Safety Instrumentation

Calibration Instructions

i3500 Rated Capacity Indicator system for telescopic cranes pressure sensing, multi-point version

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Contents

The purpose of this manual is to provide the customer with the operating procedures essential for the promotion of proper machine operation for its intended purpose. The importance of proper usage cannot be overstressed. All information in this manual should be read and understood before any attempt is made to operate the machine.

Since the manufacturer has no direct control over machine application and operation, conformance with good safety practice in this area is the responsibility of the user and his operating personnel.

All procedures herein are based on the use of the system under proper operating conditions, with no deviations from the original design. Alteration and/or modification of the equipment are strictly forbidden without written approval from RaycoWylie Systems.

The i3500 RaycoWylie Systems Rated Capacity Indicator (RCI) is to be regarded only as an aid to the operator. When the parameters are set correctly, the indicator will warn the crane operator of an approaching overload condition that could cause damage to equipment, property, and/or injury to the operator or site workers in the vicinity of the crane and its load.

This system must never be used, under any circumstances, as a substitute for the good judgment of a crane operator when carrying out approved crane-operating procedures. Responsibility for the safe operation of the crane lies with the crane operator. The indicator equipment will not necessarily prevent crane damage due to overloading and related causes if not set properly.

Before operating a crane equipped with a RaycoWylie system RCI, the operator must carefully read the information in both this manual and the crane manufacturer operator's manual. He must also be aware of all the federal, state and local safety standard and regulations applicable to his job. Correct functioning of the system depends upon routine daily inspection.

Any suspected faults or apparent damage should be immediately reported to the responsible authority before using the crane.

1.0 GENERAL DESCRIPTION

1.1 Introduction

This manual contains calibration, diagnostic and troubleshooting information for the i3500 system. Information in this manual will enable qualified personnel to calibrate and troubleshoot the i3500 system efficiently.

1.2 Personnel qualification and scope of this manual

This manual is intended to be used by qualified installation technicians and repair technicians, who are fully qualified and trained to perform the procedures described in this guide.

This manual is divided into the following sections:
SECTION 1 – GENERAL DESCRIPTION
SECTION 2 – THE i3500 SYSTEM
SECTION 3 – THE CARD/ELECTRONICS INTERFACES

1.3 Brief description of the I3500 System

The I3500 is a computerized crane monitoring system, designed as an operator aid. It comprises sensors fitted to the crane and a display located in the cabin of the crane. This version measures the boom cylinder pressure, the boom angle and length, and it indicates safe or critical conditions, while performing an authorized lift of loads.

Optional sensors may also be fitted to monitor the slew angle and the rotation of the hoist drum to provide some extra information to the operator. All the sensors are linked through a single CANbus (Controlled Area Network).

The pressure sensors provide electrical signals that are proportional to the actual pressures in the hydraulic boom cylinder system of the crane. An inclinometer provides a signal that is proportional to the boom angle and a reeling drum provides a signal that is proportional to the boom extension. The radius and the load are calculated from these signals with the dimensional crane data pre-programmed in the I3500 system.

During operation the load lifted by the crane is calculated from the measured boom cylinder pressure and is automatically compared with corresponding data related to the maximum permissible crane loading. The actual load is expressed as a percentage of the permitted load (%SWL). If this percentage exceeds a preset value, alarms and safety functions are activated. The values of the hook load, the permissible load, the main boom angle and the radius are displayed in a digital form on a graphic liquid crystal display (LCD).

Audible alarms: an intermittent buzzer sounds if the percentage of the safe working load is between 85%-99% and a continuous buzzer sounds when the % of the safe working load is in the range of 100% to 120%. Visual alarms: A yellow led illuminates for an approach to an overload between 85%-99% of the safe working load. A red led illuminates for an overload between 100%-119% of the safe working load and an additional red led illuminates for a cut out > 120% of the safe working load. If the additional sensors are fitted, then some information about the current slew angle and the hook height will also be available. The required crane duty charts are stored in a non-volatile memory and can only be modified with the approval of the crane manufacturer. The calculated crane parameters and calibration data are stored in an additional non-volatile memory. The calibration of the crane is performed only with the use of known loads, boom angles, and other pre-determined data.

2.0 THE I3500 SYSTEM

2.1 Troubleshooting

This section provides technical troubleshooting support. It will answer most questions that repair personnel may have when installing, repairing or performing maintenance on the i3500 system.

2.1.1 Diagnostic Menu

A diagnostic menu provides information on the systems status and the state of all connected sensors. To access the diagnostic menu, press #1 “mode”, and use ”⮝” or “⮟” to highlight “diagnostic”, then press “✓” to enter the diagnostic menu.

The information is divided into several pages with each page applying to only one sensor or one type of information. The different pages available are: angle/length, load, relay, general info for a specific type of calibration (e.g. telescopic multi-point), rotation and also the addresses of sensors detected by the i3500 system.

Depending on the system configuration, a minimum of three pages are always provided: angle/length, general info and detected addresses. Other pages are optional and are only shown if one or more sensors are activated by the system (refer to the option activate/deactivate I/O’ in calibration).

The use of the up/down arrows (**"▲"** and **"▼"**) will allow the user to scroll in the menu. When pressing simultaneously on an **"arrow"** key and the **"?"** key, the display will move from one page to the other. Pressing **"✓"** will show calibration details and also the original software version of the underlined sensor, this is not available for all sensors

Notes:

- Pressing **#5 "ESC"** takes you to the previous menu or exits from the diagnostic mode.

Angle/length sensor:

In the diagnostic menu, this is the typical displayed information:

sensor	ain1	ain2	dr+	a2b
angle 1	1428	1503	4.99	0
length 1	203	N/A	4.99	0

Some applications have more than one angle or length sensor. In this case, all of the angle sensors are listed first then length sensors will follow. The first angle sensor to be listed is the one installed closest to the main boom base.

Referring to the example above, for the "angle 1" sensor, values "ain1" and "ain2" vary depending on the inclinometers in the X and in Y axes that are used to calculate the angle. These values are normally between 1200 and 2900 bits. DR+ represents the D.C voltage level of excitation on the angle/length card and must be close to 5.00V.

When the multiple reel option is required every angle/length card has an ATB option that can be activated by dipswitch #4. For the angle/length card, which is not monitoring the ATB, N/A is shown under a2b instead of 0 or 1, indicating it is not available on this card. 0 is a safe condition and 1 will show a two-block condition.

For the "length 1" sensor, the value "ain1" represents the boom extension value in bits. It may vary between around 50 and 975 bits. The "length 1" sensor "ain2" value is reserved for future expansion.

Note: "angle 1" sensor and "length 1" are physically located on the same card.

To see the software version of the angle sensor and it's calibration state, press **"✓"** when "angle 1" is highlighted. The displayed information will look similar to this:

```
                        angle 1
-------------------------------------------------------------------
                          --
 ver:                  1.01   07jun07
 d1gx:       823.0             d1gy:       822.0
dzerox :     2041.0            dzeroy:     2034.0
zero angle:                    -150.2
```

The line beginning with "ver" indicates the software version of the angle/length sensor and also its creation date. The next two lines indicate if a sensor has been calibrated or if the calibration is valid.

d1gx and d1gy must be close to 820 ±1%
dzerox and dzeroy must be close to 2048 ±1%.
Zero angle is the angle in degrees given by the angle sensor when the zero of the angle has been calibrated on the machine.

To view the software version of the length sensor or it's calibration state, press **"✓"** when "length. 1" is highlighted. The displayed Information will look similar to this:

```
                        length 1
-------------------------------------------------------------------
 ver:                  1.01   07jun07
 offset :                      57
 scale :                    0.149661
```

The line beginning with "ver" indicates the software version of the angle/length sensor and also its creation date. The next two lines indicate if a sensor has been calibrated or if the calibration is valid. The "s**cale**" value must be smaller than 1.0.

Pressure sensors :

The use of the up/down arrows will permit the user to scroll in the menu.

sensor	ain	dr+	p1	p2
load 1	1325	4.96	1	1
load 2	1109	4.98	1	1

The "ain" value represents cylinder pressure measured in bits by the pressure sensor. It can reach a maximum of 4095 bits. The Dr + column is a regulated D.C. voltage level for the excitation of the pressure sensor and must be close to 5.00 VDC.

"p1" and "p2" values indicate the state of proximity sensors (prox1 and prox2). "p1" and "p2" are used to detect target for the rope direction sensor option, this option is not available for the telescopic crane pressure sensing, multi-point version.

To know the software version of a pressure sensor or it's calibration state, press **"✓"** when "load1" is underlined. The displayed Information will look similar to this:

load 1

ver:	1.00 07may07
offset :	373
scale :	0.142113

The line beginning with "ver" indicates the software version of the pressure sensor and its creation date. The next two lines indicate if a sensor has been calibrated or if the calibration is valid. The 's**cale**' value must be smaller than 1.0.

Relay:

The displayed Information will look similar to this:

	relay								inputs			
relay	1	2	3	4	5	6	7	8	1	2	3	4
card 1	1	1	1	1	0	1	1	1	1	1	1	1

The information shown for the relay cards is divided into two blocks:

- "Relay" block represents the individual state of every relay. "0" indicates that the relay coil is energized whereas "1" indicates that it is not energized.
- "Inputs" block represents the state of the 4 DIN inputs. A "0" represents an active input.

A maximum of 4 relay cards can be installed.

Press **"✓"** when card 1 is highlighted to view the software version of a relay card.

The displayed Information will look similar to this:

relay card 1

ver:	1.00 02may07

The "ver" line indicates the software version of the relay card and its creation date.

General information:

The displayed Information will look similar to this:

tx0 : 100.0	tx1 : 84.1
dir. m :	dir.a :
larq: 7.67	l. corr : 0.66
lah: 1.71	load : 0.66
fc ang: 1.00	defl: 0.02
fc len: 1.00	p0: 55.57
	pd12: 60.24

- **tx0 and tx1** are pressure sensor readings. Their values are represented in '**bars'** (metric pressure unit).

- **dir.m and dir.a** indicate direction of hook movement for the main or auxiliary winch.

  Note: This is an option used when dynamometers or load links are installed for line tension measurements.

- **larq (cable arm lever) and lah (cylinder arm lever)** are values used by engineering to verify certain calculations.

- **l. corr** is the real load including correction factors. These factors are fc ang (correction based on angle points) and fc len (correction based on length points). These factors are set in the calibration section "- load correction".

- **load** is the indicated load before application of correction factors.

- **fc ang and fc len** are correction factors applied to the load, the first one refers to hoist angle and the second one refers to boom extension.

- **defl** represents boom deflection.

- **p0** is the pressure in "bars" of the main boom without load.

- **pd12** is the total pressure in "bars" including the effect of lifted load.

Slew sensor (Rotation option):

The displayed information will look similar to this

rotation
---
ver: 0.11 17apr07
rot: 782
ratio: 1304
zero prox: 191
prox detect: 0

The “ver” line indicates the software version of the rotation interface and it’s creation date.

- **rot** is a rotation pointer and varies from 0 to ratio value minus one. (ex. 1304 -1).
- **ratio** is rotation sensor ratio (number of pulses for a complete rotation).
- **zero prox** is a rotation reference point. Angle of rotation is on ‘Zero prox’ value when the “proximity switch” is detecting the target.
- **prox detect** shows “proximity switch” state. The “0” indicates that the proximity switch is detecting a metal target set to a predetermined azimuth angle.

Detected addresses:

This page gives the sensor addresses on the CAN network detected by the i3500 system. Addresses remain in memory as long as the system is powered even if a sensor stops communicating.

2.1.2 Error Messages and the use of the “?”

During the start up and operation processes, the i3500 system analyses all interactions between internal peripheries (memories, controllers, extension cards, etc.) and also external ones (physical cards linked to the Canbus network).

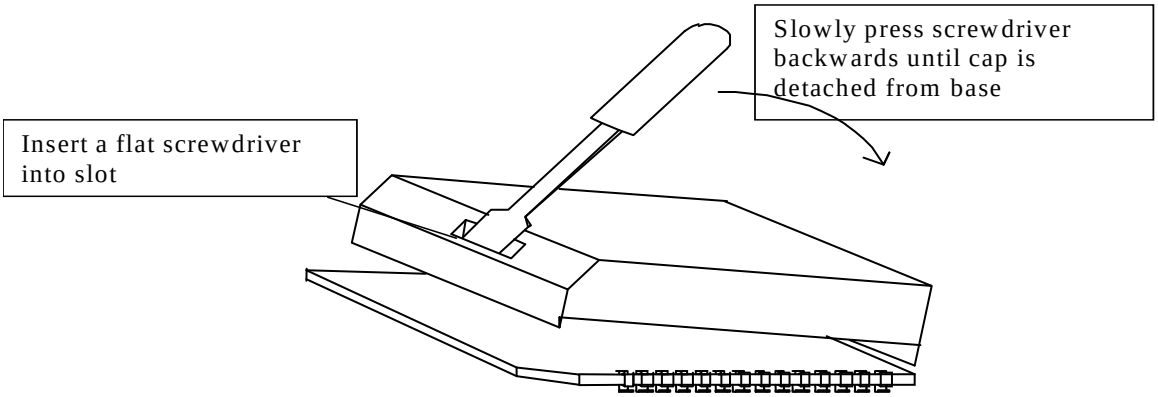
2.1.2.1 Internal peripheries

Error message	Execution process	Cause of error
Recording error	Upon startup, the system verifies itself. Logger card. If logger option is activated.	1- Logger card is not installed, 2- Connector has defective soldering or is broken, 3- There is a problem with the logger card.
Limit memory error	When starting system, there is a verification (Writing/Reading) of the backup chip of the limit programmed (limiter scope).	1- There is a problem with flash memory (U52)
Load chart error	Upon startup, the system does a read verification of load chart flash memory chip.	1- Load chart chip is not installed, 2- Verify the kind of memory it must be a flash memory, 3- There is a problem with flash memory (U12).
“C” memory error	Upon startup, the system does a read/write verification of bank C EEPROM chip. It is used as a backup for the system’s operation parameters. Ex. winch, number of strands, # duty.	1- There is a problem with EEPROM memory (U45)
Clock error	Logger option must be activated. System regularly verifies if seconds are moving. If time does not change then there is a problem.	1- Verify if black plastic cap is installed on logger card (contains battery crystal), 2- There is a problem with the logger card.
“A” memory error	Upon startup, the system does a read verification of bank A EEPROM chip. It is used as a backup for calibration data.	1- There is a problem with memory EEPROM (U44)
RAM memory error	Upon startup, the system does a read/write verification of RAM chip. This is a volatile memory.	1- There is a problem with RAM memory (U3). With Logger option, the cause is RAM memory (U5). - if system is behaving strangely, - if system initializes often during operation mode, - if system never starts.
Not calibrated	There is no calibration for selected duty.	1- Unloaded hoist calibration (empty) and unloaded deflection must be done.

Can Bus general error	Can Bus controller verification.	1- There is a problem with CANbus controller, either SJA1000 or MCP2515 (U29)
Multi-languages not supp.	Verification of programmed load chart in the system. Must be multi-languages. This option can support up to 10 languages.	1- The programmed load chart is not compatible.
External memory **(LTM)**	Verification of memory extension. Only for Lattice frames in total moment.	1- Memory extension card is not installed, 2- There is a problem with EPROM or Flash memory. 3- Connector has defective soldering or is broken.
External card (record.) **(Logger)**	"Logger" option must be activated. Upon startup, the system verifies that logger card is present.	1- Logger card is not installed, 2- There is a problem with one of the two flash memories.
Recorder low batt. **(Logger)**	System detected that Lithium battery is low. This may cause clock to stop or lose precision.	1- Logger card's plastic cap must be replaced. It contains the battery. (See illustration below for replacement).
No load chart	The actual crane configuration is unauthorized. The programmed load chart does not support it.	1- Verify if the load chart is corresponds to the crane to calibrated. 2- Does load chart depend on rotation? 3- Does load chart depend on DIN entrees?
Parameters	Crane dimensions must be entered in the system. Load value will be null or wrong.	1- CL3, CL4 and CL7 values should not be at zero.
2nd Load chart not found	"Comparison angle/radius" option must be activated. Thus a jib capacity is evaluated by its angle (offset) against the jib's chart, in comparison to the same jib's capacity evaluated by its radius against the "Main boom" chart. The smallest will be considered.	1- Load chart must be programmed for this kind of application. "One touch" field is used in the load chart for this option.

Battery replacement :

(located on Logger card)



2.1.2.2 External peripheries

A) Angle/length and ATB interface circuit board errors:

The i3500 system can support up to 5 angle interfaces. Activation of every angle sensor is done in the calibration menu section " -ent/sor activate/deactivate ".

Error message	Execution process	Cause of error
Angle sensor defect. #	The angle sensor value in volts is not valid (if < 1 volt or > 4 volts).	1- Accelerometer or converter 12 bits are defective.
Length out of range #	A 0xFFFF code is sent by angle/length card to indicate that length sensor is not present.	1- Length sensor is not installed, 2- A wire is cut between length sensor and circuit board.
Pre-calib. angle #	Indicates that angle/length card is in pre-calibration mode.	1- In operation mode, the jumper must be taken out from 'Cal' jumper located on the circuit board, 2- Verify that calibration value in bits of the accelerometer is valid.
Comm. angle/length #	I3500 system does not receive data from angle sensor. If 'time out' delay is reached, then a communication error is displayed.	1- The angle/length circuit board is defective, 2- Can bus network cable is broken.
Not calibrated length #	Length sensor is not calibrated.	
Not calibrated angle #	Angle sensor is not calibrated.	

Dr+ angle/length #	5 volts reference voltage is not valid (if < 4.5 volts or > 5.5 volts).	1- Angle/length circuit board is defective.

B) Load interface circuit board errors:

The i3500 system can support up to 4 load circuit boards. Activation of every load sensor is done in the calibration menu section "-ent/sor activate/deactivate".

Error message	Execution process	Cause of error
Off limits load #	Angle sensor value in bits is not valid (if < 150 or > 3935).	
Not calibrated load #	Load sensor is not calibrated.	
Dr+ load #	5 volts reference voltage is not valid (if < 4.5volts or > 5.5 volts).	1- Load card is defective.
Communication load #	I3500 system does not receive data from pressure sensor. If "time out" delay is reached, then a communication error is displayed.	1- Load card is defective, 2- Can Bus network cable is broken.

C) Relay and digital input interface board errors:

The i3500 system can support up to 4 relay cards. Activation of every relay card is done in the calibration menu section "-ent/sor activate/deactivate".

Error message	Execution process	Cause of error
Communication relay #	i3500 system does not receive data from relay card. If "time out" delay is reached, then a communication error is displayed.	1- Relay card is defective, 2- Can Bus network cable is broken.

Note: There is no automatic test for the relay contacts on the relay circuit board. Therefore, if a relay becomes defective there may not be a warning. Periodically, the operator should test the lockout system.

D) Generic interface board errors:

The i3500 system can support up to 4 generic cards: One for wind speed, one for inclination level, one for absolute rotation and another one for analogical output. Activation of every generic card is done in the calibration menu section "-ent/sor activate/deactivate".

Error message	Execution process	Cause of error
Not calibrated generic	An appropriate, analogical sensor is not calibrated.	
Dr+ generic	5 volts reference voltage is not valid (if < 4.5 volts or > 5.5 volts).	1- Generic card is defective.

Communication generic	i3500 system does not receive data from generic card. If “time out” delay is reached, then a communication error is displayed.	1- Generic card is defective, 2- Can Bus network cable is broken.

E) Rotation interface board errors:

The i3500 system can support only one rotation card. There are two different kinds: a relative one and an absolute one. Activation of rotation card is done in the calibration menu section “-ent/sor activate/deactivate”.

Relative rotation:

Error message	Execution process	Cause of error
Verify encoder cable	A GND wire indicates that the cable between the encoder and the rotation card is not cut. If the cable breaks, this wire will become open. Then the rotation card will send an error message to the i3500 system.	1- Replace cable between encoder and rotation card.
Encoder ratio	No ratio has been entered.	1- Put a different value than 0.
Encoder position prox.	Proximity is not detected in configured position by i3500 system.	1- Proximity is defective.
Encoder	If proximity switch has been detected when encoder did not receive a pulse. On the other hand, if proximity is detected when starting rotation card, then no error is displayed.	1- Encoder is defective.
Encoder communication	i3500 system does not receive anything from the rotation card. If “time out” delay is reached, then a communication error is displayed.	1- Rotation card is defective, 2- Can Bus network cable is broken.

Absolute rotation: (a generic card will be used for this type of interface)

Error message	Execution process	Cause of error
Encoder ratio	Ratio is not programmed.	
Encoder	Works with serial link RS-422.	In development phase
Encoder communication	i3500 system does not receive anything from rotation card. If “time out” delay is reached, then a communication error is displayed.	1- Rotation card is defective, 2- Can Bus network cable is broken.

2.2 Configuration and calibration

This section provides the necessary information to calibrate the system.

- Before starting a calibration, make sure that the overall system initialization has been completed. Otherwise, the system may behave erratically. To execute a global system initialization “init all”, it is necessary, prior to starting the system to press **“▲”** and #5 **“ESC”** simultaneously until the system asks you to confirm the system initialization.

Warning: By performing the system initialization, all data in memory will be erased. This should only be done under the advice of a qualified RaycoWylie technician.

- Sensors used by the system must be configured. In the calibration menu scroll with **“▲”** or **“▼”** until reaching the menu “-enable/disable i/o”. Press **“✓”** to confirm this choice. Use **“▲”** or **“▼”** to highlight one of the sensor inputs, then press **“✓”** to change the sensor state. Repeat this procedure for each sensor. Press **#5 “ESC”** to return to the main calibration menu.

2.2.1 System options

2.2.1.1 Data logger

This option allows you to activate the registration of certain events like the A2B, at the beginning and at the end of a lift, and so on.

An electronic “Logger card” is necessary (part # 22BCB0167). It is composed of a flash memory to backup data and also a RTC module (Real Time Clock) to log the event (i.e. registered hour and date of an event). This card is installed on the display module of the i3500. It is mounted on a male header connector.

NOTE: It should be noted that this card must be installed in the correct direction. A visual indicator has been printed on the circuit board to avoid any error. The switch RAM IN/EXT position must be switched from RAM IN to the RAM EXT. This allows the i3500 to use the real time clock module for hour and date.

2.2.1.2 Password protection

If this option is activated in calibration then during startup of the i3500 system, a message is displayed on the screen asking to enter a user identification number. The lockout will be activated until a valid password is recognized by the i3500 system, after which it will enter the normal operation mode. Normal lockout operation will be resumed.

Warning: It should be noted that this should only be changed with the advice and consent of a certified RaycoWylie technician.

Note: If the option 'Data logger' is activated, the option "Password protection" is automatically activated. Pressing key "✓" when highlighted can deactivate it.

2.2.1.3 Limit saved message

This allows the operator to turn the system on and off without losing limits. If the option "Message saved limit" has been activated if there is at least one limit programmed when starting the I3500 system, a message will appear on the screen informing the operator. He will then be able to judge whether this limit should be kept or erased. If erasure is chosen, the programmed limits will all be removed.

Warning: It should be noted that this should only be changed with the advice and consent of a certified RaycoWylie technician.

Note: To activate the "Rotation" option, select item " -in/out on/off" in the calibration Menu then activate "Rotation Rel" for rotation with relative encoder (standard) or activate "Rotation Abs" rotation with absolute encoder.

2.2.1.4 Angle/radius comparison

This option depends on the type of load chart programmed in the i3500 system. Special conditions should be added to the charts to support this option. If the chart does not support this comparison, and this option has been enabled, then an error "no load chart" will appear at any moment regardless of the duty chosen.

Warning: It should be noted that this should only be changed with the advice and consent of a certified RaycoWylie technician.

2.2.2 Selecting units of measure for calibration: ("- calib. unit: imperial")

Units of measure must be selected before starting the system's calibration. There are 2 possible choices: Imperial or metric.

Imperial: (inches x 1000 pounds) and in feet.
Metric: in te (metric ton = x1000 kg) and in meters.

In the calibration menu, using **"⮝"** or **"⮟"** to the "20-unit calibr." and select the desired units by pressing **"✓"**.

Warning: Once all the required dimensions are entered (see next section), the system will not allow to modify the calibraton units of measurement. Do not mix this with the display unit, where units can be changed at any time in the operation mode with **#1 "MODE"** button.

2.2.3 Calibration data: ("-calibration data ")

Calibration data represents all the parameters used for the system based on the client's recommendations.

2.2.3.1 Rope limit (Main/Aux)

Rope limit main: This is the maximum line pull permitted per part of line on the main hoist according to the chart. This value will be used as the load limitation if lower than the rated capacity.

Rope limit aux: This is the maximum line pull permitted per part of line on the auxiliary hoist. This value will be used as the load limitation if lower than the rated capacity.

2.2.3.2 The maximum falls

Set the maximum number of parts of line. This applies to both hoists.

2.2.3.3 Rigging angle

The RIG ANGLE is a set angle below which the operator can permanently bypass the lockout by pressing the RIG button; it should be set at the lowest practical boom angle possible. This function is used to allow the rigging of jibs or hook reeving at boom angles below the SWL chart. The RIG function is canceled when the operator booms up above the set angle or if the system is turned off.

2.2.3.4 Alarm zone

Alarm 1: This alarm is the pre-alarm on load. When the set percentage is reached, an intermittent buzzer is activated as well as pre-warning indicator light.

Alarm 2: This alarm is the maximum load limit set by the rope capacity or crane capacity (load chart). When the set percentage is reached, the red octagonal indicator light and the pre-warning indicator light turn on and the buzzer is continuous. The lockout is not activated.

Alarm 3: This alarm signals the lockout (motion cut) load limit. When the set percentage is reached, the red octagonal indicator light with the octagon and the pre-warning indicator light turn on and the buzzer is continuous. The lockout is activated.

2.2.3.5 Load chart adjustments

Outside duty radius: This variable represents a transition distance between the last radius rating and zero capacity. If the actual hook radius exceeds the maximum chart radius, the system alarms will be triggered. The system will not allow radii beyond the maximum radius given by the load charts. The OD (OUT of DUTY on RADIUS) will allow the SWL to decay evenly from the last point on the chart to zero over the distance set by this variable. Note, this is only valid if the chart interpolation is set to ‘on’, refer to section 3.7.6.

Outside duty angle: This variable works in the same way as ‘outside duty radius’ but is used for charts where the SWL is determined by boom angle and not radius.

Outside duty length: This variable represents an upper tolerance on the internal selection of the relevant load capacity chart for the actual boom length measured by the system length sensor.

Inside duty length: This variable represents a lower tolerance on the internal selection of the relevant load capacity chart for the actual boom length measured by the system length sensor.

2.2.3.6 Number of hoists

Set to the number of hoists (winches, or hooks) fitted to the crane, 1 for main hoist only or 2 for main and auxiliary hoists.

2.2.3.7 Changing of duty >20% SWL:

If set to YES this option allows duty and parts settings to be changed while a load is suspended, if set to NO these changes will not be permitted unless the load is less than 20% of the SWL. This option must be set to NO for European operation.

2.2.3.8 Angle sensor position on main boom:

It is important to specify the angle sensor position during the installation, so that it will work correctly, even if it has a 360 degree range. The angle sensor's position (left or right side of the boom) depends on the operator's location in the crane cabin.

2.2.4 Entering fixed data values: ("- dimensions")

This menu contains crane dimensions that are necessary for the calculation of the hook load, based on the hydraulic cylinder pressure. See diagrams below.
Enter all measurements seen diagram 2.2.4.2, 2.2.4.3, 2.2.4.4, and 2.2.4.5 where each value is described below;

cl1 (full retract) – the length of the main boom when fully retracted.
cl2 (full ext w ext) – the length of the boom fully extended including any manual or power pinned extension if fitted.
cl2mr (full ext w/o) – the length of the boom fully extended but with any manual or power pinned extension retracted.
Note : for full power booms without a manual section **cl2** and **cl2mr** are the same value.
cl3 (p2blh) – the horizontal distance between the boom pivot pin and lift cylinder base pin.
cl4 (p2blv) – the vertical distance between the boom pivot pin and lift cylinder base pin.
cl7 (p2buh) – the distance between the boom pivot pin and lift cylinder top pin parallel to boom telescoping centerline.
cl8 (p2cb) – the vertical distance between the boom pivot pin and the boom centerline with the boom horizontal.
cl9 (ra2cb) – the vertical distance between the lift cylinder top pin and the boom centerline with the boom horizontal. If the boom centerline is greater than the lift cylinder top pin, then the distance is positive, otherwise it is negative.
cf (slew offset) – the horizontal distance between the boom pivot pin and the centerline of rotation of the machine. If the boom pivot pin is behind the centerline of rotation then the distance is negative, otherwise it is positive.
ch1 (height rubber) – the vertical distance between the boom pivot pin and the ground when on tires.
ch2 (height outrigg) – the vertical distance between the boom pivot pin and the ground when on outriggers.
nr (number of rams) – the number of boom lift cylinders, normally 1 or 2.
ad (rod diameter) – the rod diameter of the lift cylinder.
bd (bore diameter) – the bore diameter of the lift cylinder.

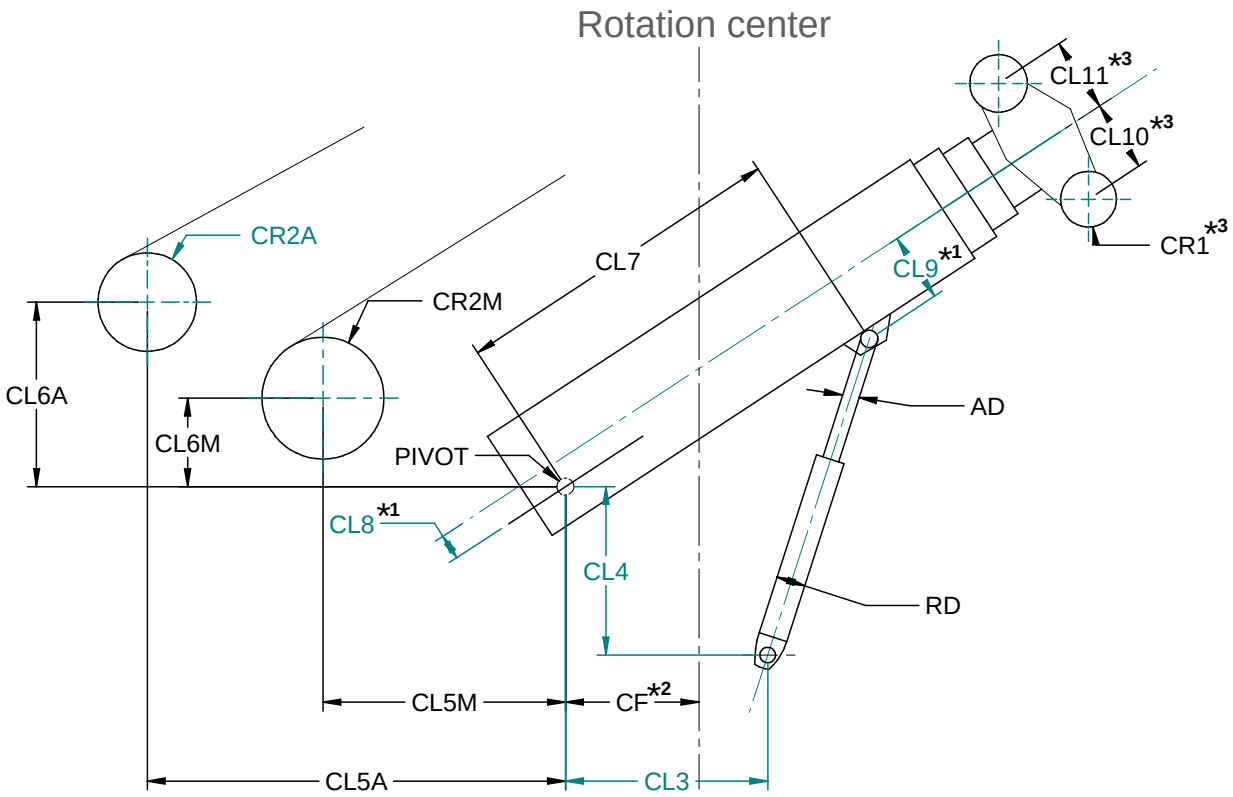
cr2m (m.h. radius) – the radius of the main hoist drum from the center to the middle of the hoist line layers. This distance is approximate and does not play a critical role in load accuracy.
cl5m (p2mhh) – the horizontal distance between the center of main hoist drum and boom pivot pin. If the drum is mounted on the boom, this dimension is zero.
cl6m (p2mhv) – the vertical distance between the center of main hoist drum and boom pivot pin. If the drum is mounted on the boom, this dimension is zero.
cr22m – the radius of the boom base mounted, main hoist guide sheave, **see note 1*.
cl28m – the vertical distance between the boom base mounted, main hoist guide sheave and the boom pivot pin with the boom horizontal, **see note 1*.
cl29m – the horizontal distance between the boom base mounted, main hoist guide sheave and the boom pivot pin with the boom horizontal, **see note 1*.
cr2a (a.h. radius) – the radius of the auxiliary hoist drum from the center to the middle of the hoist line layers. This distance is approximate and does not play a critical role in load accuracy.
cl5a (p2ahh) – the horizontal distance between the center of the auxiliary hoist drum and boom pivot pin. If the drum is mounted on the boom, this dimension is zero.
cl6a (p2ahv) – the vertical distance between center of auxiliary hoist drum and boom pivot pin. If the drum is mounted on the boom, this dimension is zero.
cr22a – the radius of the boom base mounted, auxiliary hoist guide sheave,**see note 1*.
cl28a – the vertical distance between the boom base mounted, auxiliary hoist guide sheave and the boom pivot pin with the boom horizontal, **see note 1*.
cl29a – the horizontal distance between the boom base mounted, auxiliary hoist guide sheave and the boom pivot pin with the boom horizontal, **see note 1*.

Note 1: This option is rare and these values are generally set to zero. If a guide sheave is fitted but mounted on the superstructure (not the boom) then the sheave is treated as though it is the winch drum (see sketches).

To modify one of these variables, proceed as follows:

1- Use **"▲"** or **"▼"** to highlight line "-dimension" and press **"✓"** to go to submenu.
2- Use **"▲"** or **"▼"** to highlight the required variable. Note: there are 5 pages.
3- Press **"✓"** to edit the variable.
4- Use **"▲"** or **"▼"** to modify the value. Note: If you keep **"?"** pressed in, it will accelerate the modification.
5- Press **"✓"** to save the new value.
6- Repeat steps 1 to 5 for all the other variables.
7- Press **#5 "ESC"** to come back to the main calibration menu.

2.2.4.1 Diagram: Crane dimensions



*1 Negative if on opposite side to main boom center
*2 Negative if main boom pivot is placed behind rotation center
*3 These dimensions are not available for editing

Note on the sign convention:
Every dimension is positive except **cf**. If the rotation center's axis is placed in front of the main boom's pivot, then **cf** will be negative. If any dimension falls on the other side of the reference line shown in the diagram, then the sign will change. For example, if the boom cylinder's head is above the hoist's axis, then **cl9** will be negative.

Diagram 2.2.4.2 Crane dimensions cnt'd

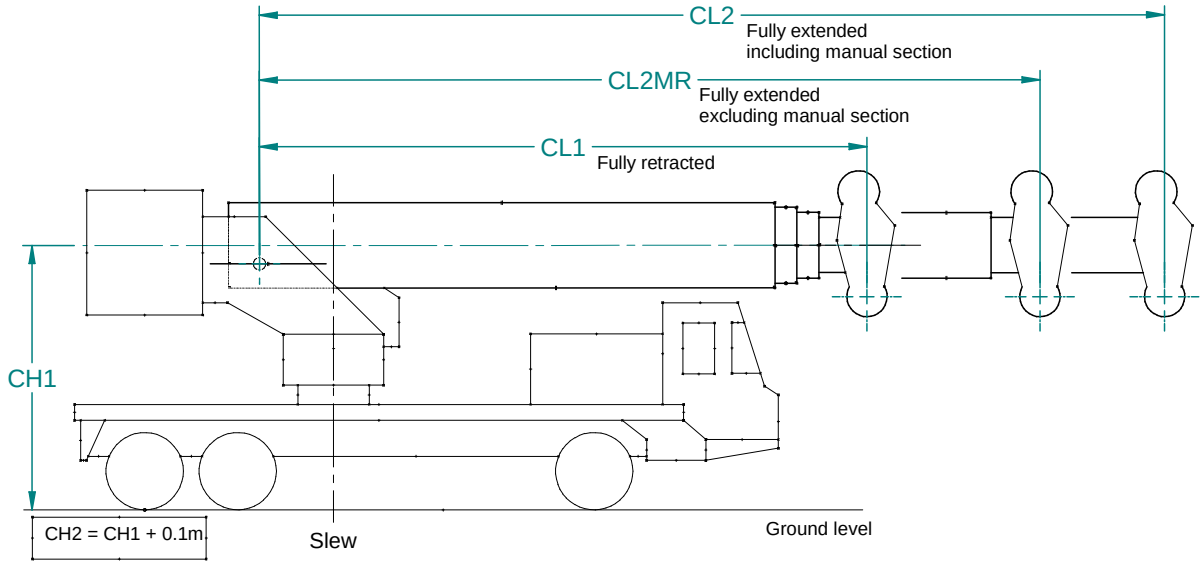


Diagram 2.2.4.3 Hoist Drum(s) on superstructure with boom mounted guide sheave(s)

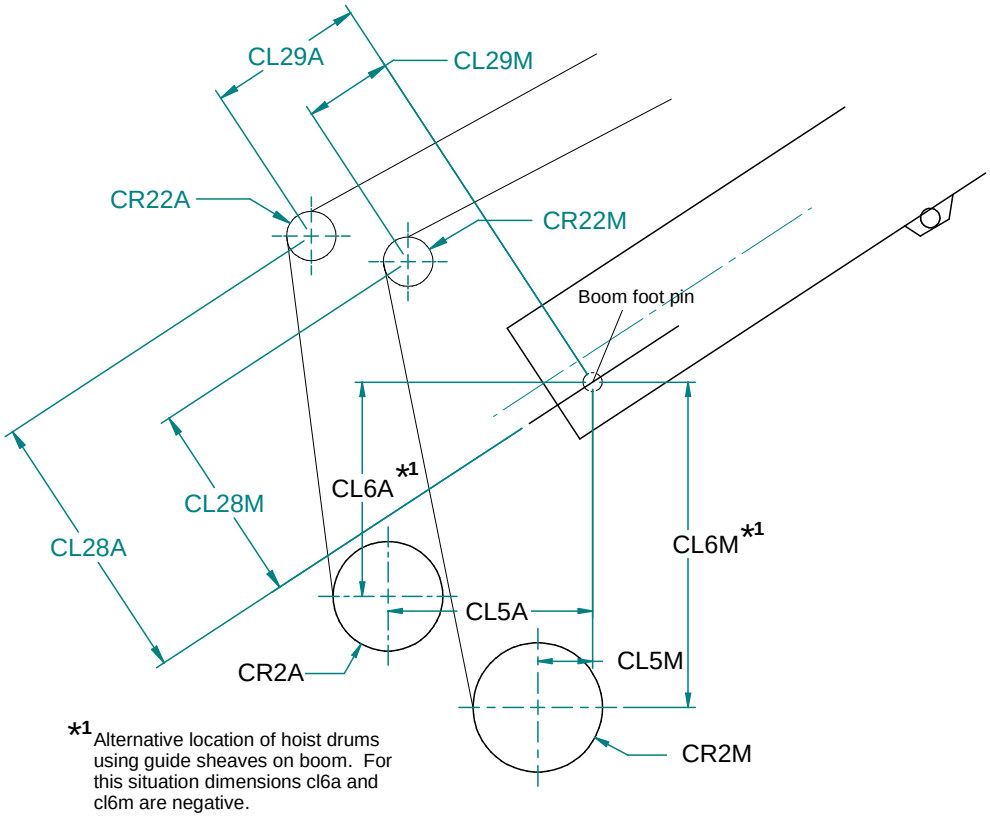


Diagram 2.2.4.4: Jib dimensions

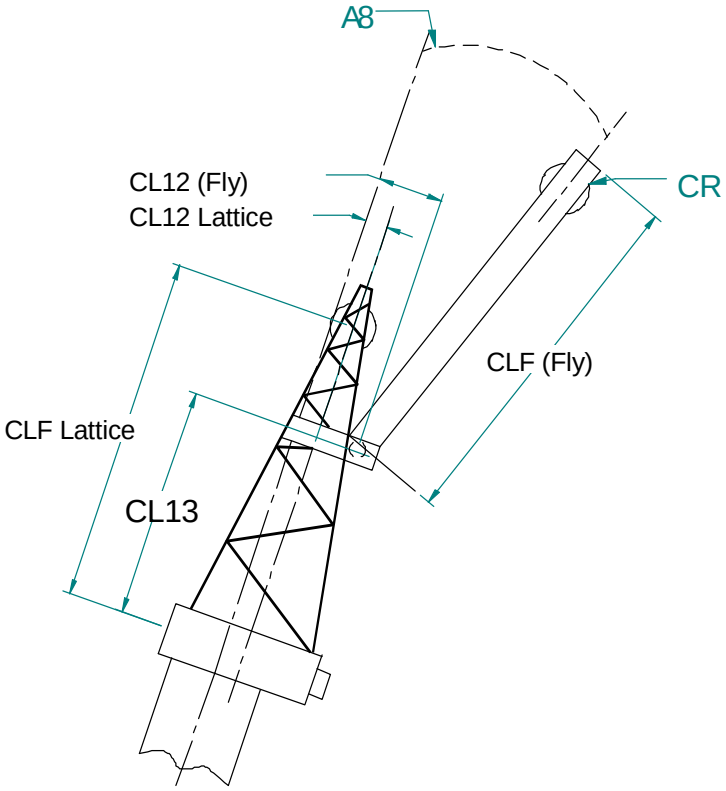
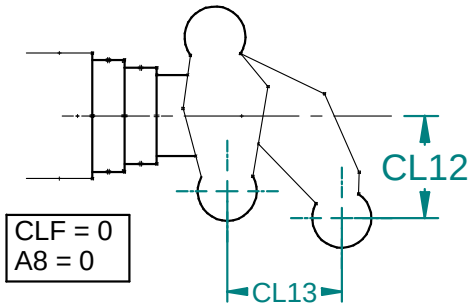


Diagram 2.2.4.5 Rooster dimensions



2.2.5 Relays configuration: ("- relays configuration")

Digital outputs can be configured according to **Table 2** below. They are linked to the action of each relay involved. For example in **Table 2**, relay #5 activates an external buzzer or a roof light. While relay #3 activates the left counterbalance. This table can be modified so that each relay can activates with several functions.

TABLE 2: Digitals outputs configuration (Relays):

Relay #1						ATB+Lockout	ATB	Disable
Relay #2							Lockout	Disable
Relay #3							Swing Left	Disable
Relay #4							Swing Right	Disable
Relay #5						External Alarm For overload	Amber lamp for Range Limiting Device	Disable
Relay #6								Disable
Relay #7								Disable
Relay #8								Disable

2.2.6.1 Bypass configuration

The “Bypass” function can be configured according to Table 3 below. Actions of the “Bypass” key and digital output “External bypass” will depend on this configuration. If the bypass configuration is disable, then the board key and digital output will be ignored.

TABLE 3: Bypass configuration:

Bypass							Cutout + ATB + Swing left+ Swing right	Disable

2.2.4 Digital inputs configuration: ("- dig. inputs config.")

Digital inputs can be configured for different input types, or for their functionality as defined in **Table 1**.

The Interlock inputs are used to detect if a boom section is locked in place with a pin. It can be detected using a magnetic or mechanical proximity switch.

The Din inputs are use to detect working area, i.e. over end, over side. It can be detected using a magnetic or mechanical proximity switch.

The External Bypass is required for the EN13000 compliance. When this function is used the “bypass” key on the i3500 display is disabled. Only an external spring key switch can be used to bypass the system.

Some options are available for specific customer needs.

RaycoWylie Systems will determine which option should be selected in the installation instruction.

TABLE 1: Digitals inputs configuration:

	DIN 4	**DIN 3**	**DIN 2**	**DIN 1**
Option #1	Interlock #1	Din #3	Din #2	Din #1
Option #2	Interlock #1	Interlock #1	Din #2	Din #1
Option #3	External Bypass	Interlock #2	Interlock #1	Din #1
Option #4	Optional #3	Optional #2	Optional #1	Bypass External

2.2.7 Angle Calibration

2.2.7.1 Zero Angle

a) Use **"▲"** or "▼" to choose the "- select sensor" line and press **"✓"**.
b) Use **"▲"** or "▼" to choose the angle sensor and press the **"✓"**, wait for the system's confirmation.
c) Use **"▲"** or **"▼"** to choose the "- Zero sensor" line and press **"✓"**.
d) Boom down to zero degree (main boom parallel to ground). The angle is displayed in degrees and the sensor value is in bits. This value must be above 100 bits. If smaller, turn the sensor to increase the value.
e) Press **"✓"** to edit the angle value using **"▲"** or **"▼"**.
f) Press **"✓"** again to confirm the zero and wait for the system confirmation.
g) Press #**5 "ESC"** to go back in the main calibration menu.

2.2.7.2 Span Angle

This step is not required for the angle sensor. The importance of displaying the sensor signal in bits is to verify that it changes through the entire working area of the boom angle, and that the resolution is above 3 bits per degree.

2.2.8 Length Sensor Calibration

2.2.8.1 Zero Extension

a) Use **"▲"** or **"▼"** to choose the "- select sensor" line and press **"✓"**.
b) Use **"▲"** or **"▼"** to choose the length sensor, press **"✓"** and wait for the system confirmation.
c) When the change is approved, scroll using **"▲"** or **"▼"** to choose the "- zero sensor" line and press **"✓"**.
d) Retract the boom completely. The sensor's value must be approximately 100 bits (0,50 volts; adjust the potentiometer inside the cable reel if necessary).
e) Press **"✓"** to edit the zero value (when the boom is completely retracted, the value must be set to zero).
f) Press **"✓"** again to confirm the value.
g) Press #**5 "ESC"** to return to the main calibration menu.

2.2.8.2 Span Extension

a) Use **"▲"** or **"▼"** to choose the "-span sensor" line and press **"✓"**.
b) Extend the boom completely. The sensor value should be 150 bits above the zero value. Please refer to the crane main boom chart. Enter the difference between the fully extended main boom length and the fully retracted main boom length. For example: A fully extended boom of 81 feet minus a fully retracted boom of 34 feet = 47 feet. You enter 47.0 at span extension.
c) Press **"✓"** to edit the span value.
d) Use **"▲"** or **"▼"** to edit the span value.
e) Press **"✓"** to confirm the value.
f) Press #**5 "ESC"** to return to the main calibration menu.

2.2.9 Pressure sensor calibration

2.2.9.1 Pressure sensor zero calibration

To zero the pressure sensors, open the hydraulic lines of both sensors in order to remove any residual pressure. Make sure the boom is resting at its lowest point to prevent sudden fall when the line opens.

The pressure sensor must be connected according to the schematics for normal operation.

<u>Select pressure sensors</u>

a) Use **"▲"** or **"▼"** to choose the "- sel load trans" line and press **"✓"**.
b) Use **"▲"** or **"▼"** to choose the Bore or Rod sensor, press **"✓"** and wait for the system confirmation.

<u>Zero pressure calibration</u>

When the change is approved, Use **"▲"** or **"▼"** to choose the "-zero pressure" line and press **"✓"**.

The reading on the lower right corner is in bits. The total scale is 4095. The display should read between 175 and 300 bits or between 650 and 1125 if connected through an amplifier.

Press **"✓"** to zero the bore side pressure sensor and press **"✓"** again to confirm.

With an amplifier, if the reading is above 1200 and below 1680, the resolution of the system will be lower.

To zero the rod pressure sensor, select the rod sensor using the "-sel load trans" line and repeat the zero pressure calibration steps. The value on the lower right corner will be greater than the bore side pressure sensor. The expected reading should be between 175 and 300, or between 650 and 1125 when using an amplifier. If reading are below these values, negative pressure may cause the load reading to drop substantially when a load is left hanging on the hook for an extended period of time. If the value is above 400, the resolution will decrease.

2.2.9.2 Pressure Sensor Span (Bore Side)

The pressure sensor must still be disconnected from the hydraulic line. In the pressure transducer interface box or the amplifier box, turn the RCAL switch to ON if available or temporarily connect the black and white wires of the full side pressure sensors together.

a) Select the Bore sensor using the "- sel load trans" line
b) Use **"⮟"** to select the "-span pressure" and press **"✓"**. The reading on the bottom represents the bits out of 4095 as seen by the control unit. The reading should be above 3200 and not exceed 3850.
c) Press **"✓"** to enter the value engraved on the pressure sensor below the label. A typical value will read: CAL 285.6 BAR.
d) Enter the value engraved on the pressure sensor. If there is two lift cylinders and one pressure sensor on the bore side of each cylinder, enter the average of the 2 engraved value.
e) Edit using **"⮝"** or **"⮟"**, then press **"✓"** key to confirm.
f) Turn the RCAL switch to OFF if available or put the black and white transducer wires to their original connections and reconnect the hydraulic line.

If the bit reading is below or above the recommended values, and the pressure sensor is connected directly in the control box, change the amplifier jumpers. Refer to the relevant amplifier table as seen earlier in this manual.

2.2.9.3 Pressure Sensor Span (Rod Side)

The pressure sensor must still be disconnected from the hydraulic line. In the pressure transducer interface box or the amplifier box, turn the RCAL switch to ON if available or temporarily connect the black and white wires of the full side pressure sensors together.

a) Select the Rod sensor using the "- sel load trans" line
b) Use **"⮟"** to select the "-span pressure" and press **"✓"**. The reading on the bottom represents the bits out of 4095 as seen by the control unit. The reading should be above 3200 and not exceed 3850.
c) Repeat calibration procedure as defined for the bore side transducer above.

2.2.10 Multi-point no-load calibration: ("-no load calibration")

This procedure must be carried out for each different condition of dead weight of the boom. For example separate no-load calibrations need to be done with the manual section in, the manual section out, each jib erected at each fixed offset etc.
Refer to the computer printout supplied with the i3500. A 'no-load' calibration plus unloaded and loaded boom deflection calibrations are necessary for each duty where the 'select' number is different (except rooster sheave duties).
The crane needs to be rigged for each of these conditions and the appropriate duty need to be selected to complete the procedure. Since this also applies to boom deflection calibration, it is recommended to do both no-load and boom deflection calibrations while the machine is rigged on one particular condition to save times.

Notes:

1. During this procedure boom angle, boom length and pressures are displayed at various times for reference purposes on the display window.
2. The derrick motion immediately before recording a calibration point should always be up/in. If it was necessary to derrick down/out, then derrick up/in slightly before recording the calibration point. When telescoping in or out it is not necessary to derrick up/in, unless the crane has had to be derricked down/out during telescoping for some other reason.
3. Ensure that the crane chassis is level for all no load, boom deflection, and load correction calibrations.

Note: it is essential that all the geometric data was checked and entered correctly in section 2.2.4 before continuing with this calibration.

2.2.10.1 Setting the length points for the No Load calibration

Start this procedure with the boom fully retracted. Navigate through the calibration menu using **"▲"** or **"▼"** to highlight the field "- no load calibration", press **"✓"** to confirm this choice.

The display shows:

Current Duty = *x*. Press 4 if OK

Where **x** is the current selected duty number. This must correspond with the current crane configuration, if incorrect use **#5 "ESC"** to exit the calibration mode and set the correct duty number in the normal working mode.

After pressing **"✓"** to accept the duty to be calibrated the display shows:

Maximum length for this Duty = *xx.x*

Where xx.x. is the maximum working boom length as measured by the extension drum in the length units selected for calibration (not including extension fly jibs etc ie usually at the top of the last telescoping section or manual section). If the boom is not to be used at the maximum length for this duty (e.g. last section(s) retracted) or to be used at

a fixed length other than maximum (e.g. pinned) use **"▲"** or **"▼"** to edit this number to the required value. Use **" ✓ "** to confirm the maximum length to be calibrated for this duty.

The display now shows:

Number of Length Steps = xx

The number of points selected will directly affect the calibration time and eventual system performance. More points mean a longer calibration sequence but with improved performance. As a guide select the number of points from the following table but note that these figures are intended as a minimum requirement and can be increased as required (up to a maximum of 7) to enable calibration lengths to coincide with rated boom lengths. This number of points includes the shortest and longest lengths for the duty, which are mandatory.

Telescopic band to be calibrated	Minimum of points
None	2 (min)
Up to 20 feet	3
20 to 30 feet	4
30 to 45 feet	5
45 to 60 feet	6
Over 60 feet	7 (max)

When the proper number of length steps is entered, press **"✓"** to accept

If more than two lengths have been entered the display now shows:

Length 2 = *xxx.x*

Where **xxx.x** is the second calibration length to be specified.

The first and last lengths will automatically be set to the minimum and maximum values specified for calibration and other calibration lengths will default to evenly distributed lengths calculated by the system.

Use **"▲"** or **"▼"** to change the default value of **xxx.x** to the boom length required for calibration length 2, if required, then press **"✓"** to accept.

Specified lengths should coincide with rated boom lengths where possible although not all rated boom lengths need be specified. Specified lengths must include lengths at which the boom telescoping sequence changes. Where no intermediate boom lengths are shown in the crane capacity chart, use the default lengths chosen by the system.

Enter the remaining lengths as prompted ensuring that each new calibration length is larger than the preceding one and less than the maximum length.

2.2.10.2 Setting the angle points for the No Load calibration

When the last calibration length has been entered the display shows:

Angle step Length 1 = *xx*

Where **xx** is the number of angle steps to calibrate for length 1.

Length 1 is fully retracted. The number of angle steps must be between 2 (min) and 18 (max). The more points used the greater the accuracy, but the longer the calibration time. It is suggested that points at 5 degree intervals will give an acceptable result. Hence for example if the maximum angle is 80 degrees and minimum is 20 degrees then 13 points should be used.

Use **"⮝"** or **"⮟"** to set **xx** to the required number of angle steps for calibration length 1 then press **"✓"** to accept.

Enter the number of angle calibration points for each length step in turn as prompted.

2.2.10.3 Hook Block Weight

After the last number of angle points is entered the display shows:

Block = *x.xx*

Where **x.xx** represents the hook block weight that will be suspended during the no-load calibration process in metric tonnes or lbs x 1000 depending on calibration units selected.

Set the hook block weight **x.xx** using **"⮝"** or **"⮟"** and press **"✓"** to accept.

2.2.10.4 Maximum Boom Angle

The display will show: **Boom up to max possible angle then press "✓"**

Derrick the boom up to the maximum possible angle, that is, with the boom hoist cylinder almost fully extended, just avoiding the maximum boom angle stops. Press **"✓"** when done.

2.2.10.5 Minimum boom angle

The display will show: **Min Angle Length 1 = *xx.x***

Where **xx.x** is the lowest working angle in degrees for length 1 (retracted). Check the load chart and determine the lowest rated angle for each of the boom lengths you have previously entered; i.e. length 1, length 2, etc. and enter separate minimum working angles for each calibration length as prompted.

2.2.10.6 Recording the 'no load' pressure map

The following procedure to record unloaded boom weight pressures should be carried out with the hook block suspended at all times. Be careful not to exceed the operating parameters of the crane particularly at long boom lengths and low angles.

The display will show: **Press "✓"** when **ready to calibrate**

The i3500 has now been programmed with all preset points and ready to calibrate. When ready press **"✓"**. Display shows;

Calibration point 1 **Press. pd1: aa.a pd2: bb.b** Boom length: cc.c < dd.d Angle: ee.e > ff.f

Where:
aa.a is the current bore side pressure
bb.b is the current rod side pressure
cc.c is the current boom length
dd.d is the target boom length
ee.e is the current boom angle
ff.f is the target boom angle

Plus a message asking to telescope in or out to the required length. When the boom length is correct the display will change to:

Calibration point 1 Press. pd1: aa.a pd2: bb.b Boom length: cc.c is ok Angle: ee.e > ff.f

Plus asking a message to boom up or down to the required angle. When the boom angle is correct the display will change to:

Calibration point 1 Press. pd1: aa.a pd2: bb.b Boom length: cc.c is ok Angle: ee.e is ok

Ensure the last derricking motion to reach the calibration point is in/up and after allowing the crane to stabilise and settle (about 30 seconds), press **"✓"** to record the calibration point. Repeat this procedure for each calibration point in turn starting with all angles for length 1 then length 2 etc. until all lengths and angles have been recorded. When the final calibration point is accepted the i3500 will automatically return to the main calibration menu and the calibration information will permanently be stored in memory.

Note: If for any reason a no load calibration is abandoned before completion, no data will be permanently stored and the full routine will need to be repeated. To abandon a no load calibration at any point before completion press **#5 "ESC"**, confirm the action by selecting **yes** and pressing **"✓"**.

Before proceeding with additional calibration work check the overall performance by moving just the hook around the working envelope; i.e. high/low angles and long/short boom. Ensure that any variation of load reading is no more than 1 to 2 percent of the SWL at that position. If greater variation is seen then check geometric dimensions entered in calibration mode, use more calibration angles and lengths, or proceed to add load correction calibrations (see separate section). Always check results at this stage after booming up. Boom down can be checked after the full calibration is completed.

2.2.10.7 Unloaded boom deflection

This procedure is used to add an allowance into the calculation of the hook radius to compensate for boom and/or chassis deflection before a load is lifted. A separate calibration is available for each crane configuration that also has an individual no load calibration. This procedure should only be used for machine configurations on outriggers or on crawlers, a separate routine is used to compensate for lifting on tires, if relevant, see section 2.2.9.8. For rooster configurations the unloaded deflection characteristics of the main boom will be inherited and a separate calibration is not required and should not be attempted.

Ensure that the current duty selection matches the actual crane configuration to be calibrated. Navigate through the calibration menu using **"▲"** or **"▼"** to highlight the field "- unloaded boom deflect.", press **"✓"** to confirm this choice.

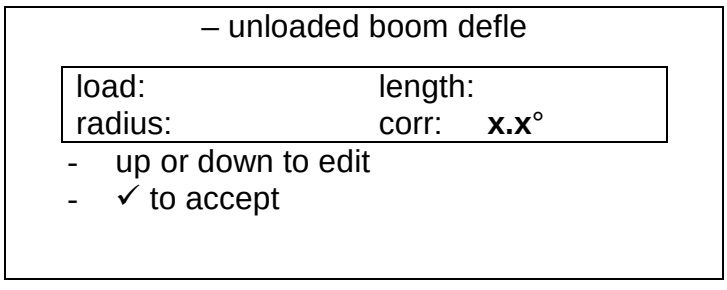
The display will show the current boom length and a target boom length for calibration. With the hook block suspended, telescope the boom out to the target length specified on the display, this is normally the maximum length available for the duty so be sure to check that the hook block does not foul the boom tip and that the boom is at a high enough angle to safely permit maximum extension.
When the boom is at the disired extension the display will change to show:

- ✓ to continue

Press **"✓"**, the display will change to show the current boom angle and a target boom angle for calibration, normally 60°.
Adjust the boom angle to the target angle, when the boom is at that angle for calibration the display will change to show:

- ✓ to continue

Press **"✓"**, the display will change to show:

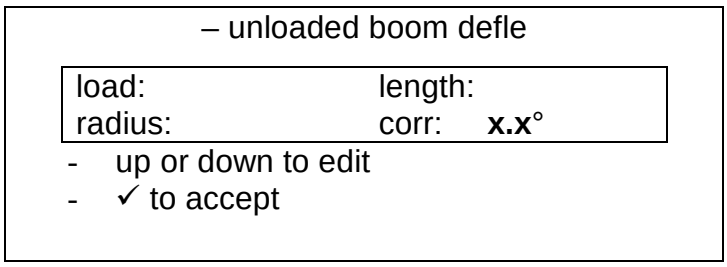


Accurately measure the actual hook radius from the centre line of slew of the machine and use **"▲"** or **"▼"** to adjust the value of **x.x** until the displayed radius equals the measured radius, note that the indicated radius can only be increased, not decreased.

Press **"✓"** to accept the change, the display will change to show the current boom length and a new target boom length. Without changing the boom angle, telescope the boom in to the new target length, when the boom is at the correct extension the display will change to show:

- ✓ to continue

Press "✓", the display will change to show:



As before, accurately measure the actual hook radius from the centre line of slew of the machine and use **"▲"** or **"▼"** to adjust the value of **x.x** until the displayed radius equals the measured radius, note that the indicated radius can only be increased, not decreased and that the value of **x.x** must be less than the equivalent value entered with the boom at maximum extension. Press **"✓"** to accept the change, the system will automatically return to the main calibration menu.

2.2.10.8 On tyres deflection

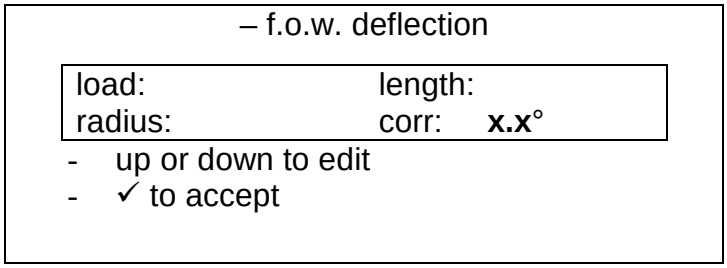
This procedure is only relevant if the machine has lifting duties on tyres, only one calibration is available. It is used to add an allowance into the calculation of the hook radius to compensate for tyre deflection before a load is lifted. This procedure should only be used for the main boom configuration.

Ensure the current duty selection matches the actual crane configuration to be calibrated, i.e. main boom on tyres. Navigate through the calibration menu using **"▲"** or **"▼"** to highlight the field "- f.o.w deflection", press **"✓"** to confirm the choice. The display will show the current boom length and a target boom length for calibration. With the hook block suspended and the boom at approximately 60°, telescope the boom in to the minimum length.

When the boom is fully retracted the display will change to show:

- ✓ to continue

Press **"✓"**, the display will change to show:



Accurately measure the actual hook radius from the centre line of slew of the machine and use **"▲"** or **"▼"** to adjust the value of **x.x** until the displayed radius equals the measured radius, note that the indicated radius can only be increased, not decreased.

Press **"✓"** to accept the change, the system will automatically return to the main calibration menu.

2.2.10.9 Loaded boom deflection

This procedure is used to add an allowance into the calculation of the hook radius to compensate for boom and/or chassis deflection due to the load being lifted. A separate calibration is available for each crane configuration that also has an individual no load calibration. This procedure should only be used for machine configurations on outriggers or on crawlers. For rooster configurations the deflection characteristics of the main boom will be inherited and a separate calibration is not required and should not be attempted.

A known test weight is required to carry out this calibration, the weight should be between 50% and 90% of the SWL for the duty being calibrated and should be based on the SWL with a fully extended boom at approximately 60° boom angle. The calculated test load should include the weight of the hook block and any slings, shackles etc. that are used.

Ensure the current duty selection matches the actual crane configuration to be calibrated. Navigate through the calibration menu using **"▲"** or **"▼"** to highlight the field "- loaded boom deflection", press **"✓"** to confirm this choice. The display will show the current boom length and a target boom length for calibration. With the hook block suspended, telescope the boom out to the target length specified on the display, this is normally the maximum length available for the duty so be sure to check that the hook block does not foul the boom tip and that the boom is at a high enough angle to safely permit maximum extension.

When the boom is at the desired extension the display will change to show:

- ✓ to continue

Press **"✓"**, the display will change to show the current boom angle and a target boom angle for calibration, normally 60°. Adjust the boom angle to the target angle, when the boom is at the correct angle for calibration the display will change to show:

- ✓ to continue

Press **"✓"**, the display will change to show:

– unloaded boom defle

load:	length :
radius:	corr : **x.x**°

- up or down to edit
- ✓ to accept

Carefully lift the test load specified above just clear of the ground. Accurately measure the actual, suspended load radius from the centre line of slew of the machine and use **"▲"** or **"▼"** to adjust the value of **x.x** until the displayed radius equals the measured radius, note that the indicated radius can only be increased, not decreased. Press **"✓"** to accept the change, the system will automatically return to the main calibration menu. Carefully replace the test load on the ground.

2.2.10.10 Load adjustment

This procedure is optional: one calibration is available per calibration configuration. Which means that the load readings for every machine's configuration will be modified by the new modification. It is used to increase the accuracy to the hook load's calculation. This will compensate for minor geometric errors. For example, it is not always possible to know the exact piston "Bore" diameter of the lifting cylinders (see section 2.2.4.).

This procedure should only be used if the load reading indicates a constant error percentage for different lengths and radius. If the error percentage is variable then verify all data entries concerning the crane geometry (see section 2.2.4) before going to section 2.2.9.13 (load correction).

The hook weight should not be used to judge the load reading performance. This should be checked with at minimum load of 50% of capacity.

It is recommended that this procedure be done while using the main boom, on outriggers if applicable.

A known load is needed to perform calibration and should be between 50% and 90% of SWL for the “duty” to be calibrated. SWL should be based on a given capacity (main boom) with an angle of around 60° with a retracted boo m.
The known test load should include the hook weight and all other supplementary weights used (“slings, shackles” and so on).

Make sure that the selected “duty” coincides with the actual configuration of the crane to be calibrated. Scroll through the calibration menu using **“▲”** or **“▼”** to highlight line “-load adjustment”. Press **“✓”** to confirm your choice.

The display will change to show:

12-load adjustment

load : **xx.x**
load adjust. factor : **1.00**

- #2 or #3 to edit
- ✓ to accept

Where **xx.x** represents the lifted load reading and **1.00** represents the adjustment factor (a value of 1.00 signifies that there is no applied adjustment). The main boom must be completely retracted with an angle of around 60°. Slowl y lift the standard load until it is off the ground. Use ”▲” or **“▼”** to modify the load adjustment factor. Modify this factor so that the displayed load is equal to the test load (known). Press “✓” to accept this change. The system will automatically go back to the main calibration menu. Carefully place the test load back to the ground.

2.2.10.11 Load offset

This procedure is optional: one calibration is available per calibration configuration. It is used to add an allowance into the calculation of the hook load to compensate for a potential build up of minor geometric errors. For example, it is not always possible to know precisely the effective bore diameter of the boom’s lift cylinder(s), see section 3.4.
This procedure should only be used if the indicated load reading is found to be in error by a constant **load** margin over a range of different lengths and radii. If variable errors are seen, then check the geometric data entered in section 3.4 before proceeding to section 3.2.15 – load correction calibration.

Use at least 3 different weights for this inspection; the hook block, 25% SWL, and a load greater than 50% SWL. It is recommended that this procedure be performed using each configuration, on outriggers if applicable. A known test weight is required to carry out this calibration, the weight should be 25% SWL, and a load in excess of 50% SWL for the duty being calibrated and should be based on the SWL with a retracted boom at approximately 60° boom angle. The calculated test load sh ould include the weight of the hook block and any slings, shackles etc. that are used.

Ensure the current duty selection matches the actual crane configuration being used for the calibration. Scroll through the calibration menu using **"▲"** or **"▼"** to highlight the field "- load offset", press **"✓"** to confirm the choice.

2.2.10.12 Friction compensation

This procedure should not be performed except under guidance from RaycoWylie Systems except for **down friction**. All of the factors in this menu, except down friction, are used to compensate for static pressure decay over time but significant testing and analysis may be required before any of these default values are modified.
The default screens are shown below for reference:

wear factor	1.00
down friction	0.00
pres. offset low(bar)	0.0
pres. offset med(bar)	0.0
pres. offset hig(bar)	0.0
stab.coef.ptimelow	1
stab.coef.ptimemed	1
stab.coef.ptimehig	1
boom down pwr low(%)	100
boom down pwr med(%)	100
boom down pwr hig(%)	100
inf. lim. pres.med-bar	0.0
sup. lim. pres.med-bar	0.0

Boom down friction compensation should only be done once the no load calibration and various deflection calibrations have been completed. Only one boom down friction compensation value is available and it will affect all configurations of the machine.

The down friction factor is best established by trial and error. Navigate through the calibration menu using **"▲"** or **"▼"** to highlight the field "- friction compensation", press **"✓"** to confirm the choice. Scroll down to "- down friction" and press **"✓"** to highlight the value for editing, To start, increase the default value from 0.00 to 0.10 and press **"✓"** to confirm. Exit the calibration mode and retest the boom down performance to establish the effect, return to the down friction calibration and modify as required.

2.2.10.13 Load correction

This procedure is optional and a separate calibration is available for each crane configuration that also has an individual no load calibration. It is used to add an allowance into the calculation of the hook load to compensate for a potential build up of minor errors in either fixed data or previous calibration data.

Note: This procedure should not normally be necessary and should not be used before exhausting other, more likely causes of load reading errors such as dimensional errors (section 2.2.4) or proper no load calibration using an adequate number of calibration points (section 2.2.6).

Some inaccuracy of load indication with very small loads at high boom angles and short boom lengths is likely due to the small boom lift cylinder pressures encountered in this zone. Do not use the weight of the hook block alone to judge load indication performance, these calibrations should be done with loads in excess of 50% SWL.

If a load correction calibration is found to be necessary the minimum number of correction factor points that must be calibrated is 2, the maximum that can be calibrated is 20. The following notes are intended to give general guidance only as each individual installation will be different. The full working envelope of the configuration can be divided into different zones for load correction calibration, see diagram 2.2.13 for examples.

Case 1

This shows a basic, two point calibration. These two points cannot have a common angle or boom length. A load correction factor will be applied to all boom positions whose angle and length are greater than point 1 and also whose angle and length are smaller than point 2. A load correction factor will not be applied to boom positions outside of this zone.

Case 2

This shows the influence of adding one additional calibration point to case 1, the pair of numbers in each sub-zone show the calibration points used to determine the load correction factor calculated for various points in that sub-zone.

Case 3

This shows a typical set of calibration points that will go on to use the most logical adjacent points for interpolation purposes and also cover the full working range of the machine.

Case 4

This shows a more practical set of calibration points that will improve the most likely area for load errors.

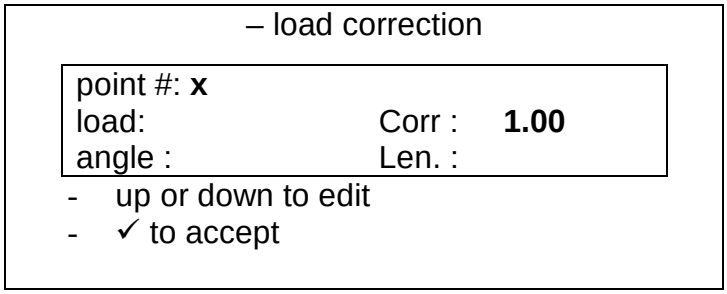
Case 5 and 6

These show the results of excluding one or more of the calibration points chosen in case 4.

To add a load correction calibration point, ensure the current duty selection matches the actual crane configuration.

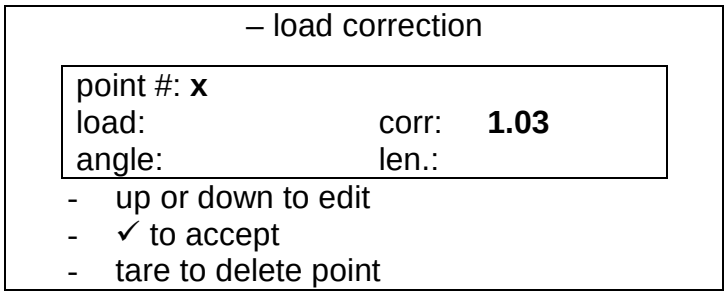
Only one load correction factor is stored at each angle/length location and the test load used to set this factor should be greater than 50% of the Safe Working Load at each location. Calibrating a load correction factor with smaller test loads could result in unacceptable errors at 100% SWL.

Navigate through the calibration menu using **"▲"** or **"▼"** to highlight the field "- load correction", press **"✓"** to confirm the choice.
The display will show:



Where **x** represents the calibration point reference number. Load, angle and length indications are current values and corr: **1.00** is the default value for the load correction factor (1.00 represents no correction is applied). Press **"✓"** to accept the point number to be calibrated. Position the boom to the required angle and length and carefully lift the test load just clear of the ground. Use **"▲"** or **"▼"** to adjust the corr. value until the displayed load equals the calculated test load. Press **"✓"** to accept the change, the system will automatically return to the main calibration menu. Carefully put the test load back on the ground. Repeat this procedure to enter a second and subsequent load correction points as required.

The last load correction point can be deleted if necessary by selecting the screen above and pressing **"▼"** to decrease the point number rather than pressing **"✓"** to accept the new point. The display will show:

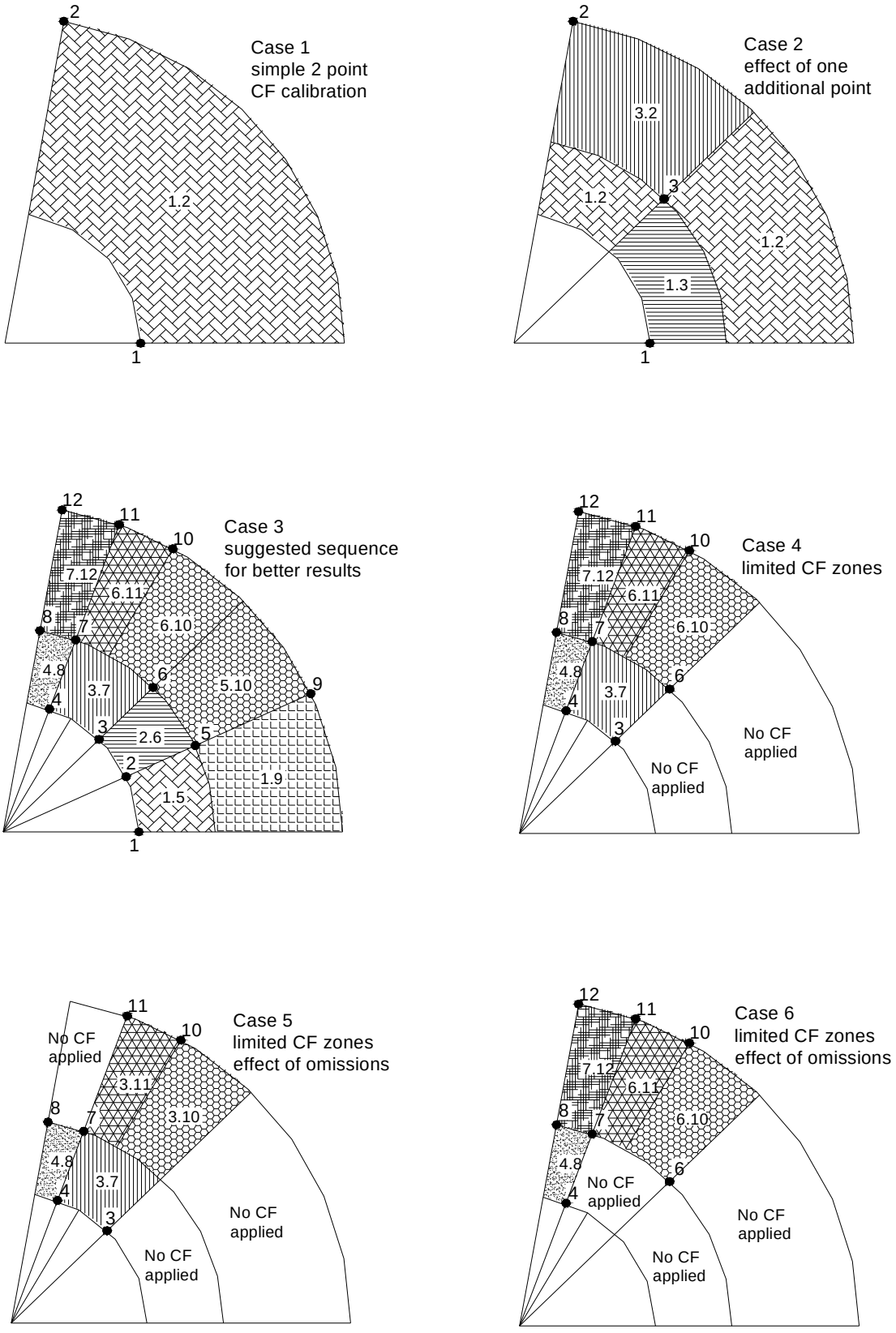


This screen will show the data stored for the last calibration point rather than current data. Press **#10 "TARE"** to delete this point from the calibration memory.

When completed, press **#5 "ESC"** to return to the normal display.

Remember: When the calibration is finished set the calibration switch to the OFF position to prevent the calibration data from being modified or corrupted.

Diagram 2.2.10.13 example of calibration for load zone to correct



3.0 CANBUS INTERFACES BOARD

Every electronic card must be supplied with a voltage between 12 and 24 volts DC.

Every interface board has its own CANbus physical address. It is configurable using switches 1 to 3. The table below shows how to position these switches to select an address.

Address	Switches		
	1	2	3
0	OFF	OFF	OFF
1	ON	OFF	OFF
2	OFF	ON	OFF
3	ON	ON	OFF
4	OFF	OFF	ON
5	ON	OFF	ON
6	OFF	ON	ON
7	ON	ON	ON

Voltage levels for different sensors are shown in section 3,5.

- Every interface board has a termination resistance on the CANBus network. This resistance can be activated when putting a jumper on the connector header identified as 'END'. Note that only the last card on the CANbus requires a termination resistance activated, that is one at each end of the network.

3.1 Angle/length and ATB sensor interface board

3.1.1 Errors detection

For the length sensor:

Maximum voltage for length sensor is 4.80V. If the voltage of the length sensor exceeds 4.80V, it will mean that either the length sensor is not installed on this card or that there is an open circuit on the card (eg. cut wire).

Acceptable range: Min: 39 bits (0.19Volts)
Max: 985 bits (4.81V)

In the diagnostic mode, the system will display 1024 if a length value received in bits is greater than 1023 and will display 2 for the **atb** if a received value is greater than 1.

For the angle sensor the ADXL203 generates signals between 1.5V and 3.5V on each of the 2 axes.

Acceptable range: Min: 819 bits (1.0Volts)
Max: 3277 bits (4.0Volts)

Note: In the case of an error, the angle value sent is 999°.

For the DR+ reference voltage an error is indicated if the DR+ reference voltage is lower than 4.5 volts DC, or higher than 5.5 volts DC.

3.1.2 Basic accelerometer's calibration:

No jumper should be on the connector's header "CAL" because this calibration is done at the factory. Warning: when there is a jumper in place, the interface will not work in its normal operation mode. If the "CAL" jumper (pre-calib.) is left in place, an error will display on the i3500 system in the normal operation mode.

3.1.3 ATB

In order to activate the ATB, switch 4 must be turned ON. If the ATB is not linked to the systems, ignore this section. Multiple ATBs can be installed on a crane and they will be supported by the display, as long as they are enabled. The ATB signal is sent to the display and to the relay board. The relay coil assigned to the ATB is controlled directly and exclusively by the signal received by the angle/ATB board.

3.2 Relay and digital input interface board:

There are two models of relay boards, one composed of 5 relays (4 Bosch relays with 5 amp contacts + 1 "OMRON" relays with 2 amp), and another with 8 "OMRON" relays with 2 amp contacts.

If the relay board loses communication with the Angle/Length and ATB interface board, the ATB will no longer function. The relay board will block the power to the coil of the relay assigned to the ATB at around 550ms.

The Relay board is designed to supervise the communications with the I3500 system. If the relay board loses any communication with the I3500 system, it will automatically block all power to the coils of relays on the relay board within 5 seconds.

3.3 Rotation sensor interface board

3.3.1 Relative Encoder

The ratio must have a value other than 0. Otherwise, there will be a “ratio error” which will be displayed in the error message screen of the I3500 system.

Angle Rotation = pointer * 360° / ratio

The pointer represents the number of pulses generated by the encoder.

3.3.2 Absolute Encoder

This encoder will be used with the generic (multi-purpose) interface board and will require specific programming. This may not be available with all systems.

3.4 Pressure transducer interface board:

The electronic interface board: There are 2 board models for the load. One, with 1 pressure transducer input, and another with 2-pressure transducer input.

It should be noted that the dual transducer interface will always have an even physical address on the CAN BUS network. See label inside the interface enclosure for more detail, this setting will be done at the factory except if spare parts are purchased, they will come with the default setting.

Acceptable range: Min: 150 bits (0.18V)
Max: 3945 bits (4.82V)

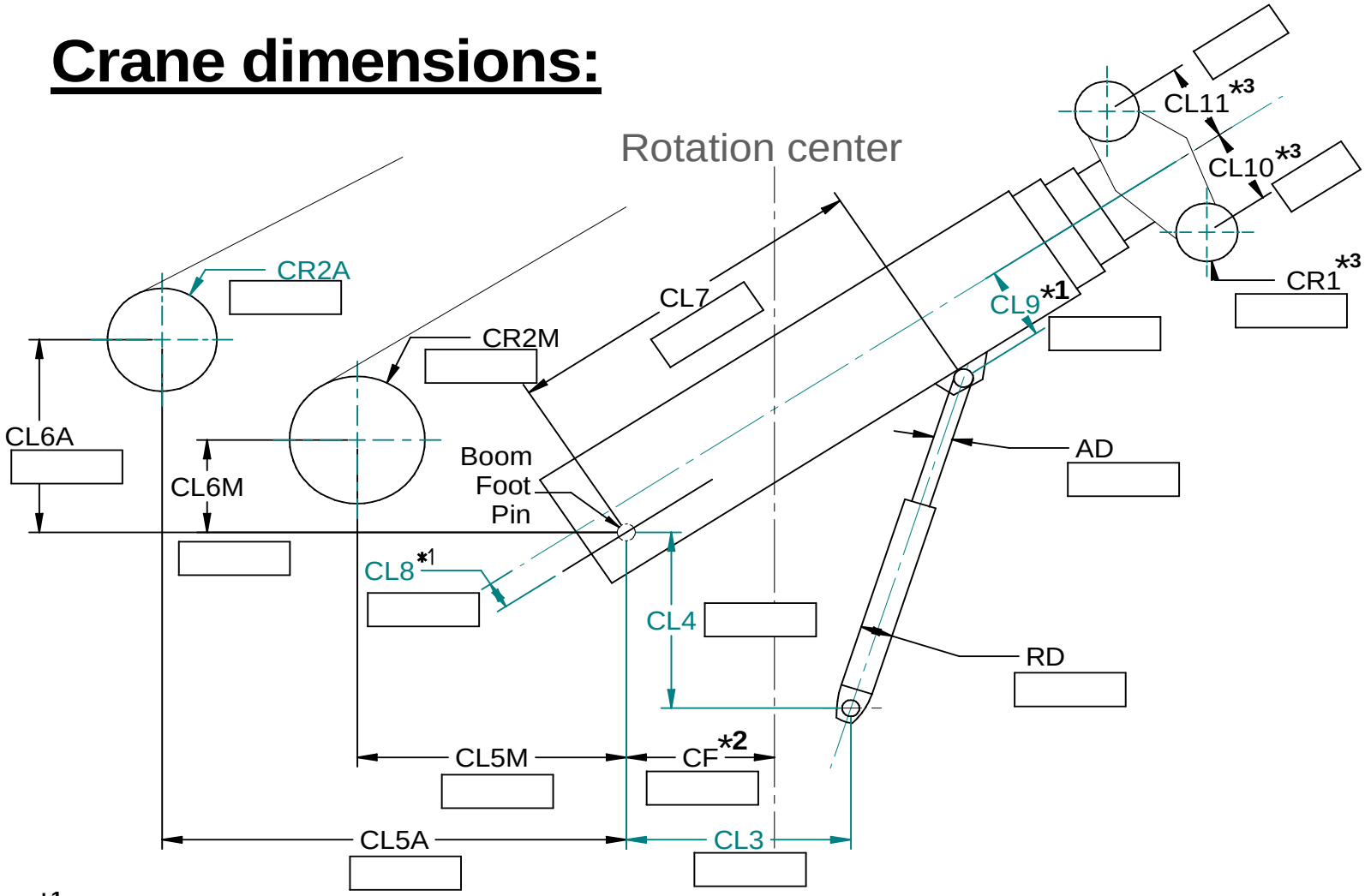
On the Interface board there are jumpers, which are used to adjust the amplification of the sensor inputs. This adjustment must be done while making sure the signal is within the above range. Since the available gain may differ depending on the revision of the interface, refer to the label inside the interface enclosure for more details.

3.5 Sensor voltages

	Bits		Volts	
	Min	Max	Min	Max
Angle	819	3277	1.00	4.00
Length	39	985	0.19	4.81
Load	150	3945	0.18	4.82
DR+	N/A	N/A	4.5	5.5

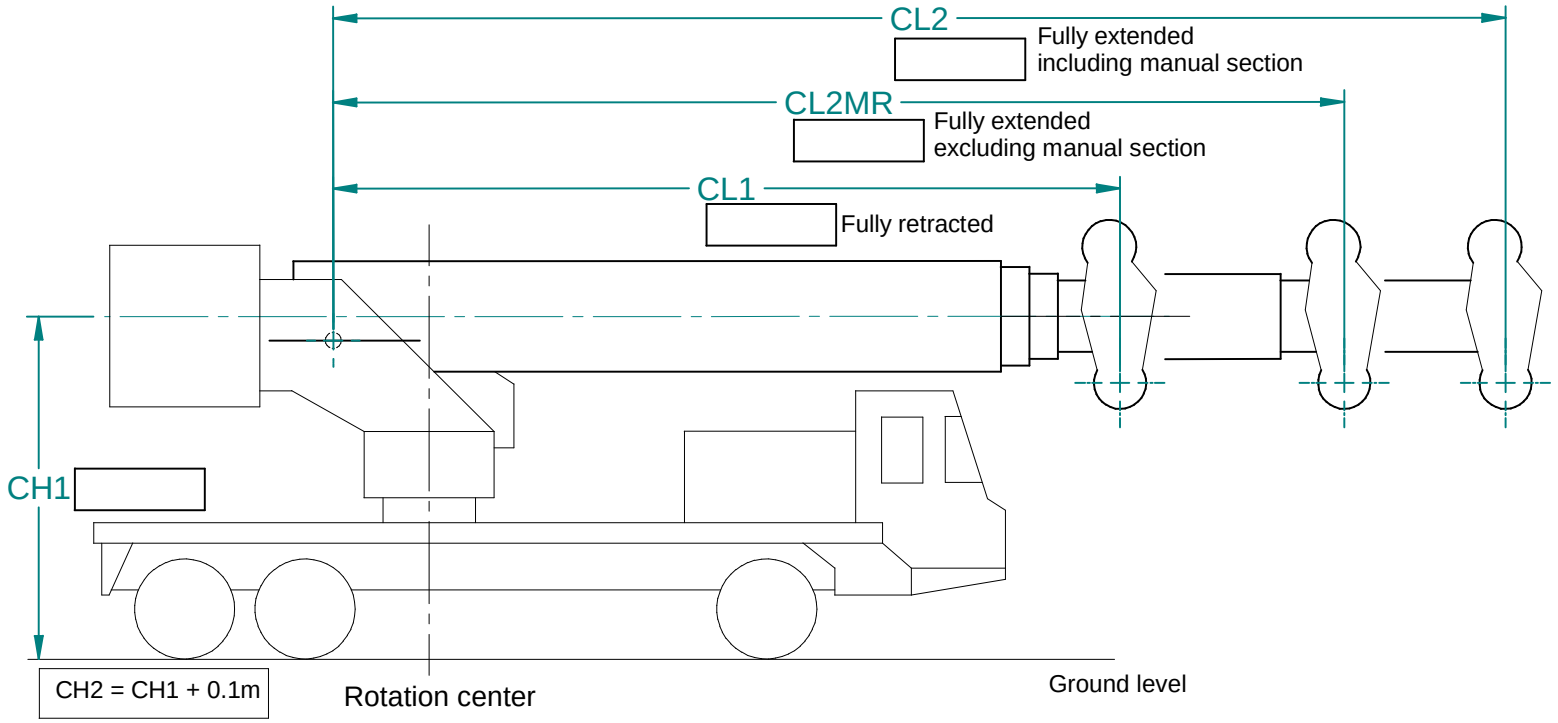
Dimensions Data Sheets

Crane dimensions:

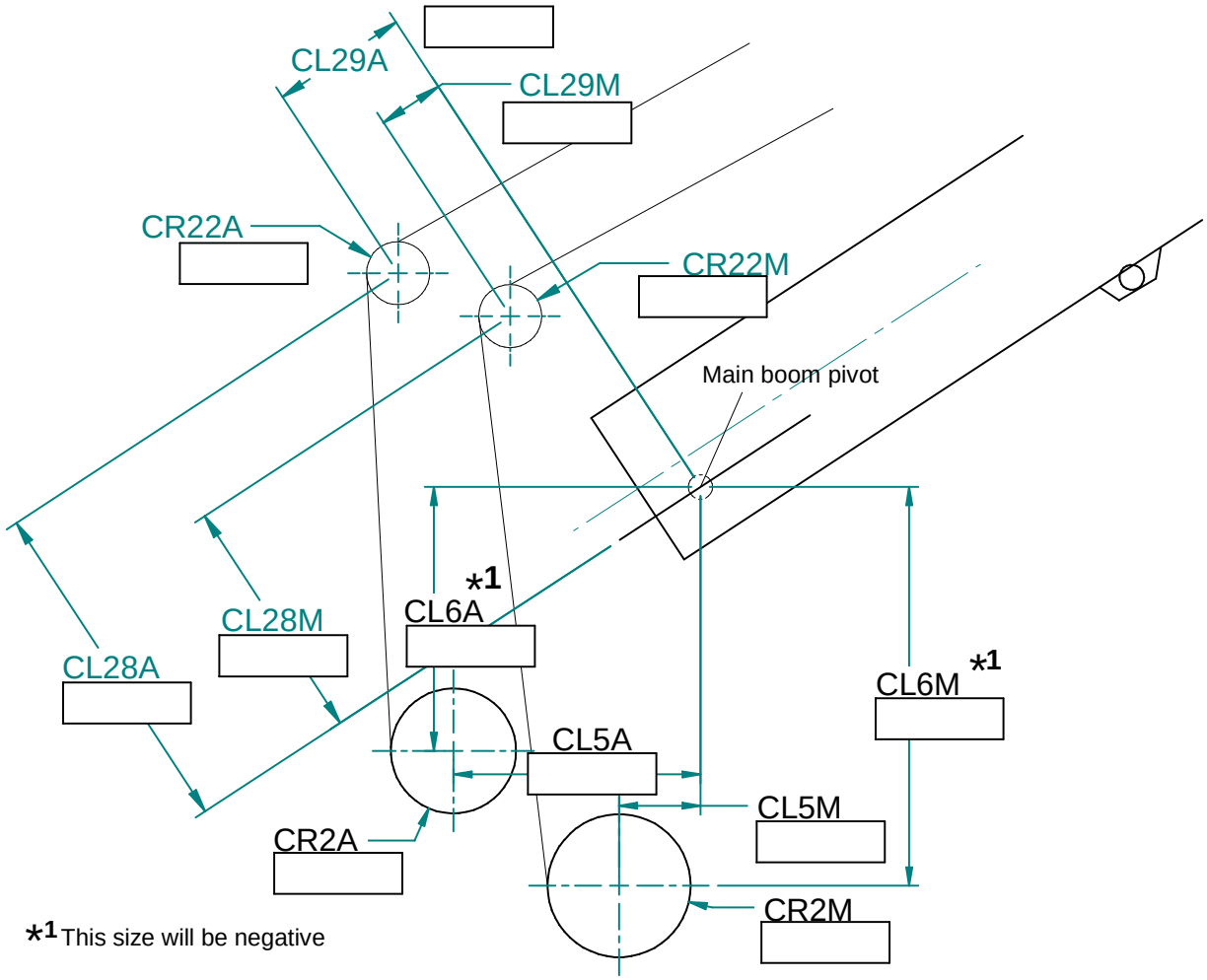


*1 Negative if boom centerline is below boom foot pin
*2 Negative if boom foot pin is behind slew centerline
*3 These dimensions are not available for editing

Crane dimensions continue:

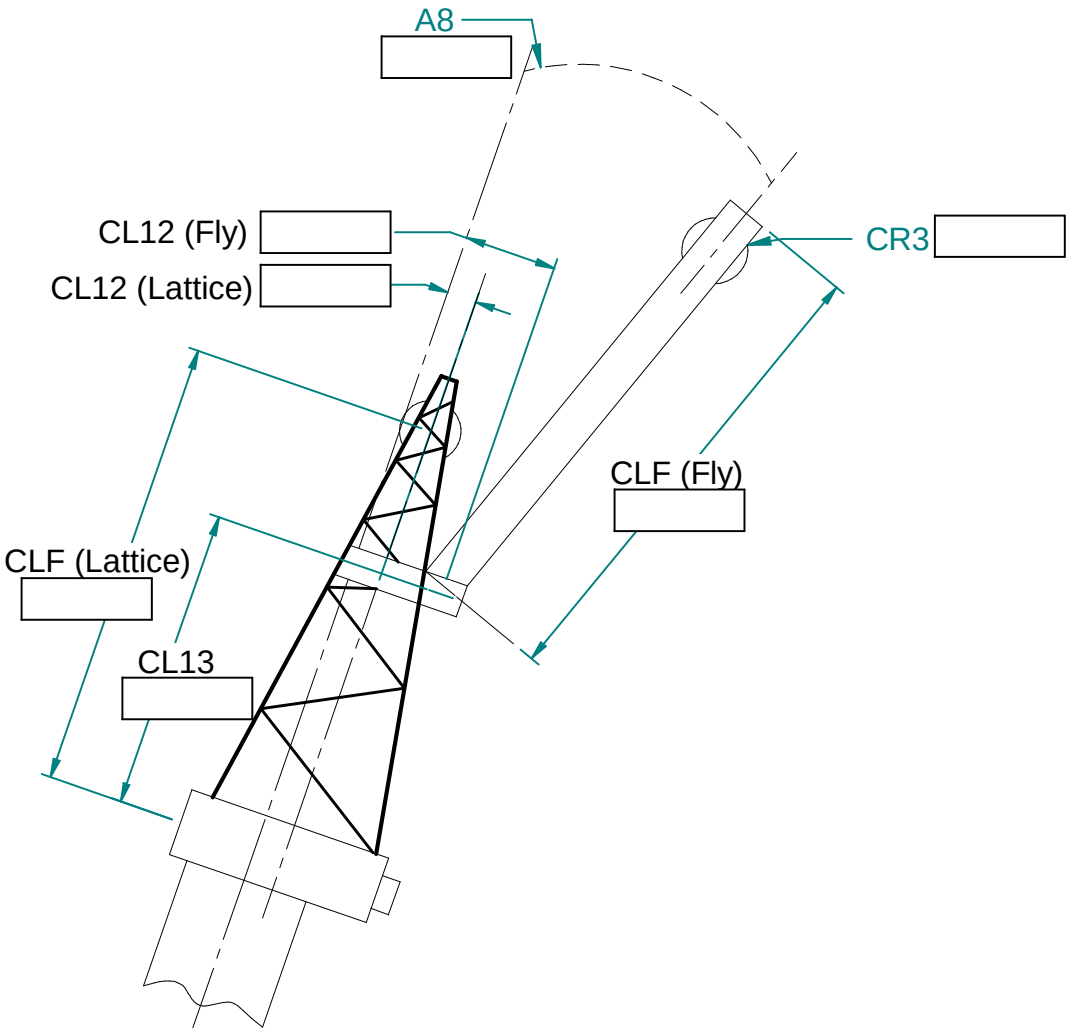


Alternative hoist placement using a guide sheave on main boom:



*1 This size will be negative

Jib dimensions:



Rooster dimensions: