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PAT

RATED CAPACITY LIMITER

DS 350 MODULAR/GRAPHIC

with Line Riders for Lattice Boom Cranes

SERVICE MANUAL

P/N 031-300-190-076, Rev. C, 03/13/2003

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NOTICE

MANUAL REVISIONS

REV	DATE	NAME	DESCRIPTION
-	2/11/00	MO	Preliminary troubleshooting handbook created for customer review and feedback.
A	09/10/00	CSH	Update drawings and measuring points
B	10/15/01	CSH	ECN 01-294
C	03/13/03	CSH	ECN 01-031

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1 GENERAL INFORMATION

The PAT Rated Capacity Limiter (RCL) 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 Rated Capacity Limiter 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 RCL 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 Rated Capacity Limiter 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 031-300-190-072 for console operating instructions.

2 WARNINGS

The RCL 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 RCL 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 RCL has to be ensured before starting the crane operation.

3 SYSTEM DESCRIPTION

The PAT Rated Capacity Limiter DS 350 consists of a central microprocessor unit, operating console, angle sensor, line riders, 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 line rider signals.
The hoist load is measured by line riders 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. Cable to main line rider
8. Main line rider (Tensiometer)
9. Dummy Plug
10. Dummy Plug
11. Cable to main boom angle sensor
12. Main boom angle sensor
13. Operator's console with cable
14. Internal light bar
15. Cable for slewing sensor or proximity switch
16. Slewing sensor or proximity switch

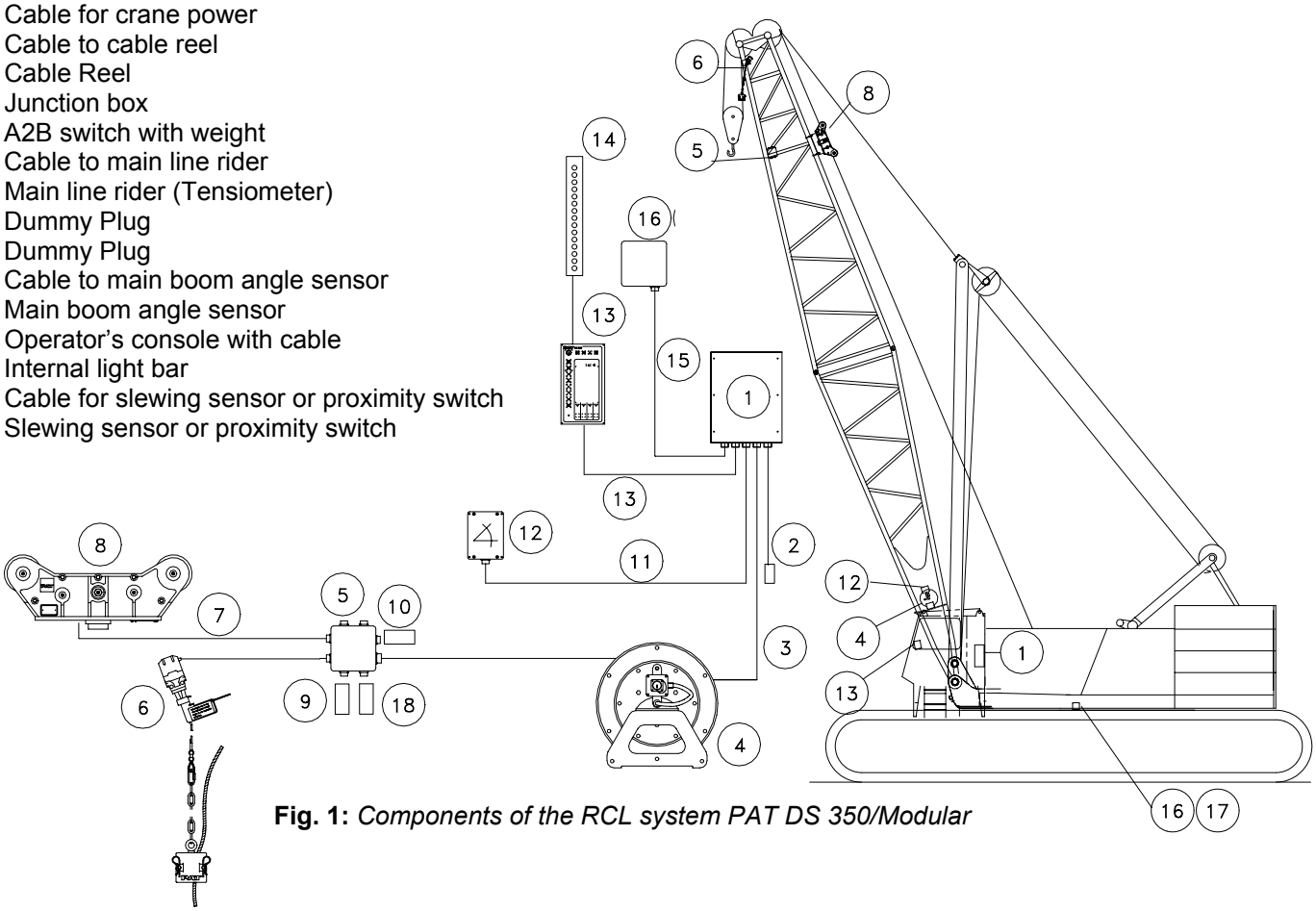
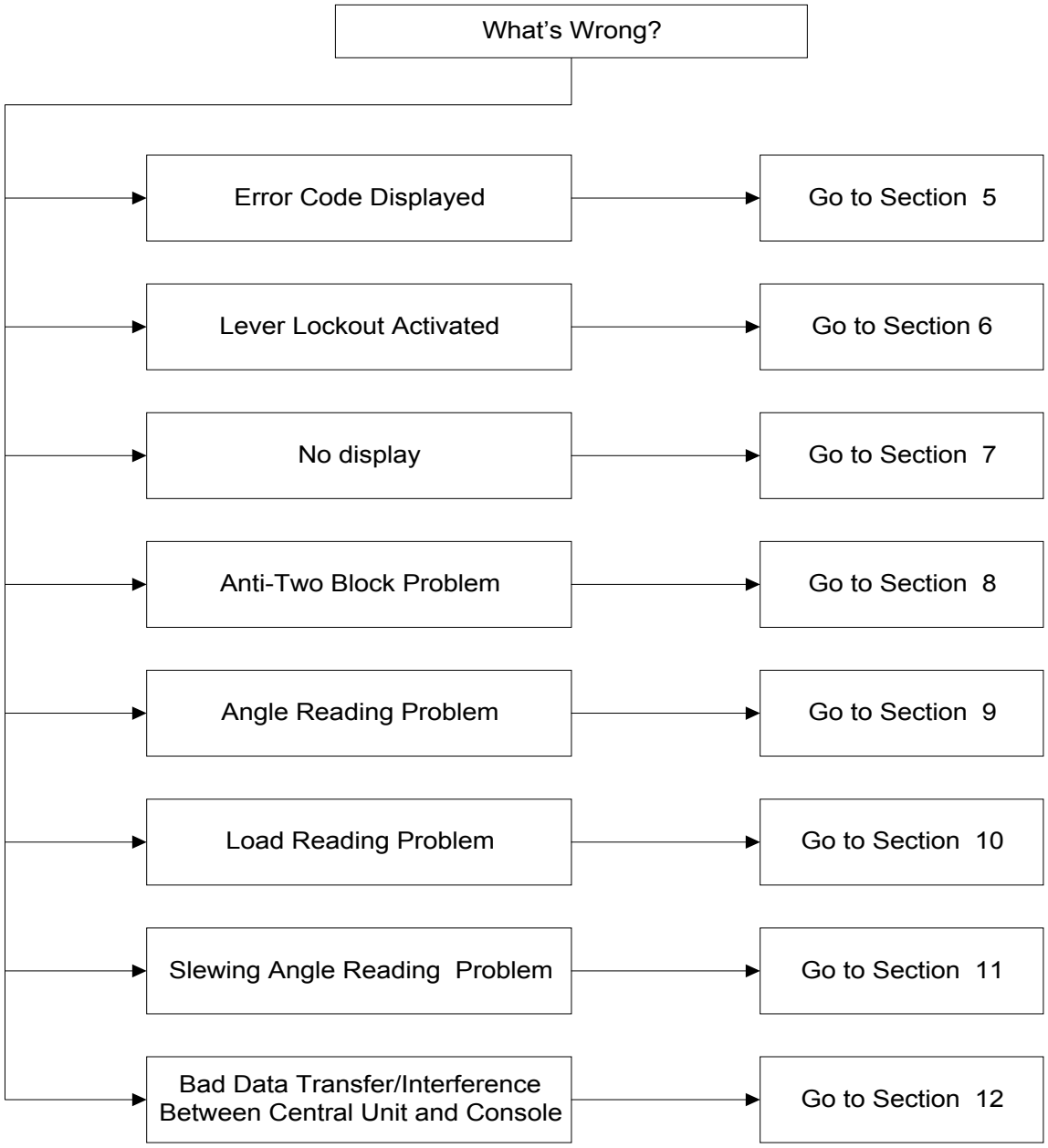


Fig. 1: *Components of the RCL system PAT DS 350/Modular*

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 Line Rider	36	E14	E24
Aux. Line Rider	24	E13	E23
Angle Sensor (Main Boom)	29	E15	E25
(Angle Sensor Luffing Jib)	(30)	(E16)	(E26)
Slewing Sensor Pot A	27	E1A	E2A
Slewing Sensor Pot B	34	E1B	E2B

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
E13	Fallen below the lower limit value in the aux. line rider channel	• Cable between the central unit and line rider defective or water inside the plugs • Line rider is defective. • Electronic component in the measuring channel is defective.	• Check cable as well as plugs, replace, if need be. • Replace line rider • Replace LMI module(s).
E23	Upper limit value in aux. line rider measuring channel has been exceeded	• refer to E13	• refer to E13

Error Code	Error	Cause	Elimination
E14	Fallen below the lower limit value in the main line rider measuring channel	• refer to E13	• refer to E13
E24	Upper limit value in main line rider measuring channel has been exceeded	• refer to E13	• refer to E13
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 • Electronic component in the measuring channel defective.	• Check cable as well as plugs, replace, if need be. • Replace angle sensor • Replace LMI module(s).
E25	Upper limit value in measuring channel "main boom angle" has been exceeded.	• refer to E15	• refer to E15
E16	Fallen below lower limit value in measuring channel "luffing angle"	• Refer to E-15	• Refer to E-15
E26	Upper limit value in measuring channel "angle 2" has been exceeded.	refer to E16	refer to E16
E1A	Fallen below lower limit value in measuring channel "slewing angle A".	• Cable between the central unit and the slewing angle sensor defective or loose. Water inside the plug of the angle sensor • Slewing angle potentiometer is defective • Electronic component in the measuring channel defective	• Check cable as well as plugs, replace, if need be. • Replace slewing angle sensor • Replace LMI main board or analog board.
E2A	Upper limit value in measuring channel "slewing angle A" has been exceeded	• refer to E1A	• refer to E1A
E1B	Fallen below lower limit value in measuring channel "slewing angle B"	• refer to E1A	• refer to E1A
E2B	Upper limit value in measuring channel "slewing angle B" has been exceeded	• refer to E1A	• refer to E1A

Error Code	Error	Cause	Elimination
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
E52	Error in load chart EPROM.	• EPROM Module not bridged correctly • Data EPROM on the main board defective.	• Replace EPROM Module and reset pressure channels. Refer to Drawing 10 / Procedure 1.
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.

Error Code	Error	Cause	Elimination
E71	Faulty acknowledgment of relay K1 on the connection board 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.	• Relay K1 or main board defective. • Main board is defective	• Replace main board. • Replace main board.
E72 **...** **E77**	Faulty acknowledgment of relays K2...K7 on the connection board.	• refer to E71	• refer to E71
E84	Error in the slewing angle measurement	• The difference between the average of the slewing angle and one of the wipers of the slewing potentiometer is out of the tolerance	• Check the slewing potentiometer adjustment • Replace the slewing potentiometer
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

Error Code	Error	Cause	Elimination
E94	No data transmission 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 • Transmitter/receiver module is defective • Computer module is defective • Electro-magnetic interferences (e.g. when switching contactors or valves)	• 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 • 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

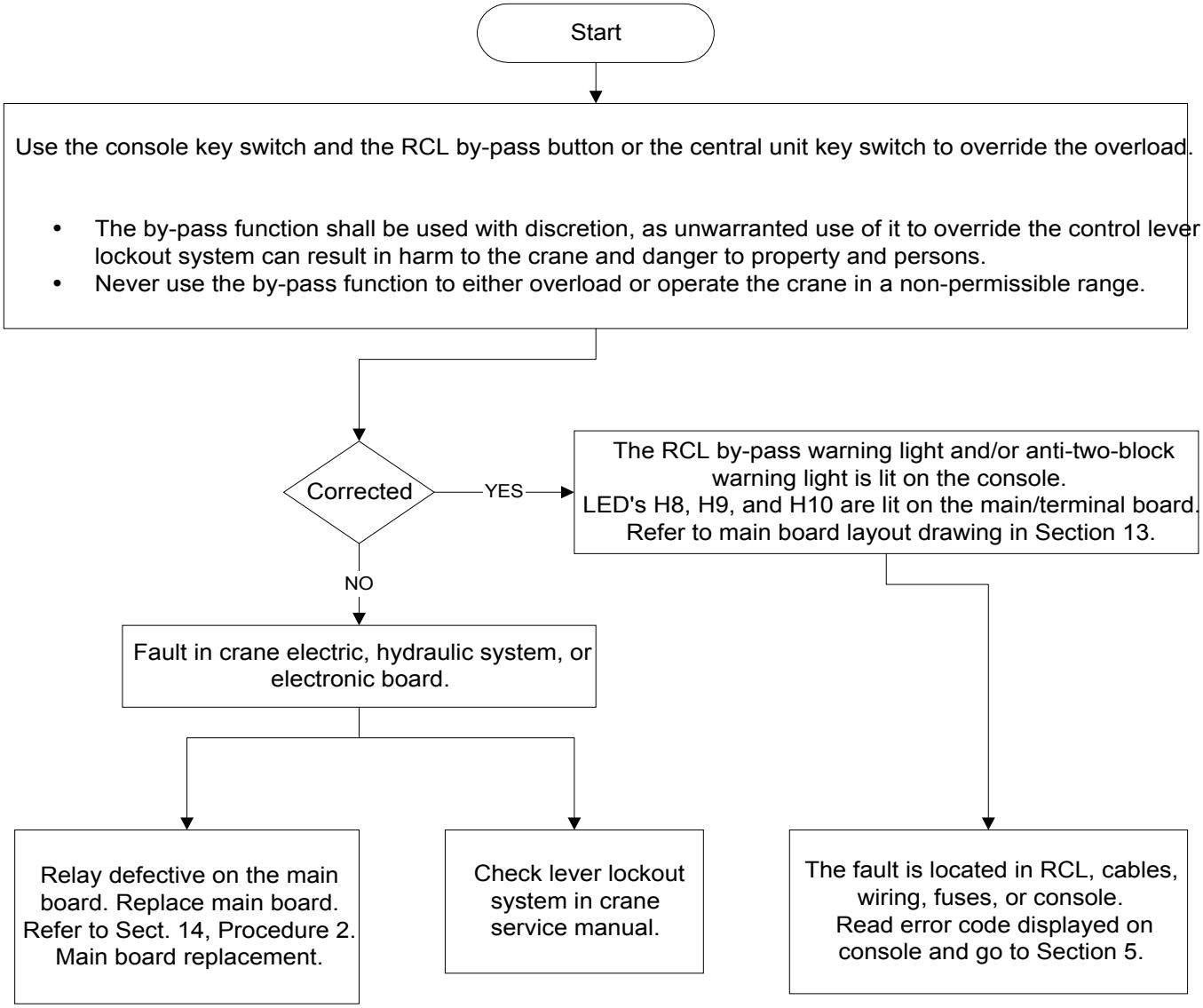
Note:
If an error message is displayed which is not contained in above list, please contact the PAT service department.

6 FUNCTION LOCKOUT

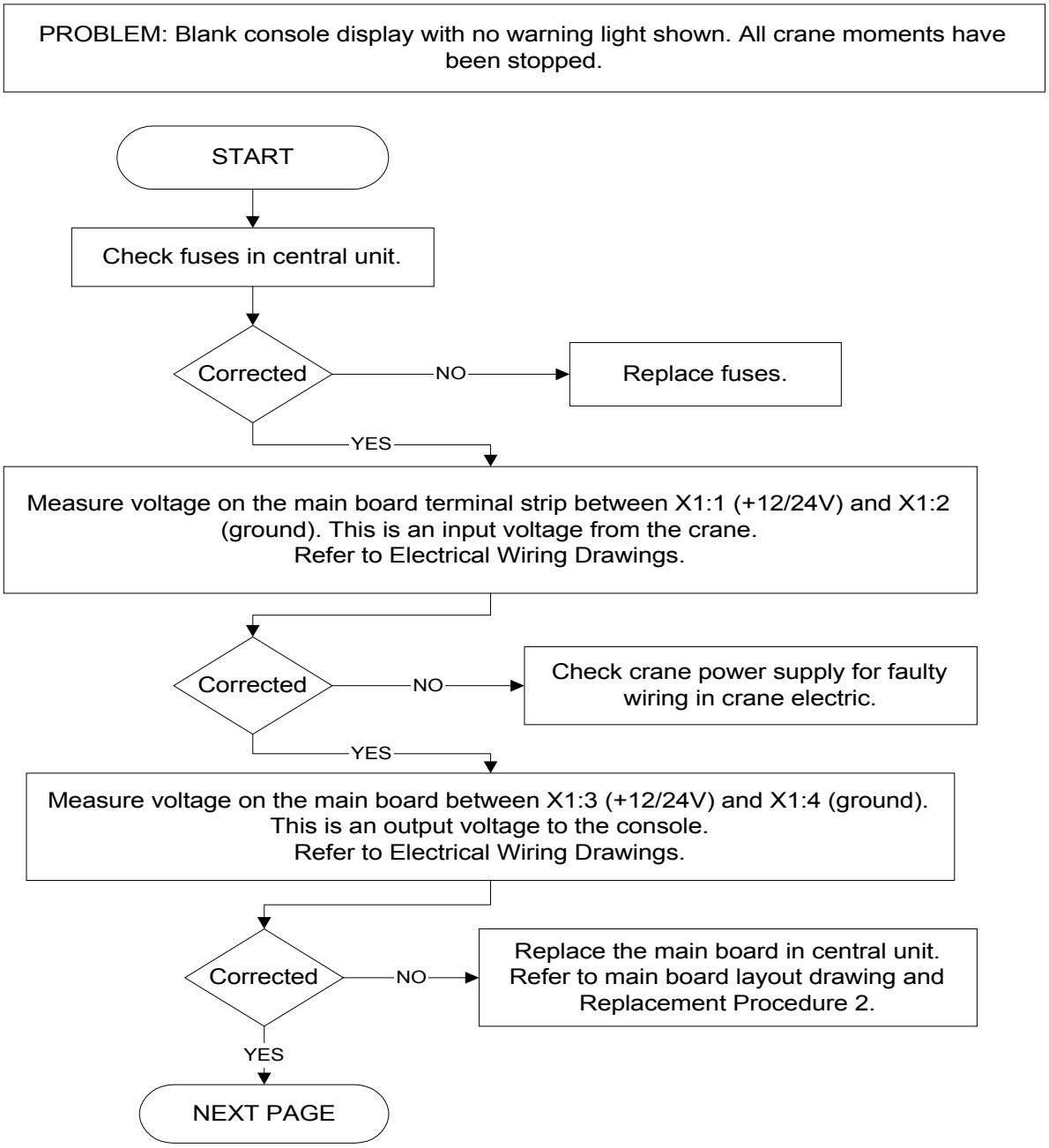
PROBLEM: The lever lockout system of the crane is activated. Crane movements “hoist up” and (optional) “boom down” are stopped. Only if the crane is not in overload or two-block condition continue with flow chart.

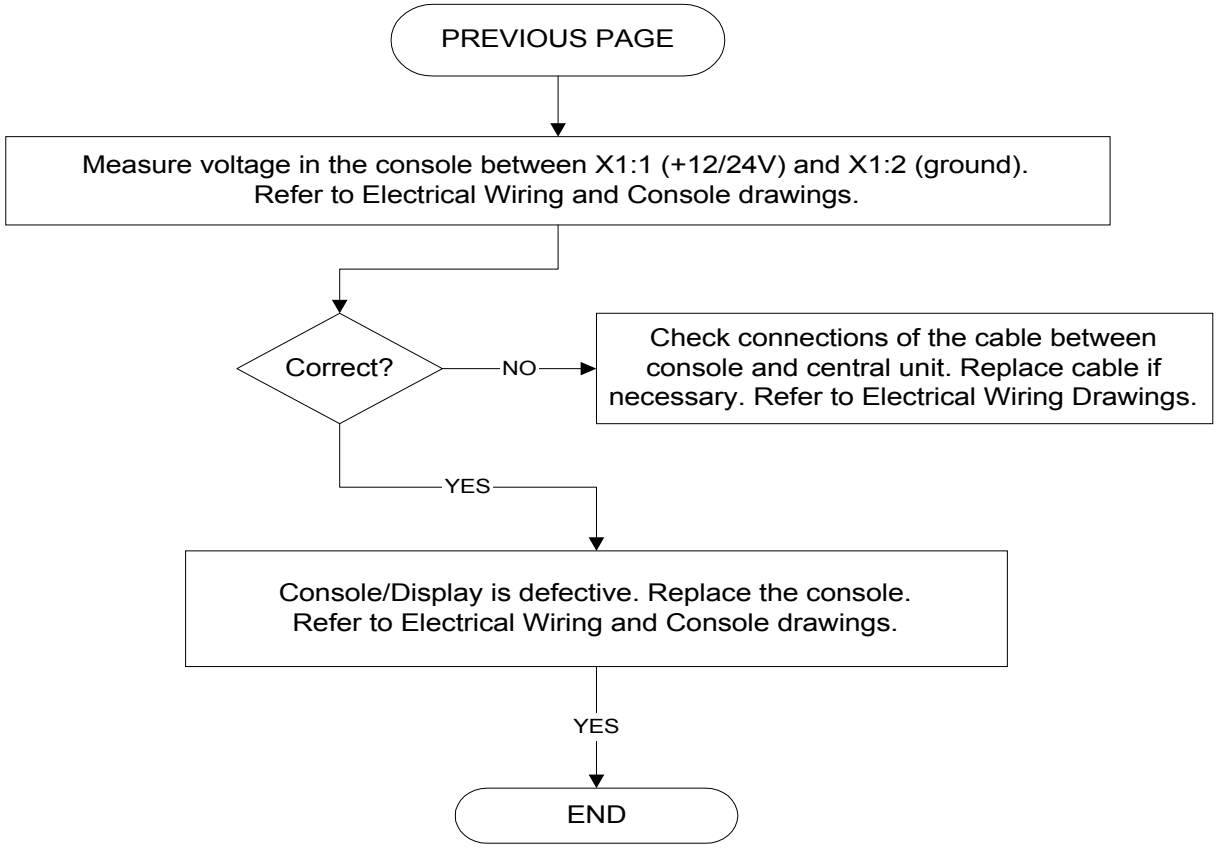
WARNING: If overload or A2B condition exists, use extreme caution and move the crane out of the condition.

If Error Code is displayed goto Section 5.

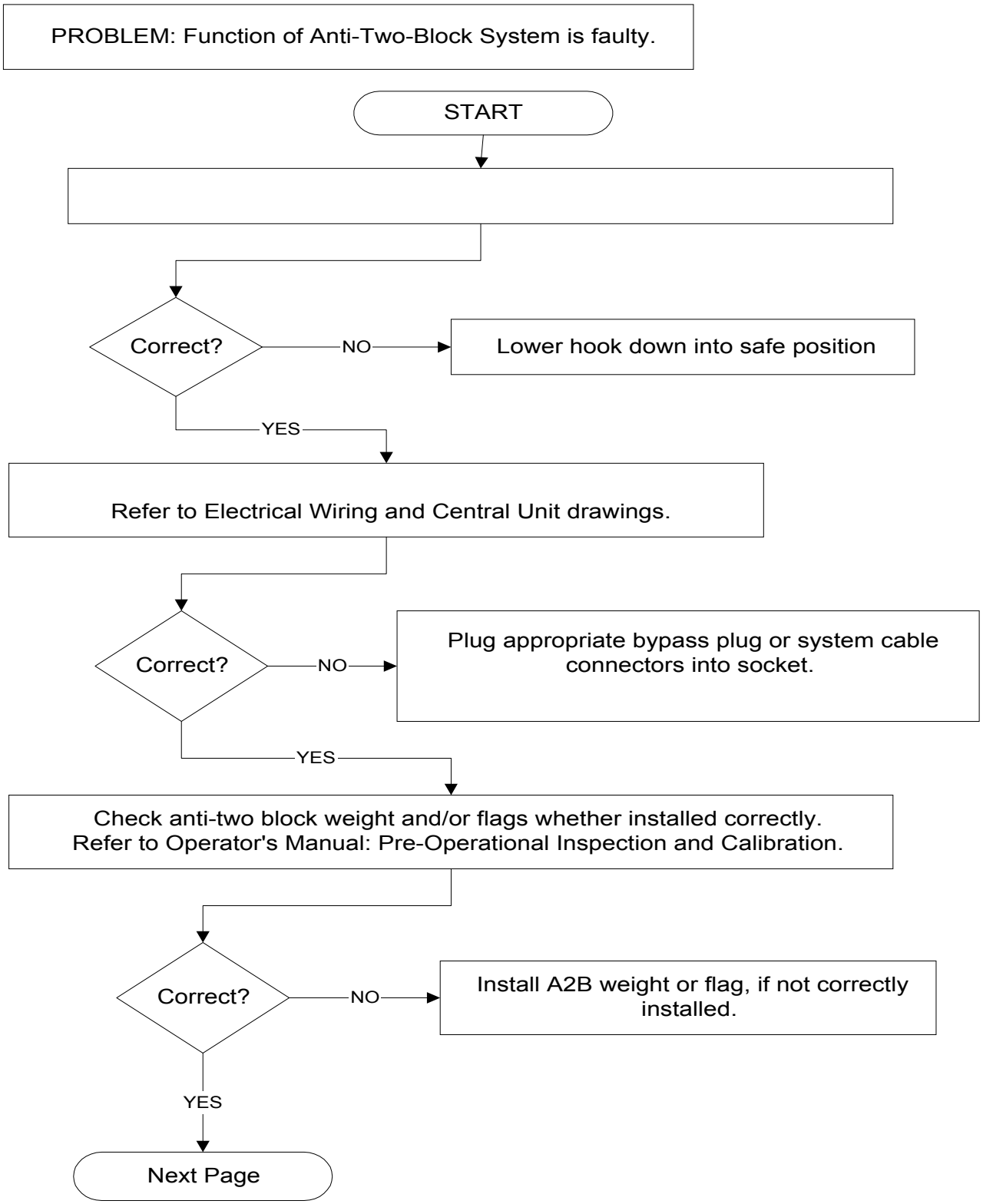


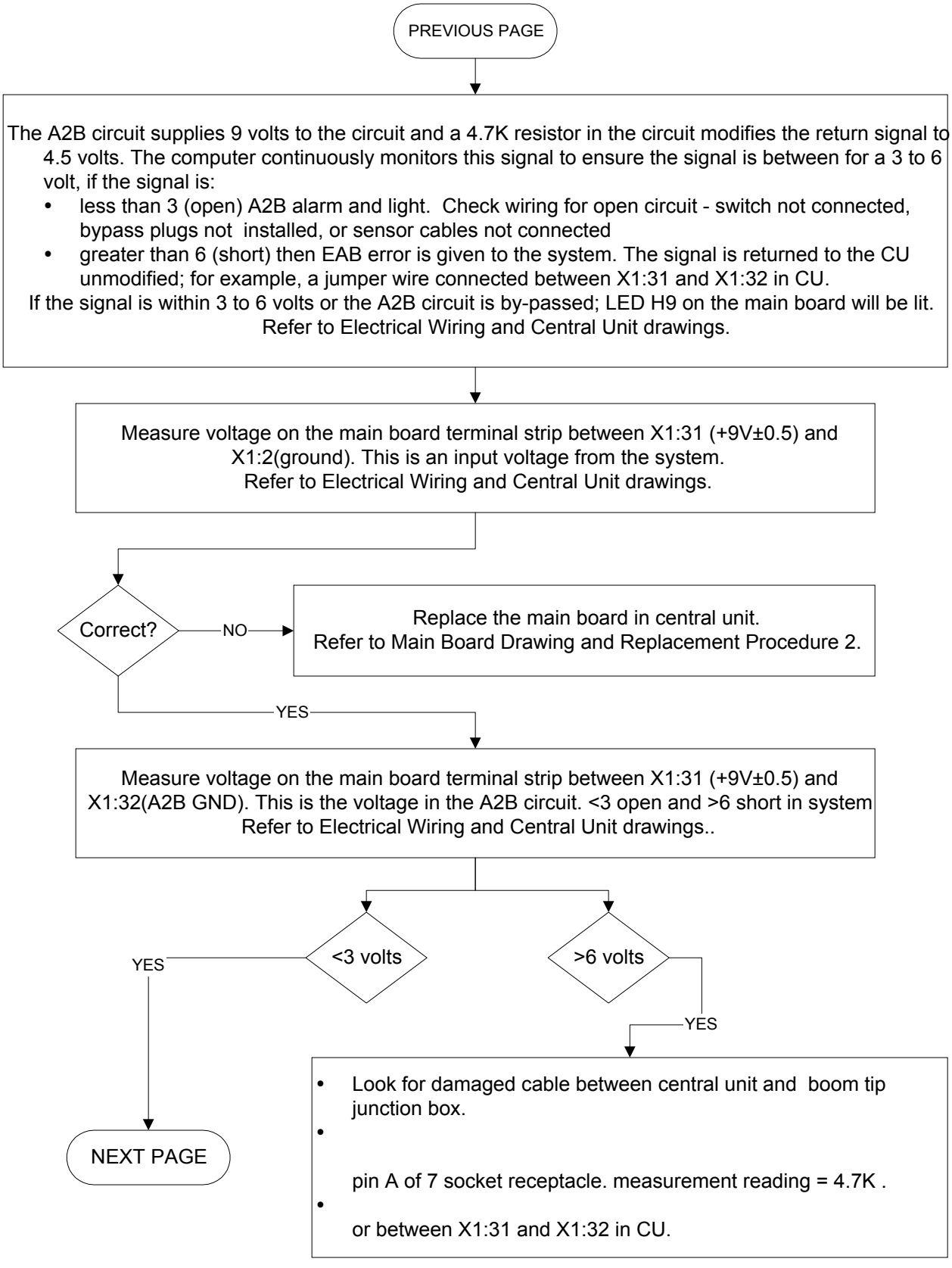
7 NO DISPLAY

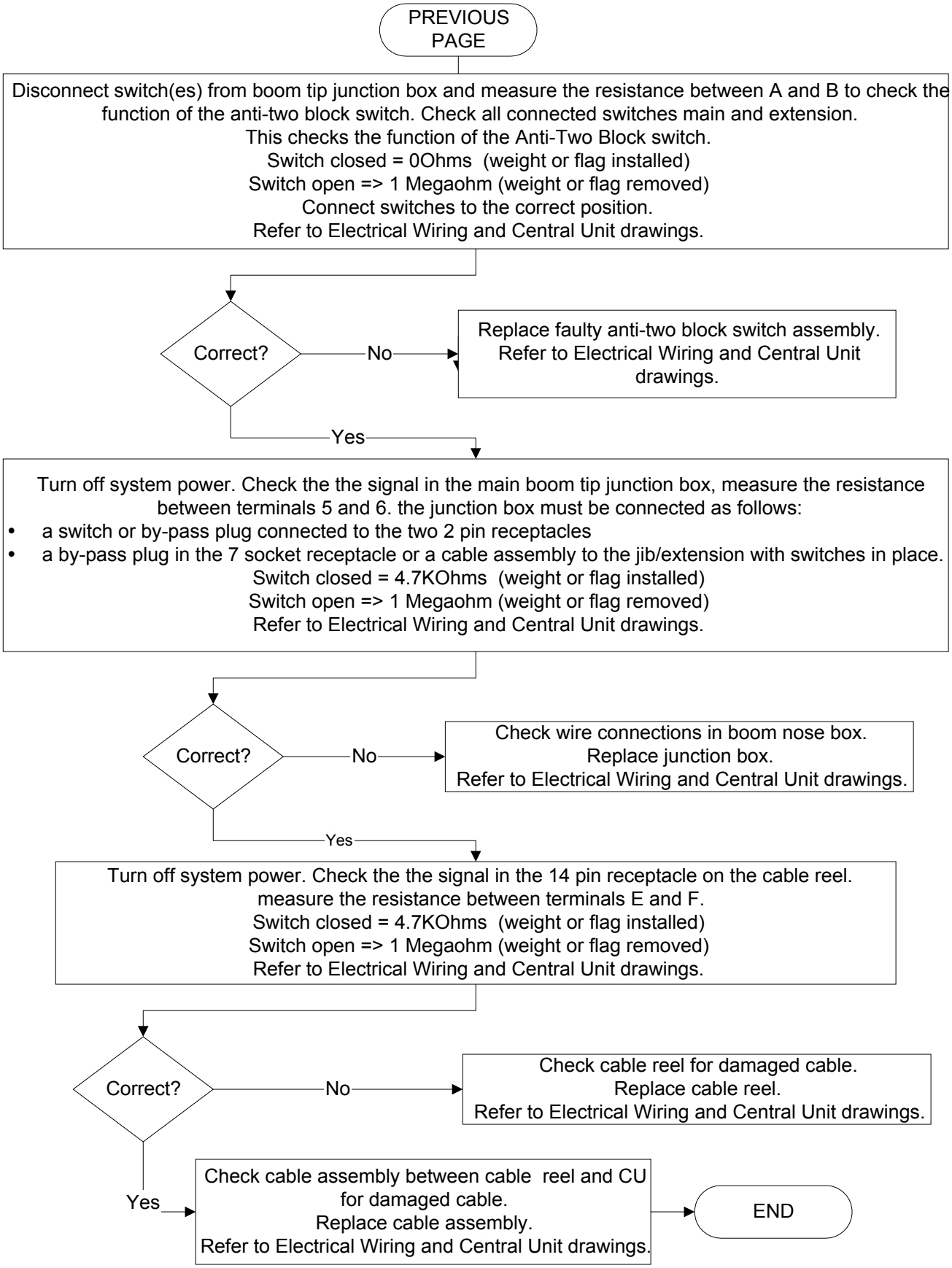




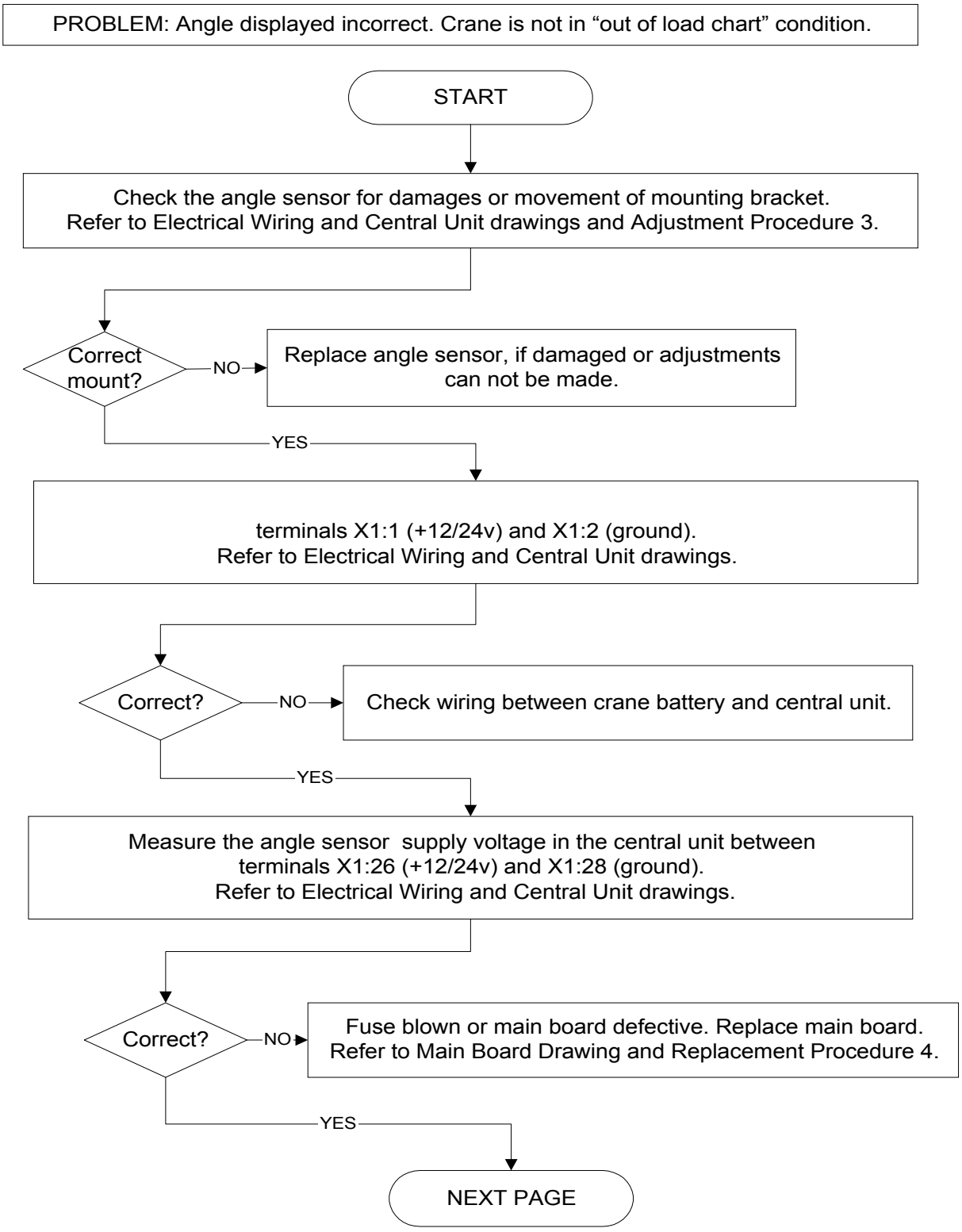
8 ANTI-TWO BLOCK PROBLEM

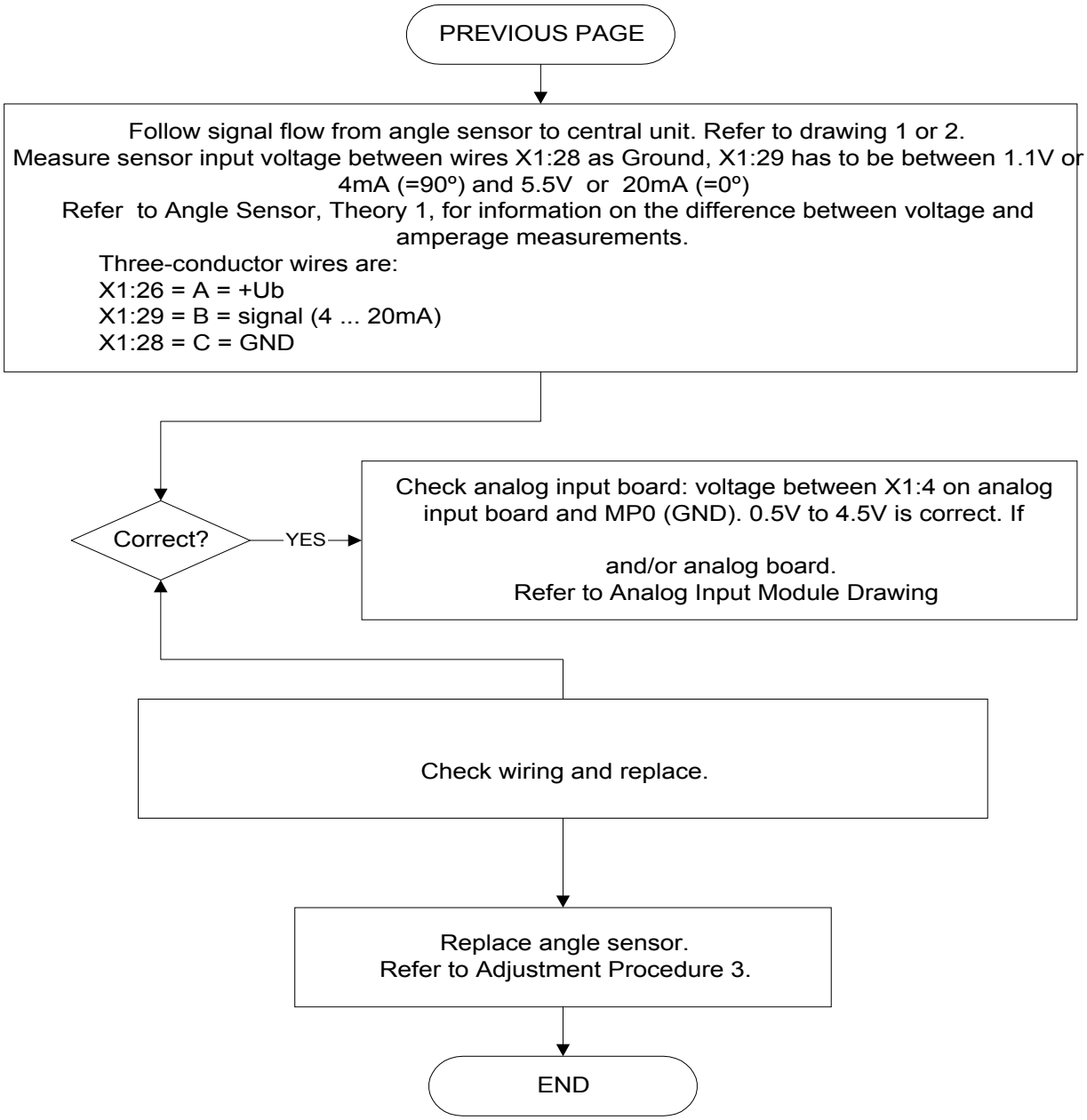




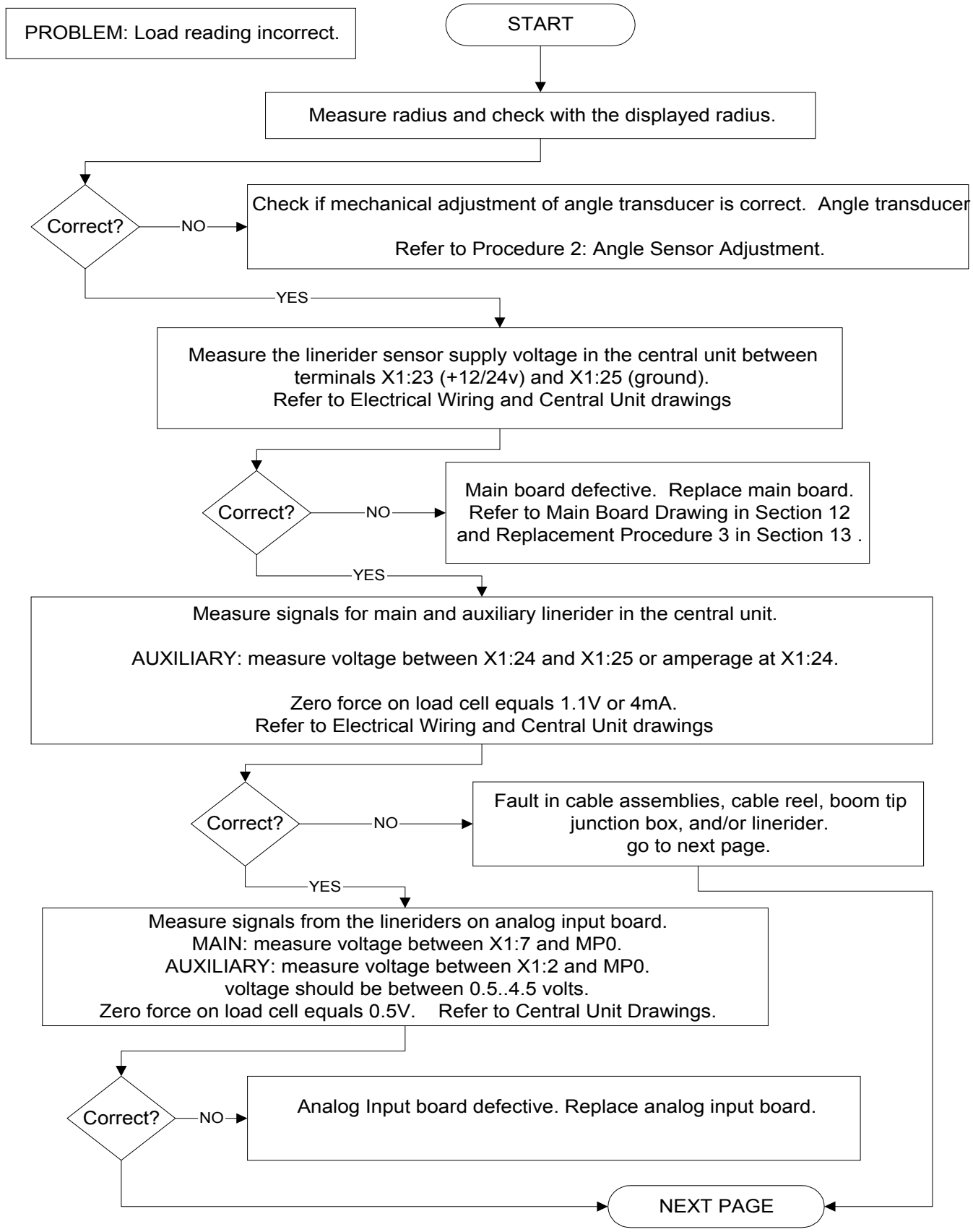


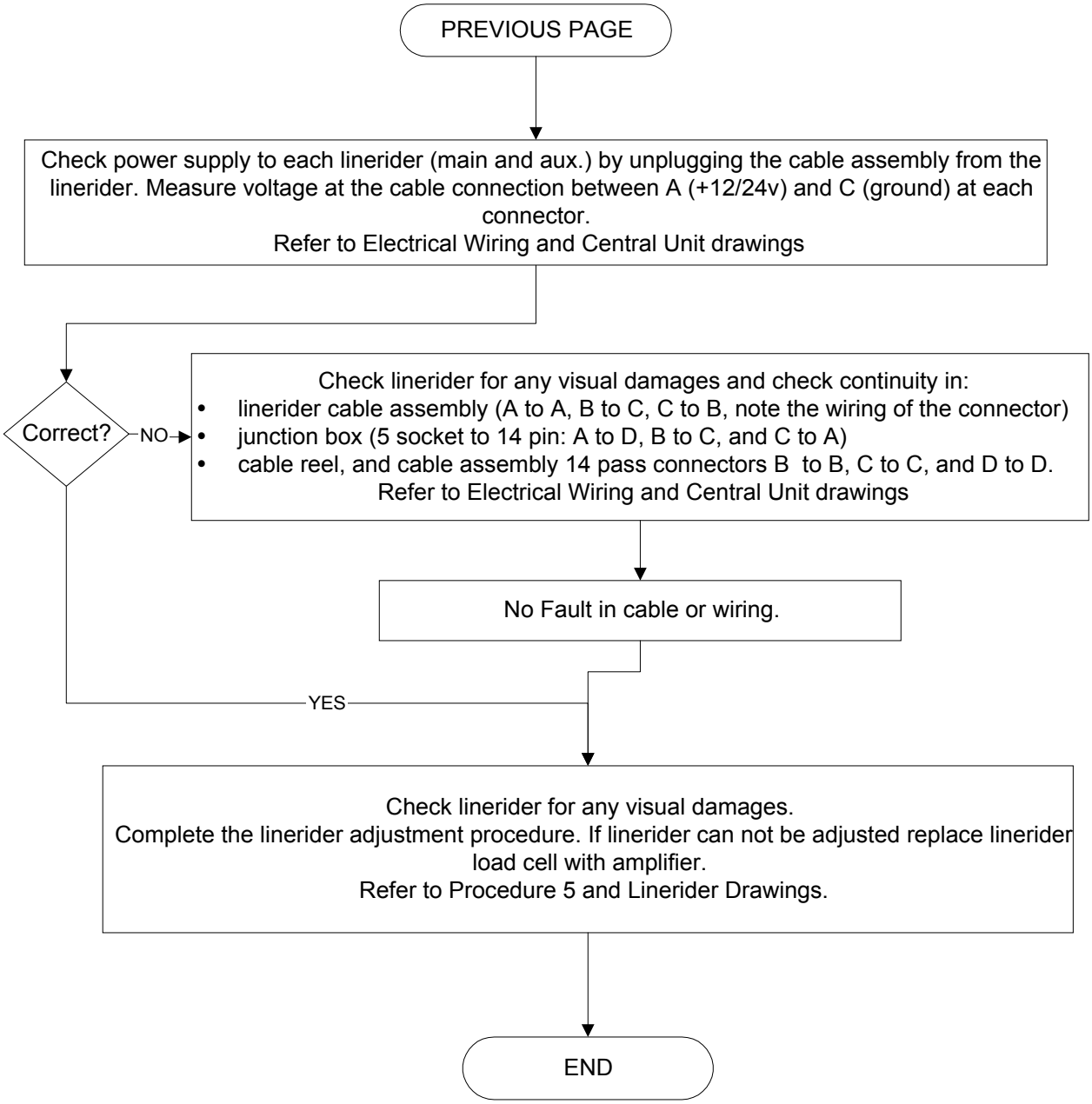
9 ANGLE SENSORS



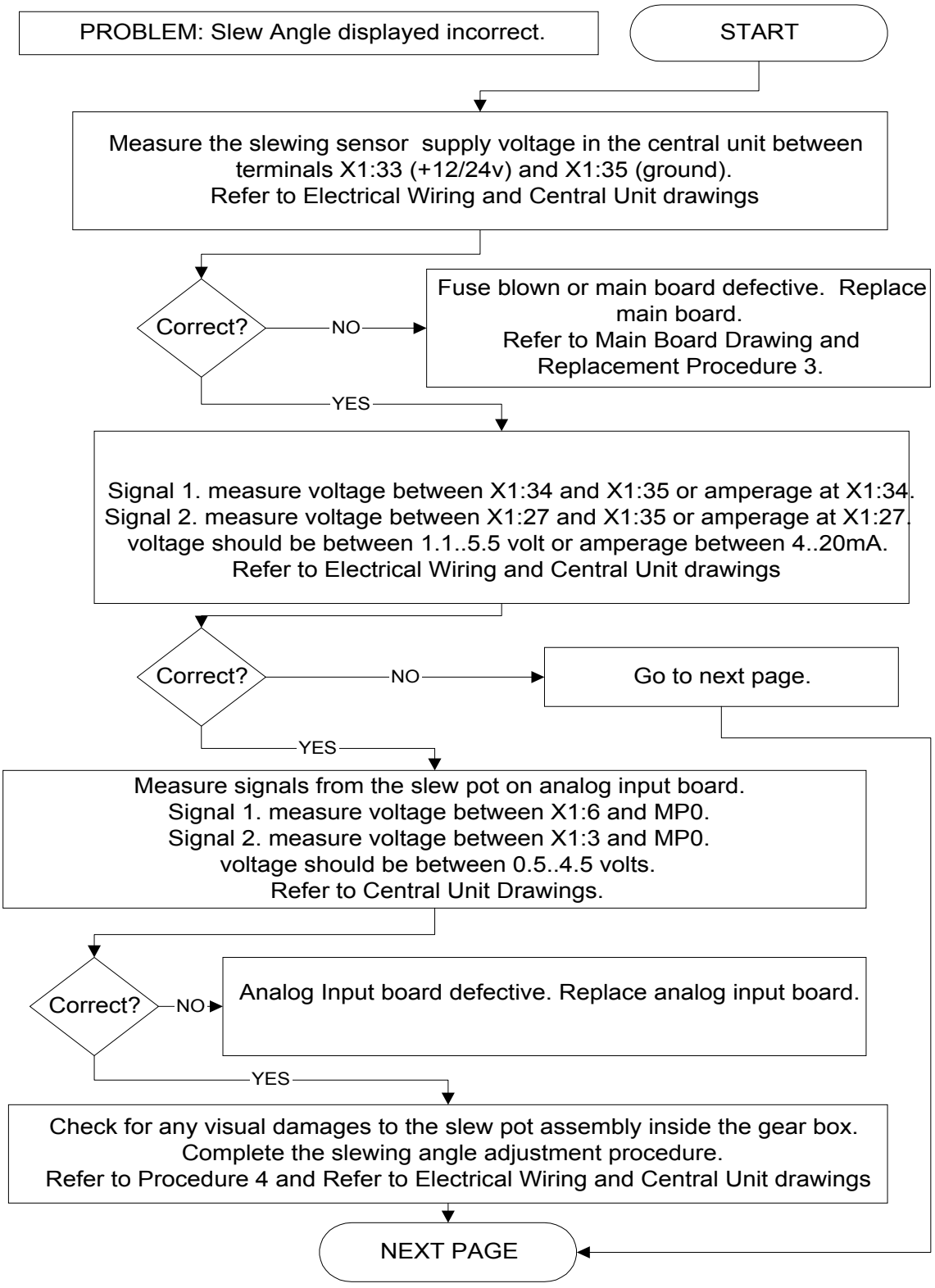


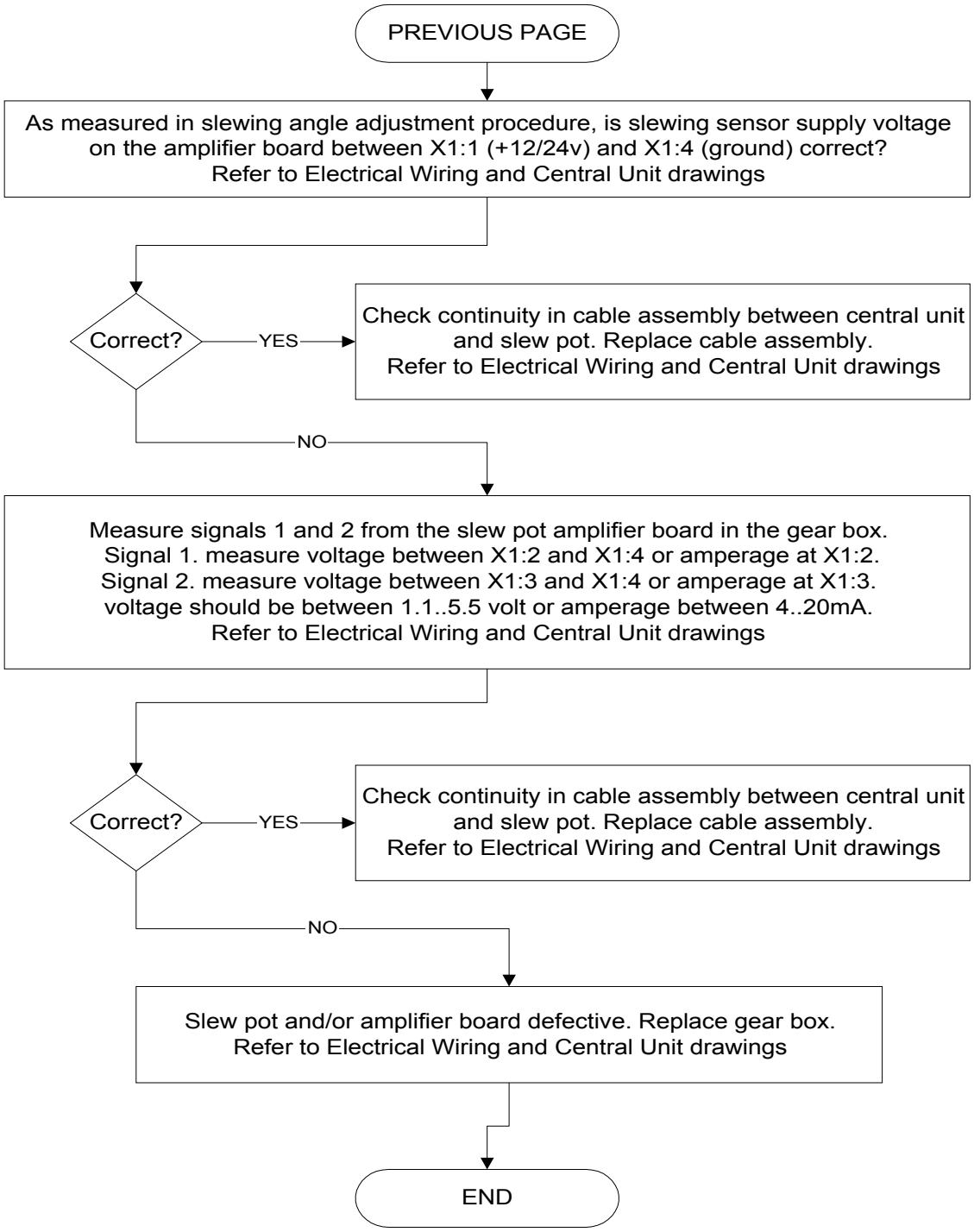
10 LOAD READING



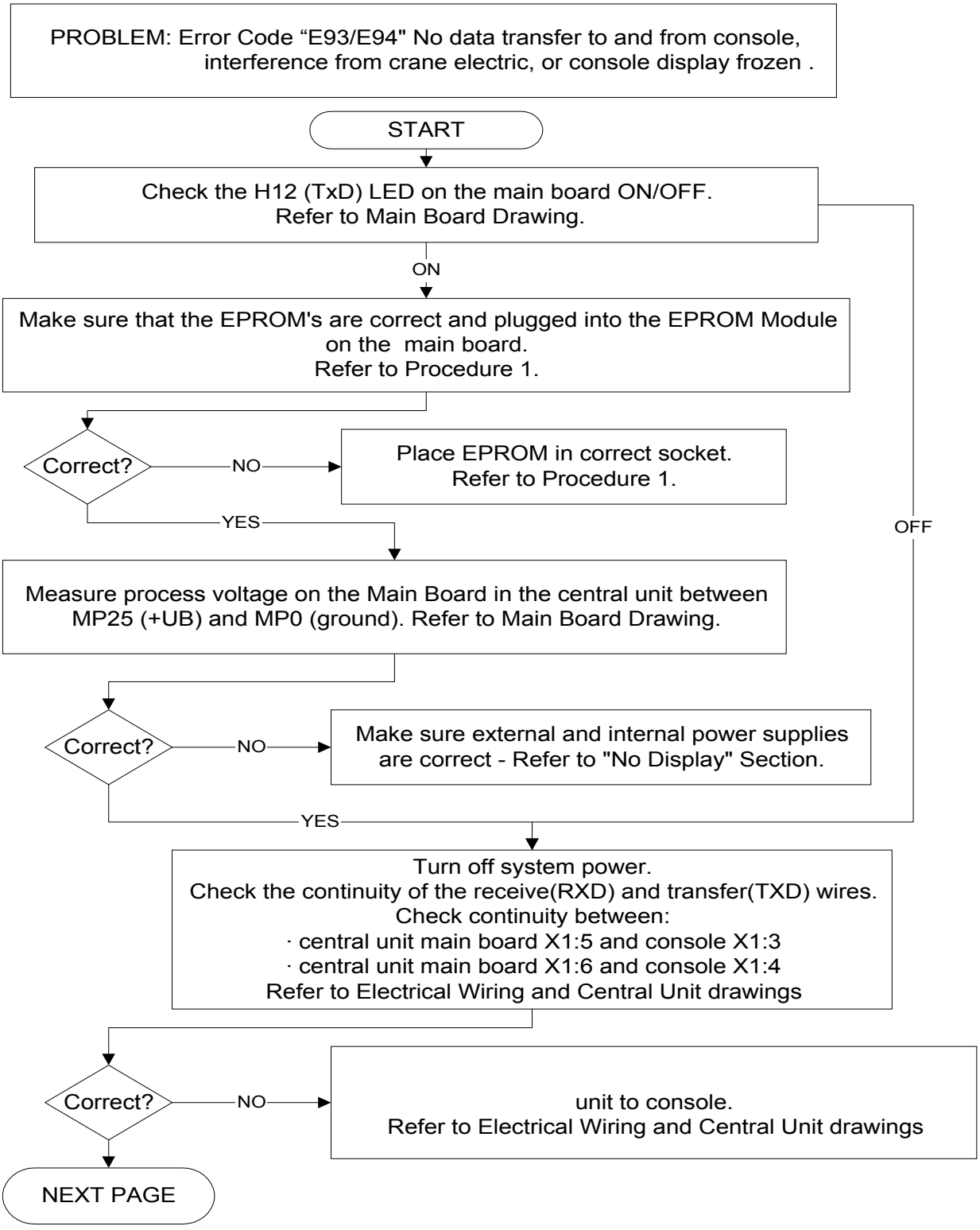


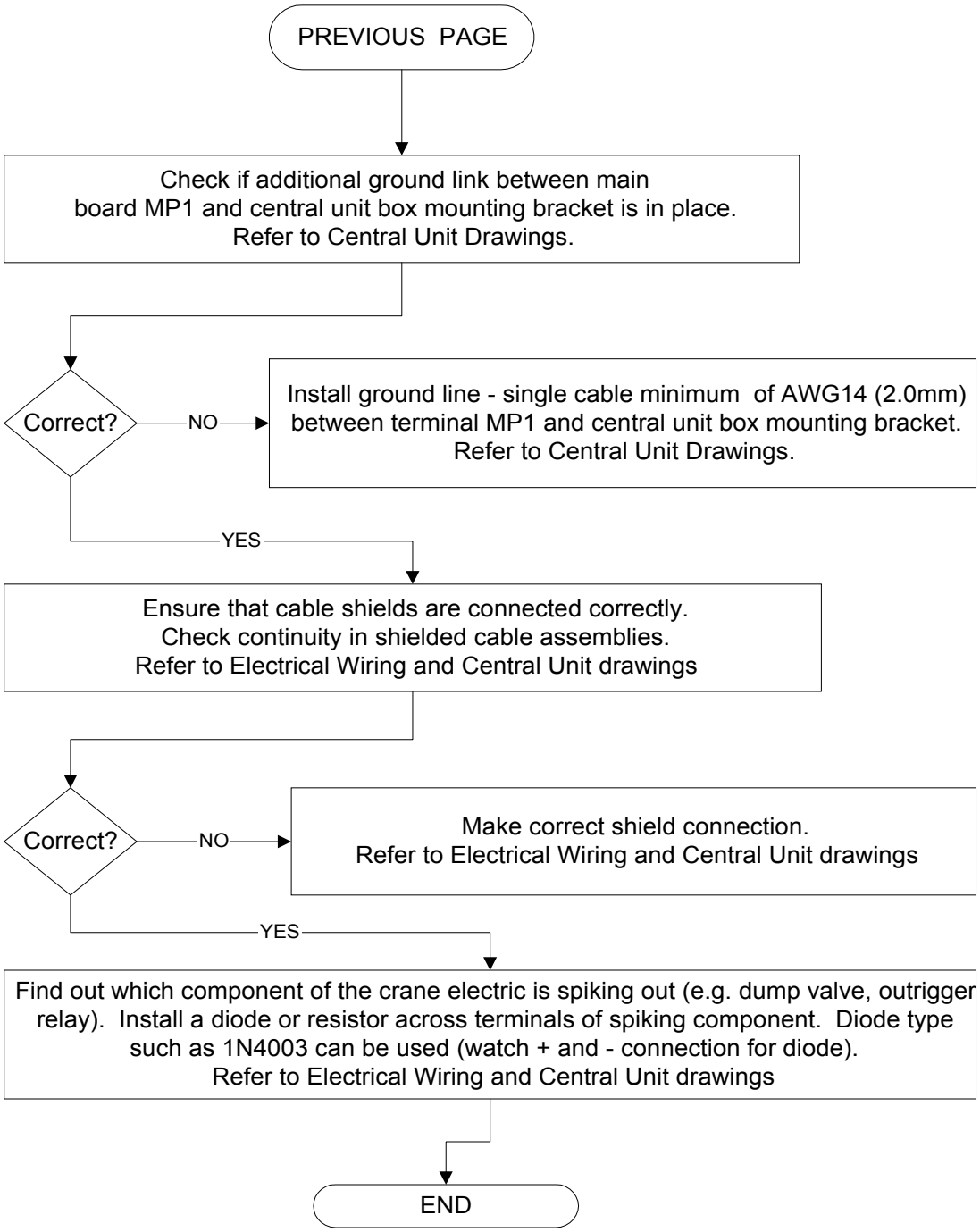
11 SLEWING ANGLE READING PROBLEM





12 DATA TRANSFER CENTRAL UNIT <--> CONSOLE

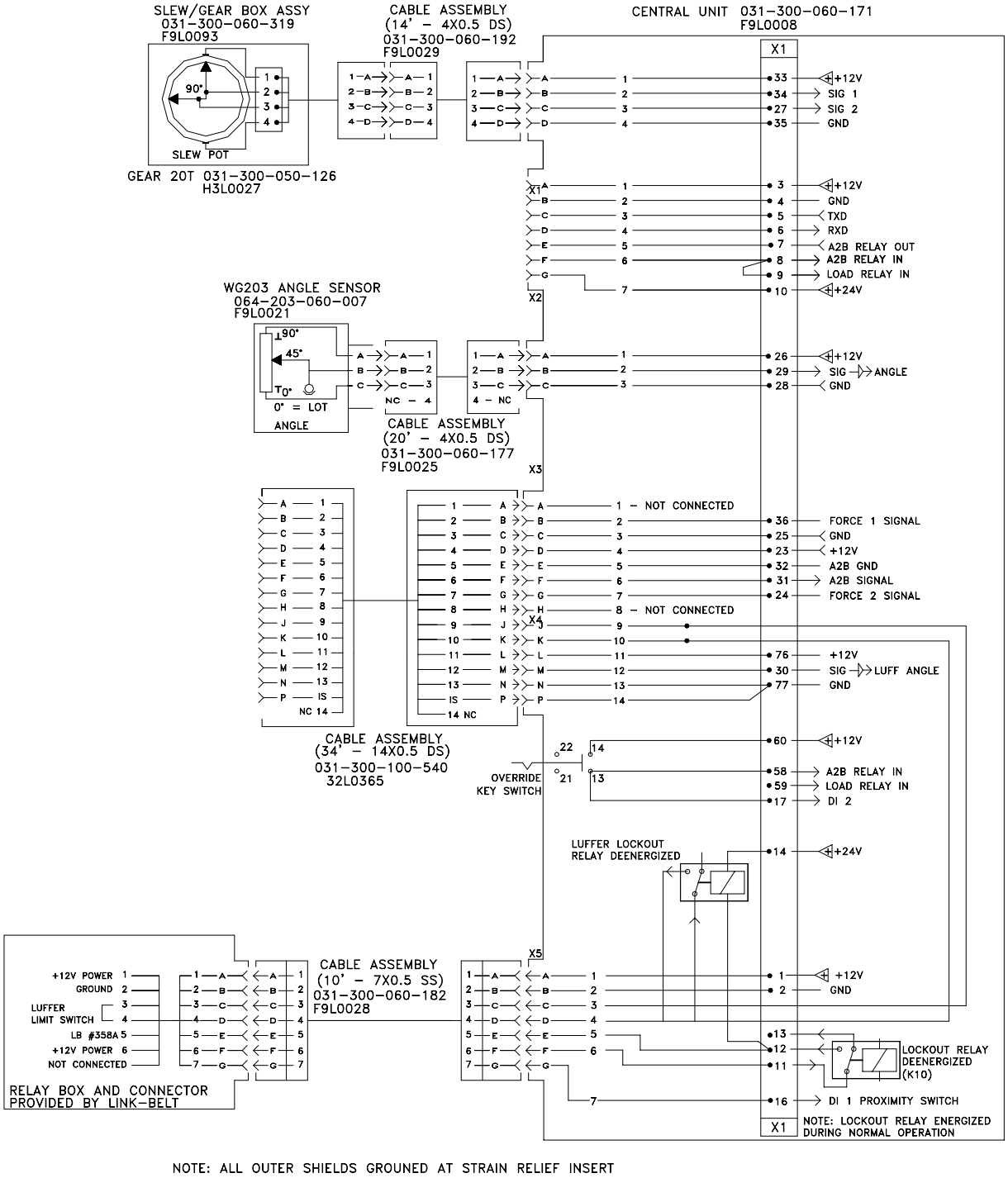




13 DRAWINGS AND SCHEMATICS

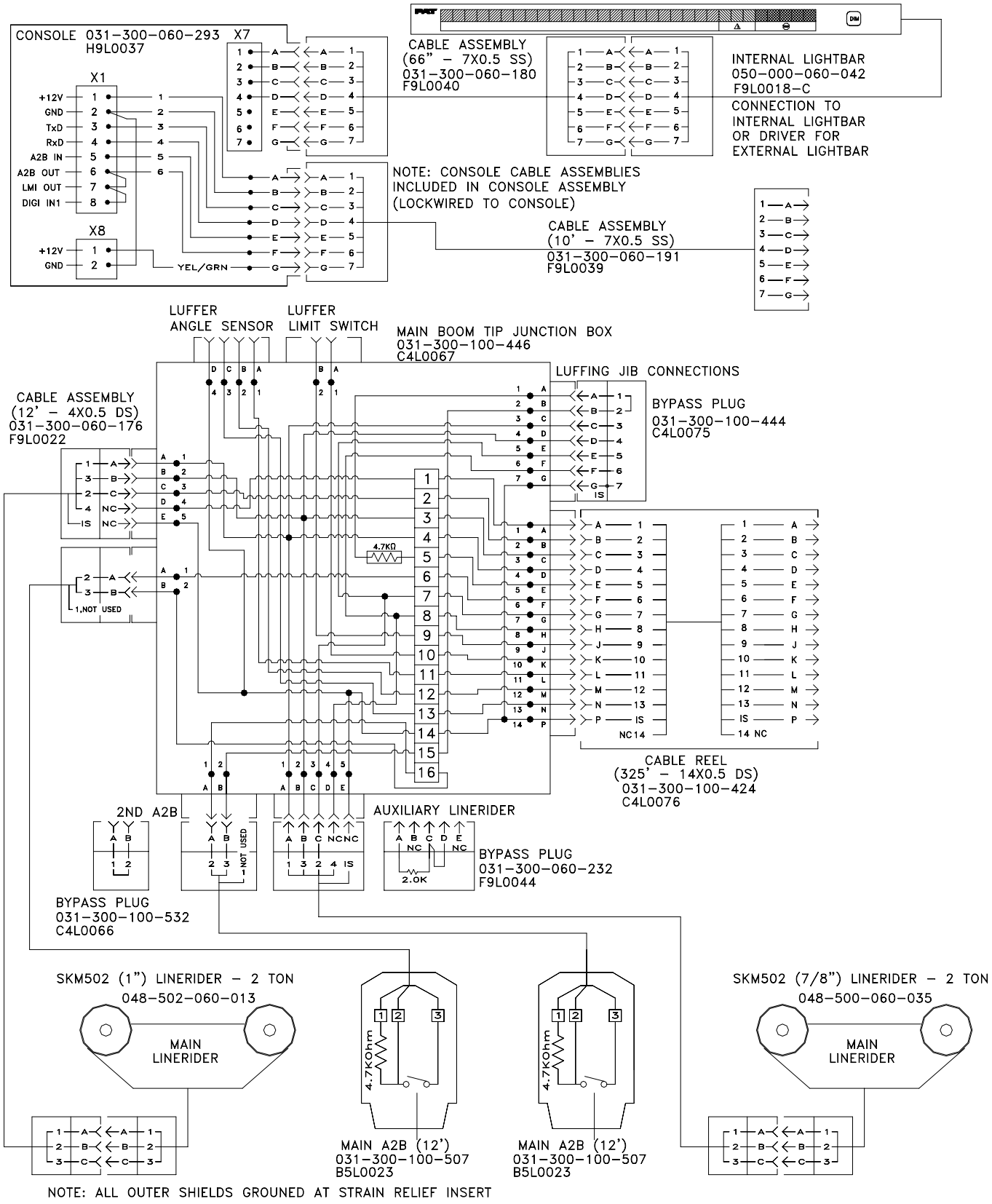
For refence information, Drawing 1 is the central unit wiring and Drawing 2 is the console and boom wiring. There are 4 different system drawings; slewing sensor 12V, slewing sensor 24V, proximity sensor 12V, and , proximity sensor 24V each have drawings 1 AND 2.

13.1 Electrical Wiring 12V Line Rider System with Slew Box 11.5 Ratio (page 1)



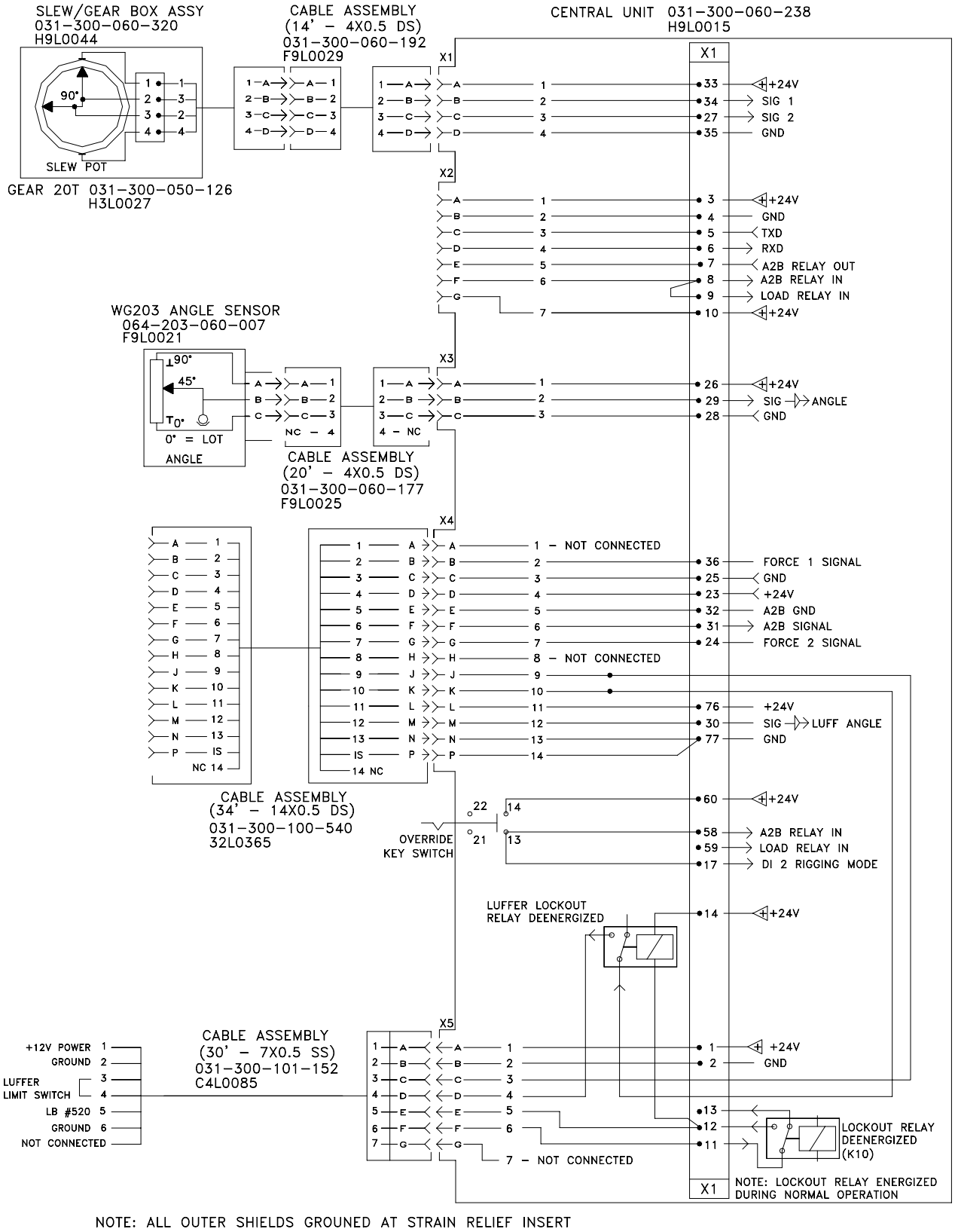
DRAWING 1. Electrical Wiring For Central Unit 031-300-060-171(+12V) To Crane, Angle Sensor, And Slewing Sensor

13.2 Electrical Wiring 12V Line Rider System with Slew Box 11.5 Ratio (page 2)



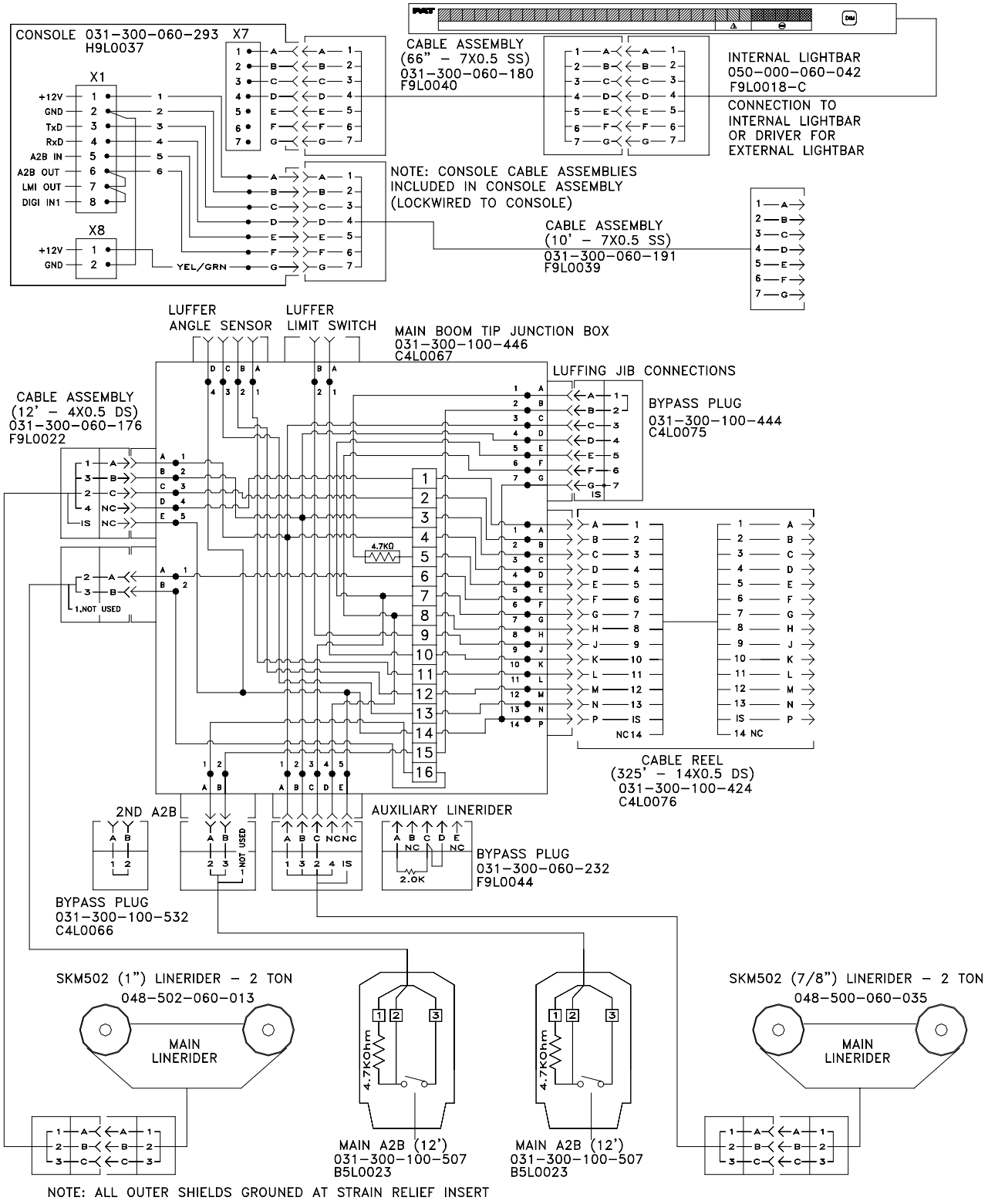
DRAWING 2. Electrical Wiring For Central Unit To Console and Main Boom

13.3 Electrical Wiring 24V Line Rider System with Slew Box 7.25 Ratio (page 1)



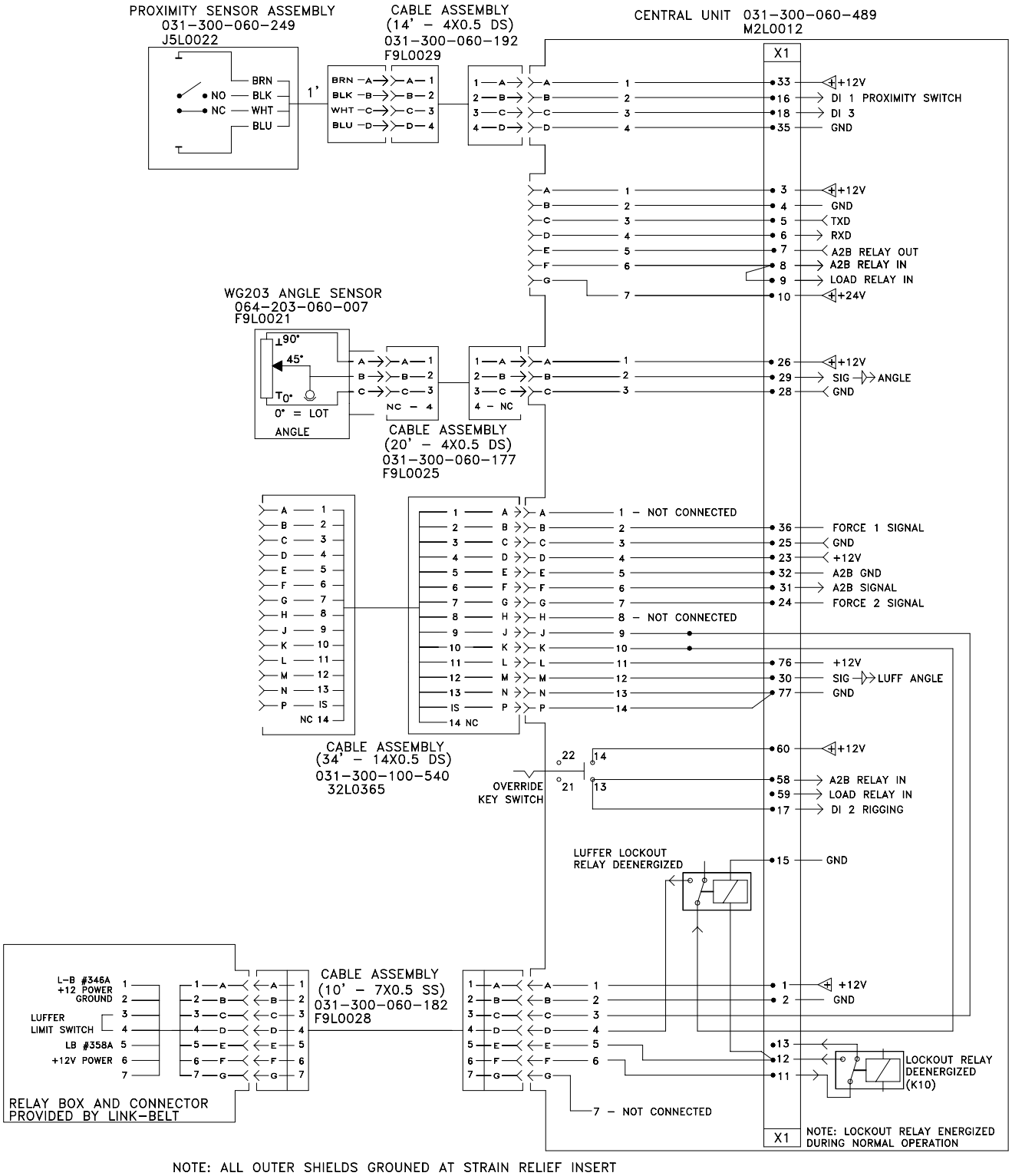
DRAWING 1. Electrical Wiring For Central Unit 031-300-060-238(+24V) To Crane, Angle Sensor, And Slewing Sensor

13.4 Electrical Wiring 24V Line Rider System with Slew Box 7.25 Ratio (page 2)



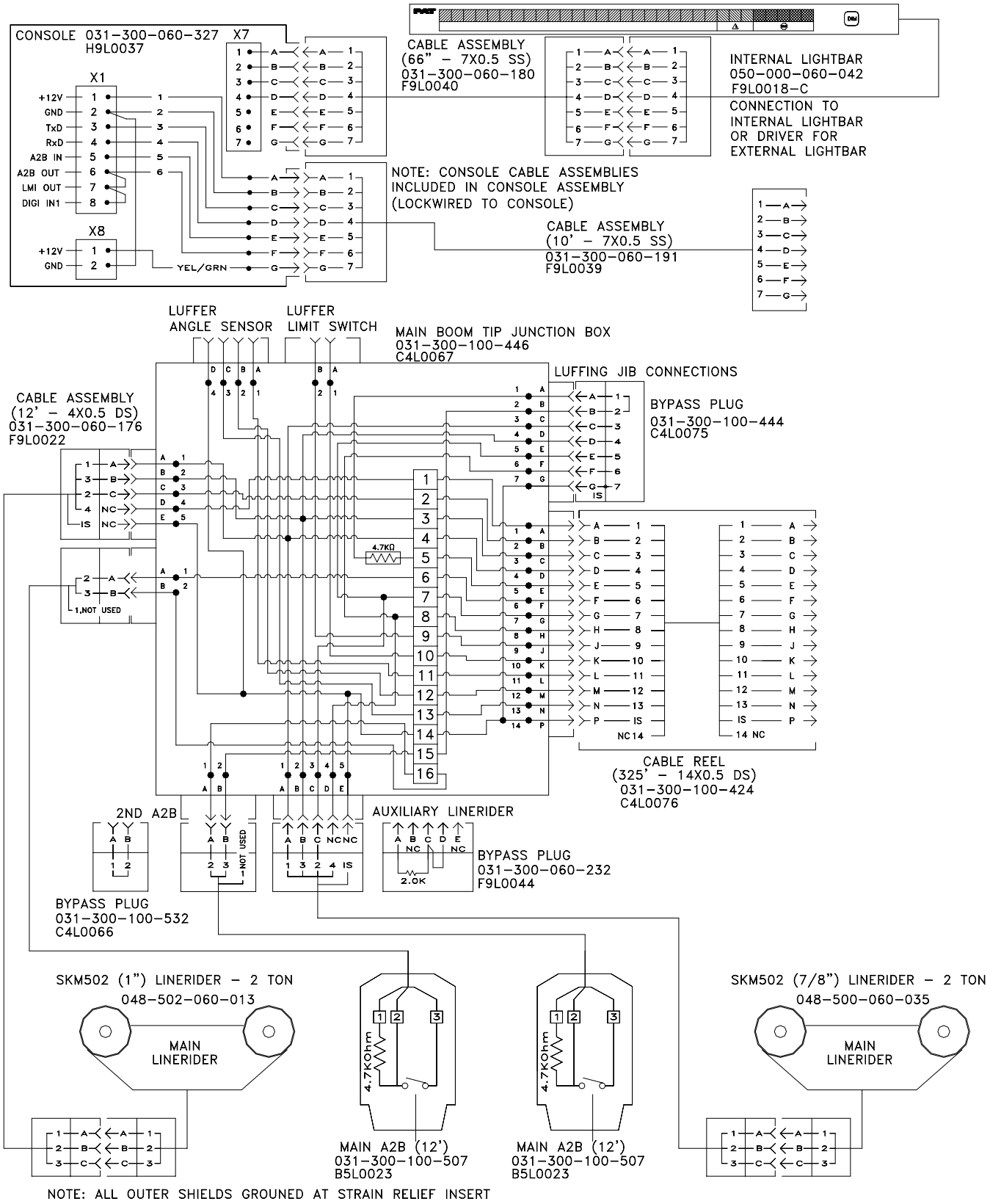
DRAWING 2. Electrical Wiring For Central Unit To Console and Main Boom

13.5 Electrical Wiring 12V Line Rider System with Proximity Switch (page 1)



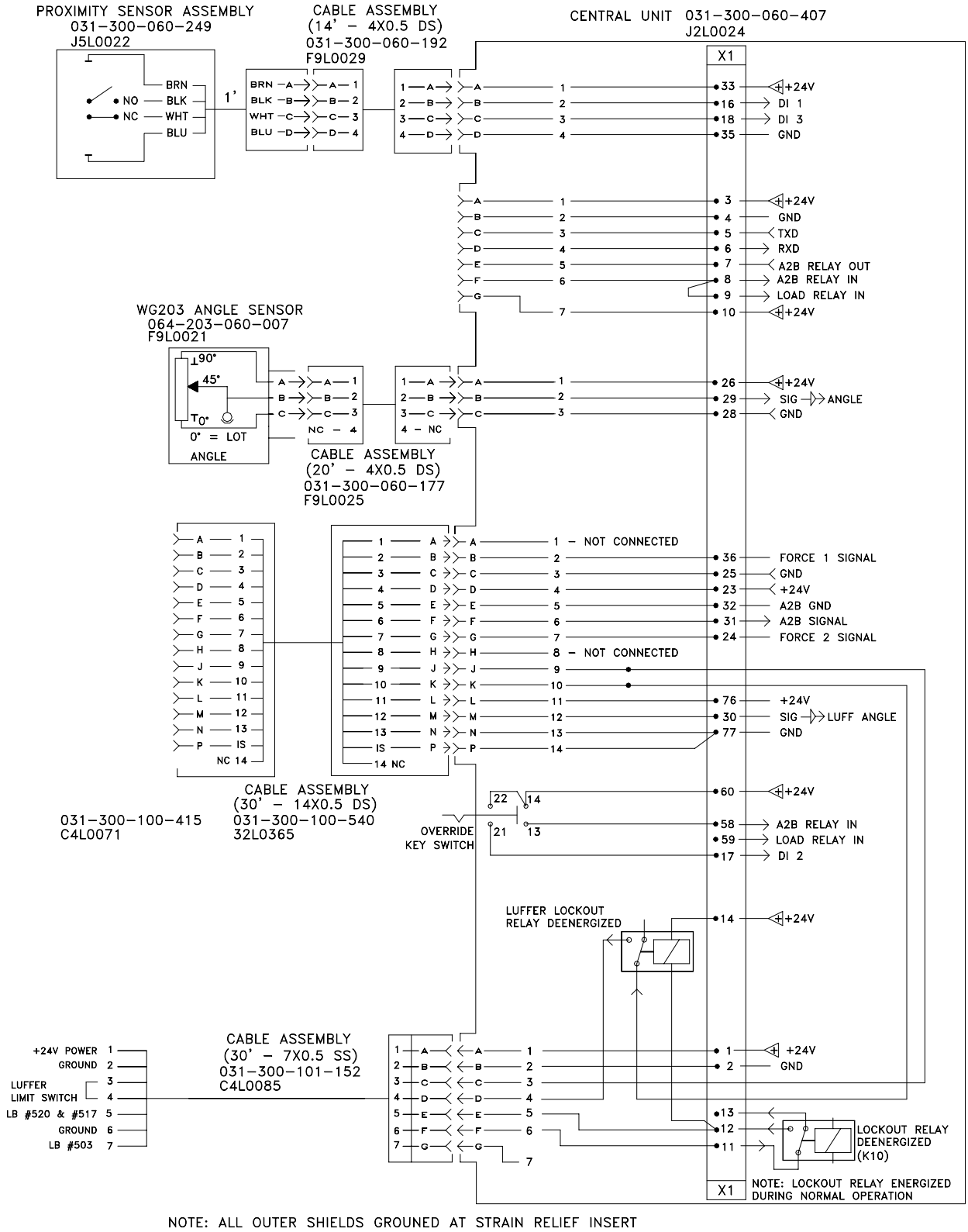
DRAWING 1. Electrical Wiring For Central Unit 031-300-060-489(+12V) To Crane, Angle Sensor, And Slewing Sensor

13.6 Electrical Wiring 12V Line Rider System with Proximity Switch (page 2)



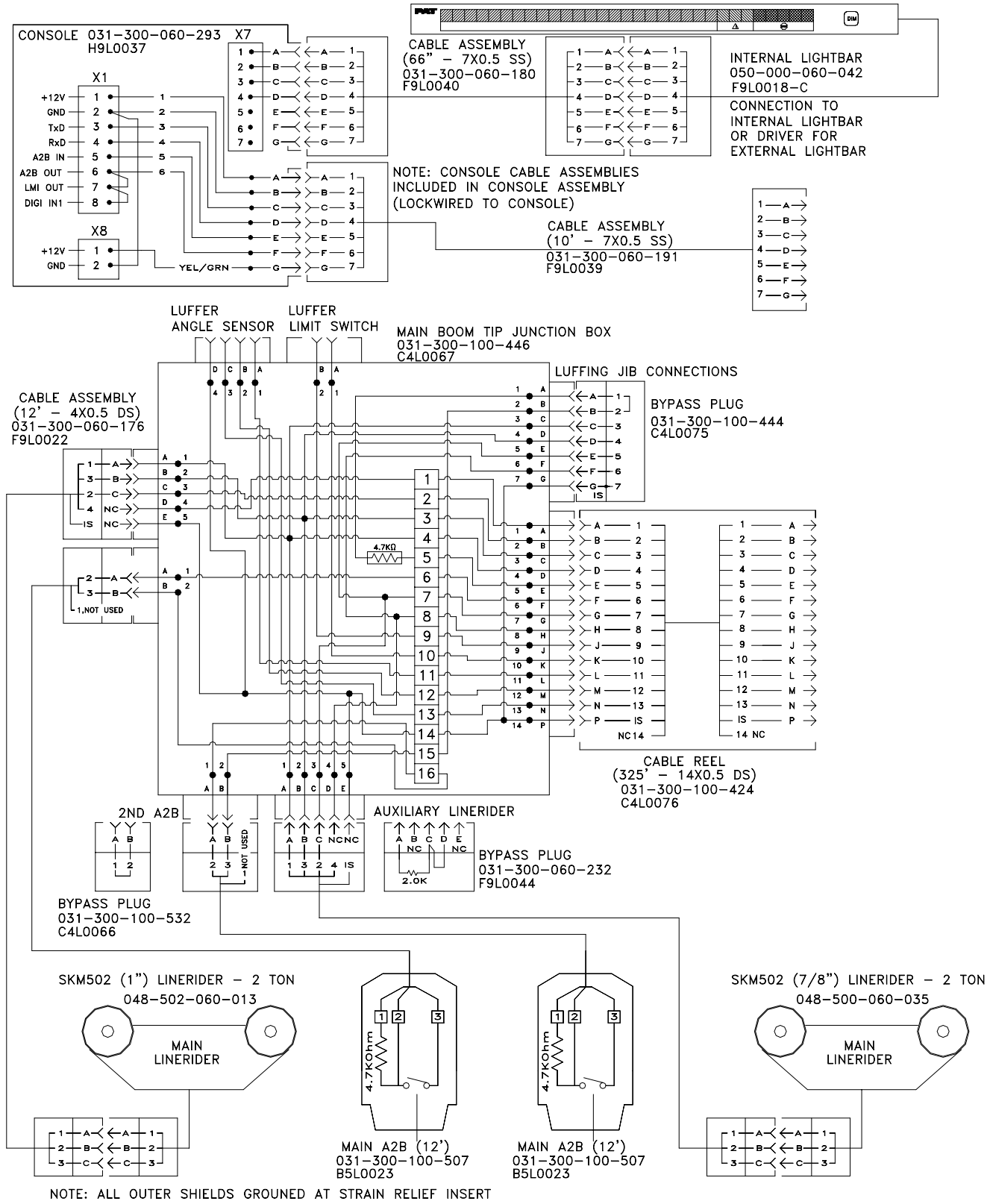
DRAWING 2. Electrical Wiring For Central Unit To Console and Main Boom

13.7 Electrical Wiring 24V Line Rider System with Proximity Switch (page 1)



DRAWING 1. Electrical Wiring For Central Unit 031-300-060-407(+24V) To Crane, Angle Sensor, And Slewing Sensor

13.8 Electrical Wiring 24V Line Rider System with Proximity Switch (page 2)



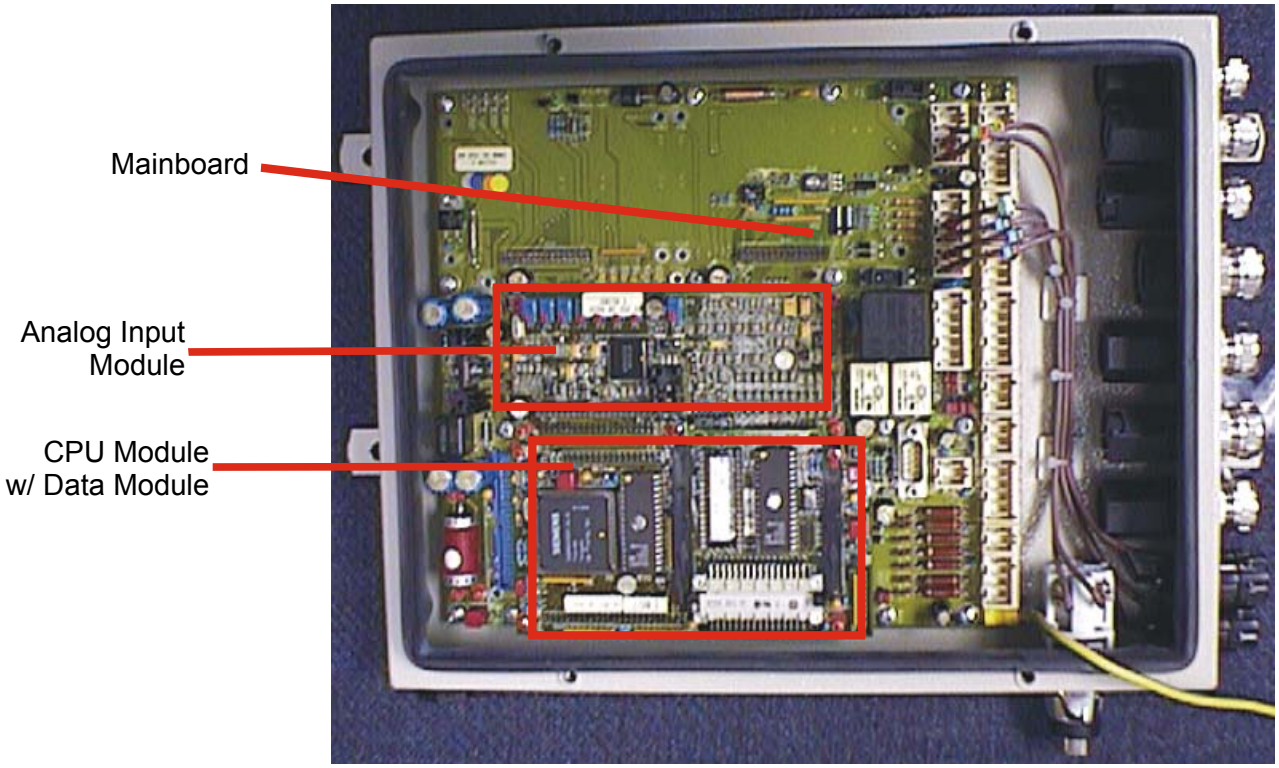
DRAWING 2. Electrical Wiring For Central Unit To Console and Main Boom

13.9 Central Unit Breakdown / Parts List

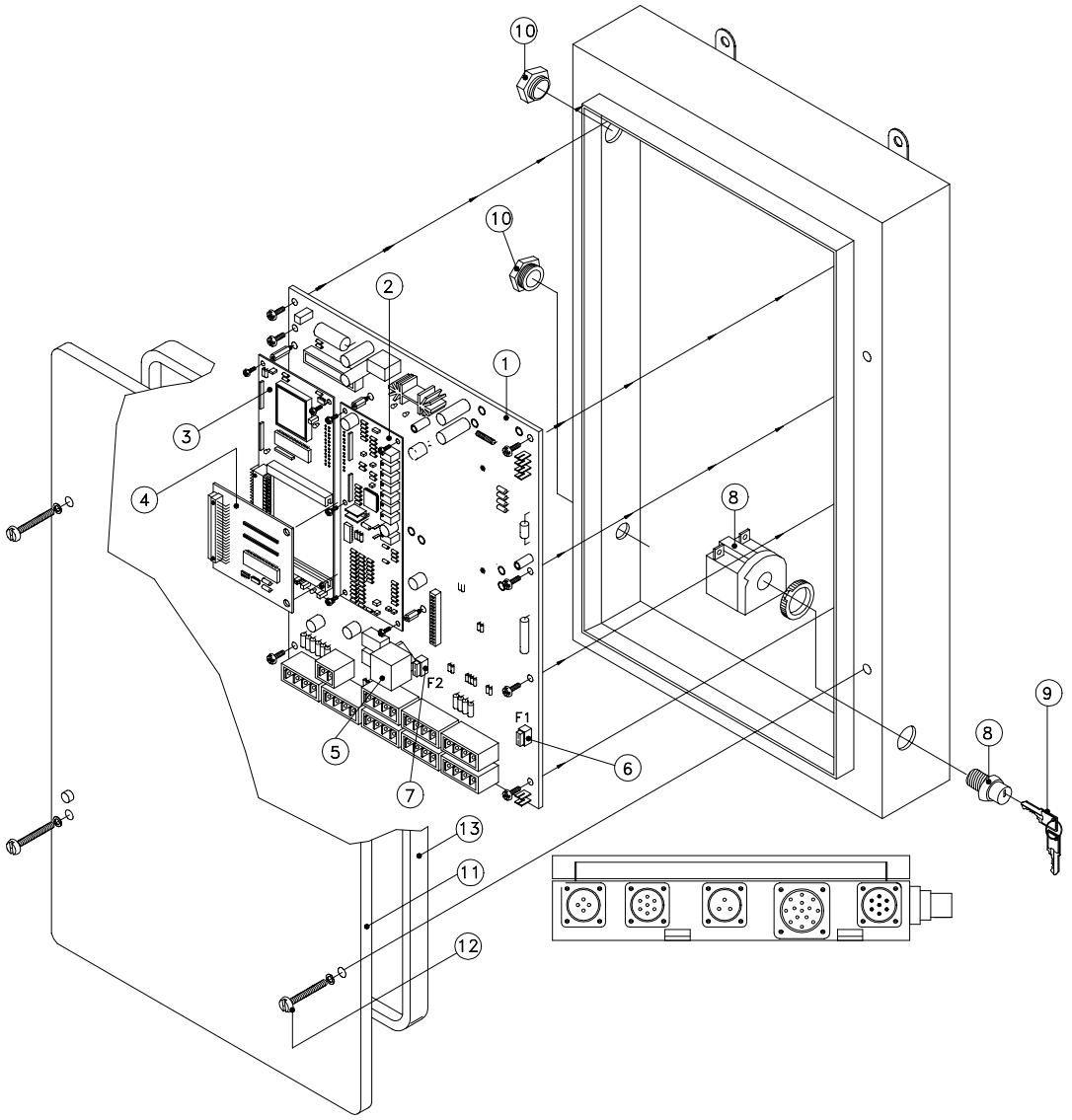
The central unit is located in the cabin, behind the operator's seat:

(shown with the lid removed).

The electronics consist of the mainboard with the following modules:



PART NO. A) 031-300-060-171 / 031-300-060-489 (12V)
PART NO. B) 031-300-060-238 / 031-300-060-407 (24V)

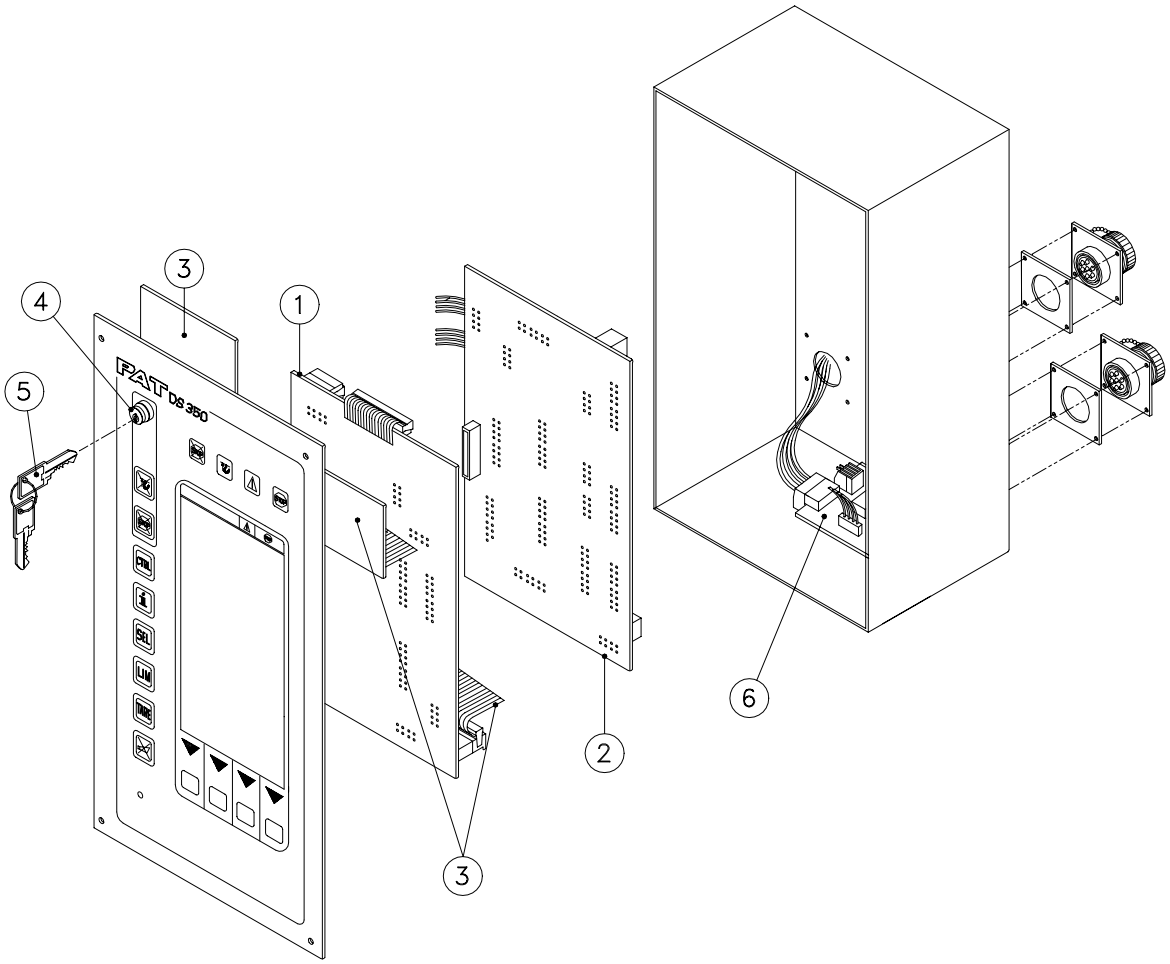


Drawing 3. Central Unit

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

13.10 Console Ds350/1334 / Parts List

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

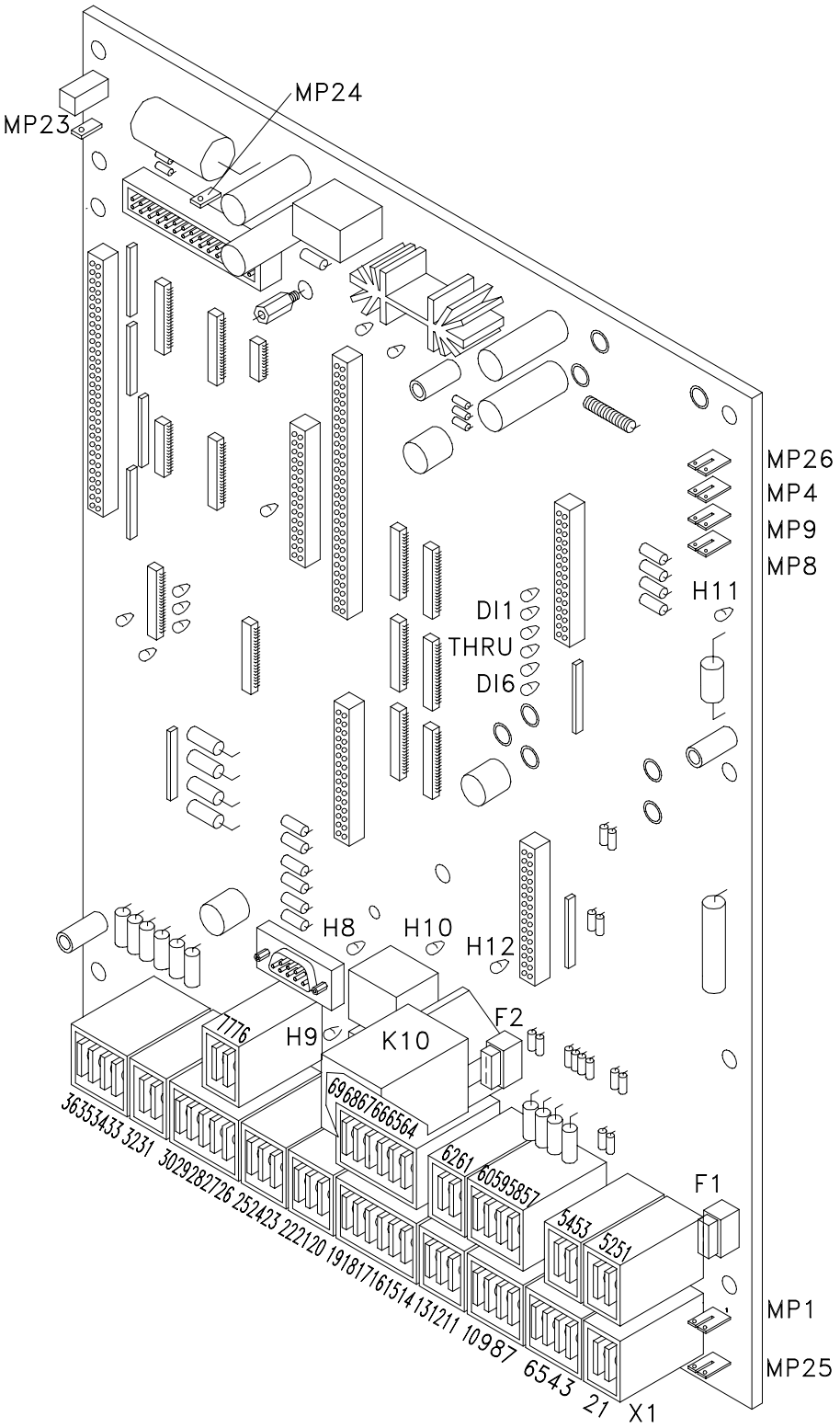


DRAWING 4. Console

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

13.11 Central Unit Main Board Layout

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

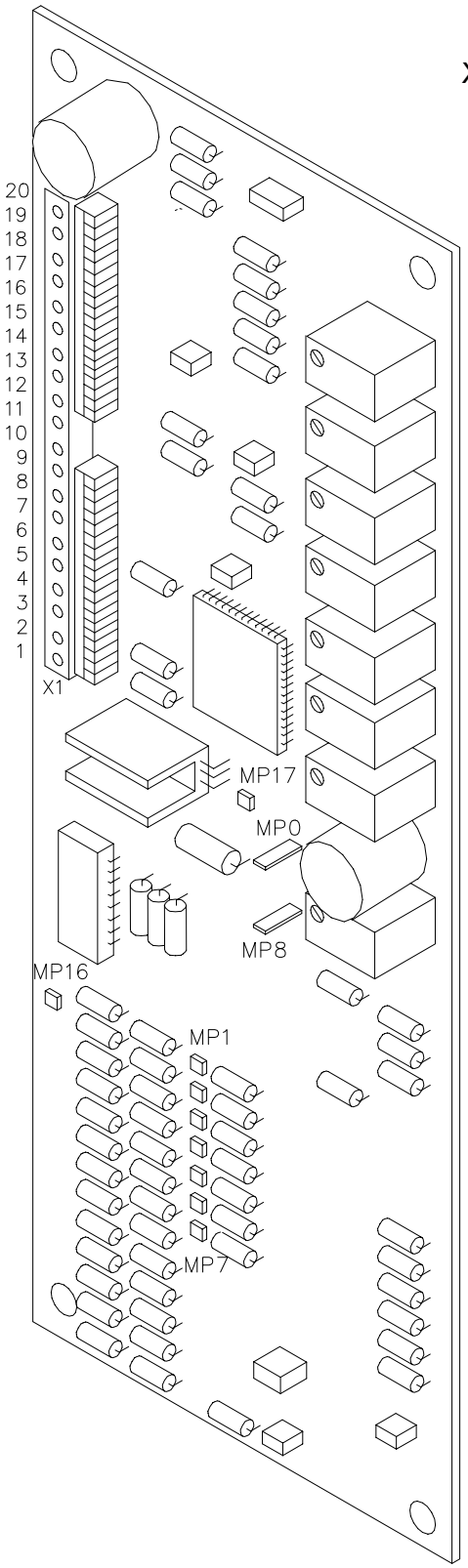
LED'S
H08 - LOAD
H09 - A2B
H10 – LOCKOUT on when K10 is lit
H11 - POWER
H12 – TxD

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

DRAWING 5. Main Board

13.12 Central Unit Analog Input Module

BOARD P/N 024-352-300-020



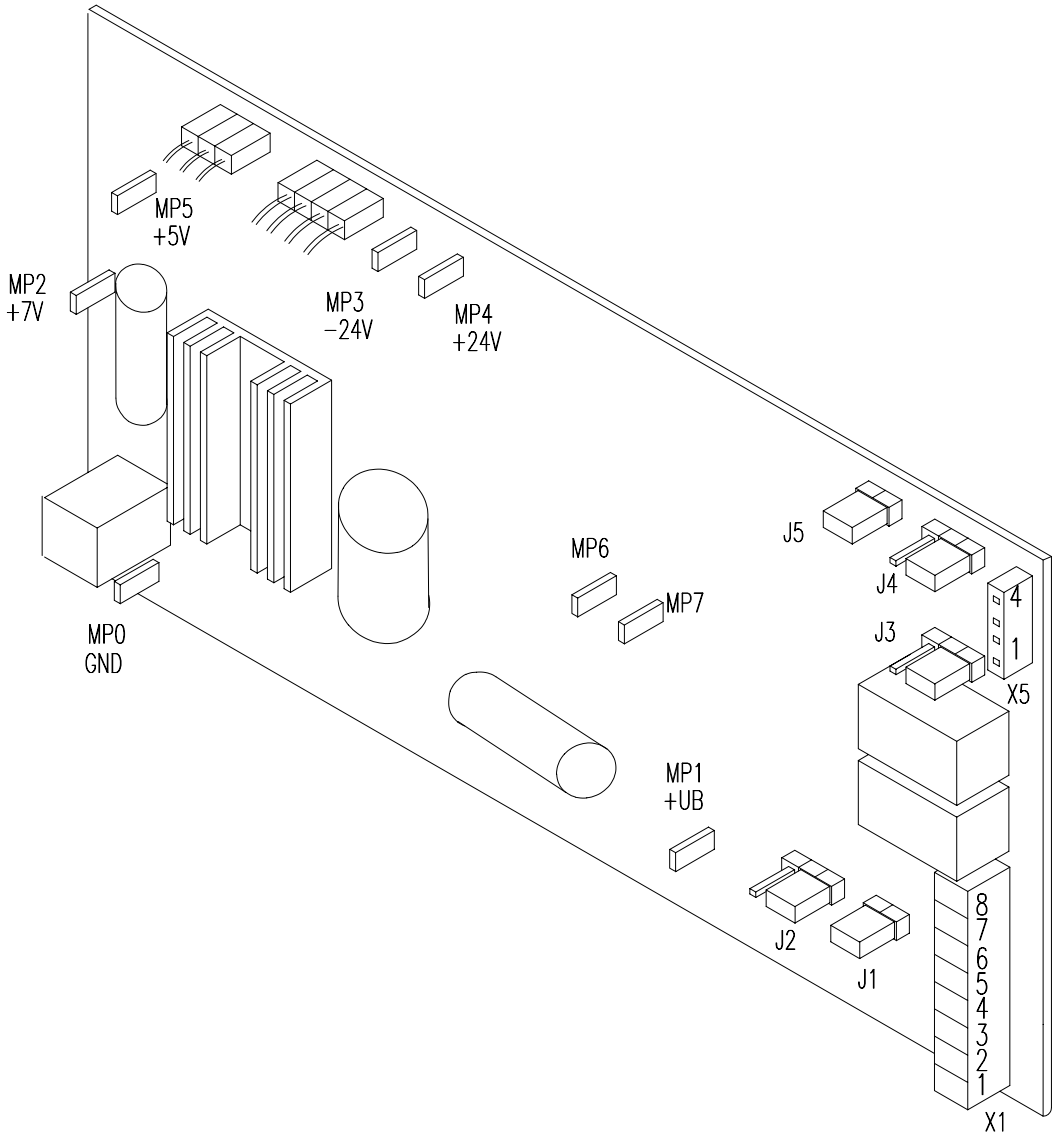
X1:1-7 = ADC INPUT 0.5V...4.5V, Note: If channel adjustments are made through the software and graphic console, DO NOT adjust offset with P1-P7.
X1:8 = TEMP (0.5V + 10mV/°C)
X1:9 = VREFA = 5.000V reference
X1:10 = AGND (reference GND)
X1:11 = VREF+ = 5.0V power ADC
X1:12-15 = CH01-04, DIN1-4 / 10
X1:16 = 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 process 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.

DRAWING 6. Analog Input Module

13.13 Console Connection Board



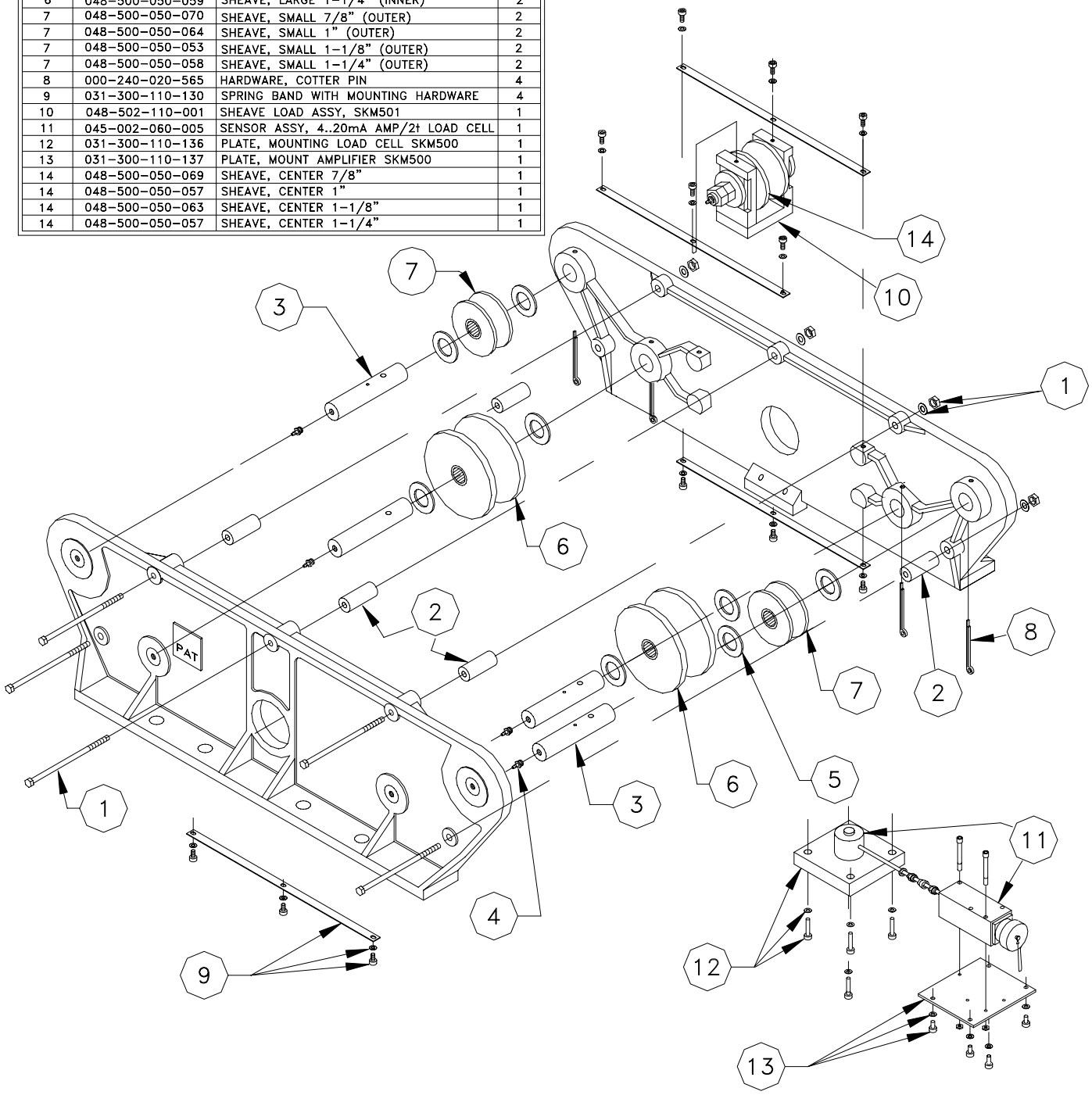
DRAWING 7. Console Terminal Board.

13.14 Line Rider SKM502 - Parts List

ITEM	PART NUMBER	DESCRIPTION	QTY
1	031-300-110-131	HARDWARE, BOLT, NUT, & WASHER	5
2	048-500-050-011	SPACER, 1.94 LONG, OD .863	5
3	048-500-050-008	SHAFT W/GREASE FITTING SKM500	4
4	002-430-201-081	HARDWARE, GREASE FITTING	4
5	002-161-302-610	HARDWARE, SPACER/WASHER	8
6	048-500-050-071	SHEAVE, LARGE 7/8" (INNER)	2
6	048-500-050-068	SHEAVE, LARGE 1" (INNER)	2
6	048-500-050-067	SHEAVE, LARGE 1-1/8" (INNER)	2
6	048-500-050-059	SHEAVE, LARGE 1-1/4" (INNER)	2
7	048-500-050-070	SHEAVE, SMALL 7/8" (OUTER)	2
7	048-500-050-064	SHEAVE, SMALL 1" (OUTER)	2
7	048-500-050-053	SHEAVE, SMALL 1-1/8" (OUTER)	2
7	048-500-050-058	SHEAVE, SMALL 1-1/4" (OUTER)	2
8	000-240-020-565	HARDWARE, COTTER PIN	4
9	031-300-110-130	SPRING BAND WITH MOUNTING HARDWARE	4
10	048-502-110-001	SHEAVE LOAD ASSY, SKM501	1
11	045-002-060-005	SENSOR ASSY, 4..20mA AMP/2t LOAD CELL	1
12	031-300-110-136	PLATE, MOUNTING LOAD CELL SKM500	1
13	031-300-110-137	PLATE, MOUNT AMPLIFIER SKM500	1
14	048-500-050-069	SHEAVE, CENTER 7/8"	1
14	048-500-050-057	SHEAVE, CENTER 1"	1
14	048-500-050-063	SHEAVE, CENTER 1-1/8"	1
14	048-500-050-057	SHEAVE, CENTER 1-1/4"	1

SKM502 LINERIDER SIZES AND ITEM-NO

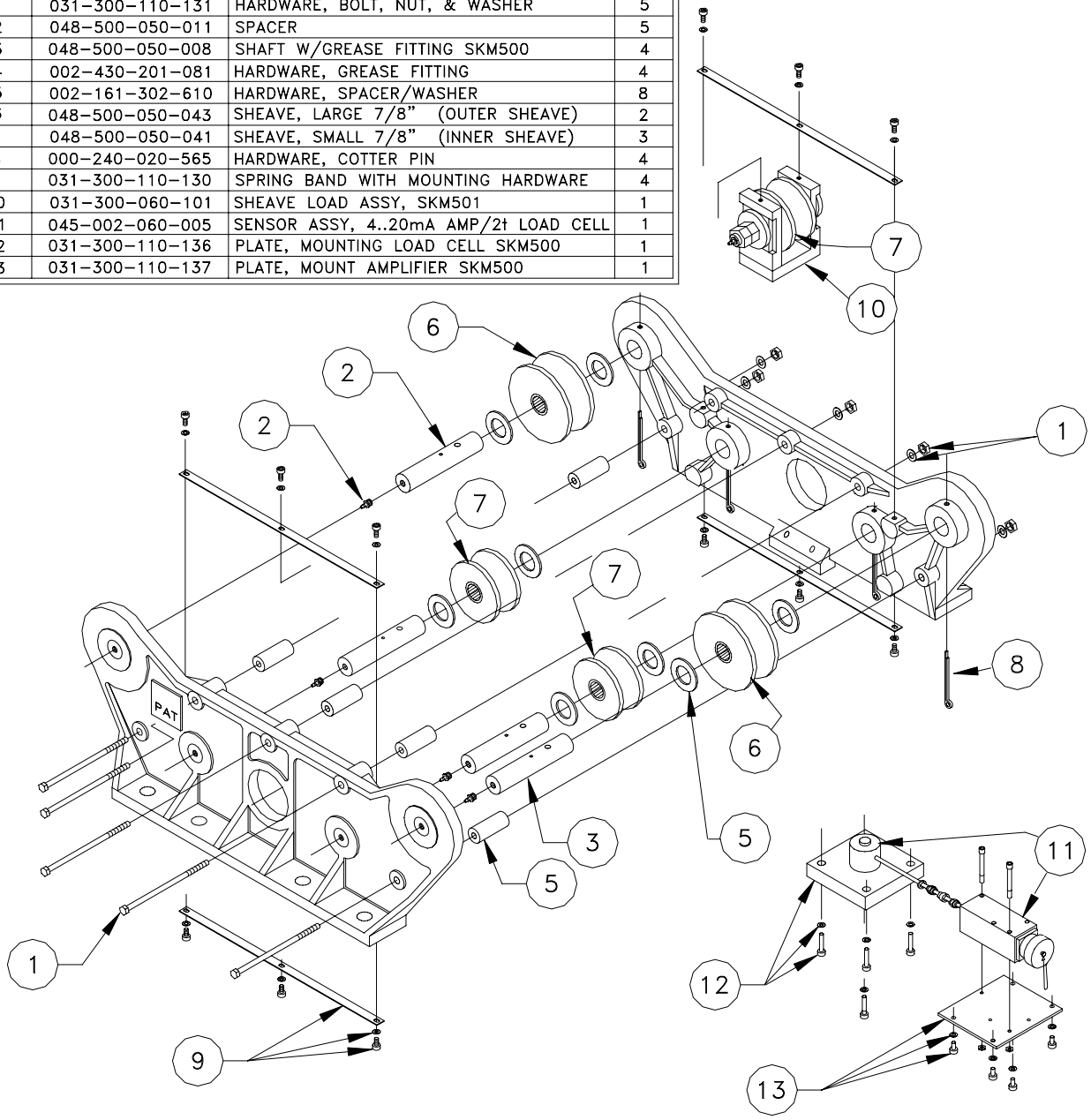
ITEM NUMBER	DESCRIPTION
048-502-060-011	SENSOR, LINERIDER SKM502 1 1/4
048-502-060-012	SENSOR, LINERIDER SKM502 1 1/8
048-502-060-013	SENSOR, LINERIDER SKM502 1"
048-502-060-014	SENSOR, LINERIDER SKM502 7/8"



DRAWING 8. SKM502

13.15 Line Rider SKM500 - Parts List

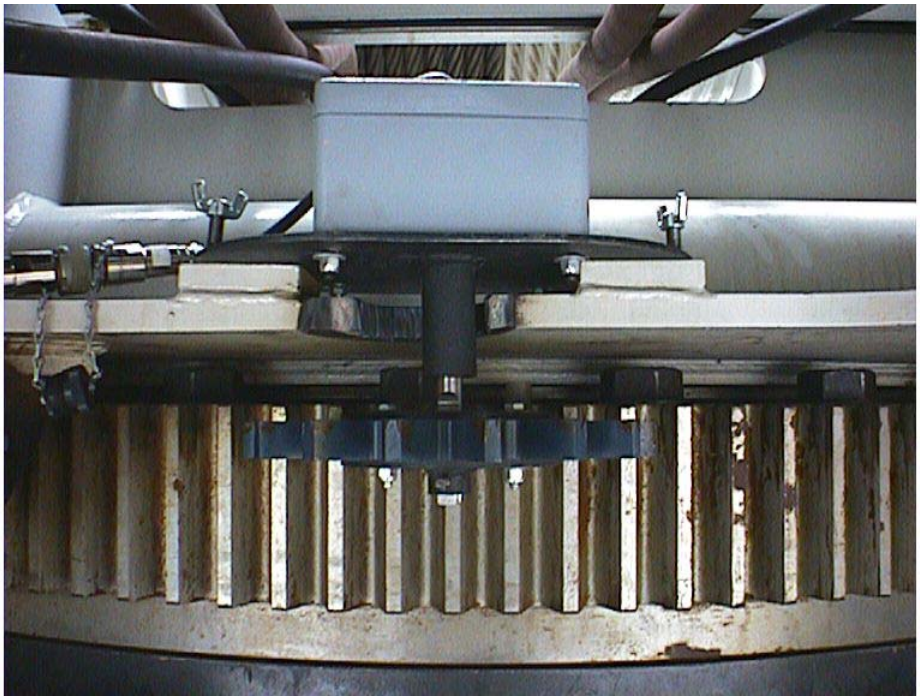
ITEM	PART NUMBER	DESCRIPTION	QTY
1	031-300-110-131	HARDWARE, BOLT, NUT, & WASHER	5
2	048-500-050-011	SPACER	5
3	048-500-050-008	SHAFT W/GREASE FITTING SKM500	4
4	002-430-201-081	HARDWARE, GREASE FITTING	4
5	002-161-302-610	HARDWARE, SPACER/WASHER	8
6	048-500-050-043	SHEAVE, LARGE 7/8" (OUTER SHEAVE)	2
7	048-500-050-041	SHEAVE, SMALL 7/8" (INNER SHEAVE)	3
8	000-240-020-565	HARDWARE, COTTER PIN	4
9	031-300-110-130	SPRING BAND WITH MOUNTING HARDWARE	4
10	031-300-060-101	SHEAVE LOAD ASSY, SKM501	1
11	045-002-060-005	SENSOR ASSY, 4..20mA AMP/2t LOAD CELL	1
12	031-300-110-136	PLATE, MOUNTING LOAD CELL SKM500	1
13	031-300-110-137	PLATE, MOUNT AMPLIFIER SKM500	1

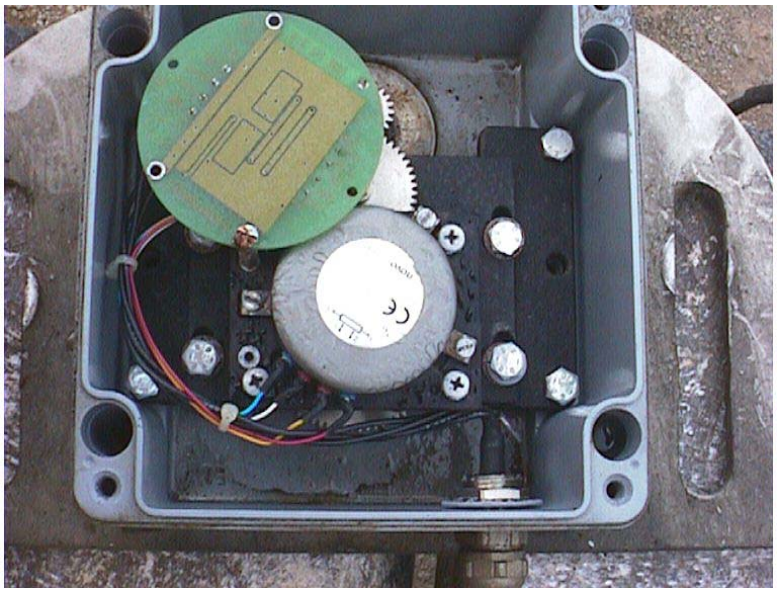


DRAWING 9. SKM500/0035; 048-500-060-035

13.16 Slew Potentiometer

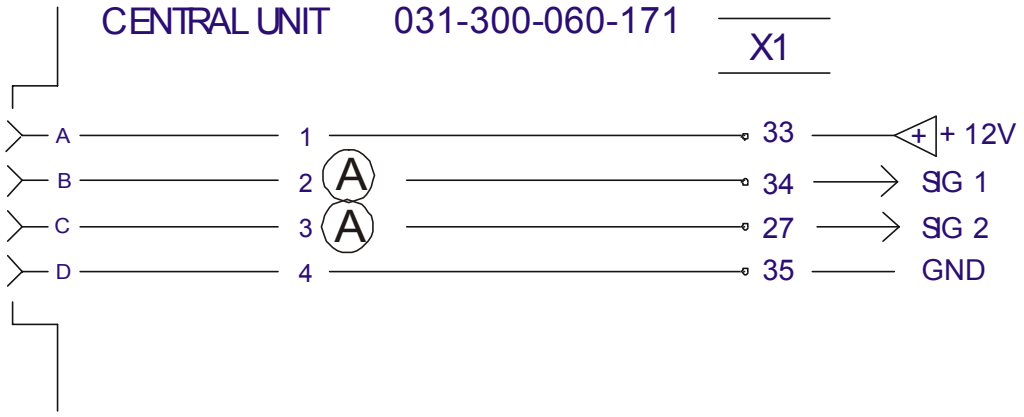
The slew potentiometer and its amplifier board are contained within a gear drive box that is accessible from underneath the carrier in the rear of the crane:





← Open gearbox.

The slew pot milliamp output is dependent on the zero point adjustment. Using the zero point adjustment through the console will change the output signal of the slew pot. The difference between the two signals is approximately 8mA at 0°, 45°, 90°, 180°, -135°, -90°, and 0° and 0mA at 135° and -45°, refer to Slew Theory section, Table 1.

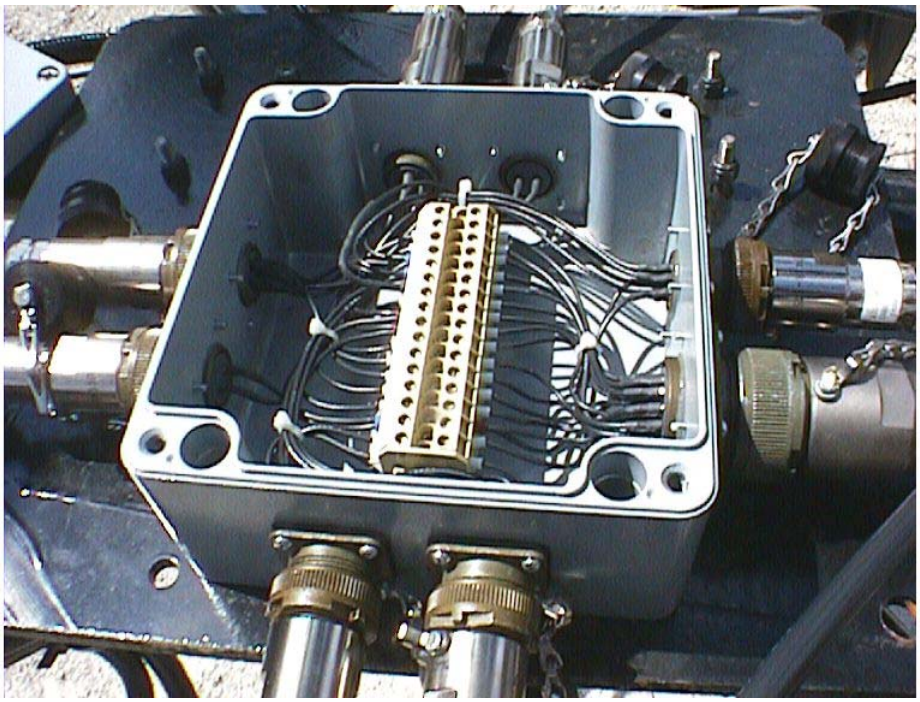


Measuring 4…20 mA
(for measuring current input, remove wires and measure with ammeter in series!)
Refer to Table 1 above for reference slew values in milliamps.

Central Unit Input Terminals
Alternative: Measuring with Voltmeter; 1.1 … 5.5 V on input terminals while wires are connected corresponds to 4…20mA. Refer to Table 1 above.

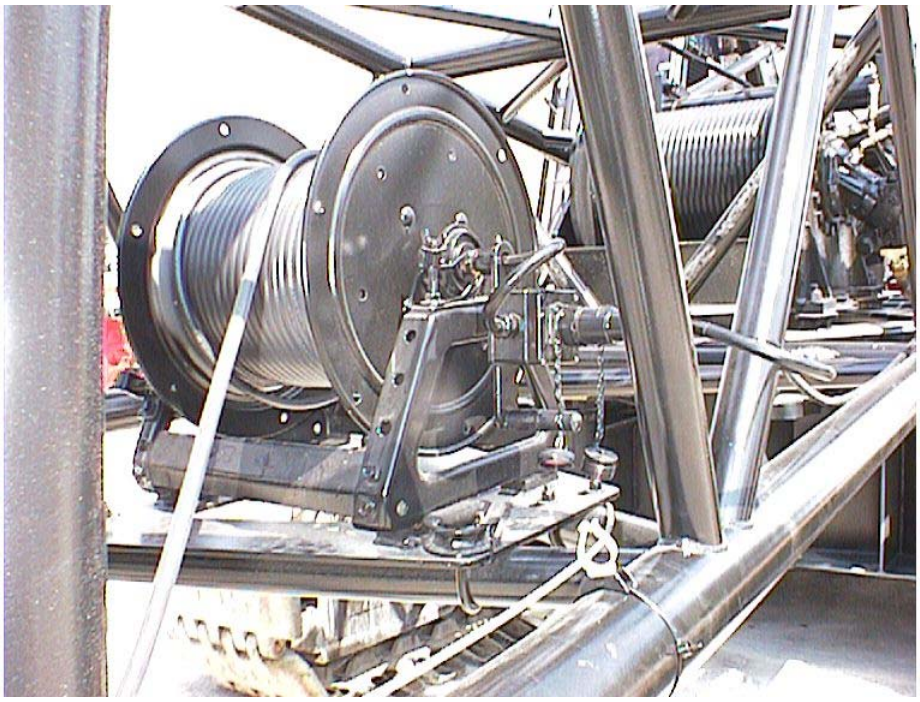
For adjustment of the slew potentiometer, see procedure 4.

13.17 Boom Junction Box



You can use the terminal strip to easily measure voltages in one central point. Refer to drawing 3 for schematics.

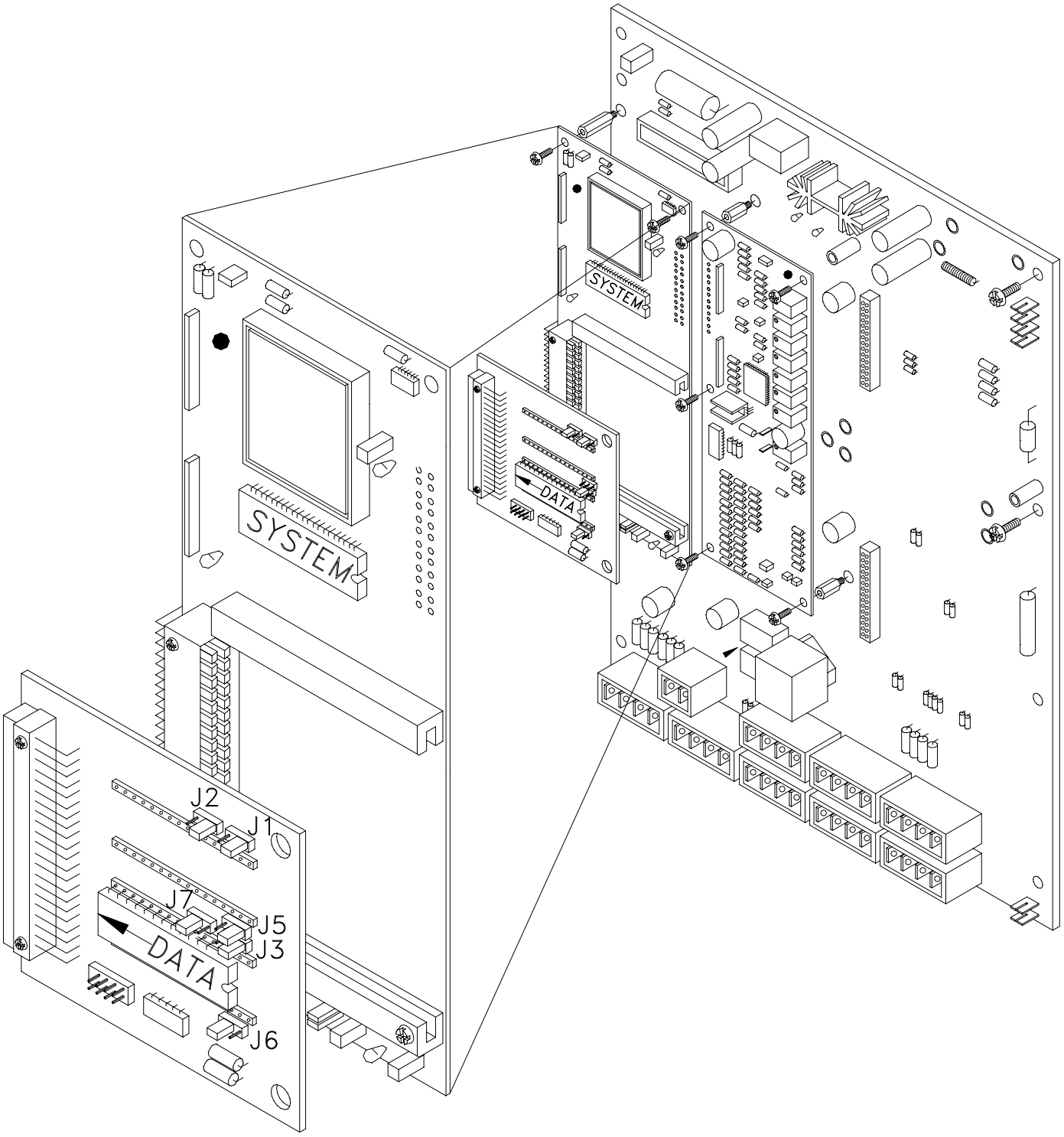
13.18 Cable Reel



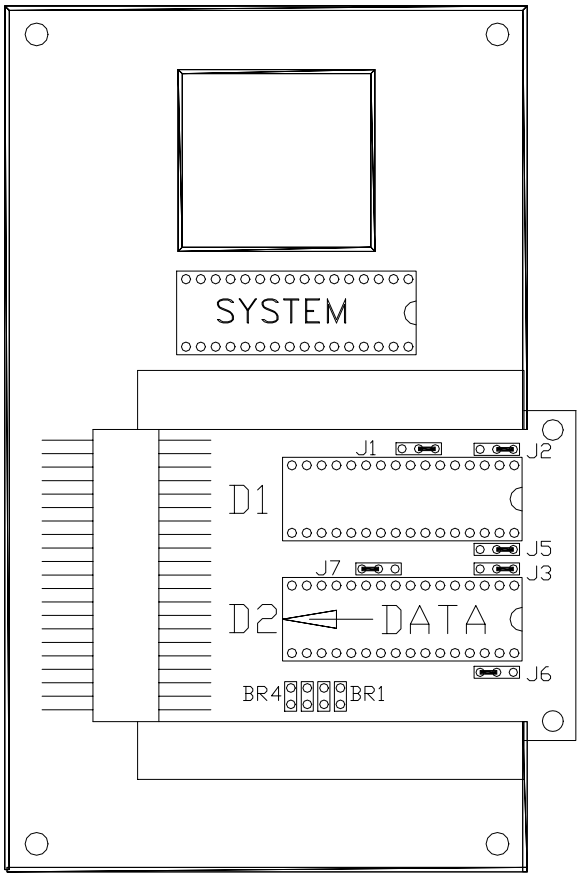
All boom tip signals go from the central unit through this cable reel to the boom tip sensors and switches. Refer to drawing 3 for schematics.

14 PROCEDURES

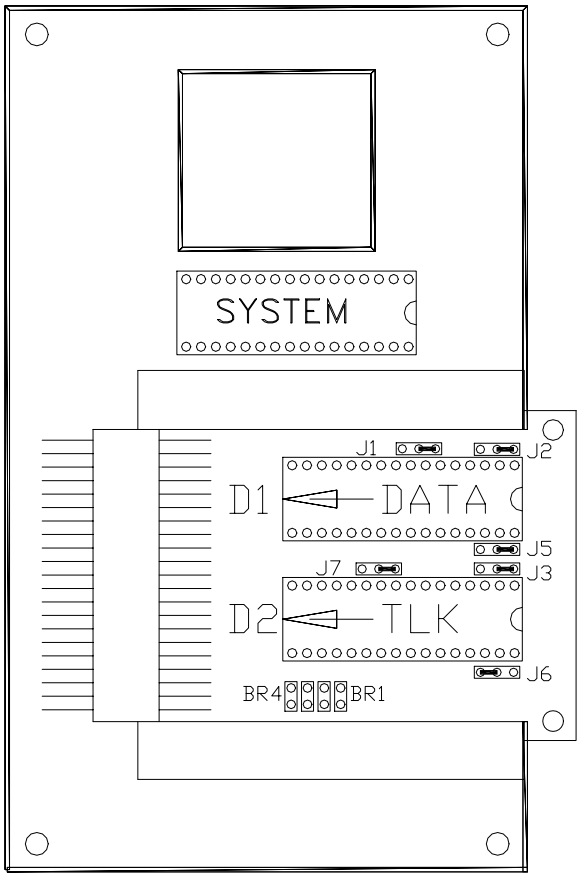
14.1 Procedure 1: EPROM Location and Installation



LS-278, HC-278, AND HC-238 (8MEG)



LS-218 II DATA (256K) AND TLK (4MEG)



- 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.
- Change the jumpers as as showen and/or as follows:
  8 Meg ERPOM 27C801 J6 and J7 closest to eprom module connector
  4 Meg ERPOM 27C801 J6 closest to eprom module connector and J7 furthest from eprom module connector

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.

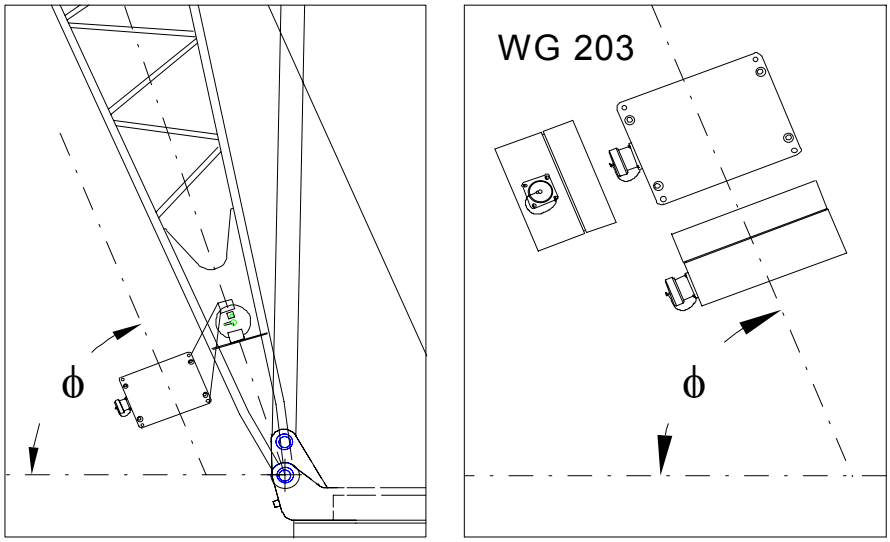
NOTE: Take care not to damage the boards with the screwdriver, when removing and inserting screws.

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 Procedure 4: Slew Potentiometer Zero Adjustment

NOTE: ONLY AUTHORIZED PERSONNEL MAY ADJUST THE ZERO-POINT SETTINGS.
Read entire document before performing any of the adjustment procedures.

14.4.1 Criteria for zeroing the slew angle through the graphic display console:

1) The upper revolving structure must be positioned so the upper is in the zero degree position; facing the idler end of the tread members for a crawler crane, and the rear of the carrier for a truck crane.

AND

Note: No mechanical adjustment is necessary with the following software install:

- Console KLKB V 2.1V P/N 071-350-480-110 or later
- System GLMG V1.2X P/N 071-350-480-111 or later

2) The mechanical alignment must be within the 20° range indicated by the decals inside the gearbox.

Quick Zero Procedure, if the above two criteria are meet and following procedures are understood: On the console face, press the INFO key, then press the CTRL key. At this point, a five digit Authorization Number must be entered, 6 7 6 7 6. Next, press the two center keys simultaneously for 4 seconds, the zero setting occurs automatically when the indicator line moves to the zero position on the bar graph. Press return arrow key to return to normal display. Verify that the indicated slew angle matches the correct upper position.

14.4.2 Gear Box Assembly General information

The gearbox assembly includes a metal cover (not shown), the slew gearbox, a mounting plate, and a nylon gear that meshes with the crane turntable bearing gear teeth.

Figure 1. Gear Box Assembly

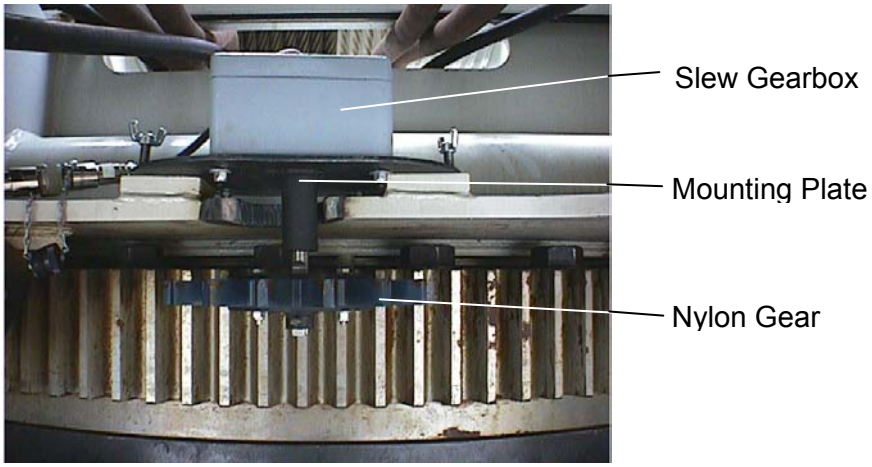
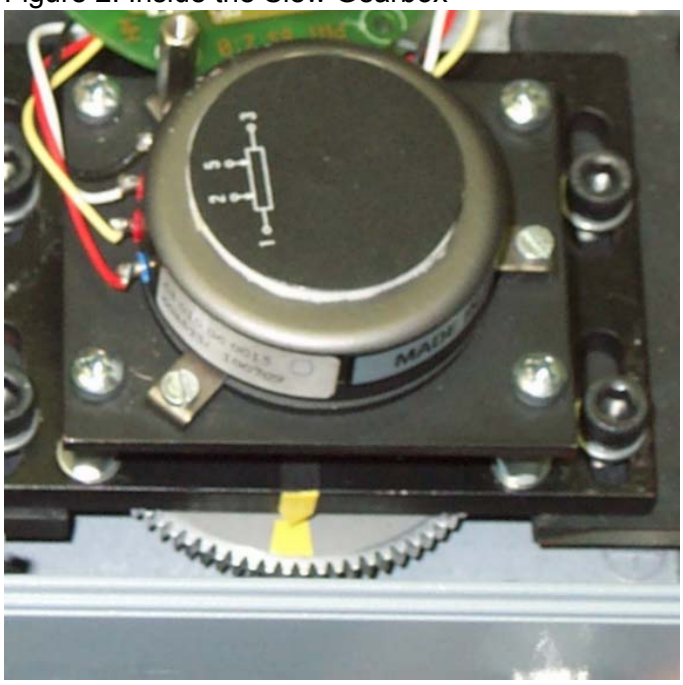
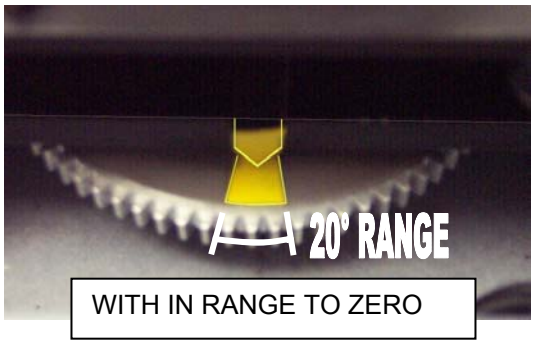
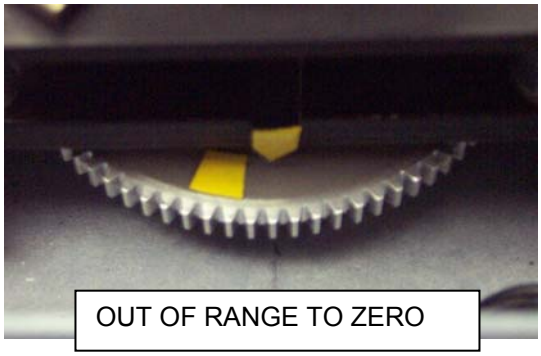


Figure 2. Inside the Slew Gearbox







14.4.3 Mechanical Adjustment of the Slew Potentiometer

No mechanical adjustment is necessary with the following software install:

- **Console KLKB V 2.1V P/N 071-350-480-110 or later**
- **System GLMG V1.2X P/N 071-350-480-111 or later**

If the slew angle is outside the 20° range, mechanically adjust gear by:

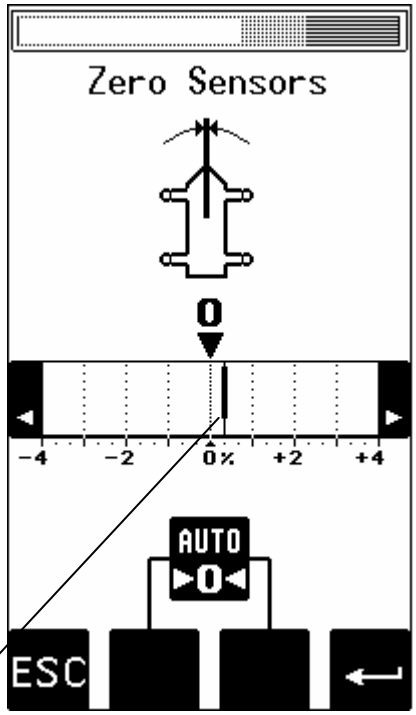
1. Verify the upper revolving frame is positioned correctly so the boom and upper frame is at the 0° slewing angle. Engage the upper house lock.
2. Remove the metal cover protecting the slew box assembly.
3. Remove the cover from the slew box assembly (Phillips screw driver). For better accessibility to slew gear mechanism, entire assembly including mounting plate may be removed as one unit.
4. Loosen the four mounting screws (5mm Allen wrench) that hold the internal gear assembly in place, and slide the gear assembly away from the small pinion gear.
5. Rotate the 80-tooth gear at the bottom of the slew mechanism so the yellow arrow points within the yellow range of the decal on the 80-tooth gear. This defines that the slew mechanism is in the 20° range for zeroing the slew potentiometer.
6. Slide the gear assembly toward the small pinion until the pinion and teeth of the gear on the slew mechanism teeth mesh. Tighten the four mounting screws of the slew mechanism.
7. Zero the Slew Potentiometer following the instructions in the next section, **"Using The Graphic Display Console To Zero The Slew Potentiometer"**.
8. Check the slew angle on display, Press limits "LIM", Press "4" for slew angle, Press "2" for virtual walls, Press "I" to display the slewing angle. Slowly swing the upper 360^{O} to the left. Visually check the relationship of the upper to the lower/carrier; with the angle indicated on the display screen, to verify the slew potentiometer is functioning correctly. Check angles at -90^{O}, -180^{O}, and 90^{O}. The display should indicate 0^{O} at the end of one revolution. Repeat the verification by swinging the upper to the right. Check angles at 90^{O}, 180^{O}, and -90^{O}. Note: The angles to the left of zero are indicated as negative (-) degrees, and angles to the right of zero are positive (+). Angles will change from negative (-) to positive (+) at the 180^{O} position, depending on the direction the upper is being swung.
9. Replace the slew gearbox cover.

10. Replace the metal cover.

14.4.4 Using The Graphic Console To Zero The Slew Potentiometer

1. To activate the zero-setting Function, return to the main operating screen.
2. Press the INFO key on the console to activate the INFO Function. Press the CTRL key. At this point, a five digit Authorization Number must be entered, 6 7 6 7 6.
3. After having successfully entered a valid password, press enter through the main and auxiliary linerider zero adjustment screens to the slew zero-point adjustment function is activated.
4. An indicator line shows the current position of the slew pot signal. Note: the indicator line may not be shown. Note: The display shows a scale from –4 to +4, which is not relevant for this zeroing procedure.
5. By pressing the two center keys simultaneously, the zero setting occurs automatically. Note: The indicator line will move to zero on the bar graph.

When finished, press the return key (arrow) and then the ESC (escape key) to return the console back to the normal operating display screen.



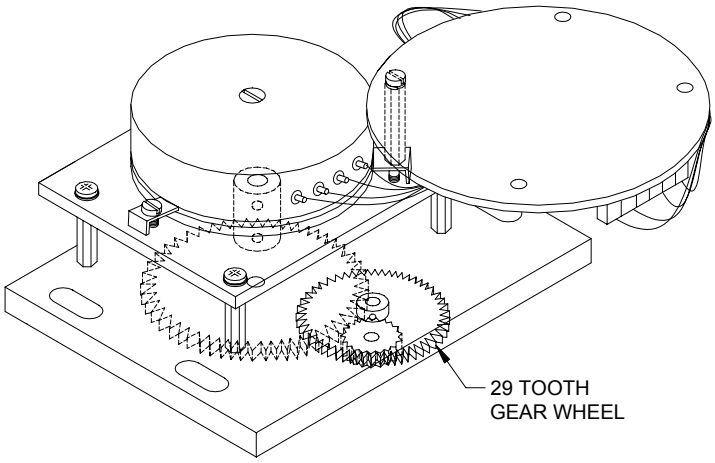
Indicator line

14.4.5 Using the Graphic Console to Display the Slew Angle

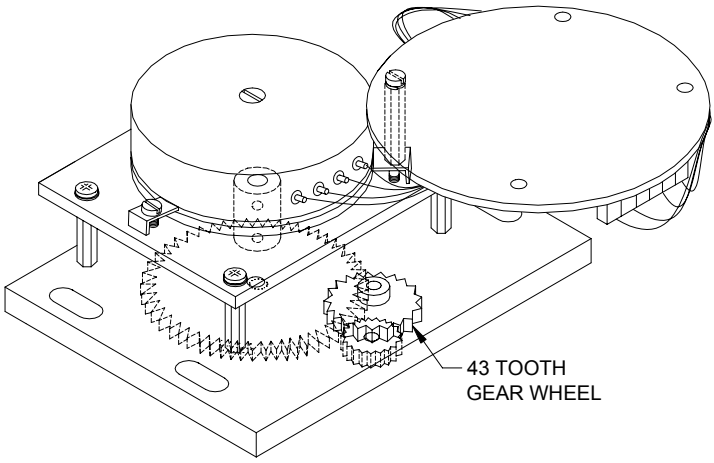
Check the slew angle on the graphic display by following the instructions below:

1. Complete the LMI console setup according to the crane's current operating configuration, then enter the virtual wall limits using following instructions:
2. Press limits "LIM"
3. Press 4 for slew angle / virtual wall limits.
4. Press 2 for virtual wall limits.
5. Press "I" INFO button to display slewing angle ("I", INFO button, toggles the slew angle display on and off)
   NOTE: Refer to the PAT Load Moment Indicator DS350 / 1334 Operator's Handbook for detailed instruction.

14.4.6 Installing New Slew Potentiometer Assembly



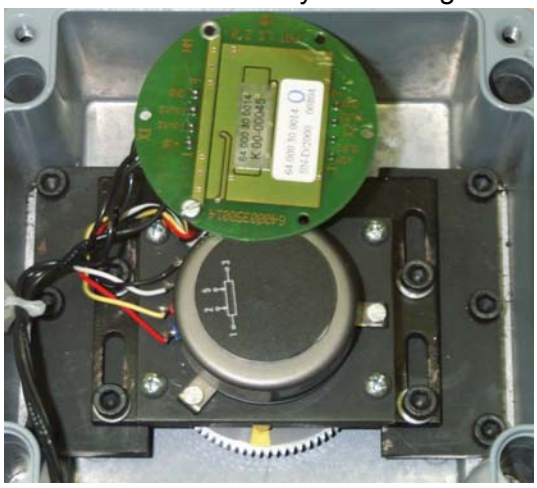
031-300-110-134 / F9L0123 GEAR ASSSEMBLY INTERNALS
FOR LS278H WITH GEAR RATIO 11.5 FOR GEAR BOX
031-300-060-319 F9L0093

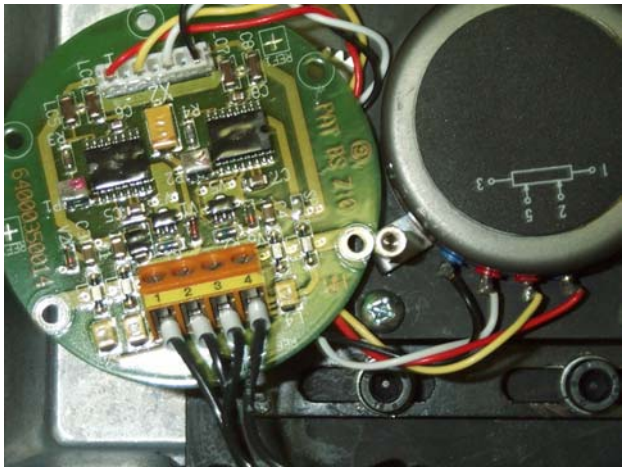


031-300-110-133 / H9L0061 GEAR ASSSEMBLY INTERNALS
FOR HC238H WITH GEAR RATIO 7.25 FOR GEAR BOX
031-300-060-320 H9L0044

The difference between the above gear assemblies is the 29 and 43 tooth gear.

Gear internal assembly and wiring connection.





1. Verify the upper revolving frame is positioned correctly so the boom and upper frame is at the 0° slewing angle. Engage the upper house lock.
2. Remove the metal cover protecting the slew box assembly.
3. Remove the cover from the slew box assembly. For better accessibility to slew gear mechanism, entire assembly including mounting plate may be removed as one unit.
4. Remove the round circuit board from mounting post.
5. Turn circuit board over and remove wires 1, 2, 3, and 4 from terminals. Mark the wires to the board connector.
6. Remove the four socket-head screws that hold the internal gear assembly in place and remove the old assembly from the box.
7. Insert the new internal gear assembly in place and insert the four socket-head screws, finger tight only.
8. Remove the round circuit board from mounting post on new slew mechanism and connect the wires 1-4 to the round circuit board terminals.
9. Mount circuit board on post.

10. Rotate the 80-tooth gear at the bottom of the slew mechanism so the yellow arrow points within the yellow range of the decal on the 80-tooth gear. This defines that the slew mechanism is in the 20° range for zeroing the slew potentiometer.
11. Slide the gear assembly toward the small pinion until the pinion and teeth of the gear on the slew mechanism teeth mesh. Tighten the four mounting screws of the slew mechanism.
11. Zero the Slew Potentiometer following the instructions in the **"Using The Graphic Display Console To Zero The Slew Potentiometer"** section.
12. Check the slew angle on display, Press limits "LIM", Press "4" for slew angle, Press "2" for virtual walls, Press "I" to display the slewing angle. Slowly swing the upper 360^{O} to the left. Visually check the relationship of the upper to the lower/carrier; with the angle indicated on the display screen, to verify the slew potentiometer is functioning correctly. Check angles at -90^{O}, -180^{O}, and 90^{O}. The display should indicate 0^{O} at the end of one revolution. Repeat the verification by swinging the upper to the right. Check angles at 90^{O}, 180^{O}, and -90^{O}. Note: The angles to the left of zero are indicated as negative (-) degrees, and angles to the right of zero are positive (+). Angles will change from negative (-) to positive (+) at the 180^{O} position, depending on the direction the upper is being swung.
13. Replace the slew gearbox cover.
14. Replace the metal cover.

14.5 Procedure 5: Line Rider Adjustments

14.5.1 General Information

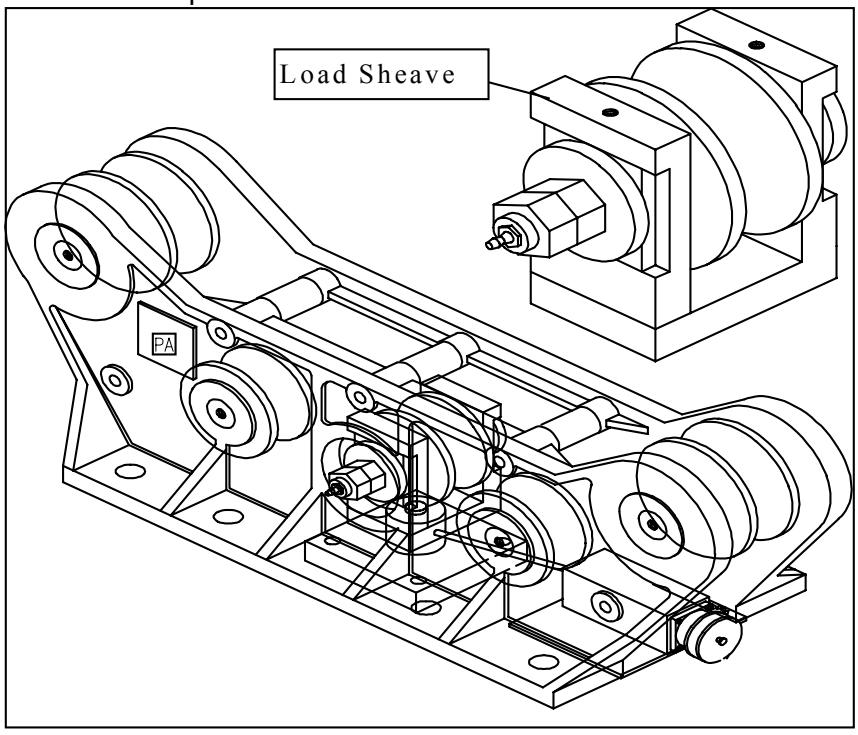
Calibration of a Line Rider will require the hoist rope line pull information, which should be provided by the manufacturer. Use single part line when calibrating the Line Rider. Line Riders require specific wire rope size, see Table 2 to insure your rope size matches your Line Rider provided.

NOTE: A new wire rope is normally over sized, the amount oversize will depend on the diameter of the rope. With normal wear the inter core breaks down and diameter decreases, See your manufactures guide lines for wire rope replacement conditions.

Line Riders should match the wire diameter of your hoist rope.

ITEM NUMBER	DESCRIPTION WITH WIRE ROPE SIZE	WIRE ROPE DIAMETER ADVISED RANGE
048-500-060-035	SENSOR, LINE RIDER SKM500 (7/8") 2 TON KMD	±3/64
048-500-060-012	SENSOR, LINE RIDER SKM502 (1-1/8”) 2 TON KMD	±3/64
048-500-060-013	SENSOR, LINE RIDER SKM502 (1”) 2 TON KMD	±1/16

The Line Rider requires a load sheave adjustment to maximize the voltage output of the amplifier and minimize the line angle through the line rider. The line rider maximum output voltage should correspond with the maximum line pull of hoist rope. For example, a 29,000lb maximum line pull should create a maximum signal output from the line rider. The load sheave may need to be adjusted by turning the eccentric wheel on the load sheave of the SKM500 series line rider. This adjustment will allow the best possible resolution of the load cell in the line rider.



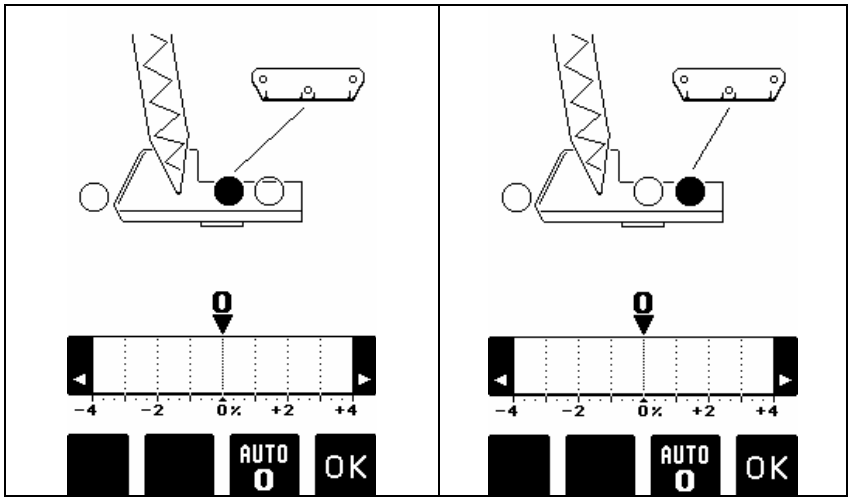
14.5.2 Line Rider Zero Point Adjustment

NOTE: Complete the following processes before placing cable through the Line Rider.

Use the Graphic Console if the following software is install:

- **Console KLKB V 2.1V P/N 071-350-480-110 or later**
- **System GLMG V1.2X P/N 071-350-480-111 or later**

1. To activate the zero-setting Function, return to the main operating screen.
2. Press the INFO key on the console to activate the INFO Function. Press the CTRL key. At this point, a five digit Authorization Number must be entered, 6 7 6 7 6.
3. After having successfully entered a valid password, the main linerider zero adjustment screen should be displayed, as shown below.



4. An indicator line shows the current position of the line rider zero point. Note: the indicator line may not be shown. Note: The display shows a scale from –4% to +4% for this zeroing procedure.
5. By pressing the AUTO 0 key to zero the linerider, the setting occurs automatically. Note: The indicator line will move to zero on the bar graph.

When finished, press OK to go to auxiliary line rider, press SEL to return to the normal operating display screen.

Adjust zero point at analog input module if older software is installed:

Check that the voltage at analog input module voltage 0.5volts ±0.025volts for the main and auxiliary Line Rider is at zero force (Refer to Drawing 7):

- Main Line Rider: X1:7 and X1:10
- Auxiliary Line Rider: X1:2 and X1:10

If voltage is out of side range, adjust the Line Rider voltages on the analog input module.

- Main Line Rider: adjust P7 to 0.5volts on X1:7 and X1:10
- Auxiliary Line Rider: adjust P2 to 0.5volts on X1:2 and X1:10

After completing this adjustment run the hoist rope through the Line Riders.

14.5.3 Line Rider Output Adjustment

a. Calculate the output voltage required from the Line Rider using the known the total load and maximum line pull information. The tolerance for the output voltage “X” is +0.0, -0.2 volts.

NOTE: The total load includes the load, rigging, cables, and hook block. Test load should be 80% of maximum rated load for the cranes configuration or condition. To comply with the SAE J376 standards the test load must be to a known accuracy of ±1%.

$$X = \frac{\text{Test Load} \times 4.0}{\text{Line Pull} \times \text{Parts - of - line}} + 0.5$$

Example for a load of 23,600 lbs, max. line pull of 29,500 lbs and single part of line:

$$X = \frac{23{,}600 \times 4.0}{29{,}500 \times 1} + 0.5 = 3.7$$

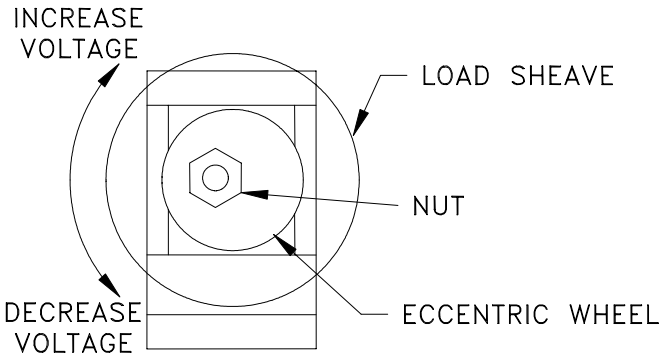
“X” is equal to the to optimum output voltage of the Line Rider. The output voltage required in this example is 3.0 to 3.2 volts.

WARNING: THE OPERATOR IS RESPONSIBLE FOR OPERATING THE CRANE WITHIN THE MANUFACTURE’S SPECIFIED PARAMETERS.

b. Pick the test load used in the calculation for the output voltage with a single part of line.

c. Take a voltage reading with a voltmeter and compare the reading with the calculated voltage and decide if a mechanical adjustment of the Line Rider is needed.
Check voltage at the analog board for the main and auxiliary Line Rider.

- Main Line Rider: X1:7 and X1:10
- Auxiliary Line Rider: X1:2 and X1:10



d. If a mechanical adjustment is necessary follow steps below, if no mechanical adjustment is necessary proceed to next Section and begin calibration.

- Before and after you set the mechanical adjustment, scribe a line on the side of the eccentric wheel to show the amount of change.
- Loosen the adjustment nut, see Figure 3. Note that there is a single lockout nut on one side and a double on the other. These both should be loosened to some degree. Adjustment from the double nut side seems to work the best after tightening the 2 nuts together.
- Depending upon the output voltage you can look at the eccentric nut from the side of the Line Rider and determine the direction you should turn. Increasing the height of the load sheave will increase the output voltage.
- Tighten all lock nuts insuring not to move the wheel.

Return and repeat step ‘c’.

14.6 Line Rider Disassemble/Assembly Procedure

This procedure can be used to replace sheave wheels, and axels on the SKM500, 501, and 502 series Line Riders. Refer to drawing 8 for the SKM502 and drawing 9 for the SKM500 when using thia procedure.

1. Remove hoist line from Line Rider and disconnect the electrical cable from the load cell.
2. Remove the Line Rider from the boom tip mounting brackets.
3. Move the Line Rider to a workbench or suitable work area.
4. Remove the load cell with the mounting plates attached item 13 (6mm allen wrench) and 14 (4mm allen wrench).
5. Note the side plate that uses cotter pins to hold the axels in place. Remove the 4 outer spring band screws item 17 that are accessible from the top and bottom of the Line Rider.
6. Loosen the 5 through bolts using 13mm size wrench.
7. Place the Line Rider on the side with the through bolt nuts, item 1, facing up and remove the 5 nuts.
8. Slowly lift the side plate up, tapping lightly on the axels as necessary to break the contact with the side plate. The side plate needs to lift evenly and straight up so the axels do not get cocked in the slots.
9. The inner and outer sheave wheels can be removed at this time.
10. Inspect the axels for pitting and corrosion, **Note: be careful when removing sheave wheels, the needle bearings may fall out**, replace axel if necessary.
    a. Replace axel by removing cotter pin and pulling the axel out of the side plate.
    b. Insert the new axel, align the cotter pin holes and insert cotter pin.
11. **Note: be careful when removing sheave wheels, the needle bearings may fall out.** Replace the sheave if necessary. Ensure the sheave wheels are correctly positioned using the exploded view drawings 8 or 9.
12. Assemble the line rider in reverse order.
13. Grease the sheave wheels.
14. Mount on the boom tip.
15. Complete the Line Rider Zero Point Adjustment using the Graphic Console and Line Rider Output Adjustment in the previous section.

14.7 Troubleshooting Moisture

The PAT DS 350 RCL 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.

14.7.1 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 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.

14.7.2 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.

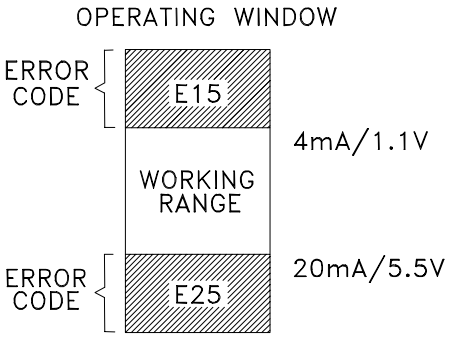
14.8 Theory 1: Operation of Angle Sensor

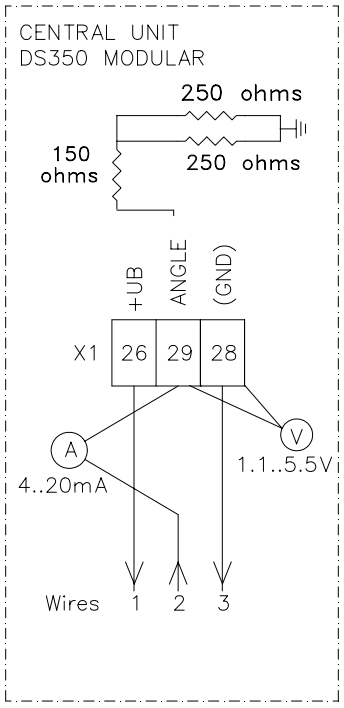
14.8.1 Measuring current:

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.

14.8.2 Measuring voltage at X1 terminal in central unit:

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.





14.8.3 Measuring voltage on analog input module in central unit:

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.

14.9 Theory 2: Operation Of Slew Potentiometer Sensor

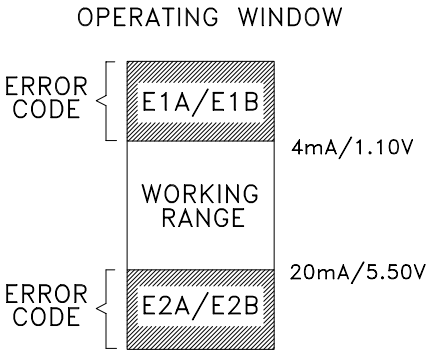
14.9.1 Measuring current:

The ammeter (A) is used to measure current at the slew angle input signal. Remove the wire from X1:34 (slew signal 1) in the central unit and measure the current with the ammeter in series. And then measure current at terminal X1:27 (slew signal 2). The measurement should be between 4..20mA.

14.9.2 Measuring voltage:

The voltmeter is (V) used to measure voltage between pins X1:34 (slew signal 1) and X1:35 (GND) and between pins X1:27 (slew signal 2) and X1:35 (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.

A



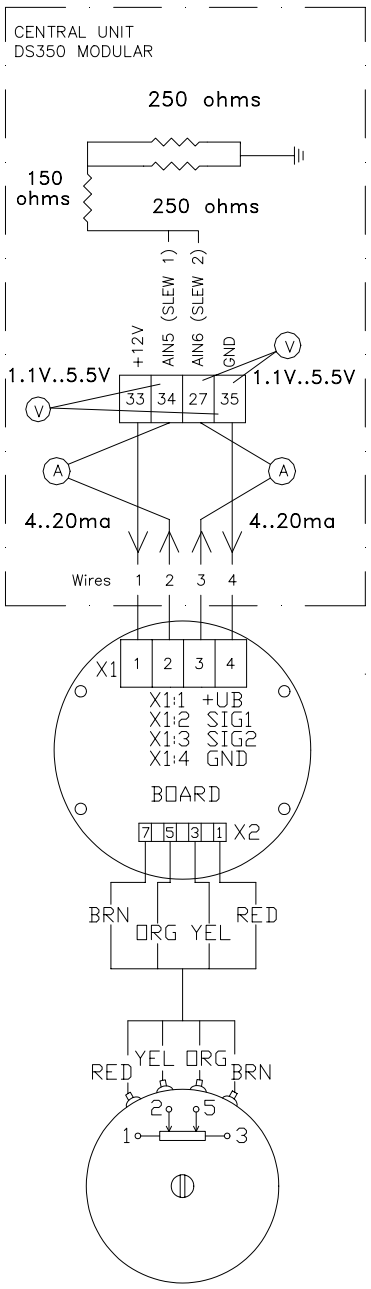


Table 1.

Indicated Angle	SIG-1 X1:34 (mA)	SIG-2 X1:27 (mA)	Differential SIG-1/SIG-2
0	3.999	11.981	-7.982
45.1	7.92	16.067	-8.147
89.9	11.987	20.003	-8.016
134.9	16.032	16.058	-0.026
-179.9	20.002	11.987	8.015
-135	16.05	7.926	8.124
-89.9	11.979	3.998	7.981
-44.9	7.894	7.913	-0.019
0	3.999	11.979	-7.98