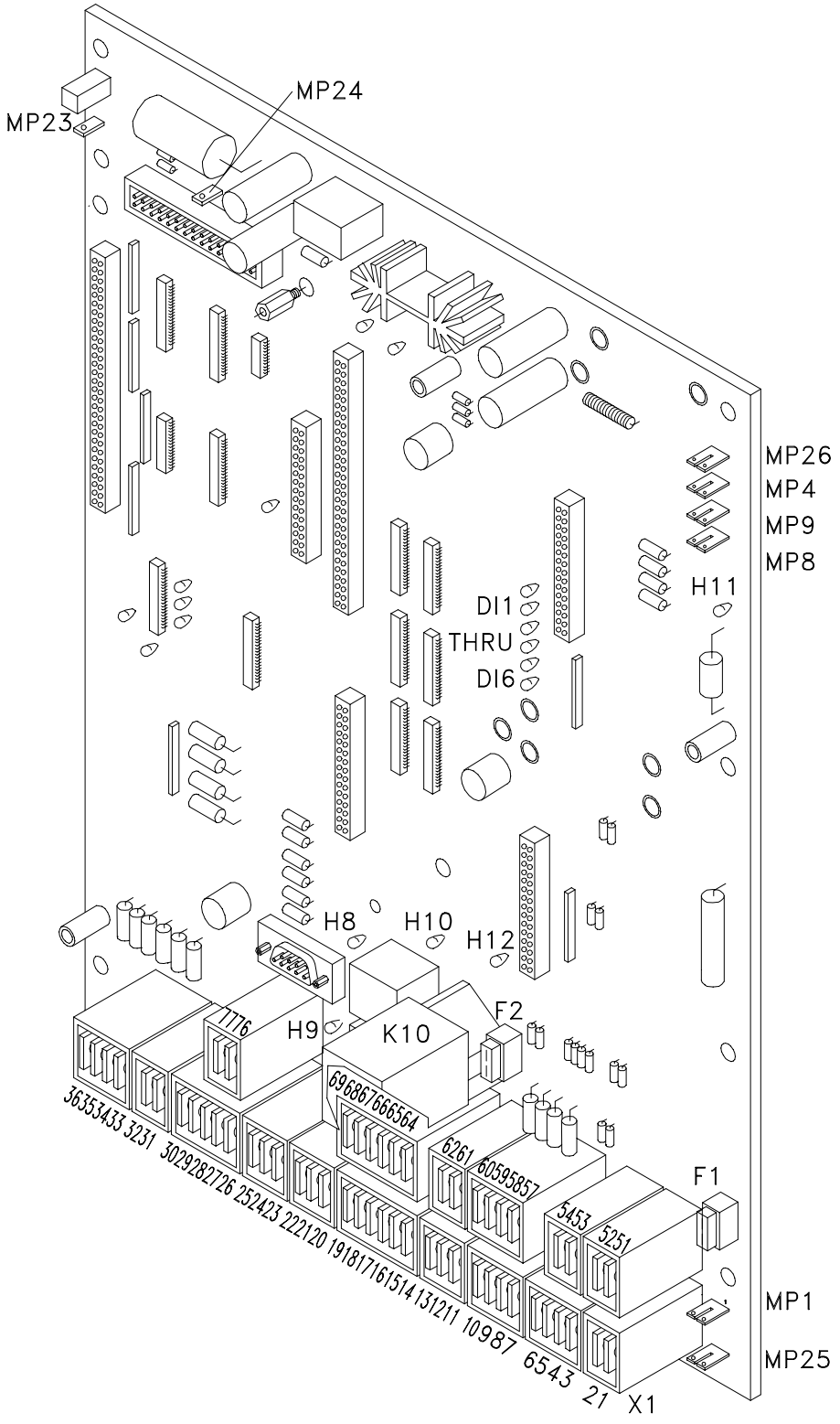
GRAPHIC CONSOLE, PARTS LIST
PART NO. 031-300-060-170



NO.	PART NO.	QTY	DESCRIPTION
01	050-150-300-050	1	BOARD
02	050-150-300-051	1	TERMINAL BOARD
03	050-150-300-052	1	BOARD, PUSHBUTTON SET (KEYBOARDS)
04	003-051-905-235	1	SWITCH, KEY
05	050-350-110-139	1	KEY, SPARE
06	050-350-300-076	1	BOARD, TERMINAL INTERFACE FOR LIGHTBAR

13.4 Central Unit Main Board Layout (Drawing 4)

BOARD P/N 024-352-300-001



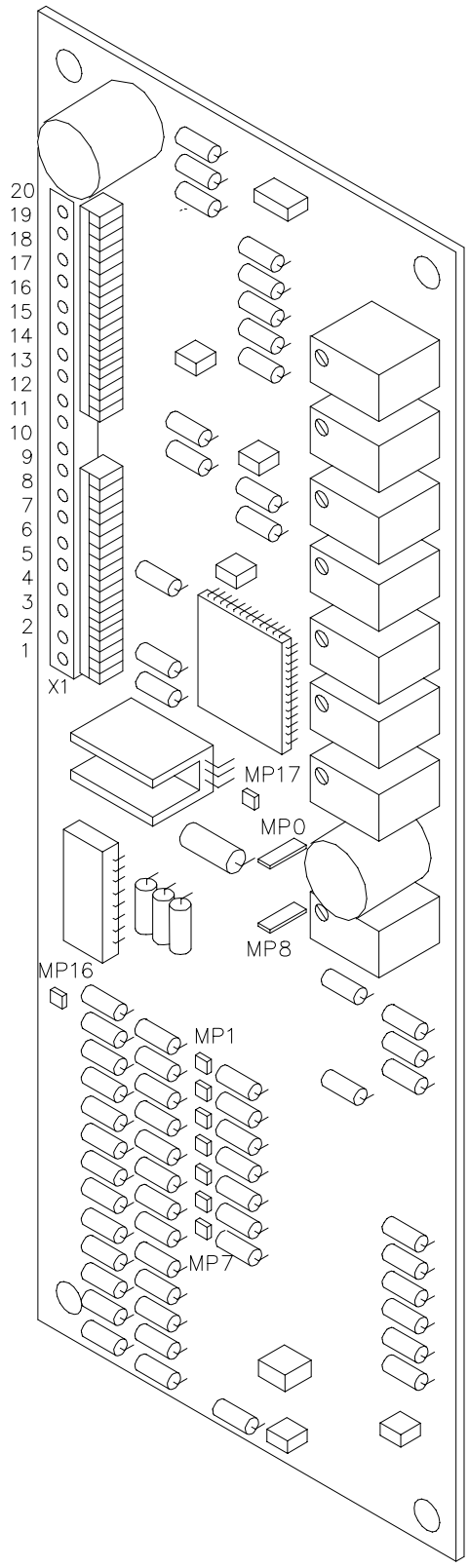
MP1 = KGND
MP4 = +5V
MP8 = +9V
MP9 = +6V
MP23 -= VBAT
MP24 -= +BATT
MP25 -= +UBS console, sensors, DI's
MP26 -= GND

LED'S
H08 - LOAD
H09 - A2B
H10 – LOCKOUT on when K10 is lit
H11 - POWER
H12 – TxD

FUSES
F1 = 4A
F2 = 10A
DI 1 not used
D1 2 rigging mode +UB on
DI 3 not used
DI 4 not used
DI 5 not used
DI 6 not used

13.5 Central Unit Analog Input Module (Drawing 5)

BOARD P/N 024-352-300-020

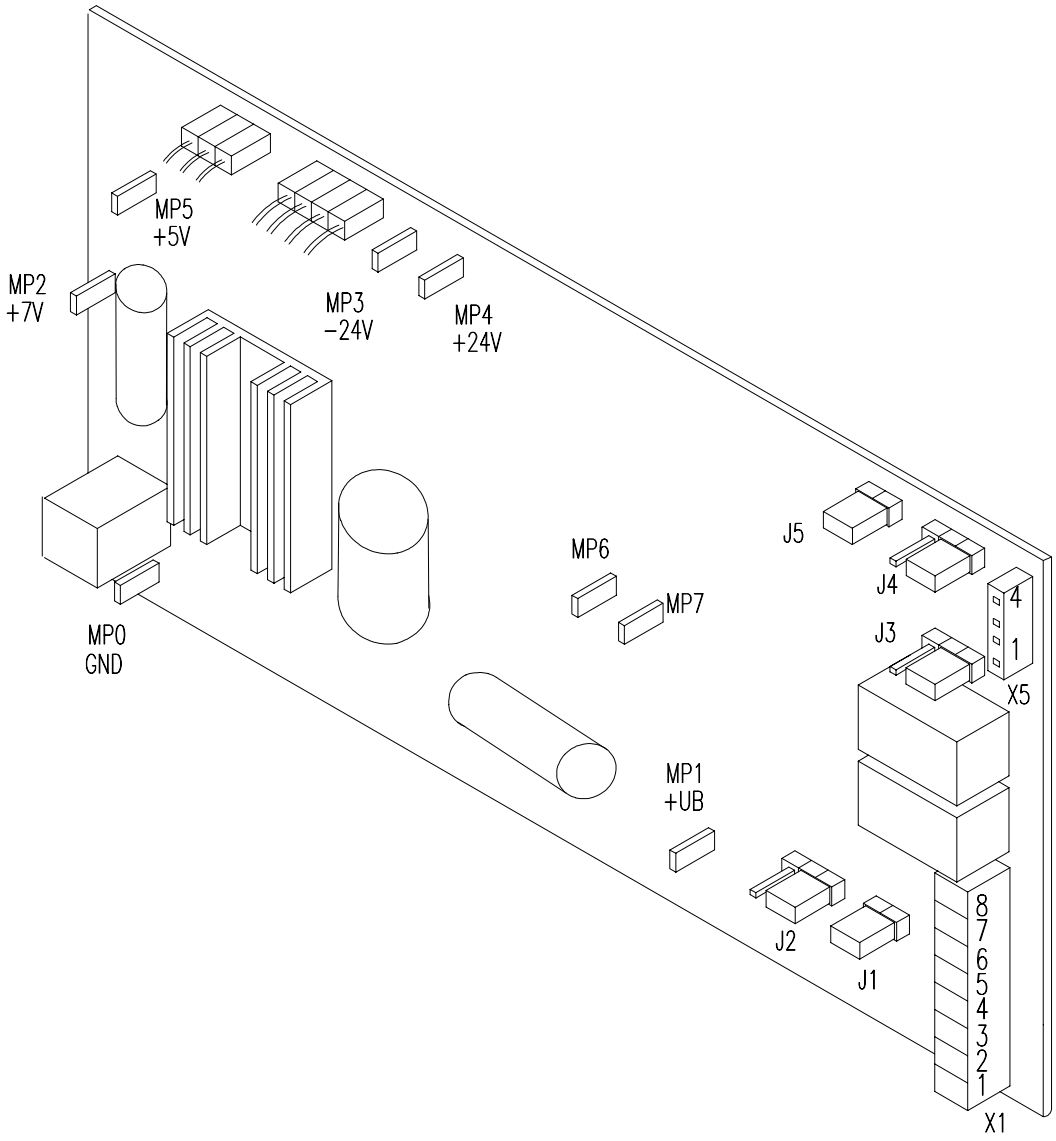


X1:1-7 = ADC INPUT 0.5V...4.5V, Note: If channel adjustments are made through the software and graphic console, DO NOT adjust offset with P1-P7.
X1:8 = TEMP (0.5V + 10mV/°C)
X1:9 = VREFA = 5.000V reference
X1:10 = AGND (reference GND)
X1:11 = VREF+ = 5.0V power ADC
X1:12-15 = CH01-04, DIN1-4 / 10
X1:16 = CH05, +UBS / 10
X1:17 = CH06, HESIN(A2B) * 4
X1:18 = CH07, +9V * 4
X1:19 = CH08, VREFA / 2 = 2.500V
X1:20 = UKLEMM, app. VREFA, limits ADC input to 5.0V

MP1 = AGND
MP8 = +5V
MP1-7 = Input channels 1-7 0.5V/4mA…2.5V/20mA
MP14 = +13V REF02
MP16 -= HESIN input voltage
MP17 = app 5.4V clamp for inputs

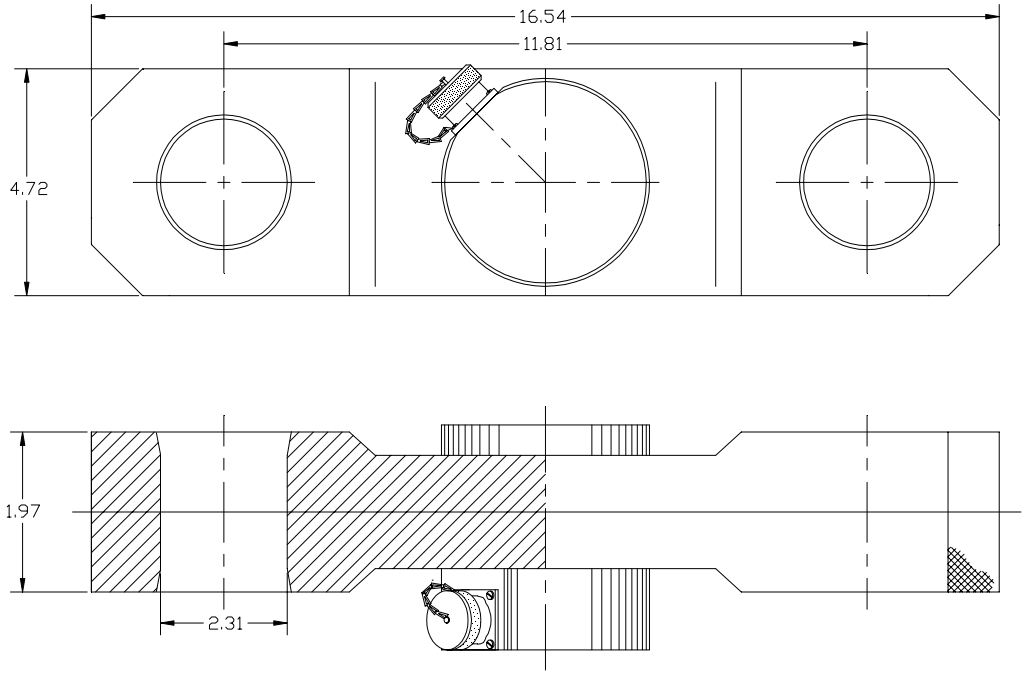
The analog input module converts the sensor signals on channels 1-7 to signals that will be processed at the CPU and software. The incoming signal measured at the measuring points (MP) will be 0.5V/4mA…2.5V/20mA. The analog input module then converts the channel signals to 0.5V…4.5V, which can be measured on X1:1 through X1:7.
The signal voltage can be measured at either point using ground and the signal input.

13.6 Console Connection Board (Drawing 6)

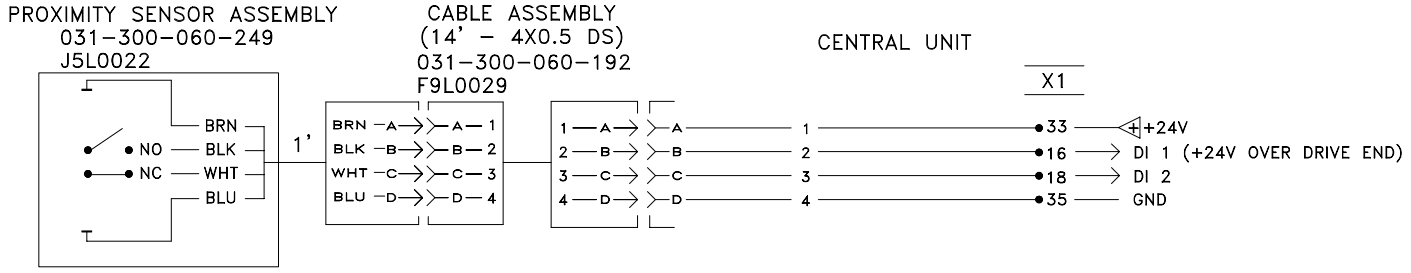


13.7 Force Transducer (Drawing 7)

There are no spare parts associated with the force transducer.

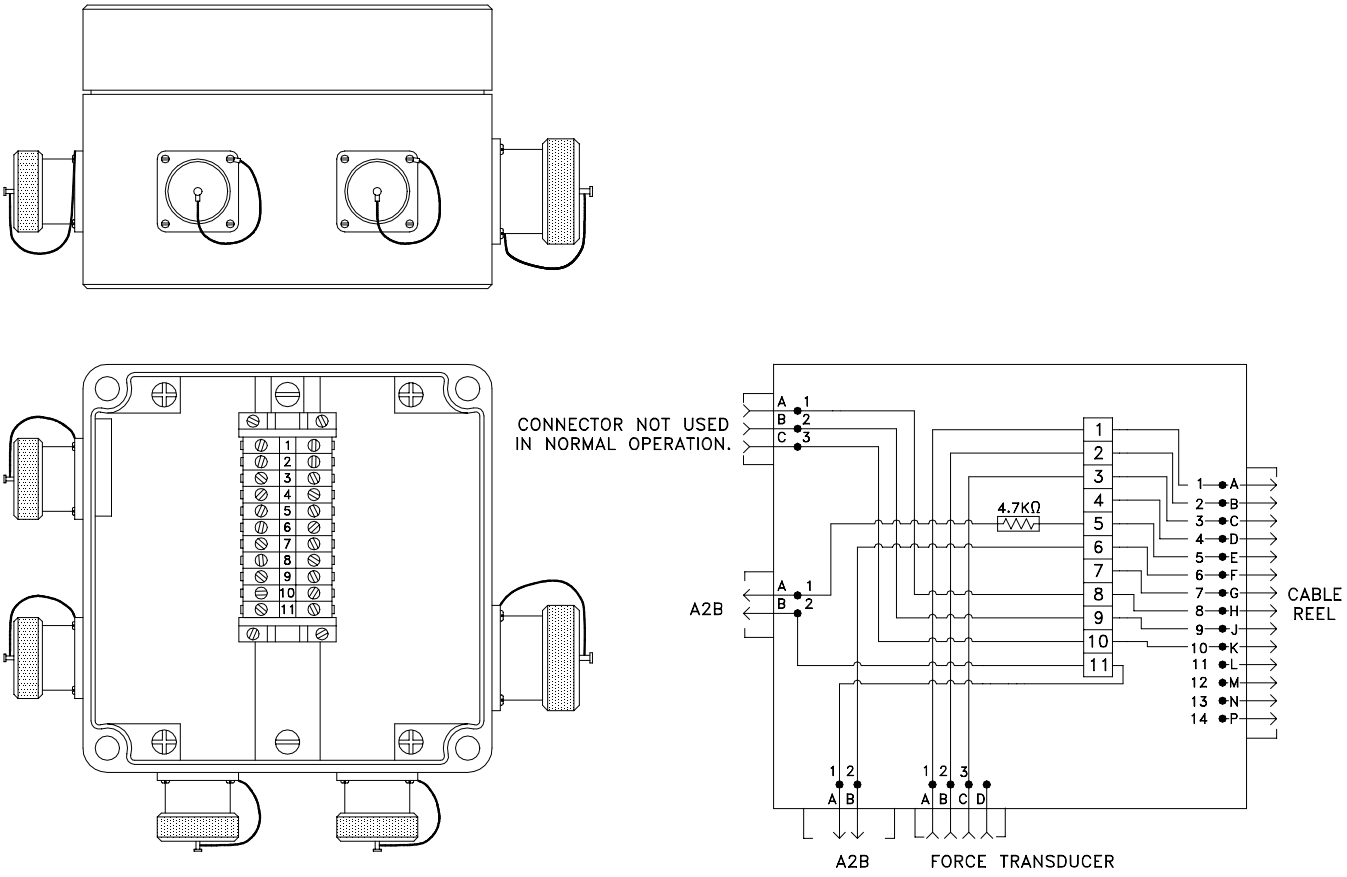


13.8 Area Definition Switch (Drawing 8)



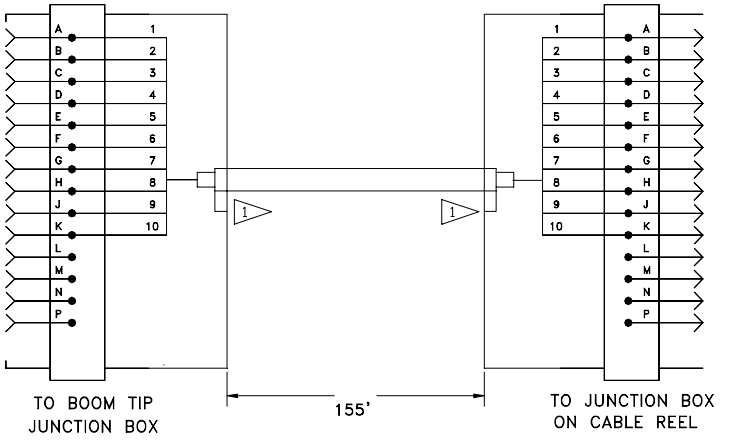
A BROWN: 10-30VDC
B BLACK: NO = +UB *LED ON
C WHITE: NC = +UB *LED OFF
D BLUE: GND
*LED ON WHEN STEEL IS PASSED IN FRONT OF SWITCH

13.9 Boom Junction Box (Drawing 9)



You can use the terminal strip to easily measure voltages in one central point.

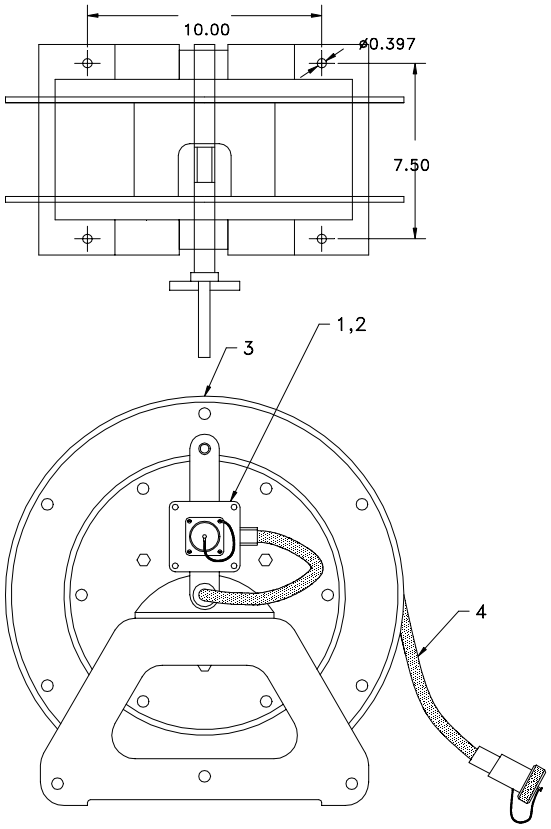
13.10 Cable Reel (Drawing 10)



ITEM	PART NUMBER	DESCRIPTION	QTY
1	031-300-060-027	JUNCTION BOX ASSY, 80X70 LATTICE REEL	1
2	031-300-100-667	SCREW, 8-32X3/4 SOCKET HEAD	2
3	031-300-050-231	CABLE REEL, LATTICE, MAIN BOOM	1
4	031-300-110-095	CABLE ASSY, 170' 10 COND W/14 SOCKET PLUG	1

NOTES:

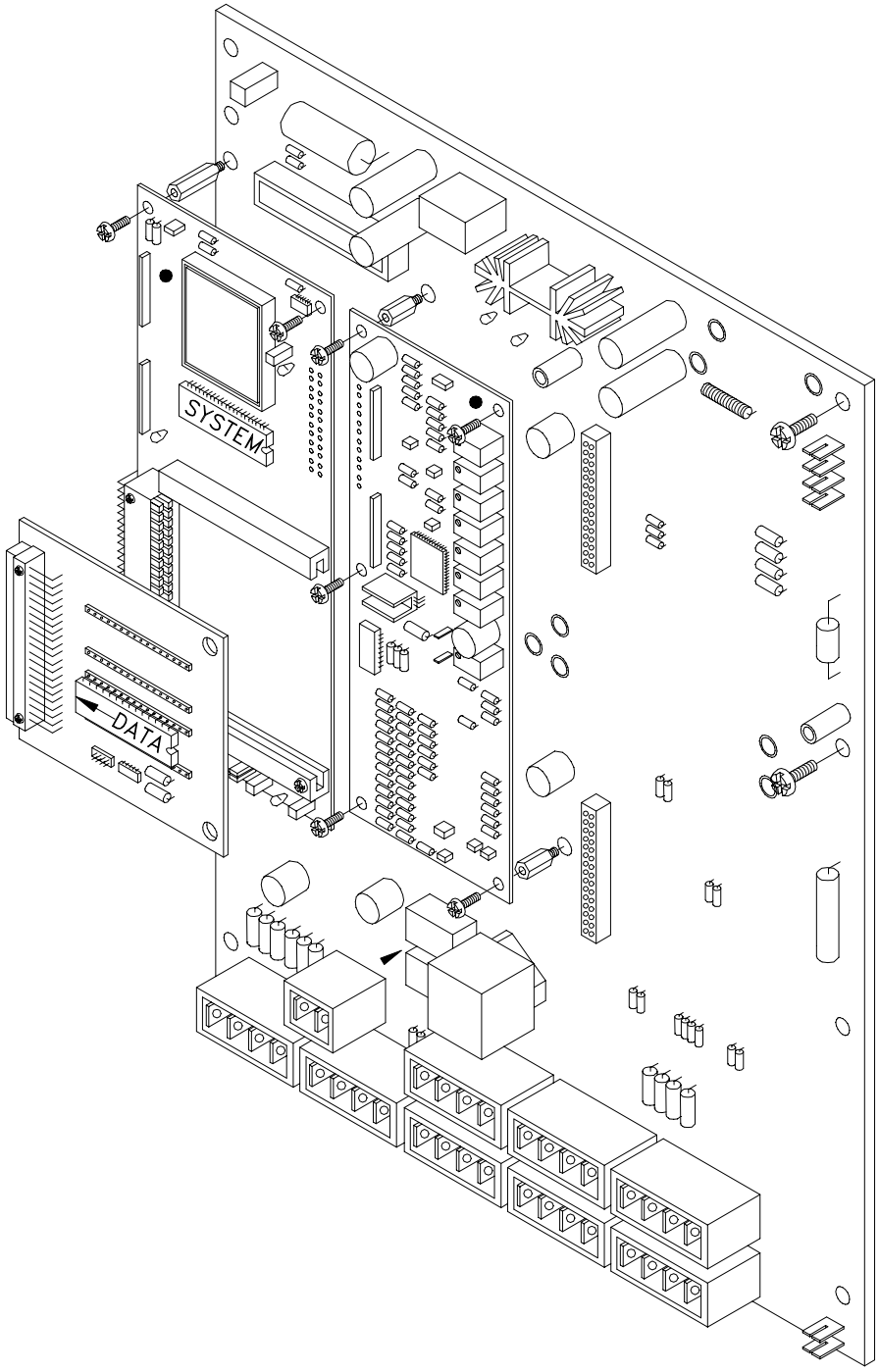
1 OUTER SHIELD GROUNDED AT STRAIN RELIEF INSERT



All boom tip signals go from the central unit through this cable reel to the boom tip sensors and switches. Refer to drawing 3 for schematics.

14 PROCEDURES

14.1 Procedure 1: EPROM Location and Installation



- Ensure the notch is in the correct direction.
- The DATA EPROM fills the bottom of the socket as shown by the arrows.
- Place EPROM's in the correct EPROM socket as shown.

14.2 Procedure 2: Main Board Replacement

Refer to Drawing 4, central unit parts list for board location.

1. Turn system power off.
2. Remove the central unit lid.

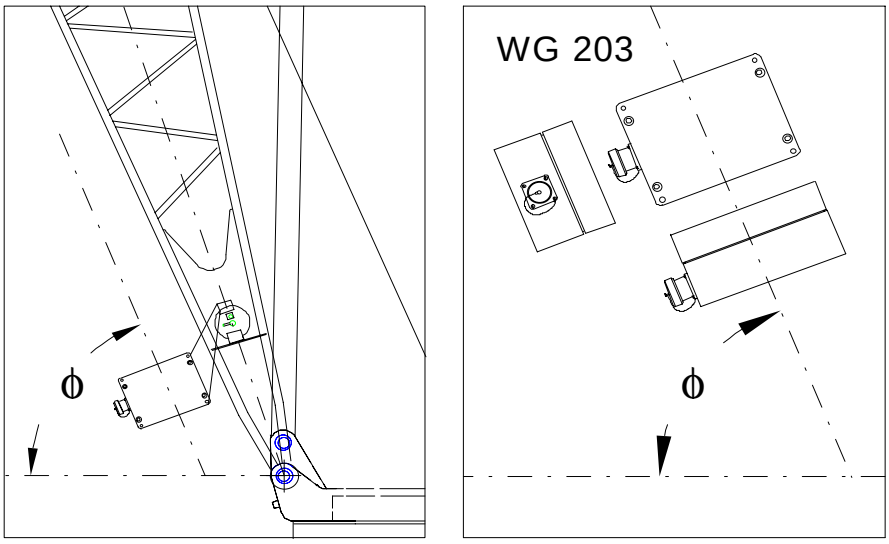
NOTE: Take care not to damage the boards with the screwdriver, when removing and inserting screws.

NOTE: Use care when lifting the CPU module board and analog input module from the main board, due to the fact that these boards have pins on the bottom side, which insert into the main board.

3. Remove CPU module board by taking out the 4 small Philips screws holding it in place.
4. Remove analog input module board by taking out the 6 small Philips screws holding it in place.
5. Remove the relay and fuses from the main board, items 5, 6, and 7 on Drawing 4.
6. Mark all connection wires before removing, to identify location for reconnecting. Disconnect all X1 terminal wires from the main board.
7. Remove the 14 large Philips screws holding the main board in place.
8. Take notice of the orientation of the main board in the central unit. Remove main board and place in the packing material that the replacement main board came in.
9. Carefully insert the new main board in place. Refer to Drawing 4 for location.
10. Insert the 14 Philips mounting screws; be sure to attach the ground wire to the KGND screw in the lower left corner. Refer to Drawing 4.
11. Insert analog input module board by lining up the pins into the sockets X16 and X17 and the 6 screw holes.
12. Insert the 6 small Philips screws and washers.
13. Insert CPU module board by lining up the pins into the sockets X11 and X12 and the 4 screw holes.
14. Insert the 4 small Philips screws and washers.
15. Insert the relay on to the main board, item 7 on Drawing 4.
16. Connect the X1 terminal wires to the main board. Refer to Drawings 1, 2 and 3.
17. Turn power on and test system.
18. Inspect the gasket for nicks, cuts, or damages before installing and tightening the cover.

14.3 Procedure 3: Angle Sensor Adjustment/Replacement

The angle "ϕ" shown in the figure below needs to be within +0, - 0.5 of the actual angle of the boom. Check boom angle at base/heel Section only. After adjustment, compare the actual boom angle with the displayed angle at about 0°, 30° and 60°.



Angle Sensor Adjustment.

Note that accuracy is more important at higher boom angles. To compare indicated angle with actual angle, make sure you use a high-precision inclinometer to determine actual boom angle **right at the angle sensor**. Due to boom deflection etc., an angle measured at another part of the boom can differ from the indicated angle.

To adjust the angle sensor, carefully loosen screws that hold it to the boom, adjust the sensor very carefully and re-tighten the screws. Double check your indicated angle. When you have found the correct position, make sure all screws are tight.

The angle sensor provides an output signal of 20 mA at 0 degrees boom angle and 4 mA at 90 degrees. Refer to Theory 1.

To comply with the SAE J375 standards the displayed angle must be +0.0° to -2.0° of the actual angle.

14.4 Troubleshooting Moisture

The PAT DS 350 LMI contains electronic components in various locations, such as central unit, sensors, junction boxes etc. These internal components cannot be designed to withstand exposure to moisture over a longer period of time. For this reason, the housings of the components are water protected according to IP 65. If you find water or moisture inside any of the housings, the source for the water ingress has to be detected and corrected to ensure proper operation.

There are two major possibilities for the occurrence of excessive moisture inside an enclosure:

1) Water ingress
2) Condensation

This outline gives instructions for detecting the cause for excessive moisture by using simple troubleshooting methods and how to prevent the moisture ingress from happening again.

14.4.1 Water Ingress

There are 6 possibilities for water to enter an enclosure:

1) Spray Cleaning
2) Missing / Loose Screws
3) Bent Lid
4) Defective Gasket
5) Loose Strain Relieves
6) Water Entry Through External Cabling

It is possible to find out the source of water ingress by going through the following steps and ruling out one possibility after the other until the cause is identified:

1) Spray Cleaning

The enclosures used for the PAT DS 350 system are water protected to IP 65. This means protection against the environment, such as rain. However, through the use of spray cleaner at short distances, it is possible to force water through the gasket or strain relieves. For this reason, avoid spraying any components from short distances with spray cleaners. Convey this fact to any member of a maintenance crew.

2) Missing / Loose Screws

All screws have to be present and to be equally tight to ensure water protection of the enclosure. If there are screws missing, replace them. If no screw is missing, check the tightness. If any were loose, then open all screws and then re-tighten them equally.

3) Bent Lid

An enclosure will only seal correctly if the lid is not bent. To check this, loosen all screws of the lid, take the lid off the box and visually inspect it for deflection. If the lid is bent or damaged, it needs to be replaced. Try to determine what has caused the lid to be bent and eliminate the reason for that. Order a new lid through your Link-Belt or PAT representative.

4) Defective Gasket

The gasket underneath the lid seals the unit. The gasket needs to be in good condition in order to seal correctly. If the gasket is torn, brittle or severely bent, it needs to be replaced. Order a new gasket through your Link-Belt or PAT representative.

5) Loose Strain Relieves

The strain relieves allow cabling to enter the box without allowing water to enter it. The strain relieves have to be correctly tightened in order to do this. Check the tightness by taking the external cable into one hand and carefully trying to turn it. If the internal wires turn with the outer cable, the strain relief is loose. Get a new grommet (insert) through your Link-Belt or PAT representative and replace the existing one with the new one. Tighten the strain relief correctly. Note: Whenever a strain relief is opened, i.e. to replace a cable, a new grommet needs to be used. Never re-use any grommet or the strain relief will not seal properly!

6) Water Entry Through External Cabling

Even with a tight strain relief, water may still enter the box through the inside of the cable. In this case, you have to find out why and where water enters the cable. Look for damages to the cable itself and inspect the opposite side of the cable. In example, if the cable comes from a connector that is full of water, the water will run through the inside of the cable and fill up the central unit, too.

14.4.2 Condensation

In a climate with high humidity and rapidly changing temperatures, condensation can happen inside any enclosure, usually the larger the volume of the box, the more likely. In this case, water drops build up on the inner components when humid air is trapped inside the box. With condensation, water tightness is not a problem – the box is sealed just fine, which is what prevents the trapped air from exiting the box. There are two ways to deal with condensation:

1. If the volume is very small, a desiccant bag might be able to soak up the air's humidity.
2. If the effect is more severe, the only way to get rid of this effect is then to give the box the ability to breath without sacrificing its water tightness. Contact your Link-Belt or PAT representative for breathing elements to than can be added to the box and will help to reduce the effects of humid climates.

14.5 Theory 1: Operation of Angle Sensor

14.5.1 Measuring current:

The ammeter (A) is used to measure current at the angle input signal. Remove the wire from X1:29 terminal in the central unit and measure the current with the ammeter in series. The measurement should be between 4..20mA.

14.5.2 Measuring voltage:

The voltmeter (V) is used to measure voltage between pins X1:29 (angle signal) and X1:28 (GND) on the main board 024-352-300-001. The resistors are there to show that at 4mA the voltage is 1.1V because current multiplied with resistance equals voltage; therefore, 4mA x 275 ohms (total resistance) = 1.1V.