



PSR Professional Service & Repair Inc.

Professional Service & Repair Inc. is a full-service mobile crane repair, inspection, and certification company. At Professional Service & Repair we understand the critical aspect of your crane being operational to your project schedule and budget. We will deliver world class service to have your crane operational in the minimum amount of time.

PSR is the global provider for sales, repair and installation of Load Moment Indicating (LMI) systems, Anti-Two Block Systems (A2B), and Rated Capacity Indicating systems. Please contact us with your crane repair and certification needs today.

PSR is the name businesses trust for crane repair, inspection, and certification.

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**P.O. Box 6506
Columbus, GA
31917-6506**

SYSTEM DESCRIPTION

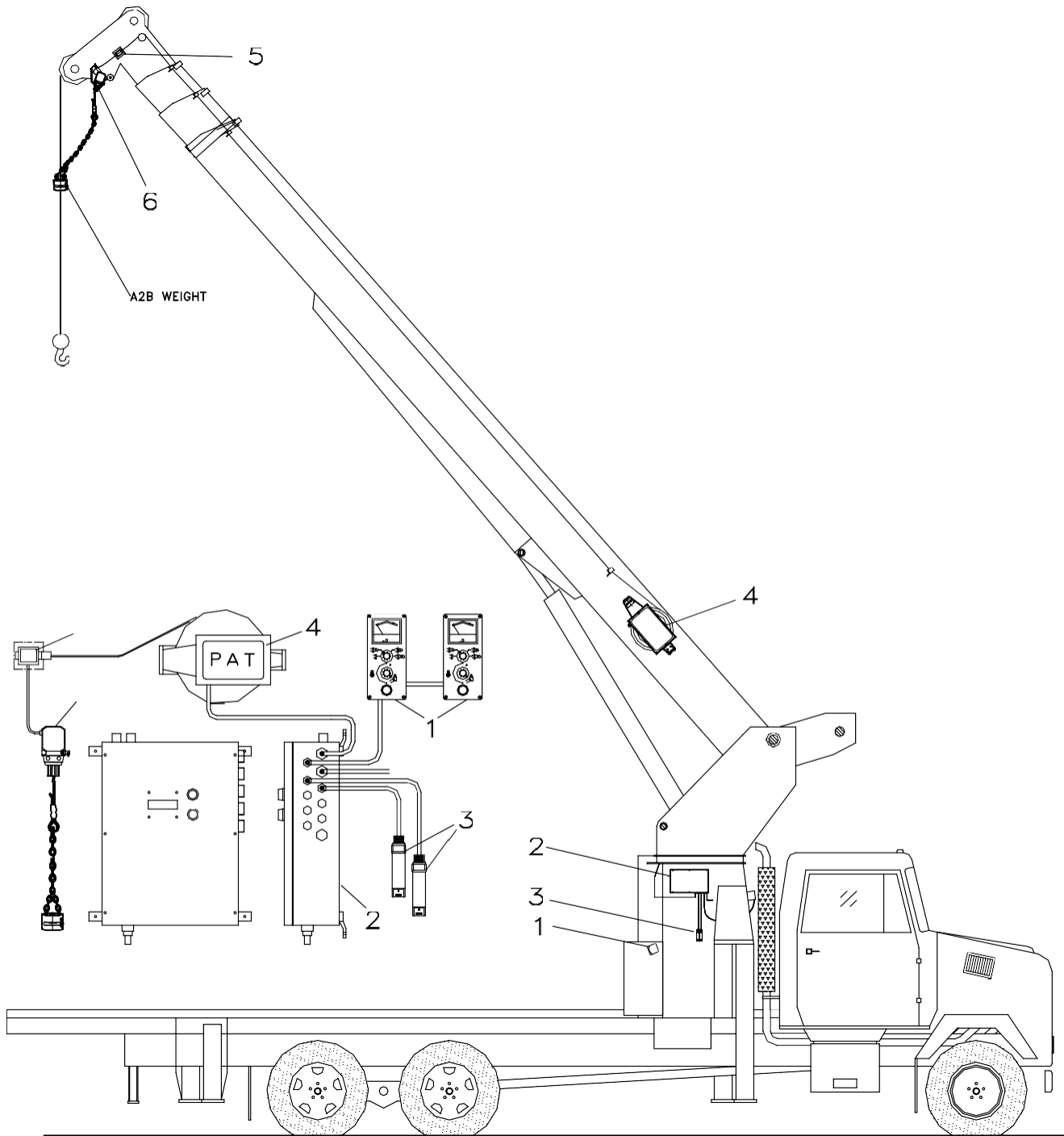


Fig. 1: Components of the LMI System PAT DS 150

1. Operator's Console
2. Central Unit
3. Pressure Transducer
4. Cable Reel
5. Boom Tip Junction Box
6. A2B Switch

TROUBLESHOOTING

The service console displays 16 variables to assist the setup and diagnostics of this system. The first numeral displayed is the reference number 1 thru 16.

The second value displayed is as follows:

REF # VALUE

- 1 Main Boom Length
- 2 Main Boom Angle
- 3 Radius
- 4 Jib Angle (with jib only, otherwise blank)
- 5 Tip Height
- 6 Operating Mode
- 7 Error Code (in case of error only, otherwise blank)
- 8 Real Moment
- 9 Jib Length (with jibs only, otherwise blank)
- 10 Rated Load (in t or 1,000 lbs)
- 11 Actual Load (in t or 1,000 lbs)
- 12 Reeving
- 13 Load Moment in %
- 14 Piston side Pressure in mV
- 15 Rod side Pressure in mV
- 16 Test

By depressing either the page up or page down" button, the display will sequence through the variables.

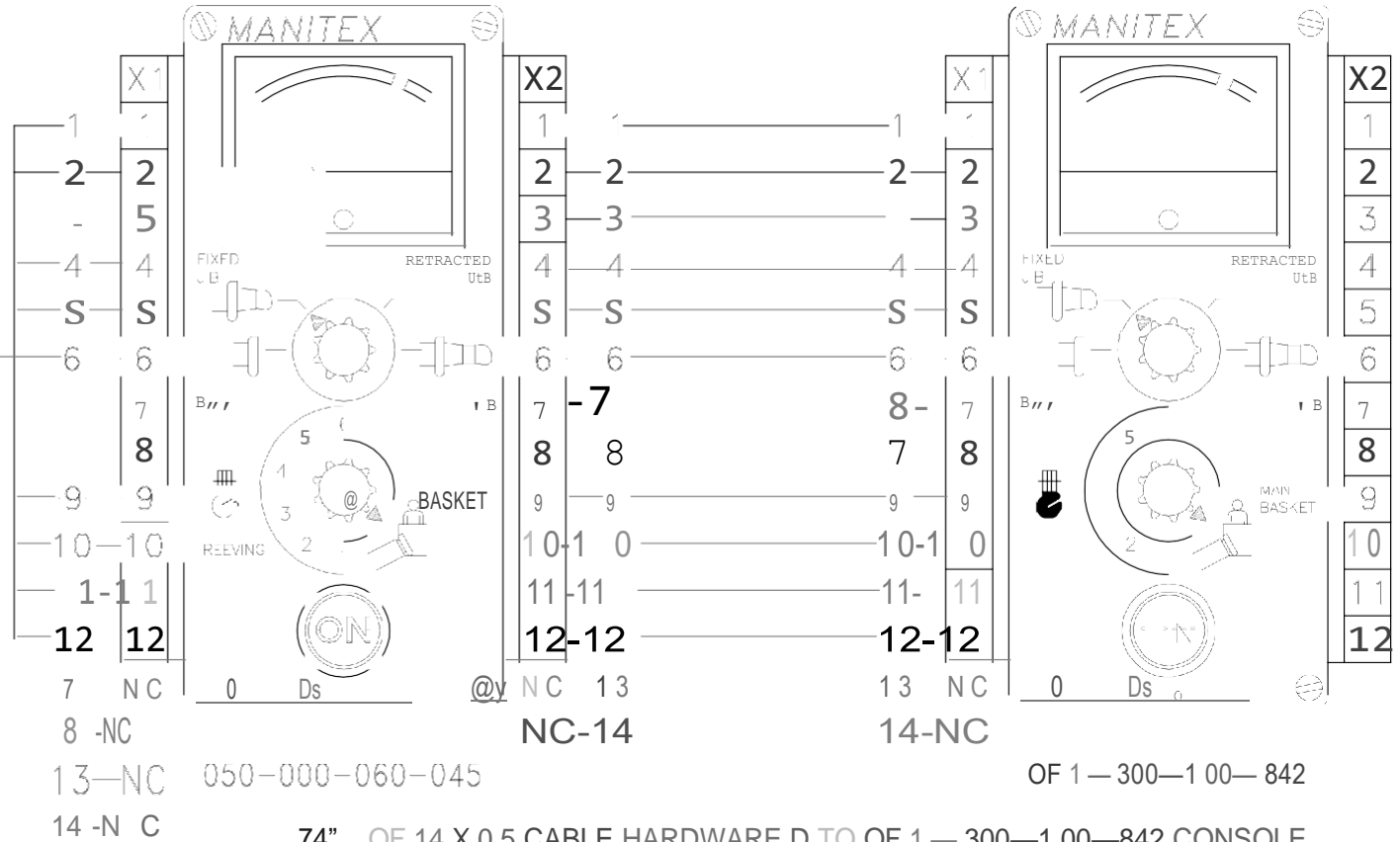
In case of a malfunction of the system, both the OVL and A2B lights will illuminate simultaneously. By selecting variable #7 on the service console, the display will indicate a code, which identifies the system malfunction.

The error codes listed in the Malfunction Table will identify various faults, which can occur with the LMI. Following the Malfunction Table is information, which explains each fault and describes the action, which should be taken to correct the fault.

Error codes 7 through 99 are faults within the electronic microprocessor and must be repaired by factory-trained service personnel.

DS1 TO CENTRAL UNIT

	X1	
AGND	23	1
BEEVING	24-2	
-IV	26-3	
+UB	43	6
BM	37	9
DI2	39-10	
DI3	41-11	
GND	36-12	2-
	EXT 8% D	
+ VASTER	+ -4	
VASTFB	- 5	
	NC- 7	
	NC- 8	
	NC-1 3	
	NC-14	



74" OF 14 X 0.5 CABLE HARDWARE D TO OF 1 - 300-1 00-842 CONSOLE, PLUG OTHER HOLE IN BACK OF CONSOLE. MANIT E X WIRES OTHER CONSOLE 050-000-060- 045 AND CENTRAL U NIT 024-150- 0 60-002.



PAT AMERICA, Inc.
1685 ORCHARD DRIVE
CHAMBERSBURG, PA 17201

DS 50 MAN TOWOC W RING
WITH LEFT AND RIGHT CONSOLES

GENERAL TOLERANCES	X.XX = 0.01 X.XXX = 0.005	P/N	03 300-101-283
REV	ECN	DESCRIPTION	BY APV DATE
			DRAWN
			CHRIS HERTZLER 12/07/99
			VED CH S HERTZLER
			SCALE: NONE SHEET: 2 OF 2
			SIZE DWG NO. RLV

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CO 001
C.A.S.E. 79750

300 10 1283 -

LEVER LOCKOUT
SOLENOID VALVE OR VALVES



DC POWER GND 2

+12 VOLTS 1

CENTRAL UNIT
DS150

REFER TO 2ND PAGE
FOR CONSOLE WIRING

LMI BYPASS
KEY SWITCH

DIGITAL INPUTS
USAGE DEPENDS ON CRANE MODEL
REFER TO PAT WIRING DIAGRAM
FOR CONNECTION PARTICULAR MODEL
DE1-TERM. 38(+)&37(-)
DE2-TERM. 40(+)&39(-)
DE3-TERM. 42(+)&41(-)

REFER TO MAIN
BOOM ANGLE
CHANNEL FOR
SIGNAL RANGES

PRESSURE SIGNAL RANGE
0.500V TO 4.5V

ZERO PRESSURE ADJUSTMENT
FOR PISTON MP11 ROD MP12
SET TO 0.5V WITH NO PRESSURE
ON TRANSDUCERS
ADJUST P1 FOR 0.500V AT MP11
ADJUST P2 FOR 0.500V AT MP12
USE AGND FOR REFERENCE

PRESS TRANSDUCER
SIGNAL RANGE
0 BAR=0.0V
500 BAR=-1.0V

BOOM LENGTH SIGNAL
RETRACTED=-0.500V
MAX RANGE=-4.5V
SEE NOTE • CABLE REEL

LENGTH SIGNAL
MIN. = +0.500V
MAX. = +4.5V
(10 TURNS/POT=MAX)

ANGLE SIGNAL
0 DEG=+4.5V
45 DEG=+2.5V
90 DEG=+0.500V

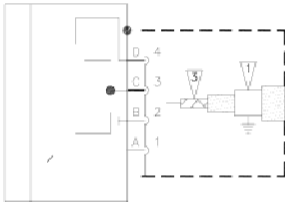
ANGLE SIGNAL
0 DEG=-3.125V
45 DEG=-2.5V
90 DEG = -1.875V

UB=CRANE SUPPLY POSITIVE VOLTAGE
D(UB)=CRANE GND
RxD=RECEIVE DATA
TxD=TRANSMIT DATA

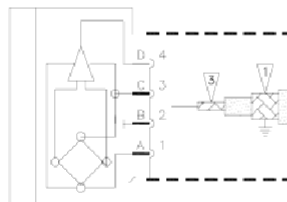
GND = INNER SHIELD
CONNECTION

CH. #1 THRU-
CH. #6 = ANALOG
MEASURING CHANNELS

PRESSURE TRANSDUCER
PISTON SIDE



PRESSURE TRANSDUCER
ROD SIDE



CABLE REEL

EMBLY

R.F. FILTER

RESISTOR

SHIELD

BOOM NOSE CONNECTOR

JUMPER PLUG

A/B SWITCH

ANGLE SIGNAL
0 DEG = -3.125V
45 DEG = -2.50V
90 DEG = -1.875V

BOOM LENGTH SIGNAL
RETRACTED = -0.500V
MAX. RANGE = -4.5V

NOTE:

MAX. LENGTH SIGNAL
VARIES WITH BOOM
MAX. VOLTAGE -4.5V IS
FOR 10 TURNS ON POT.

- 1 OUTER SHIELD GROUNDED AT STRAIN RELIEF CONNECTOR
- 2 INSULATED WIRE SOLDERED TO INNER SHIELD AND CONNECTED AS SHOWN
- 3 INNER SHIELD CUT OFF AND TAPED
- 4 OUTER SHIELD CUT OFF AND TAPED

PAT PAT AMERICA, Inc.
1665 ORCHARD DRIVE
CHAMBERSBURG, PA 17201

DS150 MANITOWOC WIRING
WITH LEFT AND RIGHT CONSOLES

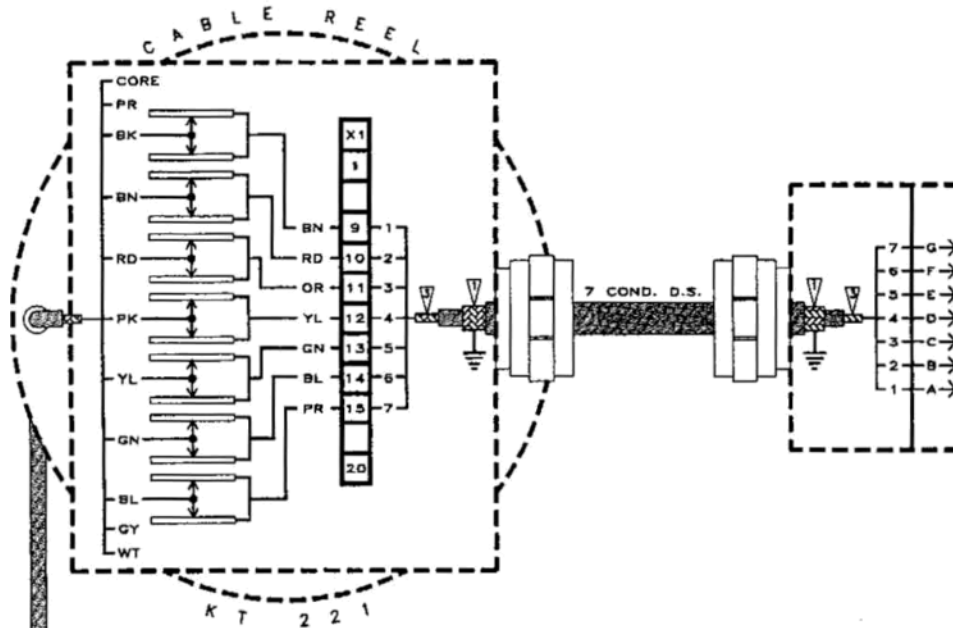
REV	ECN	DESCRIPTION	BY	APV	DATE

GENERAL TOLERANCES	X.XX = 0.01 X.XXX = 0.005	P/N	031-300-101-283
DRAWN	CHRIS HERTZLER	DATE	12/07/99
APPROVED	CHRIS HERTZLER	SCALE:	NONE
SIZE	DWG NO.	SH EET	1 OF 2

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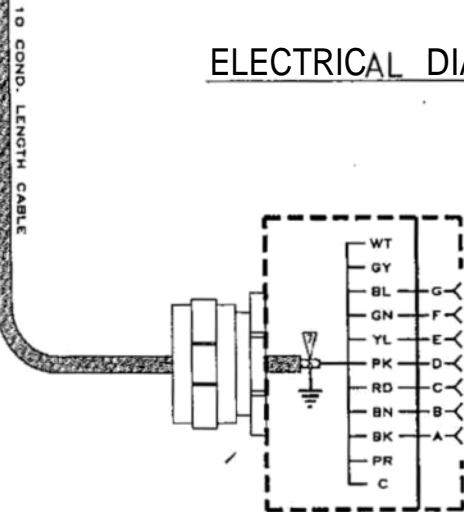
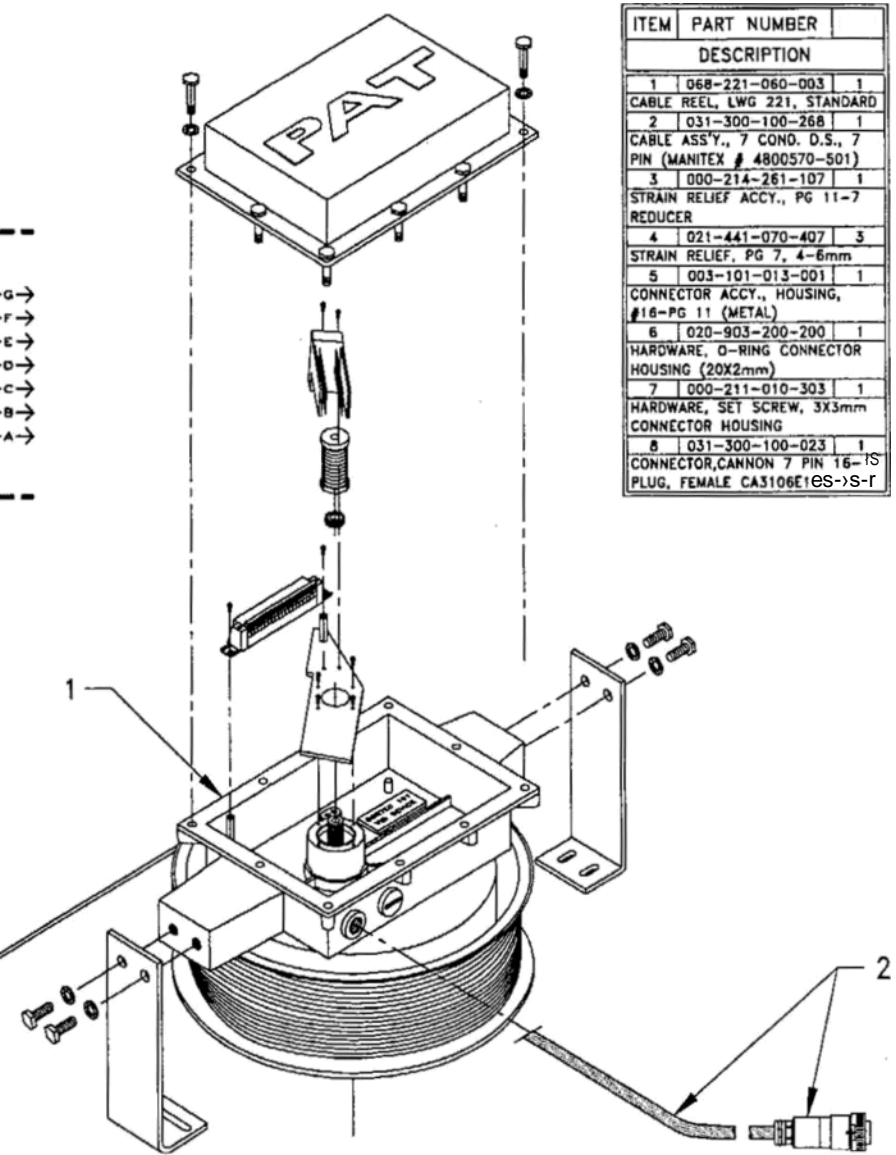
00-001
C.A.G.E. 79760

A 031 300 10 1283 -



ELECTRICAL DIAGRAM

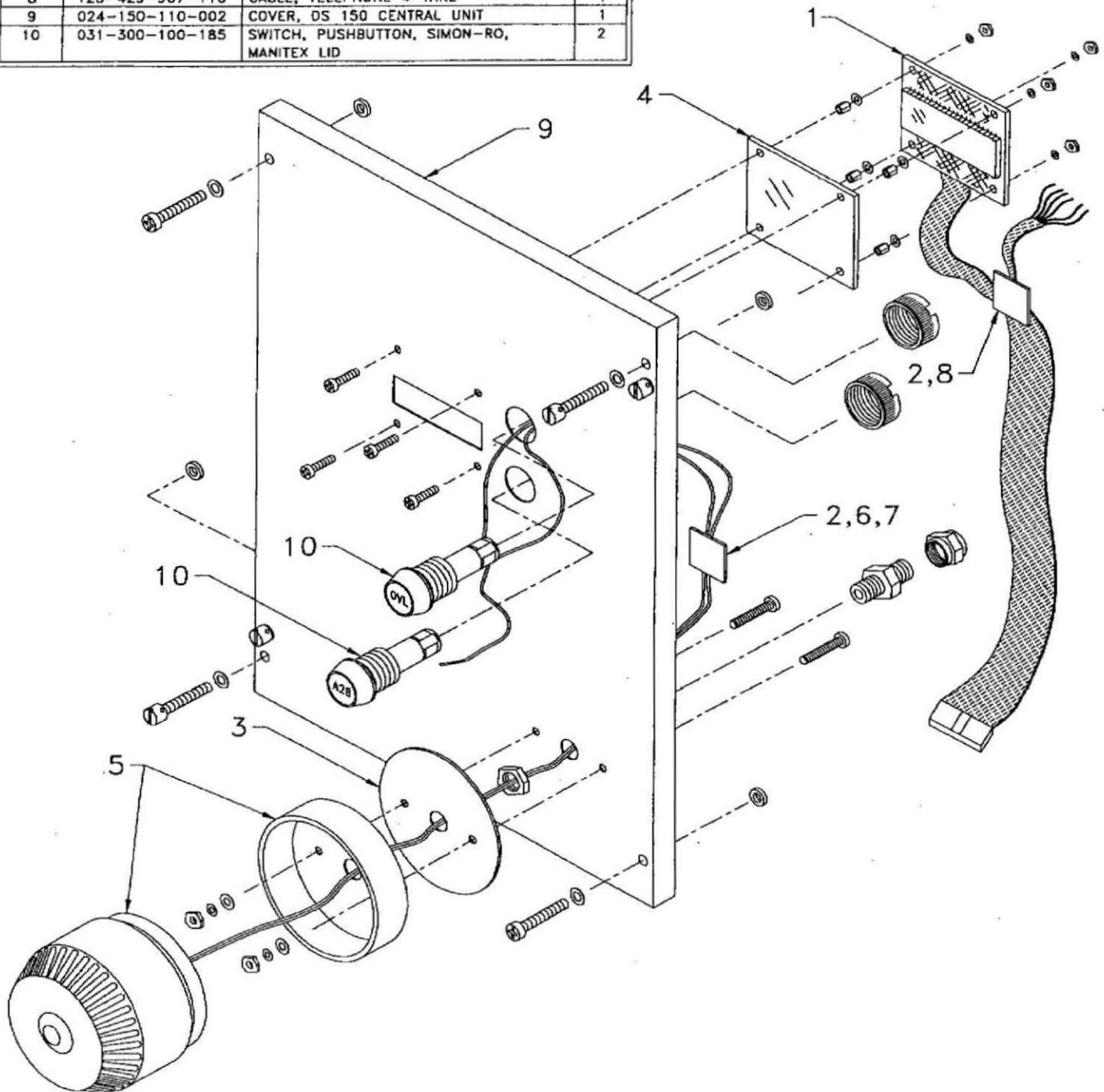
ITEM	PART NUMBER	DESCRIPTION
1	068-221-060-003	1
CABLE REEL, LWG 221, STANDARD		
2	031-300-100-268	1
CABLE ASS'Y., 7 COND. D.S., 7 PIN (MANITEX # 4800570-501)		
3	000-214-261-107	1
STRAIN RELIEF ACCY., PG 11-7 REDUCER		
4	021-441-070-407	3
STRAIN RELIEF, PG 7, 4-6mm		
5	003-101-013-001	1
CONNECTOR ACCY., HOUSING, #16-PG 11 (METAL)		
6	020-903-200-200	1
HARDWARE, O-RING CONNECTOR HOUSING (20X2mm)		
7	000-211-010-303	1
HARDWARE, SET SCREW, 3X3mm CONNECTOR HOUSING		
8	031-300-100-023	1
CONNECTOR, CANNON 7 PIN 16-TS PLUG, FEMALE CA31061ES-S-T		



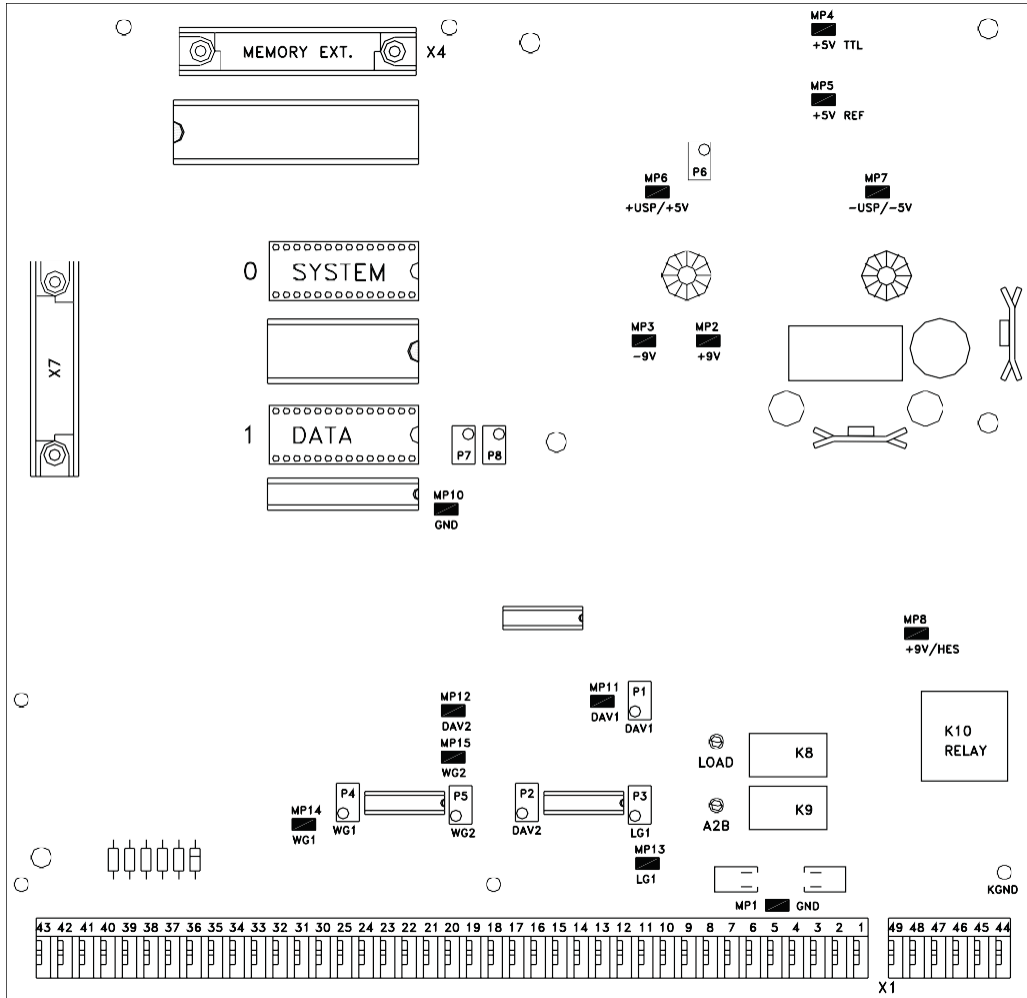
HO_E_S: ELECTRICAL

- ▽ OUTER SHIELD GROUNDED AT STRAIN RELIEF CONNECTOR.
- ▽ INNER SHIELD CUT OFF AND TAPED.

ITEM	PART NUMBER	DESCRIPTION	QTY
1	024-150-100-006	INDICATOR, DISPLAY, LCD	1
2	031-300-100-212	WIRING ACCY, ADHESIVE TIE WRAP HOLDR	2
3	031-300-100-184	ALARM ACCY, GASKET, BUZZER (MANITEX)	1
4	031-300-100-262	LENS, CENTRAL UNIT COVER FOR DISPLAY	1
5	031-300-100-183	ALARM, PIEZO RED ADJUSTABLE	1
6	031-300-100-261	WIRING ACCY, CENTRAL UNIT (SIMON-RO, MANITEX)	1
7	123-429-901-810	WIRE, HOOKUP 24 AWG BLACK	1
8	123-429-907-110	CABLE, TELEPHONE 4-WIRE	1
9	024-150-110-002	COVER, DS 150 CENTRAL UNIT	1
10	031-300-100-185	SWITCH, PUSHBUTTON, SIMON-RO, MANITEX LID	2



Central Unit Board Layout And Measuring Points 024-150-300-001



Measuring Points

- MP1: AGND
- MP2: +9V
- MP3: -9V
- MP4: 5V TTL
- MP5: 5V REF
- MP6: +5V/+UPS sensors supply
- MP7: -5V/-UPS sensors supply
- MP8: +9V HES
- MP10: AGND
- MP11: DAV1 piston pressure signal
- MP12: DAV2 rod pressure signal
- MP13: LW1 length signal
- MP14: WG1 angle signal #1
- MP15: WG2 angle signal #2

LED's

- LOAD: Overload relay ON(energized/normal conditions)/OFF (de-energized)
- A2B: A2B relay ON(energized/normal conditions)/OFF (de-energized)

Main Board Replacement

Refer to Drawing 1, 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.

3. Remove the system and data software from the main board.
4. Remove the relay from the main board.
5. Mark all connection wires before removing, to identify location for reconnecting. Disconnect all X1 terminal wires from the main.
6. Remove the 9 large Philips screws holding the main board in place.
7. Note the orientation of the main board in the central unit. Remove main board and place it in the same packing material that the replacement in which the main board came.
8. Carefully insert the new main board in place.
9. Insert the 9 Philips mounting screws.
10. Insert the relay into the main board.
11. Insert the system and data software into the main board.
12. Connect the X1 terminal wires to the main board. Refer to Wiring Diagram.
13. Zero pressure transducers using the zeroing procedure in this section.
14. Inspect the gasket for nicks, cuts, or damages. Refer to 031-300-340-003 DS 350 Central Unit Gasket Recommendations, Revision - and 031-300-340-002 Central Unit Cover Installation and Tightening Procedure, Revision A

PROCEDURE

EPROM replacement in Central Unit

Follow this procedure when changing EPROM's in the DS150 central units.

1. Remove cover, from central unit.

CAUTION: Before handling the EPROM, discharge any static electricity from your body by touching a ground source. The EPROM could be damaged if this procedure is not followed.

Use the central unit main board layout and measuring point drawing to locate the system and data EPROM's.

2. Remove the old EPROM from the main board using an EPROM puller. Be careful not to bend the legs of the EPROM when removing it.

3. Installing the new EPROM:

- Ensure the notch is in the correct direction. The direction of the EPROM is determined by the notch on the end of the EPROM.
- The DATA and TLK EPROM's fill the bottom of the socket as shown by the arrows.
- Place EPROM in the correct EPROM socket as shown.

4. Inspect gasket and install cover using the following procedures to prevent any moisture from entering the central unit.

Reference material:

031-300-340-002 Central Unit Cover Installation and Tightening Procedure; Rev A.

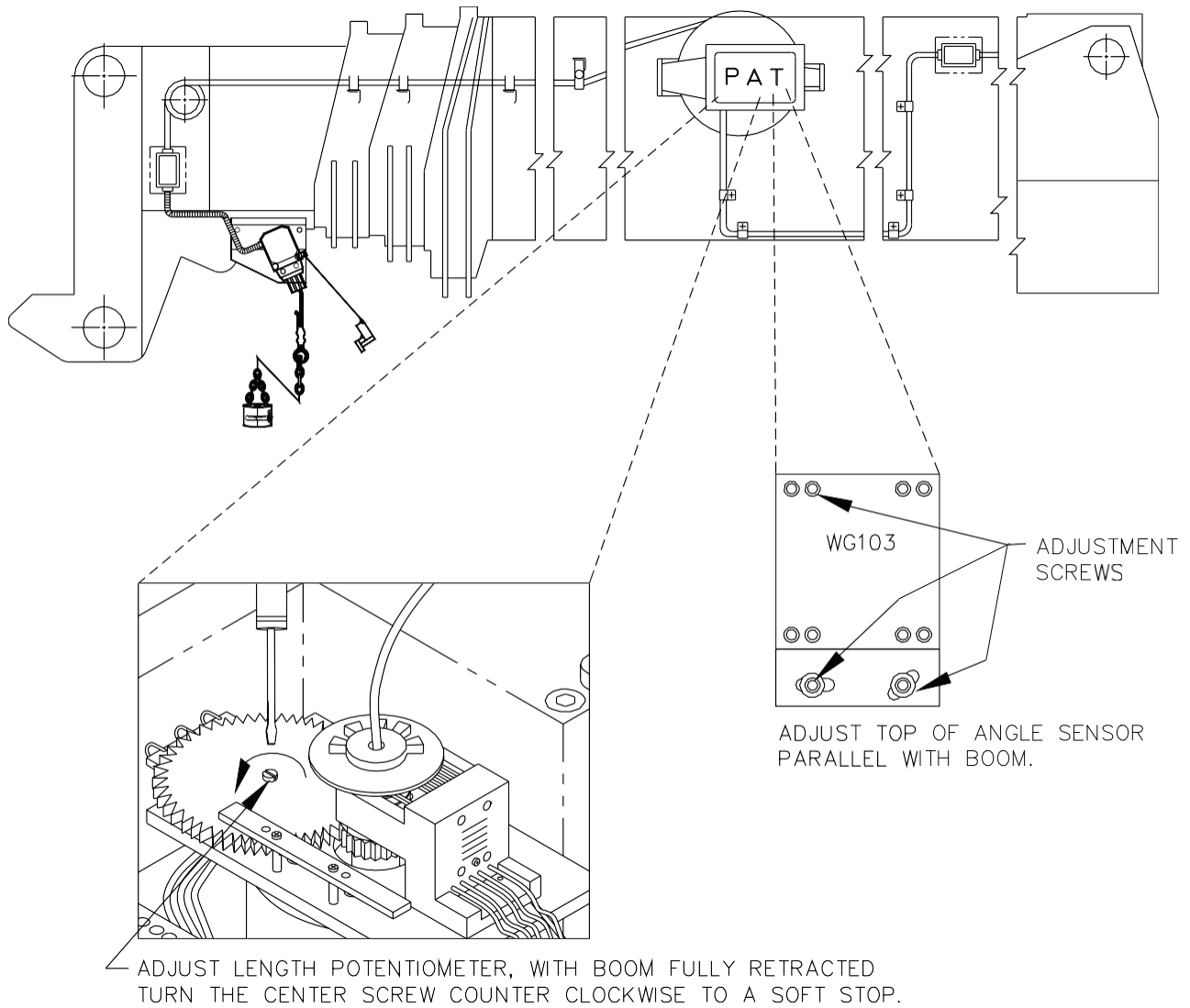
031-300-340-003 Central Unit Gasket Recommendations; Rev -.

Piston & Rod Pressure Channel Zero Point Adjustment

Use the central unit main board layout and measuring point drawing to make the following adjustments.

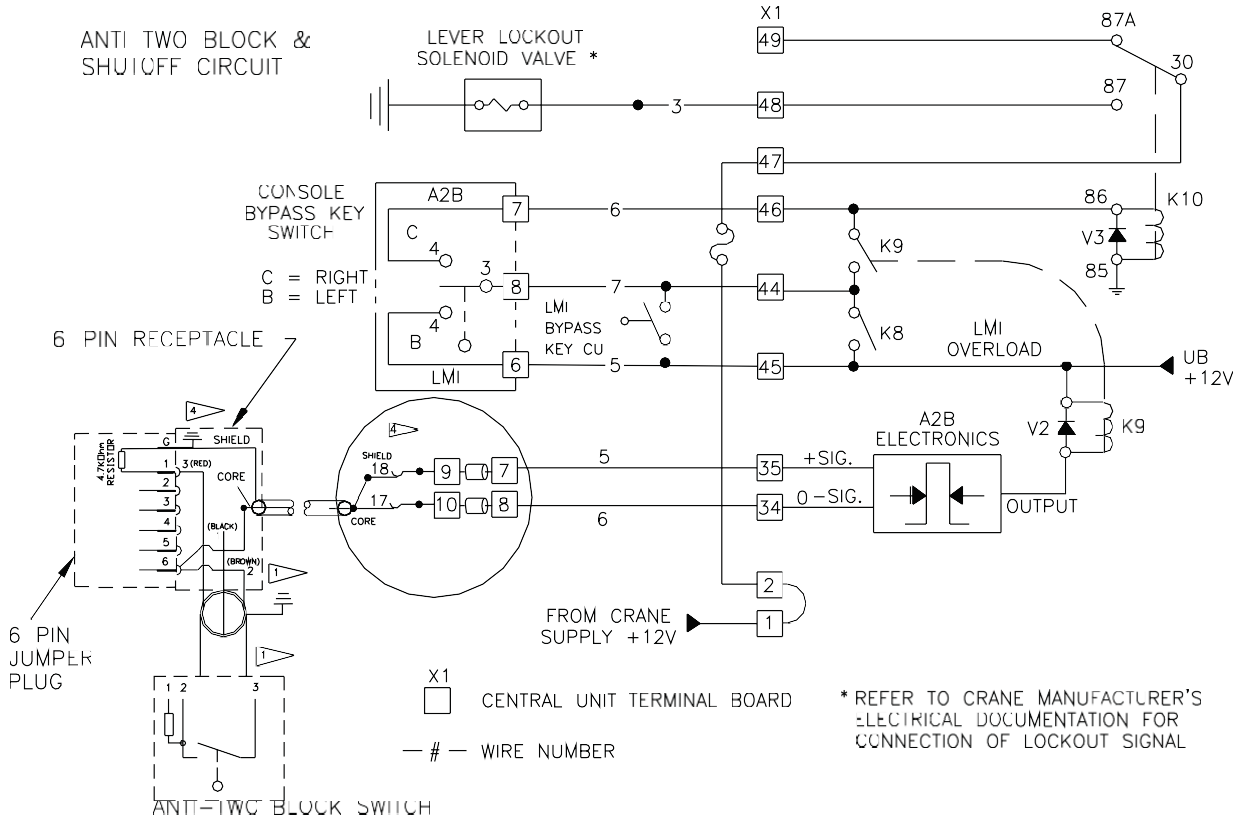
1. Lower boom all the way down (no rest pressure) then disconnect hydraulic hose from the piston side pressure transducer.
2. Connect a digital voltmeter to main board
 - A) black (-) lead to mp10
 - B) red (+) lead to mp11
3. Adjust P1 to obtain a reading of 0.500 volts (500mv) on meter.
4. Disconnect hydraulic hose from the rod side pressure transducer.
5. Connect a digital voltmeter to main board
 - A) BLACK (-) lead to MP10
 - B) RED (+) lead to MP12
6. Adjust P2 to obtain a reading of 0.500 volts (500mv) on meter.
7. Reconnect hydraulic hoses to pressure transducers, and then bleed the air from hydraulic lines.

Length & Angle Adjustments

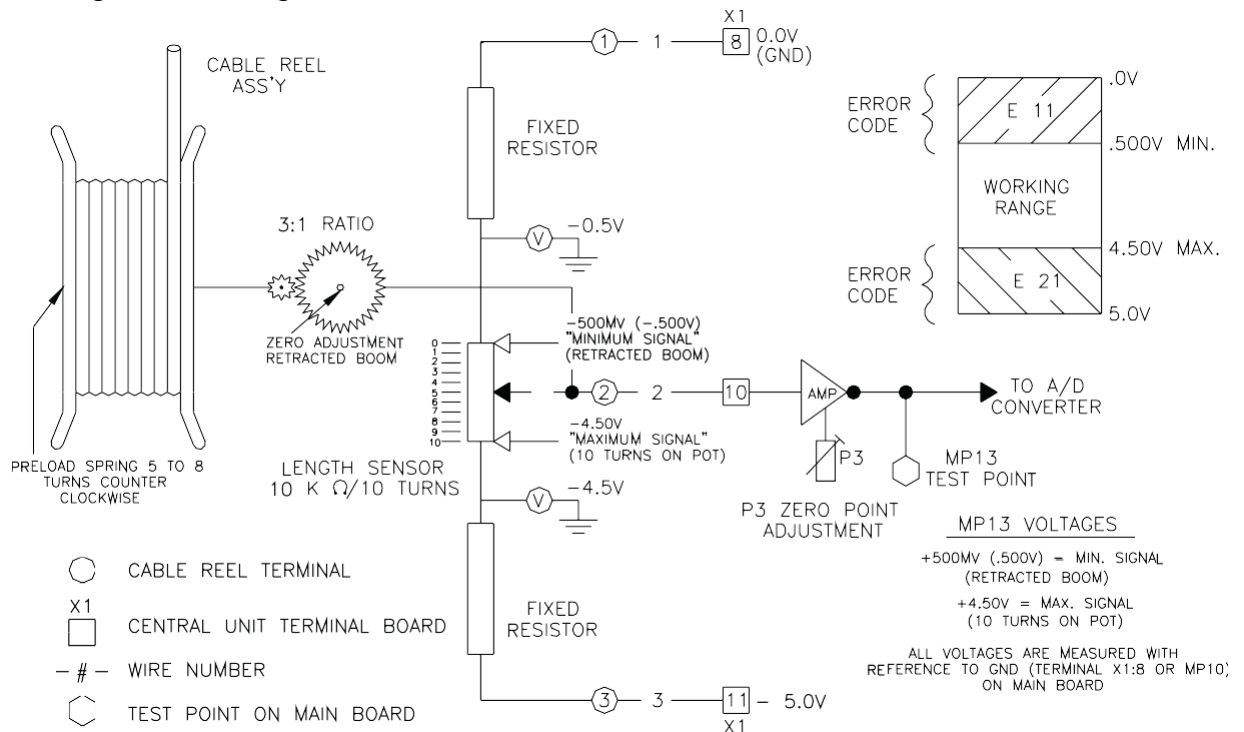


THEORY

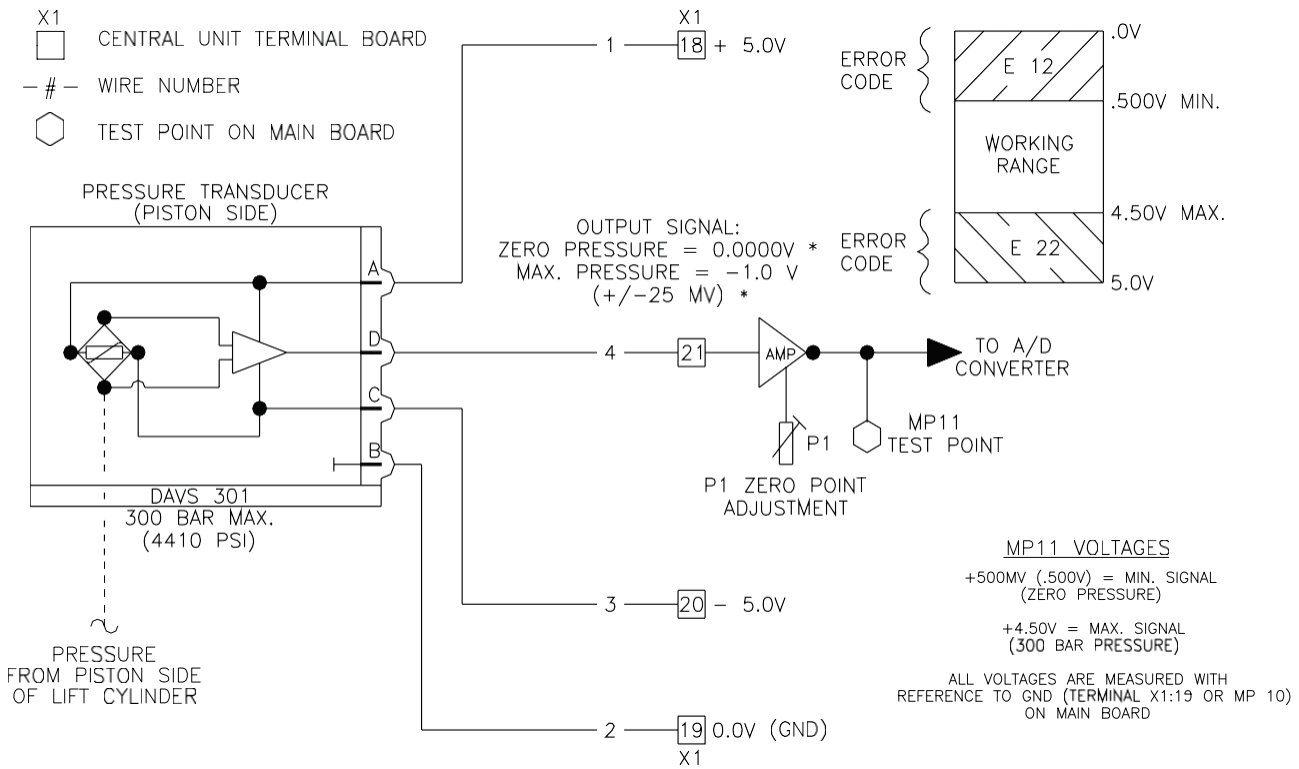
Anti-Two Block & Shutoff Circuit



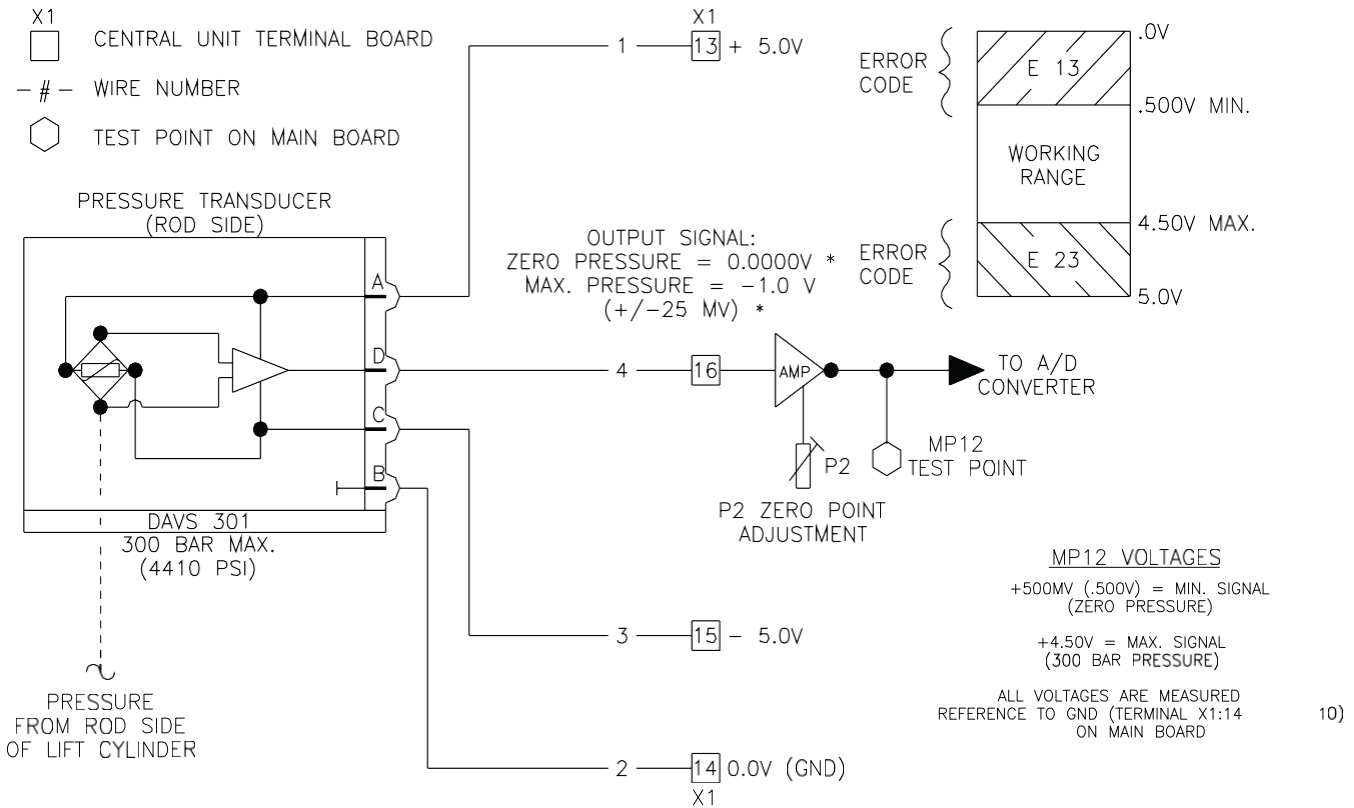
6.2 Length Measuring Channel



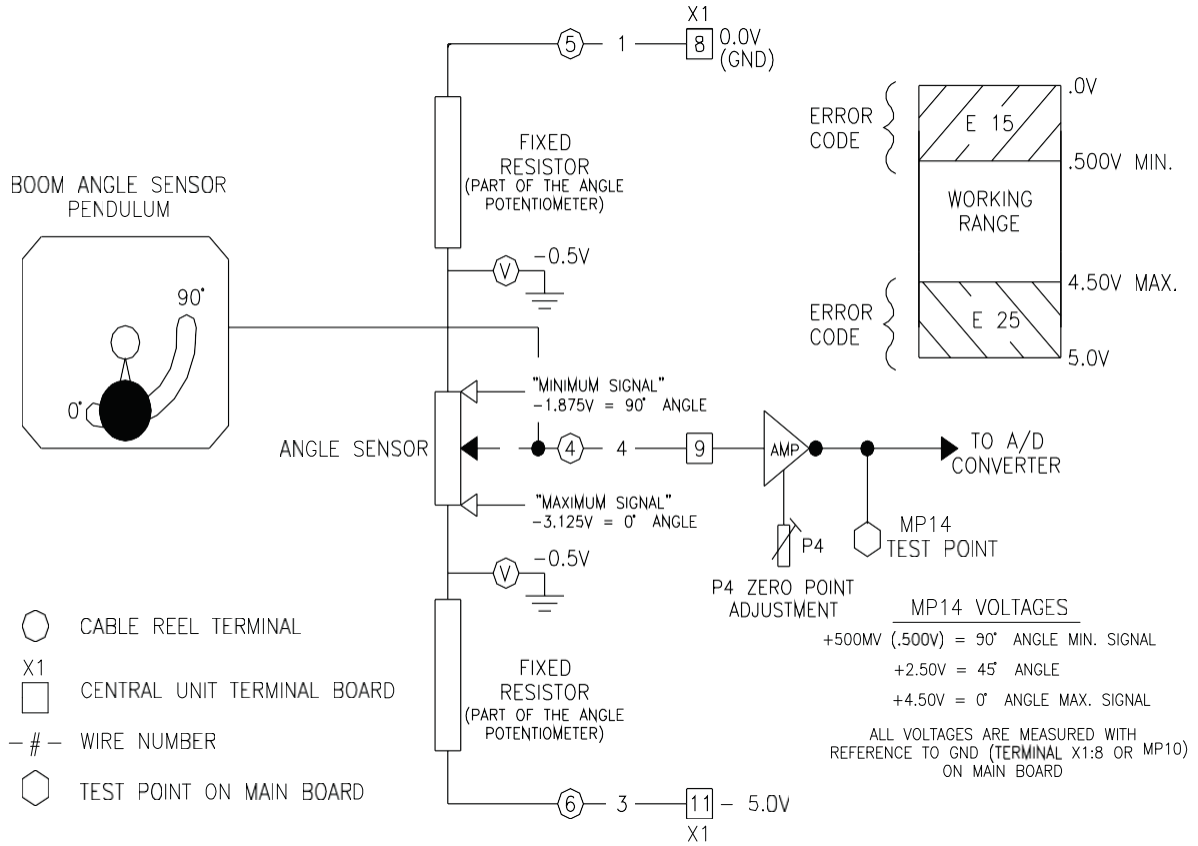
Piston Side Pressure Measuring Channel



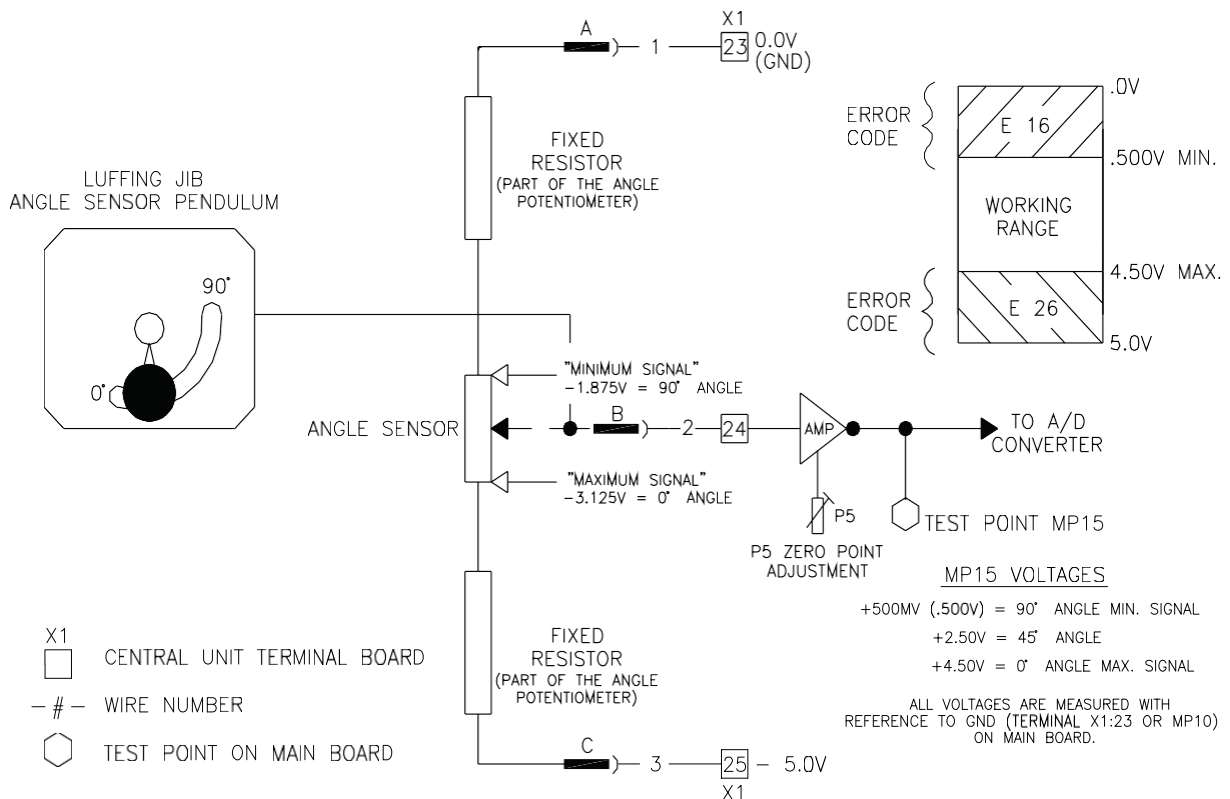
Rod Side Pressure Measuring Channel



Main Boom Angle Measuring Channel



Second Angle Measuring Channel



ERROR CODE TABLE

Error Code	Error	Cause	Elimination
E01	Fallen below radius range or angle range exceeded	<ul style="list-style-type: none"> • Fallen below the minimum radius or gone past the maximum angle specified in the respective load chart due to luffing up the boom too far 	<ul style="list-style-type: none"> • Luff down the boom to a radius or angle specified in the load chart.
E02	Radius range exceeded or fallen below angle range	<ul style="list-style-type: none"> • Gone past the maximum radius or fallen below the minimum angle specified in the respective load chart due to luffing down the boom too far 	<ul style="list-style-type: none"> • Luff up the boom to a radius or angle specified in the load chart.
E03	Non-permitted slewing zone (no load area)	<ul style="list-style-type: none"> • The slewing zone with load is not permitted 	<ul style="list-style-type: none"> • Slew to permitted area
E04	Operating mode not acknowledged or non permitted slewing zone	<ul style="list-style-type: none"> • A non existing operating mode has been selected • The boom is in a non-permitted slewing zone 	<ul style="list-style-type: none"> • Set the correct operating mode for the operating state in question • Slew the boom to a permitted area.
E05	Prohibited length range	<ul style="list-style-type: none"> • Boom has been extended either too far or not far enough, e.g. if it is prohibited to go beyond a certain maximum boom length or with load curves for jibs where the main boom has to be extended to a certain length 	<ul style="list-style-type: none"> • Extend/retract boom to the correct length
		<ul style="list-style-type: none"> • Length sensor adjustment has changed, e.g. the cable slid off the length sensor reel. 	<ul style="list-style-type: none"> • Retract boom. Check the pre-stress of the cable reel (cable must be taut). Open the length sensor and carefully turn the length sensor pot counter clockwise until loosened by using a screw driver

Error Code	Error	Cause	Elimination
		<ul style="list-style-type: none"> • Clutch between length sensor pot and drive is defective • Failure of +5V supply of analog part of analog board • Cable between central unit and length sensor is defective or disconnected. • Defective length potentiometer 	<ul style="list-style-type: none"> • Replace the complete clutch including drive wheel and adjust length sensor pot as described above • Check +5 V supply. Exchange main board in case of voltage failure or breakdown when loaded with 50 ohms approx. • Check cable and plugs, replace, if need be. • Replace length potentiometer.
E06	Radius range exceeded or fallen below angle range with luffing jib operation	<ul style="list-style-type: none"> • Maximum radius as specified in the load chart exceeded or fallen below minimum angle due to luffing down the luffing jib too far 	<ul style="list-style-type: none"> • Luff the jib to a radius or angle specified in the load chart.
E07	Faulty acknowledgment of the overload relay on the main 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.	<ul style="list-style-type: none"> • Overload relay or main board are defective • Processor board defective 	<ul style="list-style-type: none"> • Replace main board • Replace processor board.
E08	No acknowledgement from the anti-two-block relay	<ul style="list-style-type: none"> • Refer to E07 	<ul style="list-style-type: none"> • Refer to E07

Error Code	Error	Cause	Elimination
E11	Fallen below lower limit value for measuring channel "length main boom"	<ul style="list-style-type: none"> • Cable between central unit and length sensor is defective or disconnected. Water inside the plug of the length/angle sensor • Length potentiometer is defective • Electronic component in the measuring channel is defective 	<ul style="list-style-type: none"> • Check cable as well as plugs, replace, if need be. • Replace length potentiometer • Replace LMI main board or processor board.
E12	Fallen below the lower limit value in the measuring channel "pressure piston side"	<ul style="list-style-type: none"> • Cable between the central unit and pressure transducers defective or water inside the plugs • Pressure transducer is defective. • Electronic component in the measuring channel is defective. 	<ul style="list-style-type: none"> • Check cable as well as plugs, replace, if need be. • Replace pressure transducer • Replace LMI main board or processor board.
E13	Fallen below lower limit value in the measuring channel "pressure rod side"	<ul style="list-style-type: none"> • Refer to E12 	<ul style="list-style-type: none"> • Refer to E12
E15	Fallen below lower limit value in measuring channel "angle main boom"	<ul style="list-style-type: none"> • Cable between central unit and the length/angle sensor defective or loose. Water inside the plug of the length/angle sensor. • Angle potentiometer defective • Electronic component in the measuring channel defective. 	<ul style="list-style-type: none"> • Check cable as well as plugs, replace, if need be. • Replace angle sensor • Replace LMI main board or processor board.
E16	Fallen below lower limit value in measuring channel "angle 2"	<ul style="list-style-type: none"> • Cable between the central unit and the angle sensor defective or loose. Water inside the plug of the angle sensor. • Angle potentiometer defective • Electronic component in the measuring channel defective. 	<ul style="list-style-type: none"> • Check cable as well as plugs, replace, if need be. • Replace angle sensor • Replace LMI main board or processor board.

Error Code	Error	Cause	Elimination
E19	Reference and/or supply voltage defective	<ul style="list-style-type: none"> • The supply voltage is falsified by one of the sensors (DAV, LWG) • Electronic component is defective 	<ul style="list-style-type: none"> • Check the voltages on the LMI main board. Check sensors, plugs and cable, replace, if need be. • Replace LMI main board
E20	Analog and/or supply voltage defective	<ul style="list-style-type: none"> • The analog voltage is falsified by one of the sensors • Electronic component is defective 	<ul style="list-style-type: none"> • Check the voltages on the LMI main board. Check sensors, plugs and cable, replace, if need be. • Replace LMI main board
E21	Upper limit value in measuring channel "main boom length" has been exceeded.	<ul style="list-style-type: none"> • Refer to E11 	<ul style="list-style-type: none"> • Refer to E11
E22	Upper limit value in measuring channel "pressure piston side" has been exceeded	<ul style="list-style-type: none"> • Refer to E12 	<ul style="list-style-type: none"> • Refer to E12
E23	Upper limit value in measuring channel "pressure rod side" has been exceeded.	<ul style="list-style-type: none"> • Refer to E12 	<ul style="list-style-type: none"> • Refer to E12
E25	Upper limit value in measuring channel "main boom angle" has been exceeded.	<ul style="list-style-type: none"> • Refer to E15 	<ul style="list-style-type: none"> • Refer to E15
E26	Upper limit value in measuring channel "angle 2" has been exceeded.	<ul style="list-style-type: none"> • Refer to E16 	<ul style="list-style-type: none"> • Refer to E16
E29	Reference and/or supply voltage defective.	<ul style="list-style-type: none"> • Refer to E19 	<ul style="list-style-type: none"> • Refer to E19
E31 E37	Error in the system program	<ul style="list-style-type: none"> • The system program PROM is defective. 	<ul style="list-style-type: none"> • Replace system program PROM (PROM No. 0)
E38	System program and data EPROM do not match.	<ul style="list-style-type: none"> • The system program in the LMI does not match to the programming in the data EPROM 	<ul style="list-style-type: none"> • Replace the system program PROM or the data EPROM (PROM No. 1)

Error Code	Error	Cause	Elimination
E41	Error in the internal write/read memory (RAM) of the computer component 80C537	<ul style="list-style-type: none"> • Computer component 80C537 defective • CPU module defective • Processor board defective. 	<ul style="list-style-type: none"> • Replace computer component 80C537. • Replace CPU module. • Replace processor board with CPU module.
E42	Error in the external write/read memory, 1st part (RAM)	<ul style="list-style-type: none"> • Write/read memory (CMOS RAM) or processor board defective. 	<ul style="list-style-type: none"> • Replace processor board with CPU module.
E43	Error in the external write/read memory, 2nd part (RAM)	<ul style="list-style-type: none"> • Refer to E42 	<ul style="list-style-type: none"> • Refer to E42
E45	Redundancy error in the A/D conversion	<ul style="list-style-type: none"> • The A/D converter on the processing board and the redundant A/D converter in the CPU 80C537 provide different results. 	<ul style="list-style-type: none"> • Replace processor board.
E46	Error in the A/D converter uPD 7004 of the processor board.	<ul style="list-style-type: none"> • No acknowledgment of the A/D converter uPD 7004 	<ul style="list-style-type: none"> • Replace processor board.
E48 E49	Cyclic RAM test: error in the internal write/read memory (RAM) of the computer component 80C537	<ul style="list-style-type: none"> • Computer component 80C537 defective • CPU module defective • Processor board defective. 	<ul style="list-style-type: none"> • Replace computer component 80C537. • Replace CPU module • Replace processor board with CPU module.
E51	Error in the crane data EPROM or EEPROM.	<ul style="list-style-type: none"> • No valid data in the crane data EEPROM. • Memory module wrongly bridged. • Crane data EPROM defective 	<ul style="list-style-type: none"> • Load crane data EEPROM containing valid data. • Bridge memory module acc. to memory type • Replace crane data EPROM
E80	Short circuit in the Anti-two Block (A2B) switch.	<ul style="list-style-type: none"> • Short circuit in the A2B switch • Short circuit in the cable to the A2B switch 	<ul style="list-style-type: none"> • Replace A2B switch • Replace cable to the A2B switch

Error Code	Error	Cause	Elimination
E91	No data transmission from the console to the central unit	<ul style="list-style-type: none"> • 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 	<ul style="list-style-type: none"> • Check 24 V at terminal X1 of the console electronics • Check the main 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
E92	Error in the data transmission from console to central unit	<ul style="list-style-type: none"> • Loose connection in the line between console electronics and central unit • Transmitter/receiver module is defective 	<ul style="list-style-type: none"> • Check the connection between console electronics and central unit • Exchange console electronics or LMI main board
E93	Error in the data transmission from the central unit to the console	<ul style="list-style-type: none"> • Refer to E92 	<ul style="list-style-type: none"> • Refer to E92
E94	No data transmission from the central unit to the console	<ul style="list-style-type: none"> • Interruption or accidental ground in the line central unit - 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 contacts or valves) 	<ul style="list-style-type: none"> • Check line 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 interference by inverse diodes or varistors.

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

ADDENDUM A BASIC ADJUSTMENT AND VOLTAGE CHECKS

MODEL: _____

S/N: _____

PAT DS150 P/N 024-150-060-002 central unit / 024-150-300-001 main board

1. Crane Supply Voltage @ X1-1 (+) & X1-4 (GND) = VDC
2. Main Board Power Supply (Reference Voltages +/- 50 MV):
 - + 9V @ Mp2 = _____ VDC Mp 10 Ground - Piston & Rod Pressure
 - 9V @ Mp3 = _____ VDC Mp 10 Ground - Piston & Rod Pressure
 - 5V @ Mp4 = _____ VDC Mp 10 Ground – TTL on Board
 - 5V @ Mp5 = _____ VDC Mp 10 Ground – Reference on Board
 - + 5V @ Mp6 = _____ VDC Mp 10 Ground – Internal on Board
 - 5V @ Mp7 = _____ VDC Mp 10 Ground – Length and Main/Jib Angle
4. Boom Length: (MP10 Ground for Meter)
 - Fully Retracted _____ Ft. _____ VDC @ X1:10 _____ DC @ MP13
 - Fully Extended _____ Ft. _____ VDC @ X1:10 _____ DC @ MP13
 - 5 Volt Reference Voltage _____ VDC @ X1:11
5. Boom Angle: (MP10 Ground for Meter)
 - Minimum Angle _____ ° _____ VDC @ X1:9 _____ VDC @ Mp14
 - Maximum Angle _____ ° _____ VDC @ X1:9 _____ VDC @ Mp14
 - 5 Volt Reference Voltage _____ VDC @ X1:11
6. Pressure Transducers: (MP10 Ground for Meter)
 - Piston Zero Point _____ VDC @ X1:21 _____ VDC @ Mp11
 - Rod Zero Point _____ VDC @ X1:16 _____ VDC @ Mp12
 - +5 Volt Reference Voltage _____ VDC @ X1:13 & 18
 - 5 Volt Reference Voltage _____ VDC @ X1:15 & 20

