

**SILICON
INTERNATIONAL**

Crane Moment Limiter

SLI-500

(Crane Computer)

**PRELIMINARY
TECHNICAL MANUAL**

SILICON INTERNATIONAL

171-COOPERATIVE MARKET SADDAR

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I. General Introduction

During operation, according to the specific circumstances at the working site, a crane has to frequently change its working conditions, such as the lifting angle and the boom length, to provide lifting. On the other hand, the rated maximum lifting capacity and the maximum and minimum working angle changes under different working parameters are also different. Therefore, we need a set of devices to indicate the working status of a crane, such as safe operation, overload, angle or length error, and to implement relevant alarming, indication and control, so as to ensure proper operation of the lifting machinery.

The full automatic crane moment limiters are suitable for use with telescopic boom or fix boom cranes. The system, which is a micro processing embedded operating system, has a friendly user interface, a small power consumption, strong functionalities and a high sensitivity and is compact in design, easy to operate and expand. It can display a crane's working parameters such as the actual lifted Load, the rated lifting Capacity, the Angle, the Length and the Radius. It has complete pre-alarming, overload alarming and overload output control functions; it has a complete system failure self-detection function and can display failures, which provides the operator with effective guidance in solving the problems.

1) Functions

The product is integrity of electronic technologies, microcomputer technologies and crane mechanical technologies. It has the following major functions:

- ☞ It can automatically detect various kinds of signals related to lifting devices and enter the signals into instruments for micro processing. The signals include: weight signals, length signals, signals of included angle between boom and horizon, etc.;
- ☞ The instrument can display various kinds of pre-defined parameters related to the working conditions. The parameters include: jib length, rated lifting capacity, actual lifted load, working angle of boom etc.
- ☞ The system can carry out automatic sampling and real-time tracking of the performance parameters of the lifting device and can use a microcomputer to calculate, compare and determine the parameters and give out acousto-optic alarms when necessary.
- ☞ The host computer is universal and can be adapted to various kinds of lifting devices by changing the software, without having to change the host computer. This facilitates mass production. The computer has stored multiple sets of rated load curves, which meets the requirements for alarming under various working conditions;

2) Major technical parameters

1. Working ambient temperature: $-20^{\circ}\text{C} \sim 60^{\circ}\text{C}$
2. Working ambient humidity: 95% (25°C)
3. Working voltage: AC 220 V $\pm 20\%$
4. Working mode: Continuous
5. Vibration: Acceleration $\leq 5\text{g}$ (g is gravity acceleration)
6. Overall system error: Less than $\pm 5\%$
7. Overall power consumption: Less than 10W
8. Alarm volume: More than 60db

II. Composition and operating principles

A) System composition

Complete system consists of Operator Console, Junction Box, Length Sensor, Angle Sensor and Load Sensor.

1. HMI Operator Console

HMI Operator Console is a Human Machine Interface (HMI) based low power latest technology that is developed based on WIENTEK AUTOMATION Technology, the HMI embeds all the necessary functionality regarding the User Interface, the full Color Monitor Display with Touch Screen for Operation, It is highly optimized for use in harsh industrial environments with efficient sealing and packaging standards, It communicates to main Junction Box for information exchange ,thus providing extremely high reliability and resistance against interference and ensuring proper operation under the harsh ambient Temperature of -20Deg. C ~ +60Deg. C.

This HMI Operator Console takes the signal and sensors parameters from the Junction Box Console System and then prepares the User Interface Data. The power supply of this Console is also coming from Junction Box Console

HMI Operator Console displays all data with which a customer may be concerned on a single screen, such as the Angle, the actual lifted Load, the rated lifting Capacity, Boom, Length & Radius. In addition HMI Display console also display the Continuously Crane Capacity and crane's safety status.

This Console is connected with a Junction Console Box by a 3-core cable with DB-9 Connector. This cable carries the Communication/Data signals between the Junction Console Box and HMI Operator Console. Also there is 2-core 24V DC Power supply cable coming from Junction Console Box for powering the Operator HMI Console.

2. Junction Console Box

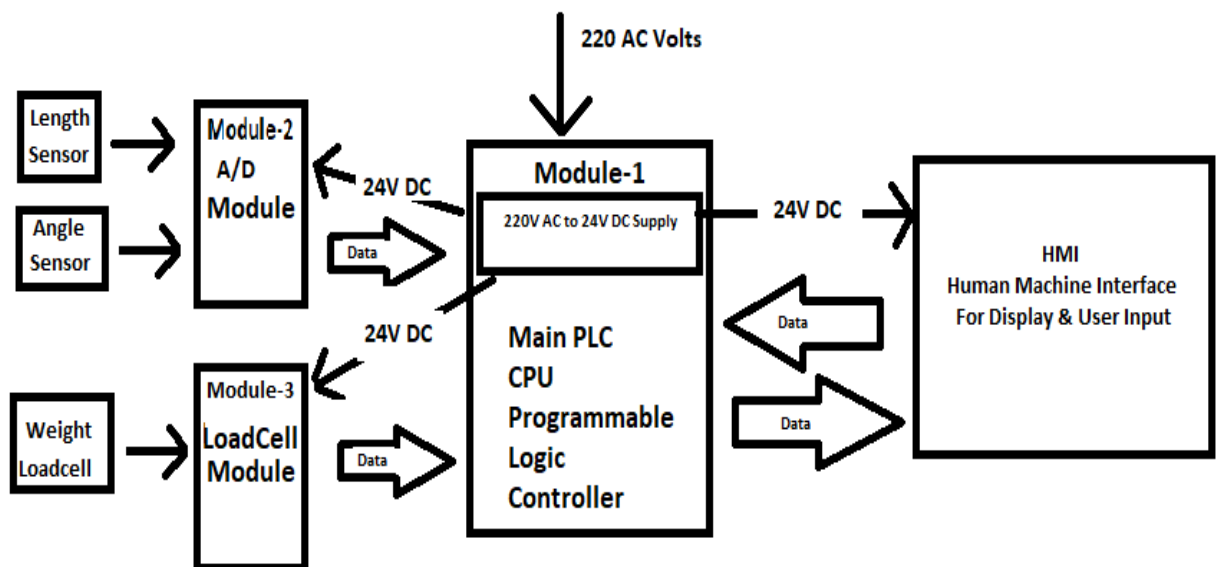
The Junction Console Box is the Brain of SLI-500 Crane Safety System, because it collects the information from various sensors and Process/Accumulate then according to their values and sends them to HMI Operator Console for User Display; also it received the commands from User and processes them accordingly.

The Junction Console Box consist of 3 Main Modules in which Programmable Logic Controller (PLC) is the First & main Module, it is also the CPU of Crane Moment Limiter, which is responsible for communicate with all other peripherals Modules of the System. It needs 220V AC basic supply and it will convert this 220V AC to 24V DC to for internal circuit working.

The Second unit is the A/D Converter Module (Analog to Digital Converter), which is used for taking the inputs of Crane's Boom Length Sensor and Boom Angle Sensor and conveys the sensor values to Main PLC module. It needs 24V DC to operate.

The Third unit is the Load-cell Input Module, the task of this module is read the value of the Load-cell for the weighting purposes, It sends its reading to the Main PLC CPU Module for further processing. It needs 24V DC to operate.

3) Schematic Block Diagram (II-3)



BLOCK DIAGRAM OF CRANE

4) Operating principles

During the operation of Crane, the Main Module PLC CPU receives the current status of the sensors from other Modules. Therefore, after collecting and processing of corresponding signals, the PLC CPU will search for the corresponding curves of the load chart's, and determine the rated lifting capacity under the conditions, compare the capacity with the actual lifted load and carry out control. Of course it can also determine whether the limit is exceeded by checking the angles and carry out control.

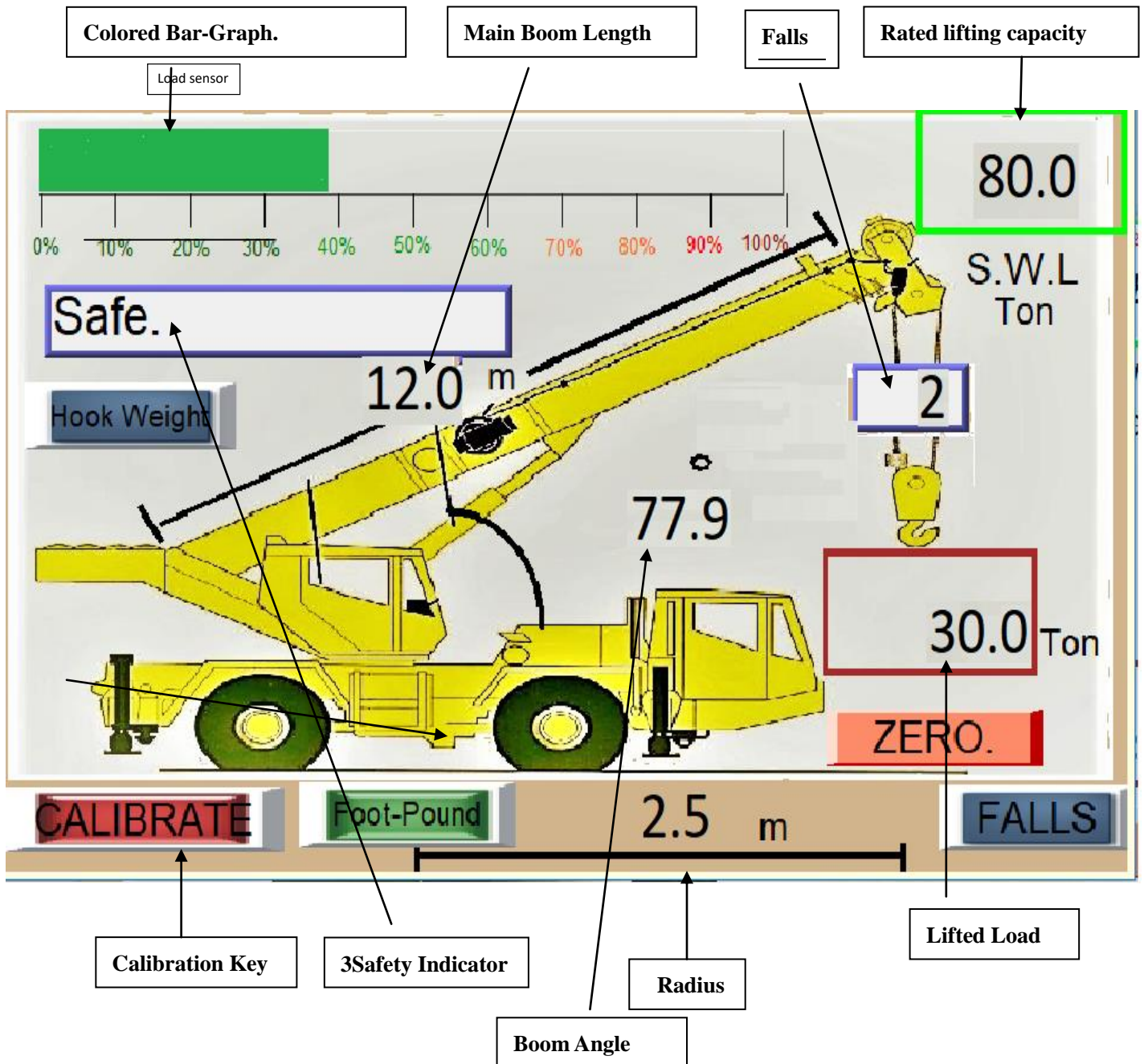
During operation, the moment limiter first detects various kinds of operational parameters (angle, length & weight) of crane by corresponding sensors. The simulated amplification adjustments of operational parameters are done in A/D module and Load-Cell Module. These refined signal are then send to PLC CPU for their adjustment according to calibration and Load-Chart Curves.

The Calibration must be done after installing the Crane Moment Limiter in the Crane, so that the system can show the actual parameters, the process of calibration is discussed in the upcoming section. Data after the adjustment of the operational parameters (angle, length & weight) is send to the HMI Display Console for User information, The HMI Display console calculate the Alarm values and messages according to the data sent by the PLC CPU, User can view the information and can calibrate the Crane Moment Limiter using Touch pad Interface.

If the Weight measure by the Crane Moment Limiter is greater than the Safe Working Load calculated by the Load Chart Curves, then HMI Display Console will show the "Over Load" Message & Trip the crane by generate an Active-High Output at its output pin so that to stop further operations of the Crane for safety requirements. The Boom Length & Angle of Boom is also compared with the Load Chart Curves, so that whenever the Boom Length of Crane is Over or Under range of the Length Values in Load Chart then System Also Generate Alarm and show the Message of "Length Error", Same principle is for the Boom Angle whenever the Calculated Radius according to Boom Angle is Over or Under the Range of the Radius Values in Load Chart, then System will generate Alarm and display the message of "Angle Error"

III. HMI Display Console Layout:

Interpretation of display interface



IV. Procedure of Calibration:

There are Three Parameters to be adjusted by the calibration.

1-Load

2-Boom Length

3-Angle

4- Radius Offset

-To enter into Calibration Mode, press “**CALIBRATE**” button, then the Password Entry Popup will appear.

-Password Entry Popup will show up for entering password, Tap the Text Entry Box, the Popup Keyboard will appear on Screen. Enter the Password shown below:

“ABCDEF”

(In Text box the password will be show as “*****”)

-After entering the above Password Press the “OK” Button, If Password is correct then Weight Calibration Window will appear, otherwise it will return to Main Screen Window again.

- Upon Successful Password entry, The **Need to Calibrate Weight?** Window will appear and ask user for **Yes/No** Confirmation.

- By pressing the Yes Button the **SLI Weight Calibration** Window will appear, or by Pressing No it will Jump to Length Calibration Confirmation.

1-Load Calibration:

First unload any lifted Weight then Continue,

-The **Sli Weight Calibration** Window will appear, (**Without Lifting- Load**)

Window will have two Boxes as follow:

At First Box “**Enter Minimum Weight = 000.0**”

At Second Box “**Minimum Weight ADC Counts = 000.0**”

-At the First Box, the user must tap the Box for input the Minimum Weight in Tons, by tapping the Box the Numeric Keypad will appear, the user will input the Minimum Weight and then press Enter on Keypad.

-At the Second Box, there is nothing to be entered by the User, it is just the A/D Value of the Load-cell Input which is shown for User Information, and this value is saved in calibration.

-When user has input the Minimum Weight, then User will press the “**Next**” Button for further processing.

First lift the known Weight then Continue,

-The Same Window will appear again for the **Maximum Load Calibration**, so the Window will have two Boxes as follow: **(With Lifting Load)**

At First Box **“Enter Maximum Weight = 000.0”**

At Second Box **“Maximum Weight ADC Counts = 000.0”**

-At the First Box, the user must tap the Box for input the Maximum Weight in Tons, by tapping the Box, Numeric Keypad will appear, and user will input the Maximum Weight and then press Enter on Keypad.

-At the Second Box, there is nothing to be entered by the User, it is just the A/D Value of the Load-cell Input, Please note that the Current A/D Count at this stage of Maximum Weight must be greater than Previous Minimum Counts, Now Press the **“Done Weight Calibrate”** Button, the Weight calibration has been completed.

-After Completing the Load Calibration, The New Window will pop up with Title **“Need to Calibrate Length”**, and ask user for **Yes/No** Confirmation.

- By pressing the Yes Button the **SLI Length Calibration** Window will appear, or by Pressing No it will Jump to Angle Calibration Confirmation.

2-Boom Length Calibration:

-The **SLI Length Calibration** Window will contain two Boxes.

First Retract the Boom to your Minimum Length.

Window will have two Boxes as follow: **(At Minimum Length.)**

At First Box **“Enter Minimum Length = 000.0”**

At Second Box **“Minimum Length ADC Counts = 000.0”**

-At the First Box, the user must tap the Box for input the Minimum Length in Meters, by tapping the Box the Numeric Keypad will appear, the user will input the Minimum Length and then press Enter on Keypad.

-At the Second Box, there is nothing to be entered by the User, it is just the A/D Value of the Length Sensor Input which is shown for User Information, and this value is saved in calibration.

-When user has input the Minimum Length, then User will press the **“Next”** Button for further processing.

First Expand the Boom to Maximum Length then Continue,

-The Same Window will appear again for the **Maximum Length Calibration**, so the Window will have two Boxes as follow: **(With Maximum Length)**

At First Box **“Enter Maximum Length = 000.0”**

At Second Box “**Maximum Length ADC Counts = 000.0**”

-At the First Box, the user must tap the Box for input the Maximum Length in Meters, by tapping the Box, Numeric Keypad will appear, and user will input the Maximum Length and then press Enter on Keypad.

-At the Second Box, there is nothing to be entered by the User, it is just the A/D Value of the Length Sensor Input, Please note that the Current A/D Count at this stage of Maximum Length must be greater than Previous Minimum Counts, Now Press the “**Done Length Calibrate**” Button, the Length calibration has been completed.

-After Completing the Length Calibration, The New Window will pop up with Title “**Need to Calibrate Angle**”, and ask user for **Yes/No** Confirmation.

- By pressing the Yes Button the **SLI Angle Calibration** Window will appear, or by Pressing No it will Jump to Radius Offset calibration.

3-Boom Angle Calibration:

First set your Boom angle to minimum position the continue,

-The **SLI Angle Calibration** Window will contain two Boxes, (**At Minimum Angle**)

At First Box “**Enter Minimum Angle = 000.0**”

At Second Box “**Minimum Angle ADC Counts = 000.0**”

-At the First Box, the user must tap the Box for input the Minimum Angle in Degree, by tapping the Box the Numeric Keypad will appear, the user will input the Minimum Angle and then press Enter on Keypad.

-At the Second Box, there is nothing to be entered by the User, it is just the A/D Value of the Angle Sensor Input which is shown for User Information, and this value is saved in calibration.

-When user has input the Minimum Angle, then User will press the “**Next**” Button for further processing.

First Elevate to Maximum Angle then Continue,

-The Same Window will appear again for the **Maximum Angle Calibration**, so the Window will have two Boxes as follow: (**At Maximum Angle**)

At First Box “**Enter Maximum Angle = 000.0**”

At Second Box “**Maximum Angle ADC Counts = 000.0**”

-At the First Box, the user must tap the Box for input the Maximum Angle in Degree, by tapping the Box, Numeric Keypad will appear, and user will input the Maximum Angle and then press Enter on Keypad.

-At the Second Box, there is nothing to be entered by the User, it is just the A/D Value of the Angle Sensor Input, Please note that the Current A/D Count at this stage of Maximum Angle must be greater than Previous Minimum Counts, Now Press the “**Done Angle Calibrate**” Button, the Angle calibration has been completed.

-After Completing the Angle Calibration, The New Window will pop up with Title “**SLI Radius Offset**” for entering the Radius offset.

4-Radius Offset:

- The Radius offset entered by the user will be in ± 000.0 Format, because this value will add to calculated radius of the Crane, and it used due to Crane Structure requirements.

The Following one box will show the Edit Radius offset value.

“**Edit Radius Offset = 000.0**”

-Tap the box, the Numeric Edit Keypad will appear, Enter the Data by first enter the + **or** – Sign according to your Radius offset requirements, and then enter the offset value of Radius in Meters, after that press the Key of **Done Radius Offset**, so that your Screen will come back to your Home Screen.

All Calibration Procedures are completed here.