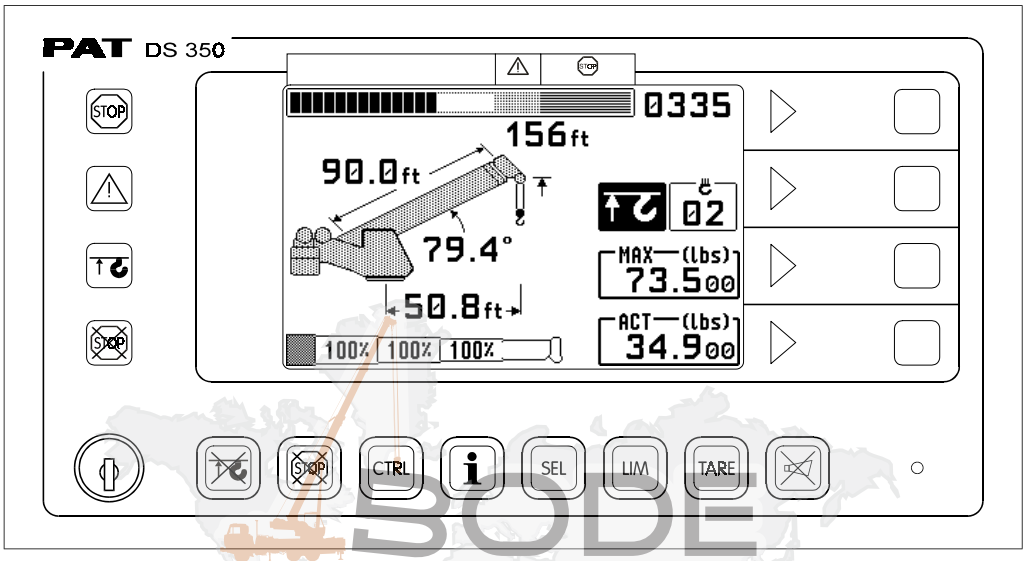
PAT

LOAD MOMENT INDICATOR



DS 350 / 1328 GRAPHIC

for GROVE AT422T

OPERATOR'S HANDBOOK

NOTICE

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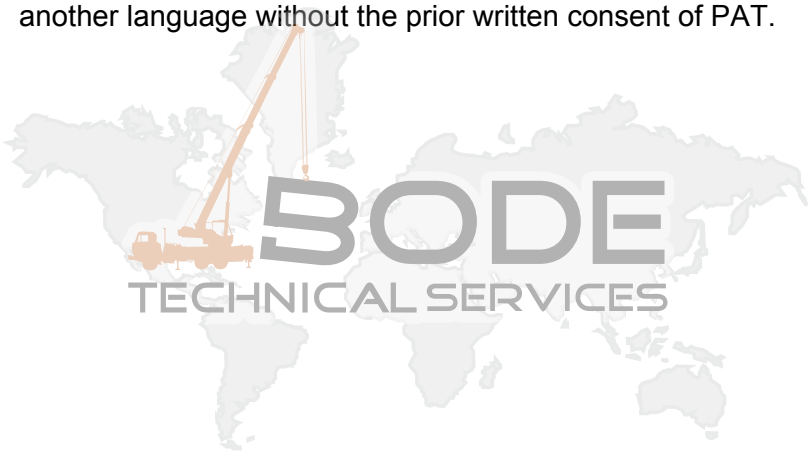

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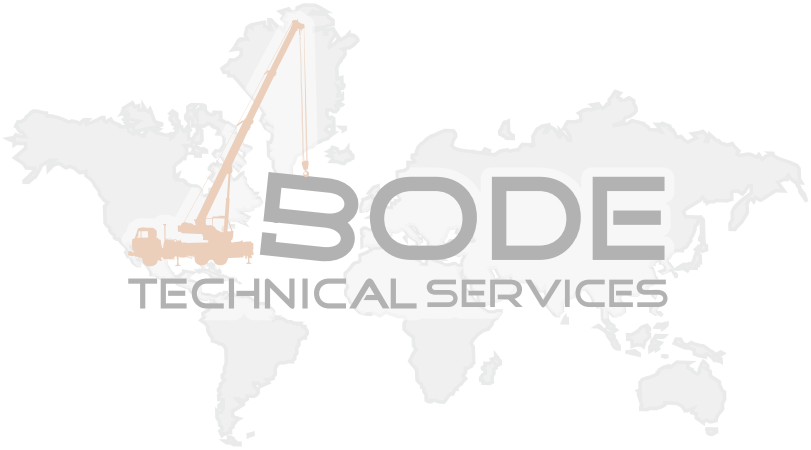

BODE
TECHNICAL SERVICES

1 GENERAL INFORMATION

The PAT Load Moment Indicator[1] (LMI) DS 350 has been designed to provide the crane operator with the essential information required to operate the machine within its design parameters.

This low temperature system uses heaters for stable system operation in a subzero climate. The main electronics are automatically warmed before the system boards and components are energized. Therefore, all system components must be installed and sealed from the environment when operating and/or troubleshooting in low temperature conditions.
Using different sensing devices, the Load Moment Indicator monitors various crane functions and provides the operator with a continuous reading of the crane's capacity. The readings continuously change as the crane moves through the motions needed to make the lift.
The LMI provides the operator with information regarding the length and angle of the boom, working radius, rated load and the total calculated weight being lifted by the crane.
If non permitted conditions are approached, the DS 350 Load Moment Indicator will warn the operator by sounding an audible alarm, lighting a warning light and locking out those functions that may aggravate the crane's condition.

[1] LOAD MOMENT: generally the product of a force and its moment arm; specifically, the product of the load and the load-radius. Used in the determination of the lifting capacity of a crane

2 WARNINGS

The LMI is an operational aid that warns a crane operator of approaching overload conditions and of overhoist 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.

⚠ WARNING

The PRIMARY (i.e. cab-side) Anti-two Block Switch must be used in ALL Operations. Simultaneous two-hoist working is prohibited in all circumstances other than Pile-Driving.

Proper functioning depends upon proper daily inspection and observance of the operating instructions set forth in this manual. Refer to Section 6. *Pre-Operation Inspection and Calibration Verification* of this handbook.

⚠ WARNING

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

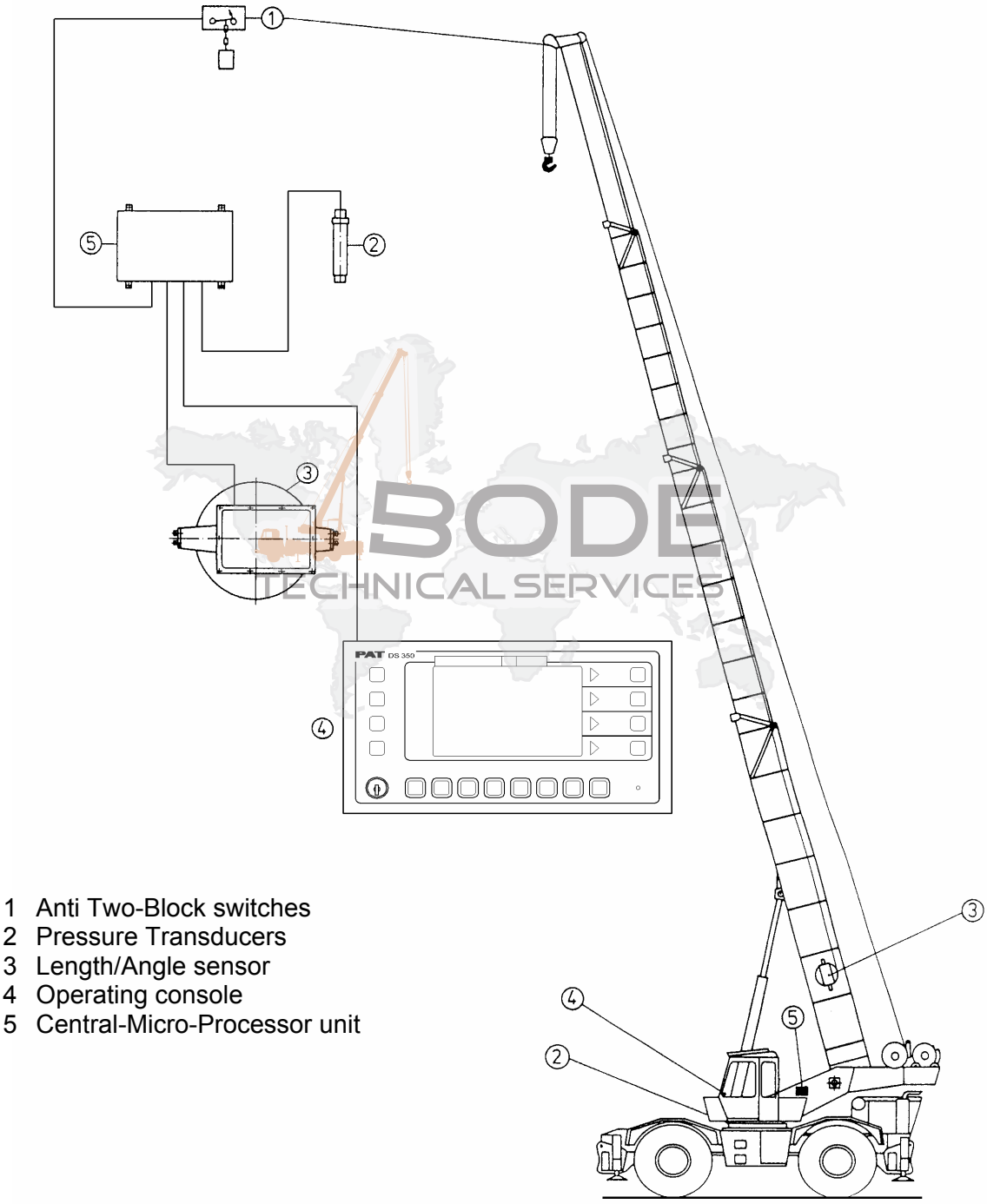
3 SYSTEM DESCRIPTION

The PAT Load Moment Indicator DS 350 consists of a central micro processor unit, operating console, length/angle sensor, pressure transducers, and anti-two block switches. This low temperature system uses heaters for stable system operation in a subzero climate. The main electronics are automatically warmed before the system boards and components are energized. Therefore, a warming period will be required in low temperature conditions.

The system operates on the principle of reference/real comparison. The real value, resulting from the pressure measurement is compared with the reference data, stored in the central processor memory and evaluated in the micro processor. 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, telescope out 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.
Boom length and boom angle are registered by the length/angle sensor, mounted inside the cable reel which is mounted on the boom. The boom length is measured by the cable reel cable which also serves as an electrical conductor for the anti two-block switches.
The crane load is measured by pressure transducers attached to the piston and rod side of the hoist cylinders.

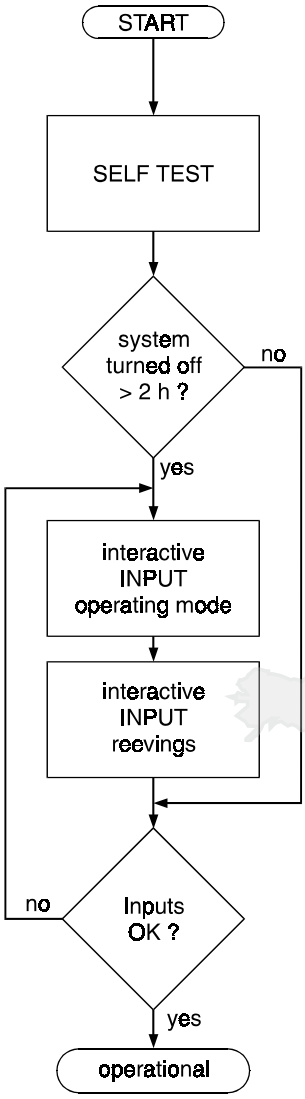
The interactive user guidance considerably simplifies the input of operating modes as well as the setting of geometry limit values.

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



1 Anti Two-Block switches
2 Pressure Transducers
3 Length/Angle sensor
4 Operating console
5 Central-Micro-Processor unit

3.1 System Function



Upon switching on, the system starts with an automatic test of the LMI system, of lamps and audible alarm. During the test, the LC display shows the initial logo.

If the system was turned off for more than two hours, the setup configuration has to be entered after the system test. (⇨ chapter 4)

First, the operating mode is determined by an interactive step-by-step interrogation of the rigging states.

Next is the interactive input of the reeving.

Now the LC display shows in symbols all inputs and awaits acknowledgment or canceling.

Upon acknowledgment of the inputs the system is ready for operation.

3.2 Operating Console

The console has 3 functions:

- inputs by the crane operator (operating mode, reeving)
- input of geometry limit values and signalization of exceeded limit values
- display of important data and information

The operator's console is mounted in the crane's cab in the operator's field of vision. For a better identification of displays and operating elements, they are continuously backlit during operation.

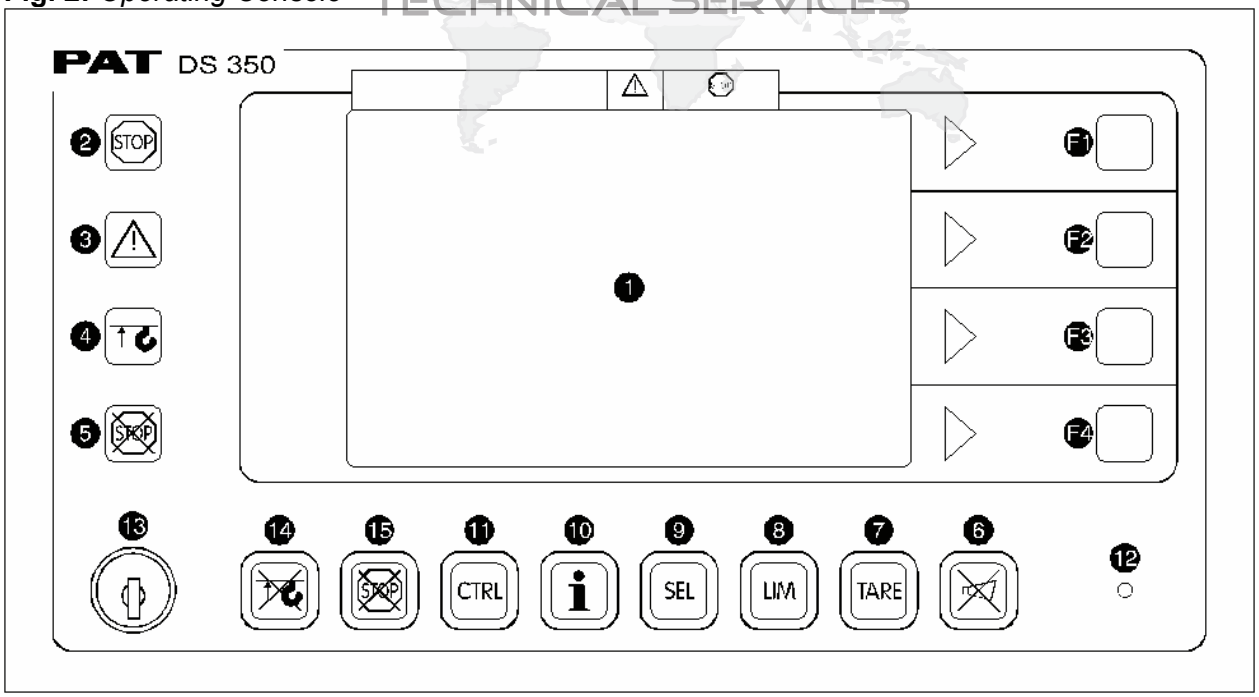
3.3 Control Identification

This unit contains a display and different controls which are described as follows:

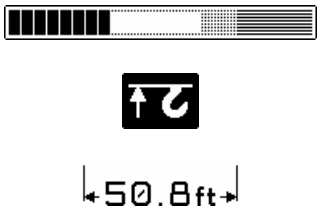
Legend to **Fig 2:**

1 LC Display Area
2 Load Moment Limit Light
3 Load Moment Prewarning Light
4 Alarm Light “Anti-Two-Block”
5 Override Key Warning Light
6 Button “Alarm Stop”
7 Button and Control Light “TARE”
8 Button and Control Light “LIMITS”
9 Button and Control Light “SELECT OPERATION MODE”
10 Button and Control Light "INFO"
11 Button and Control Light "CONTROL"
12 Audible Alarm
13 By-Pass Key Switch
14 Button and Control Light "By-Pass Anti-Two-Block"
15 Button and Control Light "By-Pass LMI shut-off function"
F1 Button "Function 1"
F2 Button "Function 2"
F3 Button "Function 3"
F4 Button "Function 4"

Fig. 2: *Operating Console*



❶ LC-Display



The LC display visualizes graphical symbols, texts and numerical values. Depending on the selected operating mode (setup, limit mode or LMI representation), the corresponding information is indicated on the display.
Please refer to the description of the different operating modes for the signification of the individual elements.

❷ Load Moment Limit Light

The red LOAD MOMENT LIMIT LIGHT (2) warns the operator that a rated load condition has been reached. It lights up when the load on the crane reaches the crane load capacity. The audible alarm also sounds when this condition has been reached.
The following crane movements will be stopped concurrently:
hoist up
telescope out
boom down

❸ Load Moment Prewarning Light

The yellow LOAD MOMENT PRE-WARNING LIGHT (3) will light up when the load on the crane reaches the defined prewarning area, thus indicating that an overload condition is approaching.
This means for the operator to continue his crane operation with extreme caution.

❹ Alarm Light “Anti-2-Block”

The red “Anti Two-Block Alarm Light” (4) lights up when the anti-two-block limit switch contacts open, indicating that a two-blocking condition is approaching. At the same time the audible alarm will sound.
The following crane movements will be stopped subsequently: hoist up, telescope out, boom down.

❺ Override Key Warning Light

The red OVERRIDE KEY WARNING LIGHT (5) flashes to indicate that the cut-off function of the A2B / LMI system is deactivated.

❻ Button and Control Light “Alarm Stop”

This ALARM STOP BUTTON (6) allows the audible alarm to be silenced for approximately 15 seconds by pressing this button. Reference ⇨ “Audible Alarm” (12).

❼ Button and Control Light “Tare”

The button “TARE” (7) is used to indicate the “Net load” on the LC Display (1). Net load is the present load, less lifting tackle and hook block. The Tare Button (7) has to be activated before lifting.

After pushing the “Tare Button” (7) the load display is set to zero (taring) and the control light lights up. After lifting a load the display shows the net load (pay load).
The net load display will change to the actual load display when the boom radius is changed (either by angle or length).

❽ Button "LIMITS"

Button to start the function "program limit values".
For the proceeding please refer to chapter 5.1.

❾ Button "SELECT"

Button to start the function "set operating mode".
For the proceeding please refer to chapter 4.1.

⚠ WARNING

The correct setting is of utmost importance for the proper function of the system and the crane. Therefore only operators who are thoroughly familiar with use and operation of the system shall set this button.

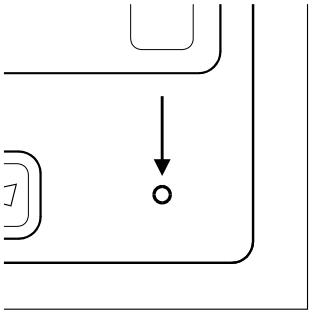
❿ Button "INFO"

Button to start the function "information crane configuration"
Please refer to chapter 5.2.

⓫ Button "CONTROL"

Button to start additional functions.
Please refer to chapter 5.3.

⓬ Audible Alarm

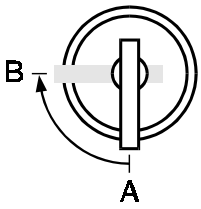


The AUDIBLE ALARM (12), sounds during the following conditions:

- overload condition
- approaching two-block condition
- preset limits reached
- malfunction of the LMI system
- operating error

The alarm can be temporarily silenced by pushing the button “Alarm Stop” (6).

⓭ Key Switch



The anti-two-block switch cut-off function is deactivated when the KEY SWITCH (13) is turned to position "B" and the “By-pass A2B” button (14) is pushed.

OR

The LMI cut-off function is deactivated when the KEY SWITCH (13) is turned to position "B" and the “By-pass LMI” button (15) is pushed

⚠ WARNING

Since button (14) and (15) deactivate the cut-off function of the LMI system / the anti two-block system, the following instructions must be obeyed:

- **The by-pass function shall be used with discretion, as unwarranted use of it to override the control lever lockout system can result in harm to the crane and danger to property and persons.**
- **Never use the by-pass function to either overload or operate the crane in a non permissible range.**

⓮ Button "By-pass A2B"

This button can be operated only if key switch (13) is turned to position B.
After pushing this button, the cut-off function of the anti-two-block switch is deactivated.
The Override Key Warning Light (5) flashes to indicate that the cut-off function is deactivated.

⓯ Button "By-pass LMI"

This button can be operated only if key switch (13) is turned to position B.
After pushing this button, the control lever lockout function of the LMI is deactivated.
The Override Key Warning Light (5) flashes to indicate that the cut-off function is deactivated.

4 CONFIGURATION SETUP

The LMI setup prucedure allows the operator to input the crane configuration using interactive displays. The operator must complete the setup procedure for the Load Moment Indicator system if the system has been turned off for more than two hours or the crane operation configuration has been changed.

4.1 LMI Setup Procedure

...starts:

- *automatically*, if the system was turned off for more than two hours.
- *manually* at each modification of the crane configuration by pressing key (9) "SEL"

...is operated:

- by answering the different questions using functional keys F1...F4 in accordance with the actual configuration of the crane.

...is cancelled:

- any time by pressing again key (9) "SEL". The system, however, is only ready for operation, if the procedure has been completed and the inputs have been confirmed.

If the system is turned off, for example during short breaks (less than 2 hours), all adjustments remain stored. When turning on again the system these adjustments can be acknowledged by merely pressing one key (provided that the crane configuration has not been modified!).

During the programming procedure the Load Moment Prewarning Light (3) and the Load Moment Limit Light (2) will light up and the aggravating crane movements will be interrupted.

Note:
If a configuration is selected which is not available, the display will indicate error code E04. In this case, the procedure has to be repeated with valid values!

⚠ CAUTION

The correct setting is of utmost importance for the proper functioning of the system and the crane. Therefore, only operators who are thoroughly familiar with the crane and the operation of the system should execute the setting of the system according the operating configuration of the crane.

The LMI programming procedure consists of the following steps:'
Note:
The main boom and counter weight configuration are automatically setup. This system is not set up for use with an extension or additional counter weight.

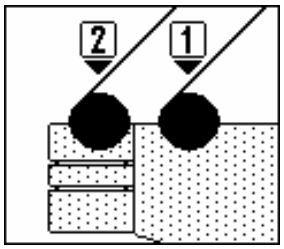
- setting the hoist configuration
- setting the outrigger configuration
- setting the reevings
- confirmation of the programming procedure

For easy operation, the computer guides the operator through the procedure step by step. (interactive operation)

Definition of the Displayed Symbols:

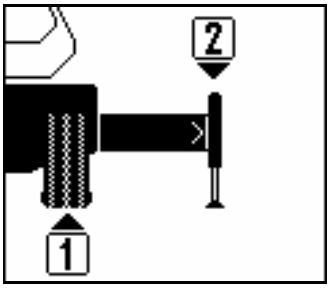
The following illustrations define the symbols appearing on the display during the setup procedure. Not all symbols will be shown, depending on the crane type and the answers to the questions.

- **Setting the hoist configuration**



1 Front Hoist
2 Rear Hoist

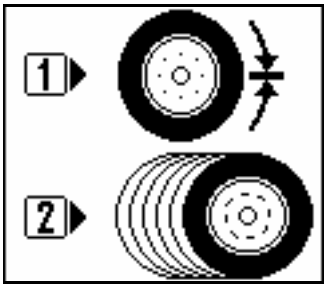
- **Setting the outrigger configuration**



1 on rubber

2 outrigger position 100%

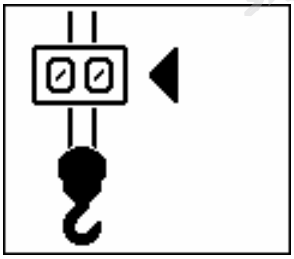
If 1 on rubber is selected you have the following selection.



1 static

2 pick and carry

- **Setting the reeving (parts of line)**

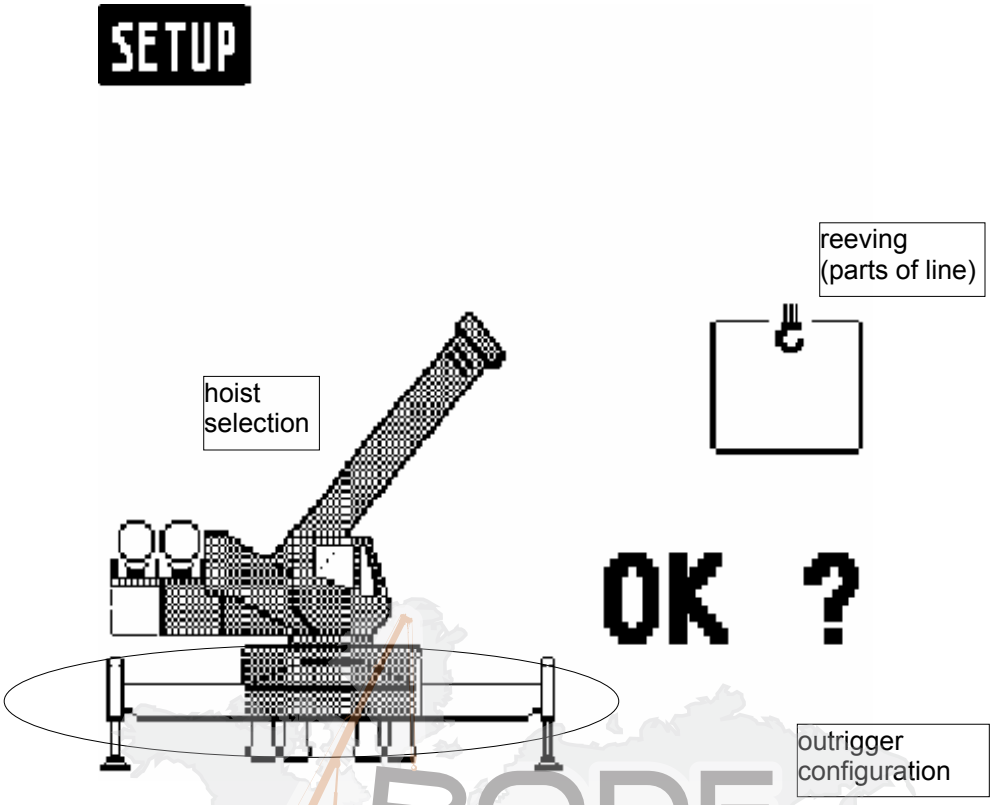


\+ increase reeving

– decrease reeving

OK confirm reeving

- **Confirmation of the programming procedure**



At the end of the procedure all inputs are represented once again in symbolic forms. If inputs have been made, the corresponding symbols are filled black.

 quick setting the reeving
(⇨ chapter 4.3)

 quick hoist line selection
(⇨ chapter 4.2)

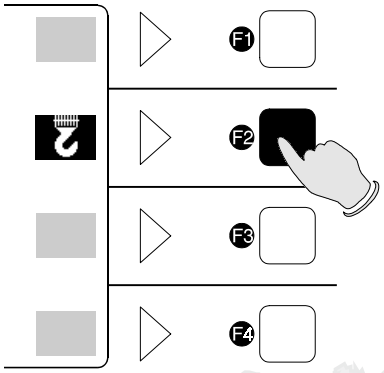
DEL cancel procedure

OK confirm inputs

4.2 Quick Setting of the Reeving

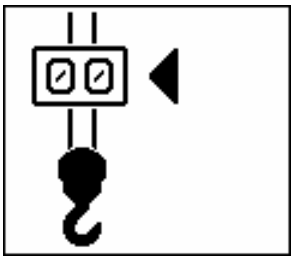
If, during the crane operation, the number of reeving is modified, the LMI system has to be adjusted to this modification. The input of the reeving can be carried out directly without having to go through the whole LMI programming procedure again:

Call LMI Programming Procedure.



Directly call function "Quick Setting of the Reevings".

Note:
The direct call is impossible, if the system has been turned off for more than 2 hours.

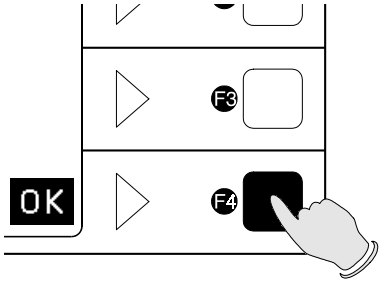


input of reeving:

+ increase reeving

− decrease reeving

OK confirm reeving



Confirm modification.

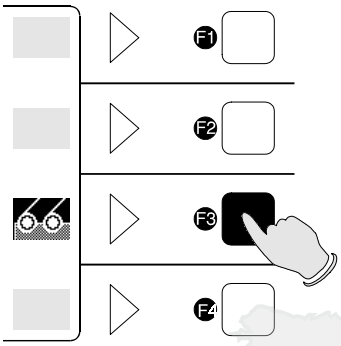
(select again the function upon faulty input)

Note:
If a configuration is selected which is not available on the present crane, the system will not accept the selection and the display will indicate the error code E04.

4.3 Quick Hoist Line Selection

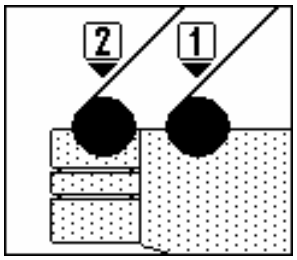
If, during the crane operation, the crane is switched over from front to rear hoist, the LMI system has to be adjusted to this modification. This modification can be entered without having to go through the whole LMI setup procedure again:

Call LMI setup procedure.



Directly call function "Hoist Line Selection".

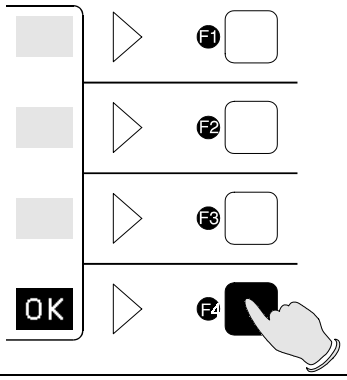
Note:
The direct call is not possible, if the system has been turned off for more than 2 hours.



Select hoist:

1 Front Hoist

2 Rear Hoist



Confirm modification.

(call up the function again if you have selected the wrong winch by mistake)

Note:
If a configuration is selected which is not available on the crane, the system will not accept the selection and the display will indicate the error code E04.

4.4 Anti-two Block (A2B) Switch(es)

AT422T cranes are fielded with two different configurations of A2B switches, i.e. some having only one switch, and some having two switches. Correct use of the A2B switches must be followed to prevent material damage and serious or even fatal accidents. The applications under which these switches are used are described below:

a. Primary A2B Switch (Mandatory For All Operations)

The **Primary** (i.e. cab-side) Anti-two Block Switch is used in **ALL** applications. For single-hoist working (i.e. normal lifting operations), always use this switch, with the weight and chain installed correctly around the main hoist cable (if the crane also has a Secondary (i.e. right-side) A2B Switch installed, the Secondary Switch is used **only** in pile-driving operations).

For single-hoist working with cranes on which a Secondary Switch is also installed, the weight and chain is to be removed from the Secondary Switch and the by-pass flag installed. However, if the crane is being used for pile-driving operations, see Paragraph b. below.

b. Secondary A2B Switch (Pile Driving Applications Only)

The Pile-Driving application requires the use of a **Secondary** (i.e. right-side) Anti-two Block Switch, as well as the Primary Switch described in Paragraph a. above. The **Secondary** Switch must be used with the by-pass flag removed and the weight and chain attached around the auxiliary hoist cable.

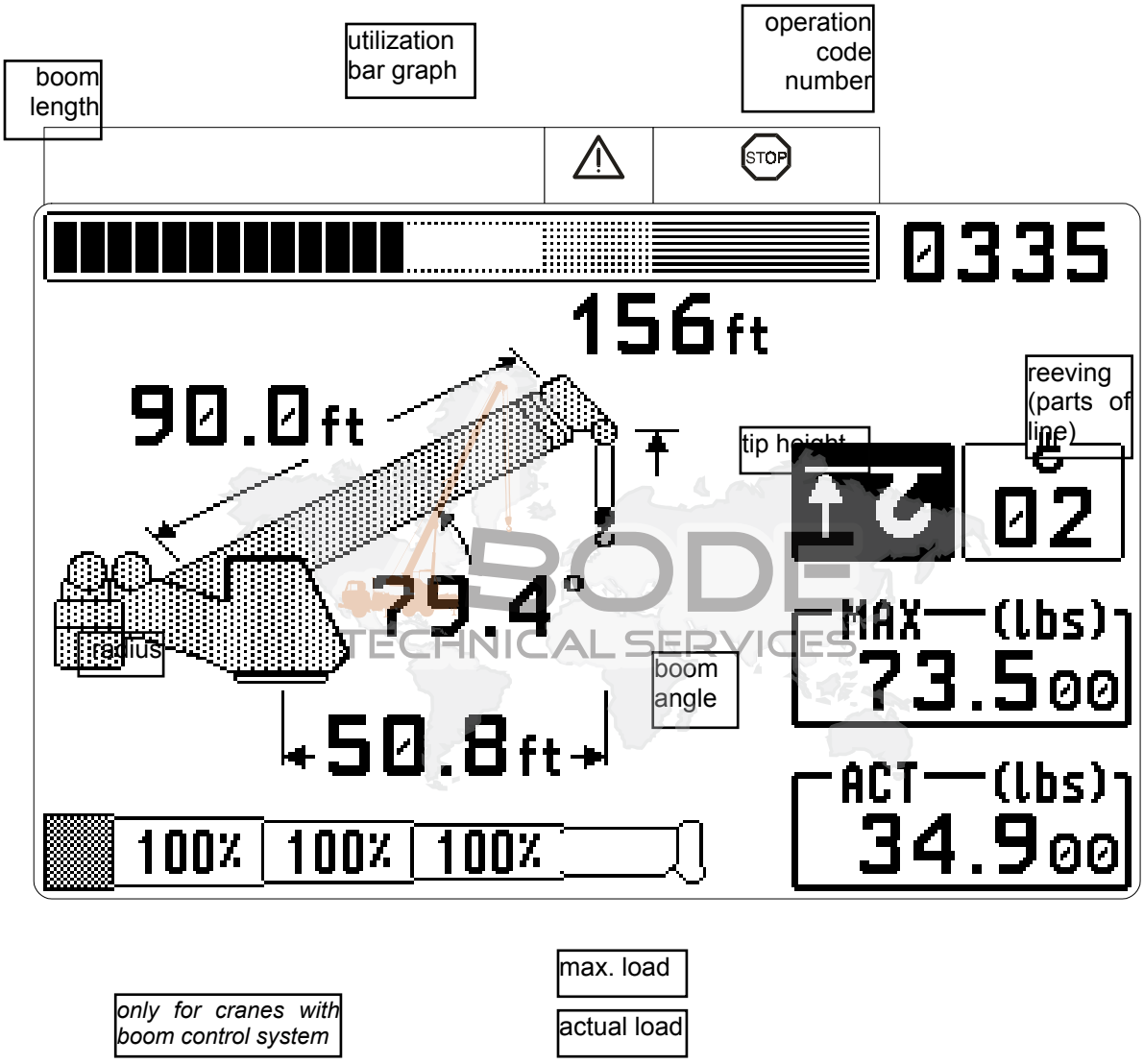
ONLY during Pile-Driving operations is the Secondary Switch used, because Pile-Driving is the **only** application in which it is permissible to deploy and operate both hoists simultaneously.

⚠ WARNING

The PRIMARY (i.e. cab-side) Anti-two Block Switch must be used in ALL Operations. Simultaneous two-hoist working is prohibited in all circumstances other than Pile-Driving.

5 OPERATION

After having set the LMI to the actual crane configuration, the system is ready for operation. The display shows the LMI screen (example for value representation).



Upon request, further symbols can be shown on the display:

Symbol **Anti Two-Block Alarm**
- visible when the anti-two-block limit switch contacts open, indicating that a two-blocking condition is approaching.

Symbol **height limitation**:
- continuously visible:
  height limitation active
- blinking:
  height limit exceeded
  (➪ see chapter 5.1.2)

Symbol **boom angle limitation**:
- continuously visible:
  boom angle limitation active
- blinking:
  angle limits exceeded
  (➪ see chapter 5.1.3)

Symbol **radius limitation**
- continuously visible:
  radius limitation active
- blinking:
  range limits exceeded
  (➪ see chapter 5.1.4)

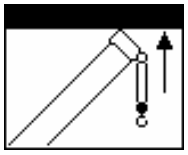
E#### Error code No. ####
(➪ see chapter 8 "Troubleshooting")

5.1 LIMIT Setting

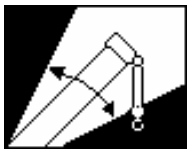
The LMI system has been equipped with programmable limits for the crane's operation range.

- Easy programming due to interactive, step-by-step user guidance
- Functions can be used individually or in combinations.
- Exceeding a programmed limit triggers an audible and visual alarm.
- Depending on the crane type not all functions listed below are available.

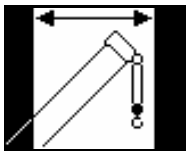
Overview limits:



Tip Height Limitation
(➪ chapter 5.1.1)



Boom Angle Limitation
(➪ chapter 5.1.2)

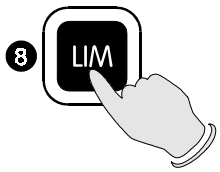


Radius Limitation
(➪ chapter 5.1.3)

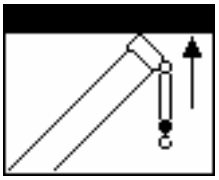
5.1.1 Tip Height Limitation

Programmable function for the limitation of the tip height

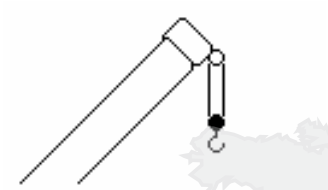
- **Set tip height / delete height limitation:**



Call LIMIT Setting.



Press the corresponding figure to select function "tip height limitation".

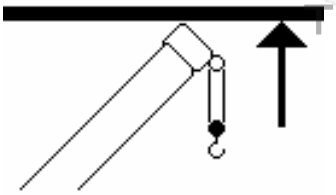


Press key

set:

Move the tip to the required upper limit.

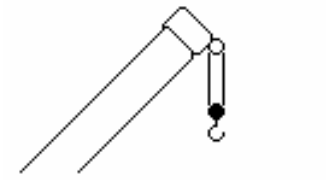
SET set present tip height as upper limit



Display shows symbol and value of the programmed height limit

delete:

DEL delete tip height limitation



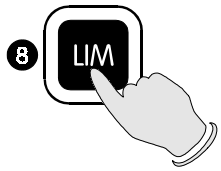
Display shows symbol without values

OK quit function

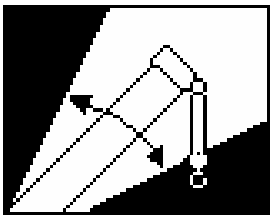
5.1.2 Boom Angle Limitation

Programmable function for the limitation of the upper and/or lower boom angle.

- **Call function:**

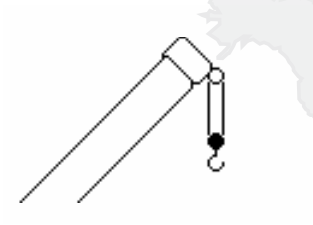


Call LIMIT Setting.



Enter the corresponding figure to call function "boom angle limitation".

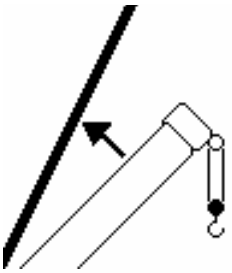
- **set / delete upper limit value:**

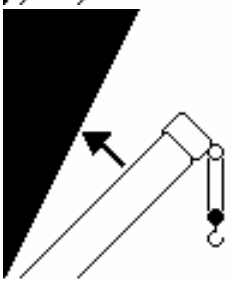


Select limit:

selection upper boom angle limit

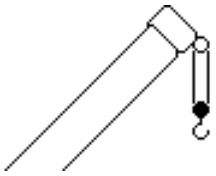
set:	**delete:**
Luff up the boom the requested limit value. SET set present boom angle as upper limit	DEL delete upper angle limit
Display shows symbol with value of the upper angle limit	Display shows symbol without value of the upper angle limit





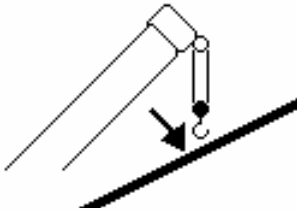
OK quit function

- **set / delete lower limit angle**

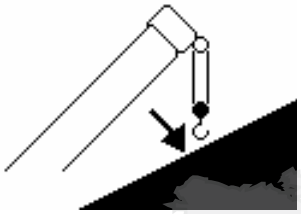


Select limit:

selection lower boom angle limit



set:	**delete:**
Luff down boom to the required limit value. SET set present boom angle as lower limit	DEL delete lower angle limit



Display shows symbol with lower angle limit

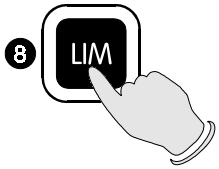
Display shows symbol without value of lower limit angle

OK quit function

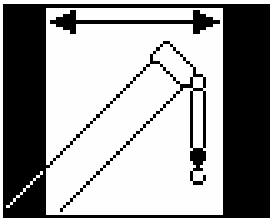
5.1.3 Radius Limitation

Programmable function for the limitation of the minimum and/or maximum working radius.

- **Call function:**

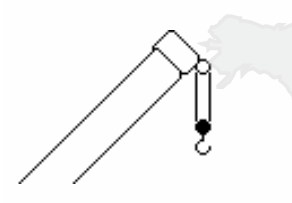


Call LIMIT Setting



Select the corresponding figure to call the function "radius limitation".

- **set / delete minimum radius:**



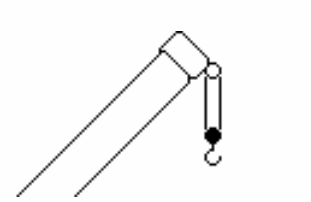
Select limits:

select minimum radius limit

set:	**delete:**
position boom at the required minimum radius value.	DEL delete minimum radius limit
SET set present boom radius as minimum radius	
display shows symbol with radius value of minimum limit	display shows symbol without value of minimum radius

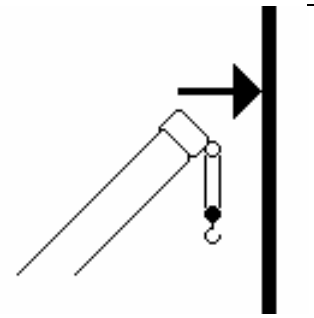
OK quit function

- **set / delete maximum radius**

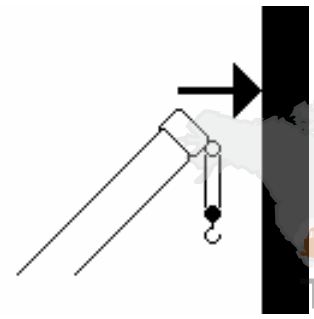


Select limit:

selection maximum radius limit



set:	**delete:**
position boom to the required maximum radius value.	DEL delete maximum radius limit
SET set present boom radius as maximum radius	



display shows symbol with radius value of max. limit

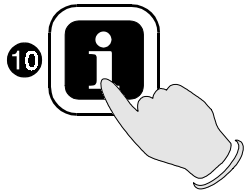
display shows symbol without value of max. radius

OK quit function

5.2 INFO crane configuration

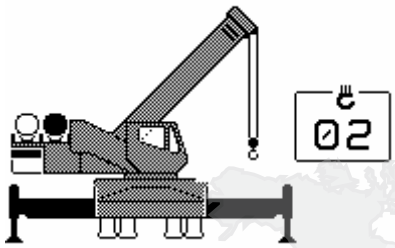
With the system being ready for operation, this function serves to display the system configuration

- **Call function**



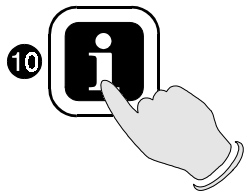
Press key "INFO".

INFO



The display shows the crane symbol representing the adjusted configuration (marked black), the extended operating code number and the reeving number (parts of line).

- **End function**

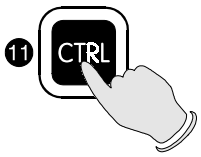


Press again key "INFO".

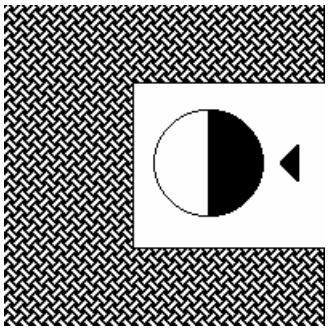
5.3 Display Contrast Control

This function serves for the contrast adjustment of the LC display. The last adjustment is stored and does not have to be repeated at every system start.

- **Contrast adjustment**



Press "CTRL".



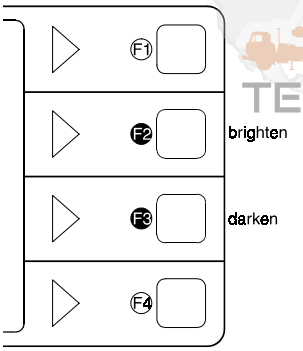
A pattern is shown by means of which the display can be adjusted to the optimum contrast. Use the functional keys to modify the contrast upon request:

+ darken display

– brighten display

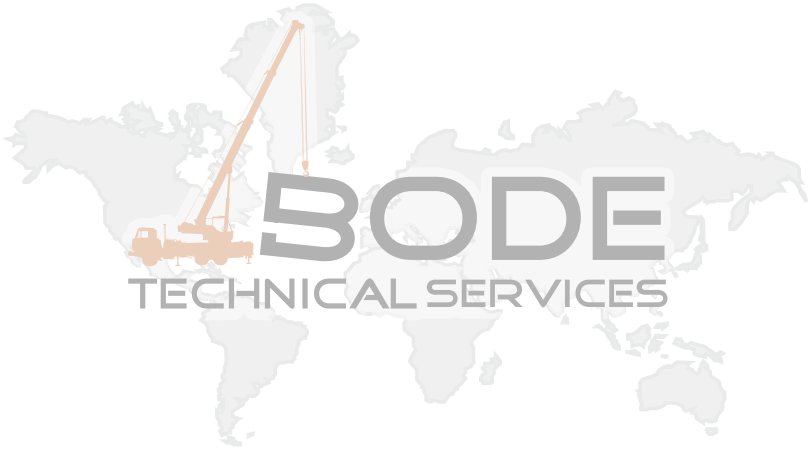
OK confirm setting

Press key "OK" to store the momentarily adjusted contrast value and to quit the function.



During normal LMI operation the display contrast can be adjusted too by pressing button:

F2 (brighten display) or
F3 (darken display).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6 Pre-Operation Inspection and Calibration Verification

Before operating the crane, the following electrical connections must be checked to ensure that the system is properly connected for the crane configuration.

Check the weight of the anti two-block switch is properly installed on the main hoist load line. The hoist line runs through the A2B weight. With even parts of hoisting line, the weight shall be attached to the dead-end line. With odd parts of hoisting line, the weight shall be attached to the line of lowest speed.

Pre-Operation Inspection and Calibration Verification

After the electrical connections have been checked to insure that the system is properly connected for the crane configuration, the following checks shall be made:

1. Check the electrical wiring connecting the various parts of the system for physical damage.
2. Check the anti two-block switch and weight for free movement.
3. Check the spring-loaded cable reel to be sure it is free to rotate, has tension and the cable is reeled properly.

WARNING

The following tests shall be performed with care to prevent damage to the machine or injury to personnel. Proper functioning of the system requires successful completion of these tests before operating the machine.

If the operator cannot see the load handling device approaching the boom nose, he shall have an assistant (signal person) watch the load handling device. The operator shall be prepared to stop the machine immediately should the LMI system not function properly as indicated by lighting the red warning light (4), sounding the audible alarm (12) and locking the crane movements, hoist up, telescope out and boom down.

1. Check the anti two-block alarm light (4) and the audible alarm (12) by performing one of the following tests:

   A) By manually lifting the weight attached to the anti two-block switches. When the weight is lifted, the audible alarm (12) should sound, the anti two-block alarm light (4) should light.
   B) Slowly raise the main boom load handling device to create a potential two-block condition. When the load handling device lifts the weight, the audible alarm (12) should sound, the anti two- block alarm light (4) should light and the motion of the load handling device should be stopped. Lower the load handling device slightly to eliminate this condition.
   C) Slowly lower the boom to create a potential two-block condition. When the load handling device lifts the weight, the audible alarm (17) should sound, the anti two-block alarm light (24) should light and the boom lowering function should be stopped. Lower the load handling device slightly to eliminate this condition.
   D) Slowly extend (telescope) the boom to create a potential two-block condition. When the load handling device lifts the weight, the audible alarm (17) should sound, the anti two-block alarm light (24) should light and the boom telescope out function should be stopped. Lower the load handling device slightly to eliminate this condition.

⚠ WARNING

If the light and audible alarm do not function as described and the crane movements are not stopped, the system is not working properly. The malfunction shall be corrected before operating the crane.

5. Check that the display of the main boom length agrees with the actual boom length.
6. Check that the display of the main boom angle agrees with the actual boom angles.
7. Check that the display of the operating radius of the crane agrees with the actual radius.
8. Check the load display by lifting a load of known weight.

Operation

Upon correct inspection the LMI is operational. The operator shall be thoroughly familiar with all controls of the LMI before operating the crane. The proper function of the system shall be checked by lifting a load of known weight and comparing the load to the information displayed on the LMI.

Rated loads include the weight of the hook block, slings, and auxiliary load handling devices. Their combined weights shall be subtracted from the listed load capacities as stated on the load capacity chart to obtain the net load to be lifted.

⚠ WARNING

If any of the displays reflects a deviation between displayed and actual values, an authorized PAT service representative shall be called for repair of the system or verification of the crane's LMI calibration.

⚠ WARNING

Any structural modifications or changes to the crane shall require verification of the crane's LMI calibration.

7 SERVICE AND MAINTENANCE

Daily maintenance of the load moment indicator consists of inspecting:

1. The electrical wiring connecting the various parts of the system.
   If electrical wiring is damaged, it shall be replaced immediately.

2. If the insulation is worn on the length sensor cable or cable guides are damaged, these parts shall be replaced.

3. Check the anti two-block limit switch for freedom of movement.

4. The cable reel shall be under tension to operate properly.

5. Check the pressure transducers at the hoist cylinder(s) and the connecting hoses for oil leakage.

Other than correcting the problems identified in the Malfunctions Table and replacing faulty mechanical parts and cables, no other repairs shall be performed by non expert personnel.

8 ERROR CODES

PROBLEM: Error code displayed. Lever lockout activated. Warning lights on.

ERROR CODE	ERROR	CAUSE	ACTION
E01	Minimum radius or maximum angle range exceeded	Fallen below the minimum radius or above the angle given in the load chart due to raising the boom to far.	Lower boom back to a radius or angle given in the load chart.
E02	Maximum radius or minimum angle range exceeded	The maximum radius or minimum angle given in the load chart was exceeded due to lowering the boom too far.	Raise boom back to a radius or angle given in the load chart.
E04	Operating mode not available	Operating mode switch in the console set incorrectly. Operating mode is not permissible with actual crane configuration.	Set operating mode switch correctly to the code assigned to the operating mode of the crane.
E05	Length range not permitted	Boom has been extended too far or not far enough. Length sensor adjustment changed; i.e. length sensor cable slid off the cable drum.	Retract or extend boom to correct length given in the load chart. See Section 6.
E07	No acknowledgment signal from overload relay (K1).	Overload relay is stuck, defective or not being selected.	Replace relay.
E08	No acknowledgment signal from Anti-Two-Block switch relay (K2).	Anti-Two-Block switch relay is defective or not being selected.	Replace relay.
E11	Fallen below limit for the measuring channel “length”.	a.) Cable between length sensor and central unit defective, not connected or water in the connectors. b.)Length sensor Potentiometer defective. c.)Electronic board in the measuring channel defective.	a.)Check cable and connector as well and replace, if necessary. Section 6. b.)Replace and reset length sensor Potentiometer. See Section 6 & Procedure 5. c.)Replace main board and reset pressure channels. See Drawing 3 & Procedure 4.

8. ERROR CODES - continued

ERROR CODE	ERROR	CAUSE	ACTION
E12	Fallen below lower limit value for the measuring channel “pressure transducer piston side”.	a.) Cable leading from the central unit to the pressure transducer defective, loose or water in the connector. b.)Pressure transducer on piston side defective. c.)Electronic component in the measuring channel defective.	a.)Check cable and connector as well and replace, if necessary. Section 7. b.)Replace pressure transducer and reset pressure channel. See Section 7 & Procedure 4. c.)Replace main board and reset pressure channels. See Drawing 3 & Procedure 4.
E13	Fallen below lower limit value for the measuring channel “pressure transducer rod side”.	a.)Cable leading from the central unit to the pressure transducer defective, loose or water in the connector. b.)Pressure transducer on rod side defective. c.)Electronic component in the measuring channel defective.	a.)Check cable and connectors as well and replace, if necessary. Section No. 7. b.)Replace pressure transducer and reset pressure channel. See Section 7 & Procedure 4. c.)Replace main board and reset pressure channels. See Drawing 3 & Procedure 4.
E 15	Fallen below lower limit value for the measuring channel “angle main boom”.	a.)Cable from central unit to the length/angle sensor defective or loose. b.)Angle sensor defective. c.)Electronic component in the measuring channel defective.	a.)Check cable. Replace if necessary. See Section 6 b.)Replace angle sensor and reset adjustment. Procedure 5 c.)Replace main board and reset pressure channels. See Drawing 3 & Procedure 4.
E19	Error in the reference voltage.	Electronic component on the main board defective.	Replace main board and reset pressure channels. See Drawing 3 & Procedure 4.
E20	No analog voltages	a.)The crane supply voltage is too low. b.)The voltage converter is defective or short circuit in the wiring.	a.)Check crane voltage. b.)Check supply voltages.

8. ERROR CODES - continued

ERROR CODE	ERROR	CAUSE	ACTION
E21	Upper limiting value for the measuring channel “length” exceeded.	a.)Cable from central unit to the length/angle sensor defective or loose. b.)Length potentiometer defective. c.)Electronic component in the measuring channel defective on main board.	a.)Check cable. Replace if necessary. See section 6. b.)Replace and reset length potentiometer. See Procedure 5. c.)Replace main board and reset pressure channels. See Drawing 3 & Procedure 4.
E22	Upper limiting value for the measuring channel “pressure piston side” exceeded.	a.)Cable from central unit to the pressure transducer defective, loose or water in the plug. b.)Pressure transducer on piston side defective. c.)Electronic component in the measuring channel defective on main board.	a.)Check cable as well as plug. Replace if necessary. See Section 7. b.)Replacepressure transducer and reset pressure channels. See Section 7. c.)Replace main board and reset pressure channels. See Drawing 3 & Procedure 4.
E23	Upper limit value for the measuring channel “pressure transducer rod side” exceeded.	a.) Cable lead in from the central unit to press trans defective, not connected or water in the connectors. b.) Pressure transducer on road side defective. c.) Electronic component in the measuring channel defective.	a.)Check cable and connectors as well and replace, if necessary. See Section 7. b.)Replacepressure transducer c.) Replace main board and reset pressure channels. See Drawing 3 & Procedure 4.
E25	Upper limit value for the measuring channel “angle main boom” exceeded.	a.) Cable leading from the central unit to the length/angle sensor defective, loose or water I the connectors. b.) Angle sensor defective c.) Electronic component in the measuring channel defective.	a.) Check cable as well as connectors and replace, if necessary. Section 6. b.) Replace angle sensor and reset adjustment. See Section No. 6 & Procedure 5. c.) Replace main board and reset pressure channels. See Drawing 3 & Procedure 4.
E27	Upper limit value for the measuring channel 7 exceeded.	a.) Cable leading from the central unit to the sensor of channel 7 defective, loose or water in the connectors. b.) Sensor of channel 7 defective. c.) Electronic component in the measuring channel 7 defective.	a.) Check cable as well as connectors and replace, if necessary. b.) Replace sensor of channel 7 and reset adjustment. c.) Replace main board and reset pressure channels. See Drawing 3 & Procedure 4.

8. ERROR CODES - continued

ERROR CODE	ERROR	CAUSE	ACTION
E29	Reference voltage defective.	a.) The total of the supply and the reference voltages on MP10 is more than 3.3V b.) A/D converter defective.	a.) Check supply voltages. b.) Replace main board and reset pressure channels. See Drawing 3 & Procedure 4.
E31	Error in the system program.	a.) EPROM with system program defective. b.) Electronic component on the main board defective.	a.) Replace system program EPROM b.) Replace main board and reset pressure channels. See Drawing 3 & Procedure 4.
E37	Error in the program run	a.) EPROM with system program defective. b.) Electronic component on the main board defective.	a.) Replace system program EPROM. b.) Replace main board and reset pressure channels. See Drawing 3 & Procedure 4.
E38	Wrong system program in the LMI.	The system program in the LMI does not correspond to the programming in the data EPROM	Replace system program EPROM
E 41	Error in the external RAM.		Replace main board and reset pressure channels. See Drawing 3 & Procedure 4.
E 42	Error in the external write/read memory (RAM).	Internal defect in digital part of CPU.	Exchange write/read memory (CMOS-RAM). Replace main board and reset pressure channels. See Drawing 3 & Procedure 4.
E 45	Error in internal communications.	Defective electronic component.	Replace main board and reset pressure channels. See Drawing 3 & Procedure 4.
E 48	Malfunction in the monitored write/read memory.	Internal defect in digital part of CPU	Replace main board and reset pressure channels. See Drawing 3 & Procedure 4.
E 51	Error in data memory.	Data EPROM on the main board defective.	Replace Data EPROM. Make sure BR3 on the main board is installed. See Theory 1.
E71	Incorrect acknowledgment of the 1. Relay on the terminal board A101.	a.) Anti Two-block relay is stuck or defective. b.) Anti Two-Block relay is not being selected due to a break on the terminal board A101, main board or ribbon cables.	a.) Replace 1. relay. b.) Check terminal board A101, main board and ribbon cables as well as replace defective part, if necessary.
E72 - E77	Analogous to E71 for the relays 2...7.	Analogous to E71 for the relays 2...7.	Analogous to E71 for the relays 2..7.

8. ERROR CODES - continued

ERROR CODE	ERROR	CAUSE	ACTION
E89	Change of the operating code during lifting a load.	The operating mode switch in the console was used during lifting a load.	Lower the load and set the operating mode switch correctly to the code assigned to the actual operating mode of the crane.
E 91	No data transmission from console to central unit. (See Section 8)	a.)24V supply of console interrupted. b.)Interruption or accidental ground in the line from console electronics to central unit. c.)Transmitter/receiver module defective.	a.)Check 24V at terminal X1 of console electronics. b.)Check the connection between console electronics and central unit. c.)If you find an accidental ground, the transmitter module in the console electronics can be damaged. You should, therefore, replace the console electronics. Replace console electronics or main board respectively. See Procedure 3
E92	Error in the data transmission from console to central unit. (See also Section 8)	a.) Temporary interruption of the data line from console electronics to central unit. b.) Transmitter/receiver module defective.	a.) Check the connection between console electronics and central unit.
E93	Error in the data transmission from central unit to console. (See also Section 8)	a.) Temporary interruption of the data line from console electronics to central unit. b.) Transmitter/receiver module defective.	a.) Check the connection between console electronics and central unit. b.) Replace console electronics or main board respectively. See Procedure 3

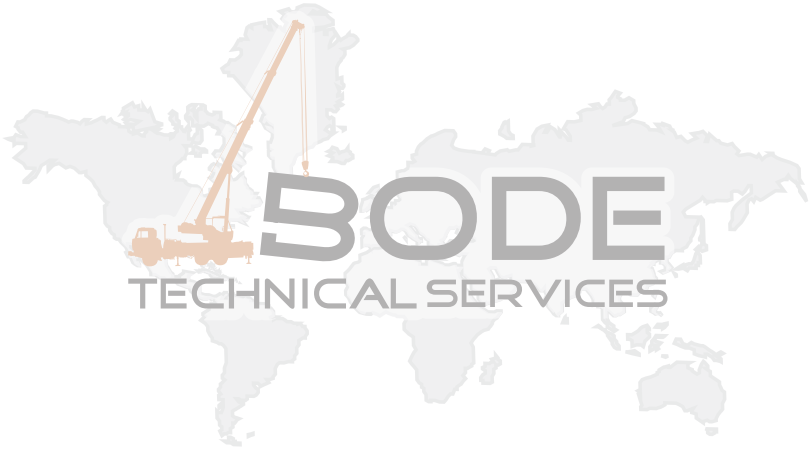
8. ERROR CODES - continued

ERROR CODE	ERROR	CAUSE	ACTION
E94	No data transmission from central unit to console. (See also Section 8)	a.) Interruption or accidental ground in the line from console electronics to central unit. b.) Transmitter/receiver module defective. c.) Data-EPROM defective. d.) CPU defective. e.) Electromagnetic interference (when switching contractors or valves)	a.) Check the connection between console electronics and central unit. If you find an accidental ground, the transmitter module in the console electronics can be damaged. Replace the console electronics. b.) Replace console electronics or main board respectively. c.)Check data EPROM. d.) Replace main board. e.) Eliminate interference source by inverse diodes or resistors.
E95	Error in the crane data EPROM	a.) Data EPROM defective b.) Position of jumper for the selection of the type of EPROM is wrong c.) Electronics component on the main board defective.	a.) Replace data EPROM b.) Check the jumper position c.) Replace main board and reset pressure channels. See Drawing 3 & Procedure 4.
E96	Error in the internal RAM of the CPU of the console	CPU or main board of the console defective	Replace console main board.
E97	Error in the external RAM of the CPU of the console	a.) External RAM of the console defective b.) Electronic component on the main board defective.	a.) Replace console main board b.) Replace console main board
E98	Wrong jumper position in the console	a.) The jumper position BR 9/BR 10 in the console does not correspond to the actual type of central unit. b.) Electronic component on the main board defective.	a.) Check the jumper position b.) Replace console main board

DS350 LMI

for GROVE AT422T

TROUBLESHOOTING SECTION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NOTICE

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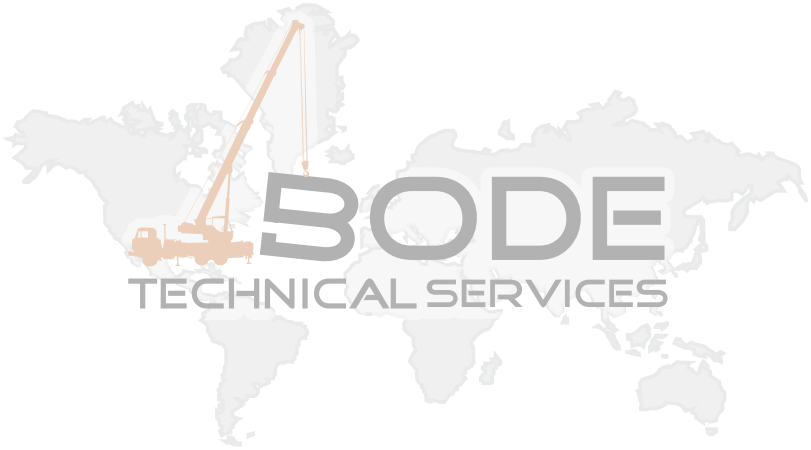
BODE
TECHNICAL SERVICES

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GENERAL INFORMATION

MANUAL INFORMATION

This troubleshooting handbook is designed to assist a service or maintenance person in identifying the system problem areas or malfunctions. A digital voltmeter and regular maintenance and service tools, see tool list below, will be required to troubleshoot the system.
NOTE: Knowledge of how to use a digital voltmeter is assumed.

This handbook covers machines with 024-350-062-766 and 024-350-062-767 central units. The troubleshooting the system use 'A' drawings for the 2766 central unit and 'B' drawings for the 2767 central unit. The central unit 024-350-062-767 hardware changes is effective on crane serial number 86638 and beyond.

The drawings in Section 10 and the procedures in Section 11 are provided as reference material that will be used in the troubleshooting flow charts. Use the drawings and procedures in conjunction with the flow charts to help understand the operation of the LMI. To further understand the theory for LMI operations, refer to Section 12.

TOOL LIST

1 - DIGITAL MULTIMETER COMPLETE WITH 2 SETS OF LEADS 1 - SOLDERING IRON 1 - INCLINOMETER 1 - #0, #1, & #2 PHILLIPS HEAD SCREWDRIVERS 1 - #0 & #1 - PHILLIPS HEAD PRECESSION SCREWDRIVERS 1 - 3/16, 1/4, & 9/32 INCH SLOTTED HEAD SCREWDRIVERS 1 - 0.040, 0.070, & 0.100 INCH SLOTTED HEAD PRECESSION SCREWDRIVERS 1 - 5.5mm, 10mm NUT DRIVERS 1 - 8" ADJUSTABLE WRENCH 1 - 10" ADJUSTABLE WRENCH 1 - 200' TAPE MEASURE FT/METERS 1 - WIRE CUTTERS 1 - WIRE CRIMPING PLIERS 1 - UTILITY KNIFE 1 - METRIC HEX KEYS SIZES 1.5, 2, 2.5, 3, 4, 5, 6, 8, & 10.	1 - STANDARD HEX KEYS SIZES 5/64, 3/32, 7/64, 1/8, 9/64, 5/32, 3/16, 7/32, 1/4, 5/16, 3/8 INCH 1 - VICE GRIP PLIERS 3 - ROLLS INSULATION TAPE 1 - 3/8" DRIVE ½", 7/10", 9/16", DEEP WELL SOCKETS - 1 - 3/8" DRIVE RATCHET AND 3" EXTENSION BAR 1 - 1/4" ADAPTER FOR 3/8" DRIVE RATCHET 1 - 1/4" -DRIVE 1/4, 9/32, 5/16, 11/32, 3/8, 7/16, & 1/2 INCH SOCKET SET 1 - 1/4" -DRIVE 4, 5, 5.5, 6, 7, 8, 9, 10, 11, 12, 13, & 14 mm SOCKET SET 1 - RETAINING RING PLIERS 1 - NEEDLE NOSE PLIERS 1 - CHANNEL LOCK PLIERS 1 - FLASHLIGHT 1 - EPROM PULLER

BASIC SYSTEM INFORMATION

This low temperature system uses heaters for stable system operation in a subzero climate. The main electronics are automatically warmed before the system boards and components are energized. Therefore, all system components must be installed and sealed from the environment when operating and/or troubleshooting in low temperature conditions.

For system operation refer to the Operator's Section of this manual.

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

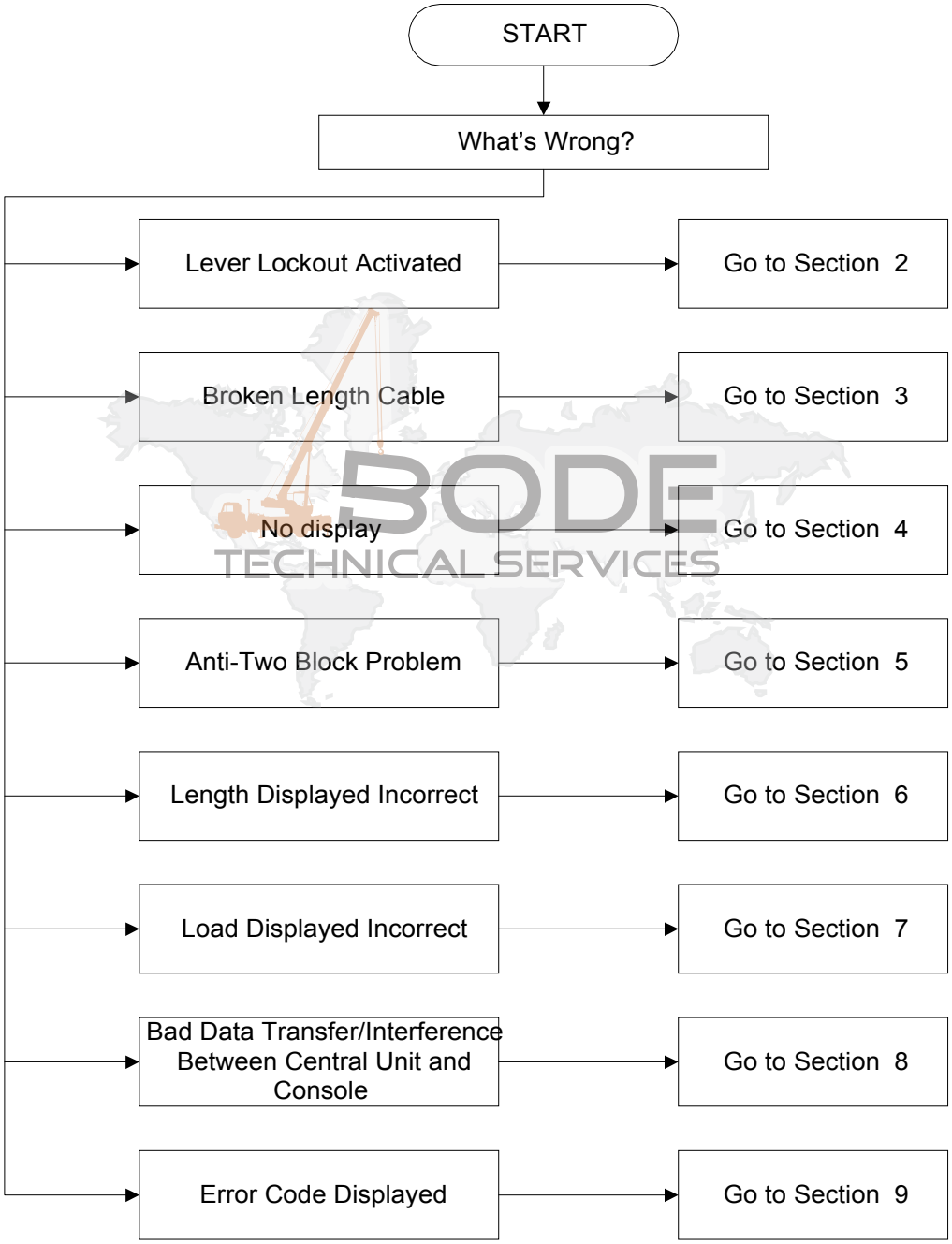
Using different sensing devices, the Load Moment Indicator monitors various crane functions and provides the operator with a continuous reading of the crane's capacity. The readings continuously change as the crane moves through the motions needed to make the lift.

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

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

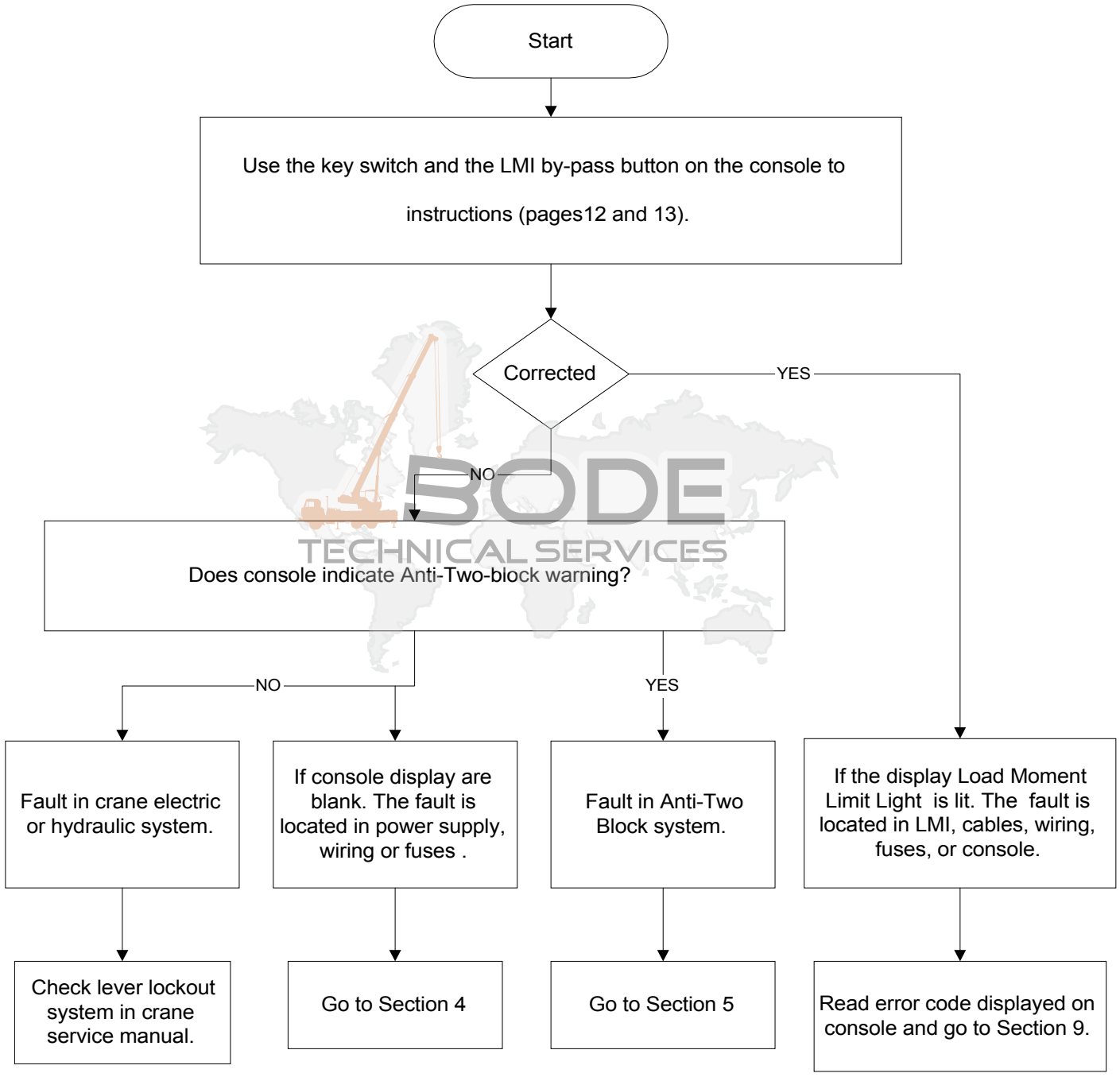
1. GENERAL FLOWCHART AND DRAWINGS

This section explains how to handle a problem that may arise with the PAT Load Moment Indicator System-PAT DS350. The procedures are given in flowchart form for the following sections. Start with the general flowchart below which will guide you to one of the detailed flowcharts shown in Sections 2 through 9. The drawings in this section will be referenced in the troubleshooting flow charts, Sections 2 through 9.



2. LEVER LOCKOUT ACTIVATED

PROBLEM: The lever lockout system of the crane is activated. Crane movements “hoist up”, “telescope out”, and “boom down” are stopped. Crane is not in overload or two-block condition.



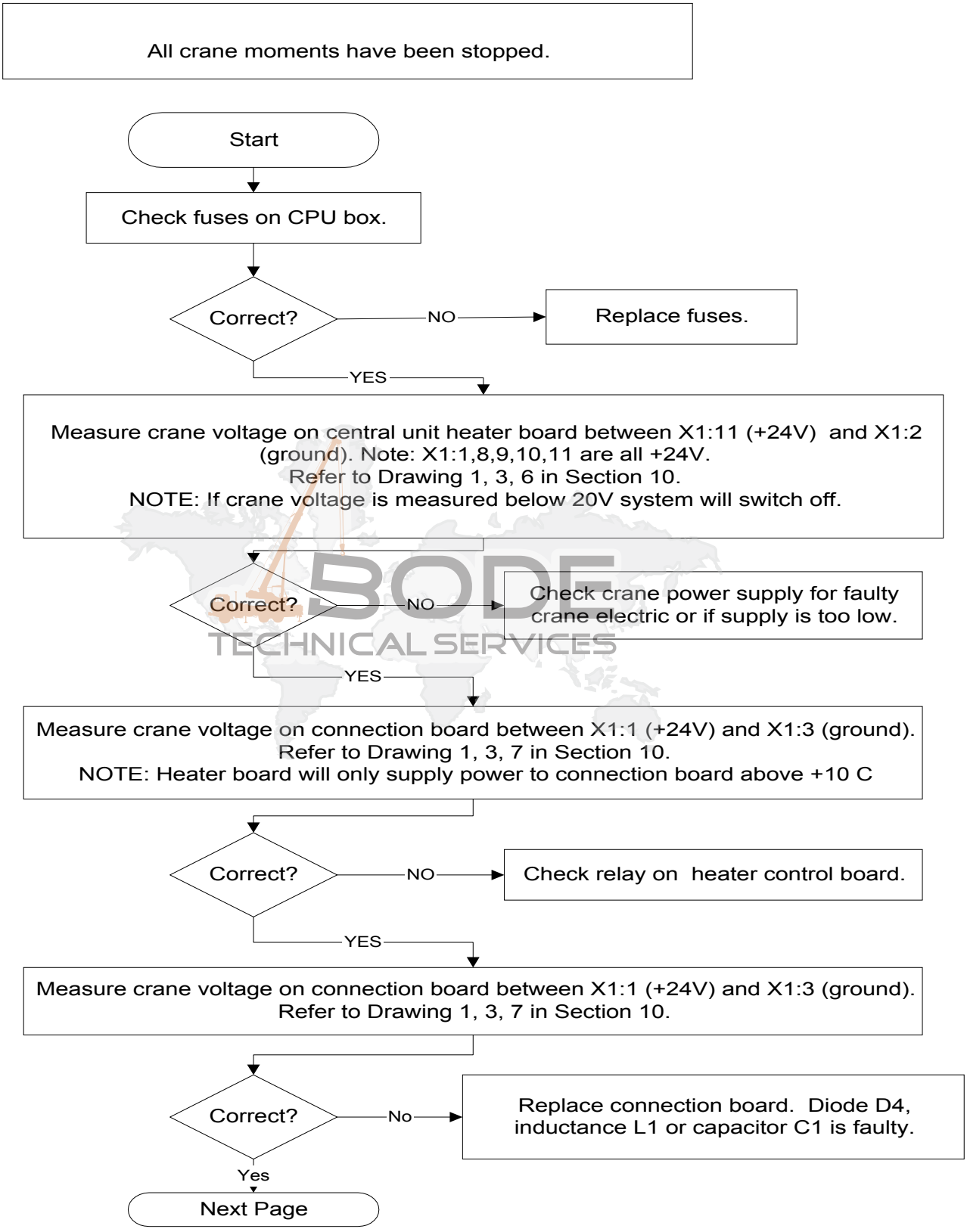
3. BROKEN LENGTH CABLE

PROBLEM: Damaged or broken length cable.

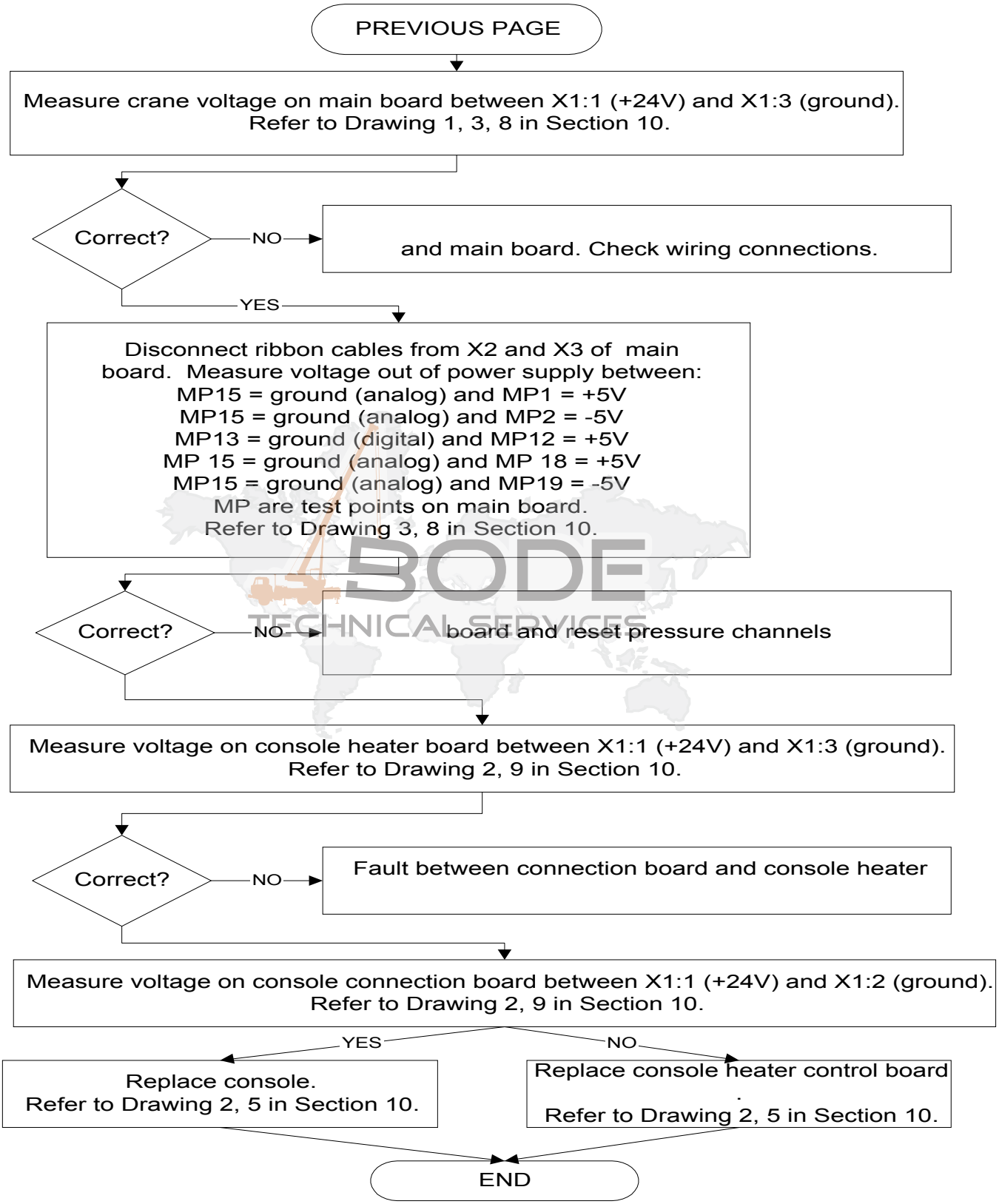
Replace length cable using the following procedure:
Refer to: Drawing 2 - Electrical Wiring Central Unit to Console/Cable Reel
Drawing 4 - Cable Reel - Parts List
Drawing 10 - Boom Tip Junction Box w/voltmeter on 1 & 2
Drawing 11 - Slip Ring Assembly w/voltmeter on Red & Brown
Procedure 5 - Mechanical Adjustment of Cable Reel

1 Cut old cable at cable drum
2 Disconnect damaged length cable from junction box at the boom nose. Refer to Drawing 2, 10.
3 Open cable reel cover and disconnect wiring from terminal block. Pull 7 conductor cable out of strain relief.
4 Remove cable reel from mounting brackets.
5 Remove damaged length cable, which is mounted to the slip rings in the cable reel, from slip ring terminal. Refer to Drawings 2, 4, 11.
6 On the back side of the cable reel, open the strain relief attached to the axle in the center of the drum. Pull existing length cable out of the cable reel.
7 Pull new length cable through the hole, pipe and strain relief and push it through the axle of the reeling drum. Tighten strain relief to ensure sealing.
8 Reconnect the length cable to the slip ring. Refer to Drawing 2, 4 ,11.
9 Remount cable reel to the boom.
10 Turn reeling drum clockwise to spool the new cable neatly onto the drum.
11 Set pre-load on cable reel by turning the drum counter-clockwise 5 to 8 turns.
12 Wrap the new length cable around the boom tip anchor pin (8 - 10 wraps) and secure with tie wraps. Leave enough length cable to connect into the boom tip junction box.
13 Connect the length cable into the boom tip junction box. Refer to Drawing 2, 10.
14 Reset length potentiometer in length angle transducer (screw is located in center of white gear); with boom fully retracted, turn potentiometer carefully counter-clockwise until it stops. Recheck length and angle display. Refer to Procedure 5.

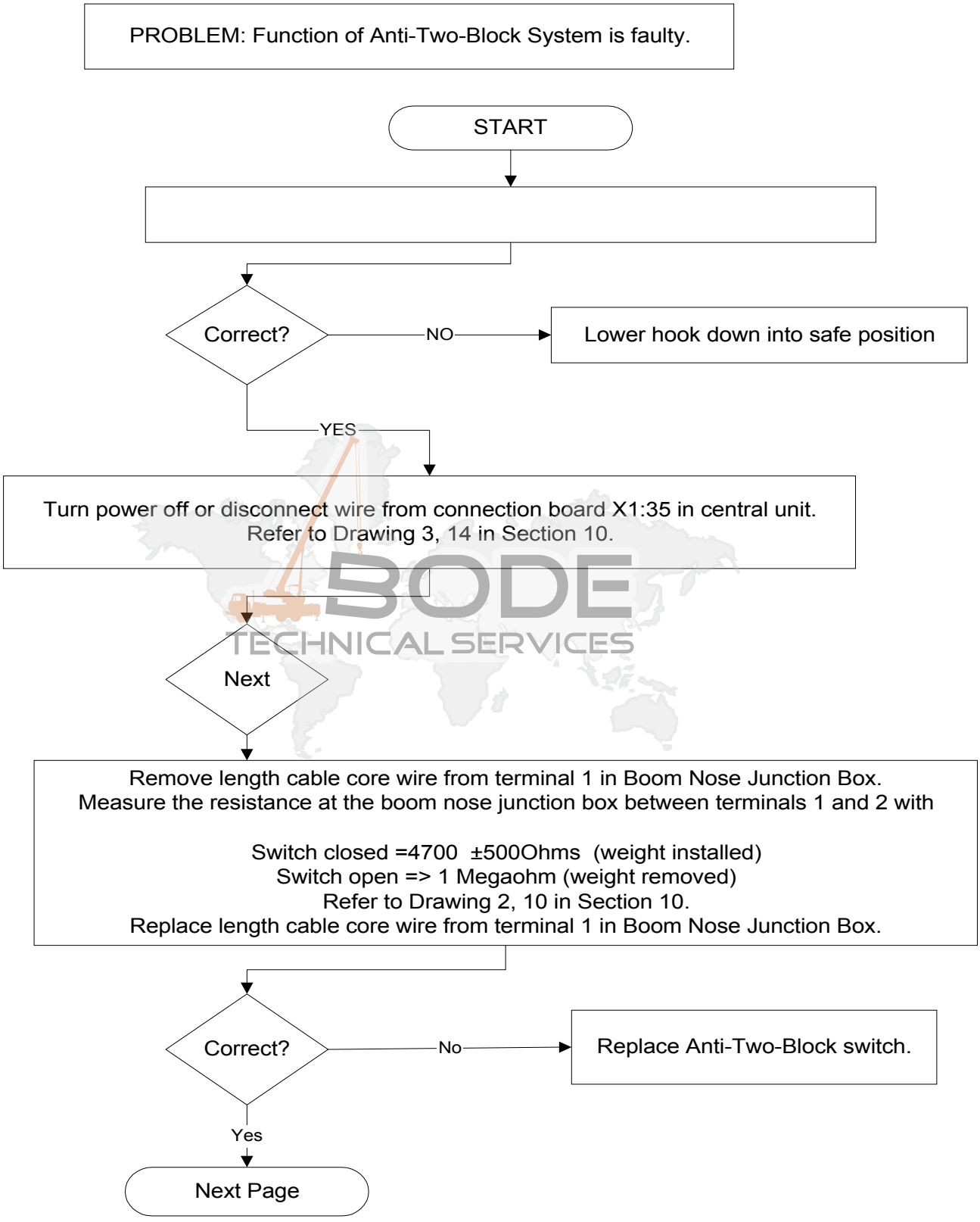
4. NO DISPLAY



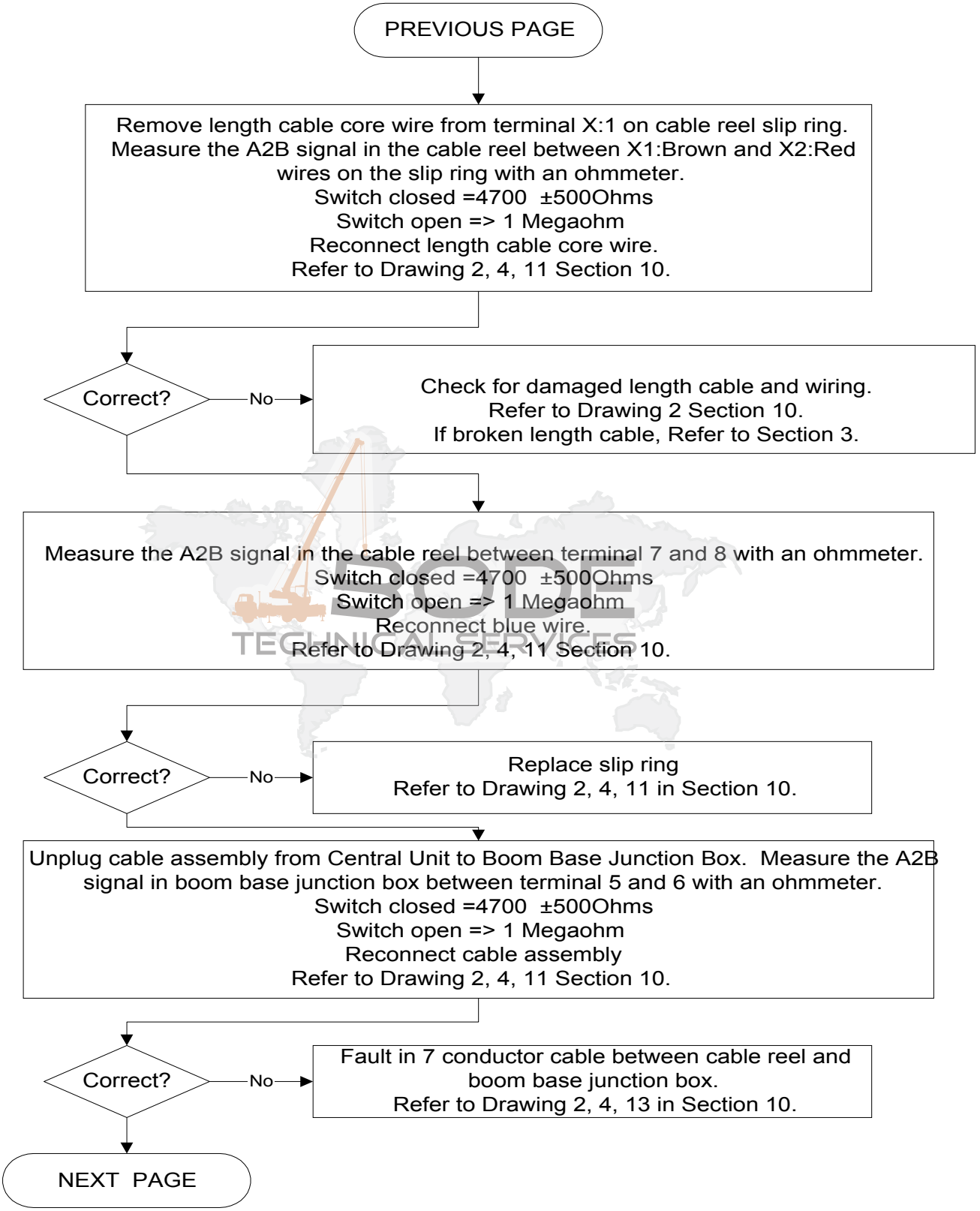
4. NO DISPLAY - continued



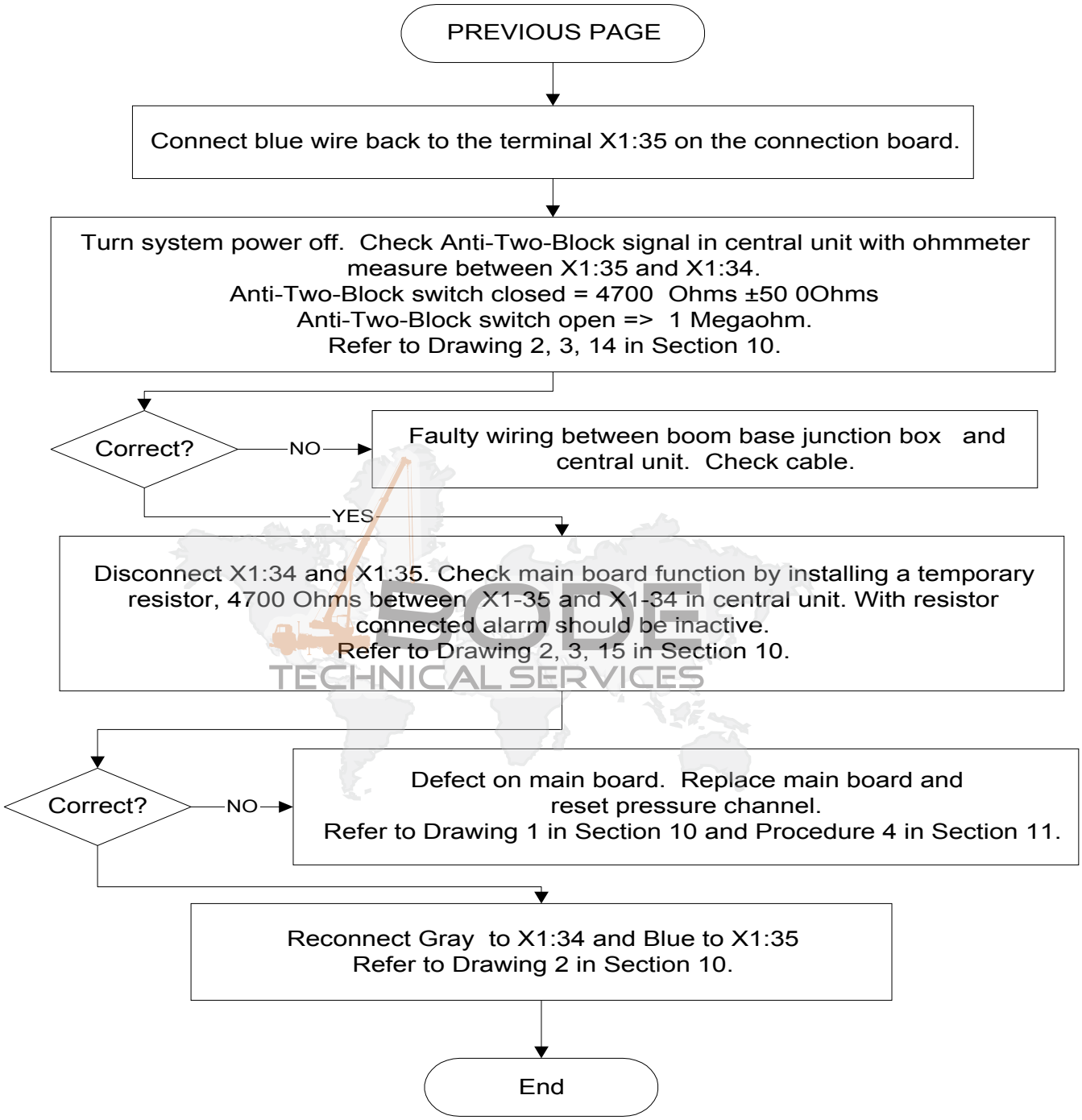
5a. ANTI TWO BLOCK PROBLEM (SINGLE SWITCH)



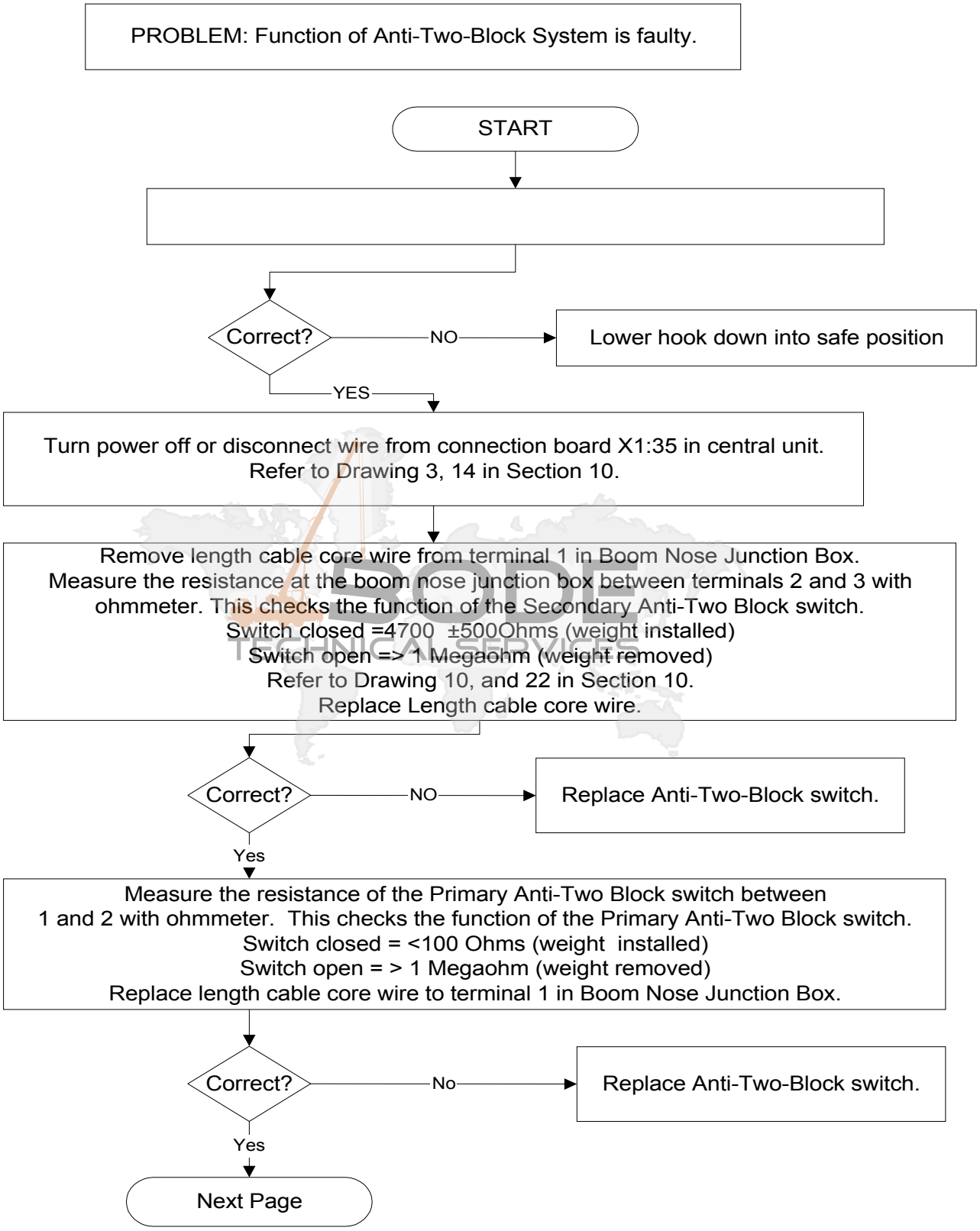
5a. ANTI TWO BLOCK PROBLEM (SINGLE SWITCH) - cont'



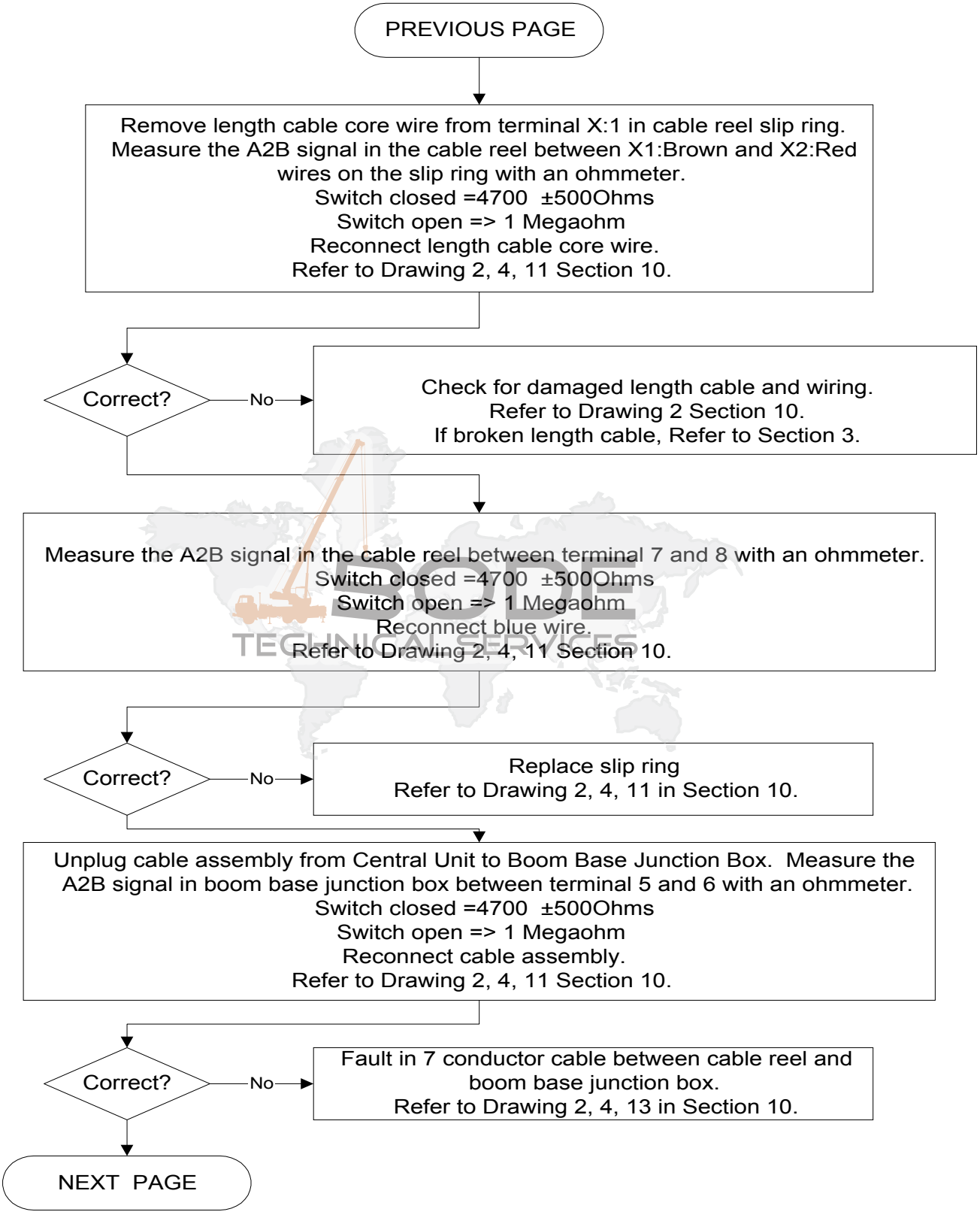
5a. ANTI TWO BLOCK PROBLEM (SINGLE SWITCH) - cont'



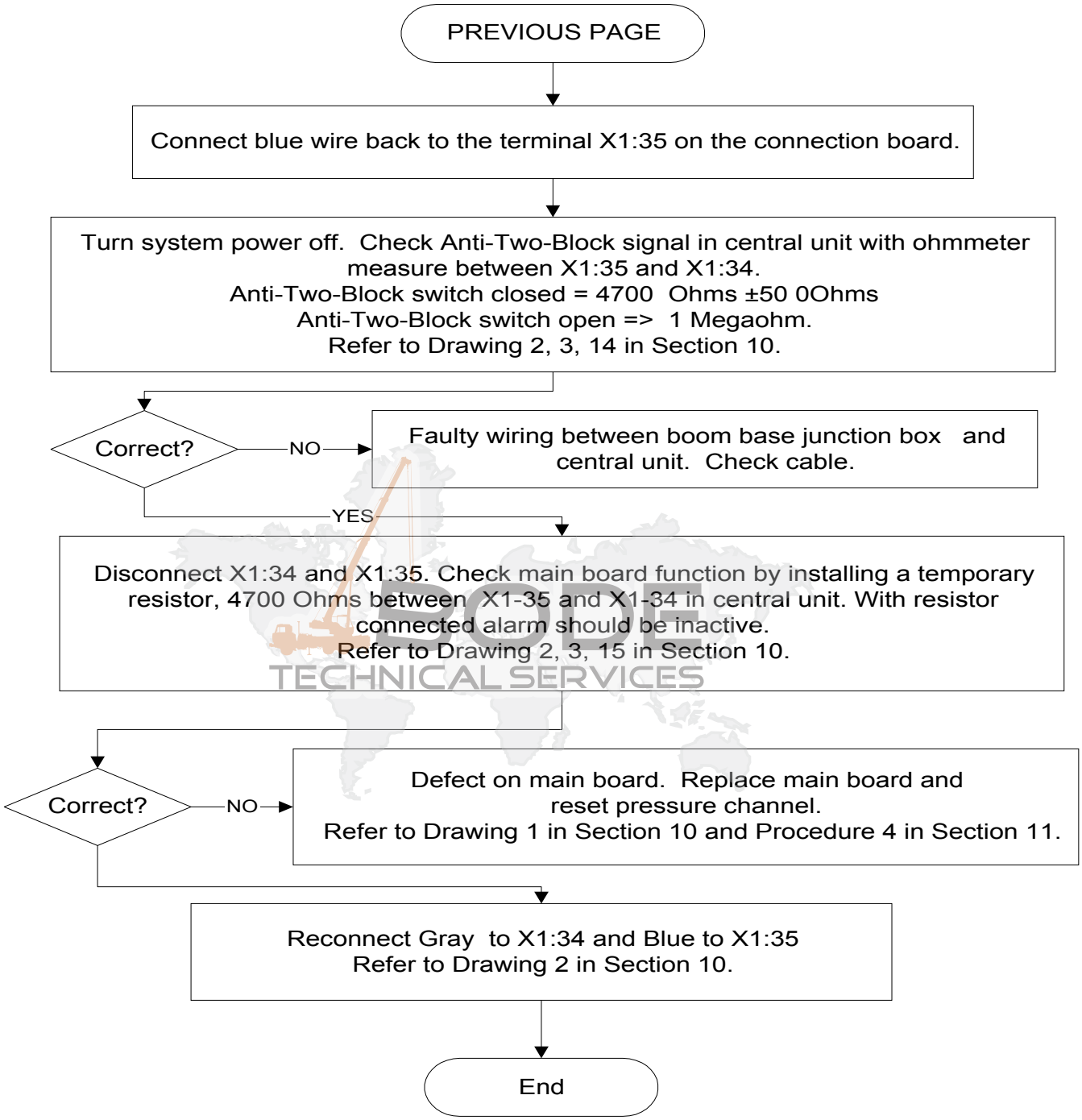
5b. ANTI TWO BLOCK PROBLEM (DOUBLE SWITCH)



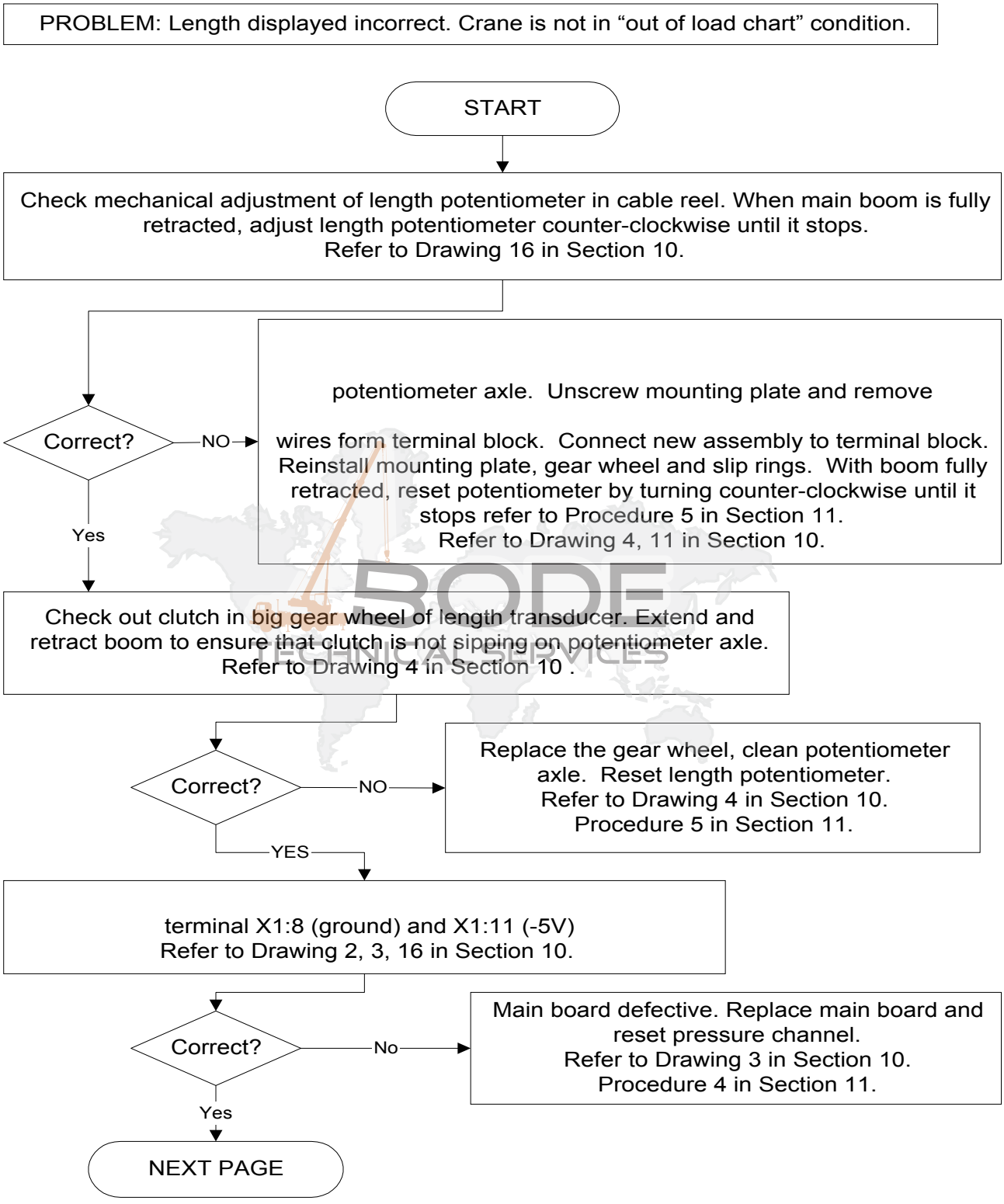
5b. ANTI-TWO BLOCK PROBLEM (DOUBLE SWITCH) - cont'



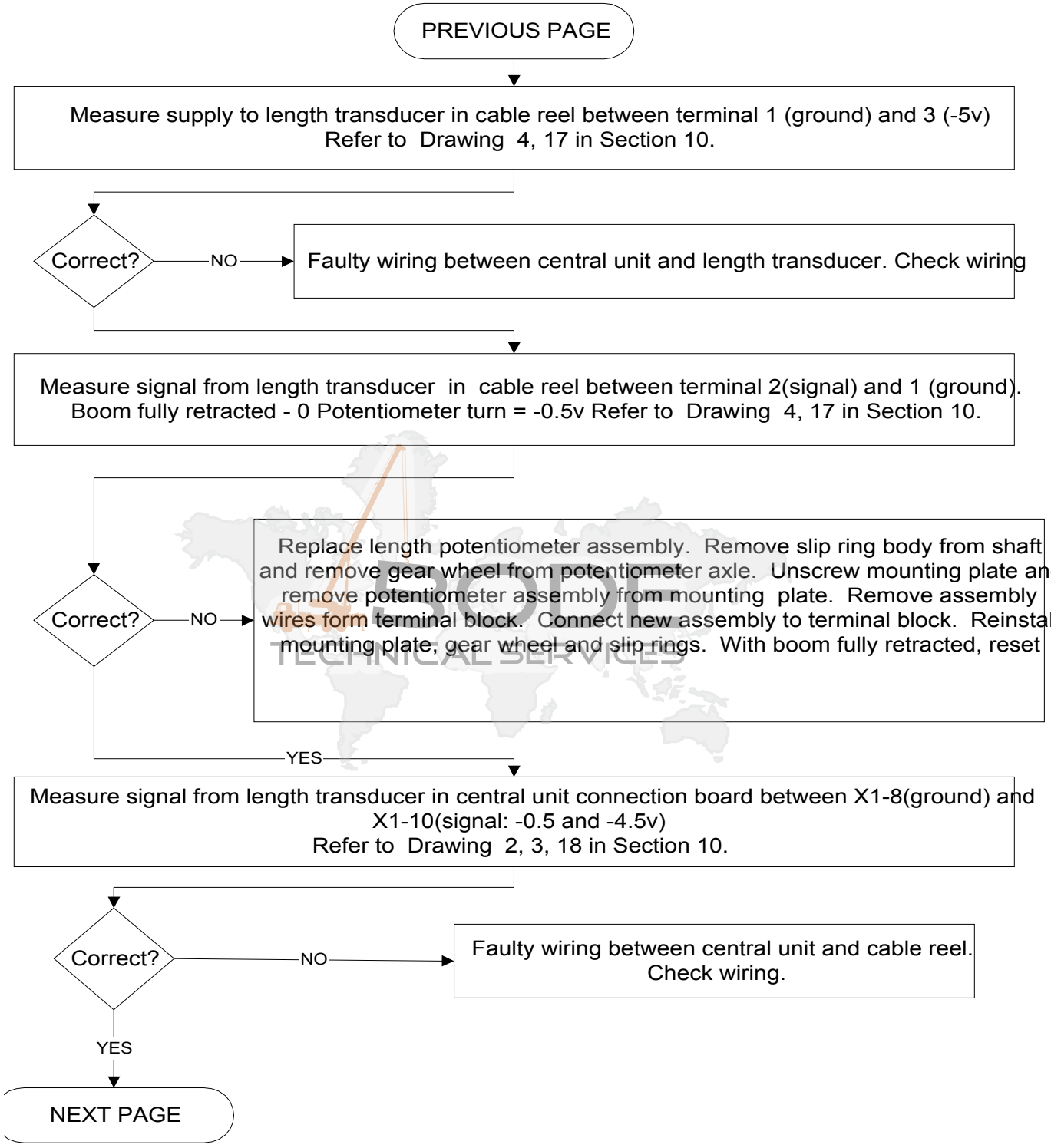
5b. ANTI TWO BLOCK PROBLEM (DOUBLE SWITCH) - cont'



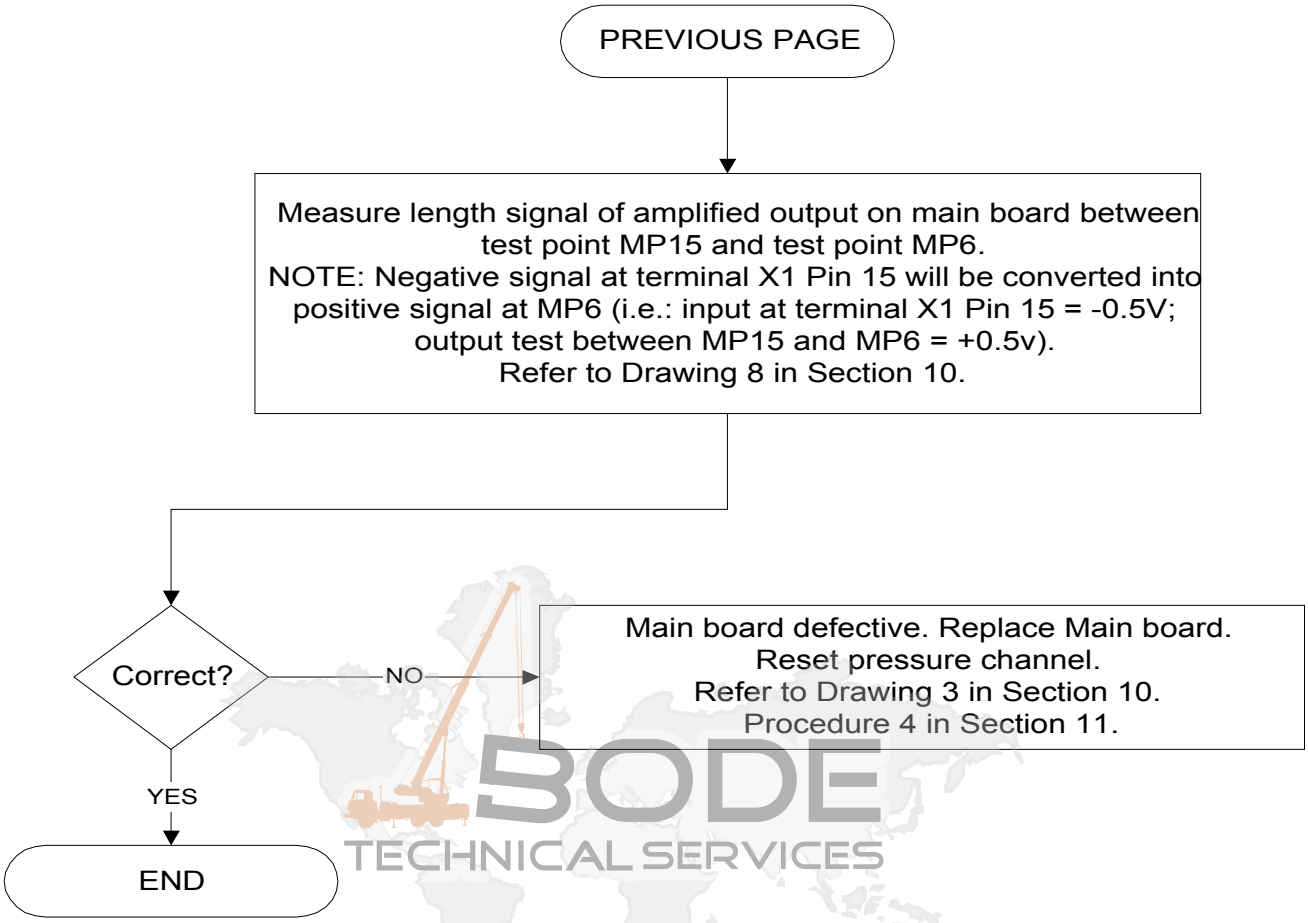
6. LENGTH READING PROBLEM



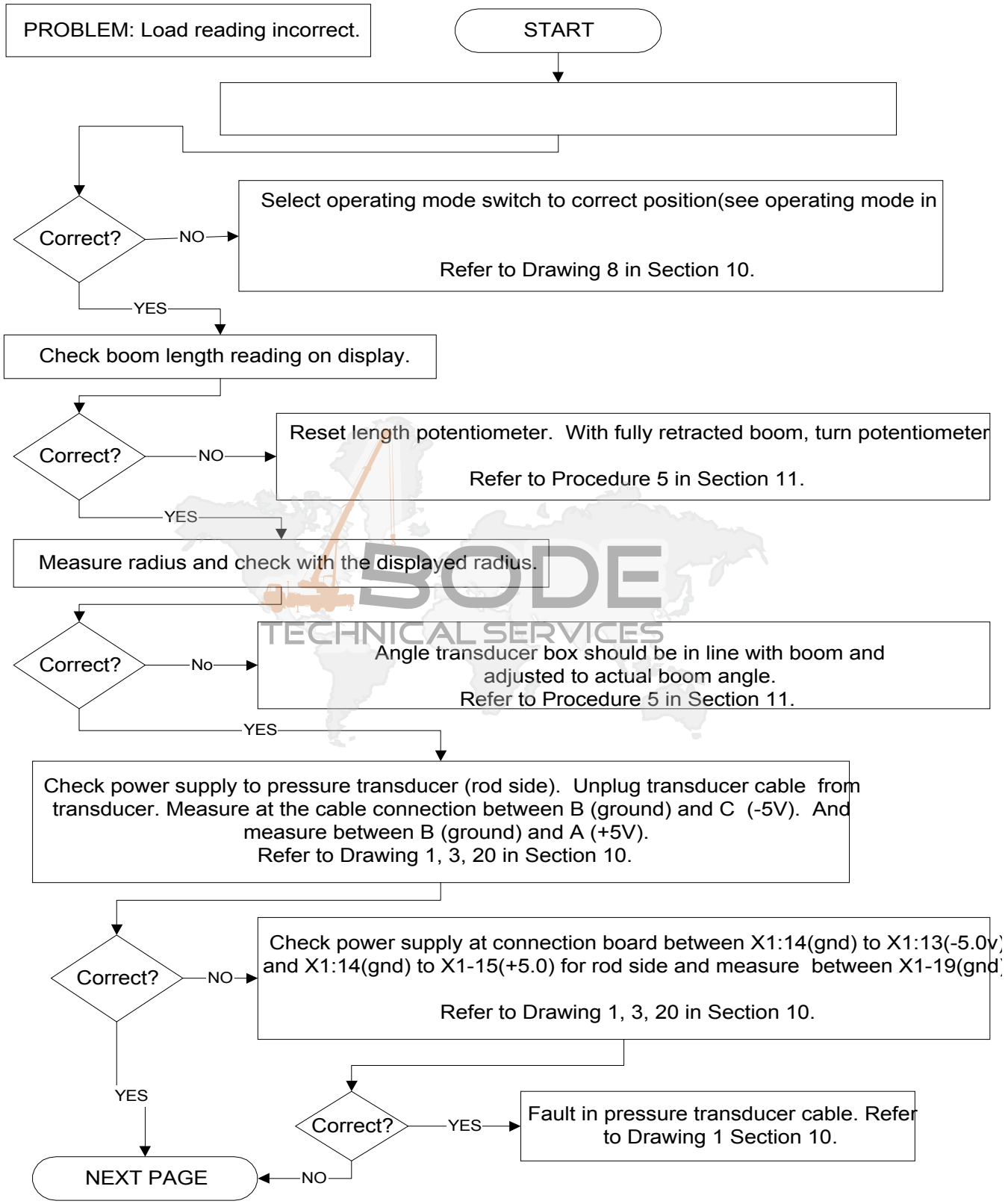
6. LENGTH READING PROBLEM - continued



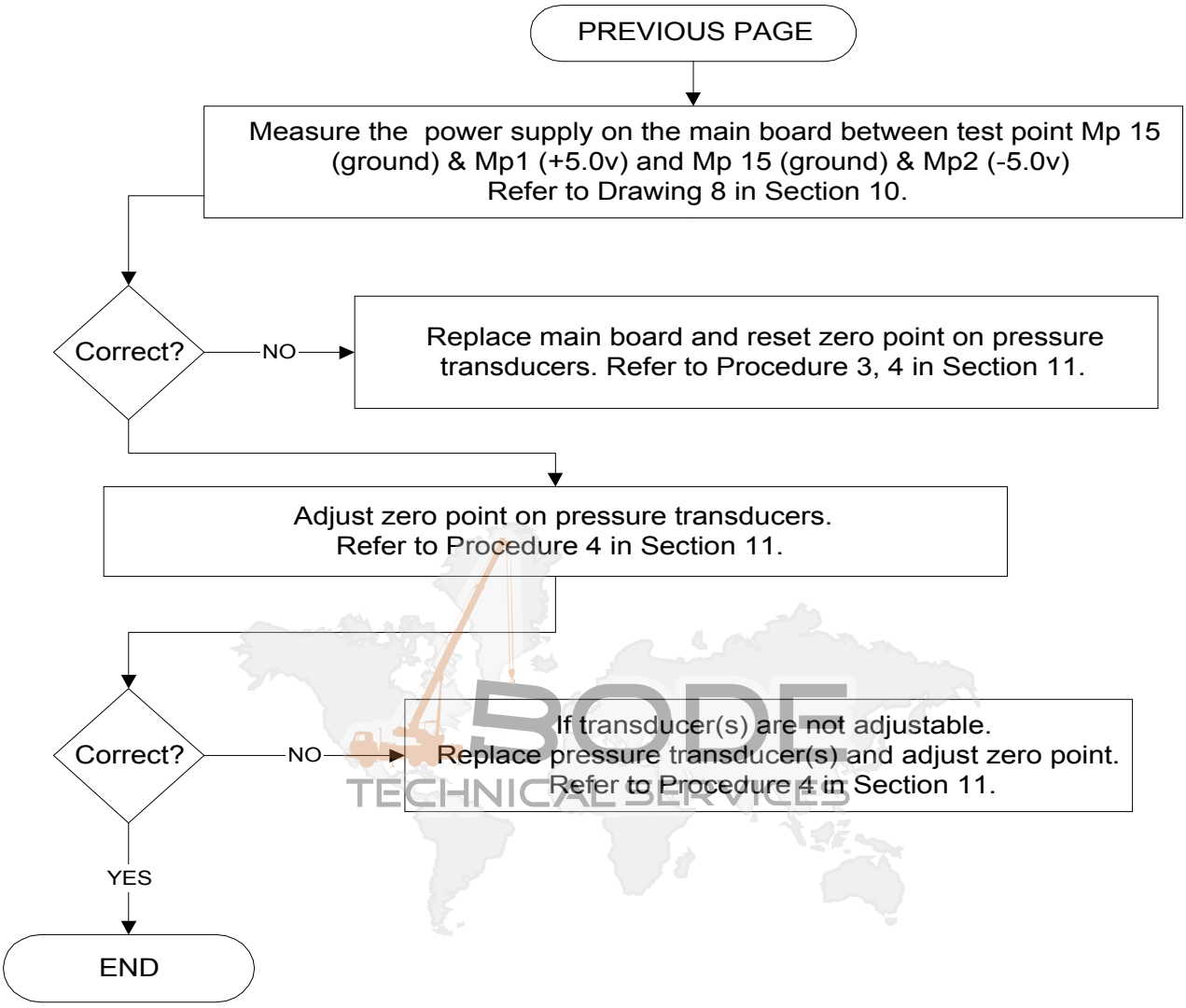
6. LENGTH READING PROBLEM - continued



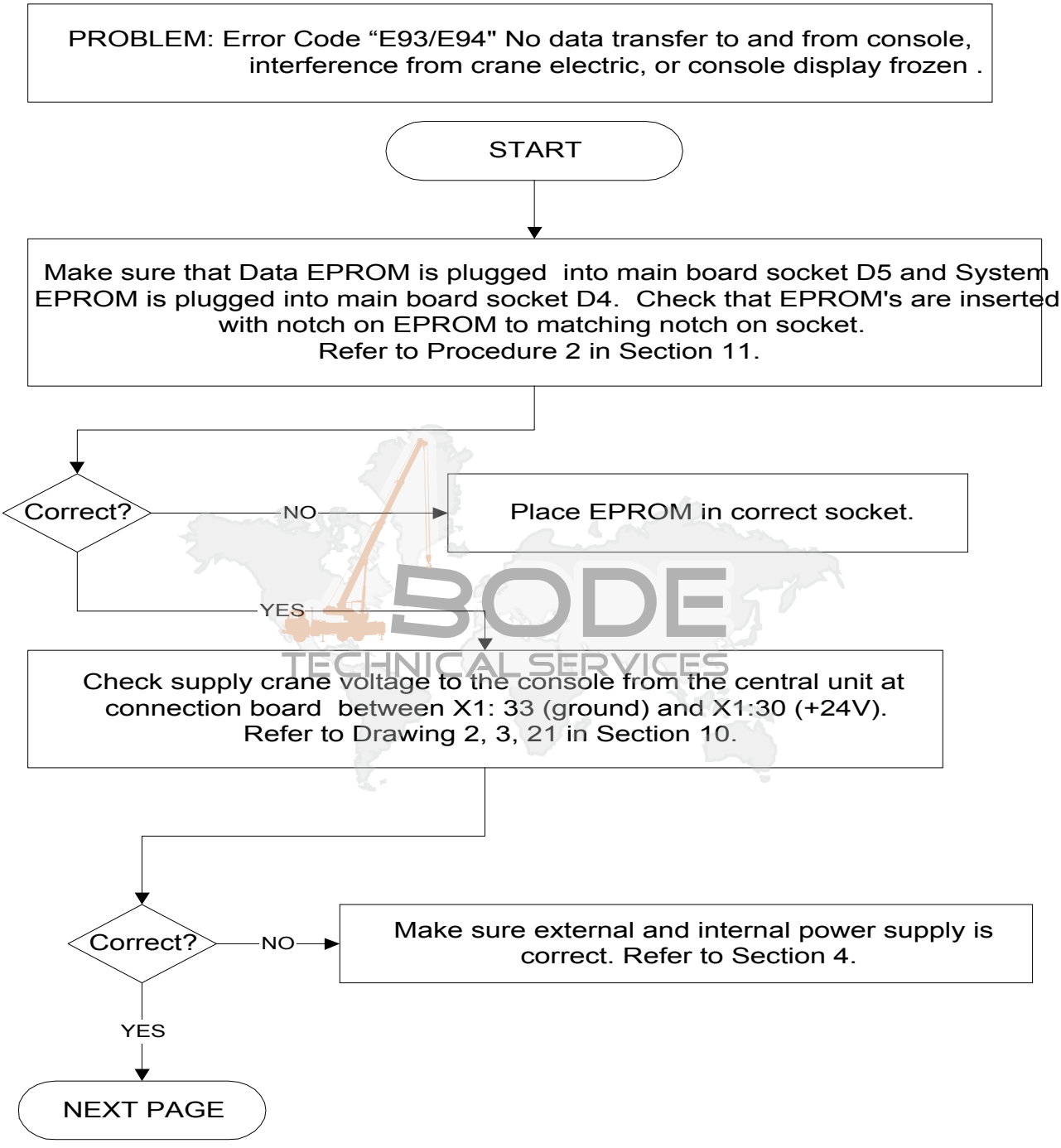
7. LOAD READING PROBLEM



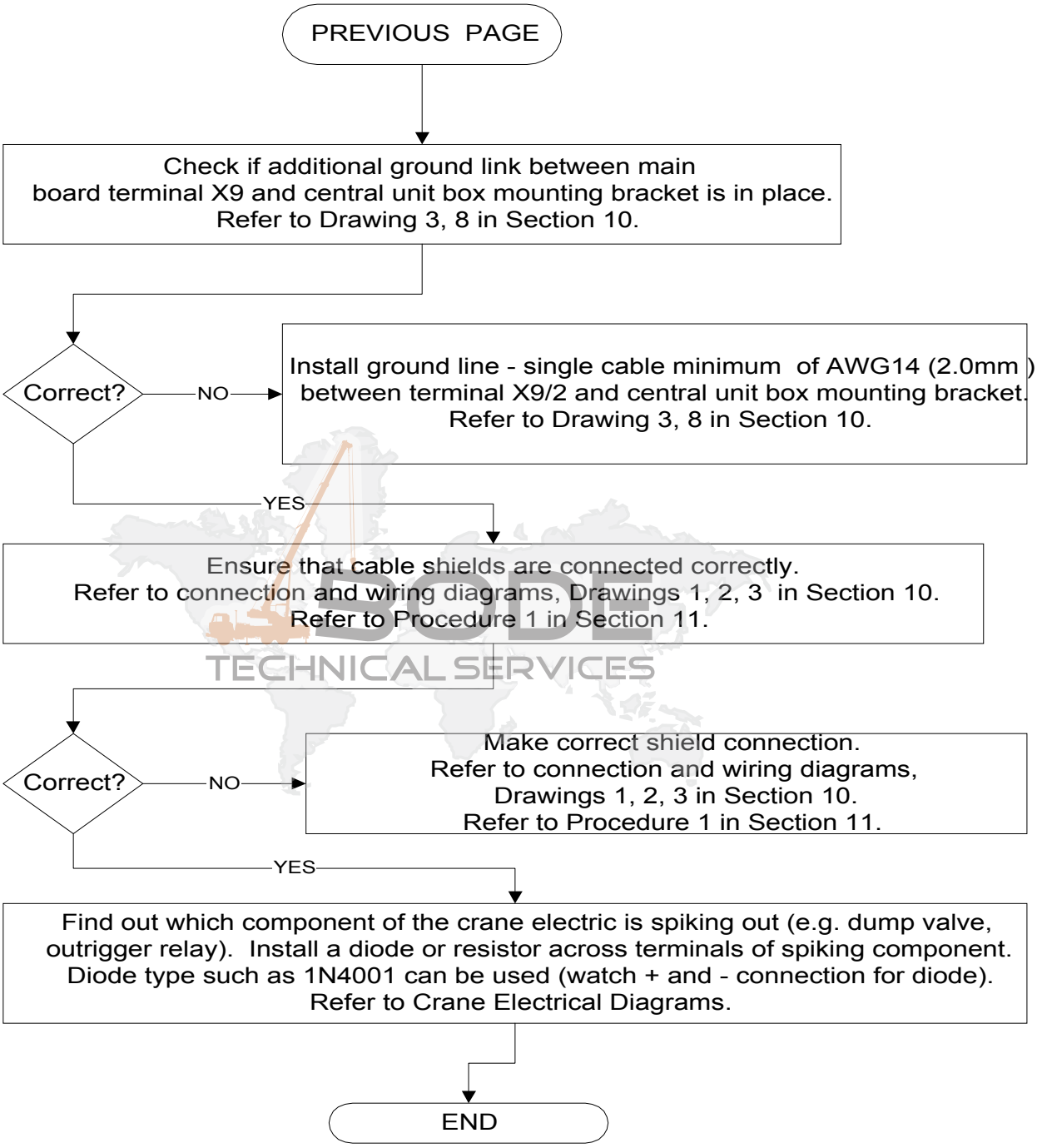
7. LOAD READING PROBLEM - continued



8 BAD DATA TRANSFER BETWEEN CONSOLE & CENTRAL UNIT, INTERFERENCE PROBLEM



8 BAD DATA TRANSFER BETWEEN CONSOLE & CENTRAL UNIT, INTERFERENCE PROBLEM - continued



9. ERROR CODE DISPLAY

PROBLEM: Error code displayed. Lever lockout activated. Warning lights on.

ERROR CODE	ERROR	CAUSE	ACTION
E01	Minimum radius or maximum angle range exceeded	Fallen below the minimum radius or above the angle given in the load chart due to raising the boom to far.	Lower boom back to a radius or angle given in the load chart.
E02	Maximum radius or minimum angle range exceeded	The maximum radius or minimum angle given in the load chart was exceeded due to lowering the boom too far.	Raise boom back to a radius or angle given in the load chart.
E04	Operating mode not available	Operating mode switch in the console set incorrectly. Operating mode is not permissible with actual crane configuration.	Set operating mode switch correctly to the code assigned to the operating mode of the crane.
E05	Length range not permitted	Boom has been extended too far or not far enough. Length sensor adjustment changed; i.e. length sensor cable slid off the cable drum.	Retract or extend boom to correct length given in the load chart. See Section 6.
E07	No acknowledgment signal from overload relay (K1).	Overload relay is stuck, defective or not being selected.	Replace relay.
E08	No acknowledgment signal from Anti-Two-Block switch relay (K2).	Anti-Two-Block switch relay is defective or not being selected.	Replace relay.
E11	Fallen below limit for the measuring channel “length”.	a.) Cable between length sensor and central unit defective, not connected or water in the connectors. b.)Length sensor Potentiometer defective. c.)Electronic board in the measuring channel defective.	a.)Check cable and connector as well and replace, if necessary. Section 6. b.)Replace and reset length sensor Potentiometer. See Section 6 & Procedure 5. c.)Replace main board and reset pressure channels. See Drawing 3 & Procedure 4.

9. ERROR CODES - continued

ERROR CODE	ERROR	CAUSE	ACTION
E12	Fallen below lower limit value for the measuring channel “pressure transducer piston side”.	a.) Cable leading from the central unit to the pressure transducer defective, loose or water in the connector. b.)Pressure transducer on piston side defective. c.)Electronic component in the measuring channel defective.	a.)Check cable and connector as well and replace, if necessary. Section 7. b.)Replace pressure transducer and reset pressure channel. See Section 7 & Procedure 4. c.)Replace main board and reset pressure channels. See Drawing 3 & Procedure 4.
E13	Fallen below lower limit value for the measuring channel “pressure transducer rod side”.	a.)Cable leading from the central unit to the pressure transducer defective, loose or water in the connector. b.)Pressure transducer on rod side defective. c.)Electronic component in the measuring channel defective.	a.)Check cable and connectors as well and replace, if necessary. Section No. 7. b.)Replace pressure transducer and reset pressure channel. See Section 7 & Procedure 4. c.)Replace main board and reset pressure channels. See Drawing 3 & Procedure 4.
E 15	Fallen below lower limit value for the measuring channel “angle main boom”.	a.)Cable from central unit to the length/angle sensor defective or loose. b.)Angle sensor defective. c.)Electronic component in the measuring channel defective.	a.)Check cable. Replace if necessary. See Section 6 b.)Replace angle sensor and reset adjustment. Procedure 5 c.)Replace main board and reset pressure channels. See Drawing 3 & Procedure 4.
E19	Error in the reference voltage.	Electronic component on the main board defective.	Replace main board and reset pressure channels. See Drawing 3 & Procedure 4.
E20	No analog voltages	a.)The crane supply voltage is too low. b.)The voltage converter is defective or short circuit in the wiring.	a.)Check crane voltage. b.)Check supply voltages.

9. ERROR CODES - continued

ERROR CODE	ERROR	CAUSE	ACTION
E21	Upper limiting value for the measuring channel “length” exceeded.	a.)Cable from central unit to the length/angle sensor defective or loose. b.)Length potentiometer defective. c.)Electronic component in the measuring channel defective on main board.	a.)Check cable. Replace if necessary. See section 6. b.)Replace and reset length potentiometer. See Procedure 5. c.)Replace main board and reset pressure channels. See Drawing 3 & Procedure 4.
E22	Upper limiting value for the measuring channel “pressure piston side” exceeded.	a.)Cable from central unit to the pressure transducer defective, loose or water in the plug. b.)Pressure transducer on piston side defective. c.)Electronic component in the measuring channel defective on main board.	a.)Check cable as well as plug. Replace if necessary. See Section 7. b.)Replacepressure transducer and reset pressure channels. See Section 7. c.)Replace main board and reset pressure channels. See Drawing 3 & Procedure 4.
E23	Upper limit value for the measuring channel “pressure transducer rod side” exceeded.	a.) Cable lead in from the central unit to press trans defective, not connected or water in the connectors. b.) Pressure transducer on road side defective. c.) Electronic component in the measuring channel defective.	a.)Check cable and connectors as well and replace, if necessary. See Section 7. b.)Replacepressure transducer c.) Replace main board and reset pressure channels. See Drawing 3 & Procedure 4.
E25	Upper limit value for the measuring channel “angle main boom” exceeded.	a.) Cable leading from the central unit to the length/angle sensor defective, loose or water l the connectors. b.) Angle sensor defective c.) Electronic component in the measuring channel defective.	a.) Check cable as well as connectors and replace, if necessary. Section 6. b.) Replace angle sensor and reset adjustment. See Section No. 6 & Procedure 5. c.) Replace main board and reset pressure channels. See Drawing 3 & Procedure 4.
E27	Upper limit value for the measuring channel 7 exceeded.	a.) Cable leading from the central unit to the sensor of channel 7 defective, loose or water in the connectors. b.) Sensor of channel 7 defective. c.) Electronic component in the measuring channel 7 defective.	a.) Check cable as well as connectors and replace, if necessary. b.) Replace sensor of channel 7 and reset adjustment. c.) Replace main board and reset pressure channels. See Drawing 3 & Procedure 4.

9. ERROR CODES - continued

ERROR CODE	ERROR	CAUSE	ACTION
E29	Reference voltage defective.	a.) The total of the supply and the reference voltages on MP10 is more than 3.3V b.) A/D converter defective.	a.) Check supply voltages. b.) Replace main board and reset pressure channels. See Drawing 3 & Procedure 4.
E31	Error in the system program.	a.) EPROM with system program defective. b.) Electronic component on the main board defective.	a.) Replace system program EPROM b.) Replace main board and reset pressure channels. See Drawing 3 & Procedure 4.
E37	Error in the program run	a.) EPROM with system program defective. b.) Electronic component on the main board defective.	a.) Replace system program EPROM. b.) Replace main board and reset pressure channels. See Drawing 3 & Procedure 4.
E38	Wrong system program in the LMI.	The system program in the LMI does not correspond to the programming in the data EPROM	Replace system program EPROM
E 41	Error in the external RAM.		Replace main board and reset pressure channels. See Drawing 3 & Procedure 4.
E 42	Error in the external write/read memory (RAM).	Internal defect in digital part of CPU.	Exchange write/read memory (CMOS-RAM). Replace main board and reset pressure channels. See Drawing 3 & Procedure 4.
E 45	Error in internal communications.	Defective electronic component.	Replace main board and reset pressure channels. See Drawing 3 & Procedure 4.
E 48	Malfunction in the monitored write/read memory.	Internal defect in digital part of CPU	Replace main board and reset pressure channels. See Drawing 3 & Procedure 4.
E 51	Error in data memory.	Data EPROM on the main board defective.	Replace Data EPROM. Make sure BR3 on the main board is installed. See Theory 1.
E71	Incorrect acknowledgment of the 1. Relay on the terminal board A101.	a.) Anti Two-block relay is stuck or defective. b.) Anti Two-Block relay is not being selected due to a break on the terminal board A101, main board or ribbon cables.	a.) Replace 1. relay. b.) Check terminal board A101, main board and ribbon cables as well as replace defective part, if necessary.
E72 - E77	Analogous to E71 for the relays 2...7.	Analogous to E71 for the relays 2...7.	Analogous to E71 for the relays 2..7.

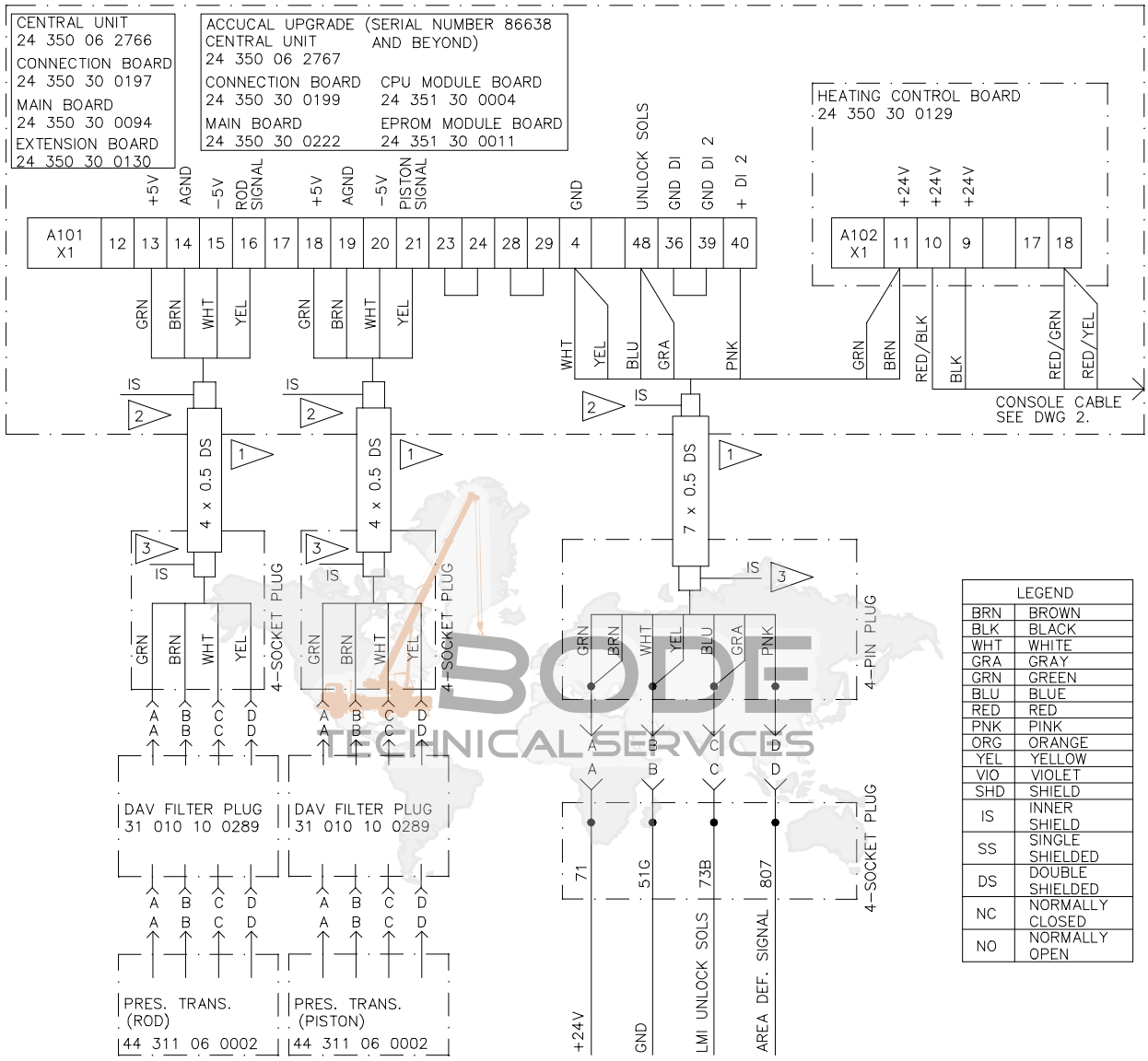
9. ERROR CODES - continued

ERROR CODE	ERROR	CAUSE	ACTION
E89	Change of the operating code during lifting a load.	The operating mode switch in the console was used during lifting a load.	Lower the load and set the operating mode switch correctly to the code assigned to the actual operating mode of the crane.
E 91	No data transmission from console to central unit. (See Section 8)	a.)24V supply of console interrupted. b.)Interruption or accidental ground in the line from console electronics to central unit. c.)Transmitter/receiver module defective.	a.)Check 24V at terminal X1 of console electronics. b.)Check the connection between console electronics and central unit. c.)If you find an accidental ground, the transmitter module in the console electronics can be damaged. You should, therefore, replace the console electronics. Replace console electronics or main board respectively. See Procedure 3
E92	Error in the data transmission from console to central unit. (See also Section 8)	a.) Temporary interruption of the data line from console electronics to central unit. b.) Transmitter/receiver module defective.	a.) Check the connection between console electronics and central unit.
E93	Error in the data transmission from central unit to console. (See also Section 8)	a.) Temporary interruption of the data line from console electronics to central unit. b.) Transmitter/receiver module defective.	a.) Check the connection between console electronics and central unit. b.) Replace console electronics or main board respectively. See Procedure 3

9. ERROR CODES - continued

ERROR CODE	ERROR	CAUSE	ACTION
E94	No data transmission from central unit to console. (See also Section 8)	a.) Interruption or accidental ground in the line from console electronics to central unit. b.) Transmitter/receiver module defective. c.) Data-EPROM defective. d.) CPU defective. e.) Electromagnetic interference (when switching contractors or valves)	a.) Check the connection between console electronics and central unit. If you find an accidental ground, the transmitter module in the console electronics can be damaged. Replace the console electronics. b.) Replace console electronics or main board respectively. c.)Check data EPROM. d.) Replace main board. e.) Eliminate interference source by inverse diodes or resistors.
E95	Error in the crane data EPROM	a.) Data EPROM defective b.) Position of jumper for the selection of the type of EPROM is wrong c.) Electronics component on the main board defective.	a.) Replace data EPROM b.) Check the jumper position c.) Replace main board and reset pressure channels. See Drawing 3 & Procedure 4.
E96	Error in the internal RAM of the CPU of the console	CPU or main board of the console defective	Replace console main board.
E97	Error in the external RAM of the CPU of the console	a.) External RAM of the console defective b.) Electronic component on the main board defective.	a.) Replace console main board b.) Replace console main board
E98	Wrong jumper position in the console	a.) The jumper position BR 9/BR 10 in the console does not correspond to the actual type of central unit. b.) Electronic component on the main board defective.	a.) Check the jumper position b.) Replace console main board

10. DRAWING 1. ELECTRICAL WIRING FOR CRANE/PRESSURE TRANSDUCER

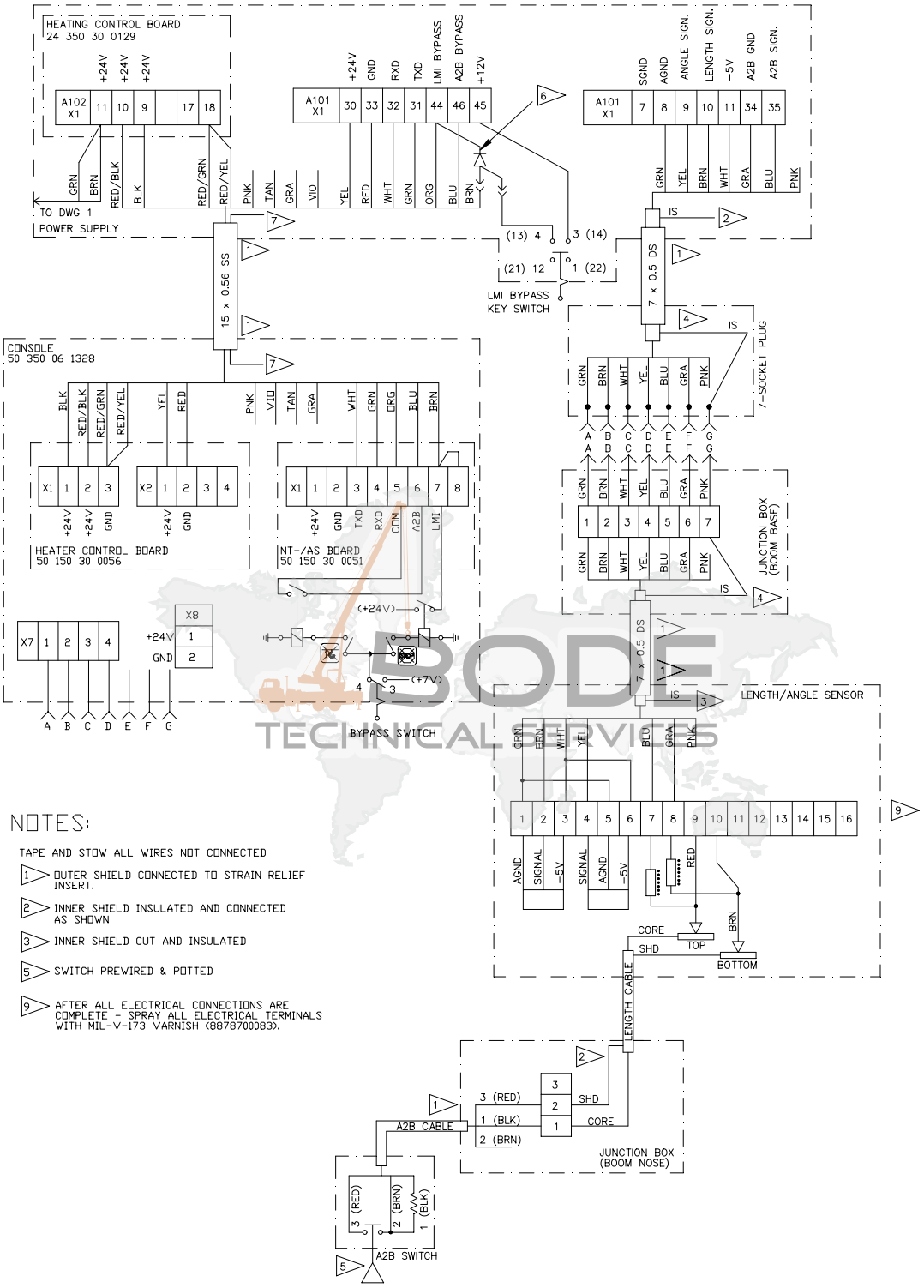


NOTES:

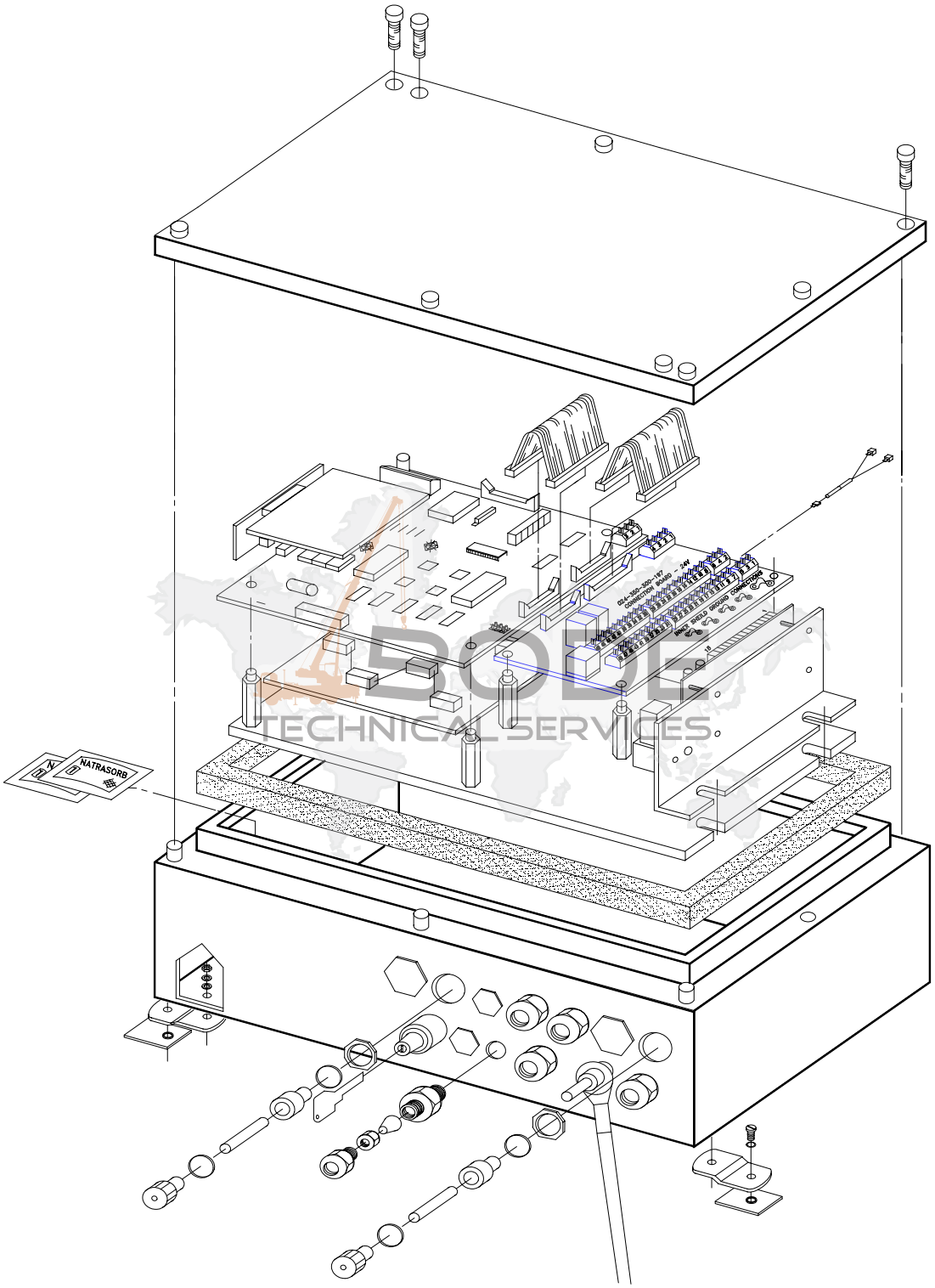
TAPE AND STOW ALL WIRES NOT CONNECTED

1. OUTER SHIELD CONNECTED TO STRAIN RELIEF INSERT.
2. INNER SHIELD INSULATED AND CONNECTED AS SHOWN.
3. INNER SHIELD CUT AND INSULATED
4. INNER SHIELD INSULATED AND CONNECTED AS SHOWN
5. SWITCH PREWIRED & POTTED
6. (DIODE ASSY) IS PREWIRED.
7. CUT, TAPE AND STOW UNINSULATED DRAIN WIRE
8. SECURE RING TERMINAL TO P.C. BOARD MOUNTING PLATE USING THE EXISTING SCREW LOCATED IN THE LOWER RIGHT HAND CORNER. (WHERE EXISTING GROUND STRAP TO C.U. COVER IS SECURED)

10. DRAWING 2. ELECTRICAL WIRING FOR CONSOLE/CABLE REEL

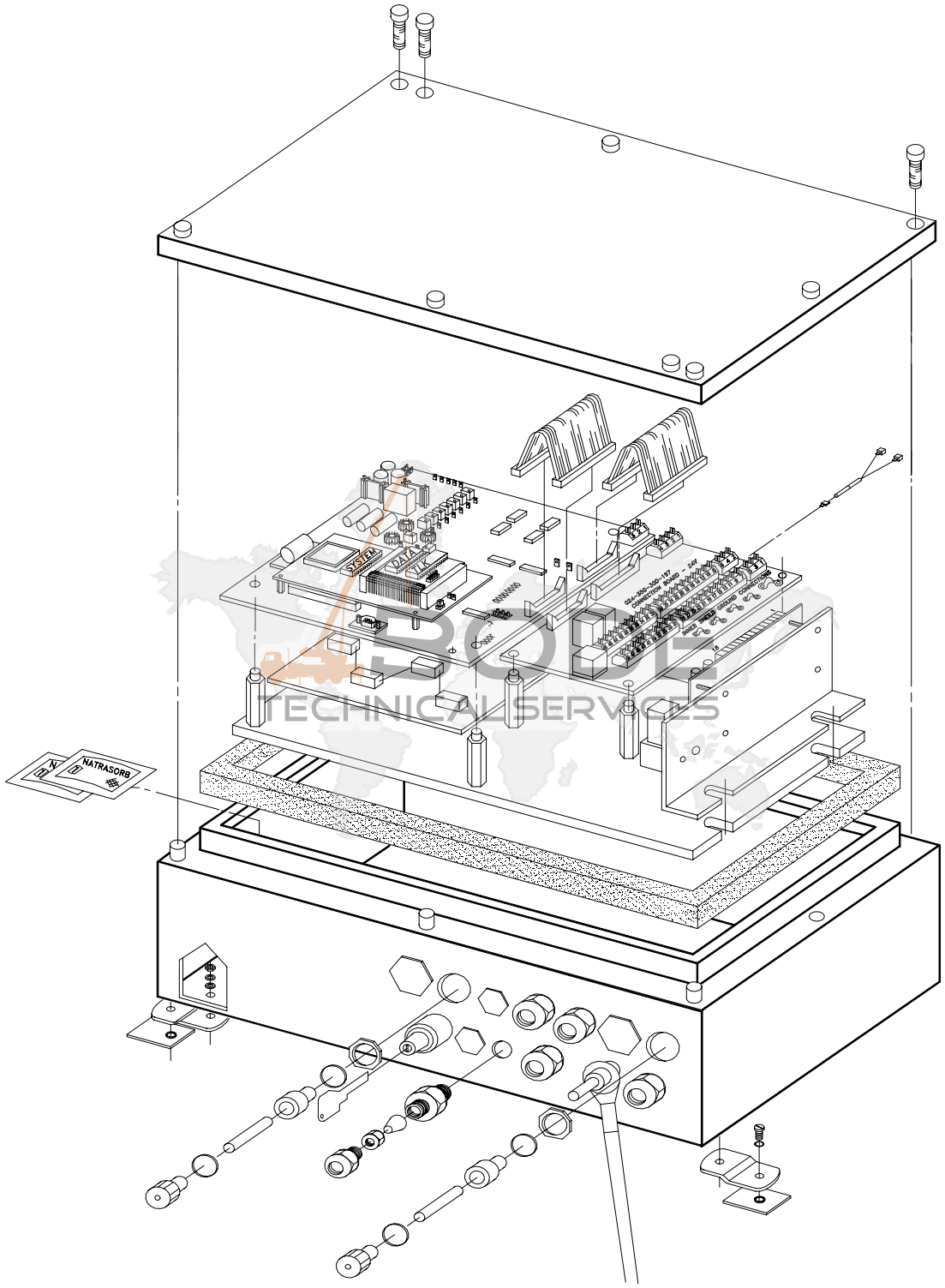


10. DRAWING 3A. CENTRAL UNIT DS350/2766

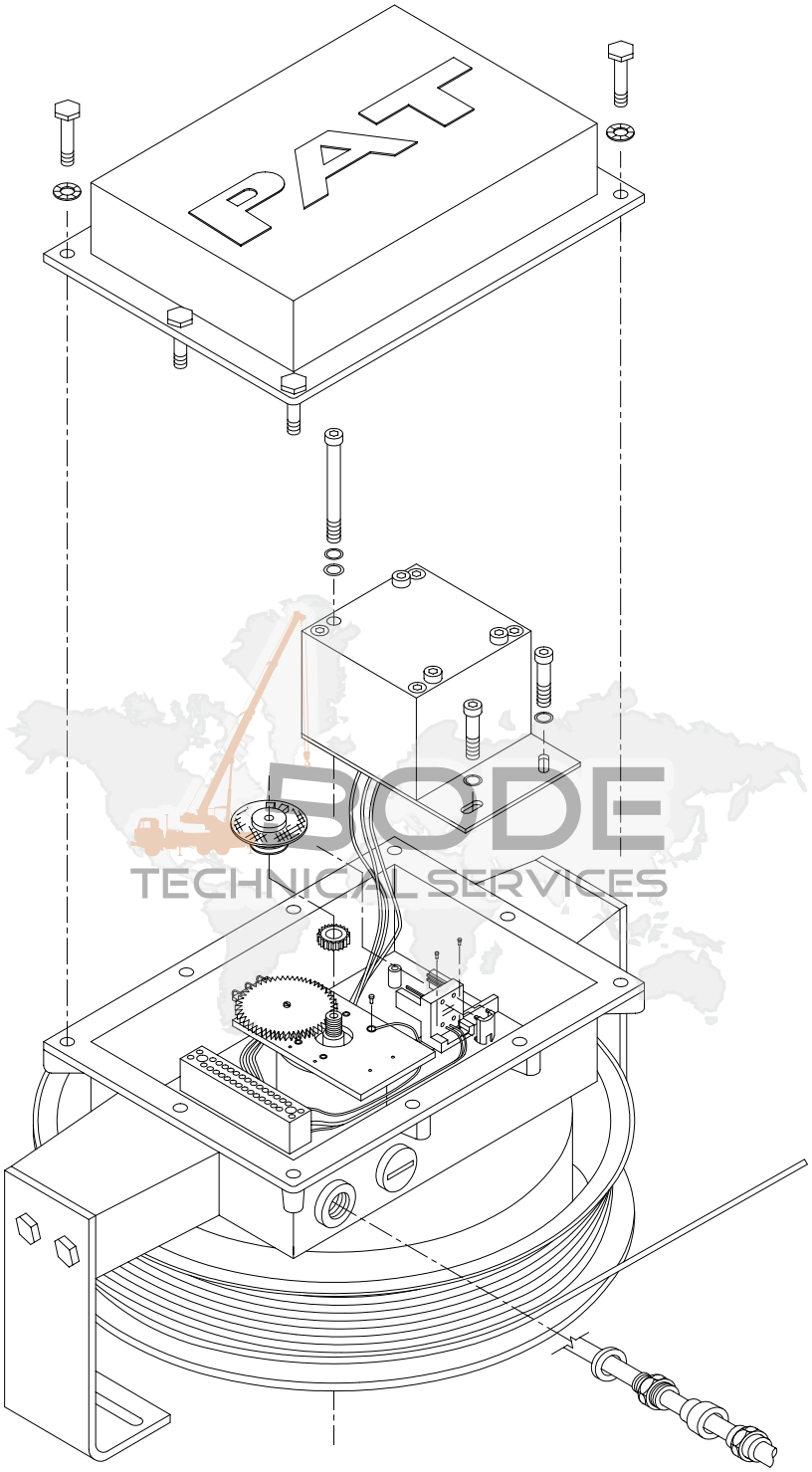


10. DRAWING 3B. CENTRAL UNIT DS350/2767

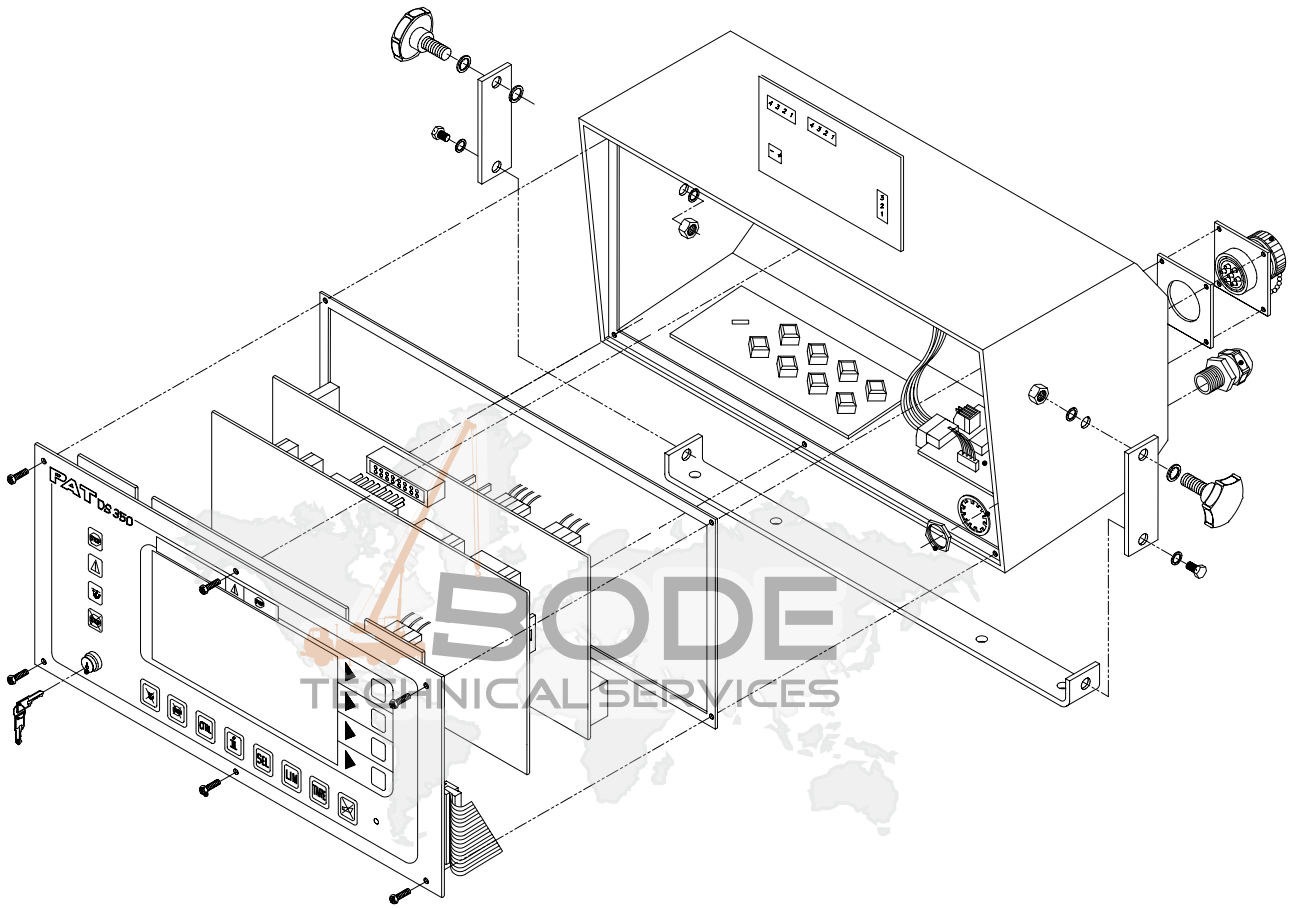
ACCUCAL UPGRADE (SERIAL NUMBER 86638 AND BEYOND)



10. DRAWING 4. CABLE REEL

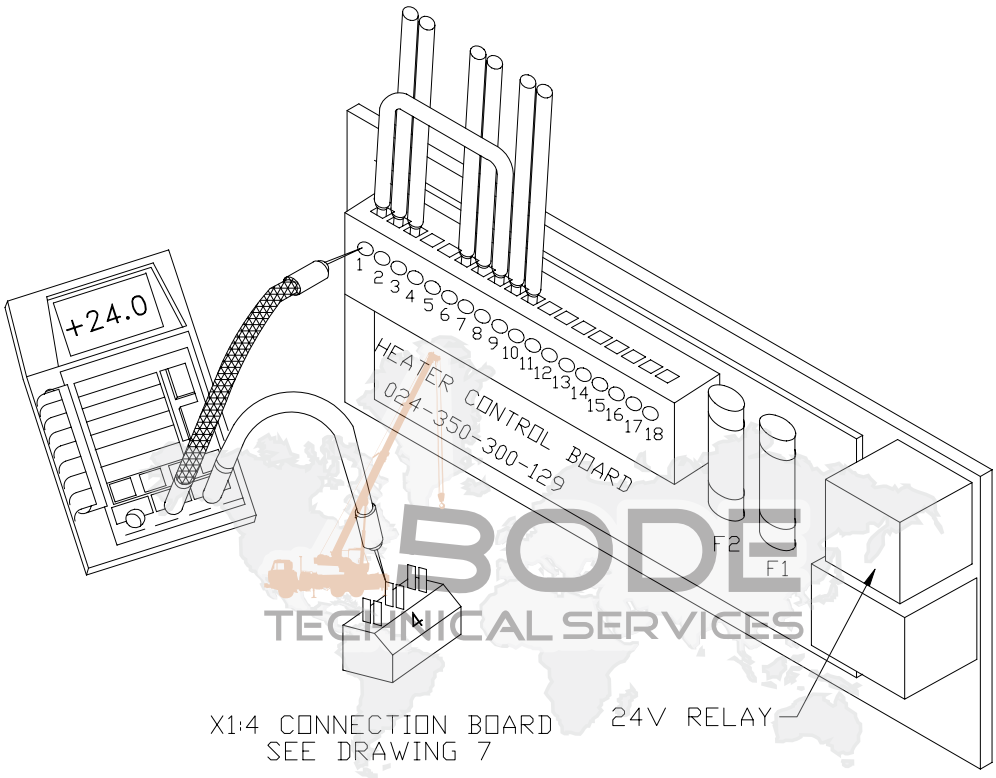


10. DRAWING 5. 050-350-061-328 CONSOLE



10. DRAWING 6. HEATER CONTROL BOARD W/VOLTMETER ON X1:1 & X1:4

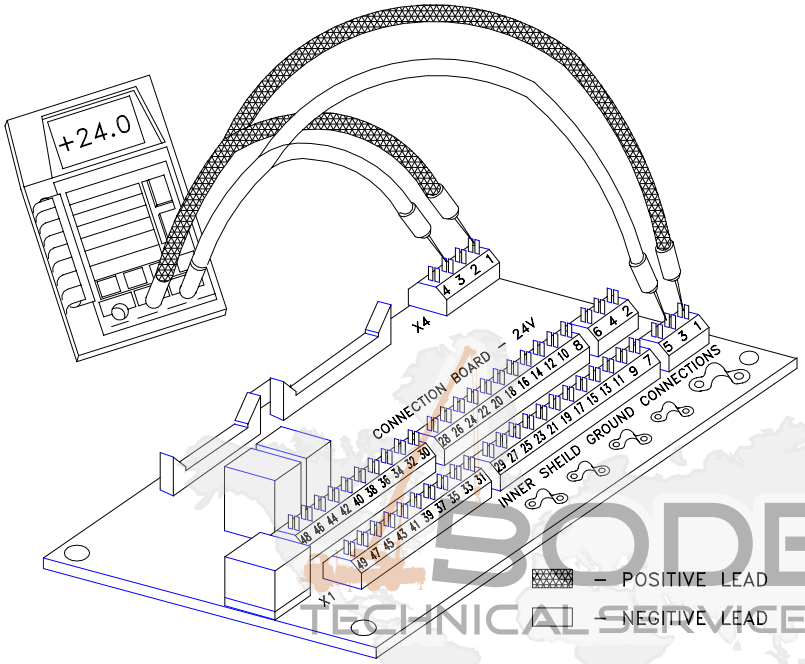
VOLTMETER SHOULD MEASURE +24 VOLTS BETWEEN CONNECTIONS X1:1,8,9,10, or 11 (+24V, POSITIVE) AND X1:2 (GROUND)
REFER TO DRAWING 1 AND 2 FOR WIRING
REFER TO DRAWING 3 FOR BOARD LOCATION



▨ - POSITIVE LEAD
▭ - NEGITIVE LEAD

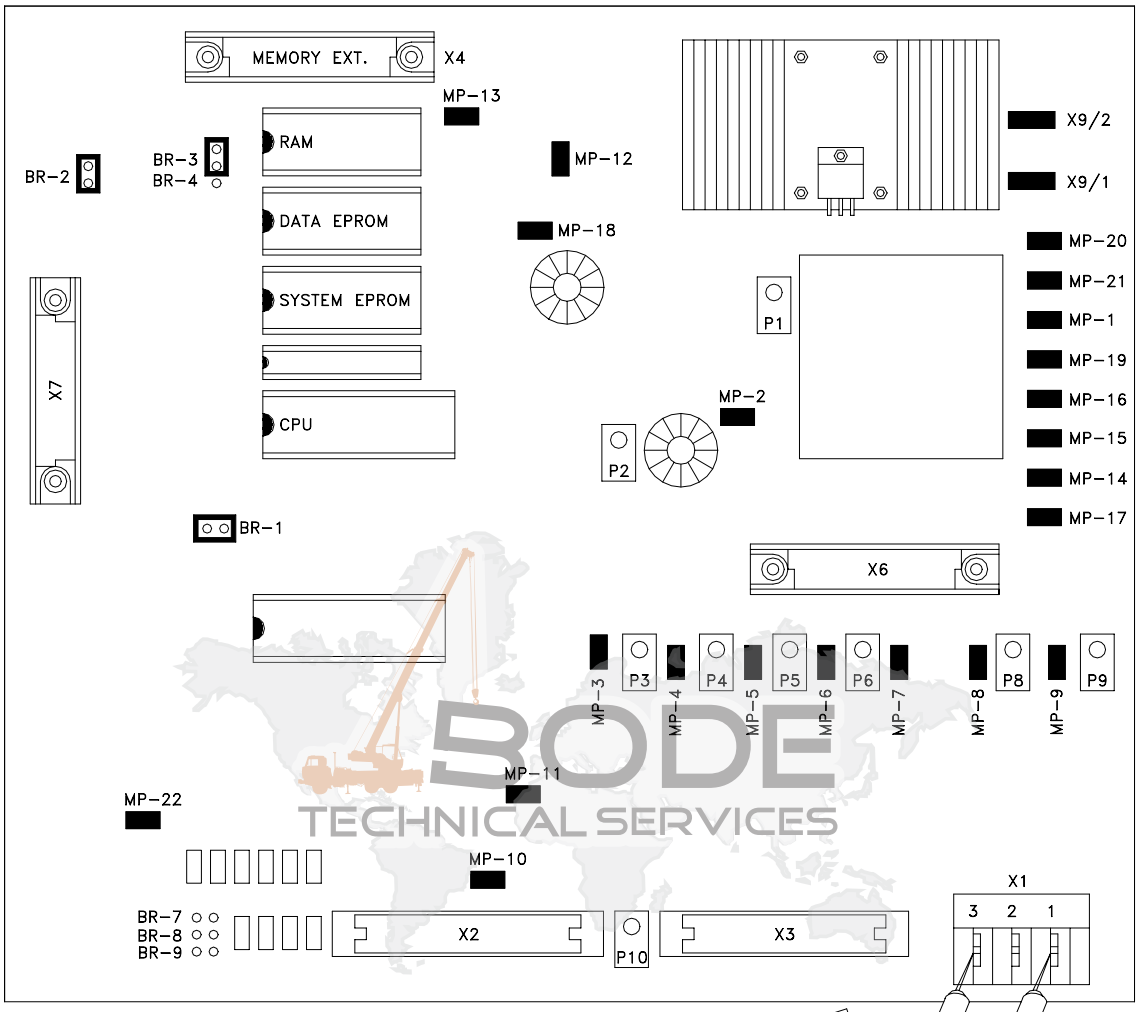
10. DRAWING 7. CONNECTION BOARD W/VOLTMETER ON X1:1 & X1:3 W/VOLTMETER ON X4:1 & X4:3

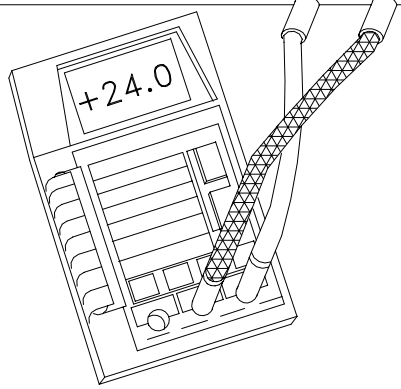
VOLTMETER SHOULD MEASURE +24 VOLTS BETWEEN CONNECTIONS:
INPUT - X1:1 (POSITIVE) & X1:3 (GROUND)
OUTPUT - X4:1 (POSITIVE) & X4:3 (GROUND)
REFER TO DRAWING 3 FOR BOARD LOCATION



10. DRAWING 8A. MAIN BOARD W/VOLTMETER ON X1:1 & X1:3

Main Board 024-350-060-094



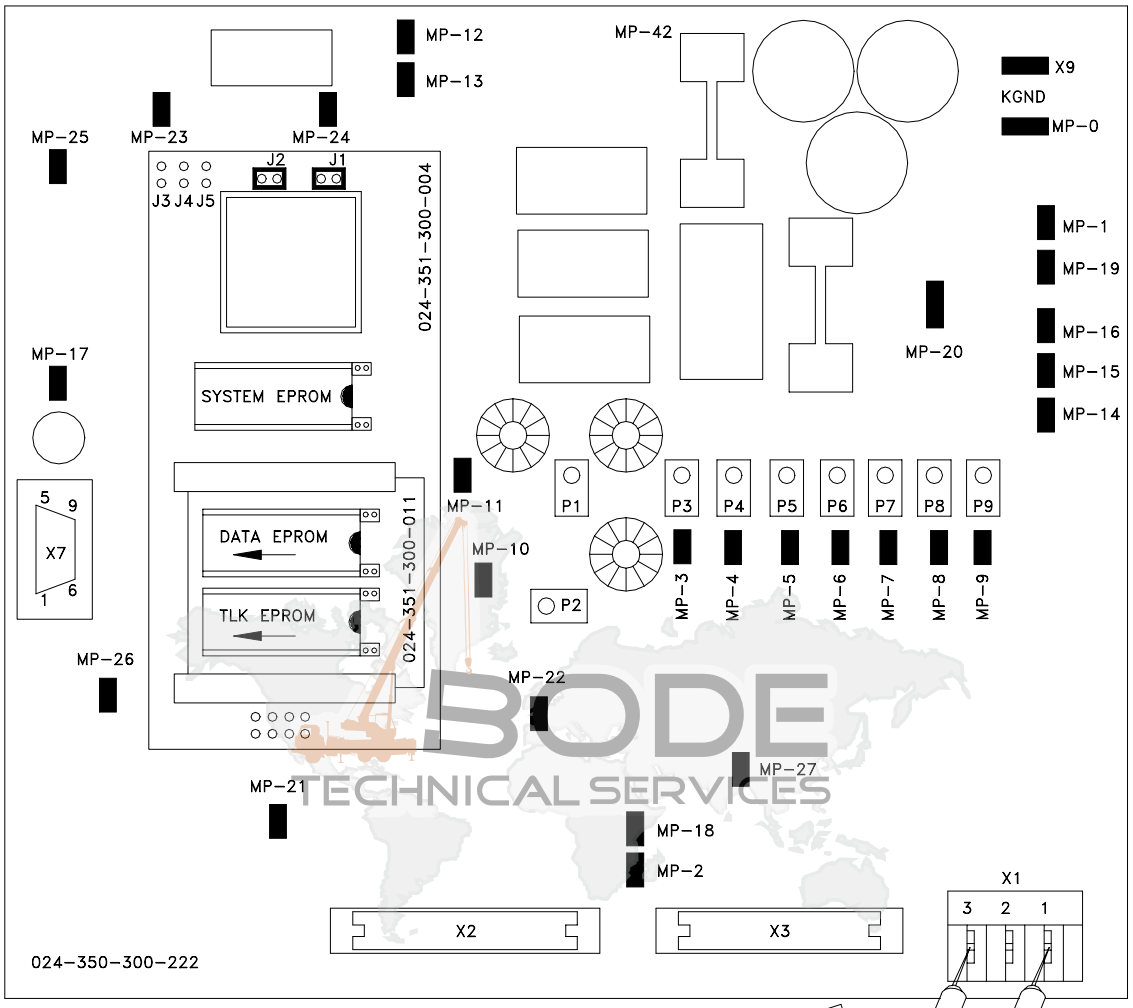


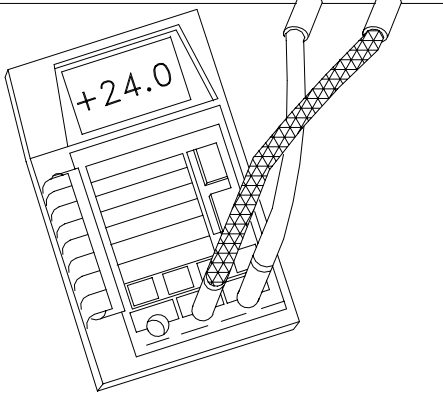
VOLTMETER SHOULD MEASURE +24 VOLTS
BETWEEN CONNECTION X1:1 (POSITIVE)
AND X1:3 (GROUND)

▨ – POSITIVE
□ – NEGITIVE

10. DRAWING 8B. MAIN BOARD W/VOLTMETER ON X1:1 & X1:3

Main Board 024-350-060-222



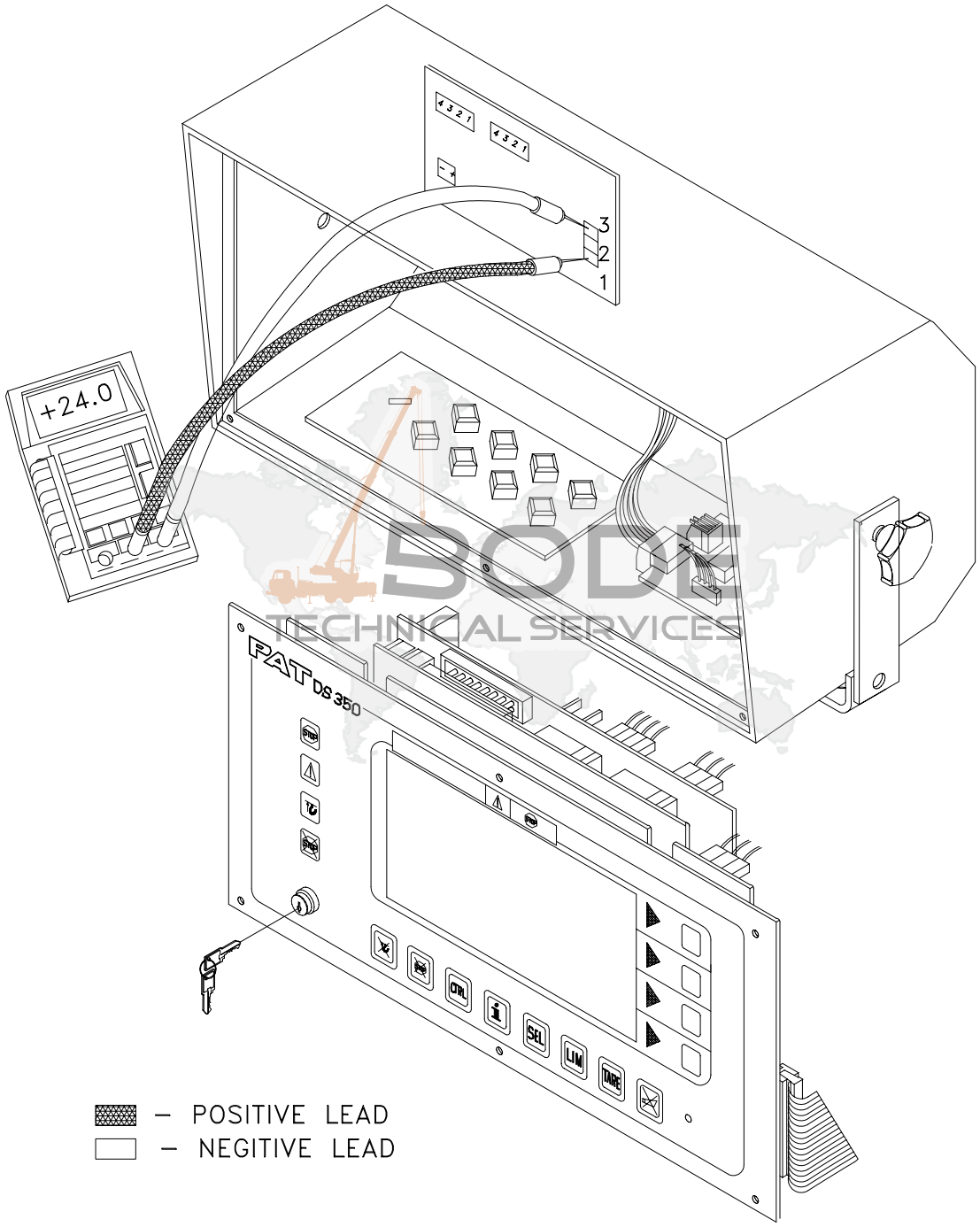


VOLTMETER SHOULD MEASURE +24 VOLTS
BETWEEN CONNECTION X1:1 (POSITIVE)
AND X1:3 (GROUND)

▨ – POSITIVE
□ – NEGITIVE

10. DRAWING 9. CONSOLE HEATER CONTROL BOARD W/VOLTMETER ON X1:1 & X1:3

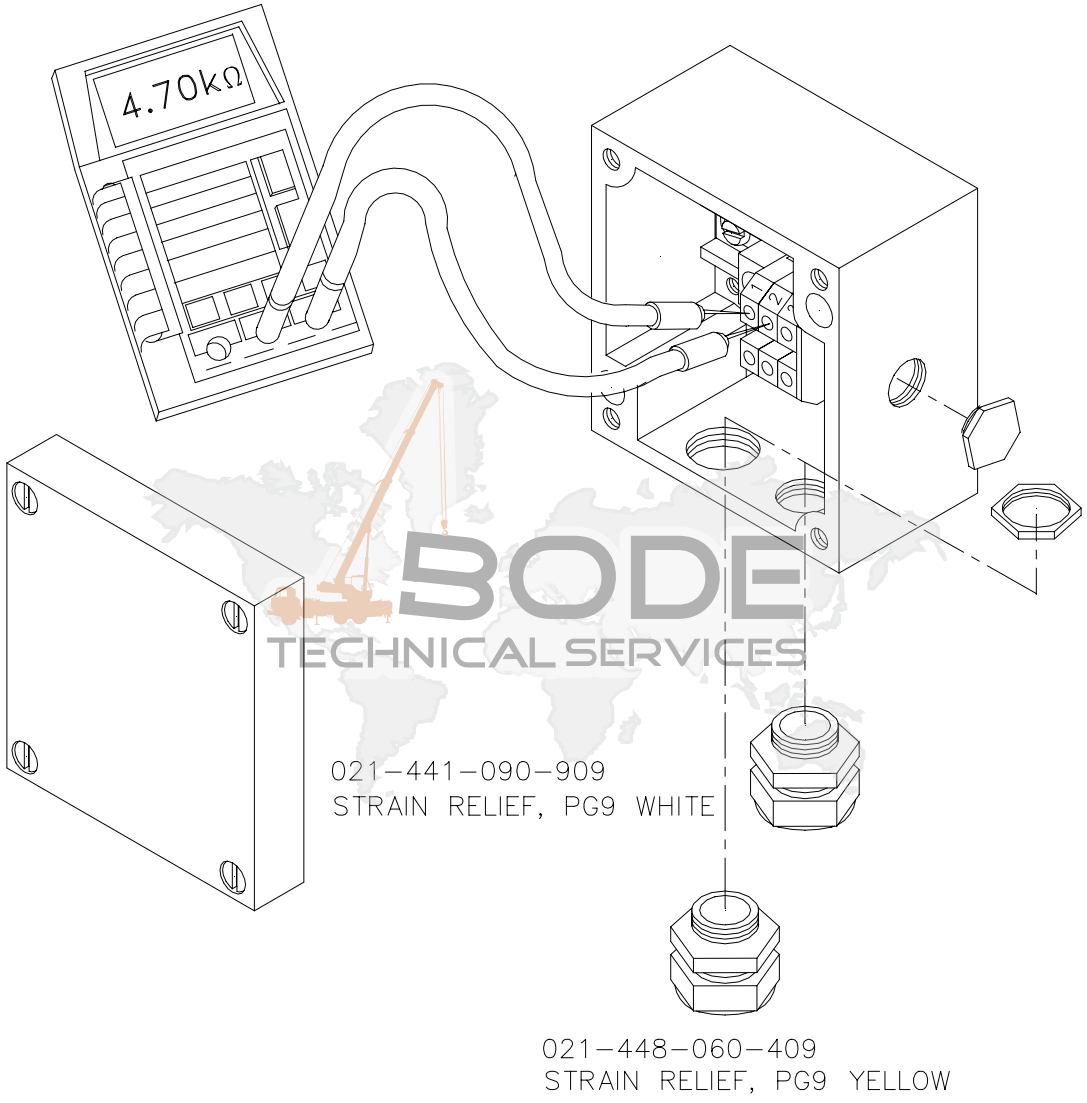
VOLTMETER SHOULD MEASURE +24 VOLTS BETWEEN CONNECTIONS X1:1 (+24V) AND X1:3 (GROUND)



10. DRAWING 10. BOOM TIP JUNCTION BOX W/VOLTMETER ON 1 & 2

TURN POWER OFF OR DISCONNECT X1:35 ON CONNECTION BOARD IN CENTRAL UNIT. MEASURE THE RESISTANCE BETWEEN TERMINALS 1 & 2.

- A2B SWITCH CLOSED = 4700 ±500 OHMS
- A2B SWITCH OPEN = 1MEGOHM

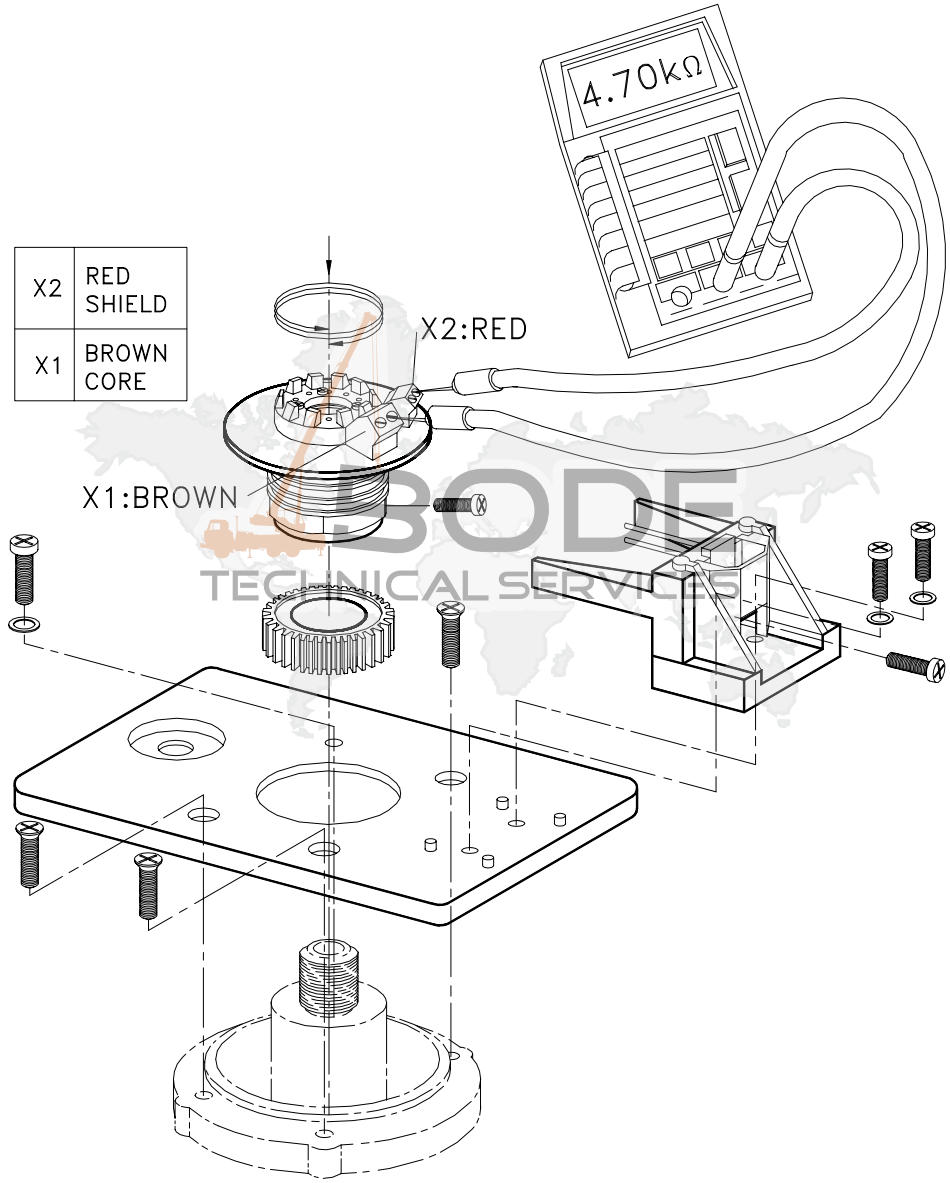


10. DRAWING 11. SLIP RING W/VOLTMETER ON RED & BROWN

TURN POWER OFF OR DISCONNECT X1:35 ON CONNECTION BOARD IN CENTRAL UNIT. MEASURE THE RESISTANCE BETWEEN X2:RED & X1:BROWN.

- A2B SWITCH CLOSED = 4700 ±500 OHMS
- A2B SWITCH OPEN = 1MEGAOHM

NOTE: REFER TO DRAWING 2 FOR WIRING DIAGRAM.

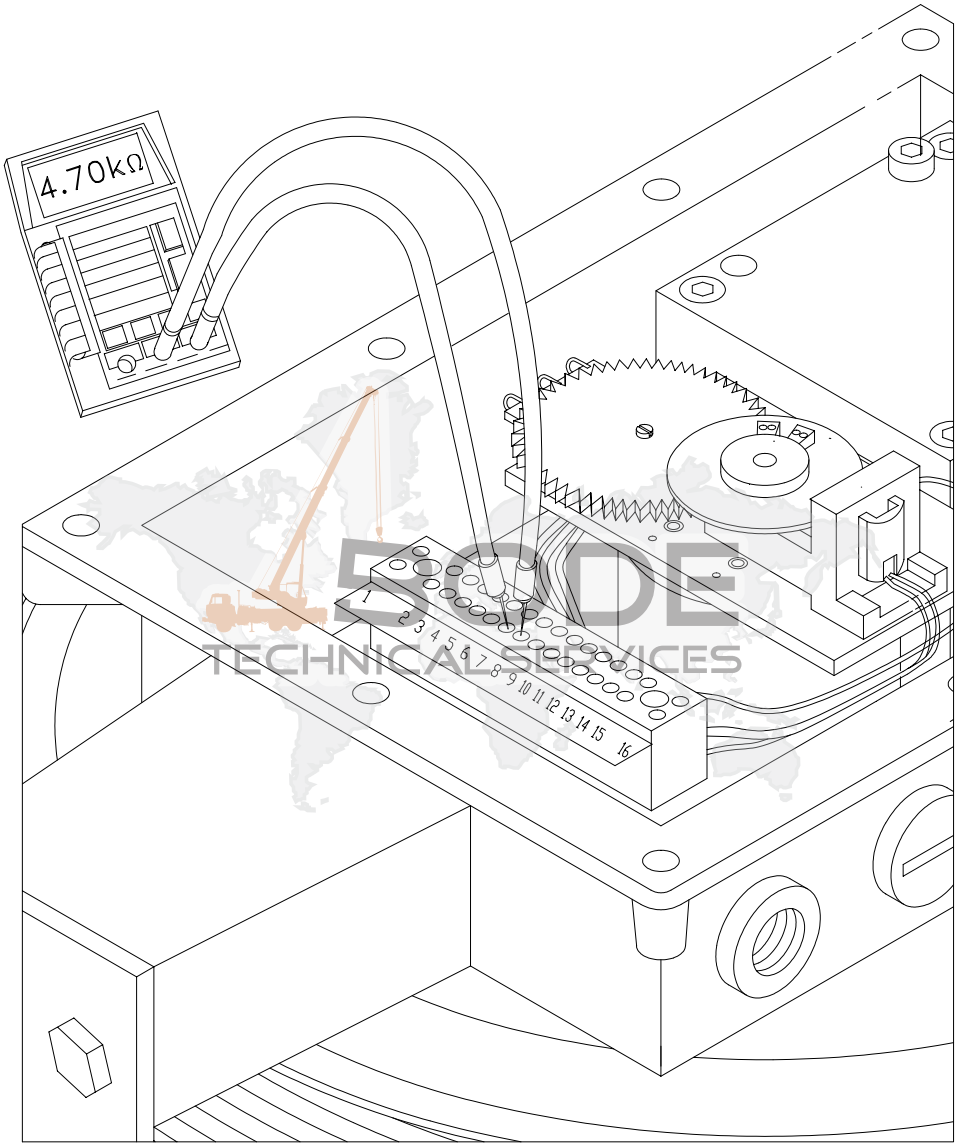


10. DRAWING 12. CABLE REEL W/VOLTMETER ON 7 & 8

TURN POWER OFF OR DISCONNECT X1:35 ON CONNECTION BOARD IN CENTRAL UNIT. MEASURE THE RESISTANCE BETWEEN TERMINALS 7 & 8.

- A2B SWITCH CLOSED = 4700 ±500 OHMS
- A2B SWITCH OPEN = 1MEGOHM

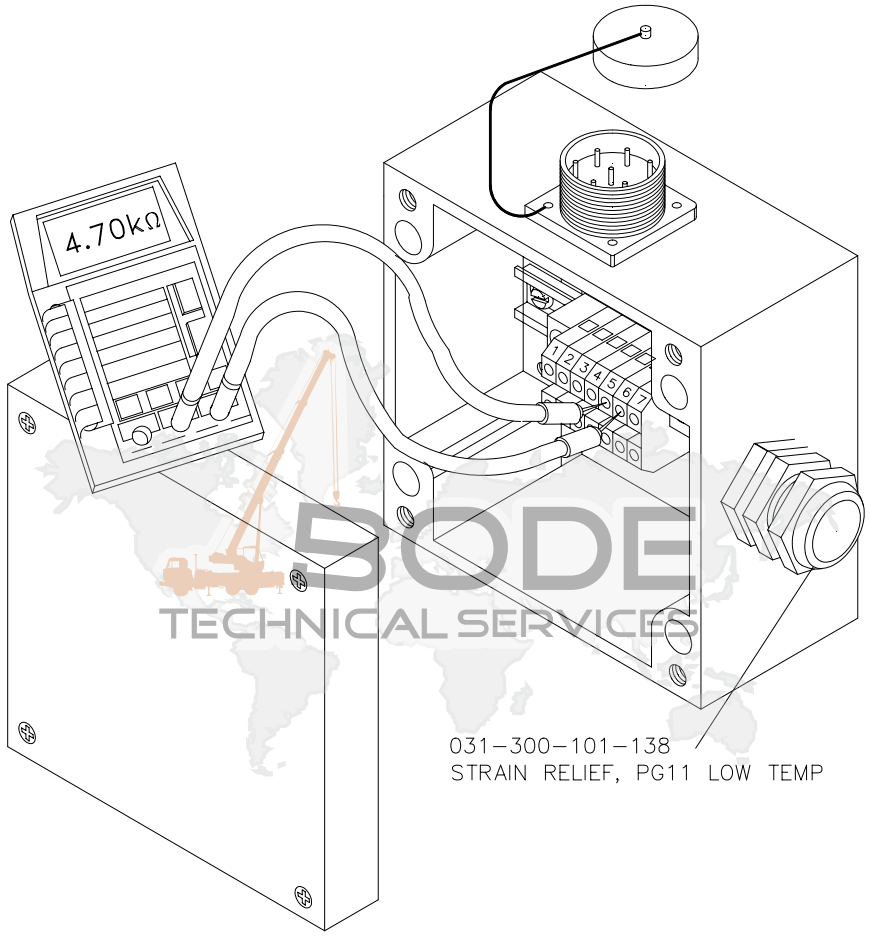
NOTE: REFER TO DRAWING 2 FOR WIRING DIAGRAM.



10. DRAWING 13. BOOM BASE JUNCTION BOX W/VOLTMETER ON 5 & 6

TURN POWER OFF OR DISCONNECT X1:35 ON CONNECTION BOARD IN CENTRAL UNIT. MEASURE THE RESISTANCE BETWEEN TERMINALS 5 & 6.

- A2B SWITCH CLOSED = 4700 ±500 OHMS
- A2B SWITCH OPEN = 1MEGAOHM

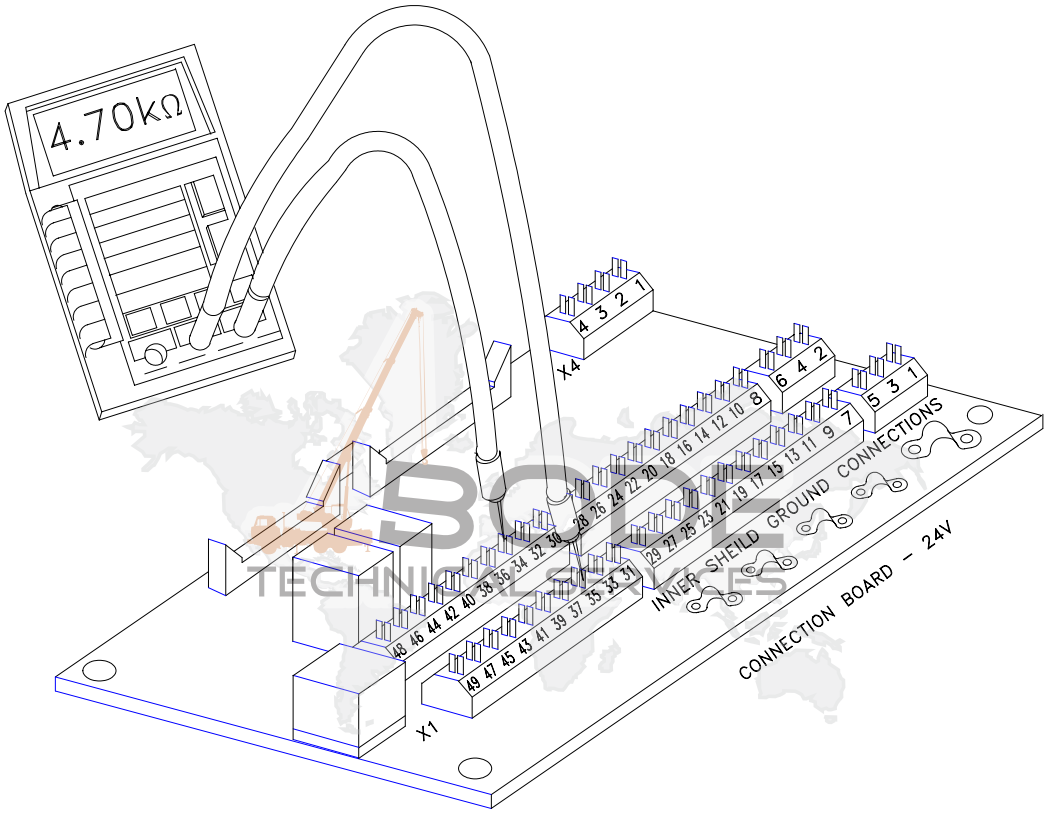


10. DRAWING 14. CONNECTION BOARD W/VOLTMETER ON X1:34 & X1:35

TURN POWER OFF TO CENTRAL UNIT. MEASURE THE RESISTANCE BETWEEN X1:34 & X1:35.

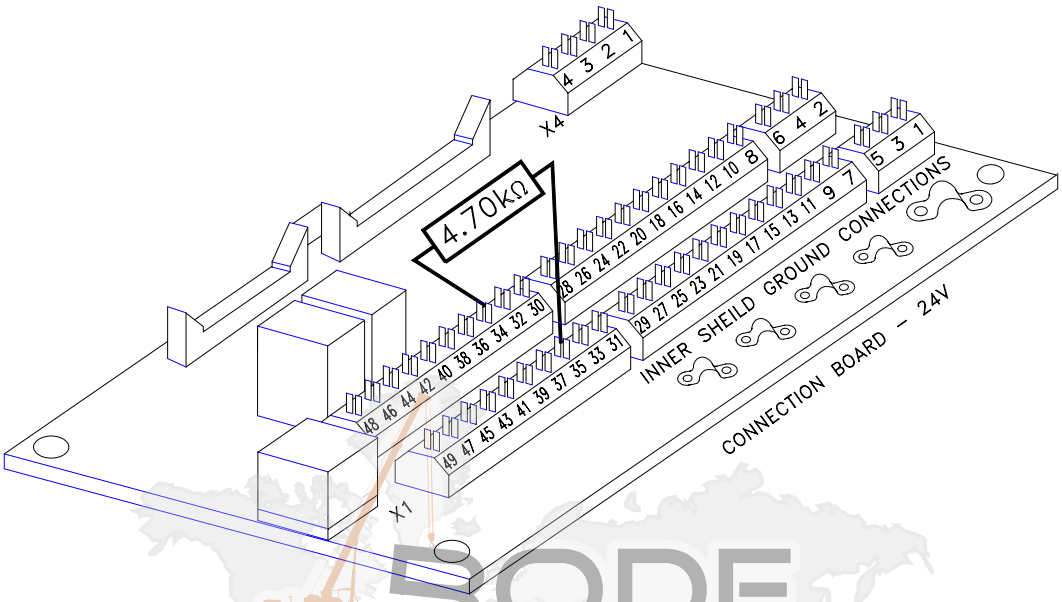
- A2B SWITCH CLOSED = 4700 ±500 OHMS
- A2B SWITCH OPEN = 1MEGOHM

REFER TO DRAWING 3 FOR BOARD LOCATION



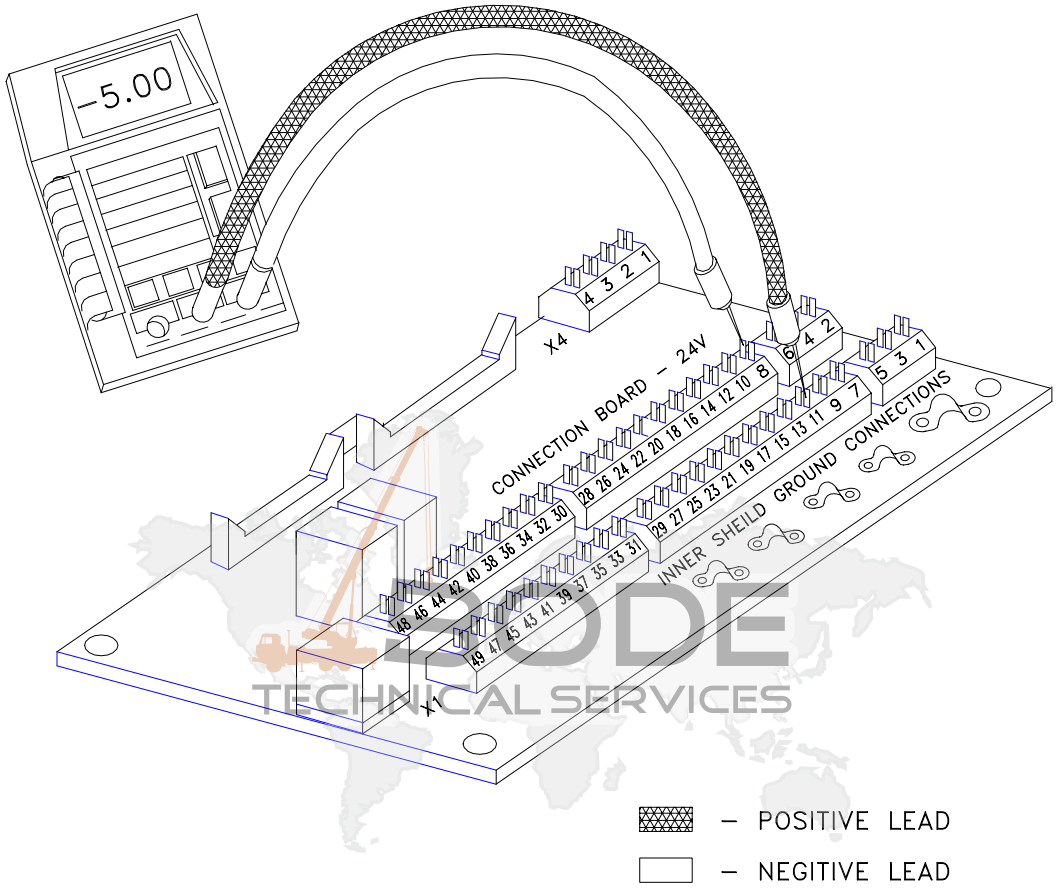
10. DRAWING 15. CONNECTION BOARD W/TEMPORARY 4.7K RESISTOR INSTALLED ON X1:34 & X1:35

TURN POWER OFF TO CENTRAL UNIT. INSTALL THE RESISTANCE BETWEEN X1:34 & X1:35. TURN POWER ON TO CENTRAL UNIT AND THE A2B ALARM SHOULD BE INACTIVE.



10. DRAWING 16. CONNECTION BOARD W/VOLTMETER ON X1:8 & X1:11

VOLTMETER SHOULD MEASURE -5.0 VOLTS BETWEEN CONNECTIONS X1:8 (GROUND) & X1:11 (-5.0V)

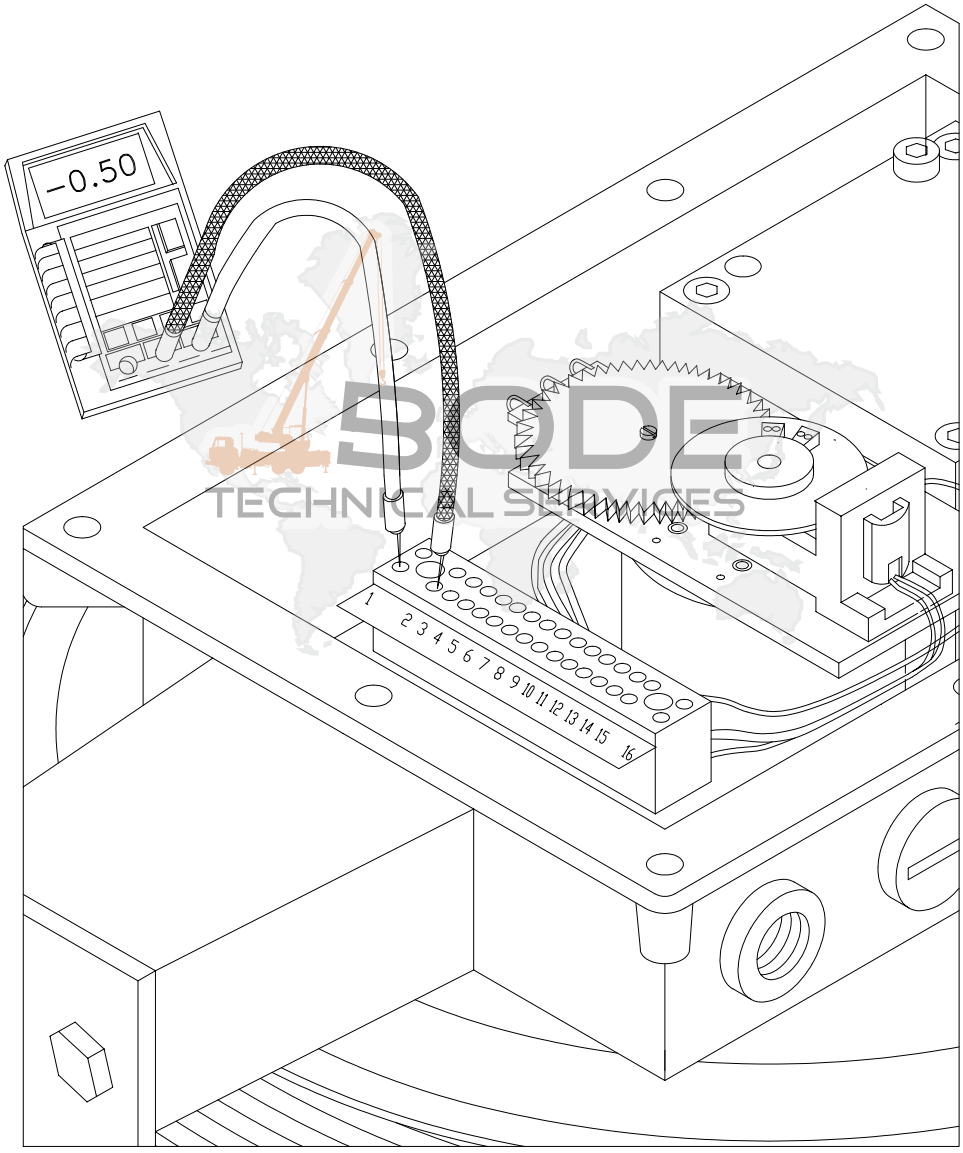


10. DRAWING 17. CABLE REEL W/VOLTMETER ON 1 & 2 W/VOLTMETER ON 1 & 3

WITH THE BOOM FULLY RETRACTED:

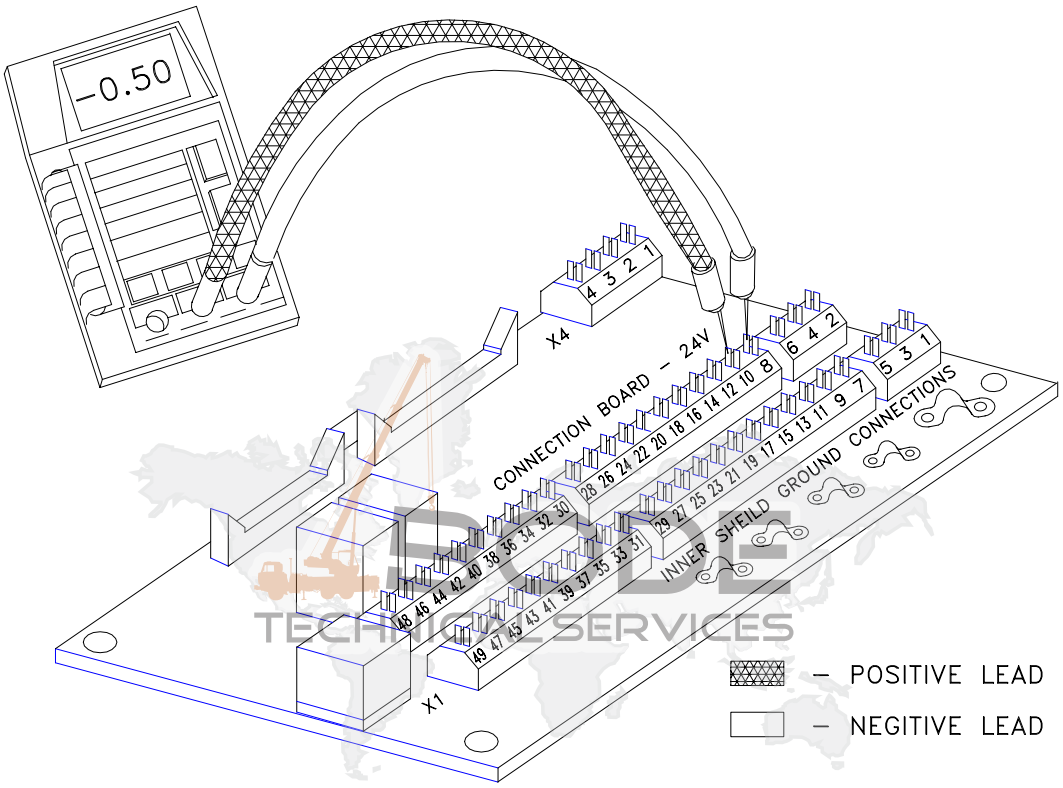
- THE VOLTMETER SHOULD MEASURE -0.50 VOLTS BETWEEN CONNECTIONS 1 (GROUND) AND 2 (SIGNAL VOLTAGE)
- THE VOLTMETER SHOULD MEASURE -5.0 VOLTS BETWEEN CONNECTIONS 1 (GROUND) AND 3 (SUPPLY VOLTAGE) - VOLTMETER NOT SHOWN

NOTE: REFER TO DRAWING 2 FOR WIRING DIAGRAM.



10. DRAWING 18. CONNECTIN BOARD W/VOLTMETER ON X1:8 & X1:10

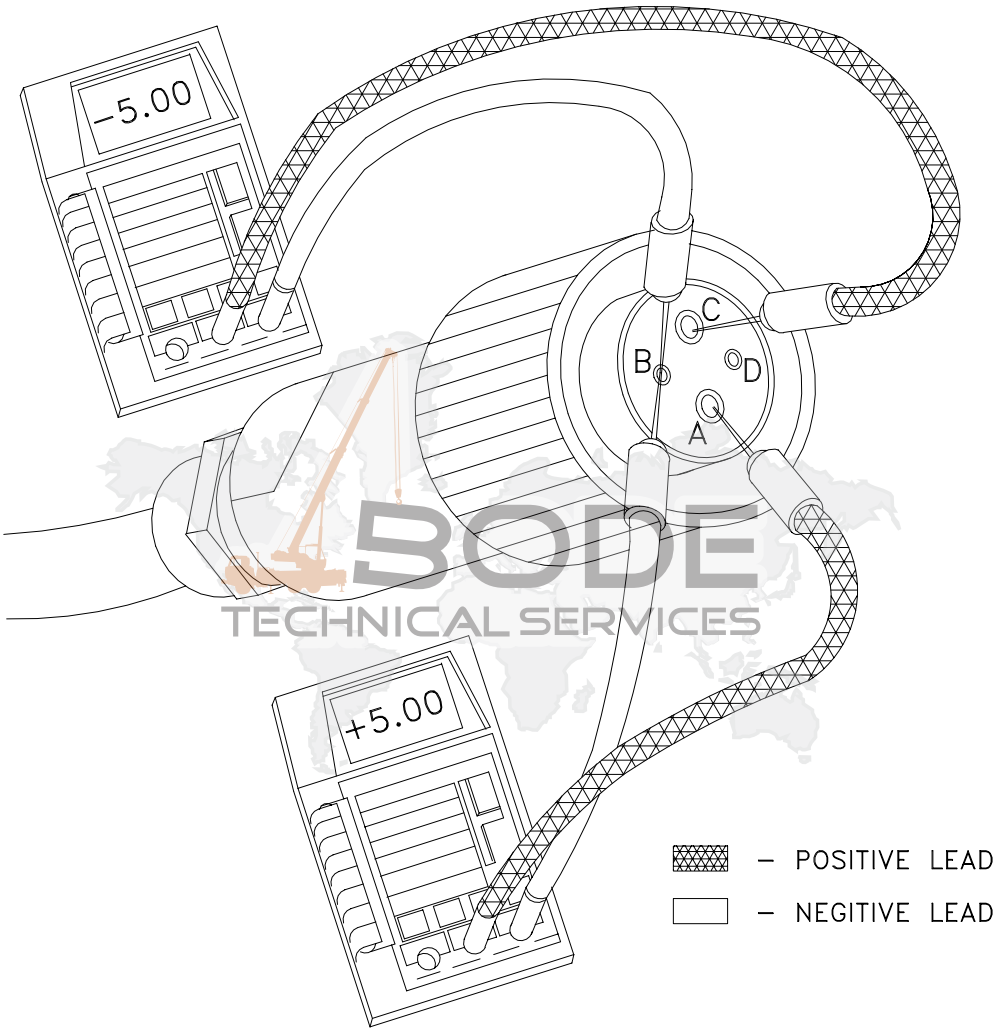
WITH THE BOOM FULLY RETACTED, THE VOLTMETER SHOULD MEASURE -0.5 VOLTS BETWEEN CONECTIONS:X1:8 (GROUND) & X1:10 (LENGTH SIGNAL)
REFER TO DRAWING 3 FOR BOARD LOCATION



10. DRAWING 19. PRESSURE TRANSDUCER CABLE W/VOLTMETER ON A & B AND B & C

- VOLTMETER SHOULD MEASURE +5.0 VOLTS BETWEEN CONNECTION A (+5.0V) & B (GROUND)
- VOLTMETER SHOULD MEASURE -5.0 VOLTS BETWEEN CONNECTION C (-5.0V) & B (GROUND)

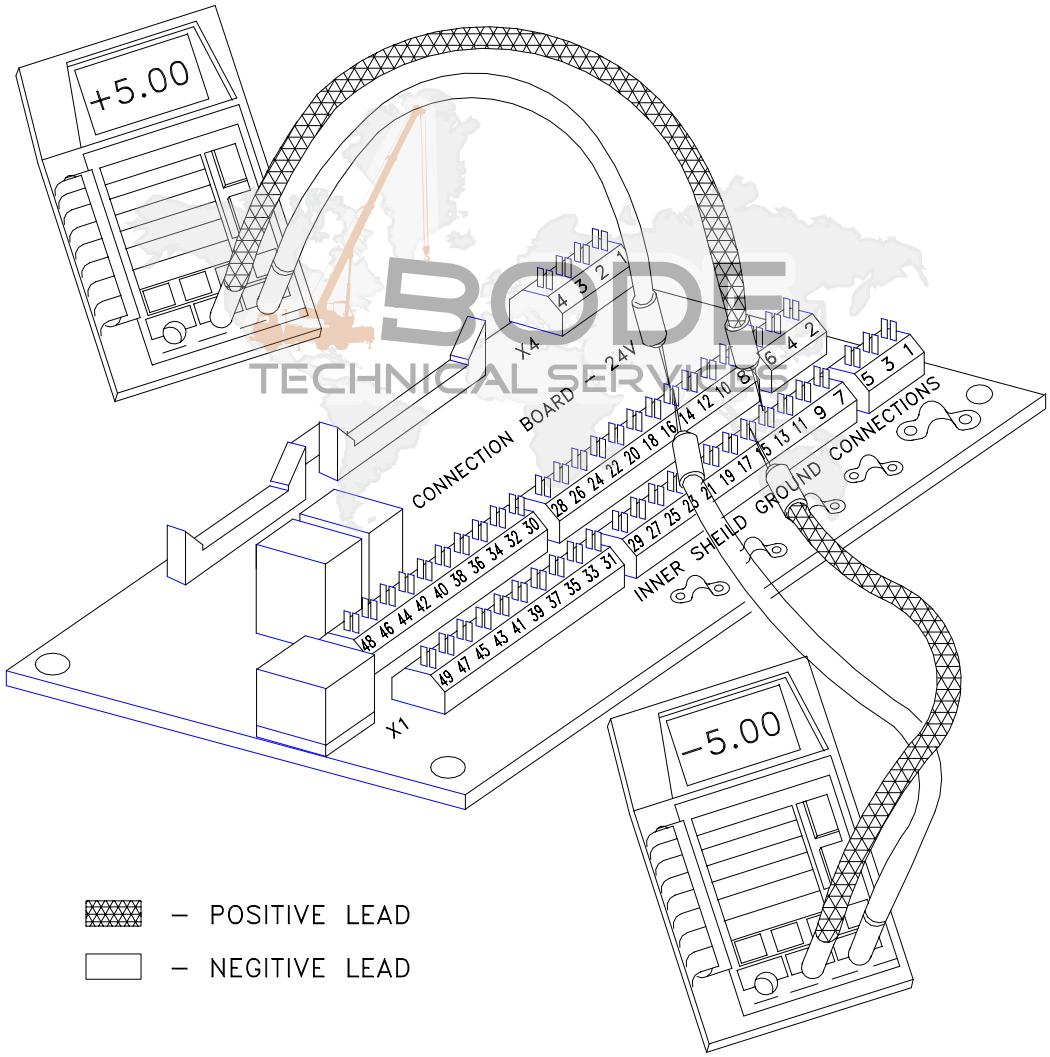
REFER TO DRAWING 1 FOR WIRING DIAGRAM



10. DRAWING 20. CONNECTION BOARD
W/VOLTMETER ON X1:13 & X1:14
W/VOLTMETER ON X1:15 & X1:14
W/VOLTMETER ON X1:18 & X1:19
W/VOLTMETER ON X1:20 & X1:19

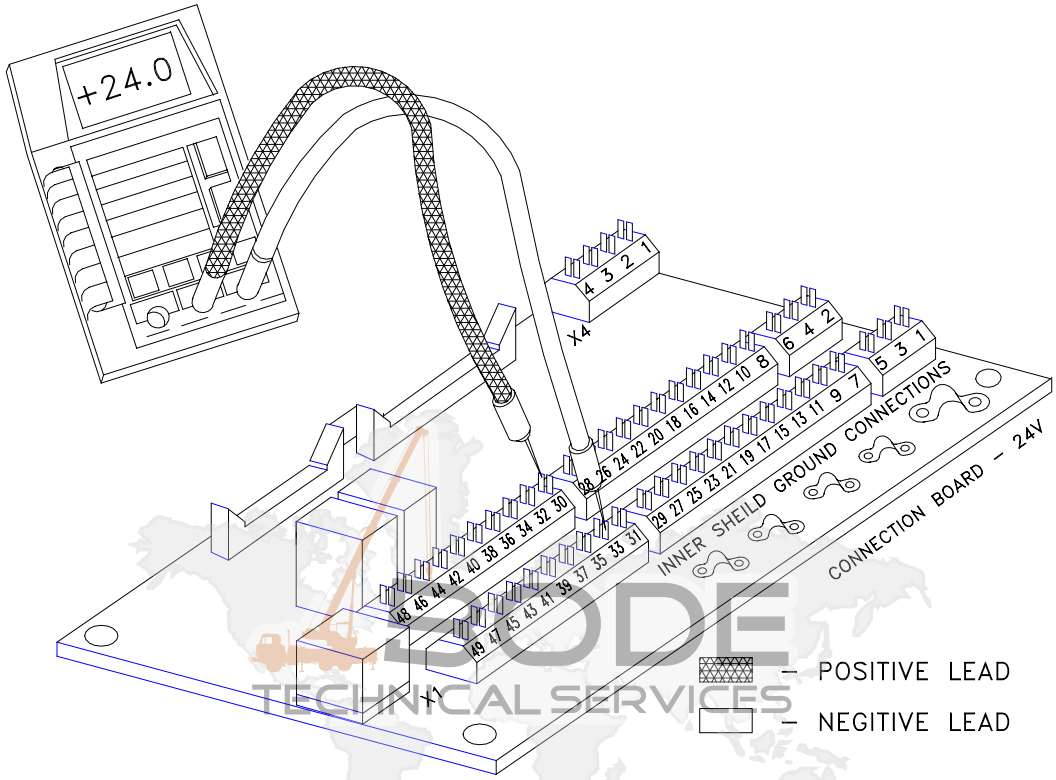
- VOLTMETER SHOULD MEASURE +5.0 VOLTS BETWEEN CONNECTIONS: X1:13 (+5.0V) & X1:14 (GROUND) X1:18 (+5.0V) & X1:19 (GROUND) - ACTUAL MEASUREMENT NOT SHOWN
- VOLTMETER SHOULD MEASURE -5.0 VOLTS BETWEEN CONNECTIONS: X1:15 (-5.0V) & X1:14 (GROUND) X1:20 (-5.0V) & X1:19 (GROUND) - ACTUAL MEASUREMENT NOT SHOWN

REFER TO DRAWING 1 FOR WIRING DIAGRAM



10. DRAWING 21. CONNECTION BOARD W/VOLTMETER ON X1:30 & X1:33

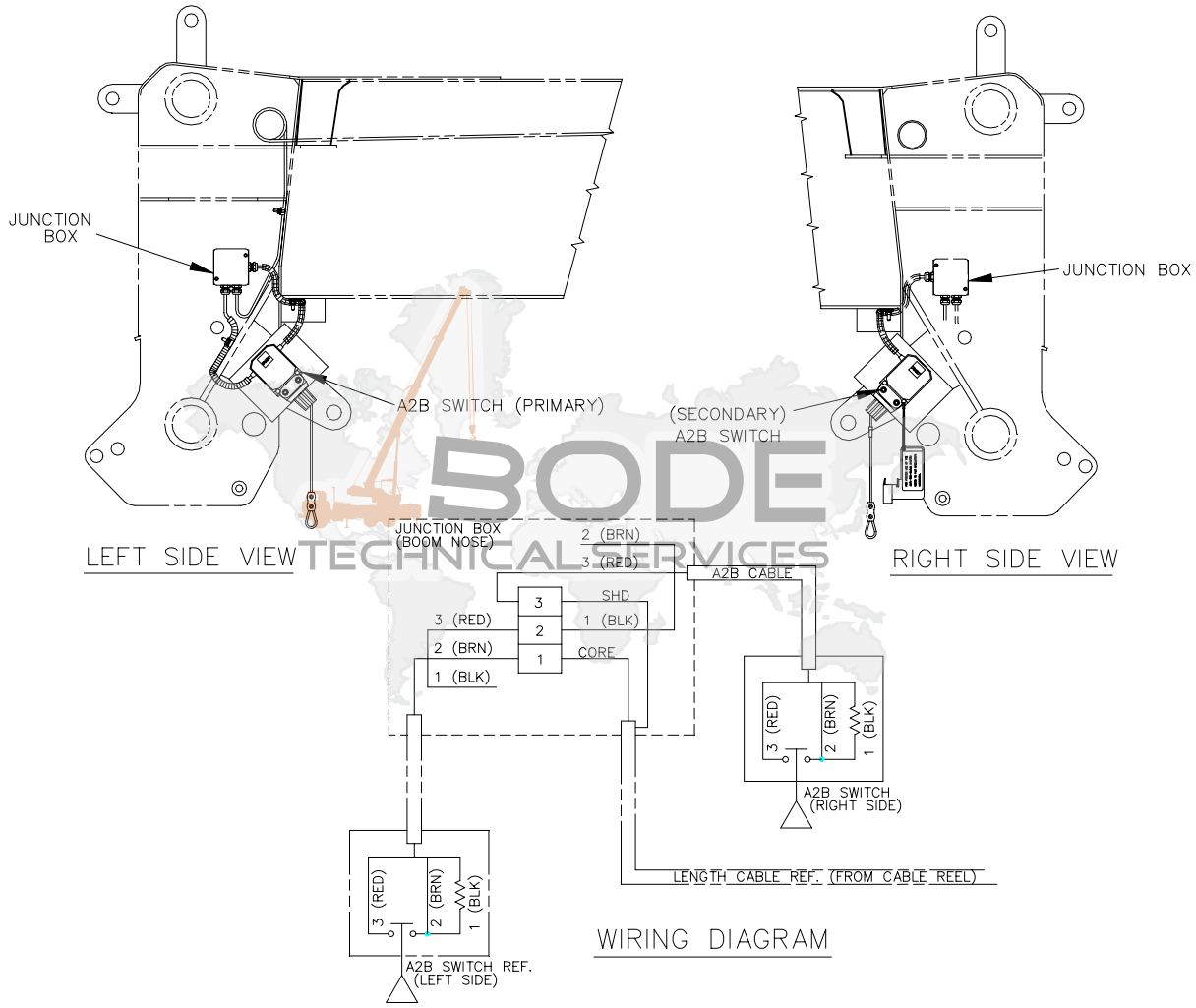
VOLTMETER SHOULD MEASURE +24 VOLTS BETWEEN CONNECTIONS:
X1:30 (POSITIVE) & X1:33 (GROUND)
REFER TO DRAWING 3 FOR BOARD LOCATION



10. DRAWING 22. SECONDARY ANTI-TWO BLOCK SWITCH FOR USE WITH PILE-DRIVER OPERATION

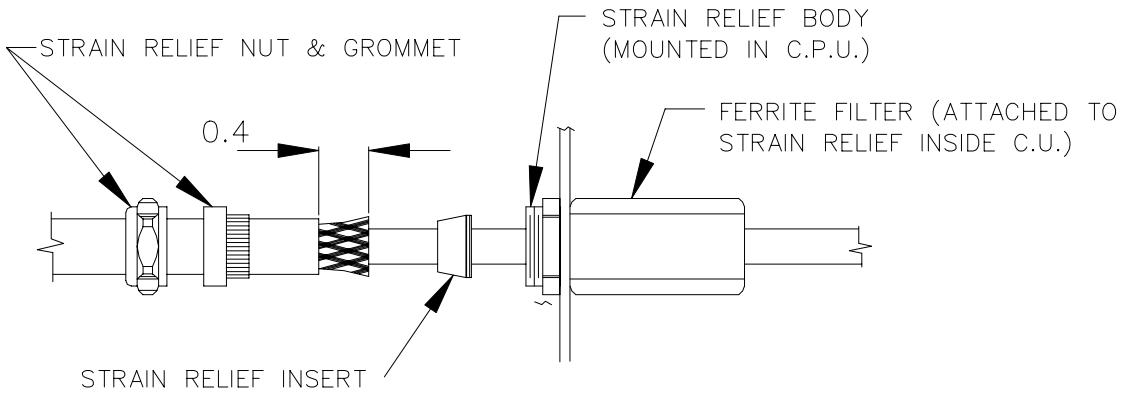
TO CHECK FUNCTION OF SECONDARY ANTI-TWO BLOCK SWITCH, MEASURE RESISTANCE AT BOOM NOSE JUNCTION BOX BETWEEN TERMINALS 2 AND 3 WITH OHMMETER.

SWITCH CLOSED = 4700 +/- 500 Ohms (WEIGHT INSTALLED)
SWITCH OPEN = > 1 MegaOhm (WEIGHT REMOVED)



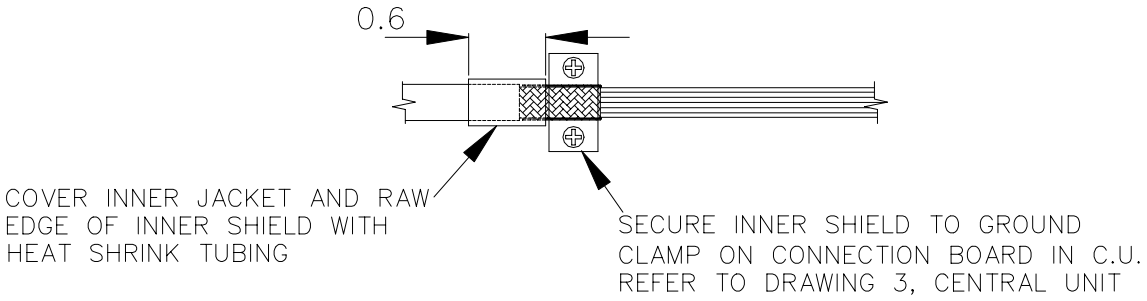
11. PROCEDURE 1. STRAIN RELIEF INSTALLATION

DOUBLE SHIELDED CABLE PREPARATION FOR EMC APPLICATIONS
Outer shield is grounded at strain relief with ferrite filter.

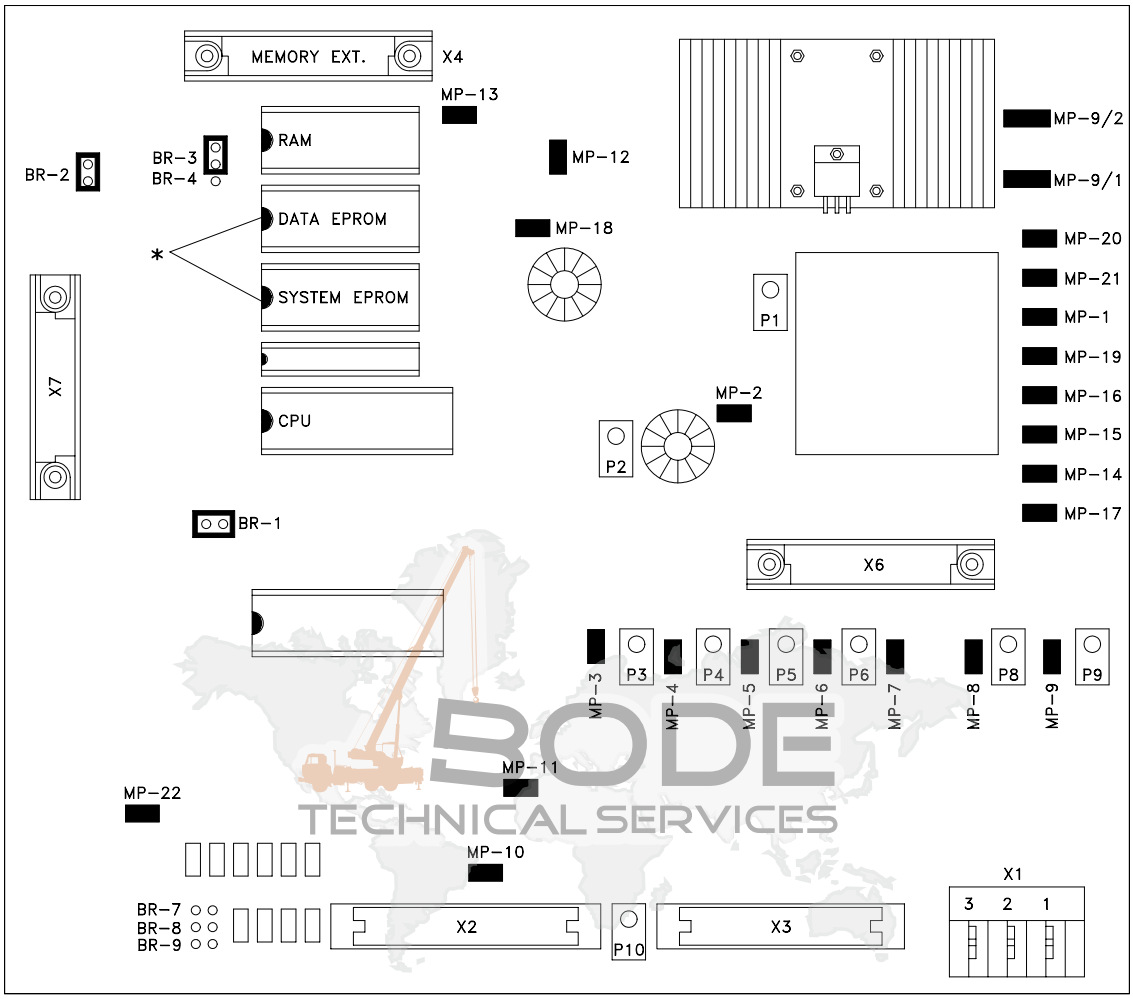


Inner shield is grounded on connection board.

Cut inner shield back to approximately 1.2 inch. Then fold inner shield back to inner jacket, so the inner shield is 0.6 inches in length.

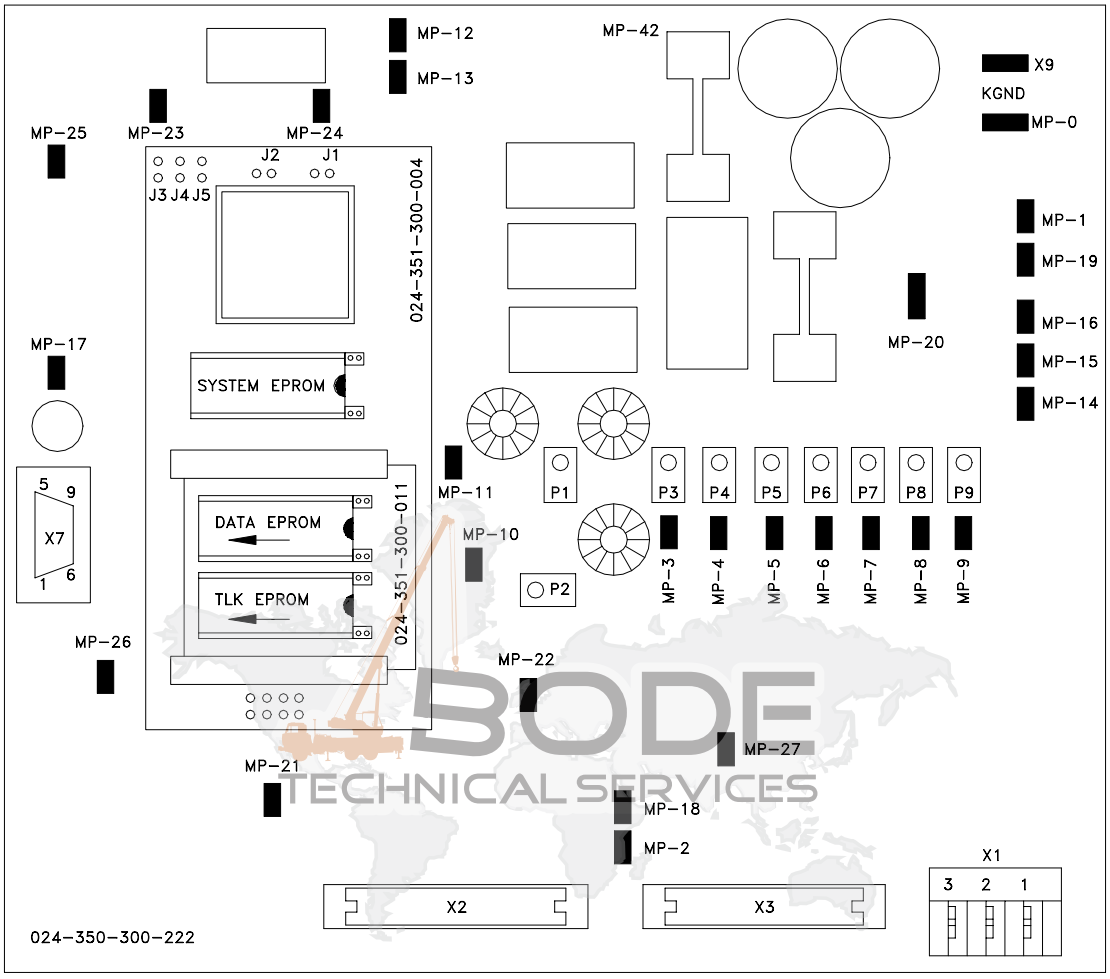


11. PROCEDURE 2A. EPROM LOCATION AND INSTALLATION



- Ensure the notch is in the correct direction.
  * Notch on eprom must match the notch on the socket and markings on the board.
- Place eproms in the correct eprom socket as shown.

11. PROCEDURE 2B. EPROM LOCATION AND INSTALLATION



- Ensure the notch is in the correct direction. Notch on eprom must match the notch on the socket and markings on the board.
- The DATA and TLK eproms fill the bottom of the socket as shown by the arrows.
- Place eproms in the correct eprom socket as shown.

11. PROCEDURE 3A. MAIN BORAD 024-350-300-094 REPLACEMENT

Refer to Drawing 3A, central unit parts list for board location.

Note: Mark all connections before removing, to identify location for reconnecting.

1. Turn system power off.
2. Remove the central unit lid.
3. See Procedure 2A for main board layout of data and system eproms. Use a eprom puller to remove eprom, be careful not to bend or break the legs on the eprom. Remove data and system eproms from old board and place in new board.
4. Remove timer board and 90° adapter #20 and #21 from old board and place in new board, see Drawing 3A for timer board location.
5. Disconnect ribbon cable #7 and #8, see Drawing 3A.
6. Disconnect connection X1:1 and X1:3, see Drawing 3A.

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

7. Remove the 9 main board mounting screws.
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. see Drawing 3B.
10. Insert the main board mounting screws and washers.
11. Connect X1:1, X1:3 and ribbon cables #7 and #8, see Drawing 3A.
12. Inspect the gasket for nicks, cuts, or damages. Refer to 031-300-340-003 DS 350 Central Unit Gasket Recommendations and 031-300-340-002 Central Unit Cover Installation and Tightening Procedure.

11. PROCEDURE 3B. MAIN BORAD 024-350-300-222 REPLACEMENT

Refer to Drawing 3B, central unit parts list for board location.

Note: Mark all connections before removing, to identify location for reconnecting.

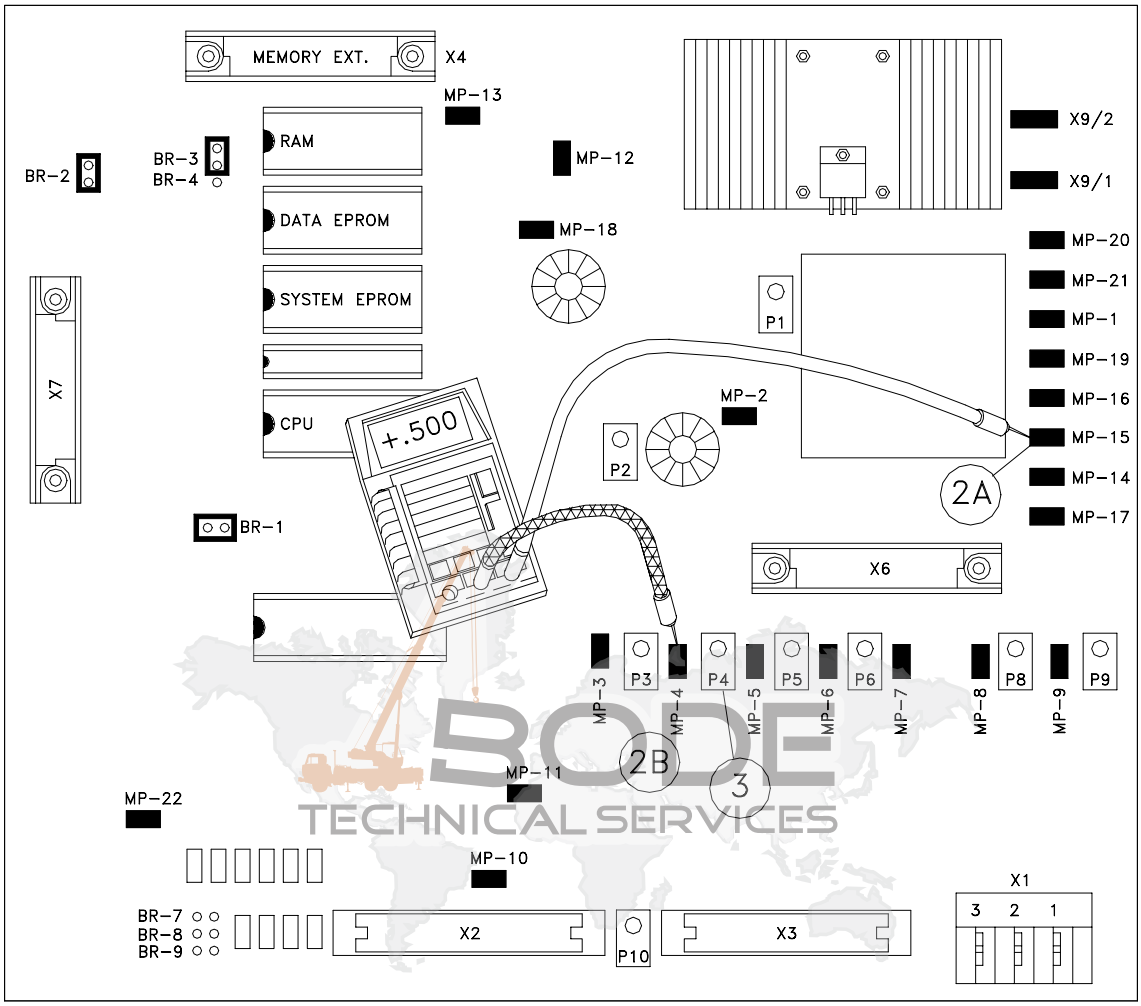
1. Turn system power off.
2. Remove the central unit lid.

NOTE: Take care not to damage the boards with the screw driver, 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.

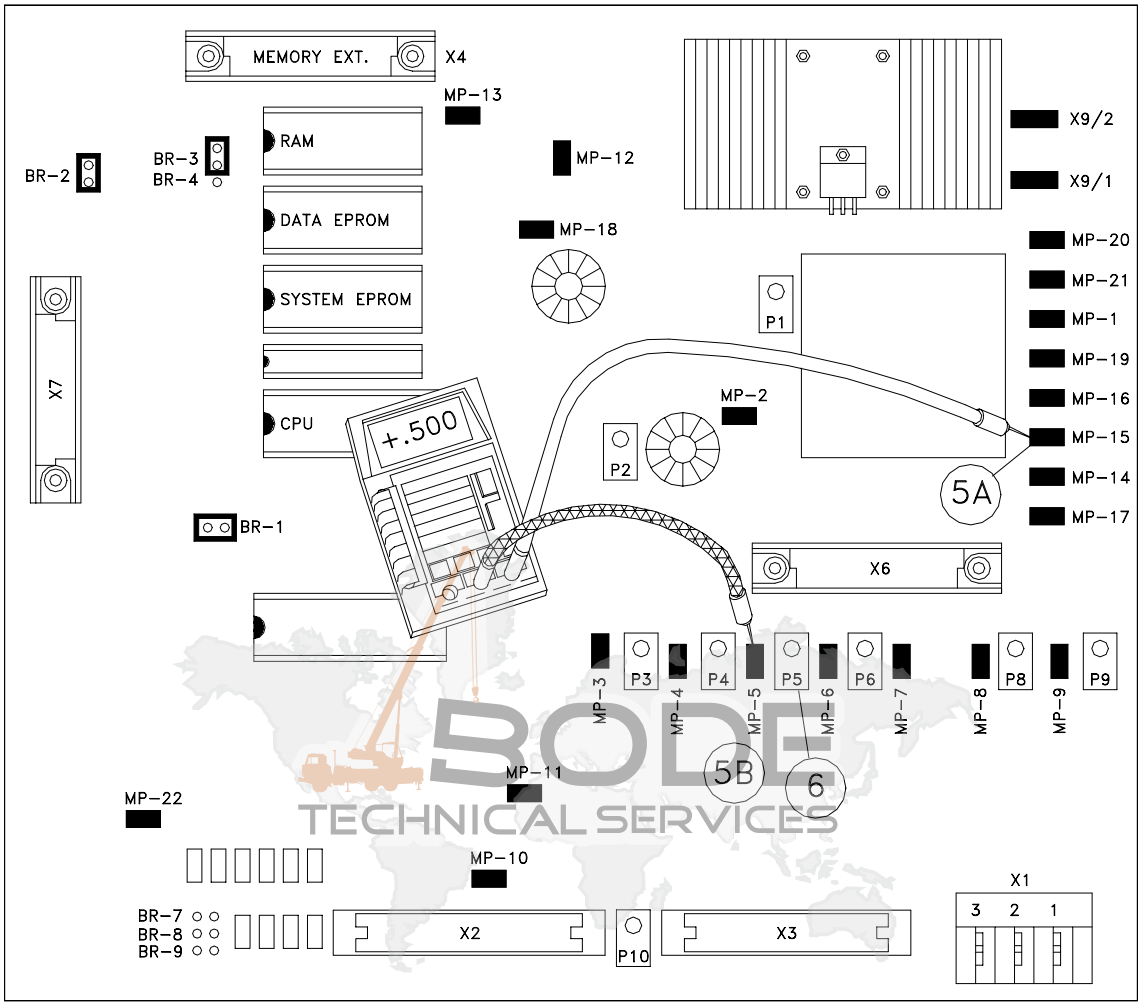
1. Remove CPU module board and eprom module Items #20 and #21, see Drawing 3B, by taking out the 4 small Philips screws holding them in place.
2. Disconnect ribbon cable #7 and #8, see Drawing 3B.
3. Disconnect connection X1:1 and X1:3, see Drawing 3B.
4. Remove the 9 main board mounting screws.
5. Take 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.
6. Carefully insert the new main board in place, see Drawing 3B.
7. Insert the main board mounting screws and washers.
8. Insert CPU module board by lining up the pins into the sockets on the main board and the 4 screws holes.
9. Insert the 4 small Philips screws and washers.
10. Connect X1:1, X1:3 and ribbon cables #7 and #8, see Drawing 3B.
11. Inspect the gasket for nicks, cuts, or damages. Refer to 031-300-340-003 DS 350 Central Unit Gasket Recommendations and 031-300-340-002 Central Unit Cover Installation and Tightening Procedure.

11. PROCEDURE 4A. PRESSURE TRANSDUCER ZERO ADJUSTMENT



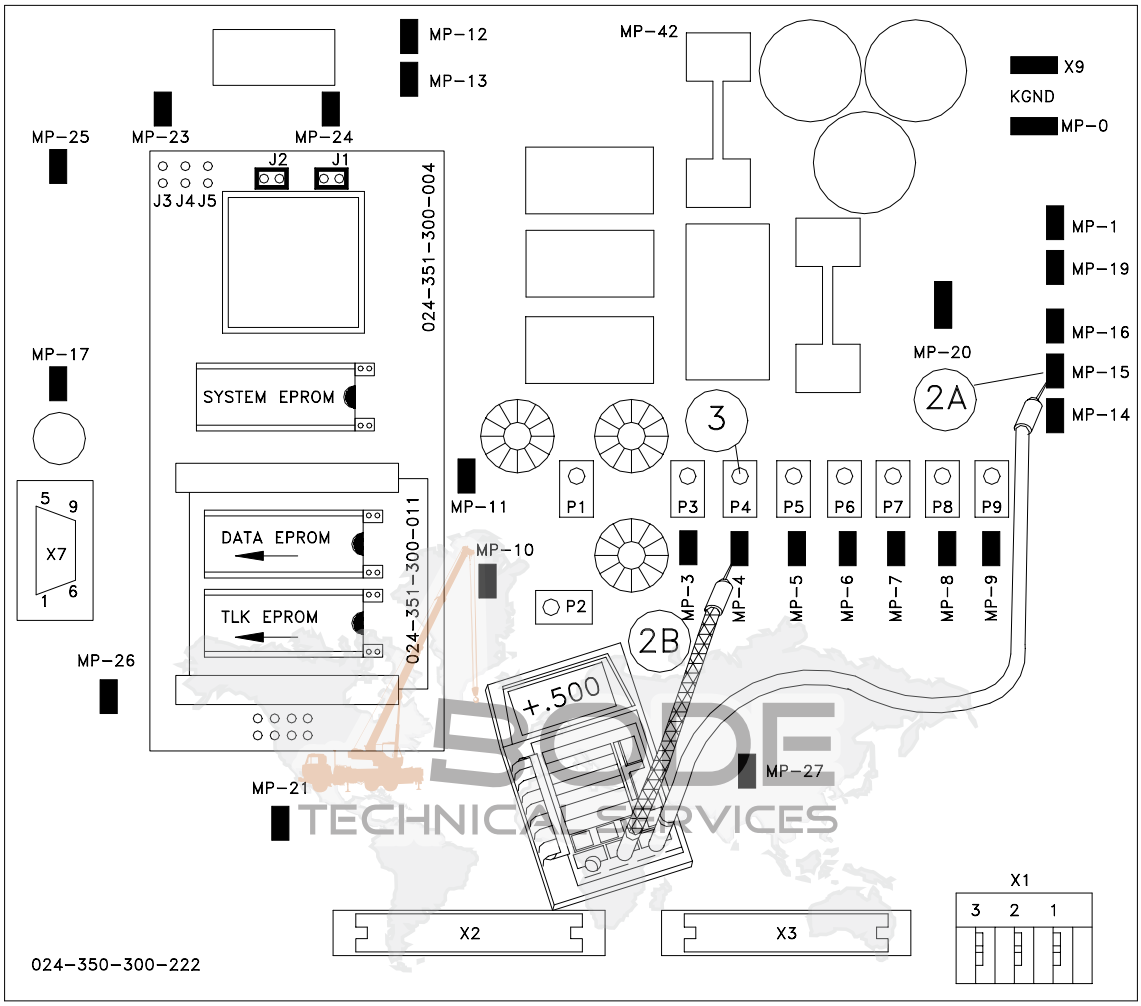
1. Lower boom all the way down (no rest pressure) then disconnect hydraulic hose from the piston side pressure transducer.
2. Connect a digital voltmeter to main P.C. board
   A) black (-) lead to MP15
   B) red (+) lead to MP4
3. Adjust P4 to obtain a reading of 0.500 volts (500mv) on meter.

11. PROCEDURE 4A. PRESSURE TRANSDUCER ZERO ADJUSTMENT - continued



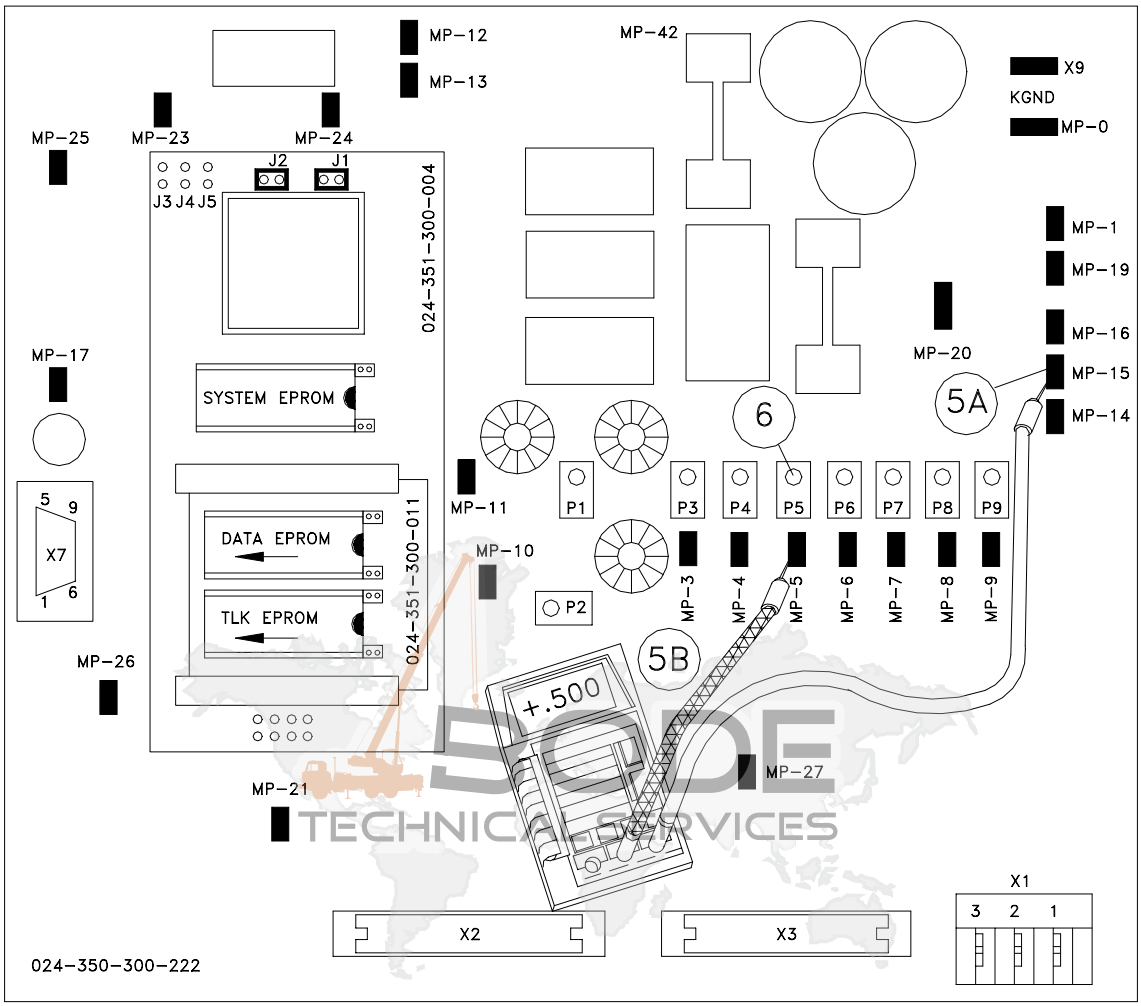
4. Disconnect hydraulic hose from the rod side pressure transducer.
5. Connect a digital voltmeter to main P.C. board
   A) black (-) lead to MP15
   B) red (+) lead to MP5
6. Adjust P5 to obtain a reading of 0.500 volts (500mv) on meter.
7. Reconnect hydraulic hoses to pressure transducers, then bleed the air from hydraulic lines.

11. PROCEDURE 4B. PRESSURE TRANSDUCER ZERO ADJUSTMENT



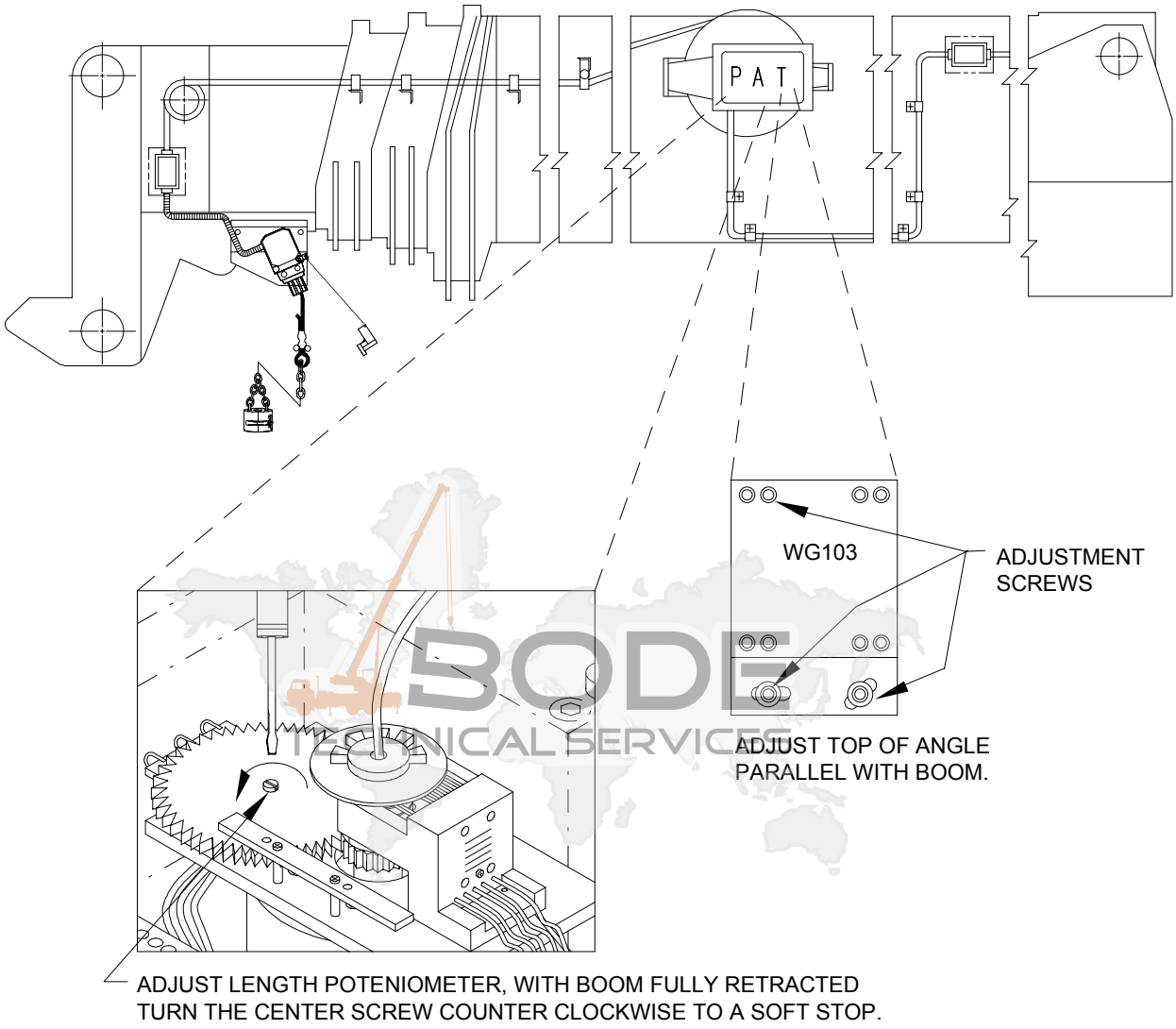
1. Lower boom all the way down (no rest pressure) then disconnect hydraulic hose from the piston side pressure transducer.
2. Connect a digital voltmeter to main P.C. board
   A) black (-) lead to MP15
   B) red (+) lead to MP4
3. Adjust P4 to obtain a reading of 0.500 volts (500mv) on meter.

11. PROCEDURE 4B. PRESSURE TRANSDUCER ZERO ADJUSTMENT - continued

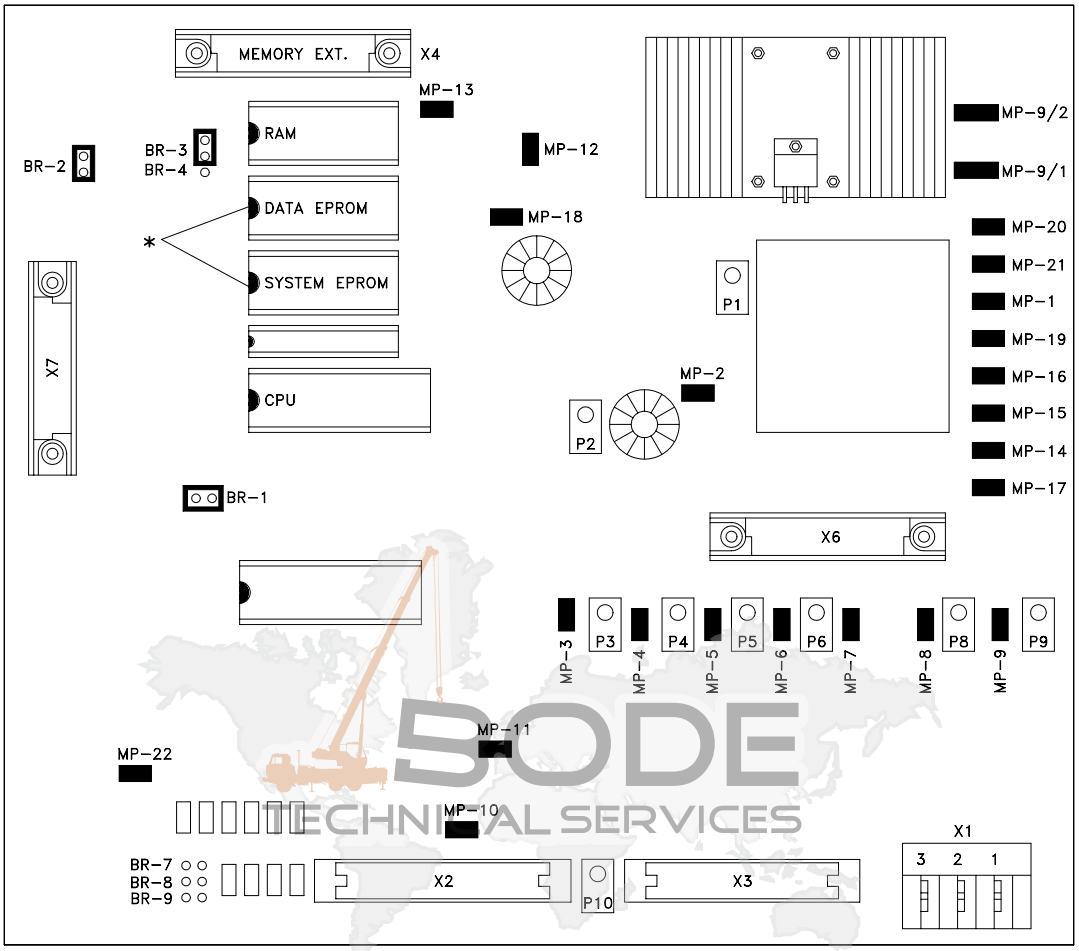


4. Disconnect hydraulic hose from the rod side pressure transducer.
5. Connect a digital voltmeter to main P.C. board
   A) black (-) lead to MP15
   B) red (+) lead to MP5
6. Adjust P5 to obtain a reading of 0.500 volts (500mv) on meter.
7. Reconnect hydraulic hoses to pressure transducers, then bleed the air from hydraulic lines.

11. PROCEDURE 5. LENGTH AND ANGLE SENSOR ADJUSTMENT



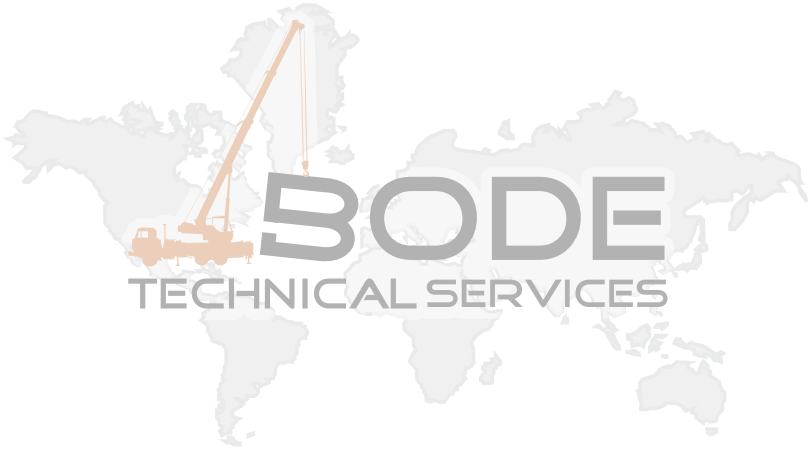
12. THEORY 1A. MAIN BOARD MEASURING POINTS



* Notch on eprom must match the notch on the socket and markings on the board.

MP TEST POINTS

MP- 0 / X9 = KGND
MP- 1 = +5V
MP- 2 = -5V
MP- 3 = SIGNAL FORCE TRANSDUCER (LOAD CELL)
MP- 4 = SIGNAL PRESSURE PISTON SIDE
MP- 5 = SIGNAL PRESSURE ROD SIDE
MP- 6 = 1ST LENGTH INPUT FOR MAIN BOOM
MP- 7 = 2ND LENGTH INPUT
MP- 8 = ANGLE MAIN BOOM
MP- 9 = ANGLE LUFFING FLY JIB
MP-10 = +3V REFERENCE VOLTAGE
MP-11 = GROUND MP-12 = +5V
MP-13 = DIGITAL GROUND
MP-14 = +9V
MP-15 = ANALOG GROUND
MP-16 = -9V
MP-17 = +5V
MP-18 = +5V
MP-19 = -5V
MP-20 = OPERATING VOLTAGE
MP-21 = INPUT VOLTAGE
MP-22 = +10V
CH.1 BOOM LENGTH, MP-6/P6 (DO NOT ADJUST)
CH.2 FORCE CHANNEL, MP-4/P4 (NOT USED)
CH.3 FORCE CHANNEL, MP-5/P5 (AUX. HOIST)
CH.4 FORCE CHANNEL, - MP-3/P3 (MAIN HOIST)
CH.5 ANGLE CHANNEL, - MP-8/P8 (MAIN BOOM) (DO NOT ADJUST)
CH.6 ANGLE CHANNEL, - MP-9/P9 (LUFFING) (DO NOT ADJUST)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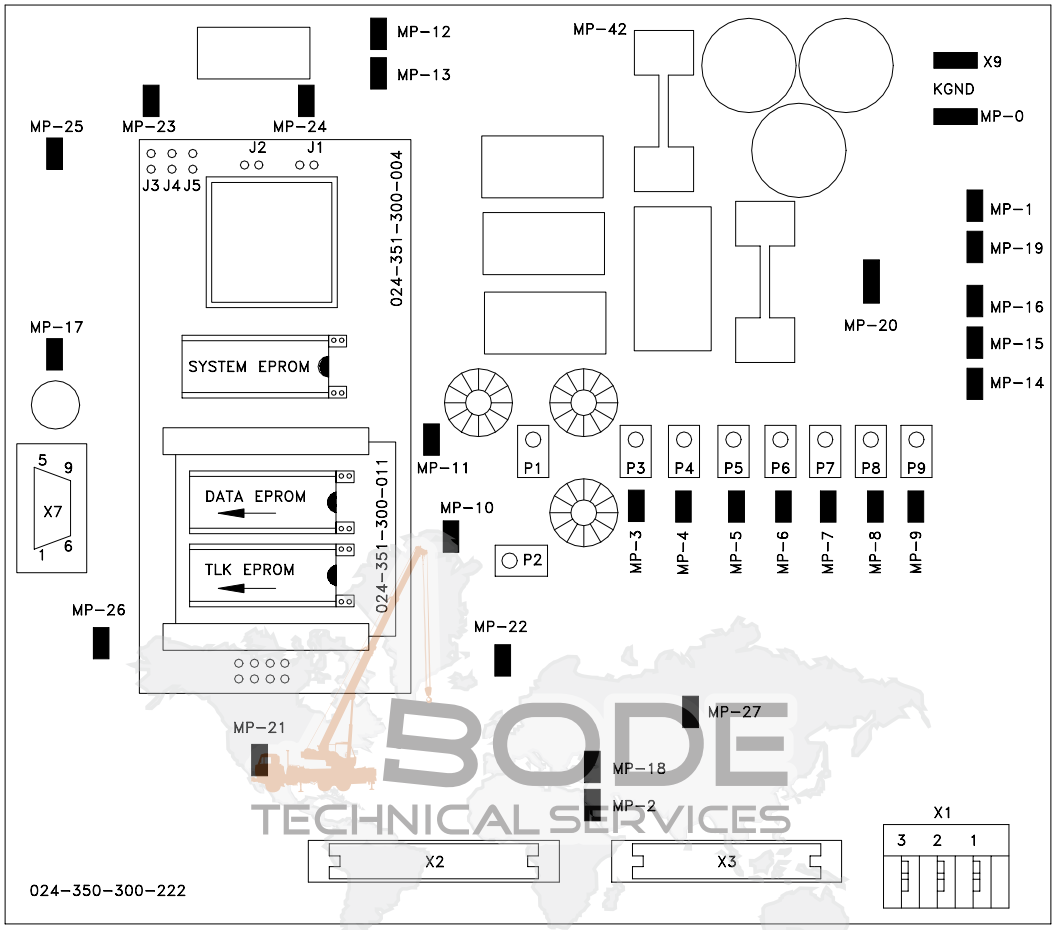
TECHNICAL SERVICES

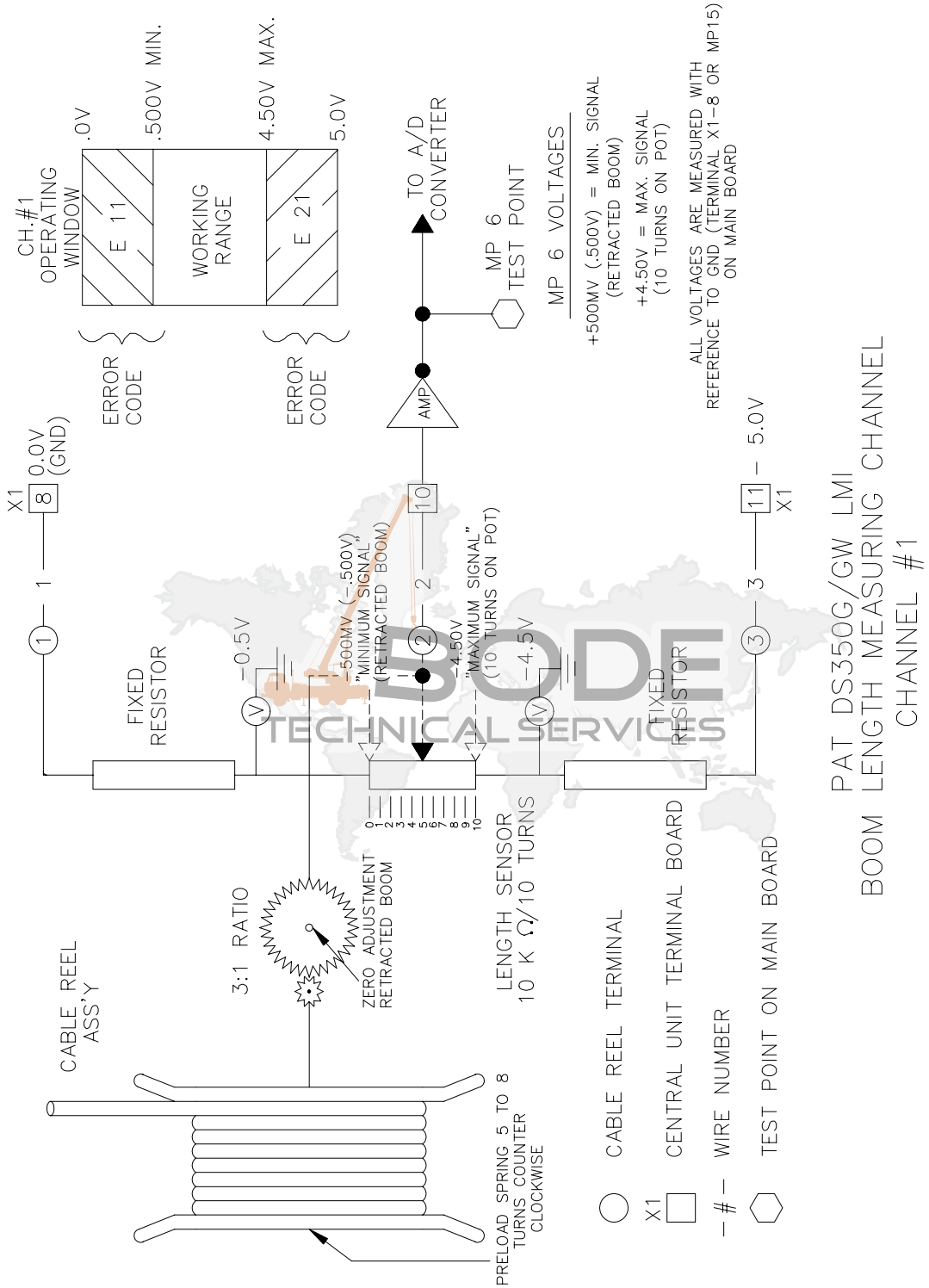
12. THEORY 1B. MAIN BOARD MEASURING POINTS



MP TEST POINTS

MP- 0 / X9 = KGND
MP- 1 = +5V
MP- 2 = -5V
MP- 3 = SIGNAL FORCE TRANSDUCER (LOAD CELL)
MP- 4 = SIGNAL PRESSURE PISTON SIDE
MP- 5 = SIGNAL PRESSURE ROD SIDE
MP- 6 = 1ST LENGTH INPUT FOR MAIN BOOM
MP- 7 = 2ND LENGTH INPUT
MP- 8 = ANGLE MAIN BOOM
MP- 9 = ANGLE LUFFING FLY JIB
MP-10 = +3V REFERENCE VOLTAGE
MP-11 = GROUND MP-12 = +5V
MP-13 = DIGITAL GROUND
MP-14 = +9V
MP-15 = ANALOG GROUND
MP-16 = -9V
MP-17 = +5V
MP-18 = +5V
MP-19 = -5V
MP-20 = OPERATING VOLTAGE
MP-21 = INPUT VOLTAGE
MP-22 = +10V
CH.1 BOOM LENGTH, MP-6/P6 (DO NOT ADJUST)
CH.2 FORCE CHANNEL, MP-4/P4 (NOT USED)
CH.3 FORCE CHANNEL, MP-5/P5 (AUX. HOIST)
CH.4 FORCE CHANNEL, - MP-3/P3 (MAIN HOIST)
CH.5 ANGLE CHANNEL, - MP-8/P8 (MAIN BOOM) (DO NOT ADJUST)
CH.6 ANGLE CHANNEL, - MP-9/P9 (LUFFING) (DO NOT ADJUST)

12. THEORY 2. OPERATION OF LENGTH SENSOR

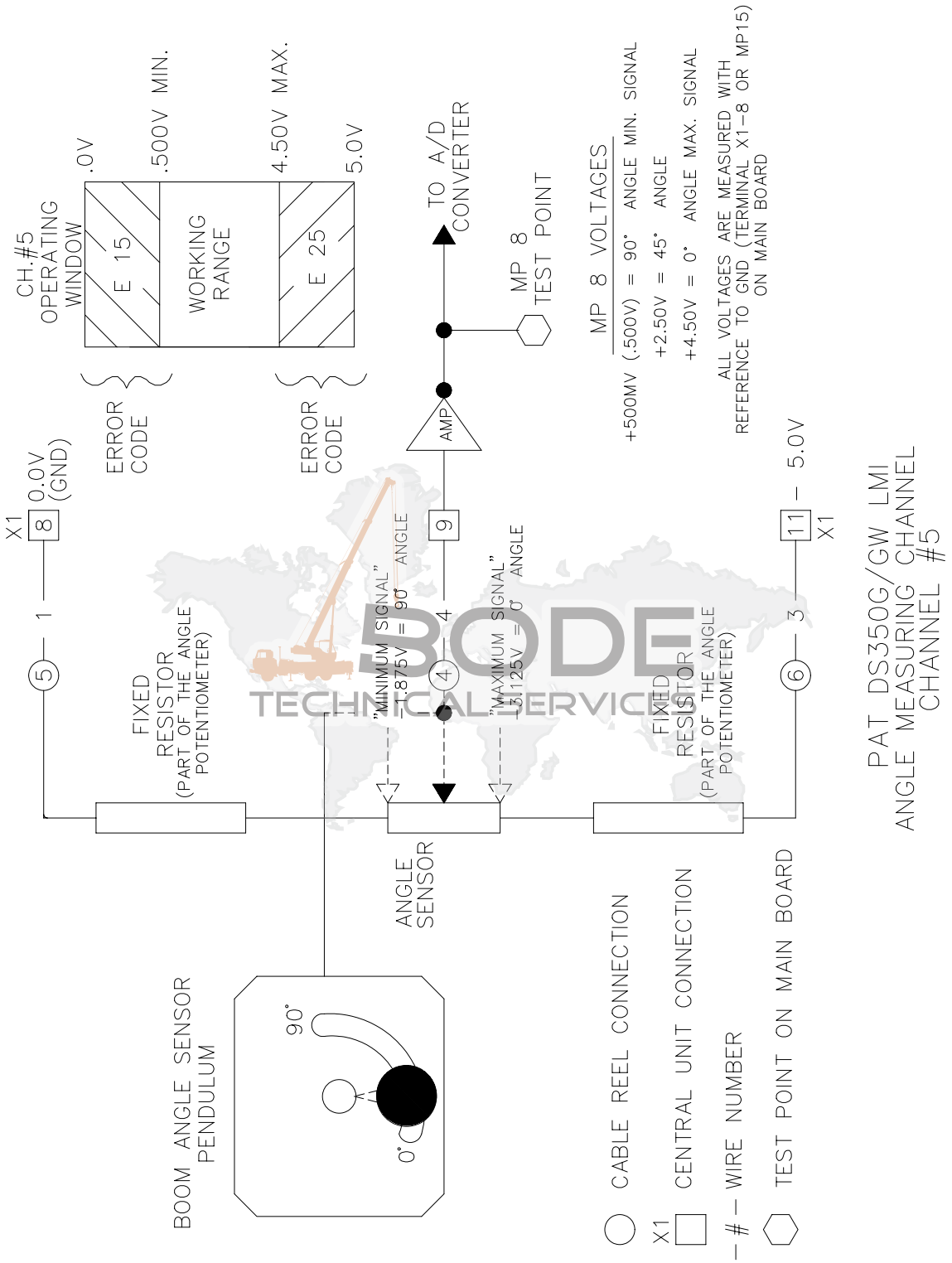


PAT DS350 MAIN BOOM LENGTH SIGNAL VOLTAGES

NO. OF TURNS ON CABLE REEL	NO. OF TURNS ON LENGTH POT.	"INPUT" SIGNAL IN VOLTS AT TERM. X1:10 IN CU (VOLTS)	"OUTPUT" SIGNAL IN VOLTS AT MP6 TEST POINT ON MAIN BOARD IN CU (VOLTS)
0	0	-0.50	0.50
3	1	-0.90	0.90
6	2	-1.30	1.30
9	3	-1.70	1.70
12	4	-2.10	2.10
15	5	-2.50	2.50
18	6	-2.90	2.90
21	7	-3.30	3.30
24	8	-3.70	3.70
27	9	-4.10	4.10
30	10	-4.50	4.50

(3 TURNS OF THE CABLE REEL = 1 TURN OF THE LENGTH POT = 0.4V)
Chart shows typical voltages. These voltages are to be used as reference only, the actual signal may vary slightly. For specific boom length voltages, check voltages at MP6 or X1:10 and compare with test data in central unit.

12. THEORY 3. OPERATION OF ANGLE SENSOR

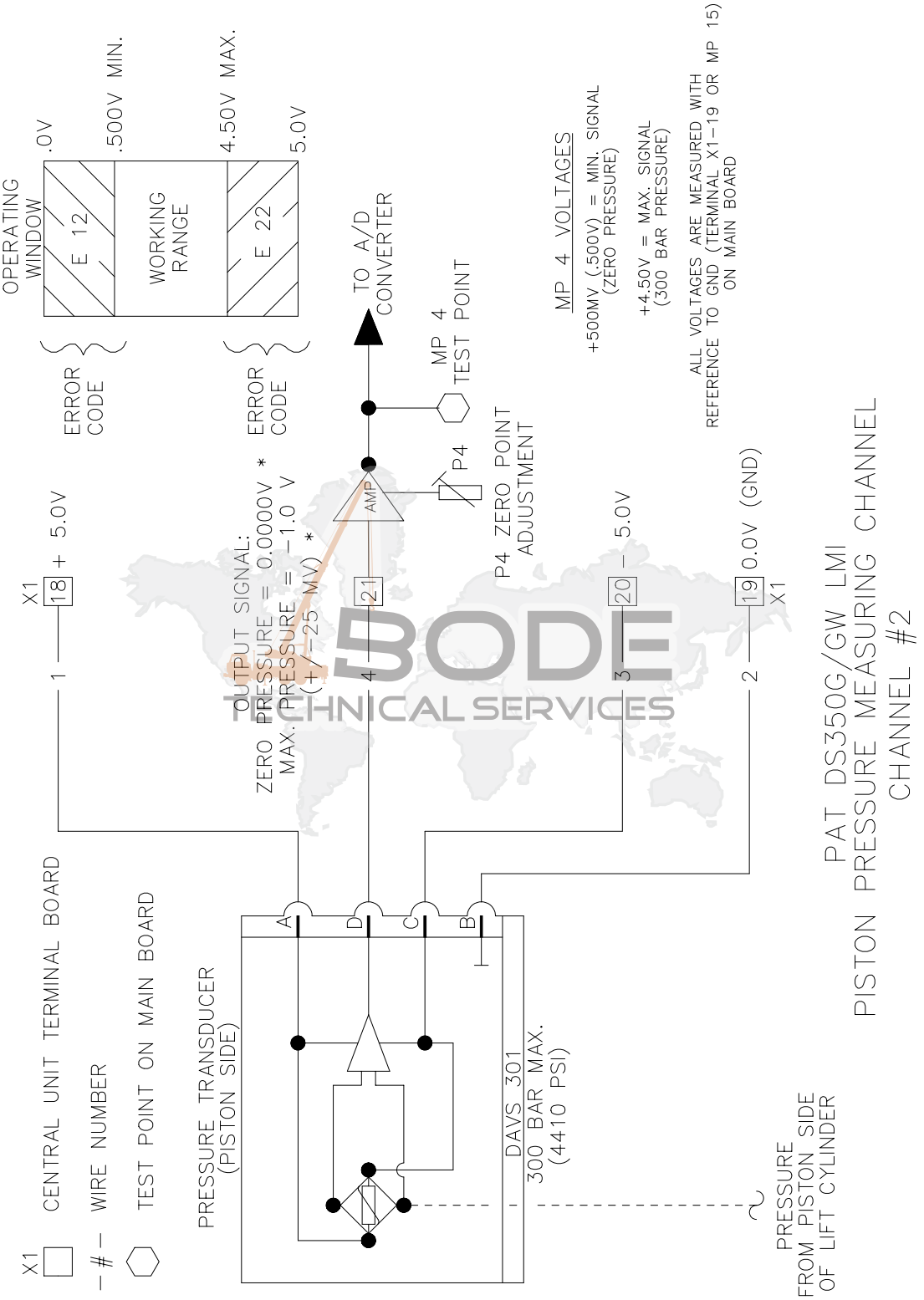


PAT DS350 MAIN BOOM ANGLE SIGNAL VOLTAGES

ACTUAL BOOM ANGLE	INPUT SIGNAL AT TERM #4 IN CABLE REEL AND TERM X1:9 IN CU (VOLTS)	OUTPUT SIGNAL AT MP8 TEST POINT ON MAIN BOARD IN CU (VOLTS)
90	-1.875	0.500
85	-1.944	0.722
80	-2.014	0.944
75	-2.083	1.167
70	-2.153	1.389
65	-2.222	1.611
60	-2.292	1.833
55	-2.361	2.056
50	-2.431	2.278
45	-2.500	2.500
40	-2.569	2.722
35	-2.639	2.944
30	-2.708	3.167
25	-2.778	3.389
20	-2.847	3.611
15	-2.917	3.833
10	-2.986	4.056
5	-3.056	4.278
0	-3.125	4.500

Chart shows typical voltages. These voltages are to be used as reference only, the actual signal may vary slightly.

12. THEORY 4. OPERATION OF PISTON SIDE LOAD SENSOR

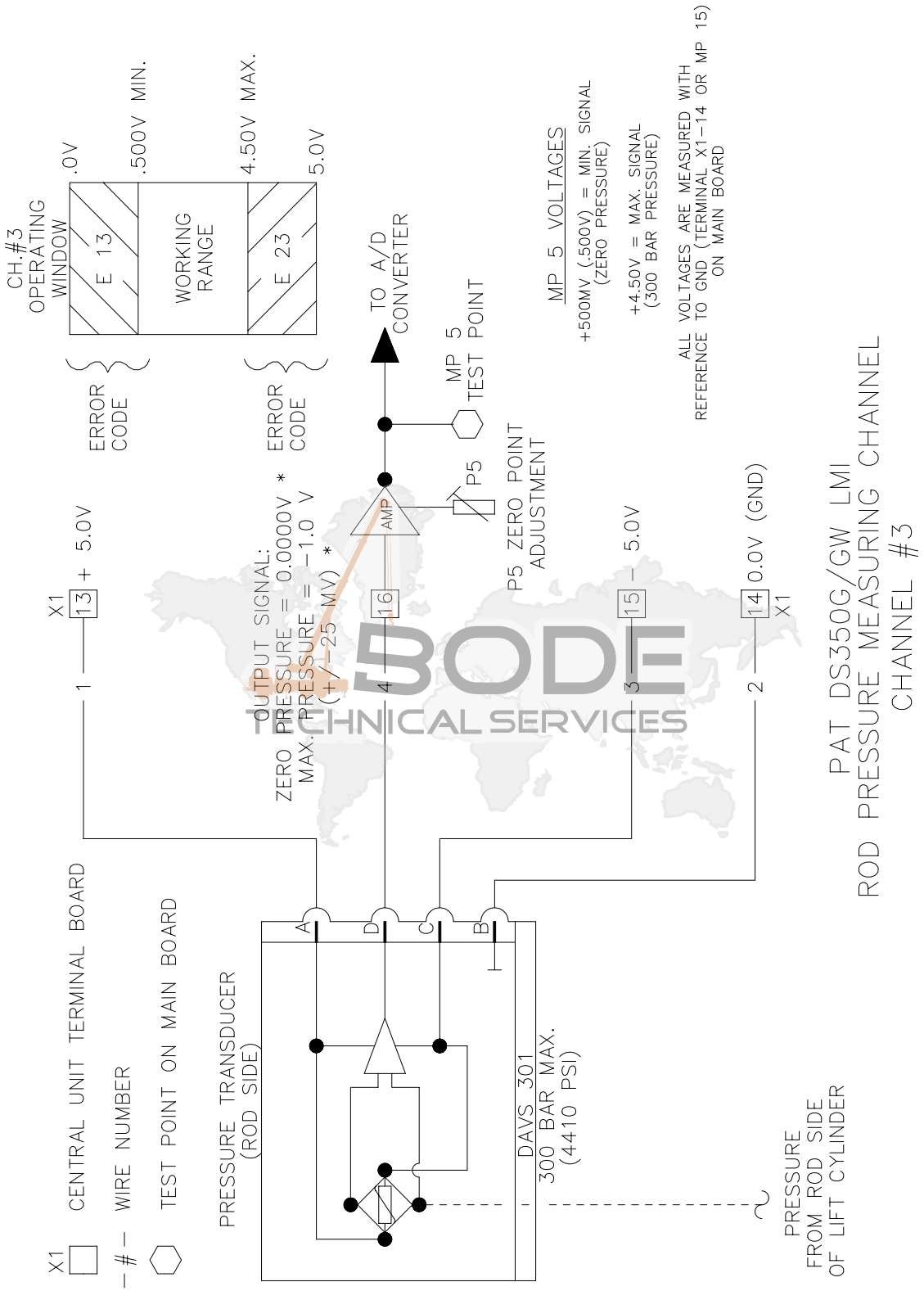


PAT DS350 TRANSDUCER SIGNAL VOLTAGES

PRESSURE (PSI)	INPUT SIGNAL AT TERM X1:21 IN CU (MILLIVOLTS)	OUTPUT SIGNAL AT MP4 TEST POINT ON MAIN BOARD IN CU (VOLTS)
0	0.0	0.50
145	-33.3	0.63
290	-66.6	0.77
435	-99.9	0.89
580	-133.3	1.03
725	-166.6	1.17
870	-199.9	1.29
1015	-233.2	1.43
1160	-266.6	1.57
1305	-299.9	1.69
1450	-333.2	1.83
1595	-366.5	1.97
1740	-399.9	2.09
1885	-433.2	2.23
2030	-466.5	2.36
2175	-499.8	2.49
2320	-533.1	2.63
2465	-566.5	2.76
2610	-599.8	2.89
2755	-633.1	3.03
2900	-666.4	3.16
3045	-699.7	3.29
3190	-733.1	3.43
3335	-766.4	3.56
3480	-799.7	3.69
3625	-833.1	3.83
3770	-866.3	3.96
3915	-899.7	4.09
4060	-932.9	4.23
4205	-966.3	4.36
4350	-999.9	4.50

Chart shows typical voltages. These voltages are to be used as reference only, the actual signal may vary slightly.

12. THEORY 5. OPERATION OF ROD SIDE LOAD SENSOR



PAT DS350 TRANSDUCER SIGNAL VOLTAGES

PRESSURE (PSI)	INPUT SIGNAL AT TERM X1:21 IN CU (MILLIVOLTS)	OUTPUT SIGNAL AT MP4 TEST POINT ON MAIN BOARD IN CU (VOLTS)
0	0.0	0.50
145	-33.3	0.63
290	-66.6	0.77
435	-99.9	0.89
580	-133.3	1.03
725	-166.6	1.17
870	-199.9	1.29
1015	-233.2	1.43
1160	-266.6	1.57
1305	-299.9	1.69
1450	-333.2	1.83
1595	-366.5	1.97
1740	-399.9	2.09
1885	-433.2	2.23
2030	-466.5	2.36
2175	-499.8	2.49
2320	-533.1	2.63
2465	-566.5	2.76
2610	-599.8	2.89
2755	-633.1	3.03
2900	-666.4	3.16
3045	-699.7	3.29
3190	-733.1	3.43
3335	-766.4	3.56
3480	-799.7	3.69
3625	-833.1	3.83
3770	-866.3	3.96
3915	-899.7	4.09
4060	-932.9	4.23
4205	-966.3	4.36
4350	-999.9	4.50

Chart shows typical voltages. These voltages are to be used as reference only, the actual signal may vary slightly.

HANDBOOK REVISIONS

REV	DATE	NAME	DESCRIPTION
-	10/27/97	CSH	Troubleshooting handbook created.
A	12/22/97	CSH	Add Appendix F Tool List - Pages changed #1, and Table of Contents
B	01/27/98	CSH	Chg console wiring in system diagram drawings 1 and 2 Correct drawing 3 and page 6; CU Parts List Correct drawing 4; Cable Reel Parts List Correct drawing 6; Console Parts List
C	02/10/98	CSH	Add Operator's Manual specifically created for the AT422T
D	03/06/98	CSH	Copy Error Codes to Operator's Section.
E	07/10/98	CSH	Chg CU to DS350/2767 with hardware for Accucal. AT422T Crane Serial Number 86638 and Beyond Restructure Troubleshooting Section • Drawings to Section 10 • Procedures to Section 11 • Theory to Section 12
F	02/02/99	CSH	Chg Key Switch Operation description in Operator's Hbk. Update Error Codes to match Trouble Shooting Section. Update TroubleShooting Section • Corrections to flow chart (dwg.no.'s and procedures) • Corrections to wiring diagrams • Update Central Unit Parts List • Update Console Parts List • Correction to Drawing 6 (Section 10) • Delete Section 13
G	03/30/99	CSH	Combine Trouble Shooting and Parts Manual. Handbook separate manual. • Corrections to wiring diagrams (console & J.B.) • Delete all Parts Lists from Trouble Shooting Section • Update Boom Nose Junction Box • Correction of Section 5 (Primary Anti-Two block Problem) • Addition of Section 5a (Secondary Anti-Two block Problem) • Addition of drawing 22 (Secondary Anti-Two block)
H	06/09/03	CSH	• Correct error codes operator's and troubleshooting Manual. • Correct section 4. No Display • Correct section 10, drawing 6