

PAT

Load Moment Limiter

DS 350 C



Operating Manual

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First Edition 01.13.1995

OPRTHDB-DS350C-24 350 06 0906

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1 General Information

The PAT Load Moment Indicator ¹⁾ (LMI) DS 350 C has been designed to provide the crane operator with essential information indispensable for the operation of the crane within the preset design parameters.

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

The Load Moment Indicator provides the operator with information about length and angle of the boom, jib height, radius, nominal load and the total load lifted by the crane.

As soon as the crane reaches an unauthorised operating state, the Load Moment Indicator DS 350 C warns the crane operator by means of an audible alarm and a signal lamp and the cut-off of all movements that could aggravate the condition of the crane.

1) Load Moment: generally, it is the product of a force and its moment arm, specifically the product of load and load radius. Is used to determine the lifting capacity of the crane.

2 Important Notes

The PAT Load Moment Indicator PAT DS 350 C is an operational aid warning the crane operator of an imminent overload or an approaching overhoist condition in order to prevent possible damages of equipment and injury of persons.

The system cannot, and shall not, be a substitute for the good judgement or experience respectively of the crane operator or of the application of working methods in the utilisation of a crane which are proven to be safe.

The crane operator is solely responsible for the safe operation of the crane. He must observe and obey all warnings and instructions displayed.

Prior to operating a crane the operator must carefully and thoroughly read and understand the information in this manual to make sure that he knows the operation and limitations of the LMI and the crane.

Proper functioning depends on proper daily inspection and observance of the operating instructions set forth in this manual. Please confer chapter 5 of this manual.

Warning

The display (1) can only assist the crane operator if the LMI is correctly adjusted and the correct load chart and operating code for the respective operating configuration have been selected. In order to prevent damages of the equipment and serious or fatal injuries of persons the correct adjustment of the LMI has to be guaranteed before starting the crane work.

3 System description

The PAT DS 350 C load moment indicator consists of a central microprocessor unit, operator's console, a length/angle sensor, pressure transducers and anti two-block switches.

The system operates according to the principle of reference/actual comparison. The actual values resulting from the force or pressure measurement are compared to the reference data stored in the central processor memory and evaluated in the microprocessor. When reaching the limits an overload warning signal is generated at the operator's console. Simultaneously, the dangerous crane movements such as hoist up, telescope out and boom down are cut-off.

The crane-specific data, i.e. load chart, boom weights, centers of gravity and dimensions are stored in the memory boards of the central unit. These data represent the reference values for the calculation of the operating conditions.

Boom length and boom angle are registered by the length/angle sensor installed inside of the cable reel mounted on the lateral side of the boom. The boom length is measured by the length sensor rope which also serves for the transmission of the anti two-block switch signal.

The crane load is measured by pressure transducers mounted to the piston and rod side of the hoist cylinder.

3.1 System Function

The PAT Load Moment Indicator (LMI) PAT DS350C has an operator's prompting simplifying the work with the crane and the LMI. After starting the engine the system executes an automatic test of the LMI-System, the lamps and the audible signals. In case of an error the respective error code is displayed on the console.

After the automatic test the crane operator has to select the operating mode corresponding to the operating condition of the crane. Then, the system is ready for operation.

3.2 Operator's console

The console has two functions:

- input of current crane configuration by the operator
- display of important data, information and instructions

Figure 1 illustrates the display and control elements of the console.

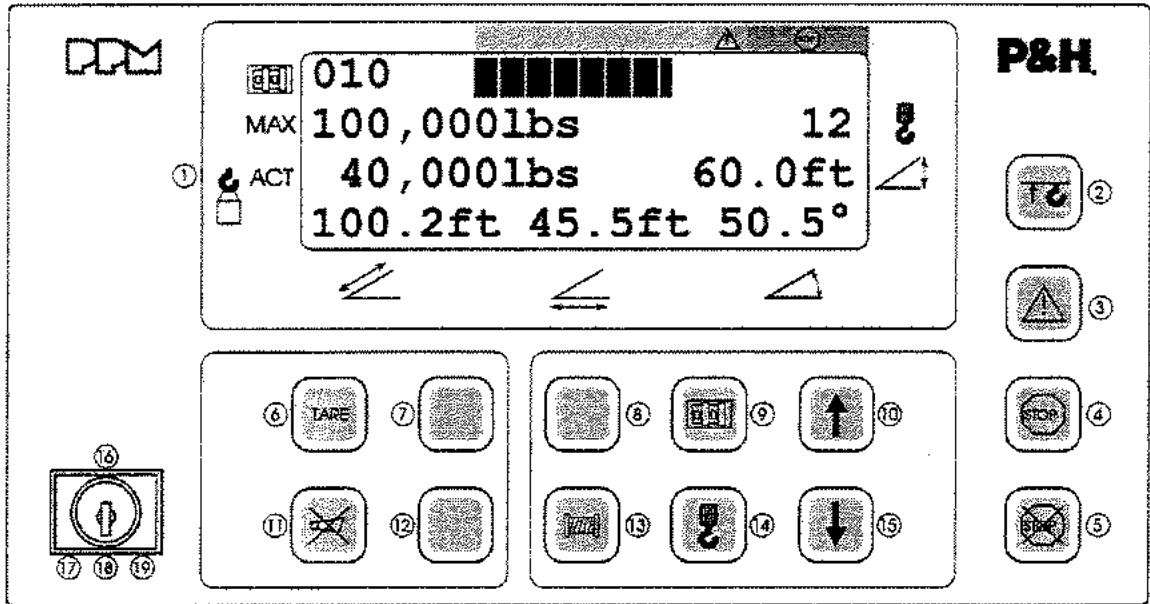


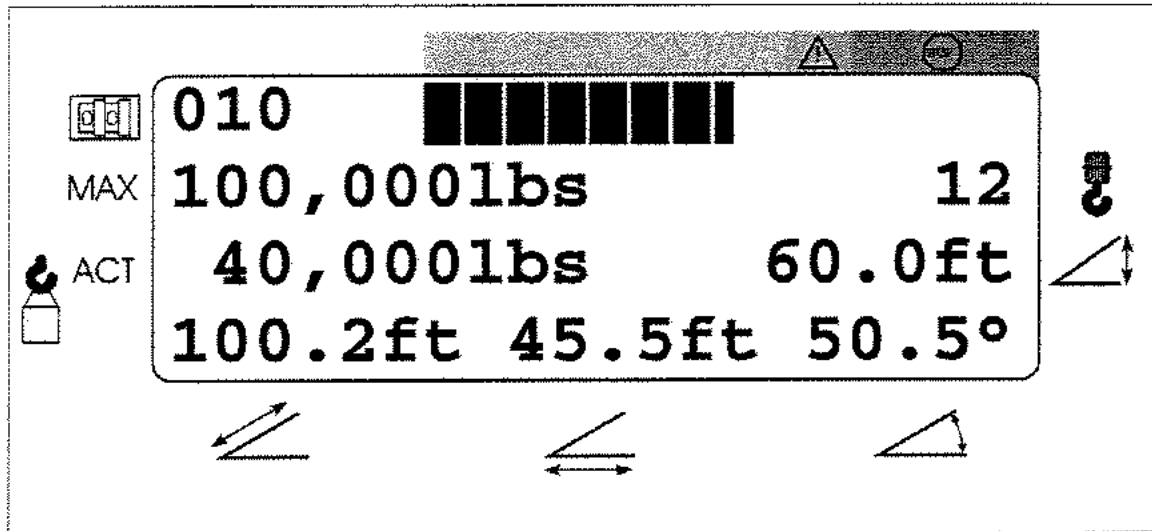
Fig. 1 Operator's console

- | | |
|----------------------------------|----------------------------------|
| 1. Display | 11. Button "Horn off" |
| 2. Anti Two-Block alarm light | 12. Without function |
| 3. Load moment pre-warning light | 13. Button "Hoist Selection" |
| 4. Overload alarm light | 14. Button "Reevings" |
| 5. Warning light "By-passing" | 15. Button "Counting downwards" |
| 6. Button "Tare" | 16. Key switch for by-passing |
| 7. Without function | 17. By-pass Anti 2-Block lockout |
| 8. Without function | 18. Normal operation |
| 9. Button "Operating Modes" | 19. By-pass LMI lockout |
| 10. Button "Counting upwards" | |

3.3 Operating Elements

Figure 1 illustrates the operating elements and display of the PAT Load Moment Indicator DS 350 C. The numbers of the illustration correspond to the numbers in the following list which describes the function of each operating element.

1 Display



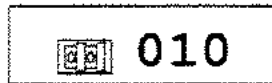
The display provides the crane operator with technical as well as operating information. During crane operation the display shows the data described in the following:

MAX 100,000lbs

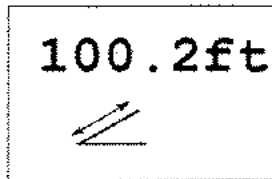
Maximum load is the maximal permissible load according to the number of parts of line selected by means of the reeving switch (14). Nominal load values between two load chart radii of the rated capacity chart are calculated by means of linear interpolation by the computer. Nominal loads between length steps are determined by means as specified by the crane manufacturer.

ACT 40,000lbs

Actual load is the actual load (gross load) on the boom. Slings and hook block are included. If a boom extension or a jib are erected, they will be taken into account when calculating the actual load displayed. However, the crane operator has to use the weight reduction values shown in the load chart.



This display shows the **operating code** selected by the crane operator.



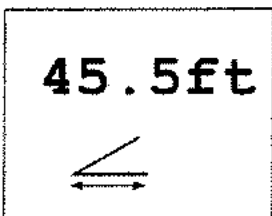
Here, the **boom length** is displayed.



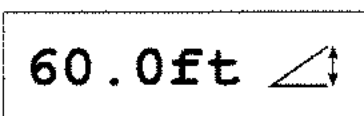
The load moment is displayed by means of this bar-graph. The display indicates how much of the reference capacity of the crane is being used. As the reference capacity of the crane changes along with the crane movements during a lifting procedure, the analog instrument displays altering values in correspondence to the respective load values valid.

The analog display has three different areas:

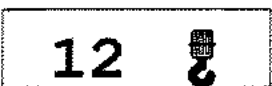
- green area (0 - 90% of the rated capacity)
- yellow pre-warning area (90 - 100% of the rated capacity)
- red overload area (more than 100% of the rated capacity)



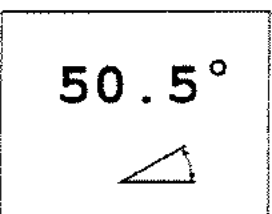
The **radius** of the crane is shown on this display.



Here, the **height of the boom head** is displayed.

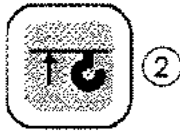


This displays shows the **number of reevings** adjusted by the crane operator.



The **angle** of the boom to the horizontal line is displayed here.

2 Anti Two-Block Alarm Light



This red warning light (2) will light up as soon as the anti two-block limit switch contact opens, indicating that a two-blocking condition is approaching. At the same time, the audible alarm will sound.

The following crane movements will be cut-off automatically: hoist up, telescope out, boom down. In addition to this, the luffing hoist down will be cut-off on cranes with a luffing jib.

3 Load moment pre-warning light



This yellow light (3) will light up, if the load on the crane is in between 90% and 100% of the respective load capacity, indicating that an overload situation is imminent. This signifies for the crane operator that the hoist is only to be executed with extreme caution.

4 Overload alarm light



This red warning light (4) will light up if the crane has reached 100 % of the admissible rated capacity.

The following crane movements will be cut-off automatically: hoist up, telescope out, boom down. In addition to this the luffing hoist down will be cut-off on cranes with a luffing jib.

5 Warning light "By-passing"



This red warning light (5) will blink when the cut-off function of the load moment limiting system is being by-passed.

6 Button "Tare"



This button (6) is used to indicate the "tare load" on the actual load display. The tare load or net load is the actual load on the hook lifted after the "Tare" button has been pushed. Slings and hook block are not included.

After actuating the "Tare" button the display will be set to zero (taring). After releasing the button, the actual load display will blink, indicating that the tare load is being displayed.

The display continues to blink until the radius of the boom (either by the angle or the length) is modified. Then, the load display will indicate the total load on the crane.

9 Button "Operating Modes"



The button "Operating Modes" (9) is actuated when a new operating code is to be entered.

After actuating the button "Operating Modes", this one will light up in order to indicate that the procedure "Enter an operating code" has been activated. Simultaneously, the overload warning light will light up and the crane movements will be cut-off.

When the procedure is completed, the lights go off and the crane movements can be continued.

The procedure "Setting the operating mode" is described in detail in chapter 4.2.

Caution

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 the crane's load charts and the operation of the load moment limiting system should set the operating mode code.

10 Button "Counting upwards"

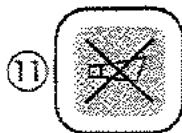


This button (10) is used for selecting the operating mode, the adjustment of the number of parts of line, or the hoist line. By means of this button bigger values are selected.

The procedure for the selection of the operating mode, the adjustment of the number of reevings, or the selection of the hoist line is described in detail in chapters 4.2 to 4.4.

This button (10) is also used for the language selection. The procedure of language selection is described in detail in chapter 4.5.

11 Button "Horn off"



The audible alarm can be cut-off indefinitely by means of actuating this button (11).

13 Button "Hoist Selection"



The button "Hoist Selection" (13) is used to confirm the selected hoist line or to select the actual used hoist line.

The procedure "Selection of hoist line" is described in detail in chapter 4.3.

14 Switch "Reevings"



The switch "Reevings" (14) is actuated if a new number of line parts is to be entered.

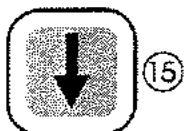
After actuating the switch "Reevings", it will light up in order to indicate that the function "Enter the number of parts of line" has been activated. The number of parts of line have to be selected by actuating the buttons "Counting upwards" (10) and "Counting downwards" (15). By means of actuating the button "Reevings" again, the function is completed, the lights go off and the crane movements can be continued.

The procedure "Setting the Reevings" is described in detail in chapter 4.4.

Caution

The correct setting of this button is of utmost importance for the proper functioning of the system and the crane.

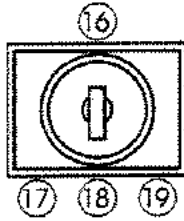
15 Button "Counting downwards"



This switch (15) is used for selecting the operating mode, the adjustment of the number of parts of line, or the hoist line. By means of this button smaller values are selected.

The procedure for the selection of the operating mode or the adjustment of the number of parts of line is described in detail in chapters 4.2 and 4.4.

16 Key Switch



This key switch (16) can only be activated with the corresponding key. The by-pass key switch deactivates the cut-off of the LMI system or the anti two-block switch momentarily to allow the crane operator to by-pass the hydraulic cut-off.

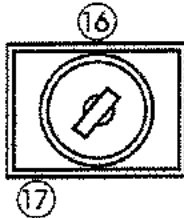
The by-pass switch has 3 positions to be described in the following.

Caution

Since this switch deactivates the cut-off function of the Load Moment Indication system and the anti two-block switch system, the following instructions have to be strictly followed:

- The by-pass key is only to be used in case of emergency as unwarranted actuating of this switch causes the by-pass of the hydraulic cut-off system that can result in harm of the crane and damages to property and persons.
- Never use the by-pass key to overload the crane or to operate the crane in forbidden operating areas.

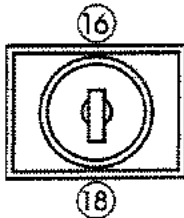
17 Anti two-block override



This position of the key switch by-passes the hydraulic cut-off system of the anti two-block switch but does not affect the LMI system. The red warning light (2) and the audible alarm for warning of an approaching two-block condition will turn on automatically.

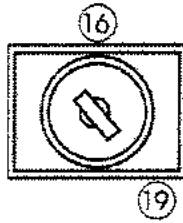
The by-pass key switch is springloaded in order to return the switch to the neutral position (18). To activate the switch, it therefore has to be held during its operation.

18 Normal operation



This is the neutral position (18) to which the switch (16) returns because of its spring-loaded mechanism. In this position, the switch does not influence the LMI or the anti two-block cut-off function.

19 LMI override



In this position (19), the by-pass key switch (16) deactivates the control lever lockout function of the LMI. All other display, indicating and alarm functions, as well as the control lever lockout function of the anti two-block system will continue to work.

The by-pass switch is spring-loaded in order to return the switch to the neutral position (18). Therefore to activate the switch, it has to be held manually during its operation.

4 Programming procedure

4.1 Startup Phase

During the complete startup phase the prewarning light (3) and the overload alarm light (4) will light up and the following crane movements will be stopped concurrently: hoist up, telescope out, boom down.

**THIS LOAD MOMENT
SYSTEM IS PROGRAMMED
FOR PPM CRANE
MODEL . . . S/N**

After the ignition of the crane has been activated and the system has passed through the system test without errors, the console will display these two phrases for about 3 seconds.

**DO NOT PUSH ANY
BUTTON UNTIL YOU'VE
READ AND UNDERSTOOD
THE OPERATOR MANUAL**

Prior to operating, the crane operator shall carefully and thoroughly read and understand the crane load capacity charts and the information contained in the manuals for the crane and the LMI, to ensure that the operator knows the operation and limitations of the crane and the LMI.

The operator has now the possibility to select between 2 languages i.e. English and German.

**UM DEUTSCH AUSZUW.,
DRUECKE TASTE #15**

This phrase appears, when during the last operation of the system the English language has been selected.

To select the German language, the operator has to push the button #15.

**TO SELECT ENGLISH
PRESS KEY #10**

This phrase appears, when during the last operation of the system the German language has been selected.

To select the English language, the operator has to push the button #10.

The procedure "Selection of Language" during normal operation is described in chapter 4.4.

When the desired language is selected, the button "Operating Modes" (9) will light up and the display shows the previously selected operating mode.

**CODE: 001 MAIN BOOM
MAN RET NO EXT
TIRES LB CWT
OVER FRONT CREEP**

If the operator wants to continue with the displayed operating mode he has to confirm by pushing the button "Operating Modes" (9).

To select a new code he has to use the buttons "Counting upwards" (10) and "Counting downwards" (15), which is described in detail in chapter 4.2.

001 >>MAIN HOIST<<
TO SELECT AUX. HOIST
PRESS KEY #15. PRESS
KEY #13 TO CONFIRM

The display shows the previously selected hoist line i.e. the main hoist. When the main hoist is used to lift the load, the operator has to confirm by pushing the button "Hoist Selection" (13).

To select the auxiliary hoist line, first the button "Counting downwards" (15) has to be pressed and subsequently button (13).

Now the "Startup Phase" is completed. The prewarning light (3) and if the machine is in a safe working condition the overload alarm light (4) will go out and all crane movements will be possible.

4.2 Setting the operating mode

After each modification of the operating configuration of the crane, the crane operator has to adjust the Load Moment Indication system to the new conditions.

This procedure consists of three parts:

- Setting of the LMI to the operating configuration of the crane
- Selecting the hoist line
- Activating and setting of the number of parts of line (chapter 4.3)

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's load charts and the operation of the system should execute the setting of the operating code or the number of parts of line respectively.

The Load Moment Indicator is switched over to a new operating code by means of the following procedure.

• Actuating button "Operating Modes"

After actuating the button "Operating Modes" (9), it will light up indicating that the function "Enter a new operating code" has been activated. At the same time the prewarning light (3) and the overload alarm light (4) will light up and the dangerous crane movements will be interrupted.

The display will show the operating code that was selected previously.

• Setting an operating mode

The buttons "Counting upwards" (10) and "Counting downwards" (15) serve to select a new operating code. After actuating the buttons, the operating codes will be displayed one after another in the succession of their codes counting either upwards or downwards on the display. This procedure will

be continued until the code of the required operating code is displayed on the console.

- **Actuating the button "Operating Modes"**

After selecting the proper operating code, the correct selection is acknowledged by means of actuating again the button "Operating Modes" (9). Then, the function "Enter a new operating code" is completed.

The procedure "Setting the operating mode" is automatically followed by the procedure "Selecting the hoist line" (Chapter 4.3).

4.3 Selecting the hoist line

After actuating the button "Hoist Selection" (13), it will light up indicating that the function "Selecting the hoist line" has been activated. At the same time the prewarning light (3) and the overload alarm light (4) will light up and the dangerous crane movements will be interrupted.

```
001 >>MAIN HOIST<<
TO SELECT AUX. HOIST
PRESS KEY #15. PRESS
KEY #13 TO CONFIRM
```

The display shows the previously selected hoist line i.e. the main hoist. When the main hoist is used to lift the load, the operator has to confirm by pushing the button "Hoist Selection" (13).

To select the auxiliary hoist line, the button "Counting downwards" (15) has to be pressed and subsequently button "Hoist Selection" (13) to confirm the selection.

```
001 >>AUX. HOIST<<
TO SELECT MAIN HOIST
PRESS KEY #10. PRESS
KEY #13 TO CONFIRM
```

This display appears if previously the auxiliary hoist line was selected. To select the main hoist line, first the button "Counting upwards" (10) has to be pressed and subsequently button "Hoist Selection" (13) to confirm the selection.

The procedure "Selecting the hoist line" is now completed and the system is ready to operate. The prewarning light (3) and the overload alarm light (4) will go out and all crane movements will be possible again if the machine is in a safe working condition. The display returns to the normal operating display (see page 4).

4.4 Setting the Reevings.

The Load Moment Indicator is switched over to a new number of parts of line by means of the following procedure.

- **Actuating button "Reevings"**

After actuating the button "Reevings" (14), it will light up indicating that the function "Enter a new number of parts of line" has been activated. At the same time the prewarning light (3) and the overload alarm light (4) will light up and the dangerous crane movements will be interrupted.

The display will show the number of parts of line that was selected before.

- **Setting a number of parts of line**

The buttons "Counting upwards" (10) and "Counting downwards" (15) serve to select a new number of parts of line. After actuating the buttons, the number of parts of line will be displayed one after another in the succession of their codes either counting upwards or downwards on the display. This procedure will be continued until the required number of parts of line is displayed on the console.

- **Actuating the button "Reevings"**

After selecting the requested number of parts of line, the correct selection is acknowledged by means of actuating again the button "Reevings" (14). Then, the function "Enter a new number of parts of line" is completed. The prewarning light (3) and the overload alarm light (4) will go out and all crane movements will be possible again if the machine is in a safe working condition.

4.5 Selection of Language

To change the language during the normal operation of the system, the button "Counting upwards" (10) has to be pushed. After actuating the button, the prewarning light (3) and the overload alarm light (4) will light up, the crane movements hoist up, telescope out and boom down will be interrupted and the following display will appear:

<p>TO SELECT ENGLISH PRESS KEY #10 UM DEUTSCH AUSZUW., DRUECKE TASTE #15</p>

To select the English language, the operator has to push the button #10, to select the German language, he has to push the button #15.

Then, the function "Selection of Language" is completed. The prewarning light (3) and the overload alarm light (4) will go out and all crane movements will be possible again if the machine is in a safe working condition.

5 Pre-operating Inspection

Prior to operating the crane, the following electrical connections have to be checked to ensure that the components of the LMI-system are properly connected according to the crane configuration.

5.1 Cranes with main hoist only

If the crane works only with the main boom without extension or jib no additional electrical connections are necessary. However be sure that the bob weight is properly installed on the main boom hoist. With an even amount of lines the bob weight is installed at the "dead end" of the wire rope. With an odd number of lines, the bob weight is installed at the line with the lowest working speed.

If the crane works with an extension/jib, the connecting cable must be installed between the junction box on the extension/jib and the junction box on the boom. The bob weight attached to main boom anti two-block switch must then be removed and reattached to the anti two-block switch at the extension or the jib respectively.

Warning

Failure to re-position the bob weight will prevent the anti two-block system from functioning properly. No weight must actuate on the anti two-block switch of the main boom when using the extension/jib.

5.2 Cranes with main and auxiliary hoist

If the extension/jib is not in operating position the by-pass plug must be installed in the junction box on the main boom and the bob weight of the anti two-block switch has to be mounted.

If the extension/jib is in the operating position, the connection cable has to be installed between the junction box of the extension/jib and the junction box at the main boom. The bob weight as well is installed at the anti two-block switch of the extension/jib.

If no wire rope is applied on the main boom, the bob weight has to be removed and the locking pin provided has to be inserted to prevent damages of equipment and injury of persons.

After checking the electrical connections to ensure the correct connection of the system components the following checks have to be executed:

1. Check all cable connections to the system components as to damage
2. Check the anti two-block switch and the bob weight as to movability
3. Check the spring loaded cable reel as to easy rotation, reel bias voltage and to the proper reel of the cable

Warning

The following tests have to be executed with care to prevent damage of the machine and injury of persons. The proper functioning of the LMI system requires a successful completion of these checks.

If the crane operator cannot see clearly the hook block approaching the boom head, he should have an assistant watch the hook block. The operator should be prepared to stop the crane immediately if the LMI does not function properly, i.e. if the red alarm light does not light up, the audible alarm does not sound and the dangerous crane movements are not cut-off.

1. Check the anti two-block alarm light (2) and the audible alarm by means of manually lifting the bob weights.
2. Carefully lift the hook block of the main boom to bring it into contact with the bob weight. As soon as the hook block lifts the weight, the audible alarm has to sound, the anti two-block switch alarm light (2) has to light up and the main hoist has to be cut-off. Lower the hook block slightly in order to eliminate this condition.
3. Then, slowly lower or extend the main boom in order to create a potential anti two-block situation. As soon as the hook block lifts the weight, the audible alarm should sound, the anti two-block switch alarm light (2) should light up and the hoist or extension procedure should be cut-off.

Note: If the warning light and the audible alarm do not function as described and the crane movements are not cut-off, the system does not function properly. The malfunction must be corrected prior to operating the crane.

4. If the crane is equipped with an extension/jib, the test procedure of the anti two-block switch of the extension/jib has to be repeated.
5. Check, if the displayed boom length corresponds to the actual length.
6. Check, if the displayed main boom angle corresponds to the actual angle.
7. Check, if the displayed radius of the crane corresponds to the actual radius.

Operation

When being set properly, the LMI system works automatically. Therefore, the crane operator has to be familiar with all operating elements of the LMI and to adjust correctly all switches prior to operating the crane. All settings must be checked by means of lifting a known load and comparing it to the information displayed on the LMI.

The values rated in the load chart include the weight of the hook block, the slings and auxiliary lifting devices. These weights have to be deduced from the values of the load chart to obtain the net load to be lifted.

6 Service and Maintenance

The maintenance of the LMI system consists of the following inspections:

1. Check all cable connections of the system. Damaged cables are to be replaced immediately.
2. Check the isolation of the length sensor cable and the cable guides. Worn isolations and damaged cable guides have to be replaced.
3. Inspection of the anti-two block switch as to easy-running.
4. Check of the cable reel as to sufficient bias voltage.
5. Check of the pressure transducers at the hoist cylinders and the connection hoses as to oil leakage.

Personnel not having been specially trained is not allowed to execute other works than correcting the problems identified in the maintenance chart, and must not replace defective mechanical parts and cables.

7 Troubleshooting

General information

In case of a system malfunction, a code to identify the error source will be shown on the display.

The code numbers listed in the malfunctions table identify various malfunctions that might occur in the LMI system. In the malfunctions table each error will be explained and the steps to be taken for their correction will be described.

Malfunctions within the microprocessor have to be repaired by factory-trained specialist only. Please inform the competent service organisation in case of errors of this kind.

Operating faults

Malfunctions of the LMI-system caused by exceeding preset areas or operating faults of the crane operator are indicated and explained on the LCD display. These code numbers could be E01, E02, E03, E04, E05 and E6. Normally, the operator can repair these faults by himself.

Malfunctions table			
Error code	Error	Cause	Elimination
E01: MIN. RADIUS	Fallen below the radius range or angle range exceeded.	Fallen below the minimum radius or exceeding the maximum angle specified in the respective load chart due to luffing up the boom too far.	Luff down the boom to a radius or angle preset in the load chart.
E02: MAX. RADIUS	Maximum radius exceeded or fallen below the angle range.	The maximum radius was exceeded or fallen below the minimum angle specified in the respective load chart due to luffing down the boom too far.	Luff up the boom to a radius or an angle preset in the load chart.
E04: ERROR OPERAT. MODE	Incorrect setting of operating mode	a) The selected operating mode is locked. b) The selected operating mode is not included in the TLK-EPROM	a) Set the operating mode in accordance with the assignment to the operating condition. b) Check the programming in the TLK-EPROM

E05: PROHIBITED LENGTH	Prohibited length range	<p>a.) Boom has been extended too far or not enough, e.g. if operation is only admitted up to a certain boom length or for load charts of jibs with the boom having to be extended to a certain length.</p> <p>b.) The length sensor adjustment was modified, e.g. rope slid off the length sensor reel.</p> <p>c.) Clutch between length sensor pot and drive is defective</p> <p>d.) Failure of the -5V-supply for the analog part of the LMI-main board.</p> <p>e.) Cable between the central unit and the length sensor defective or slack.</p> <p>f.) Length potentiometer defective.</p>	<p>a.) Retract or extend boom to the correct length.</p> <p>b.) Retract the boom. Check the prestress of the cable reel (the rope has to be under traction). Open the length sensor and carefully turn the length pot counterclockwise to the detent by use of a screwdriver.</p> <p>c.) Completely replace the clutch with the drive wheel and adjust length sensor pot as described at b.)</p> <p>d.) Check -5V-voltage. If there is no voltage or break down at a charge of 50 ohm approximately, exchange main board.</p> <p>e.) Check cable as well as connector and exchange, if necessary.</p> <p>f.) Replace length potentiometer.</p>
E07: ERROR OVERLOAD RELAY	No acknowledgement from the overload relay.	Overload relay is caught, defective or is not being driven.	Replace relay. If this replacement is not satisfactory, the connection board has to be replaced, too.
E08: ERROR A2B RELAY	No acknowledgement of the anti two-block switch relay.	A2B-relay is caught, defective or is not being driven.	Replace relay. If this replacement is not satisfactory, the connection board has to be replaced, too.
E11: ERROR MB LENGTH MIN.	Fallen below limit for the measuring channel "Length telescopic boom".	<p>a.) Cable between length sensor and central unit defective, not connected or water in the connectors.</p> <p>b.) Length sensor pot defective.</p> <p>c.) Electronic board in the measuring channel defective.</p>	<p>a.) Check cable and connector as well and replace, if necessary.</p> <p>b.) Replace length sensor potentiometer.</p> <p>c.) Replace main board or analog board.</p>

E12: ERROR PR. PISTON MIN	Fallen below lower limit value for the measuring channel "pressure transducer piston side"	<ul style="list-style-type: none"> a.) Cable leading from the central unit to the pressure transducers defective or water in the connectors. b.) Pressure transducer defective. c.) Electronic board in the measuring channel defective. 	<ul style="list-style-type: none"> a.) Check cable and connector as well and replace, if necessary. b.) Replace pressure transducer. c.) Replace CPU or analog board.
E13: ERROR PR. ROD MIN.	Fallen below lower limit value for the measuring channel "pressure transducer rod side".	<ul style="list-style-type: none"> a.) Cable leading from the central unit to the pressure transducers defective or water in the connector. b.) Pressure transducer defective. c.) Electronic board in the measuring channel defective. 	<ul style="list-style-type: none"> a.) Check cable and connectors as well and replace, if necessary. b.) Replace pressure transducer. c.) Replace CPU or analog board.
E15: ERROR MIN. ANGLE	Fallen below lower limit value for the measuring channel "angle main boom".	<ul style="list-style-type: none"> a.) Cable leading from the central unit to the length/angle sensor defective, loose or water in the connectors. b.) Angle sensor defective. c.) Electronic board in the measuring channel defective. 	<ul style="list-style-type: none"> a.) Check cable as well as connectors and replace, if necessary. b.) Replace angle sensor. c.) Replace CPU or analog board.
E19: ERROR REF. VOLT. MIN.	Reference voltage defective.	<ul style="list-style-type: none"> a.) The total of the supply and the reference voltages is less than 2.7V. b.) A/D converter defective. 	<ul style="list-style-type: none"> a.) Check supply voltages. b.) Replace analog board.
E1A: ERR. MIN. SLEW. ANG. A	Fallen below lower limit value for the measuring channel "slewing angle A"	<ul style="list-style-type: none"> a.) Cable leading from the central unit to the slewing angle sensor defective, loose or water in the connectors. b.) Slewing angle sensor defective. c.) Electronic board in the measuring channel defective. 	<ul style="list-style-type: none"> a.) Check cable and connector as well and replace, if necessary. b.) Replace slewing angle sensor c.) Replace CPU or analog board.
E1B: ERR. MIN. SLEW. ANG. B	Fallen below lower limit value for the measuring channel "slewing angle B"	cf. Error 1A	cf. Error 1A
E20: NO REF. VOLTAGE	No analog voltages	<ul style="list-style-type: none"> a.) The input voltages are too small. b.) The voltage converter is defective. 	<ul style="list-style-type: none"> a.) Check crane voltage. b.) Replace power supply board.

E21: ERROR MB LENGTH MAX.	Upper limit value for measuring channel "length telescopic boom" exceeded.	<ul style="list-style-type: none"> a.) Cable leading from the central unit to the length/angle sensor defective, not connected or water in the connectors. b.) Length sensor pot defective. c.) Electronic board in the measuring channel defective. 	<ul style="list-style-type: none"> a.) Check cable and connectors as well and replace, if necessary. b.) Replace length sensor pot. c.) Replace CPU or analog board.
E22: ERROR PRES. PISTON MAX.	Upper limit value for the measuring channel "pressure transducer piston side" exceeded.	<ul style="list-style-type: none"> a.) Cable leading from the central unit to the pressure transducers defective, not connected or water in the connectors. b.) Pressure transducer defective. c.) Electronic board in the measuring channel defective. 	<ul style="list-style-type: none"> a.) Check cable as well as connectors and replace, if necessary. b.) Replace pressure transducer. c.) Replace CPU or analog board.
E23: ERROR PRES. ROD MAX.	Upper limit value for the measuring channel "pressure transducer rod side" exceeded.	<ul style="list-style-type: none"> a.) Cable leading from the central unit to the pressure transducers defective, not connected or water in the connectors. b.) Pressure transducer defective c.) Electronic board in the measuring channel defective. 	<ul style="list-style-type: none"> a.) Check cable and connectors as well and replace, if necessary. b.) Replace pressure transducer c.) Replace CPU or analog board.
E25: ERROR MAX. ANGLE	Upper limit value for the measuring channel "angle main boom" exceeded.	<ul style="list-style-type: none"> a.) Cable leading from the central unit to the length-angle sensor defective, loose or water in the connectors. b.) Angle sensor defective c.) Electronic board in the measuring channel defective. 	<ul style="list-style-type: none"> a.) Check cable and connectors as well and replace, if necessary. b.) Replace angle sensor. c.) Replace CPU or analog board.
E29: ERROR REF. VOLT. MAX.	Reference voltage defective.	<ul style="list-style-type: none"> a.) The total of the supply and the reference voltages is more than 3.3V b.) A/D converter defective. 	<ul style="list-style-type: none"> a.) Check supply voltages. b.) Replace analog board.
E2A: ERR. MAX. SLEW. ANG. A	Upper limit value for the measuring channel "slewing angle A" exceeded.	<ul style="list-style-type: none"> a.) Cable leading from the central unit to the slewing angle sensor defective, loose or water in the connectors. b.) Slewing angle sensor defective. c.) Electronic board in the measuring channel defective. 	<ul style="list-style-type: none"> a.) Check cable and connector as well and replace, if necessary. b.) Replace slewing angle sensor c.) Replace CPU or analog board.

E2B: ERR. MAX. SLEW. ANG. B	Upper limit value for the measuring channel "slewing angle B" exceeded.	cf. Error 2A	cf. Error 2A
E31: ERROR SYSTEM EPROM	Error in the system program.		Replace system program PROM
E38: WRONG SYST.-PROM DAT	Wrong system program in the LMI.	The system program in the LMI does not correspond to the programmings in the data EPROM 1.	Replace EPROM 1 of the system program.
E39: WRONG SYST.-PROM TLK	Wrong system program in the LMI.	The system program in the LMI does not correspond to the programming of the data EPROM 2.	Replace EPROM 2 of the system program.
E41: ERROR INTERNAL RAM	Error in the internal RAM.		- Replace RAM - Replace CPU-board.
E42: ERROR EXTERNAL RAM 1	Error in the first part of the external RAM.		- Replace CMOS-RAM - Replace CPU-board.
E43: ERROR EXTERNAL RAM 2	Error in the second part of the external RAM.		- Replace CMOS-RAM - Replace CPU-board.
E45: ERROR RED. A/D CONVERTER	Redundancy error in the A/D conversion.	The A/D converter of the processor board and the redundant A/D converter in the CPU provide divergent results.	Replace CPU board.
E46: ERROR EXT. A/D CONVERTER	Error in the A/D converter uPD 7004	The A/D converter uPD 7004 of the CPU board does not provide an EOC signal	Replace CPU board.
E51: ERROR DATA EPROM	Errors in the crane data EPROM or in the EEPROM.	No valid data in the crane data EEPROM. Memory module incorrectly by-passed. Defective crane data PROM.	Load crane data EEPROM with valid data. Bridge memory module for the respective memory type. Re-place crane data EEPROM.
E52: ERR. LOAD CH. EPROM	Error in the load chart PROM.	Load chart PROM defective.	Restart LMI. Replace crane data PROM.
E56: ERROR EEPROM	Error in the crane data EEPROM.	Crane data EEPROM defective. Memory module incorrectly by-passed.	By-pass memory module according to memory type. Replace crane data EEPROM.
E57: ERROR SER. D.-EEPROM	Error in the serial crane data EEPROM.	No valid data on the serial crane data EEPROM. Memory module defective.	Write data on to the serial crane data EEPROM by means of the test program, then, restart the LMI. Load serial crane data EEPROM with valid data. Replace memory module.
E58: ERROR SER. AN.-EEPROM	Error in serial analog board EEPROM	No valid data in the serial analog board EEPROM. Analog board defective.	Write data onto the serial analog board EEPROM by means of the test program, then restart the LMI. Replace analog board.

E71: ERROR RELAY K1	Incorrect acknowledgement of the 1. relay on the analog board.	1. relay or main board or connection board defective.	Replace 1. relay, main board or connection board.
E72: ERROR RELAY K2	Incorrect acknowledgement of the 2. relay on the analog board.	2. relay or main board or connection board defective.	Replace 2. relay, main board or connection board.
E73: ERROR RELAY K3	Incorrect acknowledgement of the 3. relay on the analog board.	3. relay or main board or connection board defective.	Replace 3. relay, main board or connection board.
E74: ERROR RELAY K4	Incorrect acknowledgement of the 4. relay on the analog board.	4. relay or main board or connection board defective.	Replace 4. relay, main board or connection board.
E80: ERROR SLEWING ANG:	The measuring channels "slewing angle A" and "slewing angle B have no distance of 90 deg.	a) Cable leading from the central unit to the slewing angle sensor defective, loose or water in the connectors. b) Slewing angle sensor defective. c.) Electronic board in the measuring channel defective.	a.) Check cable and connector as well and replace, if necessary. b) Replace slewing angle sensor c.) Replace CPU or analog board.
E81: ERROR CANT	Maximally admitted cant of the crane was exceeded.	Maximally admitted cant of the crane exceeded because of outriggers not having been correctly placed.	Check outriggers and modify their position, if necessary
E82: ERROR OUTRIGGER	Error at outriggers	At least one of the four outriggers is not completely extended or not fully set onto the ground.	Completely extend the outriggers and/or correctly set the cylinders onto the ground.
E83: ERROR TELECOMBINATION	Error when telescoping	Combination of the boom elements does not correspond to the prescriptions.	Correct the combination of the boom elements.
E84: ERROR OPERAT. MODE	Error in operating mode	The selected operating mode is not included in the DATA-(E)EPROM.	Check the programming in the DATA-(E)EPROM.
E86: ERROR TELE PERCENT	Prohibited length range	cf. Error 05	cf. Error 05

Note:

If an error is displayed on the console that is not listed above, the competent PAT-service should be contacted.