PAT

ANGLE-LENGTH-RADIUS-LOAD INDICATOR SYSTEM

EI 65

OPERATOR'S AND CALIBRATION MANUAL

Link-Belt

Construction Equipment

LATTICE BOOM CRANES

L-B B5L0082/PAT 031-300-190-015 REVISION D 04/15/99

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OPERATOR'S SECTION

1. GENERAL INFORMATION

The PAT Length-Angle-Radius-Load Indicator System EI 65 has been designed to provide the crane operator with the essential information required to enable the machine to be used within its design parameters. The EI 65 System indicates the length and angle of the boom, tip height, working radius and the total calculated weight being lifted by the crane.

Using various sensing devices, the EI 65 System warns the crane operator of certain approaching hazardous conditions which could occur during the operation of his crane.

The purpose of this operator's manual is to provide information to help him operate, maintain and troubleshoot the PAT System.

The manual contains the system description, operating, and calibration information.

2. WARNINGS

⚠ WARNING

Always refer to operational instructions and load charts provided by the crane manufacturer for specific crane operation and load limits.

- The EI 65 is an operational aid that warns a crane operator of certain approaching hazardous 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 operation of the crane 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 the indicator and crane.
- Proper functioning is dependent upon proper daily inspection and observations of the operating instructions set forth in this manual.

3 SYSTEM DESCRIPTION

The PAT EI 65 System consists of an operating console with central micro processor unit, length/angle sensor, force transducers and anti-two block switches.

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 that also serves as an electrical conductor for the anti-two block switches.

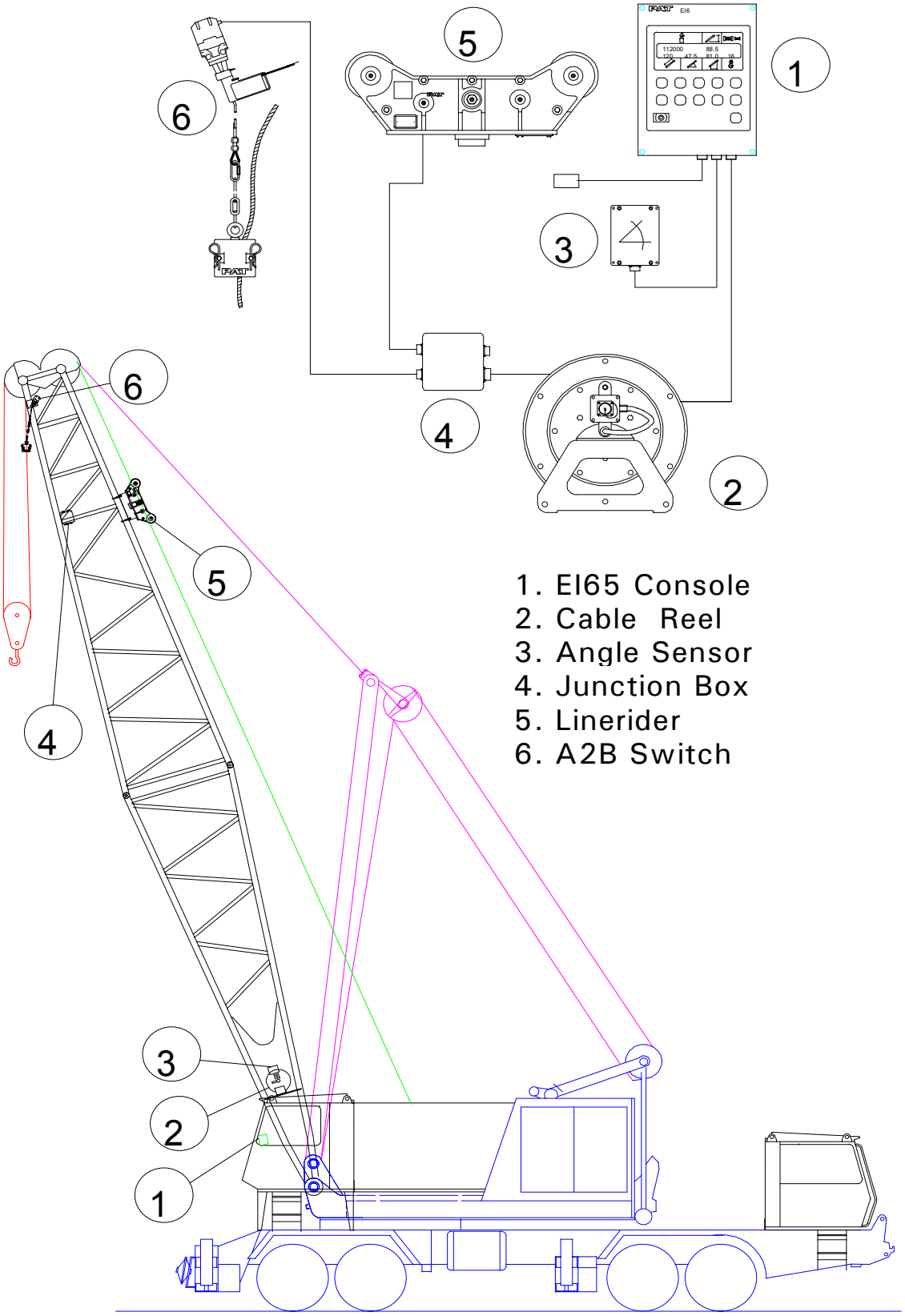
The crane load is measured by running line tensiometers attached to the upper side of the boom.

3.1 System Function

After ignition of the engine, the system starts with an automatic test of all lamps, the audible alarm and the complete system.

After the system has passed through the system test without errors, the system will request the operator to confirm the boom and jib configuration data. This allows the operator to compare the system configuration with the actual crane configuration. (see Section 4.1). After the operator confirms the system configuration, the console will indicate, on the display (13), the actual load, tip height, boom length, boom angle, and radius.

Fig. 1: Components of the PAT System EI 65

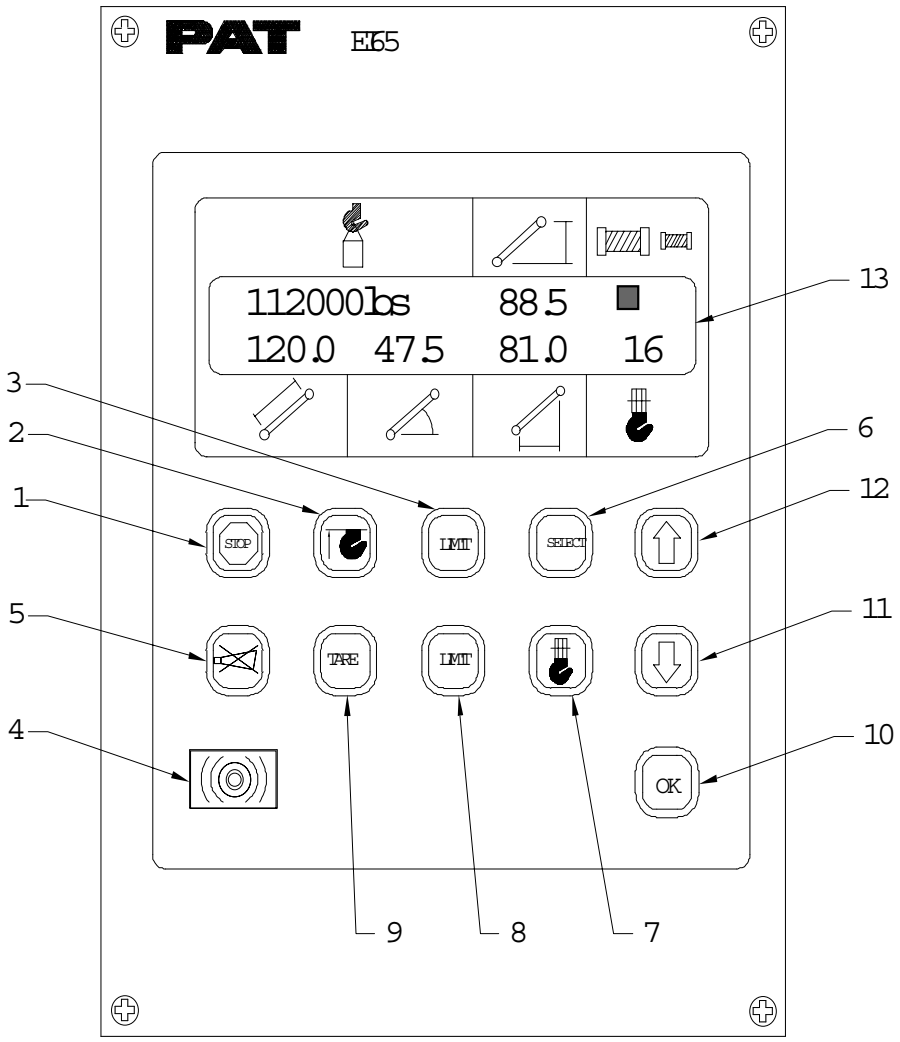


3.2 Operating Console

The console has 2 functions:

- Terminal for input of instructions and information to the system by the crane operator
- Display of crane data and information

The operating console is located in the operator's cabin in front of the operator. This unit contains different displays and controls that are described in Section 3.3.

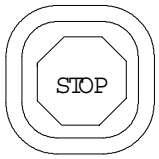


1 Overload Alarm Light
2 Anti-Two Block Alarm Light
3 Limit Alarm Light
4 Audible Alarm
5 Button "Horn OFF" and Alarm Light
6 Button "SELECT"
7 Button "Reevings/Hoist"
8 Button "LIMIT"
9 Button "TARE"
10 Button "OK"
11 Button "DOWN"
12 Button "UP"
13 Data Display

3.3 Control Identification

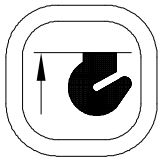
The above figure illustrates the controls and displays of the EI 65 Operating Console. The numbers of the illustration correspond to the numbers in the following list, which describes the function of each control.

1 Overload Alarm Light



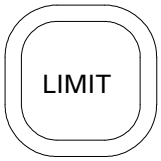
The red Overload Alarm Light (1) will light up when the preprogrammed load limit is reached. At the same time the Audible Alarm (4) will sound and the Limit Alarm Light (3) and the alarm light in the button Horn-Off (5) will light up. The corresponding crane movements will be stopped (Option).

2 Anti-Two Block Warning Light



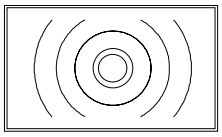
The red Anti-Two Block Warning Light (2) will light up when the anti-two block limit switch contacts open, indicating that a two-blocking condition is approaching. At the same time the Audible Alarm (4) will sound and the alarm light in the button Horn-Off (5) will light up.
The following crane movements will be stopped simultaneously: hoist up, telescope out, boom down (Option).

3 Limit Alarm Light



The Limit Alarm Light (3) will light up when one of the preprogrammed limits are reached. The limits are minimum and maximum limits of boom angle, boom length, boom height, working radius. At the same time the Audible Alarm (4) will sound and the alarm light in the button Horn-Off (5) will light up.
The corresponding crane movements will be stopped (Option).

4 Audible Alarm

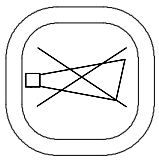


The Audible Alarm (4) is located on the bottom side of the console. It sounds during the following conditions:

- Approaching two-block condition
- Preset angle, height, length or radius limits are reached
- Preset load limit is reached
- System error.

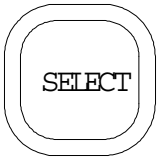
The alarm can be silenced for 15 seconds by pushing the button (5).

5 Button "Horn Off" and Alarm Light



The Button "Horn Off" (5) allows the audible alarm to be silenced for approx. 15 seconds by pressing this button. At the same time the corresponding Alarm Light (5) goes out.

6 Button "Select"

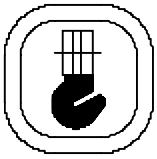


The button "Select" (6) is used for indicating and setting the values of the Operating conditions.

After pressing this button the display indicates a part of the "Select Menu". It is possible to move through the different points and pages of the menu step by step by pushing the button "DOWN" (11).

The procedure for indicating and setting the Operating Conditions is described in Section 4.2

7 Button "Reevings/Hoist"



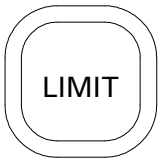
The button "Reevings/Hoist (7) is used for setting the number of reevings (parts of line) and selecting the hoist winch.

After pressing the button one time the operator is requested to enter the actual number of parts of line by using the button "Up" (12) and "Down" (11).

After pressing the button two times the operator can select the actual hoist winch by using the button "Up" (12) and "Down" (11).

The procedure for setting the reevings and selecting the hoist winch is described in Section 4.2

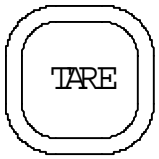
8 Button "Limit"



The button "Limit" (8) is used for activating the setting procedure of the preset limits. This limits are minimum and maximum limits of boom length, boom angle, boom height, working radius and maximum limit of load.

The procedure for setting the limits is described in Section 4.3

9 Button "Tare"



The button "Tare" (9) is used to indicate the net load on the display. Net load is the actual load, less lifting tackle and hook block. The button "Tare" has to be activated before lifting.

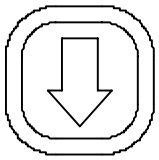
After pushing the button "Tare" (9) before lifting the load display will be set to zero (tare) and the lamp in the button lights up. After lifting a load the load display shows the net load (pay load).

The net load display will return to the normal load display when the button "Tare" (9) is pressed a second time.

10 Button "OK"

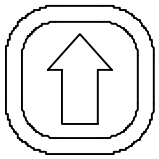
This button (10) is used to confirm values and data which are used as input for the system. The instruction to use this button will always be given on the display.

11 Button "Down"



The button "Down" (11) is used to get an decrease of a numerical value at the display during the programming and setting procedures and to move through the different menus in "Down"-direction. The instruction to use this button will be given on the display.

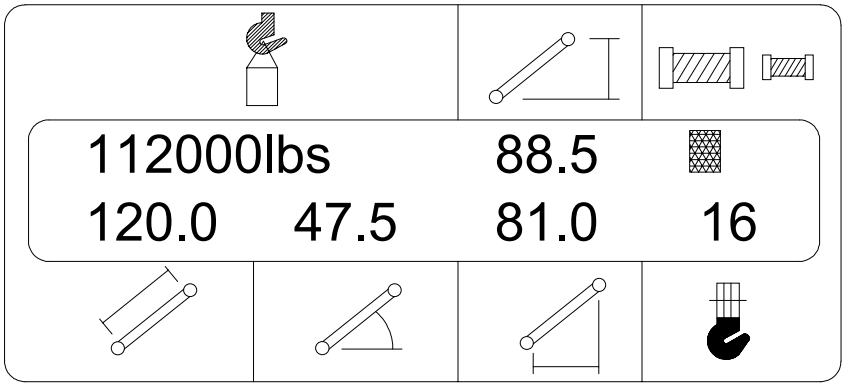
12 Button "Up"



The button "Up" (12) is used to get an increase of a numerical value at the display during the setting procedure of limits and operating conditions.

13 Display

The Display (13) will show technical information as well as operating information and instructions for the operator.



During crane operation the readout will display the actual load, the tip height, the boom length, the boom angle, the working radius, the selected hoist winch and the number of reevings (parts of line). In case of a system error an error code is displayed in place of the reevings.

During the setting procedure of the Operating Conditions and the limit setting procedure the display shows the setting values and information for the operator.

4 PROGRAMMING PROCEDURE

During the startup phase the PAT System EI 65 automatically starts with a programming procedure which relies on the correct entry by the crane operator.

This procedure consists of three parts:

- Startup Procedure
- Setting operating configuration of the crane
- Setting the preset limits

For simple operation, the computer guides the operator through the procedure step by step. The operator has to read the information displayed and is instructed to answer questions by using appropriate buttons of the keyboard. During each step of the procedure particular button lights will come on to identify the possible choices for the step.

4.1 Startup Procedure

After ignition of the engine the system starts the Startup Procedure with a self test.
During the Startup Procedure the crane operator will confirm the preset configuration stored in system memory as described below. The operator will compare the preset operating configuration values with the actual crane configuration.

If there is a difference between the indicated and the actual condition, the operator must correction those values by completing step 1 to 14 in Section 4.2.2.

The system stores the preset values for minimal 2 hours when the crane voltage is switched off. After a loss of the preset values the operator will need to reset these values.

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The display shows the previously programmed boom and jib configuration. The crane operator can compare the preset Operating Configuration Values with the actual crane configuration. To confirm the displayed values push the button "OK" (10).
To change the configuration values go to one of the following sections. **If the system configurations are correct, go to Section** 5 PRE-OPERATION INSPECTION**.**

- Section 4.2 will allow the operator to change all crane configurations.
- Section 4.2.1 will allow the operator to quickly change Reeving only
- Section 4.2.2 will allow the operator to quickly to change Hoist selection only.

Setting Operating Configuration of the Crane

STEP 1

To enter new values the button "Select" (6) has to be pushed.

The DOWN (11) button can be pressed to skip a step in the following procedure. When the a particular step is skipped, the configured values of that step remain the same as the confirmed values in Section 4.1

STEP 2

SELECT BOOM? PUSH ↓ OR OK

The operator is requested to enter the boom configuration. To enter new boom data he has to push the button "OK" (10).

Push Button "OK" (10) for next step.

To continue with the previously entered boom configuration the button DOWN (11) has to be pushed.

Step 3 to 9 will be skipped, when the button "DOWN" is pressed.

STEP 3

MAIN BOOM? PUSH ↓ OR OK

The operator is requested to push the button "DOWN" (11) if the crane is equipped with a boom extension.

If the crane is equipped only with a main boom (without jib or boom extension) the button OK (10) has to be pressed.

Step 5 to 9 will be skipped, when the button "OK" is pressed.

STEP 4

BOOM LGTH? PUSH ↓↑ OR OK

The display shows the previously programmed or default length of the main boom.

To enter a new main boom length, the operator has to select the value by pushing the buttons "UP" (12) or "DOWN" (11).

Go to Step 10 HOIST SELECT.
STEP 5

JIB SELECT? PUSH ↓ OR OK

The operator is requested to enter the jib configuration.

To enter new jib data, push the button "OK" (10).

Push Button "OK" (10) for next step.

If the operator wants to continue with the previously programmed jib configuration or the default values he has to push the button "DOWN" (11).

STEP 6

JIB LGTH_1: 45 PUSH ↓↑ OR OK

The display shows the previously programmed or default length of jib 1.

To enter a new jib length, the operator has to select the value by pushing the buttons "UP" (12) or "DOWN" (11). If no jib 1 is used the value 0.0 has to be selected.

If the operator wants to continue with the displayed length of jib 1 he has to confirm by pushing the button "OK" (10).

Push Button "OK" (10) for next step.

Note: Jib 1 is a boom extension with fixed length and without offset angle.

STEP 7

JIB LGTH_2: 25 PUSH ↓↑ OR OK

The display shows the previously programmed or default length of the jib 2.

To enter a new jib length, the operator has to select the value by pushing the buttons "UP" (12) or "DOWN" (11). If no jib 2 is used the value 0.0 has to be selected.

If the operator wants to continue with the displayed length of jib 2 he has to confirm by pushing the button "OK" (10).

Push Button "OK" (10) for next step.

Note: Jib 2 is an extension with fixed length and with different offset angles.

STEP 8

JIB OFFSET_2: 15 PUSH ↓↑ OR OK

The previously programmed or default offset angle of jib 2 is displayed.

To enter a new offset angle, the operator has to select the value by pushing the buttons "UP" (12) or "DOWN" (11).

If the operator wants to continue with the displayed offset angle of jib he has to confirm by pushing the button "OK" (10).

Push Button "OK" (10) for next step.

STEP 9

MAIN BOOM? PUSH ↓ OR OK

If the main boom length is correct, push the button "DOWN" (11). To change the main boom length the button OK (10) has to be pressed.

Confirm jib values entered in Steps 6 to 9, by pressing the button "OK".

STEP 10

HOIST SELECT? PUSH ↓ OR OK

Step 11 will be skipped, if the crane is not equipped with an Auxiliary Hoist.

The crane operator is requested to enter the actual hoist winch.

Push Button "OK" (10) for next step.

If the operator wants to continue with the previously used or default hoist he has to push button "DOWN" (11).

Step 11 will be skipped, when the button "DOWN" is pressed.

STEP 11

MAIN HOIST? PUSH ↓ OR OK
AUXILIARY HOIST? PUSH ↓ OR OK

To select either the Main Hoist or the Auxiliary Hoist the operator has to use the button "DOWN" (11).
If the operator wants to continue with the displayed hoist he has to confirm by pushing the button "OK" (10).
Push Button "OK" (10) for next step.

STEP 12

REEVING? PUSH ↓ OR OK

The crane operator is requested to enter the number of reevings (parts of line) being used.

Push Button "OK" (10) for next step.

If the operator wants to continue with the previously programmed or default number of reevings he has to push button "DOWN" (11). Step 13 will be skipped, when the button "DOWN" is pressed.

STEP 13

The display shows the previously programmed or default number of reevings (parts of line).
To enter a new number of reevings the operator has to select the value by pushing the buttons "UP" (12) or "DOWN" (11).
If the operator wants to continue with the displayed number of reevings (parts of line) he has to confirm by pushing the button "OK" (10).

Push Button "OK" (10) for next step.

STEP 14

The Setting Procedure is completed. The crane operator has the possibility to accept the conditions programmed on Step 1 to 12, or to correct the values.
For correction of the preset conditions the Button "DOWN" (11) has to be pushed. In this case the system starts again the Startup Procedure.

If the displayed conditions are O.K. the crane operator has to push Button "OK" (10).

Then the display will show the actual crane data.
Setting of Reevings

The setting procedure can be activated by the operator by pushing the button "Reevings/Hoist Winch" (7).

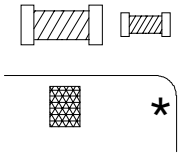
After pushing the button one time an asterisk will appear on the display beside the number of reevings, indicating that the procedure of setting the reevings is activated. To enter a new number of reevings the operator has to select the value by pushing the buttons "UP" (12) or "DOWN" (11).

If the operator wants to continue with the displayed number of reevings (parts of line) he has to confirm by pushing the button "OK" (10).

After pushing the button "OK" (10) the procedure for Number of Reevings is completed and the display will show the actual crane data.

4.2.2 Selecting the Hoist Winch

The procedure for selecting the hoist winch can be activated by the operator by pushing the button "Reevings/Hoist Winch" (7) two times.



After pushing the button two times an asterisk will appear on the display beside the symbol for the hoist winch.
Select either the main hoist "UP" (12) or the auxiliary hoist using the button "DOWN" (11).

Select the actual used hoist winch, and confirm by pushing the button "OK" (10).

The display will show the actual crane data.
Activating and Setting of Preset Limits

The PAT System EI 65 is equipped with the following presets:

- limit for maximum hook load
- limits for maximum and minimum boom angle, boom length and working radius.

The operator has the possibility to activate the load limit and/or the maximum and minimum limit of one of the above geometric dimensions. The limit which is activated is identifiable by an blinking colon.

For simple operation the computer guides the operator through the procedure step by step. The operator has to read the information displayed and is instructed to answer questions by using appropriate buttons of the keyboard. During the Setting Procedure the lamp in the particular button lights up.

After a loss of the preset values the system sets the values of the Preset Limits on maximum or minimum and deactivates all preset limits. This can happen, when the system is longer than 2 hours without supply voltage.

The Activating and Setting Procedure can be started by the crane operator by pushing the Button LIMIT (8).

3.1.1 Setting of Boom Angle Presets

STEP 1

This message appears after pushing the Button "LIMIT" (8). For activating the Setting Procedure of Boom Angle Limits the operator has to push Button "DOWN" (11).

Push Button "DOWN" (11) for next step.
STEP 2

To select the Boom Angle Preset Programming Procedure push the button "OK" (10).

Push Button "OK" (10) for next step.

To skip the angle preset limit push the button "DOWN" (11).

Step 3 to 6 will be skipped, when the Button DOWN is pressed. The system continues with Radius Limit Preset Programming Procedure (see Section 4.3.2)

STEP 3

The actual value of the Minimum Boom Angle Preset is displayed.

To enter a new value of the Minimum Boom Angle Preset, the operator has to push the button "UP" (12) for increase and the button "DOWN" (11) for decrease the displayed value.

If the crane operator wants to continue with the displayed value, he has to confirm by pushing the button "OK" (10).

Push Button "OK" (10) for next step.

STEP 4

The actual value of the Maximum Boom Angle Preset is displayed.

To enter a new value of the Maximum Boom Angle Preset, the operator has to push the button "UP" (12) for increase and the button "DOWN" (11) for decrease the displayed value.

If the crane operator wants to continue with the displayed value, he has to confirm by pushing the button "OK" (10).

Push Button "OK" (10) for next step.

STEP 5

For verification of the previously set values the Maximum and Minimum Boom Angle Preset is displayed.

Push Button "OK" (10) for next step.
STEP 6

The Setting Procedure for the Boom Angle Presets is completed. The display shows the actual crane data. To remind the crane operator of the activated Boom Angle Preset the display of the actual boom angle shows a intermittent colon.

Setting of Boom Radius Presets
STEP 1

This message appears after pushing the Button "LIMIT" (8). For activating the Setting Procedure of Boom Radius Limits the operator has to push Button "DOWN" (11) two times to skip the Length and angle preset setting procedure.

Push Button "DOWN" (11) two times for next step.
STEP 2

To select the Boom Radius Preset Programming Procedure push the button "OK" (10).

Push Button "OK" (10) for next step.

To skip the radius preset limit push the button "DOWN" (11).

Step 3 to 6 will be skipped, when the Button DOWN is pressed. The system continues with Height Limit Preset Programming Procedure (see Section 4.3.3)
STEP 3

The actual value of the Minimum Boom Radius Preset is displayed.

To enter a new value of the Minimum Boom Radius Preset, the operator has to push the button "UP" (12) for increase and the button "DOWN" (11) for decrease the displayed value.

If the crane operator wants to continue with the displayed value, he has to confirm by pushing the button "OK" (10).
Push Button "OK" (10) for next step.

STEP 4

The actual value of the Maximum Boom Radius Preset is displayed.

To enter a new value of the Maximum Boom Radius Preset, the operator has to push the button "UP" (12) for increase and the button "DOWN" (11) for decrease the displayed value.

If the crane operator wants to continue with the displayed value, he has to confirm by pushing the button "OK" (10).
Push Button "OK" (10) for next step.

STEP 5

For verification of the previously set values the Maximum and Minimum Boom Radius Preset is displayed.

Push Button "OK" (10) for next step.
STEP 6

The Setting Procedure for the Boom Radius Presets is completed. The display shows the actual crane data. To remind the crane operator of the activated Boom Radius Preset the display of the actual boom radius shows a intermitted colon.

3.1.2 Setting of Boom Height Presets

STEP 1

This message appears after pushing the Button "LIMIT" (8). For activating the Setting Procedure of Boom Height Limits the operator has to push Button "DOWN" (11) three times to skip the length, angle and radius preset setting procedure.

Push Button "DOWN" (11) 3 times for next step.
STEP 2

To select the Boom Height Preset Programming Procedure push the button "OK" (10).

Push Button "OK" (10) for next step.

To skip the high preset limit push the button "DOWN" (11).

Step 3 to 6 will be skipped, when the Button DOWN is pressed. The system continues with Load Limit Preset Programming Procedure (see Section 4.3.5)
STEP 3

The actual value of the Minimum Boom Height Preset is displayed.

To enter a new value of the Minimum Boom Preset, the operator has to push the button "UP" (12) for increase and the button "DOWN" (11) for decrease the displayed value.

If the crane operator wants to continue with the displayed value, he has to confirm by pushing the button "OK" (10).

Push Button "OK" (10) for next step.

STEP 4

The actual value of the Maximum Boom Height Preset is displayed.

To enter a new value of the Maximum Boom Height Preset, the operator has to push the button "UP" (12) for increase and the button "DOWN" (11) for decrease the displayed value.

If the crane operator wants to continue with the displayed value, he has to confirm by pushing the button "OK" (10).

Push Button "OK" (10) for next step.
STEP 5

For verification of the previously set values the Maximum and Minimum Boom Height Preset is displayed.

Push Button "OK" (10) for next step.
STEP 6

The Setting Procedure for the Boom Height Presets is completed. The display shows the actual crane data. To remind the crane operator of the activated Boom Height Preset the display of the actual boom height shows a blinking colon.

Setting of Load Limit
STEP 1

This message appears after pushing the Button "LIMIT" (8). For activating the Setting Procedure of Load Limit the operator has to push Button "DOWN" (11) four times to skip the length, angle, radius and height preset setting procedure.

Push Button "DOWN" (11) 4 times for next step.

STEP 2

To select the Load Preset Programming Procedure push the button "OK" (10).

Push Button "OK" (10) for next step.

To skip the load preset limit push the button "DOWN" (11).

Step 3 to 4 will be skipped, when the Button DOWN is pressed.
STEP 3

The actual value of the Maximum Load Preset is displayed.

To enter a new value of the Maximum Load Preset, the operator has to push the button "UP" (12) for increase and the button "DOWN" (11) for decrease the displayed value.

If the crane operator wants to continue with the displayed value, he has to confirm by pushing the button "OK" (10).

Push Button "OK" (10) for next step.

STEP 4

The Setting Procedure for the Load Presets is completed. The display shows the actual crane data.

Deactivation and Cancellation of Limits
STEP 1

This message appears after pushing the Button "LIMIT" (8). For activating the Setting Procedure of Load Limit the operator has to push Button "DOWN" (11) five times to skip the length, angle, radius, height, and load preset setting procedure.

Push Button "DOWN" (11) 5 times for next step.

STEP 2

To select the Deactivation and Cancellation of Limits Procedure push the button "DOWN" (11).

Push Button " DOWN" (11) for next step.

To return to the normal data display push the button "OK" (10).

STEP 3

For deactivation and cancellation of the previously programmed limits the operator has to push the button "OK" (10). In this case the system sets all limits on their default values. The Load Limit and Maximum and Minimum Angle Limit are active. All other limits are deactivated.

The Deactivation and Cancellation Procedure for the limits is completed. The display shows the actual crane data.

Push Button "OK" (10) for next step.

After pushing the button "DOWN" (11) the system returns to the begin of the procedure Activating and Setting of Preset Limits.

5. PRE-OPERATION INSPECTION

Prior to operating the crane, the following checks must be made:

1. Check the cabling connecting the various parts of the system for physical damage.

2. Check the anti-two block switches and weights for free movement.

⚠ 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.

3. Check the anti two-block alarm light (2) and the audible alarm by performing one of the following tests a, b, or c. If the crane is equipped with a boom extension, perform the test procedure on both the main boom and boom extension anti two-block switches.

- When checking system the operator must use caution. If the operator cannot see the load handling device approaching the boom nose, he/she shall have an assistant (signal person) watch the load handling device. The operator shall be prepared to stop the machine immediately should the EI 65 system not function properly by lighting the red warning light, sounding the audible alarm and locking the dangerous crane movements.

a) Check the anti-two block alarm light (2) and the audible alarm by manually lifting the weight attached to the anti- two block switches.
b) Slowly raise the main boom hook block to bring it into contact with the switch weight. When the hook block lifts the weight, the audible alarm should sound, the anti-two block alarm light (2) should light and the motion of the hook block should be stopped. Lower the hook block slightly to eliminate this condition.
c) Then slowly lower or extend the boom to create a potential two-block condition. When the hook block lifts the weight, the audible alarm should sound, the anti-two block alarm light (2) should light and the boom lowering and/or boom extension function should be stopped.

NOTE: 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 must be corrected before operating the crane.

4. Check that the display of the main boom length agrees with the actual boom length.

5. Check that the display of the main boom angle agrees with the actual angles.

⚠ 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 and/or verification of the crane's calibration.

6. Check that the display of the operating radius of the crane agrees with the actual radius.

7. Check the load display by lifting a load of known weight. The accuracy of the load indication shall be within the tolerance of SAE J376.

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

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

6. OPERATION

After completing Section 4 and 5, the crane configuration must match the actual configuration. Once the system is properly set, the operation of the EI 65 is fully automated. Therefore, the operator shall be thoroughly familiar with all controls, warning lights, load, length, height, radius and other information on the EI 65 console and crane. The operator is responsible for verifying the operating information is correct. At anytime the operator deems necessary, the pre-operational checks in Section 5 should be completed.

7. SERVICE AND MAINTENANCE

Daily maintenance of the system consists of inspecting:

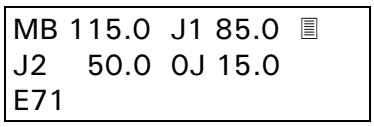
1. The electrical wiring connecting the various parts of the system. If electrical wiring is damaged, it shall be replaced immediately.
2. Check the anti two-block limit switches for freedom of movement.

3. Check the displayed main boom angle agrees with the actual angle.

4. Grease linerider sheaves.

Other than correcting the problems identified in the Malfunctions Table and replacing faulty mechanical parts and cables, all other repairs shall be performed by PAT Authorized Service Representatives.

8 TROUBLESHOOTING



In case of a malfunction of the system, a code that identifies the system malfunction will be displayed in the reeving portion of the display.

The error codes listed in the Malfunction Table will identify various faults that can occur with the EI 65. Following the Malfunction Table are pages which explain each fault and describe the action which shall be taken to correct the fault.

Faults within the electronic microprocessor shall be repaired by factory trained service personnel. When these faults occur, the competent service organization shall be contacted.

Malfunction Table

Error code	Reason	Action
11	Operating data in the buffered RAM	Turn on the system again and adjust operating data
21	Crane parameters in the serial EPROM incorrect	Re-calibrate the system
31	Wrong EPROM programming or EPROM defective	Exchange EPROM
51	Short circuit min layer device term 11&12	Check minimum layer device
52	Cable break min layer device term 11&12	Check minimum layer device
53	Short circuit A2B -switch - 2 term 13&14	Check anti-two block system
54	Cable break A2B -switch - 2 term 13&14	Check anti-two block system
55	Short circuit A2B -switch - 1 term 9&10	Check anti-two block system
56	Cable break A2B -switch - 1 term 9&10	Check anti-two block system
•61	Load on the main hoist hook too big	Reduce load on main hoist
•63	Load on the auxiliary hoist hook too big	Reduce load on aux. hoist
•71	Limit Length - Main - Boom - Max.	Decrease length limit
•72	Limit Length - Main - Boom - Min.	Increase length limit
•73	Limit WG - Main - Boom - Max.	Decrease main boom angle
•74	Limit WG - Main - Boom - Min.	Increase main boom angle
•75	Limit Boom height - Max.	Decrease main boom angle
•76	Limit Boom height - Min.	Increase main boom angle
•77	Limit Working radius - Max.	Increase main boom angle
•78	Limit Working radius - Min.	Decrease main boom angle
81	ADC-Measuring value KMD1 too big	Check zero point in linerider
82	ADC-Measuring value KMD1 too low	Check zero point in linerider
83	ADC-Measuring value KMD2 too big	Check zero point in linerider
84	ADC-Measuring value KMD2 too low	Check zero point in linerider
93	ADC-Measuring value WG1 too big	Check main angle sensor circuit
94	ADC-Measuring value WG1 too low	Check main angle sensor circuit
95	ADC-Measuring value WG2 too big	Check luffing angle sensor circuit
96	ADC-Measuring value WG2 too low	Check luffing angle sensor circuit

- Limit set by the operator refer to Operator's Handbook, Section 4.3. Activating and Setting Preset Limits

CALIBRATION SECTION

1 GENERAL INFORMATION

The Length-Angle-Radius-Load Indicating System EI 65 must be calibrated after completing installation, crane modification, or anytime there is an indication of inaccuracy. The calibration will match the installed sensor to the crane. Refer to the Installation Handbook for the system and sensor installation.
Prior to starting the calibration, it is advised to first read over this procedure in its entirety. This will also allow you a chance to obtain any necessary information. The purpose of this handbook is to provide calibration information required before operating the system. Refer to the Operator's Section of this Handbook for system description and console controls.

2 WARNINGS

Always refer to operational instructions and load charts provided by the crane manufacturer for specific crane operation and load limits.

The Length-Angle-Radius-Load Indicating System EI 65 is not and shall not be a substitute for good operator judgment, experience, or use of acceptable safe operating procedures.

The operator is responsible for operating the crane within the manufacturer's specified parameters.

The crane operator shall ensure that all warnings and instructions provided by the manufacturer are fully understood, observed, and remain with the crane.

Prior to operating the crane, the operator must carefully read and understand the information in the Operator's Handbook so that he knows the operation and limitations of the Length-Angle-Radius-Load Indicating System EI 65.

Always follow the manufacture's guidelines when operating the crane.

Always work within the capacity of the rated load charts provided by the manufacturer.

3 ESSENTIAL INFORMATION AND SETUP FOR CALIBRATION:

3.1 Prior to powering up the system verify all wiring. All unused channels must be occupied with dummy signals meeting the following requirements.

- The second angle channel must have a voltage divider installed. Install two 4.7k resistors, one between X1 #21-22 and the other between X1 #22-23.
- The second and third A2B channels must have a 4.7k resistor. Install a 4.7k resistor between X1 #11-12 and X1 #13-14.
- The second force channel must have a jumper installed between X1 #30-31.
- A no load system must have a jumper installed between X1- #26-27, for the first force channel.

3.1 Mechanically set the length and angle sensors as follows: (See Appendix A. Mechanical Adjustment for Sensors).

- Length Sensor - With the boom sections fully retracted set the length potentiometer by turning the center screw counter clockwise slowly to a soft stop.
- Angle Sensors: Align the angle sensors with the boom at zero degrees.

Write down the following geometric measurements, which will be used during calibration. (See Figure 1. Crane Measurements). The measurements taken should be in units that correspond to the load chart.(i.e. lbs/feet, Kg/meters, US-Tons/feet, Metric-ton/meters).

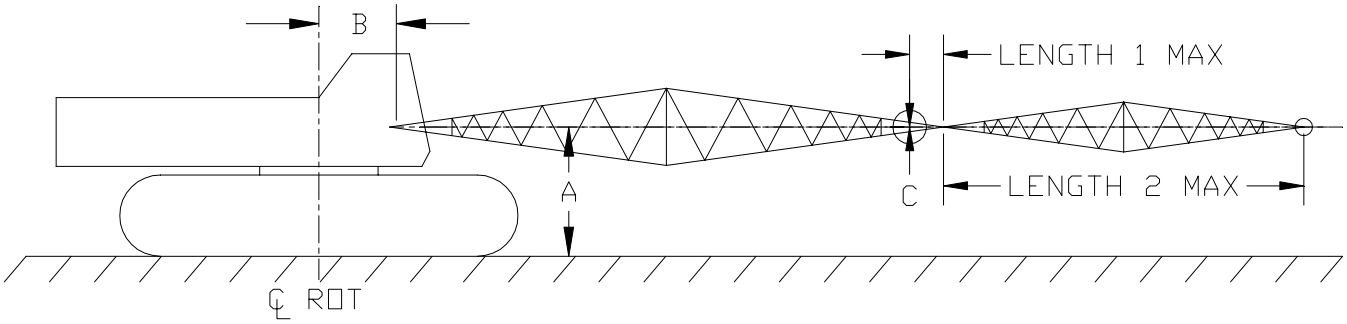


Figure 1. Crane Measurements

A. The vertical distance from the boom foot pivot pin to the ground. The calibration procedure refers to this dimension as "High Offset." (see Section 4.6.2)
B. The horizontal distance from the boom foot pivot pin to the center line of rotation. The calibration procedure refers to this dimension as "Rad Offset." (see Section 4.6.3)
C. The head offset, which is the vertical measurement between the boom foot pivot pin to the lower head sheave center pin. The calibration procedure refers to this dimension as "Head Offset." (see Section 4.6.4)
D. Jib extension lengths minimum and maximum

Table 1. Measurements

Crane Model	A (ft)	B (ft)	C	Length 1 (ft)	Length 2
LS138H	5.67	3.28	0	Min 0/Max1.5	REFER TO LBCE
LS208H	5.67	3.28	0	Min 0/Max1.5	OPERATOR'S
LS218H	7.46	4.58	0	Min 0/Max2.0	MANUAL

LINERIDER

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

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

Table 2. Lineriders should match the wire diameter of your hoist rope.

ITEM NUMBER	DESCRIPTION WITH WIRE ROPE SIZE	WIRE ROPE DIAMETER ADVISED RANGE
048-500-060-005	SENSOR, LINERIDER SKM500 7/8"	±3/64
048-500-060-006	SENSOR, LINERIDER SKM500 1"	±3/64
048-500-060-012	SENSOR, LINERIDER SKM500 1-1/8 2 TON KMD	±3/64
048-500-060-013	SENSOR, LINERIDER SKM500 1-1/4 2 TON KMD	±1/16

The linerider requires a load sheave adjustment to maximize the voltage output of the amplifier and minimize the line angle through the linerider. The linerider maximum output of 2.5 volts should be equal to the maximum hoist rope line pull. The load sheave may need to be adjusted by turning the eccentric wheel on the load sheave of the SKM500 SERIES linerider, see Figure 2.

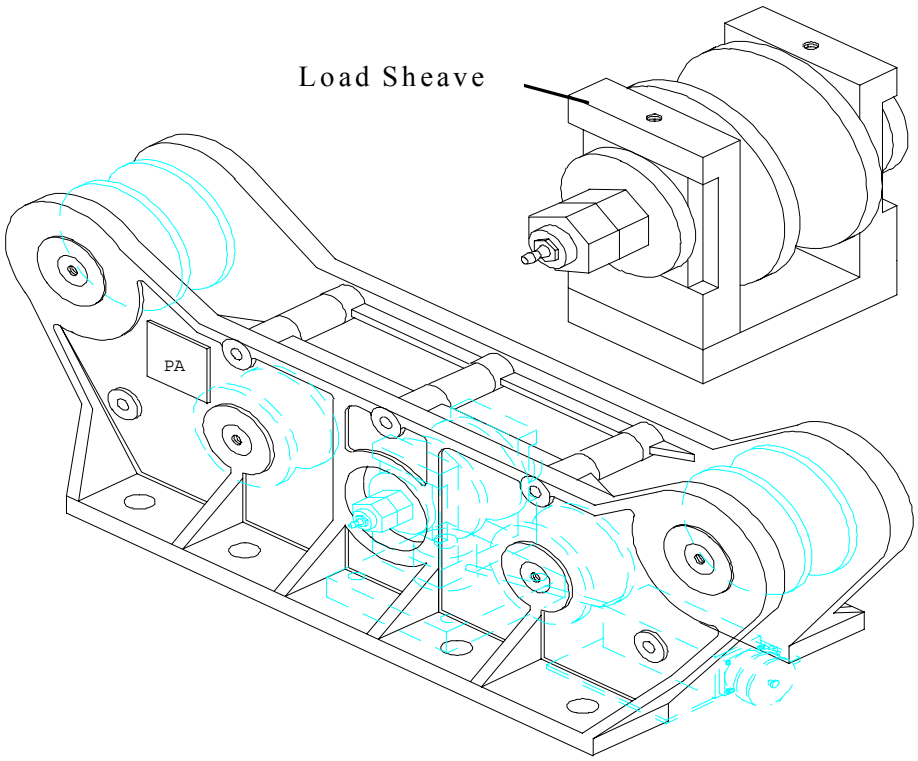


Figure 2. SKM 500 Linerider

3.1.1 Setting the line rider output voltage.

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

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

$$\frac{\text{TEST LOAD x 2.5}}{\text{LINE PULL}} = \div \text{ PARTS OF LINE} = \text{X}$$

$$\frac{23.600 \times 2.5}{29.500} = 2.0 \div 1 = 2.0$$

"X" is equal to the to optimum output voltage of the linerider. The output voltage required in this example is 1.8 to 2.0 volts.

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

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

c. Take a voltage reading with a voltmeter and compare the reading with the calculated voltage and decide if a mechanical adjustment of the linerider is needed.
   - Main Linerider: console terminal connection X1-#26 and X1-#27 or main boom tip junction box terminals 1 and 2.
   - Auxiliary linerider: console terminal connection X1-#30 and X1-#31 or main boom tip junction box terminals 7 and 8.

If no mechanical adjustment is necessary proceed to Section 4.

MECHANICAL ADJUST OF THE LINE RIDER (if required from Section 3.4.1.)

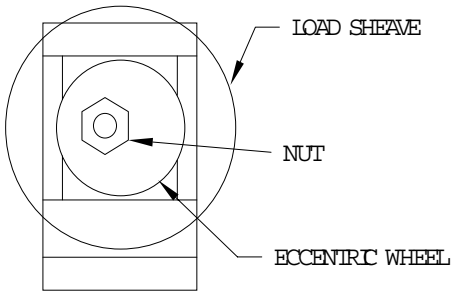


Figure 3. Load Sheave and Eccentric Wheel

a. Locate the load sheave and eccentric wheel on the linerider, see Figure 2. There is a single nut on one side and a double on the other. These both should be loosened to some degree. Adjustment from the double nut side seems to work the best after tightening the 2 nuts together. Mark the wheel before and after turning to indicate how far the wheel has been turned. This adjustment may have to be completed more than once to set the correct voltage. To increase the output voltage, the load sheave will need to move up; therefore using Figure 3 as an example, rotate the wheel clockwise. We suggest turning the wheel a maximum of a 1/4 turn. After you have set the mechanical adjustment tighten all nuts insuring not to move the wheel.

b. Complete steps 3.41.b and c until the output voltage is within tolerance.

CALIBRATION

4.1. Power up the system, the screen will display EI 65/10 software version and date.

4.2. Within 5 seconds, simultaneously press the "OK" and "SELECT" buttons in order to start calibration. Hold these buttons (approximately 15 seconds) until the screen changes to "CALIB. PASSWORD". If these buttons are not pressed and held the screen then changes to the existing operating configuration. See operators manual 56 065 08 0006 for operating instructions.

4.3. Press "OK" to enter length.

NOTE: The following sections can be selected by pressing "OK" or skipped by pressing arrow "UP" or "DOWN".

4.4. CONFIG LANGUAGE - Press "OK" to select and use the arrow "UP and DOWN" buttons to select a language; English, Spanish, or French. When complete press the "OK" button.

4.5. CONFIG UNITS - Press "OK" to select and use the arrow "UP and DOWN" buttons to select the load units; LBS (lbs), TONS (t), KILOGRAMS (kg), US-TONS (tons). When complete press the "OK" button.

NOTE: Select the units used in the load charts provided by the manufacturer.

4.6. CONFIG CRANE DEF - Calibrates the angle sensor and defines the required geometric measurement of the crane. Press "OK" to select.

4.6.1. WG OFFSET - Ensure the angle sensor is mechanically align with the boom. Measure the boom angle, using an inclinometer or similar device. Press the arrows "UP or "DOWN" to adjust the displayed angle to match the measured angle. Press "OK" to enter angle.

NOTE: Measurements should be in units that correspond to the load chart.(i.e. lbs/feet, Kg/meters, US-Tons/feet, Metric-ton/meters).

HIGH OFFSET - This is the vertical measurement from the boom foot pivot pin to the ground, as taken in step 3.2.A.. Press the arrows "UP and DOWN" to adjust the display. Press "OK" to enter measurement.

4.6.3. RAD OFFSET - This is the horizontal measurement between the boom foot pivot pin and the center line of rotation, as taken in step 3.2.B.. If the Boom Foot Pivot Pin is located behind the Center Line of Rotation the value needs to be entered as a positive. If the Pivot pin is forward of the Center Line of Rotation the value needs to be entered as a negative. Press the arrows "UP or "DOWN" to adjust the display. Press "OK" to enter measurement.

4.6.4. HEAD OFFSET - The vertical measurement between the boom foot pivot pin and the lower head sheave center pin, as taken in step 3.2.C.. If the center pin is below the

boom foot pivot pin enter the value as a negative by using the arrows "UP or DOWN" to adjust the display. Press "OK" to enter measurement.

4.7. CONFIG MAIN BOOM - This section configures the type of main boom, select fixed. Press the "OK" button and proceed by answering the questions on the screen.

4.7.1. MAIN BOOM FIXED? - Press "OK" to accept. Enter boom length as the minimum and maximum value.

4.7.1.1. Enter the minimum length using the arrows "UP or DOWN" to adjust the display. Press "OK" to enter length.

4.7.1.2. Enter the maximum length using the arrows "UP or DOWN" to adjust the display. Press "OK" to enter length.

4.8. CONFIG EXTENSION - This section configures two extensions with minimum and maximum length. Use figures 4 and 5 to help identify your configuration. Press "OK" and proceed by entering extension lengths, and angle. Configure the extensions that your crane will use and enter zero for unused portions of CONFIG EXTENSION. Recommendation: setup the extensions minimum length as zero, so if this extension is removed you can change the length in the SELECT section of operation instead of entering calibration mode to remove extension.

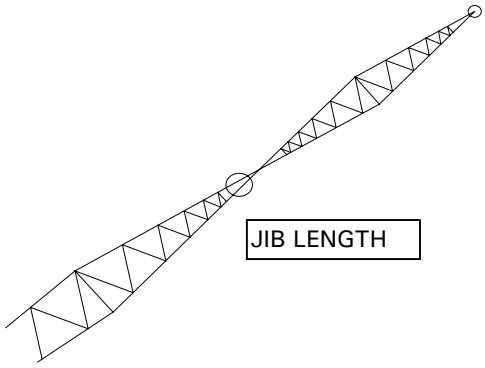


Figure 4. Jib Extension
Enter extension as length minimum and maximum

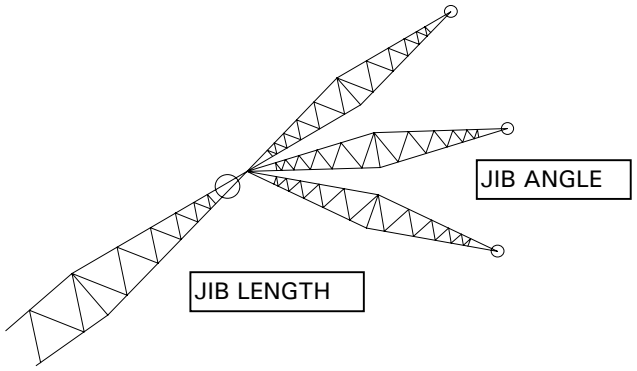


Figure 5. Jib Extension - Offset
Enter extension as length minimum and maximum and angle offset minimum and maximum

4.8.1. LENGTH_1 MIN - Press the arrows "UP or "DOWN" to display minimum length. Press "OK" to enter length. (See Table 1 in Section 3.2.D Length 1 Min)

4.8.2. LENGTH_1 MAX - Press the arrows "UP or "DOWN" to display maximum length. Press "OK" to enter length. (See Table 1 in Section 3.2.D Length 1 Max)

4.8.3. LENGTH_2 MIN - Press the arrows "UP or "DOWN" to display "0". Press "OK" to enter length.

4.8.4. LENGTH_2 MAX - Press the arrows "UP or "DOWN" to display "0". Press "OK" to enter length.

4.8.5. OFFSET MIN - Press the arrows "UP or "DOWN" to display minimum offset angle. Press "OK" to enter angle.

4.8.6. OFFSET MAX - Press the arrows "UP or "DOWN" to display maximum offset angle. Press "OK" to enter length.

4.8.7. WHIP EXTENSION - Press the arrows "UP or "DOWN" to select NO and Press "OK" to confirm entry.

4.9. CONFIGURE KMD1 - This step calibrates the main hoist force sensor. To calibrate this section you will be required to pick a know test load 80% of permissible line pull. Check the linerider output voltage, see section 3.4.1.

4.9.1. Press "OK" to calibrate the KMD1 - Main Linerider or press the arrow "DOWN" button to continue.

4.9.2. PARTS OF LINE - Use the arrows "UP or DOWN" to select parts of line. NOTE: One part of line should be used to calibrate a Line Rider.

4.9.3. KMD1 TYPE - Use the arrows "UP or DOWN" to enter the value for the "KMD TYPE" listed on Table 3.

Table 3. KMD Type values for Link-Belt wire ropes

	LINK-BELT ROPE TYPE					
WIRE ROPE SIZE	M	N	P	LB	RB	DB
7/8"	-	11	6	12	8	11
1"	-	14	8	15	11	14

For the SKM500, the KMD TYPE value equals the maximum hoist rope line pull divided by 2,204 and round up to the next whole number. (i.e. 29,500lbs. Line pull divide 30.5 by 2.204 = 13.4, rounded up = 14. The KMD TYPE value is 14.)

4.9.4. Press "OK" to confirm KMD type.

4.9.5. KMD1OFFSET - This operation sets the load at zero.

4.9.5.1 Set the hook block on the ground.

4.9.5.2 Use the arrows "UP or DOWN" to adjust the display to indicate zero load.

4.9.5.3 Press "OK" to confirm zero load.

⚠ WARNING

The operator is responsible for operating the crane within the manufacture's specified parameters.

4.9.6. KMD1 CONST - Lift a test load of at least 80% of permissible line pull for the crane configuration. See crane manufactures data for approximate load.
NOTE: To comply with the SAE J376 standards the test load must be to a known accuracy of ±1%.

4.9.6.1 Use the arrows "UP or DOWN" to adjust the display load to indicate your total test load. NOTE: The total load includes the load, rigging, cables, and hook block.
If the displayed load will not indicate the total test load. The KMD TYPE must be increased or decreased. If displayed load needs to be greater, increase KMD TYPE. Exit this section by pressing "OK" and restart KMD1 calibration by scrolling "DOWN" or "UP" to CONFIGURE KMD1 and press "OK". Return to beginning of Section 4.9.

4.9.6.2 Press "OK" to confirm total load.

4.10. CONFIGURE KMD2 - This step calibrates the auxiliary hoist force sensor (if applicable). To calibrate this section you will be required to pick a know test load 80% of permissible line pull. Check the linerider output voltage, see section 3.4.1.

4.10.1. To calibrate the KMD2 (Auxiliary Linerider) press "OK" or press the arrow "DOWN" button to configure display (section 4.11).

4.10.2. PARTS OF LINE - Use the arrows "UP or DOWN" to select parts of line. NOTE: One part of line should be used to calibrate a Line Rider.

4.10.3. KMD2 TYPE - Use the arrows "UP or DOWN" to enter the value for the "KMD TYPE" listed on Table 3 (same as Table 3 in Section 4.9.3 - repeated for your convenience.)

Table 3. KMD Type values for Link-Belt wire ropes

	LINK-BELT ROPE TYPE					
WIRE ROPE SIZE	M	N	P	LB	RB	DB
7/8"	-	11	6	12	8	11
1"	-	14	8	15	11	14

For the SKM500, the KMD TYPE value equals the maximum hoist rope line pull divided by 2,204 and round up to the next whole number. (i.e. 29,500lbs. Line pull divide 30.5 by 2.204 = 13.4, rounded up = 14. The KMD TYPE value is 14.)

4.10.4. Press "OK" to confirm type.

4.10.5. KMD2OFFSET - This operation sets the load at zero.

4.10.5.1 Set the hook block on the ground.

4.10.5.2 Use the arrows "UP or DOWN" to adjust the display to indicate zero load.

4.10.5.3 Press "OK" to confirm zero load.

⚠ WARNING

The operator is responsible for operating the crane within the manufacture's specified parameters.

4.10.6. KMD2 CONST - Lift a test load of at least 80% of permissible line pull for the crane configuration. See crane manufactures data for approximate load.

NOTE: To comply with the SAE J376 standards the test load must be to a known accuracy of ±1%.

4.10.6.1 Use the arrows "UP or DOWN" to adjust the display load to indicate your total test load. NOTE: The total load includes the load, rigging, cables, and hook block.

If the displayed load will not indicate the total test load. The KMD TYPE must be increased or decreased. If displayed load needs to be greater, increase KMD TYPE. Exit this section by pressing "OK" and restart KMD2 calibration by scrolling "DOWN" or "UP" to CONFIGURE KMD2 and press "OK". Return to beginning of Section 4.10.

4.11. CONFIG DISPLAY - This section configures the data that will be displayed on the screen.

4.11.1. SHOW LOAD? - YES arrow "UP", NO arrow "DOWN". Press "OK" to confirm.

4.11.2. SHOW HIGH? - YES arrow "UP", NO arrow "DOWN". Press "OK" to confirm.

4.11.3. SHOW HOIST? - YES arrow "UP", NO arrow "DOWN". Press "OK" to confirm.

4.11.4. SHOW RADIUS? - YES ARROW "UP", NO arrow" DOWN". Press "OK" to confirm.

4.11.5. SHOW LENGTH? - YES arrow "UP", NO arrow "DOWN". Press "OK" to confirm.

4.11.6. SHOW ANGLE? - YES arrow "UP", NO arrow "DOWN". Press "OK" to confirm.

4.11.7. SHOW REEVING? - YES arrow "UP", NO arrow "DOWN". Press "OK" to confirm.

4.12. CONFIGURATION READY??? - At this point, you may return to any part of the calibration sections by using the arrows "UP" or "DOWN" to change calibration data. Press "OK" to confirm.

4.13. SAVE TO E-EPROM??? - Save calibration data to E-Eprom by pressing "OK". Pressing the arrow "DOWN" for NO will disregard data entries made during this calibration session. If the calibration data is disregarded and the system has not been calibrated as stated in this document and the crane must not be operated.

4.14. The screen then changes to the operating configuration which is presently set. Turn power off for 10 seconds.

4.15 Turn power on. The display shows the crane configuation which is presently set.

4.16 Press 'OK'. The display shows the normal operating screen, but the main boom length, height, and radius are displayed as zero (0.0).

4.17 Press the "Select" button. The 'Select' button enters the operating configuration.

4.18 Press the "OK" button to select the boom.

4.19 Press the "OK" button to select the main boom.

4.20 Press the "OK" button to select the boom length.

4.21 The display shows the previously programmed or default length of the main boom. Enter the correct main boom length by pressing the "UP" (↑) or "DOWN" (↓) buttons.

4.22 Press the "OK" button to enter the correct length.

4.23 Press the "DOWN" (↓) button twice or until exit is displayed.

4.24 Press the "OK" button to exit the operating configuration and return to the normal operating screen. The correct data should be displayed in the operating screen, if not, refer to the operator's manual Section 4.2. to set operating conditions.

5. OPERATIONAL CHECKS

After completing calibration do the following operational checks to verify displayed values. These operational checks should be complete at anytime there is an indication of inaccuracy.

NOTE: We recommend completing all operational checks before correcting calibration data.

5.1 Check the angle of the main boom and compare it with the measure value. It should be ±1°. If the angle is incorrect complete Sections 4.1, 4.2, 4.3 and 4.6.

NOTE: Use the select button to specify crane configuration before performing the following checks. See Operators Handbook 056 065 08 0006.

5.2. Check the radius displayed and compare it with the a measured radius. The radius is a horizontal measurement from the crane centerline of rotation to the center of the hook block. The displayed radius should be equal to or greater than the measured radius by 10%. For example, if the measured radius equals 15ft then the displayed radius should be 15ft to 16.5ft. If displayed value is incorrect, verify the Rad Offset measurement taken in 3.3.B and complete Sections 4.1, 4.2, 4.3, and 4.6.

5.3. Check the total load displayed by picking the known test load. This will require picking a load for each force sensor, KMD1 and KMD2, if applicable. The displayed load should be equal to or greater than the known load by 10%. For example, if the known load equals 12,000lbs then the displayed load should be 12,000lbs to 13,200lbs. If displayed value is incorrect, complete Sections 4.1, 4.2, 4.3, and 4.9 for KMD1 and/or 4.10 for KMD2.

NOTE: To comply with the SAE J376 standards the test load must be to a known accuracy of ±1%.

HANDBOOK REVISIONS

REV	DATE	NAME	DESCRIPTION
-	04/15/97	CSH	Operating and Calibration handbook created.
A	10/20/97	CSH	Pg 22 - Del. 3. cable reel N/A Pg 23 - Chg. SAE J159 to SAE J376 Pg 24 - Chg. Service and Maintenance Pg 26 - Up-date Error Code Chart
B	07/28/98	CSH	• Combine Handbooks 031-300-190-015 Operator's Section and 031-300-190-024 Calibration Section. Obsolete part number 031-300-190-024. • Add step 4.14 thru 4.24 on page of Calibration Section for configurting the main boom length for operation. • Transfer 031-300-190-024 revision information REV - 02/26/97Create calibration handbook 031-300-190-024. REV A 06/04/98 Change pg 2 section 3.2 crane measurements. Add C dimension to Figure 1.
C	01/26/99	CSH	Pg's 27 & 33 Change Figure 1 and Table showing Crane Measurements for Length 1 for extension
D	4/15/99	CSH	Pg 33 and 35 ADD KMD type values for RB and DB rope