RCI-4100 Tension-Based System
Operation and Installation

SINGLE / TWIN WINCH
STRUT BOOM CRANE

MAN-1111 Rev H

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VERSION HISTORY

Version	Issue Date	Description
A	(not issued)	Initial draft
B	25Oct11	Minor formatting changes
C	17Feb12	Sect 4.4.1 FLASHING changed to ON. LED trip point thresholds described as typical with reference to function codes. Removed specific Function code references from body. Sect 8.3 Sensor replacement added. Datalogging Appendix F, miscellaneous updates.
D	28May12	RCI-4100 Declaration of Conformity updated to RCI-4100 Declaration Rev G.
E	20Aug12	Revised Sections 2 to 8. Added Appendices J and H. Various minor changes. RCI-4100 Declaration of Conformity updated to Rev H. RF Transmitter Caution added.
F	14Jan14	Company Name Change
G	27 Jan 15	Minor edits for errata
H	27 Feb 15	Winch Speed and Hook Height Appendix added Friction compensation information added

Important Safety Notices

Notes, Cautions and Warnings are presented to aid in understanding and operating the equipment or to protect personnel and equipment. At all times relevant codes applicable to location of service must be adhered too.
A "Note" is an advisory or illustrative statement and does not contain any mandatory statements.

A "Caution" is used where non-compliance with text may result in damage to equipment.

A "Warning" is used where non-compliance with text may result in injury to, or death of, personnel.

NOTE: This Rated Capacity Indicator is fitted to assist the crane operator. This Rated Capacity Indicator is not a substitute for operator judgement, experience or safe crane operation. At all times the driver is ultimately responsible for safe crane operation.

The operator should, prior to operation of the crane, read this manual carefully and thoroughly and shall ensure that all operational instructions and warnings are understood and complied with.

Proper system operation requires the operator to select the proper crane setup and working configuration

WARNING: THE RCI-4100IS SYSTEM IS INTENDED FOR USE IN A GROUP IIB ZONE 1 EXPLOSIVE GAS ATMOSPHERE.

WARNING: THE RCI-4100 SYSTEM IS A CRANE DEVICE WHICH WARNS THE OPERATOR OF IMPENDING OVERLOAD CONDITIONS AND OVER-HOIST CONDITIONS WHICH COULD CAUSE DAMAGE TO PROPERTY, CRANE AND PERSONNEL.

PROVIDED WARNINGS ARE NOT EXCLUSIVE, AS LSI-ROBWAY COULD NOT POSSIBLY KNOW, EVALUATE AND ADVISE SERVICE PEOPLE OF ALL CONCEIVABLE WAYS IN WHICH SERVICE MIGHT BE PERFORMED OR ALL POSSIBLE ASSOCIATED HAZARDOUS CONSEQUENCES.

ACCORDINGLY, ANYONE WHO USES SERVICE PROCEDURES OR TOOLS WHICH ARE NOT RECOMMENDED BY LSI-ROBWAY MUST FIRST SATISFY THEMSELVES TO THEIR SUITABILITY AND THAT EITHER PERSONNEL SAFETY OR EQUIPMENT SAFETY WILL BE JEOPARDISED BY THE SELECTED METHOD.

CAUTION**:** SAFE, RELIABLE OPERATION OF LSI-ROBWAY SYSTEMS REQUIRES THE SYSTEMS TO BE MAINTAINED IN A PROPER MANNER AND SERVICED BY TECHNICALLY TRAINED PERSONNEL USING TRADE (OR PROFESSION) RECOGNISED SERVICE PROCEDURES AND CORRECT TOOLS FOR THE PURPOSE.

CAUTION:	THE SYSTEM IS EQUIPPED WITH AN OVER-RIDE WHICH BYPASSES ALARMS AND MOTION CUT FUNCTION AT WHICH TIME THE SYSTEM CAN NO LONGER WARN OF IMPENDING OVERLOAD AND MUST ONLY BE OPERATED STRICTLY IN ACCORDANCE TO THE CRANE MANUFACTURER'S SETUP AND OPERATION PROCEDURES. OPERATION OF THIS KEY IS FOR AUTHORISED PERSONNEL ONLY WHO SHALL BE SOLELY RESPONSIBLE FOR ITS USE.

CAUTION:	MOTION LIMITERS MAY HAVE BEEN FITTED TO STOP THOSE FUNCTIONS THAT WILL INCREASE RADIUS AND HOIST-UP IF THE LOAD-CHART IS EXCEEDED. THIS FEATURE IS PROVIDED AS AN AID TO SAFER CRANE OPERATION. IN CERTAIN SITUATIONS, SUCH AS CRANE SETUP, THE CRANE OPERATOR MAY NEED TO 'OVER-RIDE' THE MOTION LIMITERS. AT THESE TIMES, THE SYSTEM CAN NO LONGER WARN OF OVERLOAD AND THE CRANE MUST ONLY BE USED IN STRICT ACCORDANCE TO THE CRANE MANUFACTURER'S SETUP AND OPERATION PROCEDURES. PROPER SYSTEM OPERATION REQUIRES THE OPERATOR TO CORRECTLY PROGRAM THE LSI-ROBWAY SYSTEM TO MATCH CRANE SETUP AND WORKING CONFIGURATION.

CAUTION:	HIGH TENSILE BOOMS REQUIRE PROPER WELDING PROCEDURE SPECIFICATIONS. OBTAIN SPECIALIST ASSISTANCE WHEREVER APPLICABLE.

CAUTION:	RADIO FREQUENCY EMITTING EQUIPMENT SHOULD NOT BE PLACED NEAR THE RCI-4100 CONTROLLER, DISPLAY, CABLING OR SENSORS AS IT MAY CAUSE INTERFERENCE DEPENDING ON THE TYPE, POWER OUTPUT AND OTHER CHARACTERISTICS OF THE EQUIPMENT.

1. System Description

1.1. General

This manual contains general information, installation, operation, calibration, maintenance and fault-finding information for the RCI-4100 Rated Capacity Indicating System to suit a Strut Boom Crane using Tension Based Load Measurement with one or more system components located in a hazardous area.

Applicable General Arrangement (GA) drawings and system wiring details can be found in refer RCI System Configuration Documents in Attachments.

1.2. Capabilities

The RCI-4100 once installed and setup, is a semi-automatic Rated Capacity Indicator which provides a display of the following functions:

- Safe Working Load (SWL)
- Boom Length
- Boom Angle
- Hoist Rope Falls
- Duty (or Sea-State)
- Time and Date
- Hook Radius
- Actual Load
- Actual Load as a Percentage of SWL
- Visual and audible alarms on warnings, motion-cut, and max high boom angle outputs
- Self-diagnosis and error codes
- Data-logging
- Built-in calibration and fault-finding tools
- Tare facility
- Unit's conversion (imperial/metric) facility

1.3. Hazardous Area

The RCI-4100IS system is intended for use in a Group IIB explosive gas atmospheres with specific zones indicated on the relevant GA Drawing (refer RCI System Configuration Documents in Attachments) and is comprised of the following sub-systems (see appendices for individual certifications, and refer RCI System Configuration Documents in Attachments for actual components included in this system):

- Processor and intrinsic safety barriers housed in an Ex d enclosure
- Intrinsically safe LCD Operator Display
- Selection of load and pressure sensors meeting AS NZS 60079 Simple Apparatus Assessment
- Slew/Hook Height encoder housed in an Ex d enclosure
- Intrinsically safe namur-type proximity switches
- Electronic Inclinometer housed in an Ex d enclosure

1.4. Available Options

The RCI-4100 can also be supplied with the following optional features:

- Anti –two-block (over-hoist limit)
- Restricted slew zone monitoring
- Wind speed monitoring
- Gross over-moment protection (GOP)
- Tilt Sensing
- Hook height display
- Wind direction monitoring

1.5. References

1.5.1. AS NZS IECEx 60079 - Electrical Apparatus for Explosive Gas Atmospheres

1.6. Limited Product Warranty

LSI-Robway P/L (LSI-Robway) warrants to the Buyer (Purchaser) of new products manufactured or supplied by LSI-Robway that such products were, at the time of delivery to the purchaser, compliant to LSI-Robway Quality Assurance documentation ISO 9001.

Any LSI-Robway product that has been repaired or altered in such a way, in LSI-Robway judgement, as to affect the product adversely, including installation methods and procedures, negligence, accident or improper storage or use will be judged solely by LSI-Robway in regard to any partial or full warranty claim.

LSI-Robway obligation under this warranty is limited to repairing or, at LSI-Robway option, replacement of faulty parts. Any associated transportation or labour costs (other than those directly acceptable by LSI-Robway and consumed at LSI-Robway premises) shall not be part of the warranty claim and shall be at the originator's expense.

Associated re-installation costs shall be at the originator's expense.

Replaced (or repaired items) by LSI-Robway are warranted for the remainder of the warranty period of the originally supplied goods as if they were supplied with the original goods.

This above warranty period extends for 12 months from the original supply date to original purchaser from LSI-Robway.

1.7. Intended Audience

This manual is intended for use by field engineering, maintenance, operation and repair personnel trained by LSI-Robway or familiar with LSI-Robway methods and application knowledge.

1.8. Personnel Qualifications

The procedures described in this manual should be performed only by persons who have read the safety notices in this manual, have read, and understood the relevant section and who are suitably qualified and trained to perform the procedures within.

2. Installation

This section contains general information regarding installation of the RCI-4100IS Rated Capacity Indicator and its sub-systems in a hazardous area environment.

WARNING:	**ALL EQUIPMENT INSTALLED IN AN EXPLOSIVE ATMOSPHERE MUST COMPLY WITH LOCAL GOVERNING STANDARDS. THIS INCLUDES, BUT IS NOT LIMITED TO, ELECTRONIC COMPONENTS, CABLING, JUNCTION BOXES, CONDUIT AND SENSORS, ETC.** **IT IS THE INSTALLER'S RESPONSIBILITY TO ENSURE LOCAL STANDARDS AND REGULATIONS ARE COMPLIED WITH.** **FAILURE TO COMPLY CAN RESULT IN A HAZARDOUS CONDITION WHICH MAY RESULT IN INJURY OR DEATH.** **IT IS NOT POSSIBLE TO COVER ALL HAZARDOUS AREA INSTALLATION STANDARDS IN ONE DOCUMENT. INFORMATION CONTAINED HEREIN MUST BE CONSIDERED ADVISORY ONLY.**

2.1. Setting up the Crane

CAUTION:	PRIOR TO PERFORMING ANY INSTALLATION A CERTIFIED OPERATOR MUST LOWER THE CRANE BOOM TO A SAFE AND CONVENIENT POSITION.

2.2. Power Supply

The RCI-4100 can be powered by a 10.5 VDC to 36 VDC supply.

The selected power supply may be permanently connected, however for convenience it should be made via an ON/OFF switch or relay. If the Control Unit is located within a hazardous area, the power MUST be supplied via steel wire armoured cable in accordance with local installation standards.

2.3. Installing Boom Components

This section describes the installation of all the types of tension based systems and sensors supplied by LSI-Robway.

NOTE:	Refer to the General Arrangement and Wiring drawings in **Error! Reference source not found.** to determine which components are applicable to the system supplied.

2.3.1. Boom Angle Sensor (EEx d)

The boom angle sensor consists of a 90 degree inclinometer housed in an EEx d explosion proof enclosure. The angle sensor comes complete with a standard mounting plate and kit suitable for simple and fast direct mounting to either the boom butt area or chord/lacings. Ideally the angle sensor should be mounted "inside" the boom in a convenient position close to the operators cab. The figure below shows direct mounting to the butt area where the bracket is already tack welded to the boom. If welding or drilling is absolutely essential please refer to proper welding procedure and approval from the crane manufacturer. Mount the sensor on the bolts or plate, ensuring that when you look out of the cabin, towards the boom, the angle sensor is vertical and is not tilting to the left or right.

Figure 1 EEx d angle sensor and typical installation at the boom butt section

Alternatively, the angle sensor can be "clamped" to the chord/lacing closest to the boom butt area by using the universal mounting plate and bolts provided. The position of the angle sensor enclosure on the boom chord can be at an angle (inclined to follow the chord angle), so long as the inclinometer inside is adjusted as described in section 7.4.3., Verifying Operation of Sensors. The boom angle sensor is shipped with the inclinometer correctly mounted for right hand mounting. If the angle sensor is fitted on the left hand side the internal inclinometer will need to be rotated for correct operation. Refer to Section 7.4.3., Verifying Operation of Sensors.

Route the cable carefully around the boom and boom pivot to the cabin. The angle sensor cable is passed through a gland in the controller unit before terminating into DIN mounted terminals. Fix the cable using adequate straps and fixings ensuring that the cable is not pinched or stretched as the boom moves through its full luffing arc (see also "Cabling (Sensors)" Section 2.3.6).
Note: The supplied armoured cable must be used to connect the boom angle sensor to the controller

Reference the applicable drawing(s) in APPENDIX N, System Drawings

CAUTION:	HIGH TENSILE BOOMS REQUIRE PROPER WELDING PROCEDURE SPECIFICATIONS. OBTAIN SPECIALIST ASSISTANCE WHEREVER APPLICABLE.

CAUTION:	THE ANGES4130 INCLINOMETER HOUSES NON-INTRINSICALLY SAFE CIRCUITS WITHIN AN EX D HOUSING. BLUE-JACKETED CABLE INDICATES AN INTRINSICALLY SAFE CIRCUIT AND MUST NOT BE USED WITH THE ANGES4130 IN A HAZARDOUS ZONE. LOCAL INSTALLATION GUIDELINES GOVERNING SAFE AREA CIRCUITS TRAVERSING HAZARDOUS ZONES MUST BE FOLLOWED. THE CABLE MUST BE PROTECTED FROM MECHANICAL DAMAGE; LSI-ROBWAY SUPPLIES AN ARMOURED CABLE WITH EPOXY EX D GLAND SEALING KITS FOR THIS PURPOSE.

2.3.2. Tension Cell Type

(Wired to Control Unit though an EEx ib Load Cell Isolating Barrier)

A tension plate-type load cell may be fitted at the hoist rope dead-end of the boom tip section to sense the hoist line-pull. LSI-Robway tension cells can be supplied with standard “side plates” (or “sister plates”) to provide extra protection against extreme twisting during crane operation.

Special fittings such as an “adapter plate assembly” may be required to fix the tension cell between the boom lug (pad eye) and hoist rope wedge socket. This adapter plate assembly must be specially-fabricated and supplied by the customer to suit the dimensions of the lug and socket at the dead-end termination point. It should also provide for the existing wedge socket and pin to be re-used. LSI-Robway also recommends that the adapter plate assembly be proof-load tested by a certification body prior to installing it on the crane.

Alternatively, on request, LSI-Robway can supply the adapter plate assembly (proof-load tested and certified) at extra cost. Dimensional details of the lug, wedge socket and pin will also be required by LSI-Robway at the time of ordering.

This is an intrinsically safe circuit so “blue sheathed” cable supplied by LSI-Robway is required.

Figure 2 - Tension cell with LSI-Robway-manufactured adapter plate assembly and typical installation on hoist rope dead-end

2.3.3. Single Sheave Dynamometer with Load Pin

(Wired to Control Unit though an EEx ib Load Cell Isolating Barrier)

A load pin can be fitted in a single-sheave mounted close to the boom tip for hoist-rope-tension type installations. The load pin will output an electrical signal proportional to the line-pull or tension on the hoist rope and representing the forces exerted on the load pin's sheave by the hoist rope.

Each hoist rope will have a single-sheave dynamometer.

Route the cable carefully around the boom head, along the boom, and into the RCI Control Unit. Fix the cable using adequate straps and fixings ensuring that the cable is not pinched or stretched as the boom moves through its full luffing arc (see also "Cabling (Sensors)" Section 2.3.6).

Ensure the resultant hoist rope down force on to the load-pin does not exceed the Load-pin capacity. The down force is relative to the hoist rope deflected angle over the load sensing sheave. Calculation is: -

Down Force = sin (deflected angle) x line-pull (tonnes).

Example: - 1.5mt Load-pin installation.
Rope deflected angle (wrap angle) is 2.7 degrees
Max line-pull is 25 tonnes + test allowance = 25.0 + 15% = 32.5t
Calculation: - Sin (2.7 deg) x 32.5t = 1.53t down force

This is an intrinsically safe circuit so "blue sheathed" cable supplied by LSI-Robway is required.

CAUTION:	HIGH TENSILE BOOMS REQUIRE PROPER WELDING PROCEDURE SPECIFICATIONS. OBTAIN SPECIALIST ASSISTANCE WHEREVER APPLICABLE.

Reference the applicable drawing(s) in APPENDIX N, System Drawings

Figure 3 - Typical Load Pin and installation of load pins in single sheaves

2.3.4. Telescopic Boom Length Sensor

Fix the recoil drum and pay-out cable guides to the side of the main boom.
Route the cable carefully from the recoil drum back around the boom pivot to the Control Unit. Fix the cable to the boom and turret using adequate fixings ensuring that the cable is not pinched or stretched as the boom moves through its full luffing arc. Only connect the cable to the Control Unit when finished welding.

Automatic Boom Length Recoil Drum

INSTALLATION- (Please read through before starting)
Ensure that the face onto which the unit is to be mounted is flat, vertical and parallel to the line of cable payout. The mounting position should allow free uninterrupted payout of the cable.

The unit should be mounted with fixing brackets in the horizontal plane. An anti-condensation filter is fitted to the unit close to cable entry glands, this should be at the lowest point when the reel is mounted.

Weldable pads may be supplied to provide stud fixings. These pads also act as stand offs, so that if they are not used for mounting, care should be taken to ensure that there is sufficient clearance between the reel barrel and the mounting face, to allow free rotation.

A cable anchor pulley is required to be mounted at the boom tip in order to tie off the free end of cable pulley. Following correct cable reeling drum installation, setting up can proceed as follows:

- Remove cover from unit and disengage the drive gear from turning the potentiometer.
- With all cable wound on the reel, turn the reel in the direction of payout about three full turns or until tension starts to build up. These turns, which provide the initial cable tension are called pre-load turns.
- Have an assistant prevent the reel from turning and unwind sufficient cable to reach the cable anchor while boom or travel is at minimum. Tie off cable to cable anchor securely.
- Extend boom or travel machine slowly to the full extent of travel. Before reaching the limit of travel, feed off cable from the reel by hand, to ensure that the reel will not bind up before full travel is reached.
- Check that at full extension there is at least one turn available at the reel before binding up. Whilst doing this, keep on turning the reel to bind up and note the number of turns still available. Also check that at full extension at least one full turn of cable is on the reel.
- Retract boom to minimum extension while observing that the reel is working correctly. If more tension appears to be required more pre-load turns may be applied.
- The reel should now be set up mechanically.
- Electrical connections for the hook over-hoist system (ATB) should now be made and secured.
- Freely rotate the potentiometer in the direction of retracting boom until you feel it come to its internal end stop (do not apply pressure). Rotate outwards 1 turn and then re-engage the gears.

Pay-Out cable

With the pay-out cable attached to the boom tip stand-off bracket, select positions for the intermediate cable guides provided, one for each telescoping section and one or more for the main boom allowing 2-3 metres between the drum and the nearest cable guide. Measure the distance from the cable to the sides of the booms, record lengths and mark the positions for the guides. Cut and weld the guides to the boom after removing the cable. Refit the cable through the eyes and anchor to the post using the clamp provided. Adjust the position of each eye so that the cable passes through just touching the top of the ring. When booms deflect and pads wear the cable will take up a lower position in the eye. Stainless steel cable ties are also supplied with the installation kit and to be used where required.

This is an intrinsically safe circuit so “blue sheathed” cable supplied by LSI-Robway is required.

2.3.5. Anti-Two-Block (Optional Item)

(Wired to Control Unit though an EEx ib Digital Switch Isolating Barrier)

Fix the anti-two-block (ATB) switch mounting pin to the main boom head preferably so that the bob-weight (when suspended from the switch) can be fitted to the static hoist rope below the rope anchor. The mounting pin has 2 x 9mm holes. It can either be welded on the boom head section (directly or via a steel plate), or be screwed by drilling and tapping 2 holes on a suitable location on the boom head.

CAUTION:	HIGH TENSILE BOOMS REQUIRE PROPER WELDING PROCEDURE SPECIFICATIONS. OBTAIN SPECIALIST ASSISTANCE WHEREVER APPLICABLE.

Check that the switch works correctly as the boom luffs throughout its working range. For twin winch cranes an additional switch can be added and mounted at the rooster/aux winch head sheave.

NOTE:	Cut chain to required length suitable for the winch line speed and application. A thread locking device should be applied to all shackles in the ATB assemblies.

Fix the ATB cable/s through the junction box(es) supplied and route the cable carefully along the boom (or through a boom cable tray, if available) and boom pivot to the cabin. Secure the cable on the boom using adequate straps and fixings ensuring that the cable is not pinched or stretched as the boom moves through its full luffing arc. Wire the cable into the RCI Control Unit (see APPENDIX G, Cable Gland Installation Instructions for wiring details).

If ATB function is not required, install a wire link between terminal 13 and 14 and terminal 15 and 16 on the ATB barrier (BARD1031D) – (refer RCI System Configuration Documents in Attachments for wiring details).

Figure 4 - Model BB-5 anti-two-block (ATB) switch and junction box

NOTE:	It is important to ensure that the hole of the Bob weight is kept clean of any dirt or grease as these could stick to the hoist rope and cause false activation of the ATB switch alarm and motion cut (if installed). A periodic inspection (refer section 9.3.2) of the ATB switch and Bob weight is recommended to ensure proper operation of the ATB system.

2.3.6. Cabling (Sensors)

Intrinsicaly safe Load-pin and Compression cell cabling must be “LSI-Robway-supplied” BLUE 4 core screened cable which indicates an intrinsically safe circuit. Blue jacketed cable must not be used for non I/S circuits.

Boom Angle Sensor cable must be “LSI-Robway-supplied” 4 core steel wire armoured cable (not blue). UV shield socking may be fitted.

Sensor cables should be fixed firmly to where they are installed and routed along the boom chords through to the crane cabin ensuring freedom of movement around the boom pivot pin. Secure cabling to the boom/other at approximately 600mm intervals

Stainless steel cable ties are supplied with the installation kit.

Also see Section 2.3.12 Cabling Instructions.

2.3.7. Display Unit (Ex ib)

The RCI-4100IS Display Unit is a Group IIB Ex ib certified display which may be located in Zone 1 or Zone 2 of a hazardous area.

The display has overall dimensions of 260mm (H) x 150mm (W) x 60mm (D), is rated to IP65, and weighs about 3 kg. Using the mounting kit mount the RCI-4100IS display unit in a convenient position in the crane cabin such that the operator can view the displays and reach the push buttons comfortably.

Standard ram bracket and mounting kit comprising of bolts and nuts are provided. A special bracket may need to be fabricated on site to enable suitable mounting in the cabin.

Note: Maximum cable display length is 10m.

Refer also to APPENDIX A, Safety and Installation Instructions, Model 4120 RCI-4100IS Display Barrier for further information and details. Refer also Section 2.3.12 Cabling Instructions

Reference the applicable drawing(s) in APPENDIX N, System Drawings

CAUTION:	CHECK ELECTRICAL CONNECTION BETWEEN THE DISPLAY ENCLOSURE AND THE GROUNDED CRANE CHASSIS. IF A GOOD CONNECTION CANNOT BE ENSURED THROUGH THE MOUNTING BRACKET, THEN INSTALL AN EARTH STRAP. IT IS A CONDITION OF INSTALLATION THAT AN EQUIPOTENTIAL CONNECTION MUST BE ENSURED BETWEEN THE DISPLAY ENCLOSURE AND THE CONTROL UNIT ENCLOSURE (VIA THE GROUNDED CRANE CHASSIS).

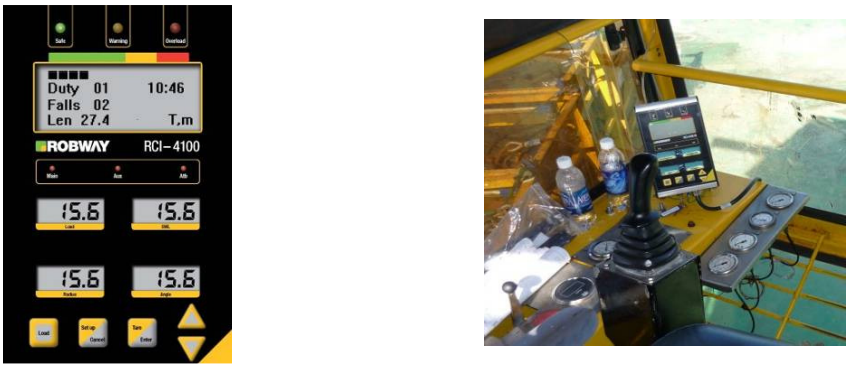


Figure 5 - Ex ib display unit and typical installation inside the cabin

2.3.8. Hazardous Area Control Unit (if not Safe Area)

The Hazardous Area Control Unit has Ex ia and Ex ib interfaces housed in an Ex d flameproof enclosure for Zone 1 and Zone 2 applications.

The Control Unit is certified to EEx d IIB (ATEX) with environmental protection of IP65. The enclosure has overall outside dimensions of 371mm (H) x 371mm (W) x 233mm (D) and weighs about 18 kgs. Wherever possible the Controller housing should be protected from direct weather. It must be remembered that the Controller housing is not hermetically sealed. High humidity environments will result in water vapour being drawn into the Controller housing as the system cools after turning off. Consequent heating and cooling cycles from normal operation can result in condensation leading to water damage. Repairing such damage is outside of the scope of LSI-Robway warranty. This situation is rarely seen on Controller housings mounted in crane cabins.

When opening the Controller housing it is critical that any water caught in the bolt holes is not allowed to enter the controller. This will likely lead to water damage which is not covered by LSI-Robway warranty. Wherever possible the Controller housing should be mounted vertically to prevent moisture pooling problems in the base of the controller.

WARNING:	**THE MACHINED SURFACES BETWEEN THE CONTROLLER BODY AND LID ARE A CRITICAL DESIGN PROTECTION MEASURE. DAMAGE TO THESE SURFACES CAN ADVERSELY AFFECT THE EX D PROTECTION MEASURES AND THE ENCLOSURE MUST BE REPLACED IF THERE IS ANY PITTING OR SCORING PRESENT.**

The Control Unit contains the termination points for all modules within the RCI-4100IS system. Terminate all connection cables in the Control Unit.

Refer also Section 2.3.12 Cabling Instructions

Reference the applicable drawing(s) in APPENDIX N, System Drawings

CAUTION:	CHECK ELECTRICAL CONNECTION BETWEEN THE CONTROL UNIT ENCLOSURE AND THE GROUNDED CRANE CHASSIS. IF A GOOD CONNECTION CANNOT BE ENSURED THROUGH THE MOUNTING BRACKET, THEN INSTALL AN EARTH STRAP. IT IS A CONDITION OF INSTALLATION THAT AN EQUIPOTENTIAL CONNECTION MUST BE ENSURED BETWEEN THE DISPLAY ENCLOSURE AND THE CONTROL UNIT ENCLOSURE (VIA THE GROUNDED CRANE CHASSIS).

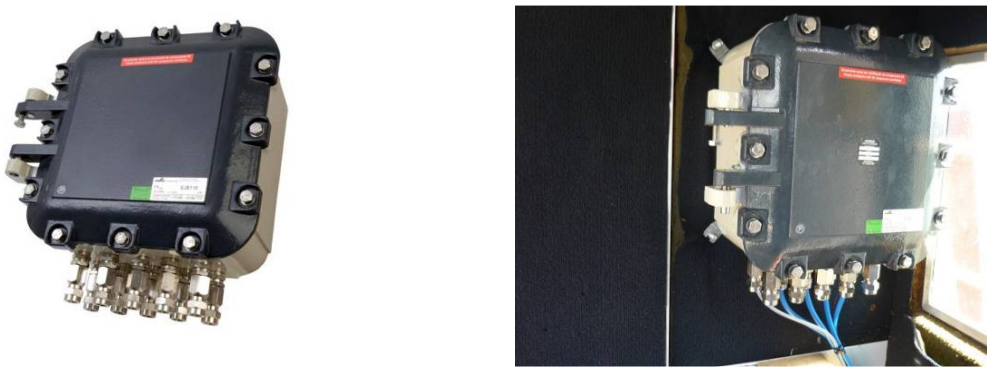


Figure 6 - Typical installation of Ex d control unit inside the operator's cabin

2.3.9. Setting DIP Switches for Cable Length

The hazardous area control unit has a display barrier (BAREX4120) which the display is connected to. This has a PCB with three DIP switches to match various display cable lengths to the display barrier. After trimming the display cable to required length these DIP switches must be set as follows:

- If the cable length is up to 2.5 metres in length then the 2.5 meter switch (SW3) is set to "ON" and switches SW1 and SW2 are set to "OFF".
- If the cable length is greater than 2.5 metres up to 5 metres in length then the 5 meter switch (SW2) is set to "ON" and switches SW1 and SW3 are set to "OFF".
- If the cable length is greater than 5 metres up to 10 metres in length then the 10 meter switch (SW1) is set to "ON" and switches SW2 and SW3 are set to "OFF".

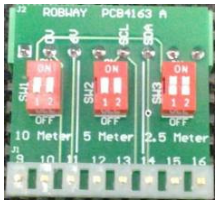


Figure 7 - DIP Switches for Cable Length - CIRPCB4163

2.3.10. Cable Glands

The cable glands used on the flameproof Control Unit are barrier glands. Instructions to fit cables and epoxy compound are included with each gland. Once the epoxy has been installed, the gland must not be re-opened as the seal will be broken. If any cable alterations are necessary, then a new barrier gland must be used. The particular glands recommended utilise a unique clamp arrangement which allows either steel wire armour or steel braid armour to be clamped within the gland. It is important to follow the instructions carefully to use the correct orientation of the clamp to suit the particular cable, and that either the armour (for power and relay cables) or the screen (I.S. cables) is clamped correctly. Do not bring the screen connection through the gland (on I.S. cables) unless the replacement gland is not suitable. In this case the screens must be terminated at the earth terminal block located above the relays on the mounting plate inside the Control Unit.

CAUTION:	DO NOT BRING THE SCREEN CONNECTION THROUGH THE GLAND (ON I.S. CABLES). ONLY “SCREEN CAPTURE” GLANDS SHOULD BE USED.

Refer to APPENDIX G, Cable Gland Installation Instructions.

2.3.11. Safe Area Control Unit (if not hazardous area)

The Safe Area Control Unit enclosure is made of stainless steel with a hinged lid and is designed for mounting inside the crane cabin.

The enclosure has overall outside dimensions of 275mm (H) x 350mm (W) x 200mm (D) with an environmental protection of IP65.

The Control Unit contains the termination points for all modules within the RCI-4100 system. Terminate all connection cables at the Control Unit.

Reference the applicable drawing(s) in APPENDIX N, System Drawings

CAUTION:	CHECK ELECTRICAL CONNECTION BETWEEN THE CONTROL UNIT ENCLOSURE AND THE GROUNDED CRANE CHASSIS. IF A GOOD CONNECTION CANNOT BE ENSURED THROUGH THE MOUNTING BRACKET, THEN INSTALL AN EARTH STRAP. IT IS A CONDITION OF INSTALLATION THAT AN EQUIPOTENTIAL CONNECTION MUST BE ENSURED BETWEEN THE DISPLAY ENCLOSURE AND THE CONTROL UNIT ENCLOSURE (VIA THE GROUNDED CRANE CHASSIS).

Figure 6 - Typical safe area control unit inside the operator’s cabin

2.3.12. Cabling Instructions

CAUTION:	THE FOLLOWING GUIDELINES ARE GENERAL RECOMMENDATIONS. ALL APPARATUS MUST BE INSTALLED IN ACCORDANCE WITH THE MANUFACTURER'S INSTRUCTIONS AND WITH THE RELEVANT HAZARDOUS AREA INSTALLATIONS STANDARDS/CODES OF PRACTICES. ALL ELECTRICAL CABLING MUST BE INSTALLED BY TECHNICALLY TRAINED PERSONNEL USING TRADE, PROFESSIONAL OR LOCAL/INTERNATIONALLY RECOGNISED STANDARD PROCEDURES.

Route the display and power cables into the controller enclosure through the gland specified on the system installation GA Drawing. If the appropriate cable gland is not specified on the system installation GA Drawing then use the cable gland nearest the internal connection point. Segregation between safe area circuits and intrinsically safe circuits is mandatory.

Within the enclosure, ensure that a 50mm separation exists between "safe area circuit" terminals and "intrinsically safe circuit" terminals.

Do not coil excess display cable outside or within the RCI-4100 enclosure – always cut off excess cable.

Blue-jacketed cable commonly denotes an "intrinsically-safe circuit" when located in a hazardous zone.

Check that the blue-jacketed cable, supplied by LSI-Robway, is used for all "intrinsically safe circuits" only. Always trap the shield of all cables in the Ex d glands of the controller.

"Intrinsically safe circuit" cable shield must only be connected to ground at the controller end and terminated within the gland. Do not allow cable screens to continue inside the controller enclosure. In the enclosure, do not ground the shield of screened cables to grounding points other than glands.

Blue-jacketed cable **must not** be used for "safe area circuits" such as power supply, slew encoder or angle sensor because these are not "intrinsically safe circuits".

Check that "safe area circuit" armoured cable is used for the power supply, slew encoder and angle sensor. This cable armour must be connected to earth at both ends. If manufacturer's instructions are followed, the Ex d cable gland is suitable for this purpose, by trapping the steel armour.

Do not run signal cables next to power cables anywhere on the crane. There should be separate cable trays for the two types of cables. This is to avoid electrical interference.

All safe area cabling and intrinsically safe circuit cabling must be protected from physical damage and UV degradation.

Do not ground screened cable shields at both ends – they only need to be trapped in the gland at the enclosure.

It is recommended that "Denso" tape or a similar approved tape/sealant be applied around all connectors subject to external weather to minimise moisture ingress.

2.3.13. Earthing

Ensure that the crane boom is earthed through a grounding strap or other means and verify its integrity.

WARNING:	**THE CRANE BOOM EARTHING STRAP OR OTHER EARTHING MEASURE MUST BE IN PLACE. IF THE CRANE BOOM IS NOT EARTHED THEN A VOLTAGE POTENTIAL MAY EXIST BETWEEN THE CABLE SHIELDS/ARMOUR AND THE BOOM AND CREATE A SPARK SUFFICIENT TO CAUSE IGNITION. CABLE ARMOUR OR SHIELD SHOULD NOT BE RELIED UPON TO PROVIDE AN EARTH CONNECTION.**

2.4. Switch Inputs

The RCI-4100 Control Unit has eight (8) digital switch inputs to suit specific applications and requirements such as slew position limit switch, external duty selector switch, etc. Please refer to the RCI System Crane Configuration Sheet in the Attachments for the list of inputs programmed in the software to suit the specific application.

Reference the applicable drawing(s) in RCI System Configuration Documents in Attachments.

2.5. Relay Outputs

The RCI-4100 Control Unit has three (3) safety relays on board the PCB and up to another eight (8) switching relays on the terminal block.

The safety relays have voltage-free contact rated to 5A and are only used to energise the coils of external high-power SLAVE relays such as motion cut, slack rope detect output, boom up motion cut (minimum radius limit), etc. Please refer RCI System Configuration Documents in Attachments s for the list of relay outputs programmed in the software to suit the specific application.

Refer to the documents in "ATTACHMENTS, RCI System Configuration Documents"

CAUTION:	PLEASE NOTE THAT ALL INDUCTIVE LOADS SUCH AS RELAYS AND SOLENOIDS REQUIRE SNUBBER DIODES (1N5404 OR 1N4004) FOR TRANSIENT SUPPRESSION.

2.5.1. MOTION-CUT OUTPUT RL-1

It is recommended that the RCI-4100 motion-cut output relay (RL1) be connected to a customer fitted 'latch-out' relay requiring a manual reset once activated.

Thus, following motion-cut activation the 'latch-out' relay will sustain motion-cut output until manually reset (provided the RCI-4100 is clear of alarm state/s).

This feature will assist to avoid dynamic situations following motion-cut, especially if activated during luffing down operations at higher boom angles.

RCI-4100 software also has a "Time Delay for Motion Cut Return" to assist with the situations mentioned above. The default setting is 5 seconds and can be changed to suit local conditions if required. Refer to Section 6.29 for further details.

2.6. Installing Slew Ring Components

(For optional Restricted Slew Zone feature)

2.6.1. Restricted Slew Zone Encoder

The Slew Encoder (Transmitter) is either fitted with a gear pulley which is belt driven by another gear pulley meshed with the crane's slew ring or pinion gear or directly gear driven from the slew ring gear. The Encoder is used to convert the number of pulses counted during slewing (left or right) into slew direction and slew angle values.

The Slew Encoder body is supplied with a standard steel plate with four mounting holes. To ensure accurate operation of the encoder drive gear, extra plates/brackets (not supplied) must be fabricated on site to connect the encoder body.

Refer to APPENDIX H, Restricted Slew Zone Monitoring Option

Figure 7 - Slew encoder
(NOTE: Encoder shown is for illustration only; actual encoder supplied may differ in model and type.)

2.6.2. Proximity Switch (For optional Restricted Slew Zone feature)

The Proximity Switch is used as a “Slew Reset” switch for the Encoder. The Slew Angle defaults back to its initial set value each time the Proximity Switch is activated (switched ON).

The switch is magnetically switched and requires a metal target to switch ON. Fabricate, fix and secure a suitable mounting plate to the switch between the two locknuts supplied. Mount the plate at a suitable location on the revolving upperstructure preferably so that the switch moves and rotates with the upperstructure (see typical installation below). LSI-Robway recommends that this switch be located so that it corresponds with the rest position of the crane so that the slew system is reset on every crane start-up. The target plate must be mounted at a suitable location on the fixed post or centre post about which the upperstructure rotates.

The gap between the switch and target must not exceed 10mm. The switch distance can be adjusted via the locknuts.

The switch is wired through the Slew Encoder box.

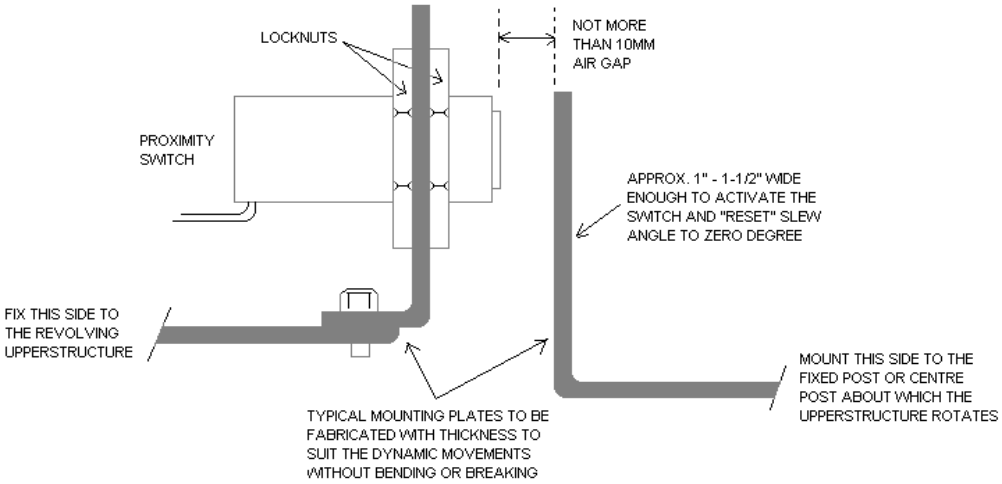


Figure 8 - Proximity switch typical installation (1)

Figure 9 - Proximity switch typical installation (2)

2.7. Installing Winch Components

(For optional Hook Height Feature)

2.7.1. Hook Height Winch Encoder

The Winch Encoder (Transmitter) is either fitted with a gear pulley which is belt driven by another gear pulley meshed with the crane's winch or pinion gear or directly gear driven from the winch gear. The Encoder is used to convert the number of pulses counted during hoisting (up or down) into winch direction and winch height values.

The Slew Encoder body is supplied with a standard steel plate with four mounting holes. To ensure accurate operation of the encoder drive gear, extra plates/brackets (not supplied) must be fabricated on site to connect the encoder body.

Figure 10 - *Winch encoder*

(NOTE: Encoder shown is for illustration only; actual encoder supplied may differ in model and type.)

Refer APPENDIX M, Hook Height Option for further information and calibration instructions.

3. Operating Instructions

The following sections explain how to operate the RCI-4100 and make best use of its capabilities.

3.1. Applying power to the RCI-4100

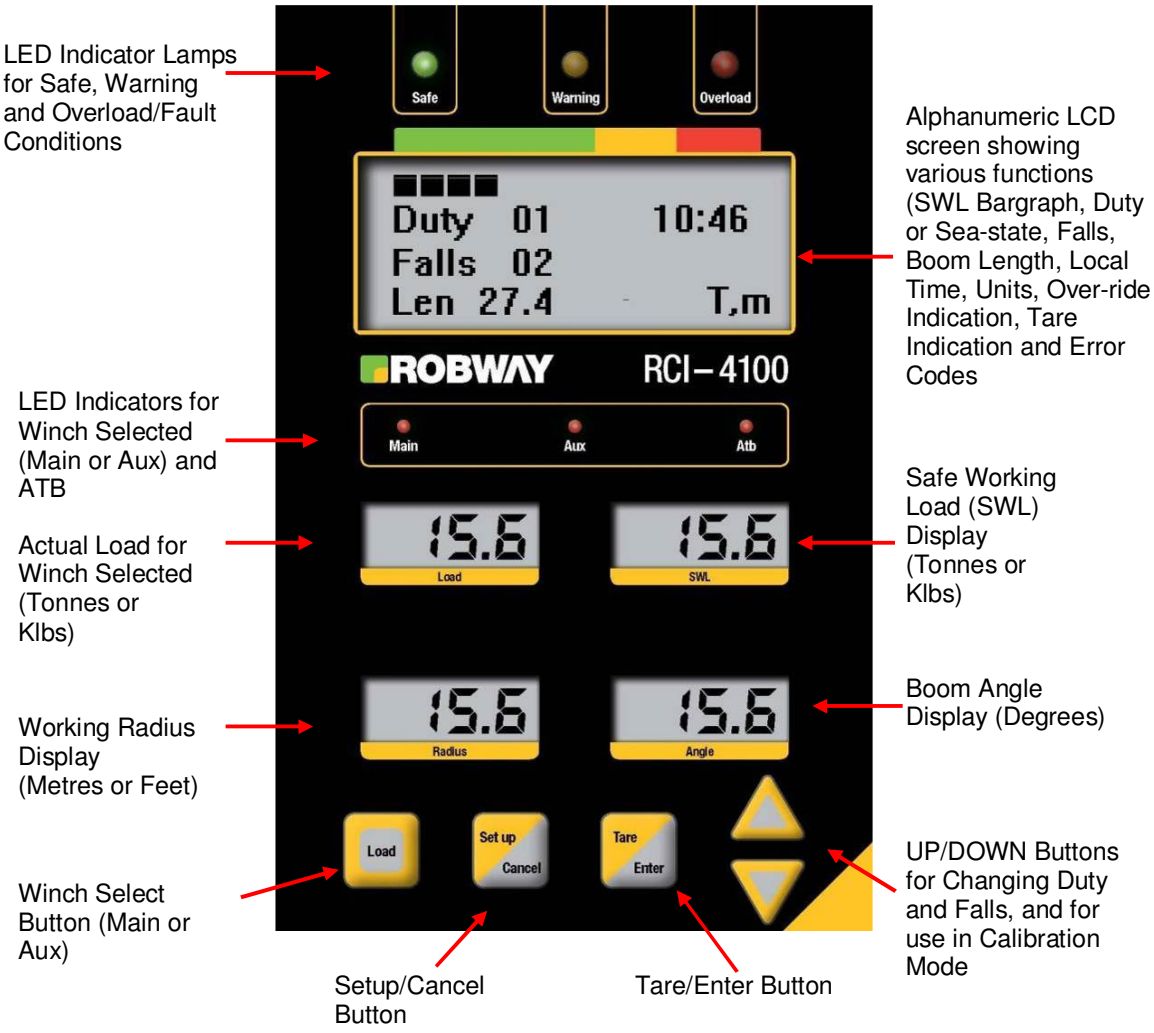
As soon as power is applied to the RCI-4100, its display and other indicators should light up and the RCI-4100 should go through its self-test operation.

3.2. Turning Off the RCI-4100

The RCI-4100 will stop working as soon as the power is removed from it.

3.3. Operating Screen

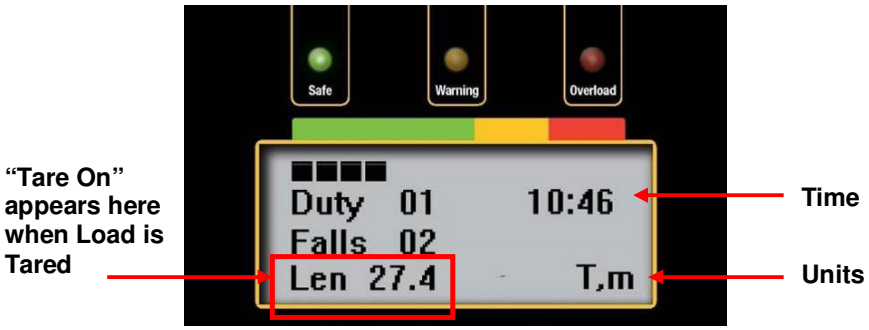
The following is the operating screen of the RCI-4100 showing the general display functions:



3.4. Display Functions

The RCI-4100 display is comprised of one 4x16 alphanumeric LCD, four 4-digit LCD's, three alarm LED's, three indicator LED's and five push buttons. The functions of these are as follows:

3.4.1. ALPHANUMERIC LCD SCREEN AND ALARM LED INDICATORS



The top line of the screen is a horizontal bargraph used to indicate the percentage of Safe Working Load (SWL). This bargraph shows the total load as a percentage of the crane's rated capacity in its current configuration with the aid of a horizontal coloured band (Green, Amber and Red) on the decal just above the bargraph.

The three alarm LED's (Green-Safe, Amber-Warning and Red-Overload) at the top of the display also work in conjunction with the SWL bargraph. Factory settings are as follows:

- The GREEN LED is on up to the first trip point which is typically set at 85% SWL.
- The AMBER LED turns on when the first trip point is reached. The audible alarm will also start sounding intermittently.
- The RED LED comes on at the second trip point which is typically set at 100% SWL. The audible alarm will sound continuously.
- The RED LED will remain on when the third trip point is reached which is typically set at 110% SWL and the audible alarm will sound continuously. Crane motion-limiting controls are also activated at this stage if fitted.

Please review function code settings for exact thresholds.

The other lines on the alphanumeric screen can display the following functions:

DUTY	-	Shows the current duty (or Sea-state) selected.
FALLS	-	Shows the current parts of line or falls for the winch selected.
LENGTH	-	Shows the boom length in unit selected (Metres or Feet) for the winch selected.
TIME	-	Shows the current local time. The time function is also used to time stamp records in the data-logger. The correct time can only be set in calibration mode (refer to Section 7.4.1 "Check/Set year, day/month and time" for details).
UNITS	-	Shows the current unit ("T, m" for Metric or "Klb, ft"for Imperial) as selected by the operator.
TARE	-	When "Tare" is selected by the operator the load value on the screen will show zero (i.e. all loads prior to activating tare will be tared out). "Tare On" appears in the lower left hand corner of the alpha-numeric display.

OVER-RIDE - The screen will show O/R on the upper left hand side of the LCD when the over-ride key switch is turned on. The over-ride key switch is only used when calibrating the system and/or when overriding the alarms (and motion cut) at which time the system can no longer warn of impending overload. Operation of this key is for authorized personnel only who shall be solely responsible for its use.

Note: LSI-Robway recommends that the over-ride key switch be switched OFF at all times and the over-ride key switch be held by the site-supervisor or another authorized person.

The TARE is an operator-settable function. It allows the operator to TARE out the weight of accessories not considered part of the load.

NOTE: Please note that when the TARE function is active, the %SWL is still determined by the total load, irrespective of what is currently displayed.

Using the TARE function
The tare function can be activated by pressing the TARE button on the lower part of the display. Once activated, the “Tare On” indication will be shown on the screen and the displayed load will change from the current load reading to zero (i.e. the load/weight prior to activating tare will be tared out). This is useful when the operator wants to see only the net weight of the load minus the accessory loads (e.g. wire rope slings, rigging accessories, etc.). When TARE is next pressed, the displayed load reverts to the total load.

While in TARE mode, the tared load will be stored in the system memory and will still be part of the total load calculation of the system.

The DUTY and FALLs are operator-settable functions. Prior to crane operation, the operator must ensure that the correct DUTY and FALLS are selected to match the actual crane configuration/operation and actual parts of line on the winch selected/used.

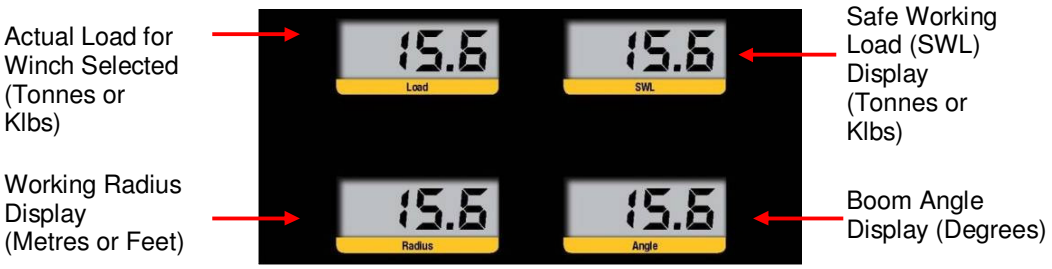
The list of the programmed DUTIES for the specific crane is provided at the rear of the manual. A copy is also provided to be placed in the crane cabin for reference by the operator.

Selecting DUTY
To change the duty, press the Set Up/Cancel key until the DUTY value on the screen flashes. While it is flashing, press the UP/DOWN arrow keys to ramp to the desired duty or sea state. Press the ENTER key to complete selection, or wait 5 seconds when the display automatically switches back to normal operating mode.

Selecting FALLS
To change the falls or parts of line, press the Set Up/Cancel key until the FALLS value on the screen flashes. While it is flashing, press the UP/DOWN arrow keys to ramp to the desired number of falls. Ensure also that the correct duty or sea state has been selected as the displayed falls apply to the winch selected. Press the ENTER key to complete selection, or wait 5 seconds when the display automatically switches back to normal operating mode.

This screen is also used to display ERROR codes when any errors are detected. The error code/s will be displayed automatically if there are any errors. Please refer to Section 8. “Troubleshooting” for the meaning and description of the error codes.

3.4.2. 4-DIGIT LCD SCREENS



There are four, 4-digit LCDs on the lower part of the display which show a numerical display of the following functions:

LOAD - Shows the current load in unit selected (Tonnes or Klbs) for the active winch.

SWL - Shows the current maximum safe working load in selected units (Tonnes or Klbs) for the active winch. The SWL will depend on radius, current duty, maximum hoist rope line-pull and falls.

RADIUS - Shows the current operating radius in unit selected (Meters or Feet) for the selected winch/hook.

ANGLE - Shows the current boom angle in degrees.

3.4.3. ACTIVE WINCH and ATB LED INDICATORS

There are three LED indicators at the centre of the display as follows:

MAIN - Illuminated when Main Winch is selected. Selection can be done by pressing the LOAD button on the lower left hand side of the display. Pressing the LOAD button will toggle between Main Winch and Aux Winch.

Aux - Illuminated when Aux Winch is selected. Selection can be done by pressing the LOAD button on the lower left hand side of the display. Pressing the LOAD button will toggle between Aux Winch and Main Winch.

ATB - Illuminated when two-blocking condition is detected, at which point the Red-Overload LED at the top of the display will also illuminate, activating the continuous audible alarm and ATB motion cut relay.

3.4.4. FUNCTION PUSH BUTTONS

There are five push buttons on the lower part of the display as follows:

LOAD	-	Used for switching between Main Winch and Aux Winch. Although the system will always check on the safe operation for both winches, it is important to ensure that the correct winch is selected as the winch selection affects the values shown on the display. When the actual load exceeds the SWL for the current crane configuration, the RCI-4100 will activate audible and visual alarms.
SETUP/CANCEL	-	Multi-purpose button used for accessing Calibration Mode (SETUP) in conjunction with the over-ride key switch, for changing Duty and Falls, and for aborting changes (CANCEL) to calibration data values during calibration/setup *(*refer *to* Section 7. “Calibration” for details).
TARE/ENTER	-	Dual-purpose button used for activating tare function (TARE) and for confirming changes (ENTER) to calibration data values during calibration/setup. Refer also to previous sections for details on the Tare function.
UP/DOWN ARROW	-	Used for changing Duty and Falls when on normal operating screen. When in Calibration Mode, these keys are used for going through the list of Function Codes and for incrementing/ decrementing numerical values when calibrating/setting up a function.

3.5. Restricted Slew Zone Monitoring – Optional Feature

Restricted Slew Zone Monitoring is an optional feature that can be integrated into the RCI-4100 system if required.

This option can provide two forms of Restricted Slew Zone Monitoring:

- Built-in slew alarm and cut-out when approaching permanent structures, and
- Operator settable alarm for temporary structures or obstacles.

Slew zones are settable both by slew position and boom angle.

If this option is supplied, please refer to APPENDIX H, Restricted Slew Zone Monitoring Option for usage information and details.

3.6. Wind Speed Monitoring – Optional Feature

Wind Speed Monitoring is an optional feature that can be integrated into the RCI-4100 system if required.

If this option is supplied, please refer to APPENDIX I, Wind Speed Monitoring Option for usage information and details.

3.7. Wind Direction – Optional Feature

Wind direction is an optional feature that can be integrated into the RCI-4100 system if required.

If this option is supplied, please refer to APPENDIX J, Wind Direction Monitoring Option usage information and details.

3.8. Gross Over-moment Protection (GOP) – Optional Feature

Gross Over-moment Protection is an optional feature that can be integrated into the RCI-4100 system if required.

This option is agreed with the crane manufacturer before installation and provides special outputs that interface with the crane to release excessive overloads.

If this option is supplied, please refer to APPENDIX K, Automatic Gross Overload Option for usage information and details.

3.9. Tilt Sensing - Optional Feature

Tilt sensing option is an optional feature that can be integrated into the RCI-4100 system if required.

This option provides a tilt indication and can also be configured to supply alarms at pre-determined points and/or switch load charts at pre-determined points.

If this option is supplied, please refer APPENDIX L, Tilt Sensing Option for usage information and details.

3.10. Hook Height – Optional Feature

Hook height for main and auxiliary winch is an optional feature that can be integrated into the RCI-4100 system if required.

If this option is supplied, please refer to APPENDIX M, Hook Height Option for usage information and details.

4. Data Logging and Data Downloading

NOTE: Where F-xx appears please refer RCI System Configuration Documents in Attachments to determine relevant function code numbers.

The RCI-4100 Control Unit has an on-board SD card to which data from the internal data logger can be downloaded and saved for reading on a PC.

The internal logger records all data within the set parameters of the logger and system. The data are stored in the on-board flash memory chip.

Calibration Mode (refer RCI System Configuration Documents in Attachments) is used for downloading the logger contents from the flash memory chip into the SD card. The SD card can then be removed from the Control Unit and inserted into the card reader on a PC for viewing, saving and printing the recorded data.

As the logger contents can only be downloaded in Calibration Mode, only authorised personnel with access to the over-ride key and Calibration Mode can perform this function.

A short procedure is as follows:

- Turn the power off.
- Open the controller and place the SD card (preferably with no files) into the SD card holder on the RCI-4100 controller unit board (see Figure 11)
- Turn the over-ride key switch ON and access Calibration Mode.
- Go to the “Download Data Log” function code and press the ENTER key.
- The default setting on the screen is “RS232”. To download to the SD Card use the up/down arrow key to change the setting from “RS-232” to “SDCARD”.
- While “SDCARD” is shown on the screen press the ENTER key and this will download the logger contents into the SD card. This may take a few minutes depending on the amount of data being transferred. While downloading 3 dots are shown under F-xx number. When download is completed the message ‘DONE’ will appear.
- Switch power off.
- Carefully remove the SD card and insert it into a card reader on a PC for viewing the logger contents. Downloaded data is in the *.LOG file.
- Switch power on.
- Open the *. LOG file using any word processing program such as MS Word or Notepad for viewing, saving and/or printing of data.
- Once saved the *.LOG file can be cleared/deleted from the SD card.

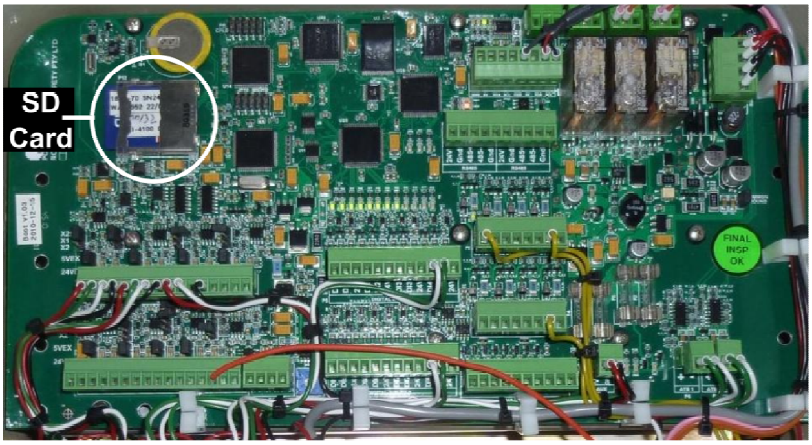


Figure 11 - RCI-4100 Control Unit board showing the SD card

Please refer also to APPENDIX F, Data Logging for usage information and details.

5. Uploading Crane Software Using SD Card

The crane software can be uploaded into the CPU of the RCI-4100 Control Unit using the SD card.

Figure 12 - RCI-4100 Control Unit board showing the SD card slot

During normal operation, the system reads and processes data from the CPU and not from the SD card. The SD card is only used to upload new crane data or changes in the crane data.

The crane software is a *.HEX file copied into the SD card either from the factory at the time of supply or sent via email. The emailed crane software can be copied into the SD card using a PC.

On system boot up, the system reads the SD card (if present) and compares two parameters as follows:

- Software Version Number
- Crane Model

If both the Software Version Number AND Crane Model on the SD card are different from the ones in the CPU, then the system will upload the new crane data from the SD card, and will prompt the user to “clear calibration data”. A recalibration of the system will be required.

If only the Software Version Number is different but the Crane Model is the same, then the system will upload the new crane data from the SD card, but will NOT prompt the user to “clear calibration data”. A recalibration will NOT be required.

If the Software Version Number is the SAME as the one in the CPU, then the system will NOT upload data from the SD card. In some cases where changes are made on the crane software with the SAME Software Version Number, the changes can still be uploaded but will first require clearing existing data from the controller PCB by loading a “dummy” software (file name: 4100_controller_dummy_c999.hex), then the new software. The dummy software is a data eraser which, when uploaded, will clear the existing controller CPU software.
Procedure to load dummy software then new crane software:

- Remove power from the RCI-4100 system.
- Delete all files from an SD card and copy the “4100_controller_dummy_c999.hex” file onto the SD card.
- Insert this SD card into the controller and apply power to the RCI-4100 system. The display will then prompt the user to clear the data and also logger contents. Turn the over-ride key switch on and keep pressing the ENTER key until the display boots up and a normal operating screen appears.
- Remove power from the RCI-4100 system and remove the SD card. Delete the “4100_controller_dummy_c999.hex” file from the SD card. Copy the new “.hex” file onto the SD card.
- Insert this SD card into the controller and apply power to the RCI-4100 system. The display will again prompt the user to clear the data and logger contents. Ensure the over-ride key

switch is on and keep pressing the ENTER key until the display boots up and a normal operating screen appears.

- Complete recalibration of the system is now required. Refer to “Section 7 Calibration” for the calibration procedure.
- Please contact LSI-Robway for further details and assistance on the dummy software.

CAUTION:	CHANGING THE SOFTWARE WILL CHANGE THE OPERATION OF THE RCI-4100 AND IT IS MOST IMPORTANT THAT THE CORRECT SOFTWARE CORRESPONDING TO THE CRANE IS USED ON EACH CRANE. THE PERSON CHANGING THE SOFTWARE IS RESPONSIBLE FOR VERIFYING ALL ASPECT OF FUNCTIONALITY AFTER CHANGING SOFTWARE.

6. Function Code descriptions

NOTE: Refer to RCI System Configuration Documents in Attachments for Function Code numbers for the RCI-4100 system. Take great care to ensure that the function code numbers are checked against this Function Code List.

Note: The following function codes are listed for explanation and may not be used in every RCI-4100software.

6.1. Exit Calibration Mode

Use this function to exit Calibration Mode. Alternatively, exiting calibration mode can also be done by pressing CANCEL button when on a function code other than F-00. Ensure that dashes (----) are shown on the bottom window before pressing CANCEL button to exit.

6.2. Main Load

6.2.1. View Calibrated Main Load

The calibrated Main Winch load can be verified on normal operating mode (operator's screen). This function is used to view the main calibrated load while still in calibration mode. This is useful when just verifying accuracy of the load readout and the calibration has not yet been finalised.

6.2.2. Calibrate Light Main Load

This function is used to calibrate the Light Main Load.

6.2.3. Calibrate Heavy Main Load

This function is used to calibrate the Heavy Main Load.

6.3. Aux Load

6.3.1. View Calibrated Aux Load

The calibrated Aux Winch load can be verified on normal operating mode (operator's screen). This function is used to view the aux calibrated load while still in calibration mode. This is useful when just verifying accuracy of the load readout and the calibration has not yet been finalised.

6.3.2. Calibrate Light Aux Load

This function is used to calibrate the Light Aux Load.

6.3.3. Calibrate Heavy Aux Load

This function is used to calibrate the Heavy Aux Load.

6.4. Angle

6.4.1. View Uncalibrated Angle Input

Use this function to view the raw counts (or raw data) of the angle sensor. Please also Section 7.4.3. "Verifying Operation of Sensors" for details.

6.4.2. View Calibrated Angle Input

The calibrated angle can be verified on normal operating mode (operator's screen). This function is used to view the calibrated angle (in degrees) while still in calibration mode. This is useful when just verifying accuracy of the angle readout and the calibration has not yet been finalised.

6.4.3. Calibrate Low Angle

This function is used to calibrate the Low Angle.

6.4.4. Calibrate High Angle

This function is used to calibrate the High Angle.

6.5. Length (Telescopic Cranes Only)

6.5.1. View Uncalibrated Length Input

Use this function to view the raw counts (or raw data) of the length sensor. Please also Section 7.4.3. “Verifying Operation of Sensors” for details.

6.5.2. View Calibrated Length Input

The calibrated length can be verified on normal operating mode (operator’s screen). This function is used to view the calibrated length while still in calibration mode. This is useful when just verifying accuracy of the length readout and the calibration has not yet been finalised.

6.5.3. Calibrate Short Length

This function is used to calibrate the Short Length.

6.5.4. Calibrate Long Length

This function is used to calibrate the Long Length.

6.6. View Uncalibrated Transducer 1 Input

Use this function to view the raw counts (or raw data) of the Main Load transducer (main load sensor). Please also Section 7.4.3. “Verifying Operation of Sensors” for details.

Function Codes – View Calibrated Transducer 1, Calibrate Low End of Transducer 1 and Calibrate High End of Transducer 1 are only used on Load Moment-Based systems only and are not applicable for this crane.

6.7. View Uncalibrated Transducer 2 Input

Use this function to view the raw counts (or raw data) of the Aux Load transducer (aux load sensor). Please also Section 7.4.3. “Verifying Operation of Sensors” for details.

Function Codes – **View Calibrated Transducer 2, Calibrate Low End of Transducer 2 and Calibrate High End of Transducer 2** are only used on Load Moment-Based systems only and are not applicable for this crane.

6.8. OFFSET and GAIN adjustment

Software provides a facility to vary sensor offset and gain. However, provided the sensors have been provided by LSI-Robway with the system, then the default value has been set by the software programmer to suit the supplied sensors and is best left as is.

CAUTION:	GAIN AND OFFSET ARE PRESET IN THE FACTORY AND SHOULD NOT BE CHANGED UNLESS DIFFERENT TYPE OF SENSOR WITH DIFFERENT OUTPUT LEVEL HAS BEEN REPLACED.

The RCI-4100 has 8 identical analogue inputs which can be assigned to different types of analogue signals such as 4 wire differential (full bridge strain gauge types as found in load cells) or single ended voltage sensors such as length and angle sensors, or 4-20mA sensors.

RCI-4100 uses 12Bit A/D convertors resulting in a maximum raw count range of 4096. The working range is between 50 to 4050. Below 50 or above 4050 is considered out of range and will flag an error state.

What is offset?
LSI-Robway analogue input channels are not designed to start at zero signal level, this is to allow for sensor error detection. Because of this offset, amplification factors would have to be limited to ensure that the high end doesn’t exceed available raw counts. So if a software offset is introduced to

decrease the low end closer to zero then more amplification can be applied to make use of the full range of raw counts. This is why an offset is used with all sensors.

What is gain level?
There are two types of gain settings for each channel, one in hardware and the other in software. Gain is signal amplification and amplifies the signal level of the analogue channel to provide the widest range of raw counts to ensure maximum resolution for each sensor.

Hardware gain is varied by setting jumpers for individual analogue channels on the PCB. Hardware gains for each channel can be X1, X2 or X250:

- X1 used for single ended voltage sensors such as length and angle sensors, and 4-20mA sensors.
- X2 is currently not used.
- X250 used for 4 wire differential (full bridge strain gauge types as found in load cells).

Refer to Figure below.

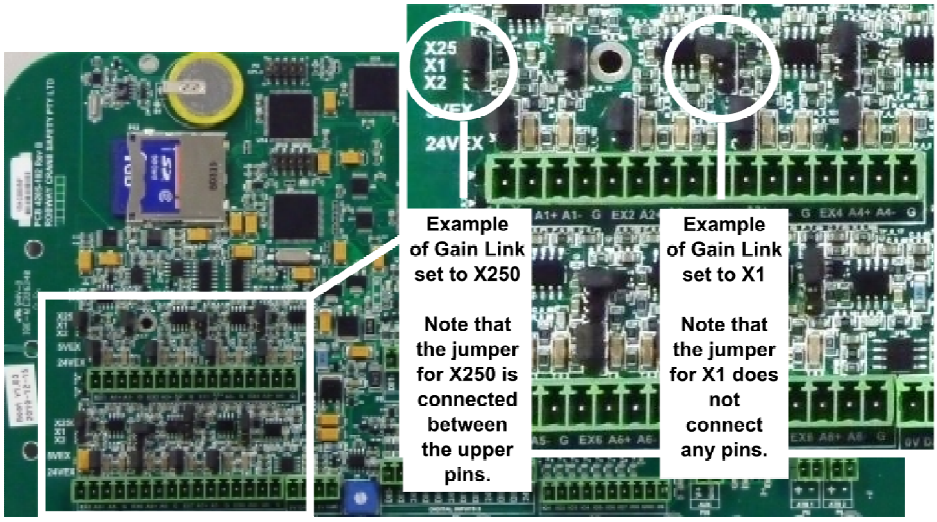


Figure 13 – RCI-4100 Controller PCB Showing Gain Link Jumpers

Software gain level is settable via function codes (as a number) from 1 (no amplification input=output) up to 1023 (maximum amplification).

LSI-Robway uses different types of load sensors and they can have different levels of output. For example a load pin has 1mV/V output and tension plate cells generally have 2mV/V output.

The maximum differential input (strain gauge type) through Intrinsically Safe Barriers used on RCI-4100IS is limited to maximum of 2.5mV/V.

Example:
A 1mV/V 5T load pin with 5V sensor excitation will have a 5mV differential output when loaded with 5T. Remember that with the in-built offset, raw counts start much higher than zero.
Using X250 hardware gain (selected with jumpers) and software gain of 790 would result in a raw count spread of about 3700 raw counts, but with a starting offset this would mean the high end would exceed 4050 raw counts (error condition). So an offset is applied so 0mV/V would result in 100 raw counts, plus 3700 raw counts for the 0-5T load resulting in a maximum of 3800 raw counts.

Gain and offset for typical sensors are listed in the following section.

6.8.1. Set Gain and Offset for Channels 1 to 8

This Gain function code refers to the gain setting of the amplifiers to match the signal output of the sensors. There are a total of 8 channels available, but only channels 1 to 3 are used for this model. Channel 1 is the main load sensor, channel 2 is the aux load sensor and channel 3 is the angle sensor. Recommended settings of the gain are as follows:

This Offset function code contains the factory default setting of the gain offset for the sensors. The factory default settings are as follows and should be checked:

Recommended Gain and Offset settings:

	Gain	**Offset**
1.5/3t Load Pin Output: 1mV/V	790	37
Compression Cell Output: 2mV/V	480	60
Angle Sensor Type: Electronic Output: 1.2 – 2.4VDC	730	255

NOTE: Correct Gain and Offset settings for the sensors on this crane can be found in the RCI Configuration Sheet and Function Code List in Attachments.

6.9. Number of Sensor Samples to Average

This function is used to stabilise the display in the event that the numbers (readouts during normal operating mode) are changing erratically. This value can be edited by using the Up/Down buttons. Default setting is “0” and the maximum selectable value is “25”. It is recommended that this value is set to “3” prior to performing calibration.

6.10. Load Chart View Mode

This function code can be used to view the load charts programmed in the software. It is not part of the calibration or set-up procedures. It is mainly used by LSI-Robway for software checking.

6.11. View Digital Inputs

This function code is used to view the state (i.e. open or closed) of the eight digital (switch) inputs. The inputs are used for wiring slew limit switches (or proximity switches), external duty selector, etc. to suit specific application. This function is also useful during troubleshooting as the input switch status can be viewed easily from the display unit in the cabin. The format is binary where input state 0 = On (low) and input state 1 = Off (high). For example, “11110101” means that switch #5 and #7 are both “on” and the rest are “off”.

6.12. Set Year

Use this function to set the current year.

6.13. Set Day and Month

Use this function to set the current day and month.

6.14. Set Time

Use this function to set the current time. The time displayed is in the format HH:MM. An invalid time will cause an error message to appear.

6.15. Download Logger Contents to PC or SD Card

Please see Section 4 “Data Logging and Data Downloading” for details and procedure. Refer also to APPENDIX F, Data Logging

6.16. Erase Logger Contents

Please see APPENDIX F, Data Logging for details and procedure.

6.17. Alter Calibration Data

This function is used for manually copying and restoring the calibration data. This should be done after completing system calibration. When sensors are calibrated, calibration values are recorded (low calibration value with corresponding sensor raw counts, and high calibration value with corresponding raw counts). These values are described as “Raw Lo”, “Cal Lo”, “Raw Hi” and “Cal Hi”. These values can be re-entered manually if calibration data is lost (for example, due to replacement of controller PCB) and can also be used for trouble-shooting (invalid calibrations can be easily identified). This data can be restored into the system simply by keying in the values without the need to luff the boom or lift test loads.

The following procedure covers instructions on how to view and copy (manually, using pen and paper), and also restore the calibration data for service records by accessing function code F-xx “Alter Calibration Data”.

If the system needs to be re-calibrated, for example, due to replacement of parts and/or sensors, these data can be restored into the system simply by keying in the values without the need to luff the boom or lift test loads.

View and Copy Calibration Data

- Access function code “Alter Calibration Data” by selecting it in calibration mode and pressing the ENTER key.
- The screen will then show “An1” (Angle channel) on the screen. This is the default sensor that comes up on the screen. Pressing the Up/Down arrow keys will scroll through the various sensors, but only the following functions need to be copied (for a tension based twin winch strut boom crane):
  - Function — Description
  - An1 — Angle
  - Ld1u — Load 1 (or Main Load) Up
  - Ld1d — Load 1 (or Main Load) Down
  - Ld2u — Load 2 (or Aux Load) Up
  - Ld2d — Load 2 (or Aux Load) Down
- Once a function is selected, press the ENTER key again to access the calibration data for the particular sensor as follows:
  - Calibration data — Description
  - Lo_r — Raw Counts (Low)
  - Lo_c — Calibrated Data (Low)
  - Hi_r — Raw Counts (High)
  - Hi_c — Calibrated Data (High)
- A table similar to the one below can be used to record the calibration data of the sensors.

	Angle Channel	**Load 1 (Main)**		**Load 2 (Aux)**	
	An1	Ld1u	Ld1d	Ld2u	Ld2d
Lo_r					
Lo_c					
Hi_r					
Hi_c					

Figure 14 – Example Table to Record Calibration Data

Restoring Calibration Data

Restoring the calibration data requires entering the calibration data copied from the procedure above using the same function code.

Similar to the above, select the “Alter Calibration Data” function, and then scroll to the required sensor and then the calibration data (Lo_r, Lo_c, Hi_r, Hi_c) for this function. But this time, press the ENTER key again to access the EDIT MODE (i.e. the screen will show “Edit”).

Once “Edit” is displayed on the screen, use the Up/Down arrow keys to change the current value of the particular calibration code with the recorded values previously copied using the procedure above. Press the ENTER key to save this new value.

Repeat this procedure for all calibration data values to be restored.
Repeat this procedure for other sensors as required.

6.18. Clear All Calibration Data – USE EXTREME CAUTION!

Activating this function will clear all the calibration data. This must only be used by LSI-Robway-trained personnel for troubleshooting purposes.

The display will prompt the operator to press ENTER if he wishes to erase the calibration data. Pressing ENTER here will clean out the memory system and default back to hard coded software. Any on-site changes made will be lost.

6.19. Main Winch Slack Rope Threshold

This function code is used to set the required load limit or threshold of the main winch for activating a digital output in the RCI Control Unit. This function may be used to control the crane’s main hoist by activating “hoist up” when the load on the block is equal to or less than the limit set in this function code. The factory default setting is normally -0.4t and can be changed to suit specific application.

Please see also Section 7.4.14. “Testing the Slack Rope Function” for details.

6.20. Aux Winch Slack Rope Threshold

This function code is used to set the required load limit or threshold of the aux winch for activating a digital output in the RCI Control Unit. This function may be used to control the crane’s main hoist by activating “hoist up” when the load on the block is equal to or less than the limit set in this function code. The factory default setting is -0.2t and can be changed to suit specific application.

Please see also Section 7.4.14. “Testing the Slack Rope Function” for details.

6.21. User Variables (SWL % Alarms, Motion Cut)

Function codes are used to set the Safe Working Load (SWL) percentages for activating Visual and Audible Alarms as well as the Motion Cut output function. The factory default values can be changed to suit specific requirements.

6.22. User Variables (Crane Geometry)

Function codes are used to set the actual physical dimensions (geometry) of the crane.

The factory default values are based on details and information received at the time of order and supply of system. Any changes to geometry will also require changing of these values on these function codes.

6.23. User Variables (Data Logging Setup Parameters)

Function codes are user variables relating to the setup parameters of the internal data logger. Please see APPENDIX F, Data Logging.

6.24. Load / Angle Correction

Load/Angle correction function is designed for use in cases where the displayed load is seen to increase by a reasonable amount as the boom is luffed down through its operating range. This phenomenon is particularly apparent when a single sheave dynamometer is used at the boom tip.

Please see Section 7.4.10. “Using Load/Angle Correction Function” for details and procedure.

6.25. Main Winch Rigging SWL

This function is used to set a rigging SWL value for the crane and the boom to get past the maximum radius without activating the alarms. The value set must not exceed the weight of the Main hook block. When this function is used, the crane will assume a SWL equal to the weight of the hook block; thus, allowing the boom to go further down to the ground for rigging purposes without alarms as long as no load is lifted on the Main block.

The factory default setting is 0.0t (or no rigging SWL allowance) and can be changed using this function code to suit specific application.

6.26. Auxiliary Winch Rigging SWL

This function is the same as the Main Winch Rigging SWL but for the Aux Winch.

The factory default setting is 0.0t (or no rigging SWL allowance) and can be changed using this function code to suit specific application.

6.27. Boom Height Offset

Use this function to set the “Boom Height Offset” which is the vertical distance from the BOOM FOOT pin to the platform (required reference point). Ensure that this is measured accurately and set for accurate indication of boom tip HEIGHT.

6.28. Metric/Imperial Units Switching

Use this function to select the required unit of measure (Metric or Imperial). Factory default setting is “Metric” (displayed in function codes as “SI”).

6.29. Time Delay for Motion Cut Return

This function code sets the motion cut return time to avoid the motion cut output changing state rapidly under some conditions. Default setting is 5.0 seconds.

6.30. Slew Encoder (if applicable)

The following variables are provided to ensure accurate counting of the slew encoder to provide correct slew angle. A proximity switch is normally used provide a reset position in the event that the crane is slewed when the RCI-4100 is switched off.

6.30.1. View Slew Encoder Raw Counts

Use this function to view the raw counts (or raw data) of the slew encoder. Please refer to Section 7.4.3. “Verifying Operation of Sensors” for details.

6.30.2. Counts per 360deg slewing of crane

Use this function to verify the number of raw counts generated for one complete revolution of the crane. If the encoder is not counting accurately, this value can be changed.

6.30.3. Slew Encoder direction

Use this function to set slew encoder direction. This value can be changed if slew direction is incorrect (possible values are 1.0 or -1.0)

6.31. Hoist Rope Friction Compensation

Compensating for hoist rope friction
On some cranes head sheave friction, hook block friction and/or rope friction can be enough to cause a significant difference to the displayed load between winching up and winching down. This normally affects hooks with multiple falls and often there is no difference on the auxiliary as it may only have one fall.

To overcome this, a hoist direction signal can be input to the system and two separate calibrations can be done.
Hoist direction is a digital signal fed into a digital input, separate inputs are required for main and auxiliary.
Default is normally down (no input used). When this feature is used load calibrations are stored in two locations: LD1D (Load One Down) and LD1U (Load One Up). Auxiliary load is stored in LD2D and LD2U.
Two calibrations are required for each winch – light load is calibrated as the load is being winched up, then repeated (using the same function code and weight) as the load is being winched down.
This procedure is repeated with a heavy load.
These procedures are repeated for the auxiliary if required.
Note that all tension based systems have this feature.

Two calibration procedures, one without friction compensation, and one using friction compensation (for both Main and Aux) are detailed in Section 7 Calibration. Refer Sections 7.4.6 to 7.4.9.

7. Calibration

CAUTION:	BEFORE ANY CALIBRATION FUNCTIONS CAN BE ACTIVATED, YOU MUST ENTER CALIBRATION MODE. CALIBRATION SHOULD ONLY BE CONDUCTED BY AUTHORISED PERSONNEL. RE-CALIBRATION NEED ONLY BE DONE AS A LAST RESORT AFTER PERFORMING ALL OTHER SYSTEM TESTS.

7.1. Calibration Mode

The RCI-4100 sensors (load cells/pins, angle sensor etc.) require calibration (scaling) on the crane so that their outputs accurately reflect crane parameters. All calibrations, as well as changes to any settings (geometry, alarm thresholds etc.) are done using function codes when the display is in calibration mode. Function codes can only be accessed when in calibration mode and are a structured way of entering data into the processor for both LSI-Robway personnel and personnel in the field. They are also used when data or settings need to viewed.

7.1.1. Entering Calibration Mode

- Ensure that the software number is correct for the crane and that the correct corresponding software documents and GA (general arrangement - refer RCI System Configuration Documents in Attachments) drawing is being used.
- Ensure all duties (refer RCI System Configuration Documents in Attachments) match crane load charts.
- Make sure that the correct duty number (crane configuration, sea state) and falls (parts of line) are selected,
- Insert the over-ride key into the RCI-4100 Display and turn it on, make sure that the over-ride indicator (O/R) is shown on the display,
- Press and hold the SETUP button for about 2 seconds,
- F-xx will be shown on the alphanumeric display, where xx is the last calibration function performed or F-00 if this is the first time you entered calibration mode since last powering the system,

7.1.2. Using Calibration Functions

- Once calibration mode is entered use the UP/DOWN keys to ramp through the calibration functions.
- When the correct function code is shown on the screen press the ENTER button to select that function.
- If the value is just being viewed and does not need to be changed, press CANCEL to return to the function code number. Values will not be changed unless the ENTER key is pressed.
- If the value is to be changed, use the UP/DOWN keys to change the value and when the value is correct press the ENTER button, note that the new value will be memorised at the time that the ENTER button is pressed.

- To exit calibration mode either select F-00 or press the CANCEL key until the F-xx code is cleared from the screen.

Note: This procedure is used to change any settings in the function code menu including user variables such as geometry and alarm settings.

7.2. Tools/Items Required for Calibration:

- An accurate angle finder for calibrating boom angle sensor,
- An accurate tape meter (at least 100 ft. long) for verifying radius,
- Known test weights for calibrating loads,

Software configuration sheets and function codes list can be found in the Attachments.

7.3. Map of Calibration (Suggested Order):

Suggested Order of Calibration

NOTE: Ensure that the function code numbers are checked against the RCI System Configuration Documents in Attachments

- Set year, day/month and time.
- Check / Set the following functions:
  - Amplifier gains and offsets for all sensors.
  - Number of sensor samples to average
  - Metric/Imperial units switching
- Verify that raw counts stay stable and responding, and remain within 50-4050 for full working range of all sensors.
- If Restricted Slew Zone encoder is installed, verify that its raw counts are incrementing/decrementing when the boom slews right/left.
- If a wind speed sensor is installed ensure that the anemometer is free to rotate and that a measurement is present in the display.
- Review all crane geometry against the supplied Crane Configuration settings for accuracy; refer to APPENDIX O, for factory default settings. Check each setting and change if required.
- Review all SWL % parameters against actual requirements and change if required – refer to APPENDIX O, for factory default settings.
- Review the data logger recording points against actual requirements and change if required – refer to APPENDIX O, for factory default settings. Check each setting and change if required.
- Calibrate low and high boom angle.
- Calibrate light and heavy main winch load.
- Calibrate light and heavy aux. winch load.
- Perform functional and operational checks and load tests to ensure accuracy of system.
- If the load readout decreases as the boom is luffed up, apply load/angle correction factor.
- If required by specific requirement, apply a “winch rigging safe working load” for the main hook and aux hook.
- Set the slack rope limits and test the slack rope function.
- **Verify calibration results.**
- Once satisfied with the calibration results, manually record (pen and paper) the calibration data and all the settings mentioned above.

7.4. Calibration Procedure

Note: that while in view mode, that is using either "VIEW UNCALIBRATED ..." or "VIEW CALIBRATED ..." functions, the ENTER key works as a toggle switch to turn that channel ON or OFF. This function allows the user to temporarily turn a sensor off if it is not needed, e.g. if you want to use the main winch only on a twin winch system; normally, if you have not connected the auxiliary sensor up, the RCI-4100 will report an error and activate motion cut. To prevent this you can press the ENTER key, while in "VIEW UNCALIBRATED TRANSDUCER 2 function", to turn the auxiliary channel off.
To turn a channel back on, you have to re-enter the same VIEW UNCALIBRATED... function and press the ENTER key again.

Remember that the "CANCEL" button must always be used to leave a view function.

7.4.1. Check/set year, day/month and time.

- Check/set year
- Check/set day/month
- Check/set time

7.4.2. Check / Set the following:

- Amplifier gains and offsets for load and angle sensors.
- Number of sensor samples to average – set to "3.
- Metric/Imperial units switching – set to required unit.

7.4.3. Configuring User Variables

LSI-Robway stores the load-charts, crane geometry, default alarm and motion control settings, default data logging parameters, fine-tuning settings, and other useful user variables in the memory of the RCI-4100 at the time of manufacture. As this information may vary from crane to crane, even if they are of the same model, the RCI-4100 allows the installer to change these variables on site. These user variables include dimensions such as slew-offset, maximum falls for main/aux winches, maximum line-pulls, sheave diameters, etc.
The actual values of these variables are listed in the RCI System Configuration Documents in Attachments . To verify or change the current value of any of these user variables follow the procedure at Section 7.1.2 Using Calibration Functions.

CAUTION:	THE VALUE OF THESE VARIABLES IS VERY IMPORTANT AS THEY AFFECT THE SAFE OPERATION OF THE RCI-4100 INDICATOR. THEREFORE THE VALUES OF THE USER VARIABLES MUST BE CHECKED AND CORRECTED IF NECESSARY BEFORE PROCEEDING WITH FURTHER CALIBRATION OR OPERATION.

7.4.4. Verifying Operation of Sensors

NOTE: Before you start calibrating the RCI-4100, you must make sure that the sensors are working correctly and their signals are reaching the RCI-4100.

The RCI-4100 'sees' the crane and its surroundings through sensors. The signals from these sensors are represented as numbers inside the RCI-4100. The range of possible numbers is 0 to 4095 for each sensor.

The RCI-4100 allows the user to view either the UNCALIBRATED or the CALIBRATED signal from a given sensor(refer RCI System Configuration Documents in Attachments).

When viewing the UNCALIBRATED signal from a sensor, make sure the number displayed is less than 4050 and is more than 50 as you work the sensor through its working range. This is the correct operating range. Also make sure that the numbers displayed in the window are changing in a nice, smooth manner. If you find that the number is too unstable (i.e. changes by more than 10), then you should check the connections to the RCI-4100 (refer to Section 8. "Troubleshooting").

If the signal is less than 50, suspect a short circuit somewhere on that input channel, e.g. the cable to the RCI-4100 has been crushed and has an internal short circuit in it. Moisture inside the plugs can look like short circuit too.

If the count displayed in the window is 4095, look for an open circuit on that input channel. e.g. disconnected lead. This is especially important for the angle sensor.

Check the angle sensor as follows:

- Enter calibration mode, if not already activated, and select “View Uncalibrated Angle” function code.
- Safely luff the boom down to its lowest operating angle.
- Ensure the reading is between 50 and 4050. If the reading is outside these values adjust the inclinometer inside the angle senor as follows (refer to Figure 15);

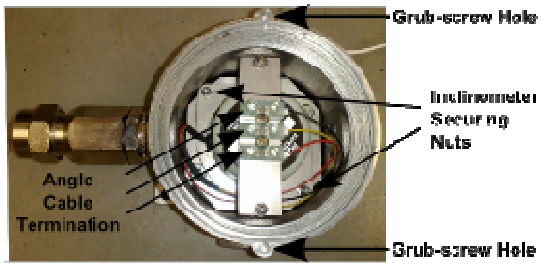


Figure 15 - Angle Sensor Internal View

- Remove the grub screw on the top cover of the angle sensor. Remove the top cover by twisting top cover of the angle sensor counter-clockwise. Loosen the inclinometer securing nuts and rotate the inclinometer until “View Uncalibrated Angle” function code reading is between 50 and 4050.
- When the low angle raw counts are within the operating range safely luff the boom up to the highest operating angle. Ensure the reading is between 50 and 4050. If the reading is outside these values adjust the inclinometer inside the angle sensor as above.
- Tighten the inclinometer securing nuts. Refit the top cover by rotating clockwise by hand. Do not overtighten the cover and align the grub-screw hole. Insert the grub-screw into the hole and tighten.
- **Tip**: raw counts should be approximately 2000 when boom is at 45 deg.

If the sensors check out then you can continue with the calibration procedure. If any problems are found refer to Section 8. “Troubleshooting or seek help from your nearest LSI-Robway representative.

7.4.5. Calibrating Boom Angle

Step 1) Calibrating Low Boom Angle

a) Safely luff the boom down to a low angle, e.g. 30°.
b) Enter calibration mode, if not already activated, and select “Calibrate Low Angle” function code.
c) Accurately measure the actual boom angle using an angle finder.
d) Use the UP/DOWN keys to ramp the display to the required value then press ENTER to accept this value. Proceed to next Section “Calibrating High Boom Angle”.

Step 2) Calibrating High Boom Angle

a) Safely luff the boom up to a high angle, e.g. 65°.
b) Enter calibration mode, if not already activated, and select “Calibrate High Angle” function code.
c) Accurately measure the actual boom angle using an angle finder.
d) Use the UP/DOWN keys to ramp the display to the required value then press ENTER to accept this value.

Step 3) Verify that the boom angle Calibration

a) Use the “View Boom Angle” function code.
b) Luff the boom and stop on different boom angle points.
c) Check boom angle with the angle finder and verify accuracy against the displayed angle.
d) Re-calibrate if necessary.

7.4.6. Calibrating Load on the MAIN Winch (without Friction Compensation)

Step 1) Calibrating Light Main Load

a) Safely lift a light, known test load. The load should be heavy enough to produce approximately 10% of the maximum main winch line-pull.
b) The total weight of any lifting gear or tackle under the hook block (such as slings, lifting frames, etc.) must be added to the weight of the light test load.
c) If a light test load is not available, raise the empty hook block off the ground/platform and use the weight of the block as light load.
d) For some cranes where the hook block is considered part of the crane, raise the empty hook block off the ground/platform and use the value “0.0t” as light load.
e) Enter calibration mode, if not already activated, and select the “Calibrate Light Main Load” function code.
f) Use the UP/DOWN keys to ramp the display to the required value (calculated light load).
g) Press ENTER to accept value. Proceed to next Section “Calibrating Heavy Main Load”.

Step 2) Calibrating Heavy Main Load

a) Safely lift a heavy, known test load. The load should be heavy enough to produce at least 70% of the maximum main winch line-pull whilst staying within current SWL.
b) The total weight of any lifting gear or tackle under the hook block (such as slings, lifting frames, etc.) must be added to the weight of the heavy test load.
c) For some cranes where the hook block is considered part of the crane, do not include the weight of the hook block to the total heavy load.
d) Enter calibration mode, if not already activated, and select the “Calibrate Heavy Main Load” function code.
e) Use the UP/DOWN keys to ramp the display to the required value (i.e., calculated heavy load above).
f) Press ENTER to accept value.

Step 3) Verify that the Main Load Calibration

a) Use the “VIEW CALIBRATED MAIN LOAD” function code.

7.4.7. Calibrating Load on the AUX Winch (without Friction Compensation)

Step 1) Calibrating Light Aux Load

a) Safely lift a light, known test load. The load should be heavy enough to produce approximately 10% of the maximum aux winch line-pull,
b) The total weight of any lifting gear or tackle under the hook block (such as slings, lifting frames, etc.) must be added to the weight of the light test load.
c) If a light test load is not available, raise the empty hook block off the ground/platform and use the weight of the block as light load.
d) For some cranes where the hook block is considered part of the crane, raise the empty hook block off the ground/platform and use the value “0.0t” as light load.
e) Enter calibration mode, if not already activated, and select “Calibrate Light Aux Load”.
f) Use the UP/DOWN keys to ramp the display to the required value (i.e., calculated light load above).
g) Press ENTER to accept value. Proceed to next section “Calibrating Heavy Aux Load”.

Step 2) Calibrating Heavy Aux Load

a) Safely lift a heavy, known test load. The load should be heavy enough to produce at least 70% of the maximum aux winch line-pull whilst staying within current SWL.
b) The total weight of any lifting gear or tackle under the hook block (such as slings, lifting frames, etc.) must be added to the weight of the heavy test load.
c) For some cranes where the hook block is considered part of the crane, do not include the weight of the hook block to the total heavy load.
d) Enter calibration mode, if not already activated, and select the “Calibrate Heavy Aux Load” function code.
e) Use the UP/DOWN keys to ramp the display to the required value (calculated heavy load).
f) Press ENTER to accept value.

Step 3) Verify that the AUX Load Calibration

a) Use the “VIEW CALIBRATED AUX LOAD” function code.

7.4.8. Calibrating Load on the MAIN Winch (with Friction Compensation)

Note: Ensure that Hoist Up and Hoist Down switches have been fitted. Check for correct operation of digital inputs (refer RCI System Configuration Documents in Attachments and 6.11 View Digital Inputs.

Step 1) Calibrating Light Main Load

a) The load used should be heavy enough to produce approximately 10% of the maximum main winch line-pull,
b) The total weight of any lifting gear or tackle under the hook block (such as slings, lifting frames, etc.) must be added to the weight of the light test load.
c) If a light test load is not available, the weight of the empty hook block may be used as light load.
d) For some cranes where the hook block is considered part of the crane, use the empty hook block as a light load use the value “0.0t” as light load.
e) Enter calibration mode, if not already activated, and select “Calibrate Light Main Load”.
f) Use the UP/DOWN keys to ramp the display to the required value (i.e., calculated light load above).
g) Start hoisting up slowly.
h) Press ENTER to accept value. Stop hoisting.
i) Select “Calibrate Light Main Load”.
j) Use the UP/DOWN keys to ramp the display to the required value (i.e., calculated light load above).
k) Start hoisting down slowly.
l) Press ENTER to accept value. Stop hoisting.
m) Proceed to next section “Calibrating Heavy Main Load”.

Step 2) Calibrating Heavy Main Load

a) The load used should be heavy enough to produce approximately 70% of the maximum main winch line-pull, whilst staying within current SWL.
b) The total weight of any lifting gear or tackle under the hook block (such as slings, lifting frames, etc.) must be added to the weight of the heavy test load.
c) Enter calibration mode, if not already activated, and select “Calibrate Heavy Main Load”.
d) Use the UP/DOWN keys to ramp the display to the required value (i.e., calculated heavy load above).
e) Start hoisting up slowly.
f) Press ENTER to accept value. Stop hoisting.
g) Select “Calibrate Heavy Main Load”.
h) Use the UP/DOWN keys to ramp the display to the required value (i.e., calculated heavy load above).
i) Start hoisting down slowly.
j) Press ENTER to accept value. Stop hoisting.

Step 3) Verify that the Main Load Calibration

a) Use the “VIEW CALIBRATED MAIN LOAD” function code.

7.4.9. Calibrating Load on the AUX Winch (with Friction Compensation)

Step 1) Calibrating Light Aux Load

a) The load used should be heavy enough to produce approximately 10% of the maximum aux winch line-pull,
b) The total weight of any lifting gear or tackle under the hook block (such as slings, lifting frames, etc.) must be added to the weight of the light test load.
c) If a light test load is not available, the weight of the empty hook block may be used as light load.
d) For some cranes where the hook block is considered part of the crane, use the empty hook block as a light load use the value “0.0t” as light load.
e) Enter calibration mode, if not already activated, and select “Calibrate Light Aux Load”.
f) Use the UP/DOWN keys to ramp the display to the required value (i.e., calculated light load above).
g) Start hoisting the load up slowly.
h) Press ENTER to accept value. Stop hoisting.
i) Select “Calibrate Light Aux Load”.

j) Use the UP/DOWN keys to ramp the display to the required value (i.e., calculated light load above).
k) Start hoisting down slowly.
l) Press ENTER to accept value. Stop hoisting.
m) Proceed to next section "Calibrating Heavy Aux Load".

Step 2) Calibrating Heavy Aux Load

a) The load used should be heavy enough to produce approximately 70% of the maximum main winch line-pull, whilst staying within current SWL.
b) The total weight of any lifting gear or tackle under the hook block (such as slings, lifting frames, etc.) must be added to the weight of the heavy test load.
c) Enter calibration mode, if not already activated, and select the "Calibrate Heavy Aux Load" function code.
d) Use the UP/DOWN keys to ramp the display to the required value (i.e., calculated heavy load above).
e) Start hoisting the load up slowly.
f) Press ENTER to accept value. Stop hoisting.
g) Select "Calibrate Heavy Aux Load".
h) Use the UP/DOWN keys to ramp the display to the required value (i.e., calculated heavy load above).
i) Start hoisting down slowly.
j) Press ENTER to accept value. Stop hoisting.

Step 3) Verify that the Aux Load Calibration

a) Use the "VIEW CALIBRATED AUX LOAD" function code.

7.4.10. Using Load/Angle Correction Function

On cranes using single sheave load-line sensors, the rope dead-weight is greatest at low boom angle but disappears at higher angles. This changing dead-weight influence can be compensated for as it will cause the displayed load to increase marginally as the boom is luffed down.

Load/Angle correction is accessible when calibrating through use of four calibration function codes as follows (refer RCI System Configuration Documents in Attachments):

- Low Angle for Load Correction - Applies to both Main and Aux winch
- High Angle for Load correction - Applies to both Main and Aux winch
- Load / Angle Correction Factor for Main Winch
- Load / Angle Correction Factor for Aux Winch

These function codes allow the operator to enter the luffing range of the crane and the change in the displayed load that is observed over this range.

The *Low Angle* you enter should be the lowest angle the crane can actually luff to in operation. Similarly the *High Angle* should be set to the highest angle the crane can be luffed to during normal operation.

How to Calculate the Load / Angle Correction Factor

The number entered here is a correction value, when this number is 0.0 no correction is being applied (i.e. Load / Angle correction is disabled). It expresses the *load error (in tonnes)* seen when the crane is luffed from the highest angle in the luff range to the lowest angle. This correction is applied progressively from the highest boom angle through to the lowest boom angle.

To determine the error value simply position the boom at the highest boom angle and take note of the load reading. Luff the boom through the entire operating range (taking notice the load value is increasing when luffing lower) and once at the lowest possible boom angle record the load value again. The correction factor is simply the difference between the two load values you have recorded.

Enter the correction value against the appropriate Function Code and luff the crane through its operating range once again to ensure the correction was successful.

Example:

- A test weight of 20 t is lifted on the Main winch at the highest possible boom angle, eg 80º (NOTE: It is not necessary to use a test weight, the hook block alone will suffice for the test).
- The 20 t load is luffed through the entire angle range and the displayed load is seen to rise to 25.3 t at the lowest possible boom angle eg 30º.
- The error in this reading is the highest displayed load minus the known test weight i.e. 25.3 t - 20.0 t = 5.3 t error.
- Hence, in this example:
  - The “Load / Angle Correction Factor “would be entered as 5.3 t.
  - The “Low Angle for Load Correction” would be entered as 30º
  - The “High Angle for Load Correction” would be entered as 80º.
- Repeat the same procedure on the Aux winch.

7.4.11. Set Main Winch Rigging SWL

To set the main winch rigging SWL:

- Enter calibration mode and select Main Winch Rigging SWL function code.
- If the main hook block is part of the load chart, enter a value of 0.2.
- If the main hook block is not part of the load chart, enter a value slightly above the actual main hook block weight.

7.4.12. Set Aux Winch Rigging SWL

To set the aux winch rigging SWL:

- Enter calibration mode and select Aux Winch Rigging SWL function code.
- If the aux hook block is part of the load chart, enter a value of 0.1.
- If the aux hook block is not part of the load chart, enter a value slightly above the actual main hook block weight.

7.4.13. Slew Encoder Operation (If Installed)

Check correct slew encoder operation.

- If the direction is incorrect, access function code F-xx and change the value (1.0 or -1.0).
- Slew the crane, as the slew proximity switch target passes the target, slew position should reset to the 0.0. If this is not the case, the proximity switch or the proximity switch target should be re-aligned (see Section 2.6.2).
- Check that displayed slew position is accurate. If the position is not correct access function code F-xx and change this value using the following formula: -

- F-xx Value = $\frac{\text{No of teeth on Slew Ring Gear}}{\text{No of teeth on the Encoder}}$ X 120(No pulses/rev encoder)

- This will give the theoretical value. Further slight adjustment of the F-xx value will be required until the correct slew position is achieved.

7.4.14. Testing the Slack Rope Function

This function may be used to automatically activate “hoist up” on the selected winch (Main or Aux) to maintain tension on the winch rope when it gets slack, e.g. when lowering the hook block on the deck of a boat/vessel or platform, etc.

Function codes are used to set the load activation threshold for each winch. When the load sensed by the selected winch is equal to or less than the value set, the function is activated.

This function controls a digital output (refer RCI System Configuration Documents in Attachments) of the RCI Control Unit which de-energises when the load value is at or below the set limit.

The factory default setting for main winch is typically -0.4t and -0.2t for the auxiliary winch. Enter the appropriate function code and enter the “weight” of the empty Main hook block. Repeat the same for the Aux block using the appropriate function code. This setting will enable the function to operate when the load on either block gets lower than its weight (i.e., slack condition).

To test the function, lower either one of the hook blocks on the deck or platform until the rope gets slack and the rope is hoisting up. When the load equals or is less than the appropriate value, the word “SLACK” appears in the “LOAD” window and the appropriate digital output changes state.

Reference the applicable drawing(s) in the RCI System Configuration Documents in Attachments.

CAUTION:	PLEASE NOTE THAT ALL INDUCTIVE LOADS SUCH AS RELAYS AND SOLENOIDS REQUIRE SNUBBER DIODES FOR TRANSIENT SUPPRESSION.

7.5. Post Calibration Checks

After completing the calibration check all functions of the RCI-4100 including:

- Displayed radius for accuracy.
- Lift some test weights on main and aux winches to ensure accuracy.
- Test all digital inputs.
- Test all digital outputs before connection to crane
- Test all relay outputs before connection to crane.
- Check slew position and that the slew reset is working (if applicable).
- Set restricted slew zones (if applicable).
- Check wind speed sensor operation (if applicable).
- Check any other sensors used by the RCI-4100 system.
- Record Calibration Data:
    - After calibrating the sensors the calibration data should be recorded (manually, using pen and paper) for service records by accessing function code F-xx “Alter Calibration Data”.
    - Refer to Section 6.17 Copying and Restoring Calibration Data for details and procedure.

8. Troubleshooting

A trouble-shooting or fault-finding section is always a difficult document to write because things that are obvious to one person can be anything but obvious to another. On the other hand, most times when you read such a guide the fault you are trying to solve happens to be the very fault that has been left out! The main purpose of this section is to help both us at LSI-Robway and you the reader to find the problem and solve it quickly. Sometimes this takes patience, which isn't always easy when you are on the site, your customer is angry because you haven't fixed it yet, and the LSI-Robway guy at the other end of the phone wants you to tell him all over again what you just did!! We frequently find that when a situation is described by the service person a couple of times new details come out in the conversation that are vital to solving the problem. It seems that the more trouble we have finding the faults, the more simple the cause was!

The RCI-4100 IS system incorporates a number of software features that are designed to help the service person quickly identify a fault; however it must be stressed that these features cannot identify everything. They can only be used as a guide to identify additional checks that can be made. Some notes are provided below, followed by some example faults and possible causes.

Identify the symptoms
Take time to find out exactly what is happening to indicate a problem. If possible have the problem demonstrated so you can "describe it in your own words". Sometimes what someone else has told you is only part of the story.

Leave the calibration alone!
Too many times a re-calibration has been attempted in order to rectify a problem before the real cause of the problem has been correctly identified. This leads to added confusion as the perspective is generally moved from the real fault to "calibration problems". We have often received a message indicating that our display has "not accepted the calibration data". Most times this is due to a fault in a cable or sensor which was not identified prior to re-calibration. Re-calibration must only be performed when all sensor inputs have been verified for correct operation. In actual fact re-calibration is rarely necessary.

Do you have your simulator with you?
A simulator is a very quick way to verify if the fault is external to the display and will save you a lot of heartache. A simulator is purely resistive and hence considered simple apparatus and can be used freely in a hazardous area. Simulators can be purchased from LSI-Robway at very reasonable prices.

Have you read the manual?
When all else fails, read the manual! Your answer may actually be in there.

Know what information you need to gather
If you collect the correct information from the display the job is half done. Before you begin to suspect faults with the system, you must satisfy yourself that the display is correctly configured for the crane environment. In other words, check that the correct duty, falls, slew zones etc. have been selected. Are all of the sensors connected? In general if sensors have been supplied with the system, they must always be connected. The display will check them continuously and issue an error if that sensor cannot be detected. Check crane duty/configuration, length, angle and radius against the load chart to verify that the equipment is permitted to be in that situation. If there is still a problem once these have been checked, then you will need to check the hardware.

The main pieces of useful information
Obtainable from the displays are the **error codes** and **raw counts**. Error codes are discussed in Section 8.1.1 “Problems That Produce Error Codes”. The raw count shows what the actual inputs are doing (i.e. like a signal strength indication). These raw counts are manipulated in software according to the calibration data stored in the controller to produce the readouts on the Display Unit. If the calibration has been done incorrectly, or the configuration is incorrect, or something else is wrong, then the Display Unit readouts (e.g. the LOAD or ANGLE values) may provide you with misleading information. **YOU MUST USE THE "VIEW UNCALIBRATED...." FUNCTION CODES TO DETERMINE THE CORRECT OPERATION OF THE EXTERNAL SENSORS, NOT THE "CALIBRATED" VALUES**. It should be noted here that for load related problems, the **"VIEW UNCALIBRATED TRANSDUCER"** function code must be used, and not **"VIEW CALIBRATED LOAD"**. For correct operation these values must be in the range 50 to 4045. Anything outside of this range will produce an error. Refer to Section 6, “Function Code Descriptions” on how to access these raw counts.

Check the obvious
Once you have found a problem with a sensor for example, check all of the obvious things to do with that sensor such as making sure all of the connectors are tight. Be systematic - make notes about what you have done and what you found. You will find that under pressure you can easily forget what you have checked and it becomes very easy to miss things.

8.1. Example Problems and Possible Causes

8.1.1. Problems That Produce Error Codes

Error code 101:
This indicates that the signal from the angle sensor is too low or too high. This should be confirmed by viewing the UNCALIBRATED ANGLE INPUT and noting that the value shown in the LOAD display is less than 50, or higher than 4050.

Possible causes:

- Angle sensor incorrectly mounted. This is especially critical for the Electronic Angle Sensor. Refer to Section 7.4.4 “Verifying Operation of Sensors” of the manual for calibration of the angle sensor.
- The angle sensor signal wire is short circuited to the shield or to the angle 0V.
- The angle sensor signal wire is shorted to the excitation positive wire.
- The angle sensor is not connected or there is an open circuit in either the angle sensor signal wire or the angle excitation positive wire.
- The angle sensor excitation voltage is shorted. If this is the case it will also affect the length and load channels.
- The angle sensor 0V wire is open circuit.

Error code 201:
This indicates that the signal from the main load sensor is too low or too high. This should be confirmed by viewing the UNCALIBRATED TRANSDUCER 1 INPUT and noting that the value shown in the LOAD display is lower than 50, or higher than 4050.

Possible causes:

- Load cell signal wires shorted together.
- The signal + is shorted to the shield.
- The excitation - is shorted to the shield.
- The excitation supply is shorted together. This will obviously affect all of the external sensors. Measure the excitation voltage and compare it with the expected value. If this is the cause, the UNCALIBRATED value will generally be non-zero, but below 50.
- The load cell is disconnected or there is an open circuit in one of the signal wires.
- The signal - is connected to the shield.
- The signal + and the excitation + are swapped.
- The signal - and the excitation - are swapped.

Error code 202:
This indicates that the signal from the auxiliary load sensor is too low or too high. This should be confirmed by viewing the UNCALIBRATED TRANSDUCER 2 INPUT and noting that the value shown in the LOAD display is lower than 50, or higher than 4050.

Possible causes:

- Load cell signal wires shorted together.
- The signal + is shorted to the shield.
- The excitation - is shorted to the shield.
- The excitation supply is shorted together. This will obviously affect all of the external sensors. Measure the excitation voltage and compare it with the expected value. If this is the cause, the UNCALIBRATED value will generally be non-zero, but below 50.
- The load cell is disconnected or there is an open circuit in one of the signal wires.
- The signal - is connected to the shield.
- The signal + and the excitation + are swapped.
- The signal - and the excitation - are swapped.

Error code 240:
This indicates that an overload has been detected. This error generally accompanies most other errors simply because most other errors will place the display into an overload condition. This being the case, you need to check what other errors are present and correct them first. Once these have been addressed the E240 error generally takes care of itself. The exception is of course, when the equipment has been put into a genuine overload situation which has not been caused by any external faults.

Possible causes:

- A genuine overload condition exists.
- It has been caused by another error code condition.

Error code 280:
This indicates that the rated line-pull has been exceeded.

Possible causes:

- A genuine line-pull error exists.

Error code 301:
This indicates that the angle being measured is outside of its allowed range.

Possible causes:

- A genuine violation of the angle limits has occurred.
- The angle sensor mounting may have loosened allowing the sensor to move.
- Check the angle displayed against the actual angle of the boom.

Error code 304:
This indicates that the radius being measured is outside of its allowed range.

Possible causes:

- A genuine violation of the radius limits has occurred.
- Check as per Error code 301.

Error Code -999
This indicates an invalid calibration

Possible causes:

- Low and high end of sensor calibrated to same raw counts.

Sensor needs to be re-calibrated to clear this error

8.1.2. Error Codes Summary

Code	Meaning	Datalog Error Code				
101	Angle sensor 1 is open or short circuit	01	00	00	00	00
102	Angle sensor 2 is open or short circuit	02	00	00	00	00
104	Angle sensor 3 is open or short circuit	04	00	00	00	00
108	Angle sensor 4 is open or short circuit	08	00	00	00	00
110	Length sensor 1 is open or short circuit	10	00	00	00	00
120	Length sensor 2 is open or short circuit	20	00	00	00	00
140	Length sensor 3 is open or short circuit	40	00	00	00	00
180	Length sensor 4 is open or short circuit	80	00	00	00	00
201	Load sensor 1 is open or short circuit	00	01	00	00	00
202	Load sensor 2 is open or short circuit	00	02	00	00	00
204	Load sensor 3 is open or short circuit	00	04	00	00	00
208	Load sensor 4 is open or short circuit	00	08	00	00	00
210	Digital input error detected	00	10	00	00	00
220	Crane is two-blocking (RCI-1550/3100 only)	00	20	00	00	00
240	Current load exceeds safe working load	00	40	00	00	00
280	Current load exceeds line-pull	00	80	00	00	00
301	Angle is off load the chart or limit is exceeded	00	00	01	00	00
302	Length is off load the chart or limit is exceeded	00	00	02	00	00
304	Radius is off load the chart or limit is exceeded	00	00	04	00	00
308	Height is off load the chart or limit is exceeded	00	00	08	00	00
310	Crane has been positioned in a non-lifting area	00	00	10	00	00
320	Duty/Winch has not been calibrated	00	00	20	00	00
340	Reserved	00	00	40	00	00
380	Reserved	00	00	80	00	00
401	Problem reading flash image	00	00	00	01	00
402	Tower out of valid angles	00	00	00	02	00
404	No chart for active slew/tower zone	00	00	00	04	00
408	Chart Type not supported in code (null f-ptr for type)	00	00	00	08	00
410	Loads on > 1 winch	00	00	00	10	00
420	Combined loads exceed active winch SWL	00	00	00	20	00
440	Relative angle too small	00	00	00	40	00
480	Relative angle too big	00	00	00	80	00
501	Radio Receiver not responding	00	00	00	00	01
502	Radio Transmitter not responding	00	00	00	00	02
504	Radio Transmitter battery failure	00	00	00	00	04
508	Radio Transmitter short-circuit	00	00	00	00	08
510	IIC device error	00	00	00	00	10
520	Faulty data logger memory, the system could not store log data, the system needs to be restarted so it can execute recovery sequence	00	00	00	00	20

Datalogger error code notes: - Multiple errors may be shown in one error code. For example,:

0140000000 would be a 101 and 240 at the same time and 0300000000 would be a 101 and a 102 at the same time

As hex code is used, when errors in a particular column exceed 9, hex codes are used: A=10, B=11, C=12, D=13, E=14, F=15 etc. For example,: - 00C0000000 would be a 240 and a 280 at the same time

00C0000000 would be a 240 and a 280 at the same time

00000F0000 would be a 301, 302, 304 and 308 at the same time.

8.1.3. Problems That Do Not Produce Error Codes

The load does not vary when I lift a weight.

The load cable or the load sensor is faulty (or both are faulty). Check the load cable for faults. If cable is good, check the resistance values of the load cell. This, however, does not give the complete story. Even if the resistances are correct, there is still a chance that the sensor is faulty. Check the view UNCALIBRATED TRANSDUCER INPUT for that sensor, ensure that the value changes when a load is lifted. If the value doesn't change as the load changes then it may be a fault with the sensor or sensor mounting hardware - ensure that the load is being applied to the load cell correctly (eg sister plates binding a tension cell, or dynamometer centre sheave damaged/stuck). If the value changes as a load is lifted then calibration needs to be checked or re-calibrated. If no problem found then replace the load cell.

The load display is very erratic and displays massive changes in value.

Check the view UNCALIBRATED TRANSDUCER INPUT for that sensor. If the values are flickering by 2-3 counts while the display is changing by say a number of tonnes, then the cause is most probably calibration. One common cause of this is if different load values were entered for the high and low calibration without the actual load being altered (or of course there was an error in a load channel while you were calibrating). In other words you forgot to lift the heavy load! (It happens often). In this situation the display is confused because the calibration data is telling it that the signal it is seeing represents both the low load value and the high load value simultaneously. Correct the calibration.

This can also occur if only part of the calibration procedure has been completed. You should expect strange results if you have not completed the calibration of that sensor.

When the system starts in the morning the displays are erratic, but settle during the day.

This is a common sign of moisture ingress into the display, the connectors, the sensors or the cable. These should be checked, dried and sealed.

The display does not start.

Check the power supply. Refer to Section 11. "General Specification" for the required voltage range. If the supply is within range, open the RCI Control Unit and check the fuses.

On start-up the display shows "LCtrl" on top screen and then hangs (boot up not completed).

This is a data logger control error. It happens when the internal data logger has been corrupted or when an upgraded or new software has been installed. To fix this error, insert and turn the over-ride key switch ON, then press the ENTER button. The display will show "YES" to confirm. While "YES" is shown on the screen, press the ENTER button again until the display gets into the normal initialisation/ set-up routine and then to normal operating mode. Note that this will clear the data log of all entries.

8.2. Problems with Digital Inputs, Digital Outputs and Relay Outputs.

8.2.1. Description of Digital Inputs, Digital Outputs and Relay Outputs.

Digital Inputs
Digital inputs provide switched inputs to the RCI-4100. Digital switched inputs can be used for a wide range of uses. Examples are (but not limited to):

- Proximity switches (slew reset, hoist direction, boom angle limit).
- Inputs from mechanical switches to select different load charts or to reduce SWL e.g. personnel lift switches, sea state switches.
- Slew encoder and wind speed inputs.

Digital inputs may be connected to the RCI-4100 controller PCB through IS barriers or DIN rail mounted terminals in the RCI-4100 enclosure. Digital inputs can be configured as “Normally Open” or “Normally Closed”, “Switched Positive” or “Switched Negative”. LSI-Robway uses a “Fail/Safe” philosophy so digital inputs are normally configured to limit crane movements or reduce SWL unless the switch is powered on.

Digital Outputs
Digital outputs provide switched outputs which are energised during certain conditions under software control. When a digital output is ‘energised” it provides a negative. Digital outputs are normally used to activate a DIN rail mounted relay in the enclosure with contacts rated at 5A. They are not designed to control high power (or many) solenoids, rather they are designed to switch intermediate relays which are then used to directly switch high power (or many) solenoids. This relay provides “NO” and “NC” contacts. Digital outputs can be used for a wide range of uses. Examples are (but not limited to):

- External audible alarm
- Boom up, or down motion cut
- Minimum radius motion cut
- CW, CCW slew motion cut

LSI-Robway uses a “Fail/Safe” philosophy so digital outputs are normally configured to limit crane movements or reduce SWL unless energised.

Relay Outputs
Relay outputs provide switched outputs which are energised during certain conditions under software control. Relay outputs are provided from safety relays mounted on the RCI-4100 controller PCB and are rated at 5A. They are not designed to control high power (or many) solenoids, rather they are designed to switch intermediate relays which are then used to directly switch high power (or many) solenoids. The safety relays provide “NO” and “NC” contacts. These are connected to DIN rail mounted terminals in the RCI-4100 controller. Relay outputs are normally used for “Motion Cut” and “ATB Motion Cut” but can be used for the same purposes as digital outputs. LSI-Robway uses a “Fail/Safe” philosophy so relay outputs are normally configured to use “NO” contacts.

8.2.2. What are the inputs and outputs on this crane?

The digital inputs, digital outputs and relay outputs are listed in the RCI System Configuration Documents in Attachments. The GA (General Arrangement drawing) are also in the RCI System Configuration Documents in Attachments and shows the wiring for the digital inputs, digital outputs and relay outputs.

NOTE: Some GA’s cover a range of crane configurations. These may include inputs and outputs not used on this crane. If an input or output is on the GA but does not appear on the RCI Configuration Sheet it should be ignored.

8.2.3. Troubleshooting Digital Inputs

Refer RCI System Configuration Documents in Attachments to identify digital inputs used on this crane.

To confirm that a digital input is being switched, open the RCI-4100 controller and check that the applicable digital input LED on the controller PCB is illuminated. Figure 16 shows location of digital input LEDs.

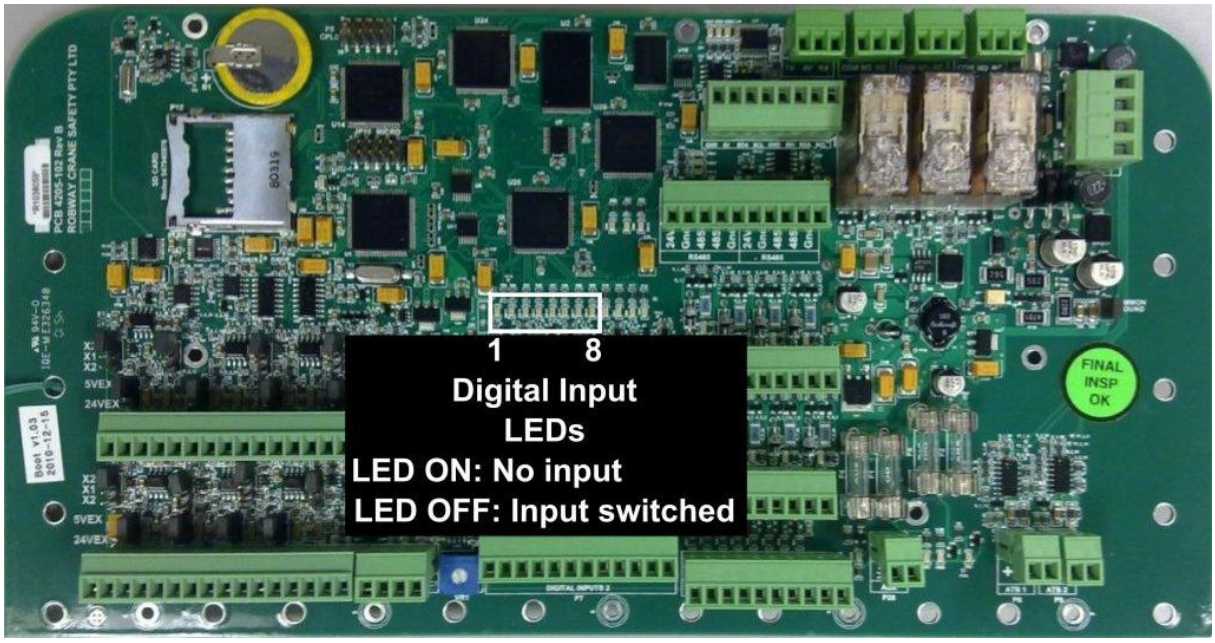


Figure 16 - RCI-4100 Controller PCB showing location of Digital Input (DI) LEDs

If the LED is not illuminated:
Trace wiring back through the applicable DIN rail or IS barrier or terminals to the switch.

8.2.4. Troubleshooting Digital Outputs

Refer RCI System Configuration Documents in Attachments to identify digital outputs used on this crane.

To confirm the state of a digital output, open the RCI-4100 controller and check the applicable digital output LED on the controller PCB. Figure 17 shows location of digital output LEDs.

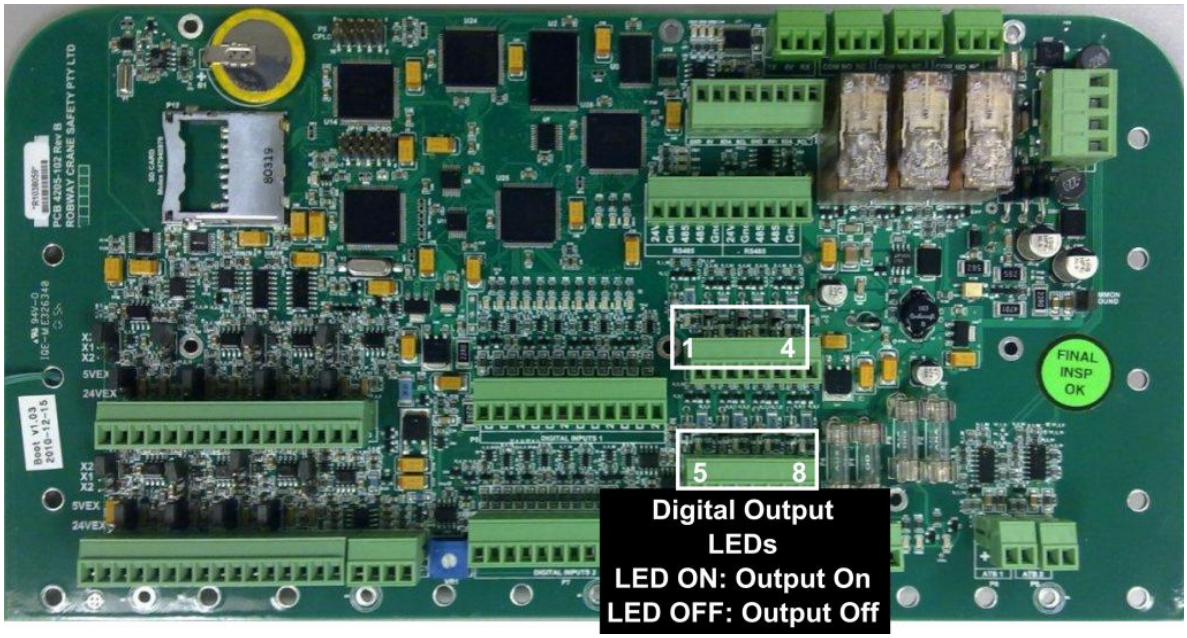


Figure 17 - RCI-4100 Controller PCB showing location of Digital Output (DO) LEDs

- If the applicable LED is not illuminated the output is not energised.
- If the applicable LED is illuminated the output is energised.
- If the applicable LED indicates that the digital output is in the incorrect state confirm that the RCI-4100 operating conditions are correct (check applicable digital inputs, displayed radius, angle, main and aux load).
- If the LED is illuminated but the crane relay/solenoid is not operating, trace wiring back through the applicable DIN rail relay to the crane relay/solenoid.

NOTE: Switching the over-ride key switch on will normally energise all digital outputs.

Note: Snubber diodes should always be fitted to relays and solenoids switched by the RCI-4100. For more information on snubber diodes and their use contact LSI-Robway.

Troubleshooting Relay Outputs

Refer RCI System Configuration Documents in Attachments to identify safety relay outputs used on this crane.

To confirm the state of a relay output, open the RCI-4100 controller and check the applicable relay.

Figure 18 - RCI-4100 Controller PCB showing location of Relay Outputs (RL) Connectors

- Relay LED indications:
- If the applicable relay status indicates that the relay is in the incorrect state confirm that the RCI-4100 operating conditions are correct (check applicable digital inputs, displayed radius, angle, main and aux load).
- If the applicable relay status is correct but the crane relay/solenoid is not operating, trace wiring back through the applicable DIN rail terminals to the crane relay/solenoid.

NOTE: Switching the over-ride key on will normally energise all relay outputs.

8.3. Sensor Replacement

Whenever a sensor is replaced the displayed calibrated values of that sensor should be checked and sensor re-calibration completed if required. This applies to all sensors including (but not limited to):

- Load sensors (tension cells, load pins, pressure transducers, dynamometer beam cells and compression cells)
- Angle sensors
- Length sensors
- Slew angle and hook height sensors (encoders)

After sensor replacement the following checks should be completed for the affected sensor:

- Tension based system:
  - A known light load (approximately 10% line pull) and a known heavy load (at least 70% line pull but within current SWL) should be lifted and if displayed load is not within (regulatory, site, operator or owner) acceptable accuracy then load calibration procedure should be completed.
- Load Moment system:
  - Known loads (light and heavy) should be lifted and if displayed load is not within (regulatory, site, operator or owner) acceptable accuracy transducer calibration should be checked and if required, transducer calibration procedure should be completed. After calibration light and heavy loads should again be lifted and if displayed is not acceptable then load moment calibration procedure should be completed.
- Angle sensor: The boom angle should be checked at a low and a high angle against a calibrated angle meter. If the displayed boom angle is not within (regulatory, site, operator or owner) acceptable accuracy then angle calibration procedure should be completed. Ensure that maximum and minimum angles are accurate so as not to unnecessarily cause maximum or minimum angle errors.
- Length sensor: The boom length should be checked at a short (fully retracted) and a long (extended at least 50%) length with a tape measure. If the displayed boom length is not within (regulatory, site, operator or owner) acceptable accuracy at these lengths then length calibration procedure should be completed.
- Slew angle sensor: The slew angle should be checked at 90deg and 270deg and if displayed slew angle is not within (regulatory, site, operator or owner) acceptable accuracy at these angles then slew calibration procedure should be completed.
- Hook height sensor: Hook height should be checked at ground level then at a high height with a tape measure. If displayed hook height is not within (regulatory, site, operator or owner) acceptable accuracy at these hook heights then hook height calibration procedure should be completed.
- Any other type of sensor should be checked for displayed accuracy at least at one reading, two if possible and sensor re-calibration procedure should be completed if accuracy is not within (regulatory, site, operator or owner) acceptable accuracy.

8.4. Fuse Replacement

If a fuse is found to be blown refer to the picture below for fuse labels, locations and specifications:

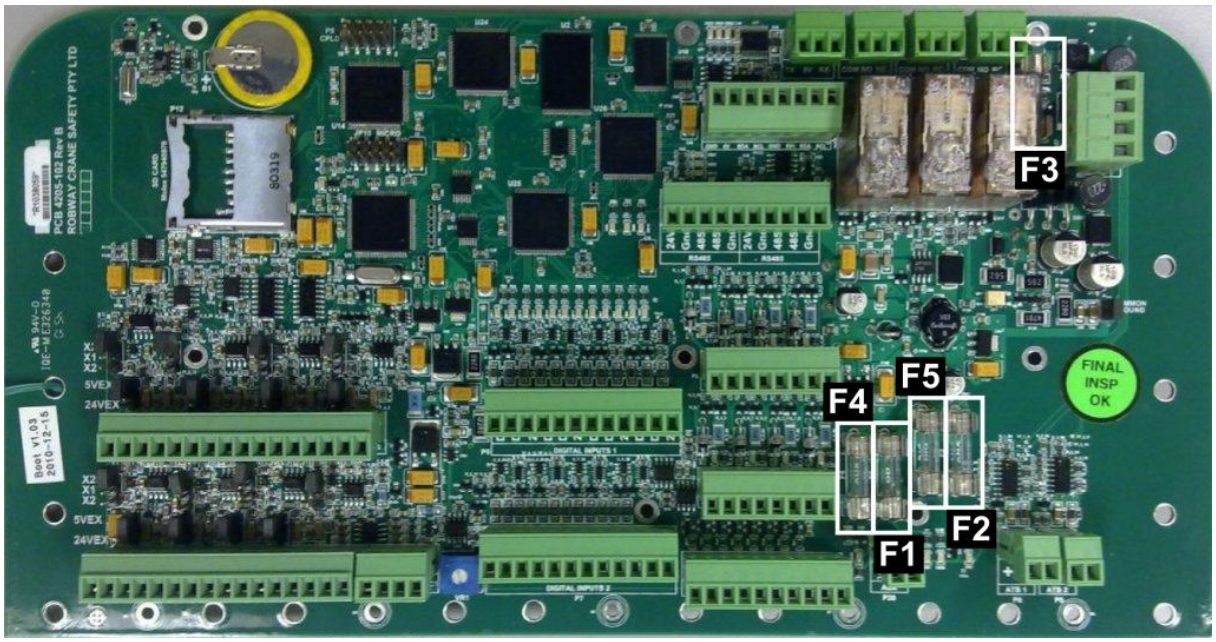


Figure 19 - RCI-4100 Controller PCB showing location of Fuses

Fuse Specifications:

	Current/Voltage Rating	Size	Type	Purpose
F1	500mA/250V Fast-blow	5 x 20mm	Glass Cartridge	24VDC Digital Output Supply
F2	500mA/250V Fast-blow	5 x 20mm	Glass Cartridge	24V Excitation Supply
F3	3.15A/240V Slow-blow	5 x 20mm	Glass Cartridge	Main Power In
F4	500mA/250V Fast-blow	5 x 20mm	Glass Cartridge	24V Auxiliary Supply
F5	500mA/250V Fast-blow	5 x 20mm	Glass Cartridge	24V Digital Input Supply

9. Inspection

This section is advisory only and does not presume full compliance with local regulation and/or standards.

This section describes the requirements for the three phases of the equipment life.

The requirements are based on AS2381.7 - "Electrical equipment for explosive atmospheres - Selection, installation and maintenance. Part 7: Intrinsic safety." This manual assumes that the initial selection phase has already been completed and installation is about to commence. These requirements are only applicable to Hazardous Area installations.

It is the responsibility of the supervisor to comply with all local relevant regulations and/or standards.

9.1. Pre-installation

The following information should be made available to the person(s) responsible for the installation, prior to the time of installation, and should remain available to those responsible for the safe operation of the installation:

9.1.1. The zone classification of areas in which each item of electrical equipment and any interconnecting cables are to be installed.

9.1.2. The certificate number of the system.

9.1.3. A list of all uncertified items used in the installation. With the RCI-4100 IS system, for example, uncertified items are loadcells, simple switches, junction boxes and potentiometer type sensors. All these items are classified by the standard as simple apparatus and do not require certification.

9.1.4. Details of the cable types used and their electrical parameters. For the RCI-4100 IS system, there are two cable types specified, these being SWA for the Power and Motion control signals (relays) and instrumentation cable for all other applications. When the cable is supplied as part of the system, use the appropriate cable parameters supplied in the Electrical Parameters section. When the cable is not supplied as part of the system, but is obtained from a third party by the installer/customer/contractor/etc., it is the installer's responsibility to determine the cable parameters. In either case, the parameters listed in the certification documentation must be complied with. Maximum allowable cable length must be checked against the requirements of each installation. In the application where the Control Unit is located in a safe area, the SWA cable may be replaced with an unarmored equivalent.

9.1.5. Refer to any special requirements listed in the certification documentation and note how these requirements will be met in this particular installation. There are only three such requirements for the RCI-4100 IS, these being:

- Installation must be as per the General Arrangement drawings and the cable parameters must not exceed values specified in the relevant certifications. If the cables have been supplied by LSI-Robway, then this condition will have been verified by LSI-Robway. Should the cable be supplied from a source other than LSI-Robway, it is the installer's responsibility to ensure that the cable meets the specified requirements.
- The Display Unit can only be installed in a Gas Group IIB, or safe area, must have a cable length of not more than 10m connecting it to the Control Unit, and must have a cable type with part number 90320R. It is a condition of certification that ONLY this cable type be used between the Control Unit and the Display Unit.

9.1.6. The approximate physical location on the plant of each item of electrical equipment to be installed, and the proposed routing of any interconnecting cables. Where interconnecting cables cross a zone boundary, care must be taken to ensure that such a crossing is permitted, and if so, what additional requirements are placed on the cable installation. Refer to the system overview drawing in the rear of the manual for component identification.

9.1.7. Any cable identification detail. All cables containing Intrinsically Safe (IS) circuits must be identified as such, either by a form of physical marking, or by the use of blue sheathing.

9.1.8. Inspection check lists against which commissioning and routine inspections should be carried out. Refer to the checklists on Section 9.4. “Inspection and Test Schedule”.

9.1.9. Details of electrical testing required at commissioning and inspections. Should there be an operational problem, there may be electrical testing required. Refer to the Trouble shooting section.

9.1.10. A record of any modifications and the justification for each modification. If such modifications were present as supplied by LSI-Robway, then such a justification will accompany the system. Where these modifications were performed by a party other than LSI-Robway, these justifications must be supplied by those responsible for such modifications. LSI-Robway takes no responsibility for modifications done to the system that have not been authorised by LSI-Robway in written form.

9.1.11. Details of any previous inspections. This generally will not be applicable, but is included for the sake of completeness.

9.1.12. Check the gas group requirements.

9.2. Post-installation

Following the initial installation of the system into a Hazardous Area, the equipment and installation shall undergo a Detailed Inspection to ensure;

- The suitability for the hazardous area in which it is installed,
- That it complies with the relevant system documentation, and
- That no obvious damage has occurred during installation.

Refer to the Detailed Inspection column on Section 9.4. “Inspection and Test Schedule”.

9.3. Post-commissioning

Following commissioning, there are three levels of inspection required by the standard, these being:

9.3.1. Detailed Inspection

A Detailed Inspection should be performed on the equipment and installation at the following times:

- Following commissioning of any new system,
- Following any modification or repair to the system to ensure the continued suitability of the system, and
- Following any change in area classification or process change on a plant to ensure the safety requirements remain valid.

Detailed Inspections should be performed in accordance with the "Detailed" column on Section 9.4. “Inspection and Test Schedule”, and is used to ensure the same level of safety determined by the Post-Installation Inspection.

9.3.2. Periodic Inspection

These inspections must be regular inspections of the equipment and installation to ensure a continuing level of safety. The frequency of inspections should be determined by the person responsible for the safety of the plant, however initially a three (3) month period is recommended. Once a level of confidence has been established, then this interval can be increased. If the interval is increased beyond two (2) years, then Visual Inspections must be performed at intermediate intervals as defined on Section 9.3.3 below. Periodic Inspections should be performed in accordance with the "Periodic" column Section 9.4 “Inspection and Test Schedule”.

9.3.3. Visual Inspection from Floor Level

Where the Periodic Inspection interval exceeds two (2) years, the equipment and installation must be visually inspected in accordance with the "Visual" column in the Inspection and Test Schedule, with an interval which must not exceed half the Periodic Inspection interval.

For all inspections, the results must be recorded.

9.4. Inspection and Test Schedule

	Check that	Detailed	Periodic	Visual
1	System or equipment is appropriate to area classifications	A	A	A
2	Are there any modifications.	A	S	A
3	System group is correct.	A	S	N
4	Equipment temperature class is correct.	A	S	N
5	Equipment or system is clearly marked, and particularly that any equipment or cable labels are legible.	A	S	N
6	Equipment or system carries the correct identification.	A	S	N
7	There are no unauthorised modifications to type and rating of fuses.	A	S	A
8	Relays are of correct type and without damage.	A	A	A
9	Segregation is maintained between Intrinsically Safe and Non-Intrinsically Safe circuits in any junction boxes or similar.	A	A	A
10	Cabling is installed in accordance with the documentation.	A	N	N
11	Cable screens are earthed in accordance with the documentation. This may be difficult when the screens are designed to be terminated within the cable glands.	A	S	N
12	Earthing is according to the documentation.	A	A	A
13	Earth continuity is satisfactory.	A	N	A
14	Electrical connections are tight.	A	S	N
15	Point to point connections are correct.	A	N	N
16	There is no visible damage to equipment or cables and there is no undue accumulation of dust or dirt. Whenever possible, check flame path for signs of damage.	A	A	A
17	Equipment is adequately protected against corrosion, moisture, vibration, excessive temperature, and other adverse factors.	A	A	A
18	Installation is in compliance with the documentation.	A	S	N

*In the above chart, **A=**All, **S=**Sample and **N=**Not required by the standard, but sample is recommended.*

10. Maintenance

When maintenance is to be performed on the RCI-4100 system, care must be taken to ensure that the level of safety is not reduced. Such a reduction in the level of safety can easily be done by the careless use of tools or test equipment, either directly or by damage to safety components, wiring or clearances. Therefore it is essential that maintenance be performed by competent personnel only.

The following are recommendations from the Standard (AS2381.7 - "Electrical equipment for explosive atmospheres - Selection, installation and maintenance. Part 7: Intrinsic safety.) on maintenance procedures.

10.1. Checklist

It is recommended that a checklist similar to the one below be prepared prior to maintenance.

Maintenance Checklist

Pre-maintenance	Necessary documents are available. All records have been examined. Test gear is available and is satisfactory for use in hazardous areas. Permission to enter or work has been granted. The area is safe to enter. Any precautions necessary have been taken.
Maintenance	All reconnections have been made. Equipment is functional. Malfunctions have been reported. Installation conforms to drawings and documentation. Any modifications have been approved. Area classification is still valid. Earthing requirements are still valid. General check in accordance with the Inspection and Test Schedule completed.
Post-maintenance	Documentation is completed and filed. Inspection report is complete. Company and operator requirements have been satisfied.

10.2. Removal of Electrical Equipment

When any electrical equipment is removed for maintenance, any exposed IS conductors which remain must be mechanically and electrically secured in a manner to prevent the occurrence of an unsafe condition.

10.3. Maintenance Work in Hazardous Areas

When the Control Unit is installed in a hazardous area it is protected by a flameproof enclosure and must not be opened when a hazard is present. To work on the Control Unit, all power must be removed for at least four (4) minutes before the lid can be removed. Alternatively a gas free permit may be obtained allowing for the removal of the lid while power is still connected. The same constraints apply to the power and motion control cabling as these are not Intrinsically Safe (I.S.)

Work external to the Control Unit should be restricted to the following:

- Disconnection of, and removal or replacement of, items of electrical equipment and cabling although it is recommended that power be removed from the Control Unit prior to this being done.
- Measurement of various parameters such as loadcell excitation voltage or resistance, or other such maintenance activities. Note, however, that such measurements can ONLY be done with certified test instruments (e.g. Multimeters) otherwise a gas free permit must be obtained. The parameters that may need checking are listed in the “error/possible causes” paragraphs in the Troubleshooting section.

It is important that the person performing the maintenance tasks ensures that the equipment meets the requirements of the relevant documentation on completion.

10.4. Maintenance Work in Non-Hazardous Areas

There are few items in the RCI-4100IS system that are located in a non-hazardous area, these being;

- Applications where the Control Unit is located in a safe area and contained within an enclosure other than a flameproof enclosure,
- Power supply for the Control Unit, and
- The motion control solenoids or relays.

If any work is required to be done on the above items other than measurements power must be removed from the Control Unit. Measurements made on the IS circuits in the Control Unit must only be made with a certified test instrument if a hazard still exists on the other end of the cables. Failure to do this may cause an ignition source to be transferred into the hazardous area from the test instrument. Care should also be taken to ensure that safety components are not "bypassed" by the test instrument, thus voiding the safety aspect of the Control Unit.

10.5. Modification or Repair

Repairs performed in a hazardous area are specifically discouraged by the Standard. Such repairs should be performed away from the hazardous location.

10.6. Inspection after Maintenance

It is considered essential by the Standard that a Detailed Inspection is performed following any maintenance to ensure that the equipment and installation continue to comply with the documentation.

10.7. Records

Ensure that that dates of all inspections, tests, maintenance, and defects are recorded.

10.8. Printed Circuit Board (PCB) Handling

If the RCI-4100 controller PCB is removed for any reason anti-static precautions must be employed.

10.9. CUFRCI4100 Flameproof Controller Mating Surfaces Precautions

The mating surfaces between housing and cover of the CUFRCI4100 flameproof controller must be kept clean and damage free. Always ensure surfaces have thin coating of Dow Corning #4 Silicone Grease to prevent corrosion.

NOTE: If the mating surfaces are damaged the controller must be replaced.

11. General Specifications

Controller and Display	Control Unit: The Control Unit has Ex ia and Ex ib interfaces and is optionally housed in an Ex d flameproof enclosure for Zone 1 applications. May be used without Ex d enclosure in safe zones. The control unit contains the 24 volt input power supply and processor module. For Zone 1 applications the Ex d enclosure is supplied with 10 standard (up to 12 maximum) Ex d certified glands for wiring to display unit, external sensors, switches, etc. Display Unit: The Display is certified Group IIB Ex ib Zone 1 applications.
Explosive Atmosphere Certifications	Display: IECEx 60079 Ex ib IIB T4 (-20 < Ta < +60°C) ATEX Environmental Protection, IP20 Al-Si Aluminium Alloy housing, black powder-coated finish Control Unit in Flameproof Housing, Hinged Lid: LOM 02 ATEX 3060 U Class 1, Zone 1 and Zone 2 II 2 G - EEx d, II B T4 to T6 IEC 60079 BKI 07.0018 Class 1, Zone 1 Ex ib IIB, T4 Al-Si Aluminium copper-free alloy, grey powder-coated finish Sensors: Refer to the "Declaration of Conformity"
Display	5 Liquid Crystal Display (LCD) Windows: Top, 4x16 alphanumeric LCD, multifunction display Centre, (2) 4-digit LCD, Load, SWL display Bottom, (2) 4-digit LCD, Radius, Angle display White LED Backlighting LED indicators for hook selection and ATB Status
Display Cable	4-core, screened instrumentation cable Maximum 10-metre length Hard-wired with gland at the back plate of display to Ex d gland of the Control Unit DC resistance, 38 Ω/km @ 20°C Inductance, 277 µH/km Capacitance, 17 nF/km L/R ratio, 7.29 µH/Ω

Display Alarm	LED Indicators: Green (safe) Amber (warning) Red (overload) Main Aux ATB Audible Alarm: Piezo ceramic buzzer Intermittent – approach to SWL or over-ride active Continuous – overload and/or error(s) Text Messages: Alphanumeric Alarm/Error conditions
Over-ride Feature	Over-ride key switch on Display Unit

Analogue Voltage Inputs	8 channels Resolution, 12 bits Option for Ex ia Zone 1 interface, or safe area Load cells with 1, 2, or 3 mV/V output and typical bridge impedance of 350 Ω 4-20 milliamp input Voltage or potentiometer input Excitation 4 or 12 volts DC
Analogue Outputs	Number of Outputs: 2 (special request) Safe Area Application: Load Constant Tension Gross Over-Moment Protection
Anti 2 Blocking Input	2 channels Switch input with open and short circuit detection
Digital Inputs	8 channels Option for Ex ia, Zone 1 interface or safe area Configurable: State (e.g. proximity switch) Quadrature (e.g. slew) Accumulator (e.g. event counter) Frequency (e.g. wind speed) Open circuit switch voltage: approx. 3 VDC Closed circuit switch current: 3 mA

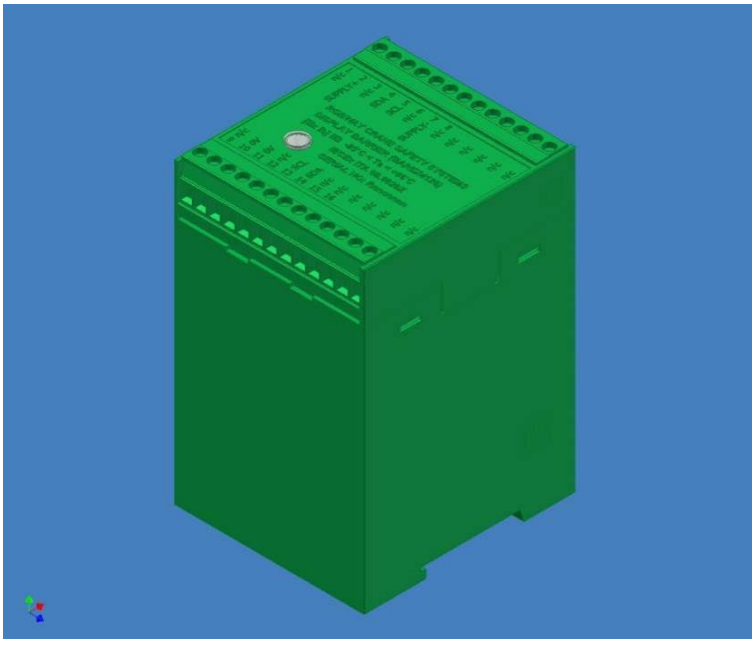
Relay Outputs **Safe Zone**	6 channels (3 safety relays for general safety critical indication) Safe Area Rating: 5 amp, 250 VAC Function: Limiting, External Alarm, External Indicators, etc. An optional Digital Expander Module (safe area) with 8 relay outputs can also be supplied if more outputs are required
Sensors Supported	Analogue Voltage (length, angle, etc.) 4-20 milliamp current RS232 Load Cells RS485 Digital Input (proximity switches, etc.) Quadrature input (slew angle encoders, etc.) Frequency (wind speed, winch speed, etc.)
Serial Communications	RS-232: Safe area, Ex ib Zone 1 Optional Data log download Configuration upload/download Program upload/download 9600 baud factory configured RS485: Safe area, Ex ib Zone 1 Optional 9600 baud factory configured
Processor Speed	25 Mips
System Memory	Data Memory: 128 Kbyte of non-volatile FRAM (calibration, setup) 8 Mbyte FLASH (load charts, datalog) Program Memory: 128 Kbyte FLASH SD Card: Up to 32 GByte can be accommodated Program upload/download Calibration upload/download Logged Data download
System	Microprocessor Watchdog Onboard Timekeeping with power backup Automatic System Diagnostics
On-board Calibration	System Calibration via Operator Console

Unit Conversion	Conversion between metric and imperial units
Power Supply Input	Voltage: 10.5 VDC – 36 VDC Power: 15 VA
Physical	Display Unit: 260 mm (H) x 150 mm (W) x 60 mm (D) Weight, approx 3 kgs Control Unit: Hinged lid, 371 mm x 371mm x 233mm (depth) Weight, approx 18 kgs
Environmental	Display: Operating Temperature -20°C to +60°C Dust and Water Ingress, IP65 Control Unit with Ex d Housing: Operating Temperature -20°C to +60°C Dust and Water Ingress IP65
EMC	61000-6-4 61000-6-2
RoHS Compliant	Yes

RoHS Compliant	Yes

APPENDIX A, Safety and Installation Instructions, Model 4120 RCI-4100IS Display Barrier

Safety and Installation Instructions
Model 4120 RCI-4100 Display Barrier



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This installation manual must be read and used by qualified personnel during system design and installation of the RCI-4100 Display and the Model 4120 Isolating Barrier.

Warning

The 4100 Display is a Group IIB Ex ib certified display which may be located in Zone 1 or Zone 2 of a hazardous area.

The 4100 Display must be operated within environmental limitations and must only be connected to certified intrinsic safety barriers meeting the Model 4100 input parameters.

The 4100 Display and the 4120 Display Barrier must only be installed by qualified personnel in accordance with the relevant international installation standards. Particular care must be given to physical control and clear identification of IS cabling.

The 4100 Display may be installed in a Hazardous Area only with proper protection from the weather.

The 4120 Display Barrier must not be connected to equipment that uses or generates more than 250 Vrms with respect to earth ground.

The Model 4120 Barrier must be operated within environmental limitations.

The Model 4120 Barrier is an isolated Intrinsically Safe (IS) apparatus to be installed on a standard EN50022 T35 DIN rail located in a safe area / non-hazardous location.

The Model 4120 Barrier may be installed in a Hazardous Area ONLY if enclosed in an appropriately approved and/or certified “explosion proof” housing conforming to applicable standards.

The 4100 Display and Display Barrier cannot be repaired by the end user thus any units exhibiting a failure must be returned to the manufacturer or its authorized representative.

SAFETY ANALYSIS

In a system safety analysis, always check that the Hazardous Area / Hazardous location devices conform to the relevant standards. The 4100 Display and Barrier system as supplied with its 10 metre cable conforms to the specified product certification but there may be other relevant installation standards which must be met.

Although longer interconnecting cable runs may function satisfactorily LSI-Robway does not warrant the system working with a longer interconnecting cable than that supplied. In addition, if the interconnecting cable is to be extended beyond what is supplied the capacitance and inductance values must not exceed the limits given. If a longer cable run is desired please consult the factory.

4100 Display + Cable Parameters	Must be	Model 4120 Hazardous Area Isolating Barrier Group IIB Load Parameters
Ci + C of cable	≤	Co
(Li device + L cable) / (R cable)	≤	Lo / R
L of cable	≤	Lo

OPERATION

The LSI-Robway Model 4100 Display is intended to be used with the Model 4120 Display Barrier. The Model 4120 Barrier provides isolated power to the Model 4100 display and also an isolated intrinsic safety barrier for I2C communications from a host data system located in a safe area.

Proper operation of the 4100 Display is indicated by the LCD backlights being illuminated and the alarm sounding. If a data system is connected and functioning properly then digits will also appear on the display according to the relevant system manual. If normal operating conditions are not apparent when 24 VDC nominal is applied to the system then the 4100 display and/or the 4120 Isolating Barrier must be considered faulty and may only be repaired or replaced by qualified personnel after the system fault is determined and rectified.

INSTALLATION

Display

The 4100 Display is a Group IIB Ex ib device is housed in an IP65 style enclosure; however it is only intended to be mounted in a location protected from direct weather and condensing humidity. The 4100 Display is not certified to IP65 protection levels.

A gimballed mounting arm is provided for securing the 4100 Display to a dash panel or other solid mounting surface. Other mounting methods may be possible however the 4100 Display must be mounted securely and the integrity of the enclosure must be maintained. The 4100 display is not certified for use as a portable device.

The 4100 Display has a captive cable supplied which meets the specified cable parameters. Inside the 4100 Display is a 4-pole terminal block from which the cable may be disconnected for ease of cable routing or shortening of the cable. This cable may only be lengthened after it is determined that the cable parameters do not exceed allowable parameters. Although the 4100 Display and Barrier may function satisfactorily, the 4100 Display and Barrier system is not warranted for operation with longer cable than supplied. Consult factory if longer cable runs are desired.

If the 4100 display cable is to be shortened and re-attached at the display end, the cable conductors must be stripped and terminated in an identical manner as originally supplied. Generally speaking the cable must be installed in a secure manner and protected from physical damage along its entire length. The 4100 Display cable must be segregated from non-IS conductors and wired in accordance with relevant national and international installation standards.

Although the 4100 Display earth strap is not required to meet the intrinsic safety certification it should be connected to a suitable earthing point which is determined to have a reliable path to earth. The earthing strap is required to provide a higher level of noise and transient immunity.

A vinyl dust-cover with transparent window is offered as a factory option however it is not covered under the 4100 Display IECEx Ex ib certification and must be considered to be a static hazard. The dust cover can only be used in accordance with relevant national/international installation standards.

Isolating Barrier

The 4120 Isolating Barrier does not require an earth for its protection. If using the 4120 Isolating Barrier in an “explosion-proof” enclosure the appropriate “explosion-proof” cable gland must be used and manufacturer’s instructions followed. The Um of the 4120 Isolating Barrier “Safe” terminals is 250 Vrms. The 4120 Isolating Barrier must not be connected to any equipment which is connected to or can produce a voltage higher than 250 Vrms.

Warning

The 4100 Display provides a minimum IP 20 protection. If the 4100 Display is to be installed outdoors then additional protection is required.

If either the 4100 Display or 4120 Isolating Barrier enclosure needs to be cleaned use a slightly dampened anti-static cloth to avoid static discharge risk. Avoid any penetration of cleaning fluids into either enclosure as this could effectively bypass intrinsic safety protection measures.

4100 Display Power/Data Wiring Detail

4100 DISPLAY TO BARRIER WIRING				
Barrier Description	4120 Isolating Barrier Terminal	Conductor Colour	4100 Display Terminal	Display Description
Supply-	10	Black	1	0V
Supply+.	11	Red	2	6V
SDA	14	Green	3	SDA
SCL	13	White	4	SCL

STARTUP

Before applying power to the system check that all wires are properly connected, particularly supply conductors and their polarity, and serial data wires. Also check that IS conductors and cables are segregated from any other circuits including other IS circuits. Check conductors for exposed wires that could touch each other causing dangerous shorts.

Apply power to the system. The green LED on the top of the Model 4120 Barrier should come on and there should be a nominal 6 volts across the power output terminals. The LCD backlights should come on and the Alarm will sound continuously. There will not be any data displayed if there is no data system connected to the Model 4120 Barrier. If a data system is connected and functioning normally then data will be displayed according to the data system manual.

If these conditions are not observed, promptly remove power from the system and locate and remedy the fault before re-applying power to the system.

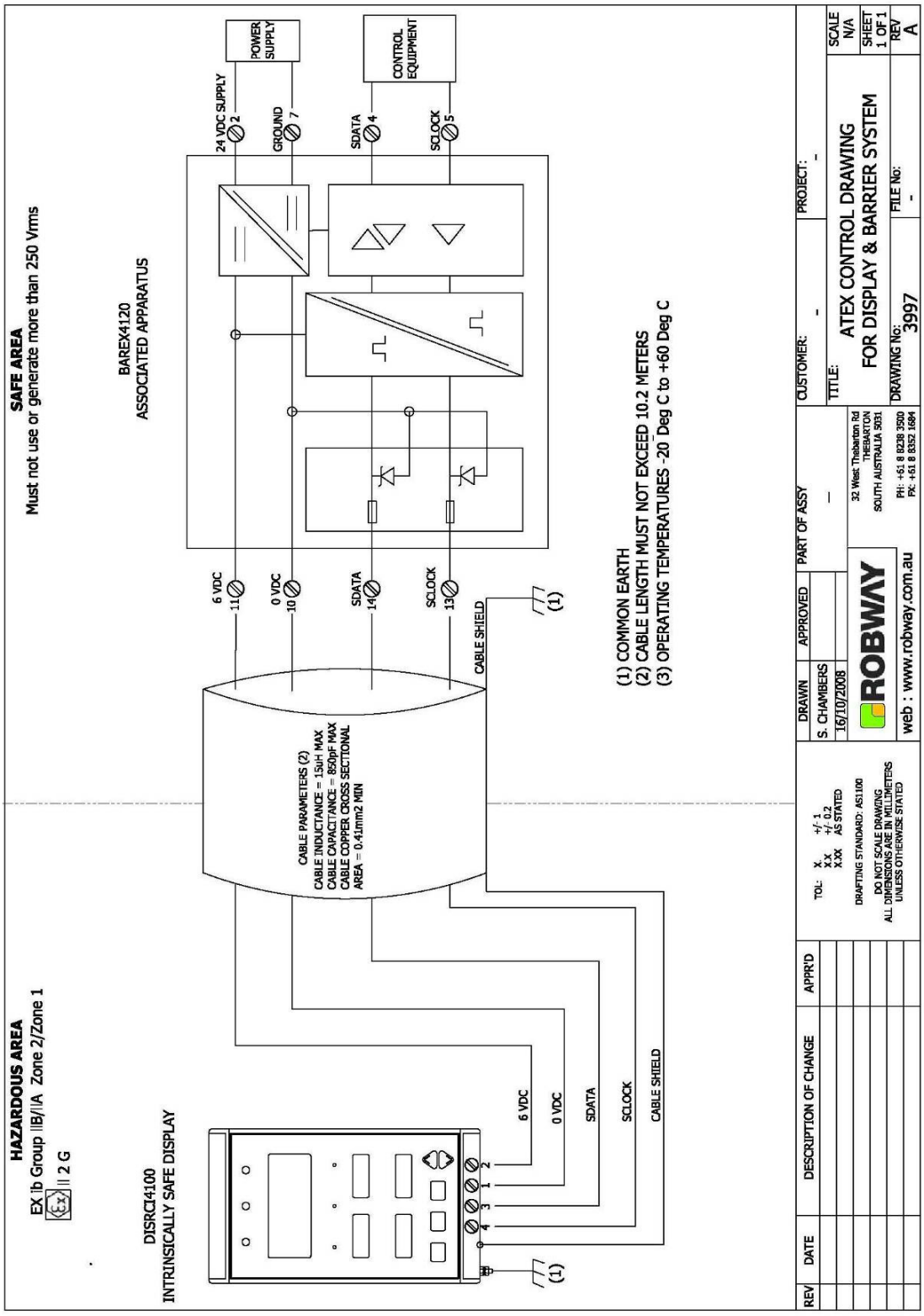
STORAGE

The ambient temperature may exceed the operating temperature limits of -20°C to +60°C for limited periods of time such as experienced during air transport.

DISPOSAL

The 4100 Display and 4120 Isolating Barrier are compliant with the Directive 2002/95/EC of The European Parliament on the Restriction of the use of certain Hazardous Substances (RoHS). Neither the 4100 Display nor the 4120 Isolating Barrier has any on-board batteries. Please separate and dispose of electronic goods responsibly and follow guidelines and regulations for your region.

INSTALLATION CONTROL DRAWING



4100 Display

Compliance	IECEx Certificate Number	ITA 08.0021X Ex ib, Group IIB
	ATEX Certificate Number	NEMKO 08 ATEX 1433X
	Temperature Classification	T4, -20°C < Tamb <+60°C
	RoHS	Yes
Product Markings	ATEX	Ex ib IIB/IIA T4 -20°C < Ta < +60°C NEMKO08ATEX1433X Ex II 2 G CE 0470
	IECEx	Ex ib IIB T4 -20°C < Ta < +60°C IECEx ITA 08.0021X
Intrinsic Safety Parameters	Ui	8 VDC
	Ii	3 A
	Ci	7.7 µF
	Li	15 µH (includes mated cable)
LED Indicators	Safe Working Load	Green
	Approach to Overload	Yellow
	Overload	Red
	Main Hook in Use	Red
	Aux Hook in Use	Red
	ATB Condition	Red
LCD Indicators	Alphanumeric	4 x 16 characters
	7-Segment Numeric	4
Power Supply	Voltage	6 VDC nominal
	Current	30 milliamps
Physical	Dimensions (excluding mount)	60 x 150 x 280mm(h x w x d)
	Weight (excluding cable)	1.8 kg
	Cable Length	10 m
	Cable Diameter	10.5 mm
	Cable Capacitance	85 pF/m core-to-core
	Cable Construction	4-core, 20 AWG, UV-stable PVC sheath Tinned Copper Braid-shield
	IP Rating	20
Environmental	Operating Temperature	-20°C to 60°C
	Humidity	0 to 95%, non-condensing

4120 Isolating Barrier

Compliance	IECEx Certificate Number	ITA 08.0020X Ex ib, Group IIB
	ATEX Certificate Number	NEMKO 08 ATEX 1433X [EEx ib] IIB
	Temperature Classification	T4, -20°C < Tamb <+60°C
	RoHS	Yes
Product Markings	ATEX (Associated Apparatus)	[Ex ib] IIB/IIA -20°C < Ta < +60°C NEMKO08ATEX1433X Ex II (2) G CE 0470
	IECEx (Associated Apparatus)	[Ex ib] IIB -20°C < Ta < +60°C IECEx ITA 08.0020X
I/S Parameters Safe Area Terminals	U_m	250 V
I/S Parameters Hazardous Area Terminals	U_o I_o P_o C_i L_i	7.14 V 2.81 A 1.81 W Negligible Negligible
I/S Parameters, Load, Group IIB (maximum values) -OR-	Capacitance Inductance L/R Ratio	268 µF 0.018 mH 28.4 µH/Ω
I/S Parameters, Load, Group IIA (maximum values) -OR-	Capacitance Inductance L/R Ratio	1000 µF 0.036 mH 56.7 µH/Ω
Indicators	Status LED	Green = OK
Input Power Supply	Voltage Current, no load Current with 4100 Display	20 to 30 VDC 30 milliamps 90 milliamps
Output I/S Power Supply	Voltage Current	6 VDC nominal 90 milliamps
Physical	Dimensions Weight IP Rating DIN rail	75 x 67 x 105 mm (l x w x h) 0.5 kg 20 EN50022 T35
Environmental	Operating Temperature Humidity	-20°C to 60°C 0 to 95%, non-condensing

System, Isolating Barrier and Display

EMC	61000-6-2, Immunity, Industrial 61000-6-4, Emissions, Industrial
Product Quality Assurance Notification	Nemko 09ATEX4069Q

EC Declaration of Conformity

in accordance with EN 45014 (ISO/IEC22)

LSI-Robway Pty. Limited

Declares that Associated Apparatus Models:

BAREX4120 Isolating Barrier

RCI-4100 IS Display

are in accordance with the following European Directives:

94/9/EC	Equipment intended for use in potentially explosive atmospheres (ATEX)
2002/95/EC	Restriction of the Use of Certain Hazardous Substances in Electrical And Electronic Equipment

and have been designed and manufactured according to the following standards:

IEC 61000-6-4:2001	EMC Emission Standard for Industrial Environments
IEC 61000-6-2:2001	EMC Immunity Standard for Industrial Environments
IEC 60079-0	Electrical apparatus for explosive gas atmospheres. Part 0: General Requirements
IEC 60079-11	Explosive atmospheres. Part 11: Equipment protection by intrinsic safety ‘i’
ISO 9001:2000	Quality Management System

and are covered by:

IECEx ITA 08.0020X	IECEx Certificate of Conformity for Barrier Module Type BAREX4120
IECEx ITA 08.0021X	IECEx Certificate of Conformity for Display Module Type RCI-4100 IS
NEMKO 08 ATEX 1433 X	ATEX Type Examination Certificate for Hazardous Areas
NEMKO 09 ATEX 4069 Q	Product Quality Assurance Notification

APPENDIX B, Declaration of Conformity, RCI-4100IS Hazardous Area Rated Capacity Indicator System

Declaration of Conformity
LSI-Robway Pty. Limited

Declares that:

RCI-4100 Hazardous Area Rated Capacity Indicator Systems

Are covered by one or more of the following certifications / classifications:

Description	Robway Model	Certificates / Standards	Markings on Equipment	Material Composition
RCI4100 Controller Ex d Housing	CUFRCI4100	LOM03ATEX2004X IECEx BKI 07.0018 Ingress: IP65	EEx d IIB T4; -20°C < Ta < +60°C Ex II 2 G	Housing L2560 alloy Copper Free Alloy, See Note 1 Epoxy Powder-coated
RCI4100 Controller Safe Area Housing	CUSRCI4100	Ingress: IP66	n/a	Housing 316 Stainless Steel
Display Module Type RCI-4100 IS	DISRCI4100IS	NEMKO 08ATEX1433X IECEx ITA 08.0021X NEMKO 09ATEX4069 Q	Ex ib IIB/IIA T4; -20°C < Ta < +60°C Ex II 2 G	Housing to EN AC 44300 Epoxy powder-coated ASTM B179-06 Bracket Al-Si copper-free alloy, See Note 1
Isolating Barrier Module	BAREX4120	NEMKO 08ATEX1433X IECEx ITA 08.0020X NEMKO 09ATEX4069 Q	[Ex ib] IIB/IIA Ex II (2) G	Housing ABS Plastic
Boom Angle Sensor Model	ANGES4130	LOM02ATEX2037 IECEx BKI 07.0026	EEx d IIC T6; -20°C < Ta < +55°C Ex II 2 GD	Housing L2560 alloy Copper Free Alloy, See Note 1 Epoxy Powder-coated

LSI-Robway 4100 system Declaration of Conformity Rev J

Isolating Barrier Module 4-20 milliamp repeater 1-Channel	BARD1054S	DNV-2004-OSL-ATEX-0199 IECEx DNV 07.0001	[EEx ia] IIC; -20°C < Ta < +55°C Ex II (1) GD	Housing ABS Plastic
Isolating Barrier Module Load Cell 1-Channel	BAREX1063S	DNV-2004-OSL-ATEX-0199 IECEx DNV 07.0001	[EEx ia] IIC; -20°C < Ta < +55°C Ex II (1) GD	Housing ABS Plastic
Isolating Barrier Module Digital Proximity Switch 2-channel	BAREX1031D	DMT 01 ATEX 042 X IECEx BVS 07.0027	[EEx ia] IIC/IIB/IIA Ex II (1) GD	Body SS316 Sensing face Plastic PBT
Isolating Barrier Module Digital Proximity Switch 4-channel	BAREX1031Q	DMT 01 ATEX 042 X IECEx BVS 07.0027	[EEx ia] IIC/IIB/IIA Ex II (1) GD	Body SS316 Sensing face Plastic PBT
Isolating Barrier Module Voltage Repeater 2-channel	BARD1072D	DMT 01 ATEX 042 X IECEx BVS 07.0027	[EEx ia] IIC/IIB/IIA Ex II (1) GD	Housing ABS Plastic
Shaft Encoder Incremental Quadrature Output	ENCH38D	DEMKO 04 ATEX 0335698	EEx d IIB T4; -40°C < Ta < +80°C Ex II 2G UL Class 1, Div 1, Group C,D	Shaft SS303 Enclosure Aluminum <6% magnesium, Hard-anodized with zinc dichromate finish
Shaft Encoder Absolute SSI Interface	ENCPF188583	ZELM 02 ATEX 0078	EEx d IIC T6; -20°C < Ta < +55°C Ex II 2G	Shaft SS303 Enclosure Aluminum <6% magnesium, Hard-anodized with zinc dichromate finish
Cable Gland Ex e, 13mm cable	GLATWAE1M13	IECEx TSA 09.0024	Ex d IIC	385 Brass, 3-5um nickel plated
Cable Gland Ex d, 13 mm cable	GLATWAB1M13	IECEx TSA 09.0024	Ex d IIC	385 Brass, 3-5um nickel plated
Cable Gland Ex d, 16 mm cable	GLATWAB1M16	IECEx TSA 09.0024	Ex d IIC	385 Brass, 3-5um nickel plated
Cable Gland Ex d, 20 mm cable	GLATWAB1M20	IECEx TSA 09.0024	Ex d IIC	385 Brass, 3-5um nickel plated

LSI-Robway 4100 system Declaration of Conformity Rev J

Load Pin, 2 metric ton 4-20 milliamp interface	CELPINTC2000EX	BVS 08 ATEX E 075 X	EEx ib IIC T4; -25°C < Ta < +85°C Ⓔx II 2G	Body Stainless steel
Proximity Switch Namur	SWIPROXNJ15	PTB 00 ATEX 2048 X	EEx ia IIC T6 Ⓔx II 2 G	Body Stainless Steel Sensing Face PBT plastic
Junction Box, 90mm, 3 entry Ex e	JUNBOX4053	DEMKO 01 ATEX 130324	EEx e II 2GD	Glass Reinforced Polyester
Lightning Arrestor Gas tubes	PROLOADT2	KEMA 00ATEX1099X IECEx KEM 10.0063X	Ex ia IIC T4..T6 GA	n/a
Lightning Arrestor Enclosure	PROLOADT2	IECEx BKI 07.0034	Ex e IIC T6	Body and Cover, Cast copper-free aluminium. Cover Screws, Stainless Steel.
Sea-State Switch Console, Housing	SWISB4493	IECEx BKI 04.0003	Ex ed IIC T6	Enclosure Polymide 12 Cover Screws, Stainless Steel
Sea-State Switch Console, Switches	SWISB4493	PTB 97 ATEX 1081 U	EEx de IIC Ⓔx II 2 G	n/a
AGOP Operator Console, Housing	CONTDSEA2-LD	IECEx BKI 04.0003	Ex ed IIC T6	Enclosure Polymide 12 Cover Screws, Stainless Steel
AGOP Operator Console, Switches	CONTDSEA2-LD	PTB 97 ATEX 1081 U	EEx de IIC Ⓔx II 2 G	n/a
External Alarm	ALARMD81HA	BASEEFA 02ATEX0207	EExd IIB T3; –20°C < Ta < +55°C	LM25 corrosion resistant alloy stainless steel cover screws.
Cable, M12	CABENCxxA	BVS 11 ATEX E 009 X	II 1G Ex ia IIB T6 Ga	n/a

LSI-Robway 4100 system Declaration of Conformity Rev J

Description	Robway Model	Compliance	Simple Apparatus Compliance Report	Material Composition
ATB Junction Box	JUNBOXATB	Complies with IEC 60079.0, light alloys and non-metallic parts and IEC 60079.11 Simple Apparatus Clause 5.7 for Group IIA/IIB, Zone 1 and Zone 2	SAC0001	Body AL413
Dynamometer Junction Box	JUNBOX1843	Complies with IEC 60079.0, light alloys and non-metallic parts and IEC 60079.11 Simple Apparatus Clause 5.7 for Group IIA/IIB, Zone 1 and Zone 2	SAC0001	Body AL413
Wind Speed Sensor	ANEMOMETER3	Complies with IEC 60079.0, light alloys and non-metallic parts and IEC 60079.11 Simple Apparatus Clause 5.7 for Group IIA/IIB, Zone 1 and Zone 2	SAC0002	Body AL6061 Cups AL 3003 Arms Stainless T304
ATB Switch	SWIBB5	Complies with IEC 60079.0, light alloys and non-metallic parts and IEC 60079.11 Simple Apparatus Clause 5.7 for Group IIA/IIB, Zone 1 and Zone 2	SAC0003	Stainless steel GR316 UV-Resistant Plastic weather cover
Wind Direction Sensor	ANEMOMETER4	Complies with IEC 60079.0, light alloys and non-metallic parts and IEC 60079.11 Simple Apparatus Clause 5.7 for Group IIA/IIB, Zone 1 and Zone 2	SAC0004	Body AL6061 Arms Stainless T304 Vane AL5052-H32
Relative Angle Sensor	ANGBROSA01	Complies with IEC 60079.0, light alloys and non-metallic parts and IEC 60079.11 Simple Apparatus Clause 5.7 for Group IIA/IIB, Zone 1 and Zone 2	SAC0005	Body AL5083 Measuring arm Stainless Steel.
Recoil Drums	DRU195 Series DRU320 Series DRU340 Series DRU470 Series DRU520 Series	Complies with IEC 60079.0, light alloys and non-metallic parts and IEC 60079.11 Simple Apparatus Clause 5.7 for Group IIA/IIB, Zone 1 and Zone 2	SAC0006	General construction mild steel Central hub alloy EN AW-2011
Pressure Transducer 5000 psig	TRAPRES5C	Complies with IEC 60079.0, light alloys and non-metallic parts and IEC 60079.11 Simple Apparatus Clause 5.7 for Group IIA/IIB, Zone 1 and Zone 2	SAC0007	Body 17 4ph Stainless Steel
Load Pin 2 metric ton	CELRW1500CA	Complies with IEC 60079.0, light alloys and non-metallic parts and IEC 60079.11 Simple Apparatus Clause 5.7 for Group IIA/IIB, Zone 1 and Zone 2	SAC0008	Body 17 4ph Stainless Steel

LSI-Robway 4100 system Declaration of Conformity Rev J

Tension Cell Range	CELTPK6P CELTPT10P CELTPT15P CELTPT20P CELTPT25P CELTPT30P CELTPT70P CELTEN20T	Complies with IEC 60079.0, light alloys and non-metallic parts and IEC 60079.11 Simple Apparatus Clause 5.7 for Group IIA/IIB, Zone 1 and Zone 2	SAC0009	Body 17 4ph Stainless Steel
Compression Cell Range	CELTPK6OS CELTPK10OS CELTPK12OS	Complies with IEC 60079.0, light alloys and non-metallic parts and IEC 60079.11 Simple Apparatus Clause 5.7 for Group IIA/IIB, Zone 1 and Zone 2	SAC0010	Body 17 4ph Stainless Steel
Beam Cell Dynamometer 4000 lb	CELBTD5P	Complies with IEC 60079.0, light alloys and non-metallic parts and IEC 60079.11 Simple Apparatus Clause 5.7 for Group IIA/IIB, Zone 1 and Zone 2	SAC0011	Body Tool Steel Electroless Nickel
Compression Cell 3 metric ton	CELTKPALS3	Complies with IEC 60079.0, light alloys and non-metallic parts and IEC 60079.11 Simple Apparatus Clause 5.7 for Group IIA/IIB, Zone 1 and Zone 2	SAC0012	Body Stainless Steel

Note 1: ≤ 0.50 percent composition by mass considered to be copper free alloy.

LSI-Robway Pty. Limited
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APPENDIX C, ATEX EC Type-Examination Certificate

Nemko

[1] EC TYPE-EXAMINATION CERTIFICATE

[2] Equipment or Protected System Intended for use in Potentially explosive atmospheres Directive 94/9/EC

[3]	**EC-Type Examination Certificate Number:**	**Nemko 08ATEX1433X**	**Issue 1**
[4]	**Equipment or Protective System:**	Display Module RCI-4100 and Display Barrier BAREX4120	
[5]	**Applicant / Manufacture:**	LSI- Robway Pty Ltd	
[6]	**Address:**	32 West Thebarton Rd, Thebarton South Australia, 5031 Australia	

[7] **This equipment or protective system and any acceptable variation thereto are specified in the schedule to this certificate and the documents therein referred to.**

[8] **Nemko AS, notified body number 0470 in accordance with Article 9 of Council Directive 94/9/EC of 23 March 1994, certifies that this equipment or protective system has been found to comply with the Essential Health and Safety requirements relating to the design and construction of equipment and protective systems intended for use in potentially explosive atmospheres given in Annex II to the Directive.**

The examination and test results are recorded in confidential report no. 230628

[9] **Compliance with the Essential Health and Safety Requirements has been assured by compliance with:**

CENELEC EN 60079-0: 2006, CENELEC EN 60079-11: 2007

[10] **If the sign "X" is placed after the certificate number, it indicates that the equipment or protective system is subject to special conditions for safe use specified in the schedule to this certificate.**

[11] **This EC-TYPE EXAMINATION CERTIFICATE relates only to the design, examination and tests of the specified equipment or protective system in accordance to the directive 94/9/EC.**
Further requirements of the Directive apply to the manufacturing process and supply of this equipment or protective system. These are not covered by this certificate.

[12] **The marking of the equipment or protective system shall include the following :**

CE_{0470}	Ex	II 2G	Ex ib IIB/IIA T4 -20°C≤Ta≤+60°C (Display Module RCI-4100)
CE_{0470}	Ex	II (2)G	[Ex ib] IIB/IIA -20°C≤Ta≤+60°C (Display Barrier BAREX4120)

Oslo, 2013-04-11

Asle Kaastad
Certification Manager, Ex-products

Postal address: **P.O.Box 73 Blindern N-0314 OSLO, NORWAY**
Office address: **Gaustadalléen 30 0373 OSLO**
Telephone: **+47 22 96 03 30** *Fax:* **+47 22 96 05 50**
Enterprise number: **NO 974404532**

APPENDIX D, IECEX Certificate of Conformity, Display Module Type RCI-4100IS

IECEx Certificate of Conformity

INTERNATIONAL ELECTROTECHNICAL COMMISSION
IEC Certification Scheme for Explosive Atmospheres

For rules and details of the IECEx Scheme visit www.iecex.com

Certificate No.: IECEx ITA 05.0021X Issue No.:2

Certificate history:
Issue No. 2 (2013-9-2)
Issue No. 1 (2013-1-14)
Issue No. 0 (2009-2-7)

Status: Current

Date of Issue: 2013-09-02 Page 1 of 5

Applicant: **LSI – Robway Pty Limited**
32 West Thebarton Road
Thebarton
South Australia, 5031
Australia

Electrical Apparatus *Optional accessory:* **Display Module Type RCI-4100 IS**

Type of Protection: **Ex ib IIB T4**

Marking: Ex ib IIB T4 (-20°C ≤ Tamb ≤ 60°C)
IECEx ITA 05.0021X

Approved for issue on behalf of the IECEx Certification Body: Parveen Adher

Position: Certification Authority

Signature: (for printed version)

Date: 2013-09-02

1. This certificate and schedule may only be reproduced in full.
2. This certificate is not transferable and remains the property of the issuing body.
3. The Status and authenticity of this certificate may be verified by visiting the Official IECEx Website.

Certificate issued by:

TUV Rheinland Australia Pty. Ltd
4 - 6 Second Street
Bowden SA 5007
Australia

TÜVRheinland

APPENDIX E, IECEX Certificate of Conformity, Model 4120 Power Supply and I2C Barrier

IECEx Certificate of Conformity

INTERNATIONAL ELECTROTECHNICAL COMMISSION
IEC Certification Scheme for Explosive Atmospheres

for rules and details of the IECEx Scheme visit www.iecex.com

Certificate No.:	IECEx ITA 08.0020X Issue No.:2	Certificate history: Issue No. 2 (2013-9-2) Issue No. 1 (2013-1-14) Issue No. 0 (2009-3-30)
Status:	Current	
Date of Issue:	2013-09-02	Page 1 of 4
Applicant:	LSI – Robway Pty Limited 32 West Thebarton Road, Thebarton, South Australia, 5031 Australia	
Electrical Apparatus *Optional accessory:*	Model 4120 Power Supply and I2C Barrier	
Type of Protection:	[Ex ib] IIB	
Marking:	[Ex ib] IIB (-20°C ≤ Tamb ≤ +60°C) IECEx ITA 08.0020X	
Approved for issue on behalf of the IECEx Certification Body:	Parveen Adher	
Position:	Certification Authority	
Signature: *(for printed version)*	Parveen Adher	
Date:	2013-09-02	

1. This certificate and schedule may only be reproduced in full.
2. This certificate is not transferable and remains the property of the issuing body.
3. The Status and authenticity of this certificate may be verified by visiting the Official IECEx Website.

Certificate issued by:

TUV Rheinland Australia Pty. Ltd
4 - 6 Second Street
Bowden SA 5007
Australia

TÜVRheinland

APPENDIX F, Data Logging

Data Logging on the RCI-4100

Introduction
Description of Logging features
Setting Up the Data Logger
Log Cycle Description
Accessing the Data Logger
Downloading the Data Logger (Overview)
Data Format
Erasing Data Logger Information
Errors in Data Logger
Detailed Instructions to Download Data Log Using SD Card
Viewing a DataLog using MSExcel
Datalog Error Codes

Introduction

The RCI-4100 data logging occurs automatically whenever the driver lifts a load, whenever the RCI-4100 detects an error condition on the crane such as moving outside the load chart or whenever the over-ride key switch is operated. The installer has the option to set the percentage of SWL a load must reach before the load will be logged. This logging percentage can be set anywhere between 13% and 110% of SWL.

In addition, the installer can configure three lift counters which can count the number of lifts performed in three distinct SWL % regions below the logging percentage.

Description of Logging Features

Data Logging is stored in a circular arrangement. That is, when the logs are full and another log is performed, the oldest log in the logger will be over-written. Each record stores the following data:

Log Number	Sequential number starting at “1”
Start Date	Date log started (dd/mm/yyyy)
Start Time	Time log started (hh:mm:ss)
Finish Date	Date log finished (dd/mm/yyyy)
Finish Time	Time log finished (hh:mm:ss)
Peak Load	Maximum Peak load recorded during log cycle
Stable Load	Maximum Stable load recorded during log cycle
SWL	Safe Working Load at operating position
Percent SWL	Percentage of Load/SWL
Radius	Operating Radius
Error Codes	Standard 3 digit LSI-Robway error codes compiled into a 10 digit number
Crane Model	Not used (always “1”)
Duty Number	Selected Duty number
Winch selected	Selected winch
Falls reeved	Selected falls
Over-ride state	Over-ride key switch state: Off or On

Logging is performed automatically when the percentage of SWL exceeds a threshold value which is set in Function Codes.

When the *logging percentage* is not exceeded while lifting a particular load, the lift occurrence can still be recorded in a *lift counter*. Three separate *lift counters* can be configured to store the number of lifts which occur in a particular SWL % region. Once again, the exact SWL percentages which will be counted can be configured by setting the appropriate Function Codes.

A summary of the logging percentage Function Codes is displayed in the following table:

Function Code Name	Description	Default Setting
Low Load Lift counter	swl percentage to record	20.0%
Medium Load Lift counter	swl percentage to record	40.0%
High Load Lift counter	swl percentage to record	65.0%
Logging Percentage	swl percentage to log	90.0%

These default settings would give rise to the following logging operation:

Low Load Lift Counter: counts the number of lifts which produce a SWL % which is greater than or equal to 20% but less than 40%.
Medium Load Lift Counter: counts the number of lifts which produce a SWL % which is greater than or equal to 40% but less than 65%.
High Load Lift Counter: counts the number of lifts which produce a SWL % which is greater than or equal to 65% but less than 90%.
Logger Records full data log of any lift which produces a SWL % which is greater than or equal to 90%

Setting Up the Data Logger

Data logging will occur at all times the display is operational. This includes the cases when, the over-ride is activated, the display is reporting an error and during the initial calibration of the system.

For the logger to operate properly the display must be fully and correctly calibrated. This includes date and time being set correctly. However, since the logger was recording during calibration it may be desirable to erase the logger contents after completing the angle and load calibrations on the RCI-4100 since the logger would have recorded some invalid information during the calibration of the sensors.

To erase the data logger contents, simply activate the appropriate Function Code once calibration is complete (refer **Erasing Data Logger Information**).

The operator can access three more Function Codes which control how the actual logging of loads operates. These three Function Codes are summarised in the following table

Stable Load Time	time during which load must stay stable in order to log
Stable Load Variation	load must stay within this variation to be considered stable
Reset Time	load must stay below the Low Load Counter threshold for this time before the log cycle ends

The first two Function codes in the table are used for definition of a stable load. When a load is hoisted it is probable that the initial load reading will be greater than the actual load on the hook because of the "snatching effect." The stable load is recorded only when these dynamic factors have died down and the load can be considered to be hanging from the hook in a relatively motion free position.

The "Stable load time" and "Stable load variation" Function codes can be used to adjust the load recording to minimise the effect of dynamic factors. The load will be considered stable if the load reading does not change by more than the "Stable load variation" setting (which is normally 0.5t by default) for a period of time set by "Stable load time" (which is normally 2 seconds by default).

The third Function code, "Reset time," is used for terminating a log cycle. When the load causes a SWL % which is less than the logging values (specifically the Low Load Lift counter percentage), then it is assumed that the driver must be putting the load down again. In order to ensure that a single load is not logged multiple times because the SWL % was hovering around the logging threshold, a log cycle will not complete until the load SWL % remains below the threshold for a certain period of time, namely of course the "Reset time" (by default the reset time is normally 5 seconds).

Log Cycle Description

Three types of log cycles are possible:

- Load is lifted inside load chart boundaries (valid SWL is seen at all times)
- SWL drops to 0 indicating the load chart has been exceeded, sensor error has occurred or slew error has occurred.
- Over-ride key switch is operated.

Type 1 Log- Valid SWL cycle

A log cycle is started when:
- The current SWL % (load/swl) exceeds the THRESHOLD (which will be the value set for the Low Load Lift Counter function Code).

During a log cycle:
- The load is monitored, the peak load seen is continually updated and if no stable load has been recorded then all other data is recorded against peak load
- A stable load condition will apply when the load remains within a small variation range (set by user through F-Code "Stable Load Variation") for a certain period of time (also an F-Code "Stable Load Time")
- When a stable load is seen, all data (except peak load) are recorded against the stable load.
- Load monitoring continues, the SWL percentage is continually checked against the SWL percentage which was stored, if the percentage increases, a new stable load will be recorded.

A log cycle is completed when:
- The current SWL % drops below the THRESHOLD for a period of time set by the Reset Time Function Code, or
- The SWL drops to 0 initiating a Type 2 Log cycle.

In either case, the currently performed log will be stored prior to initiating a new cycle.

Type 2 Log- Out of Load Chart / Error conditions

A log cycle is started when:
- SWL drops to 0, implying SWL % is unknown but definitely greater than 110%. In this case the SWL is nominally set to 110% and appears as ">110%" in the logger print out

During a log cycle:
- The load is monitored and the peak load seen is continually updated (in log 1)
- The radius is monitored and the max. Radius seen is continually updated (in log 2)

A log cycle is completed when:
- SWL becomes > 0 (log 1 AND log 2 are stored and condition for starting a type 1 log is checked)

Hence, if a load is lifted within the load chart a single log is performed. If the boom is positioned outside of the load chart, any log cycle in progress is stored and a new cycle begins. During this overload cycle two individual logs will be performed. One log will record the maximum load reading which is observed and the other will record the maximum radius which is observed. It is necessary to perform two logs because it is impossible to know which is a more unsafe condition, a longer radius or a shorter radius but higher load on the hook.

Stable loads are not monitored during out-of-chart/error logging cycles.

Logging on Multiple Winch Cranes

As previously stated, each winch that is being monitored will have its own set of lift counters which will automatically increment every time a load is lifted that generates a SWL percentage exceeding the Function Code value set for the "Low Load Lift Counter."

Actual logging of the load will occur only when the lift causes a SWL percentage which is higher than the "Logging Percentage" set in Function codes. It is possible to log a lift on the Auxiliary winch while the main winch is selected on the display.

As a further precaution, on twin winch systems, SUM winch logging can also occur. A log which refers to the M-SUM or A-SUM winch as the affected winch is implying that the combination of main + auxiliary loads would have exceeded the "Logging Percentage" value when referenced to what the boom can lift. This log is recorded in the instance when the main and auxiliary loads separately do not exceed the logging threshold (rather the individual SWL percentages for each winch would cause the winch counters to increment) but when considered together, they cause a SWL percentage which exceeds the "Logging Percentage" of what the boom is capable of lifting.

In this special instance, two logs will be stored to the data logger records in addition to the normal incrementing of the separate winches lift counters. These special logs are easily identified in the log table as they will identify M-SUM or A-SUM as the affected winch. The first of the two entries (M-SUM) relates information about the main winch condition when the (approach to) over load occurred and the second (A-SUM) records details the auxiliary winch condition.

Example Load Lift

Suppose a driver lifts a load and luffs out. If we assume the SWL % generated at the edge of the load chart is sufficient to cause a log to record then as soon as the driver exceeds the maximum radius on the chart, the active log cycle completes and is written to the logger prior to beginning an "out-of-chart" log cycle.

The out-of-chart cycle continues until the driver luffs the crane back into a safe condition. As soon as the safe condition is achieved, the out-of-chart logs (one for max. load and one for max. radius) will be stored to the logger.

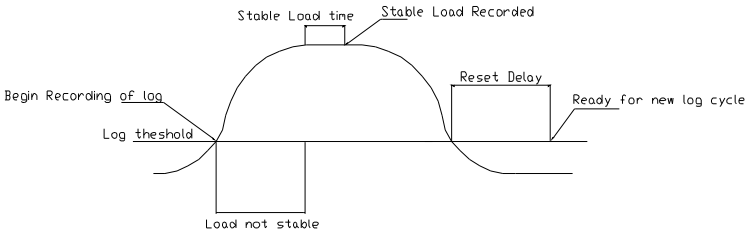
Because the crane is now back in a safe condition, a new logging cycle begins. When the driver finally puts this load down (assuming he does not luff off the chart again) the normal log cycle completes and another log is written to the logger.

Hence, although the driver has lifted only a single load and luffed it to several positions, the actual load has been recorded a total of 4 times. This example serves to illustrate that if the crane is continually working on its outer radius, the Logger will fill very quickly.

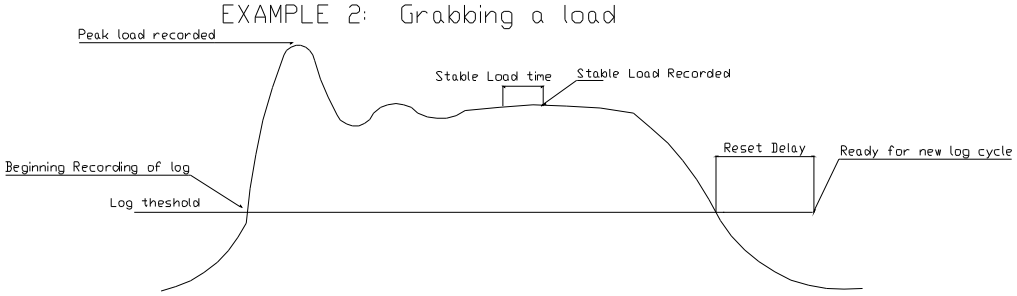
It should be noted that if motion cut is connected and the display is not in over-ride, luffing to the outer radius limits of the load chart could cause the crane to oscillate as motion cut activates. In this case many logs may be recorded.

Example Lift Cycles

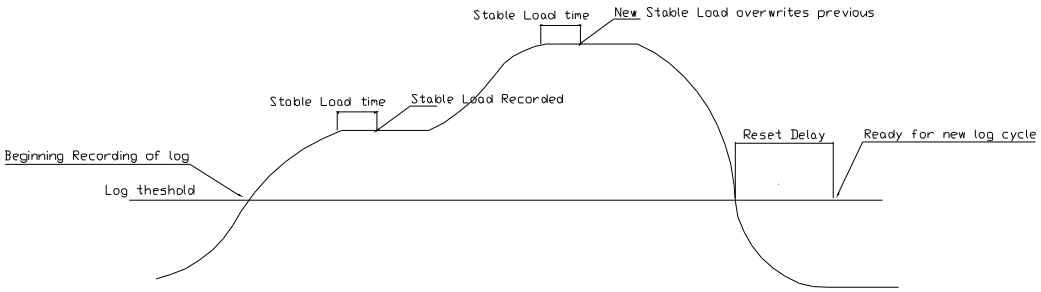
EXAMPLE 1: Smooth lifting of load



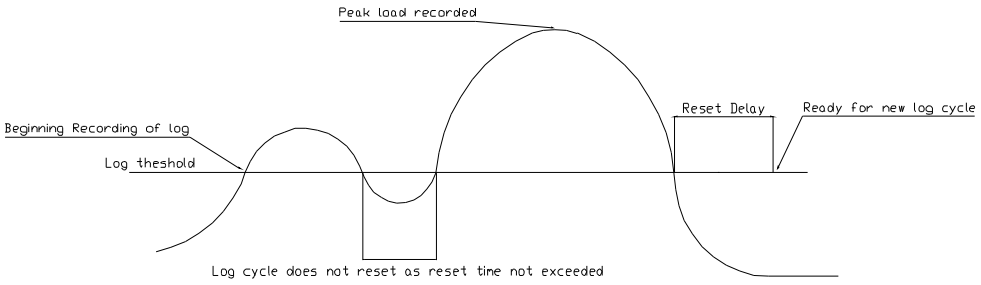
EXAMPLE 2: Grabbing a load



EXAMPLE 3: Partial lift (tension line) then lift load



EXAMPLE 4: Grab then drop or Crane Failure



Type 3 Over-ride key switch is operated.

A data log is created every time the over-ride key switch is operated. This data-log records crane data at the time that the over-ride key switch is operated.

Accessing the Data Logger

The operator can use two more Function codes for accessing the information stored in the data logger. These Function codes are used for:

- Downloading the data logger records to a PC or to an SD card fitted to the RCI-4100 controller SD card holder.
- Erasing the content of the data logger

Downloading Data Logger (Overview)

Downloading of data logger records can be performed at any time using the in-built SD card holder or by connecting a cable between the RCI-4100 and a standard PC or laptop and selecting the "Download Logger Contents" Function code.

Downloading using SD Card

See "**Detailed Instructions to Download Data Log using SD Card.**" below.

Downloading using a cable

The download can also be performed as an ASCII file transfer and the Hyper-Terminal program is normally used to receive the information from the RCI-4100. For further details contact LSI-Robway.

Data Format

Data is downloaded and saved as a log file and can be opened with any word processing program. Downloaded file name is normally xxxxx_nnnnnn.log where xxxxx is the last 5 digits of the software (WA number), and nnnnnn is the date (ddmmyy) the log was downloaded. Note that this date comes from the internal RCI-4100 clock. The log can also be imported into MSExcel for easier viewing. Each record will be printed in chronological order followed by the lift counter. If no records have been stored only a summary is shown.

A header is at the top of the data log:

DOWNLOAD PERFORMED (date time)

This line records the date and time when the download was performed.

After the last data log the following appears:

>END OF LIST<

Percentages Changed			(date time)
Lift Counter %		Main	Aux
20% to	40% SWL	x	x
40% to	65% SWL	x	x
65% to	90% SWL	x	x

Note: x = Actual number of lifts recorded.

- ">END OF LIST<" appears after the data log and confirms that all data logs have been downloaded.
- "Percentages Changed" shows the date and time when the percentage values for the counters and/or the logging percentage were last changed. The default date displayed is 01/01/2007. If the percentages are changed, this date and time will be stored. This date and time will be maintained until the values are once again altered or calibration data is cleared.
- "Lift Counter %" "Main" "Aux" are headers for the following entries:
- "20% to 40%" "40% to 65%" "65% to 90%" lines give a count of the total number of lifts recorded in the specified regions of SWL %. There are separate columns for Main and Auxiliary. The percentages shown in this table can be changed in Function codes (causing the date in the second line to change as previously mentioned).

The records are printed 1 per line with each field in the record separated by a tab character. This means the resultant file is a tab de-limited text file which is a suitable format for importing into spreadsheet programs such as MSExcel.

Downloading of the logger can be performed any number of times without affecting the contents of the logger.

Erasing Data Logger Information

Erasing of data logger records can be performed at any time by accessing the Function code for "Erasing Logger Contents."

Erasing the data logger will cause all currently recorded logs to be erased (hence the information can no longer be downloaded) and it also clears the SWL % counters.

Errors in Logger Data

On powering the display the contents of the data logger is checked in three separate operations. In almost all cases these checks will all pass OK. If however a check fails, the state of the logger is immediately questionable. These errors should not occur except in extenuating circumstances. If an error occurs the following message is displayed in the calibration window “LDATA” If this occurs the user must erase the logger contents. To erase contents in this event the over-ride key switch must be switched and “Enter” button pressed until normal display start-up resumes.

Detailed Instructions to Download Data Log using SD Card.

The RCI-4100 Control Unit has an on-board SD card to which data from the internal data logger can be downloaded and saved for reading on a PC.

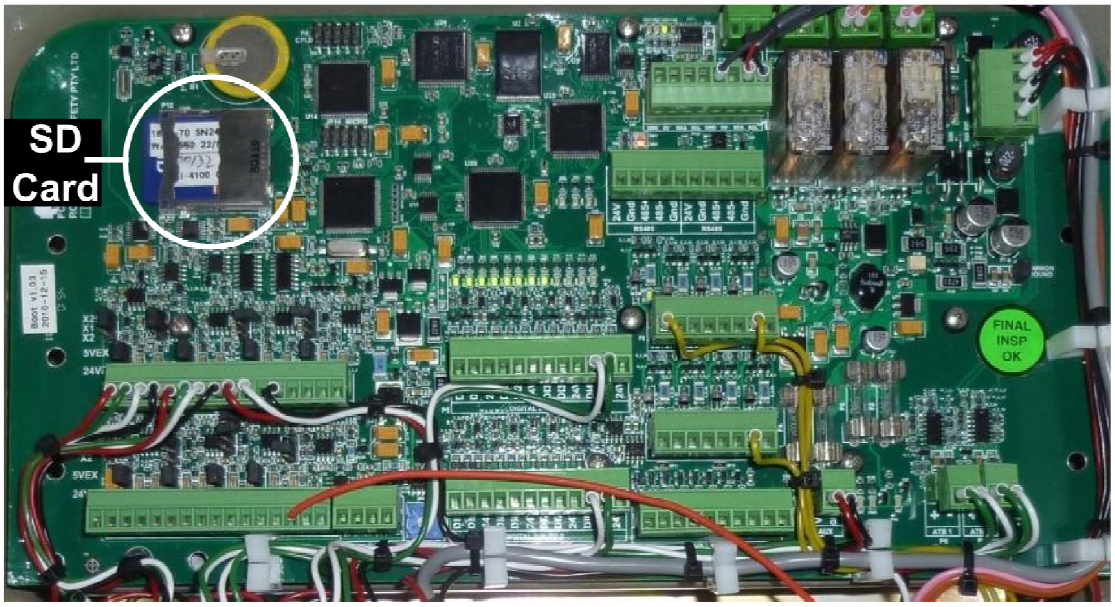
First, the internal logger records all data within the set parameters of the logger and system. The data is then stored in the on-board flash memory chip.

Calibration Mode Function Codes are used for downloading the logger contents from the on-board memory into the SD card. The SD card can then be removed from the Control Unit and inserted into the card reader on a PC for viewing, saving and printing the recorded data.

As the logger contents can only be downloaded in Calibration Mode, only authorised personnel with access to the over-ride key and Calibration Mode can perform this function.

Procedure is as follows:

- Turn RCI-4100 power off.
- Open the controller and place an SD card into the SD card holder on the RCI-4100 controller unit board (see figure below)



- Turn the over-ride key switch ON and access Calibration Mode.
- Go to the “Download Data Log” function code and press the ENTER key.
- The default setting on the screen is “RS232”. Use the up/down arrow keys to select “SD CARD”.
- While “SDCARD” is shown on the screen press the ENTER key and this will download the logger contents into the SD card. This may take a few minutes depending on the amount of data being transferred. While downloading 3 dots are shown under F-xx number. When download is completed the message ‘DONE’ will appear.
- Switch RCI-4100 power off.
- Carefully remove the SD card and insert it into a card reader on a PC for viewing the logger contents. Downloaded data is in the *.LOG file.
- RCI-4100 power can be re-applied now.
- Open the *. LOG file using any word processing program such as MS Word or Notepad for viewing, saving and/or printing of data. This file can also be imported into MS Excel for easier viewing.
- Once saved the *.LOG file can be cleared/deleted from the SD card.

Viewing a DataLog using MS Excel

For easier viewing of the log, it can be imported into a MS Excel spreadsheet. Contact LSI-Robway for further details.

Datalog Error Codes

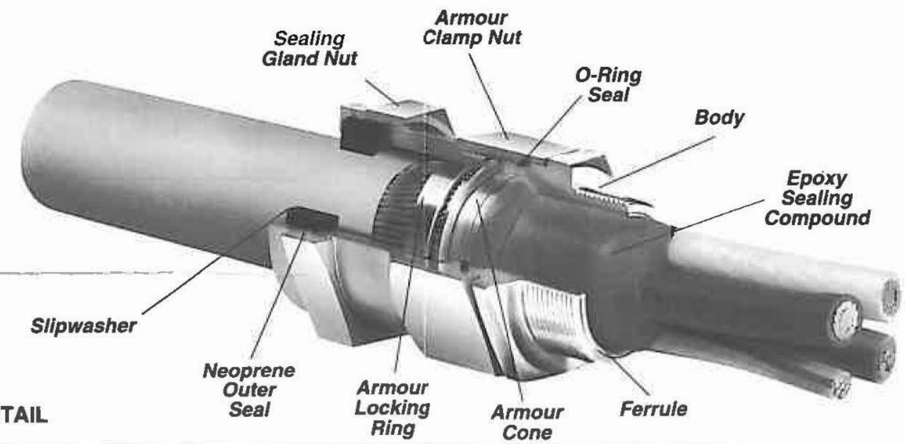
The following page lists the error codes and an explanation on how to interpret them.

Code	Meaning	Screen message *(Italics - borers only)*	Datalog Error Code				
	No errors		00	00	00	00	00
101	Angle sensor 1 is open or short circuit	Angle Sensor 1	01	00	00	00	00
102	Angle sensor 2 is open or short circuit	Angle Sensor 2/*RightFront O/R SW*	02	00	00	00	00
104	Angle sensor 3 is open or short circuit	Angle Sensor 3/*RightRear O/R SW*	04	00	00	00	00
108	Angle sensor 4 is open or short circuit	Angle Sensor 4	08	00	00	00	00
110	Length sensor 1 is open or short circuit	Length Sensor 1	10	00	00	00	00
120	Length sensor 2 is open or short circuit	Length Sensor 2/*LeftRear O/R SW*	20	00	00	00	00
140	Length sensor 3 is open or short circuit	Length Sensor 3/*LeftFront O/R SW*	40	00	00	00	00
180	Length sensor 4 is open or short circuit	Length Sensor 4/*Encoder Comms Error*	80	00	00	00	00
201	Load sensor 1 is open or short circuit	Load Sensor 1	00	01	00	00	00
202	Load sensor 2 is open or short circuit	Load Sensor 2	00	02	00	00	00
204	Load sensor 3 is open or short circuit	Load Sensor 3	00	04	00	00	00
208	Load sensor 4 is open or short circuit	Load Sensor 4	00	08	00	00	00
210	Digital input error detected	Digital Input	00	10	00	00	00
220	Crane is two-blocking (RCI-1550/3100 only)	ATB	00	20	00	00	00
240	Current load exceeds safe working load	Overload	00	40	00	00	00
280	Current load exceeds line pull	Linepull	00	80	00	00	00
301	Angle is off load the chart or limit is exceeded	Angle out of allowed range	00	00	01	00	00
302	Length is off load the chart or limit is exceeded	Length out of allowed range	00	00	02	00	00
304	Radius is off load the chart or limit is exceeded	Radius out of allowed range	00	00	04	00	00
308	Height is off load the chart or limit is exceeded	Height out of allowed range	00	00	08	00	00
310	Crane has been positioned in a non-lifting area	Slew out of allowed range	00	00	10	00	00
320	Duty/Winch has not been calibrated	Load not cal. (Load moment Only)	00	00	20	00	00
340	Reserved		00	00	40	00	00
380	Reserved		00	00	80	00	00
401	Problem reading flash image	Flash Image Error	00	00	00	01	00
402	Tower out of valid angles	Tower Angle Range	00	00	00	02	00
404	No chart for active slew/tower zone	Illegal lifting zone	00	00	00	04	00
408	Chart Type not supported in code (null f-ptr for type)	Unsupported Chart Type	00	00	00	08	00
410	Loads on > 1 winch	Loads on > 1 winch	00	00	00	10	00
420	Combined loads exceed active winch SWL	Combined Loads Exceed SWL	00	00	00	20	00
440	Relative angle too small	Relative Angle too small	00	00	00	40	00
480	Relative angle too big	Relative Angle too big	00	00	00	80	00
501	Radio Receiver not responding	Radio Rx Comms	00	00	00	00	01
502	Radio Transmitter not responding	Tx Comms Fail	00	00	00	00	02
504	Radio Transmitter battery failure	Tx Low Battery	00	00	00	00	04
508	Radio Transmitter short-circuit	Tx ATB Short	00	00	00	00	08
510	IIC device error	IIC Device Error	00	00	00	00	10

520	Faulty data logger memory, the system could not store log data, the system needs to be restarted so it can execute recovery sequence	Logger memory problem, logging stopped, please restart (RCI-1550/3100 only)	00	00	00	00	20

Datalogger error code notes:
Multiple errors may be shown in one error code. Eg:
0140000000 would be a 101 and 240 at the same time
0300000000 would be a 101 and a 102 at the same time
As hex code is used, when errors in a particular column exceed 9, hex codes are used: A=10, B=11, C=12, D=13, E=14, F=15 etc. Eg:
00C0000000 would be a 240 and a 280 at the same time
00000F0000 would be a 301, 302, 304 and 308 at the same time.

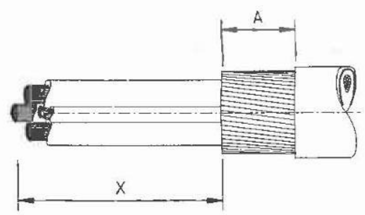
APPENDIX G, Cable Gland Installation Instructions



TORQUE TIGHTENING TABLE		
Metric mm	NPT inches	Newton Metres
20	1/2"	54Nm
25	3/4"	68Nm
32	1"	83Nm
40	1-1/4"	92Nm
50	1-1/2"	123Nm
63	2"	141Nm
75	2-1/2"	178Nm

FIGURE 1. TWAB ASSEMBLY DETAIL

FIGURE 2. PREPARING THE CABLE



1. Mark length x to give sufficient room inside enclosure to connect to the relevant terminals.
2. Cut through the outer sheath and partly through the armour wire.
3. Split and discard the outer sheath and then bend and break off armour wire.
4. Cut and remove inner sheath and fillers to expose cable cores.
5. Measure off length 'A'. Cut and remove outer sheath.

CABLE AND GLAND DETAILS

8 sizes cover cable diameters from 16mm to 78mm.
Entry sizes from M20 to M75 I.S.O./½ NPT to 2½ NPT

ENTRY DIAMETER		TERMINATOR SELECTION	CABLE RANGE DETAIL					GLAND SIZE DATA				
		CATALOGUE NUMBER	ACTUAL DIAMETER				DIAMETER OF WIRE ARMOUR	ENTRY LENGTH	APPROX PROJ LENGTH	HEXAGON SIZE		LENGTH 'A' (Figure 2)
METRIC	NPT	For ∗ Add M (Metric) or N (NPT)	UNDER ARMOUR		OVERALL					ACROSS FLATS	ACROSS CORNERS	
			MIN mm	MAX mm	MIN mm	MAX mm						
mm	inch						mm	mm	mm	mm	mm	mm
20	1/2"	TWAB1∗16	6.0	8.0	10.2	15.8	0.9/1.25	14.0	58.0	30.4	34.0	15
20	1/2"	TWAB1∗20	7.0	12.0	14.0	20.8	0.9/1.25	14.0	58.0	30.4	34.0	15
25	3/4"	TWAB2∗27	11.0	18.0	18.0	27.2	1.25/1.6	16.0	60.0	38.5	43.0	20
32	1"	TWAB3∗34	17.0	25.0	25.0	33.5	1.6/2.0	20.0	72.0	47.2	53.0	22
40	1-1/4"	TWAB4∗40	24.0	31.0	30.0	39.9	1.6/2.0	20.0	74.0	57.0	64.0	25
50	1-1/2"	TWAB5∗53	30.0	41.0	36.0	52.6	2.0/2.5	20.0	82.0	70.0	78.0	30
63	2"	TWAB6∗66	40.0	54.0	51.0	65.3	2.0/2.5	22.0	90.0	80.0	88.0	35
75	2-1/2"	TWAB7∗78	53.0	65.0	63.0	78.0	2.5/3.5	22.0	98.0	101.0	112.0	40

GLAND ASSEMBLY (Figure 1)

1. Screw gland body into threaded entry in equipment.
2. Prepare the cable (Fig. 2).
3. Assemble in order, over the cable — heat shrink or shroud, gland nut assembly and armour locking ring.
4. Assemble armour cone up to armour wire, raise the wire and push the cone in under the wire until the wire ends are against the shoulder on the cone.
5. Assemble the ferrule onto the cone, feed the conductors and the whole assembly into the gland body and tighten the gland nut, thus clamping the armour wire in the cone and clamp ring assembly.
6. Loosen the gland nut and remove the cable assembly with the ferrule from the gland body.

YOU ARE NOW READY TO LOAD THE EPOXY COMPOUND

A. Mix the epoxy according to instructions in epoxy container.
B. Spread the cable cores and push epoxy into the inner space.
C. Squeeze cores back together — pack epoxy around the cores into the armour cone cavity and into the large end of the ferrule leaving a hole up the centre.
D. Slide the loaded ferrule over the cable cores and into the armour cone up to the marked ring on the cone.

7. Assemble the cable and epoxied components into the gland body and tighten gland nut up tight. See torque table.
8. Loosen the gland nut and remove excess epoxy from the outer surfaces of ferrule and inner surfaces of gland body.
9. Reassemble — tighten outer gland nut onto cable. See torque table.
10. Leave to harden for a minimum of 4 hours at 20°C.

APPENDIX H, Restricted Slew Zone Monitoring Option

Operating Instruction (Restricted Slew Zone Controller)

The following sections explain how to set and operate the Restricted Slew Zone Controller and make best use of its capabilities.

This RCI-4100 has an integrated Restricted Slew Zone (RSZ) controller designed to warn the operator of an impending collision between the crane boom and a fixed structure/obstacle. The RSZ controller works independently from the normal Rated Capacity Indicator mode of the RCI-4100 system. It is comprised of the following components integrated into the system:

Slew Encoder
The slew encoder is used to monitor the position (slew angle) of the crane boom. It is usually fitted with a suitable drive gear and meshed directly with the crane's slew ring or pinion gear.

Boom Angle Sensor
In addition to its normal function to the Rated Capacity Indicator mode, the main boom angle sensor is also used in combination with the slew angle in setting unsafe zones.

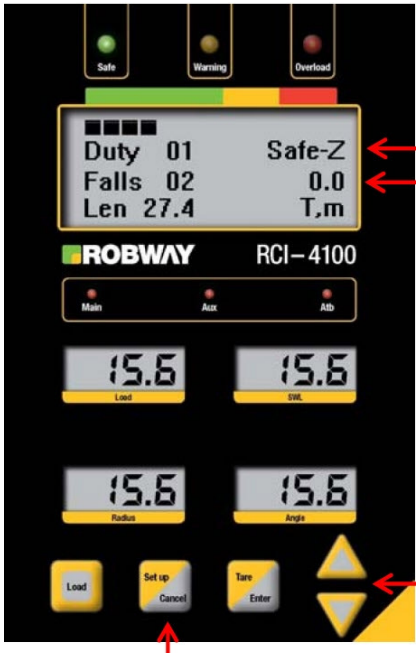
Operating Screens (RSZ)

Viewing Slew Angle and RSZ Status:

Rated Capacity Indicator (RCI) Mode

Press & hold UP or DOWN arrow key for about 5 seconds to view slew angle and RSZ status.

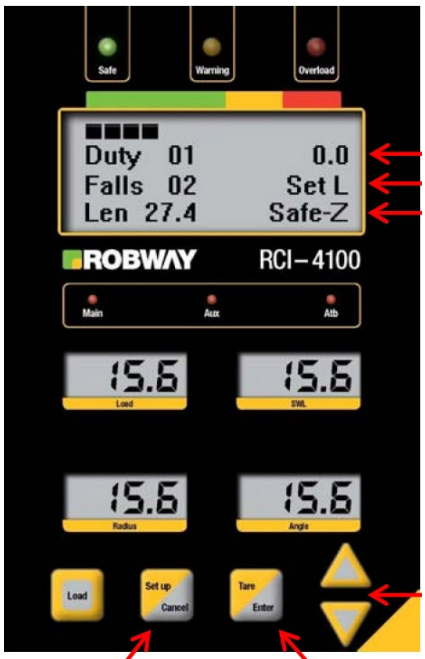
RSZ View Mode



RSZ status (Safe, Rest, No-Go) Boom slew angle

Press UP or DOWN arrow key again to enter RSZ setup mode (see next Section "Setting Up Zones).

Press SETUP/CANCEL key to return to RCI mode



Boom Slew Angle
Menu Items
RSZ Status
(Safe, Rest, No-Go)

Use the UP or DOWN arrow key to select a menu item (Set L, Set R, Lo Ang, Hi Ang, Delete, ClrAll, Split, Unite L, Unite R)

Press SETUP/CANCEL key to return to RCI mode.

After selecting a menu item, press the ENTER key to accept and confirm the selection, or press the CANCEL key to abort changes to current selection.

Checking Slew Angle

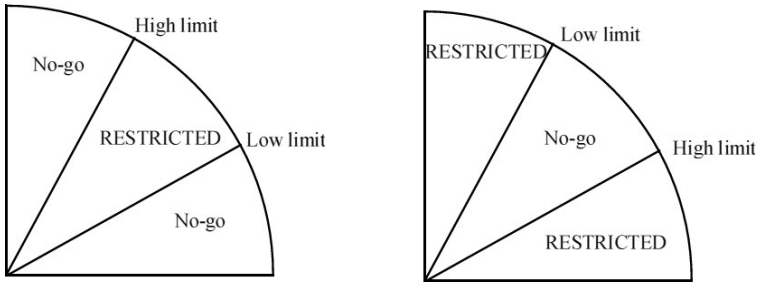
Slew angle is shown relative to the reset position (0 degree). Turning the superstructure to the right (clockwise) increases the angle while turning it to the left (anti-clockwise) decreases it. The full range is 0 to 360 degrees. The operator can see the current slew angle and RSZ status of the machine by pressing the UP or DOWN arrow key for about 5 seconds while in normal RCI mode. The alphanumeric screen will switch to RSZ view mode showing the current slew angle and RSZ status.

Permanent and Temporary Zones

Two independent sets of zones are maintained. The permanent zone set can only be accessed by authorised personnel who are equipped with the "over-ride" key. The temporary set can be accessed and edited by the operator freely. The system will monitor both sets continuously and will work out combined safety restrictions.

Boom Angle Limits

An unsafe zone is fully defined only if boom angle limits are set in it. High and low angle limits are used. When a new restricted zone is added, both limits are set to 90.0 degrees (boom vertical). That makes the whole zone a "no-go" area. Boom angle limits can be changed by executing a respective command from the menu items of the RSZ setup mode (see also "Setting Zones" below). The "no-go" section of the unsafe zone is limited by High Angle Limit from below and by Low Angle Limit from above. The drawing below explains the idea and shows two possible cases of setting for an unsafe zone:



Setting Zones

In order to set slew zones the operator will need to enter the RSZ setup mode. If the over-ride key switch is concurrently switched on, the Permanent Set will be active, otherwise the Temporary (Operator's) Set will be active. The operator can browse through the menu items list by pressing the UP or DOWN arrow key.

The menu items on RSZ setup mode are as follows:

"Set L"	Set left	Set an unsafe zone left boundary
"Set R"	Set right	Set an unsafe zone right boundary
"Lo Ang"	Low angle	Set the low boom angle limit for the current unsafe zone
"Hi Ang"	High angle	Set the high boom angle limit for the current unsafe zone
"Delete"	Delete	Change the zone status from "safe" to "unsafe" and vice versa
"ClrAll"	Clear all	Remove all the zones and sets one safe zone 360 degree wide (start 0 deg)
"Split"	Split	Split an unsafe zone into two unsafe zones
"Unite L"	Unite left	Merge an unsafe zone to the adjacent unsafe zone to the left
"Unite R"	Unite right	Merge an unsafe zone to the adjacent unsafe zone to the right

Remarks

- On the first start-up the whole area is set to "Safe" with the start and the end at 0 deg.
- Executing a "Set Left" or "Set Right" command in a safe zone will split that zone into a safe and an unsafe zone (the actual boom position will become a new boundary).
- Executing "Set Left" or "Set Right" commands inside an unsafe zone will adjust that zone and the adjacent one boundary.
- The standard maximum number of zones in one set (safe and unsafe altogether) is 6. There are two sets of zones: the Permanent Set and the Temporary (Operator's) Set.
- If the maximum number of zones has been reached no new zones can be created. "Set Left" or "Set Right" command will only adjust an existing unsafe zone boundary in this case (no splitting. no adding).
- If two safe zones become adjacent to each other they will be automatically merged into one.
- In order to create a safe zone inside a restricted zone split it into three first and then delete the middle zone.

Alarms and Motion Cut Conditions

The following are the zone information, descriptions and alarm/motion cut conditions:

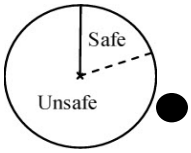
Zone Info	Alarm	Crane Motion	Description
Safe	No alarm	Not affected	Safe zone
Rest	Intermittent audible alarm only	**Not** affected	Unsafe zone, "restricted" section
No Go	Continuous audible and visual alarms (all LEDs ON). Error code E310 will also be shown on screen.	Slew motion cut active	Unsafe zone, "no-go" section

Error Code

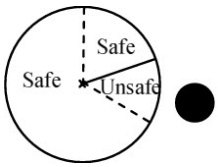
The RSZ controller has its own error code "E310" which will be shown if the boom is positioned in a "No Go" zone.

Examples

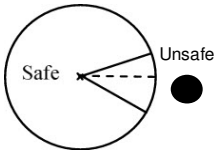
On first start-up and after executing "Clear All" command (C1rAll) there is only one area defined. The area is safe and starts from slew position 0.0 degree. The over-ride key switch has to be switched ON if zones set-up is to be permanent. For the "operator's" set-up leave the key OFF.



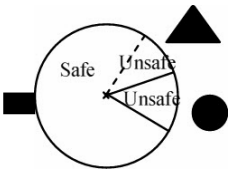
The black dot represents an obstacle. In order to define an unsafe area its boundaries have to be defined. The operator slews to the position marked by the broken line and executes "Set Left" zone boundary (Set L) command.



Next the operator slews the boom to the other side of the obstacle and executes "Set Right" zone boundary" (Set R) command. Two safe adjacent zones will be automatically merged together.



For the unsafe area being fully defined the boom angle limits have to be set. The boom must be placed somewhere inside the respective unsafe area and luffed to the position of the limit. Then the "Set High Angle Limit " (Hi Ang) or "Set Low Angle Limit" (Lo Ang) command has to be executed as required (see also: "Boom Angle Limits" above). The first unsafe zone has been defined.



The procedure for defining subsequent unsafe zones is slightly different and depends on their position relative to other zones. If the new zone adjoins another unsafe zone it is enough to set its other boundary. In the example, the operator only needs to position the boom as the broken line shows and execute "Set Left" zone boundary" ("Set L") command.

APPENDIX I, Wind Speed Monitoring Option

Operating Instruction (Wind Speed Monitoring)

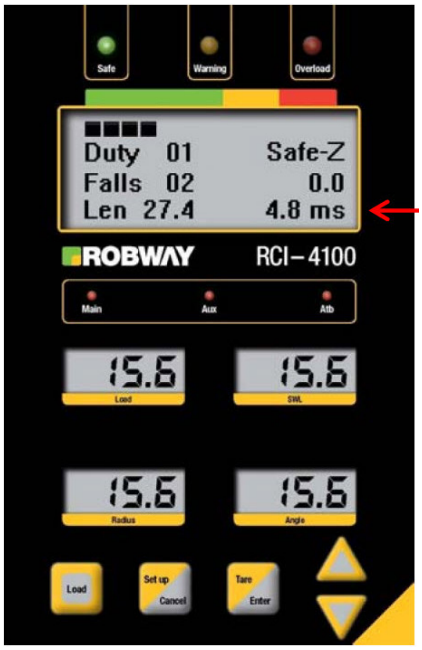
General Information

The RCI-4100 system can be used to monitor and display wind speed by integrating a wind speed sensor (LSI-Robway Part No. ANEMOMETER3).

Refer to the Wind Speed Sensor specifications at the end of this section.

Refer RCI System Configuration Documents in Attachments for wiring details.

The RCI-4100 displays the wind speed on the lower right hand side of the alphanumeric screen in metre per second (ms) as shown on the illustration below.



Wind speed indication in metres per second

Wind speed monitoring can be included in the RCI-4100 system with the following options:

- Basic Wind Speed Monitor
    - This option provides continuous monitoring and display of the wind speed but without alarms on warning and maximum limit.
- Wind Speed Monitor with Alarm Limit
    - This option provides continuous monitoring and display of the wind speed as well as function codes to set warning alarm and maximum wind speed limit alarm.

Calibration

The wind speed sensor is pre-calibrated in the RCI-4100 software. No on-site calibration is required.

Periodic System Testing

There is no periodic testing or re-calibration required.

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LSI ROBWAY
A TRIMBLE COMPANY

Windspeed Sensor
Part Number: ANEMOMETER3
Revision: 1.1

The ANEMOMETER3 Wind Speed Sensor has been specifically designed to accurately and reliably measure wind velocity under the most adverse environmental conditions. It is particularly useful in remote, unattended monitoring applications where high winds and/or heavy icing conditions are likely to be encountered. Corrosion resistant materials such as stainless steel and anodized aluminum, are used in production.

Features

- Low starting threshold
- Stainless steel ball bearings for greatest accuracy and operating life
- Built-in ice skirt allowing operation with a 5.1cm (2") ice load
- Robust aluminum cup assembly
- Sealed magnetic reed switch

Specifications

PERFORMANCE CHARACTERISTICS	
Range:	67 m/s / 0 - 150 mph
Starting Threshold:	0.45 m/s / 1.0 mph
Accuracy:	±0.11 m/s / 0.25 mph or 2%
Distance Constant:	Less than 4.5m / 15 ft
Operating Range:	-50°C to +70°C (-58°F to +158°F)
Contact Rating:	10 mA maximum
PHYSICAL CHARACTERISTICS	
Weight:	400gms / 14oz
Finish:	Black anodized aluminium
MOUNTING	
Mounting:	Optional PN 191 Crossarm assembly (optional – can also be used to mount wind direction sensor ANEMOMETER4)

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APPENDIX J, Wind Direction Monitoring Option

Operating Instruction (Wind Direction Monitoring)

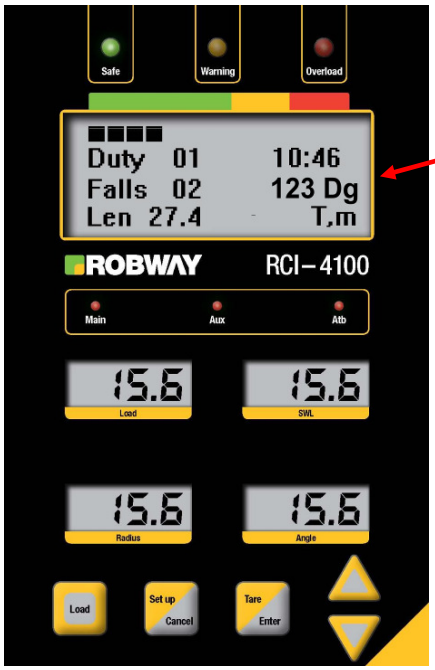
General Information

The RCI-4100 system can be used to monitor and display wind direction by integrating a wind direction sensor (LSI-Robway Part No. ANEMOMETER4).

Refer to the Wind Direction Sensor specifications at the end of this section.

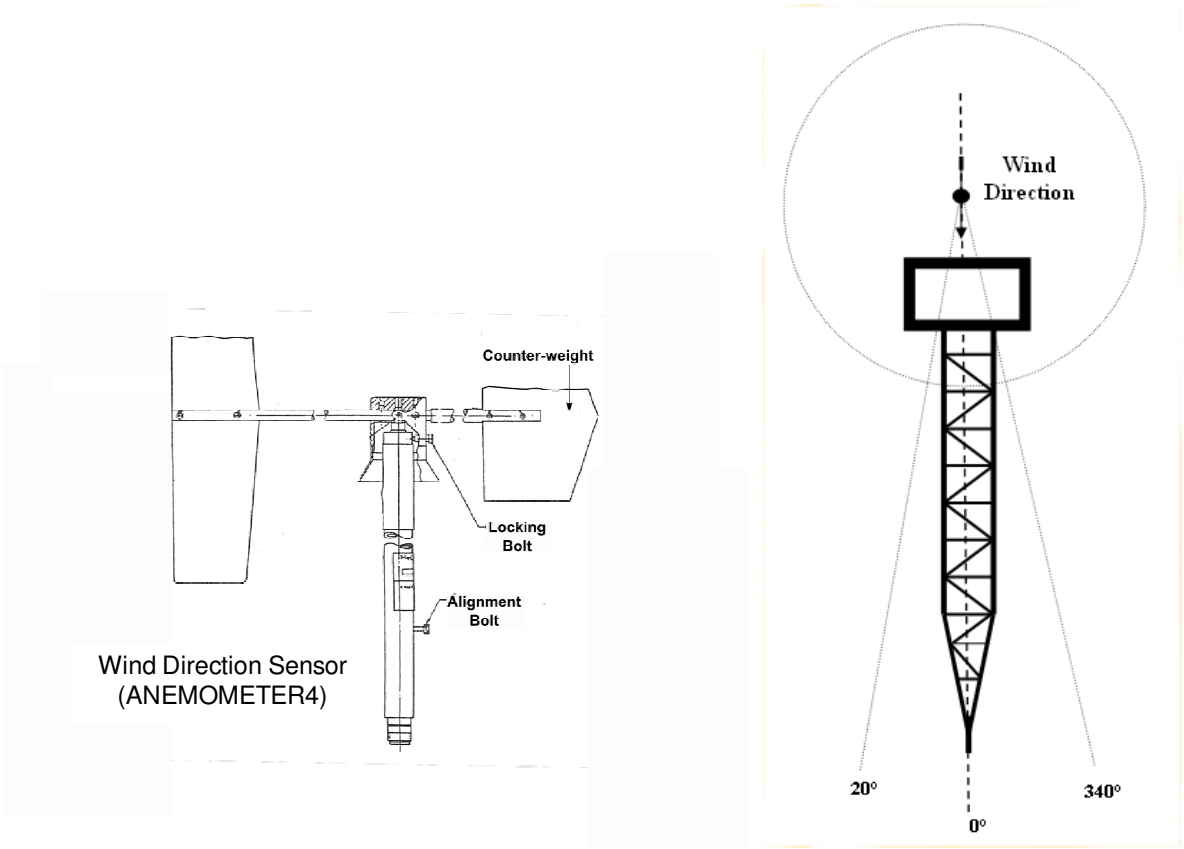
Refer RCI System Configuration Documents in Attachments for wiring details.

The RCI-4100 displays the wind direction on the lower right hand side of the alphanumeric screen in degrees as shown on the illustration below. If Restricted Slew Zone (RSZ) is being used, RSZ messages may overlay the wind direction reading.



Calibration

The wind direction sensor is pre-calibrated in the RCI-4100 software and is shipped with the direction arm locked to the mounting shaft.
The wind direction sensor is normally mounted on a cross arm (LSI-Robway Part No CROSSARMASSY) specifically designed for mounting this sensor. After installation the wind direction sensor should be rotated so that the counterweight points towards the rear of the boom then the mounting bolts on the cross arm tightened. Refer to picture below.



After installation is complete remove the locking bolt (and retain for future use). The wind direction sensor is now free to rotate. The sensor will now face into the prevailing wind and is fully operational.

Periodic System Testing

There is no periodic testing required.

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LSI ROBWAY
A TRIMBLE COMPANY

Wind Direction Sensor
Part Number: ANEMOMETER4
Revision: 1.1

LSI-Robway's Wind Direction Sensor has been specifically designed to accurately and reliably measure wind direction under the most adverse environmental conditions. It is particularly useful in remote, unattended monitoring applications where high winds and/or heavy icing conditions are likely to be encountered. Only the best corrosion resistant material, such as stainless steel and anodized aluminum, are used in production.

Features

- Low starting threshold of 0.67 m/s (1.5 mph)
- Unique "Mechanical Average System" reduces sensor wear
- Built-in alignment and calibration fixture
- Built-in ice skirt allowing operation with a 5.1cm (2") ice load
- Slotted shaft coupler for increased sensor life

Specifications

PERFORMANCE CHARACTERISTICS	
Electrical Range:	0° - 360°
Maximum Wind Speed:	67m/s/150 mph
Accuracy:	±10° Standard Optional ±5°
Delay Distance:	4.5M/15 ft
Damping Ratio:	.3
Potentiometer Specifications	
Sand, dust, fungus:	MIL-E-5272
Salt spray:	MIL-E-12934
Resistance Value:	10 K ohms
Operating Range:	-50°C to +70°C (-58°F to +158°F)
PHYSICAL CHARACTERISTICS	
Weight:	0.68 kg / 1.5 lbs
Finish:	Black anodized aluminum
MOUNTING	
Mounting:	Optional PN 191 Crossarm assembly (optional -- can also be used to mount wind direction sensor ANEMOMETER4)

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APPENDIX K, Automatic Gross Overload Option

RCI-4100 AUTOMATIC GROSS OVERLOAD PROTECTION

An Automatic Gross Overload Protection (AGOP) option is available for LSI-Robway RCI-4100 Rated Capacity Indicator systems. The AGOP output is triggered when the maximum SWL is exceeded by a predetermined percentage and several other confirming conditions are met for arming AGOP.

The system features are:

- Tension-based Main and Auxiliary load calculation
- AMBER AGOP Armed indicator provided to Operator
- RED AGOP Active indicator provided to Operator
- Onboard / Personnel Lift / Offboard duty selector knob for Operator
- Duty selector switch provides a redundant set of contacts to physically disconnect the AGOP output signal when either Personnel Lift or On-board Duty is selected
- Slew zone switch closed when crane slews offboard
- Slew switch provides a redundant means of disabling the AGOP output signal when the crane is slewing in an onboard slew zone.
- Absolute value encoder used both as a restricted slew zone control and as a redundant slew value to back up the slew proximity switch.
- Maximum Luff RAM pressure table versus boom angle to validate the load data.

THEORY OF OPERATION

The LSI-Robway AGOP system uses a combination of hardware interlocks and software checks to prevent the unwanted release of a load suspended in an on-board condition, i.e. release is prevented over the deck of the platform (on-board), and at all times during a personnel lift. Several conditions must be met in order for the LSI-Robway system to output an AGOP Active output. These are:

a) Duty Selector knob in “OFF-BOARD” position.
b) On-board / off-board slew proxy closed (closed = off-board)
c) Absolute encoder indicating off-board position.
d) Hoist-rope tension exceeding SWL by a predetermined percentage e.g. 150%
e) Overload condition validated by luffing RAM pressures indicating an overload condition based upon customer-supplied maximum pressure versus boom-angle charts.
f) Short time-delay exceeded after all conditions met to filter out transient signals.

Optional AGOP system features are:

g) Hook height below deck monitoring
h) Constant tension controls in winches (manufacturer provided)
i) Proximity siren warning of Active AGOP

Hardware Interlocks

The following prevents an AGOP trigger regardless of the RCI-4100 controller state:

1. Duty Selector rotary switch in operator console NOT set to “Off-board” duty.
2. Slew Proxy switch on-board and/or slew proxy switch circuit OPEN.

Software AGOP Arming and Activation

Software performs the following checks with each software cycle to arm and then activate an AGOP output:

1. Off-board duty selected.
2. Off-board Slew Proxy switch circuit CLOSED.
3. Absolute slew encoder indicating Off-board crane slew.

At this point AGOP is ARMED indicated by an AMBER Operator Console indicator light.

4. Hoist tension indicating 150% overload present.
5. Hoist rope tension overload validated by cross-referencing with luffing RAM pressures exceeding 100%.
6. Pre-set 0.1 to 2.5 second delay exceeded after AGOP conditions met (transient filtering).

At this point AGOP is ACTIVATED indicated by a RED Operator Console indicator light. Both Main and Aux hooks are monitored regardless of operator winch selection.

The AGOP output relay will remain in an activated energised state until a pre-set AGOP reset time expires. The AGOP reset time is programmable from 0 to 60 seconds.

Crane Operator Console

In order to minimize human error with duty selection an operator console is provided which gives the crane operator a single rotary switch to select duty and a second rotary switch to select sea-state. The operator console has two indicator lamps which gives the operator an AMBER lamp indicating that AGOP is armed and a RED lamp warning that AGOP has been activated. These indicator lamps are driven by the RCI-4100 controller based upon conditions above.

Additional System Components Required

1. Ex d Operator Console with AGOP Status indicator lamps and rotary duty selector knob. (LSI-Robway supply)
2. Ex d Absolute Value slew encoder with SSI interface (LSI-Robway Supply)
3. Luff-Ram pressure transducers. Bridge-type transducers compliant with IEC 60079.11 Simple Apparatus clause (LSI-Robway Supply).
4. Off-board slew proxy switch compliant with IEC 60079.11 Simple Apparatus clause

Periodic System Testing

Periodic testing shall be black-box testing. This means that neither the system software, nor loadchart data is modified during the testing process.

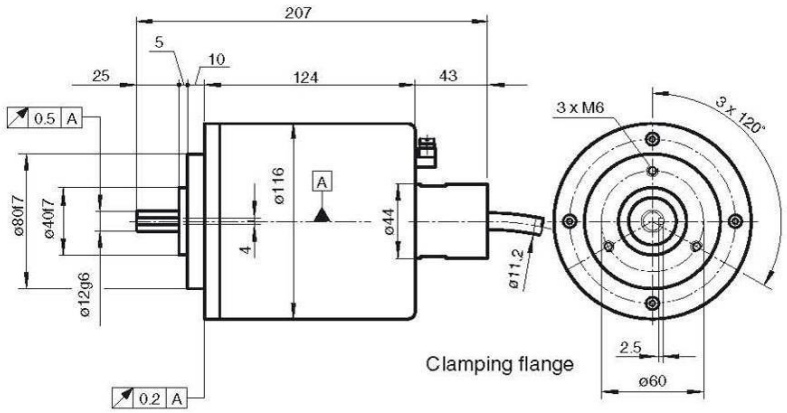
In order to facilitate periodic testing after the crane has been commissioned an AGOP Isolator switch is required. This lockout switch prevents an AGOP active output from reaching the winch controls.

See Procedure TP0233, “AGOP Periodic Maintenance Test Procedure”.

System Diagnostics

The system wiring uses two safety relays with contact feedback wired in series on the RCI-4100 processor to allow output diagnostics with each system start-up. By having two relays in series the RCI-4100 can test one relay at a time without generating an AGOP active output. This is only performed when the system starts or is reset and only if there is no load on either the main or aux hook. This prevents an unwanted AGOP active signal in the event of loss of power and subsequent restart during a lift.

RCI-4100 ABSOLUTE SLEW ENCODER



DESCRIPTION

The Pepperl-Fuchs AVM14 Series ATEX EEx d encoder with SSI interface is used for monitoring crane slew. The AVM14 is an absolute encoder which always maintains an accurate reading regardless of either RCI or AVM14 encoder power cycling.

The AVM14 Absolute Encoder has 24 bit resolution consisting of 12 bits resolution per shaft revolution and 12 bits of resolution to count number of shaft revolutions.

The serial data is continuously clocked out of the AVM14 via a hardware shift register implemented in a PCB4205 CPLD. The AVM14 also has an encoder-zero preset function which may be performed in the sensor junction box by connecting a shorting jumper between the zero-preset function pin to signal ground for one second. By default the encoder will count in a CCW direction and direction can be changed to CW by connecting pins 1 to 8 in the junction box.

NOTE: The RCI-4100 CPLD versions for AGOP application are non-standard and must be specially programmed for AGOP system operation.

INSTALLATION

The AVM14 Encoder must be installed in accordance with Pepperl-Fuchs instructions and with the relevant hazardous area installations standards/codes of practices.

WIRING

The AVM14 data interface is based upon RS422 clock and data signals. The PCB4205 Processor GPIO port is utilized for the data interface and requires a CIRPCB4311 TTL-to-RS422 signal conversion daughterboard.

Green/Yellow	Protective conductor	Description
1	GND (rotary encoder) 1	Supply minus
2	+Ub (rotary encoder) 2	Supply plus 10-30 VDC
3	Clock (+) 3	RS422+ Input
4	Clock (-) 4	RS422- Input
5	Data (+) 5	RS422+ Output
6	Data (-) 6	RS422- Output
7	Zero Preset 7	Normal – floating input Zero Sensor - Short to Pin 2 for one second
8	Counting direction 8	Normal = floating input = CCW Ascending Jumper to Pin 1 = CW Ascending

The following must performed to commission the absolute slew encoder:

1. Identify and document intended zero-degree heading for the installation. Zero-degree heading must be in an onboard location for fail-to-safe response.
2. Install and power encoder as per system diagram and instructions.
3. Slew crane to the pre-determined zero degree reference heading.
4. Set Encoder to zero counts by shorting pin 7 to pin 2 for one second inside the junction box.
5. Select the appropriate RCI-4100 function code to enter number of teeth on slew gear.
6. Use appropriate RCI-4100 function code to enter the number of teeth on the encoder cog.

Once these steps are performed the encoder will read from 0.0 to 359.9 degrees as the crane slews. Note that the encoder is limited to 2047 rotations in either direction. This will not be an issue with most installations since the slew gearing ratio may typically be 15:1, thus the crane would need to slew in one direction only 137 turns before reaching the limit.

APPENDIX L, Tilt Sensing Option

OPERATION

OVERVIEW

The RCI-4100 system may be fitted with an optional dual-axis tilt sensor which may be used to monitor the tilt of a crane in any direction. Software revision is required to add a tilt sensor to an installed RCI-4100 system.

The RCI-4100 displays the tilt in degrees on the lower right hand side of the alphanumeric screen.

THEORY OF OPERATION

The dual-axis tilt sensor is mounted in the bottom of the RCI-4100 controller housing and is zeroed at time of installation. The sensor scaling parameters are hardcoded in the RCI-4100 firmware thus no calibration other than zeroing of the sensor at installation is required.

Only one number is reported for the Tilt of the crane structure. The Tilt value reported is the absolute value of the tilt in any direction. The Tilt value is calculated by trigonometrically summing the X and Y axis tilt magnitudes. Thus if the tilt of the crane is 10 degrees in any direction throughout a 360 degree range the X and Y output signals will be converted to vectors and summed. This means that the orientation of the sensor in the X and Y axis is not important, only the initial level when it is zeroed.

The RCI-4100 will generate an alarm when the alarm threshold is exceeded which varies with Duty Selection. These alarm thresholds are 2.5 degrees and 5 degrees. No motion-cut output signals are activated when the alarm threshold is exceeded.

COMPONENTS REQUIRED

The components required for adding the Tilt Monitoring capability to the RCI-4100 are identified in the following table:

Qty	Order Code	Description	Location
1	TILTSENKUB5V-10	Tilt Sensor, Dual Axis, ±10 degrees.	Controller Enclosure
3	TER280520	DIN terminals, See G/A DWG xxxx	Controller DIN Rail
1	WAxxxxxx	Tilt Monitoring Software functionality	Firmware
1	N/A	G/A Drawing XXXX	N/A

INSTALLATION

Warning The Dual-Axis Tilt sensor is not intrinsically safe and must be installed in a safe area. Installing the tilt sensor inside the RCI-4100 controller enclosure will satisfy this requirement.

The RCI-4100 controller enclosure must be mounted such that:

1) The RCI-4100 Controller enclosure is firmly affixed to the structure of the crane to be monitored for tilt.
2) The RCI-4100 is mounted such that the bottom face is within +/-5 degrees of level. NOTE: Any variation from level will add or subtract correspondingly from full scale in a given direction.
3) The Tilt sensor must be connected to the analogue input as shown on the system GA drawing.

CALIBRATION

The tilt sensor is pre-calibrated in the RCI-4100 firmware to a range of +/- 10 degrees in each axis. A single slope value is computed from the X and Y axis vectors. There is no RCI-4100 system programmability; however the sensor must be zeroed according to the following:

1) Tilt Sensor must be zeroed upon initial installation.
2) Tilt Sensor must be zeroed if the RCI-4100 controller housing is relocated or moved in any way.

The sensor zeroing procedure is as follows:

1) Ensure the crane is level to within a tenth of a degree as verified by a precision tilt meter.
2) Apply power to the system
3) Short Zero-Teach input to RCI-4100 system ground for two seconds.
4) Verify tilt reading on the RCI-4100 display shows 0.0 degrees.

If there is any change in the RCI-4100 enclosure orientation the sensor must be zeroed again.

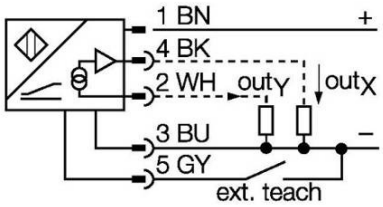
PERIODIC SYSTEM TESTING

There is no periodic testing or re-calibration required.

TILT SENSOR SPECIFICATIONS

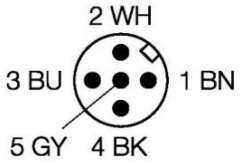
Axes	X and Y	
Range	± 10°	
Accuracy	± 0.3°	
Resolution	≤ 0.05°	
Output	0.1 to 4.9 VDC	
Sensor Zero Range	Within ± 5°	
Mechanical	Housing Material	Plastic PBT-GF20-V0
	Dimensions LxWxH mm	60 x 30 x 20 mm
	Weight	0.05 kg
Power Supply	Voltage	10-30 VDC
	Current	20 mA
Environmental	Temperature	-20C to +70C
	Ingress	IP68
	Humidity	99%
	Shock	30 g, 11 ms
	Vibration	55 Hz (1 mm)
Compliance	RoHS	Yes
	CE	Yes
	EMC Emissions	EN 61362-2-3
Interconnection	Power, zero teach, and 2 axis outputs	M12-5 male

Connections

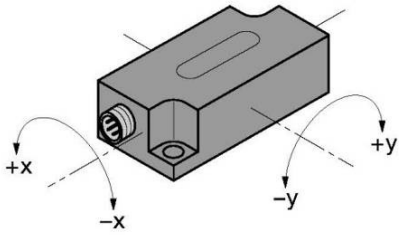


ext. teach: if this input is connected to 0 V, then the output of the inclinometer is reset to 0°.

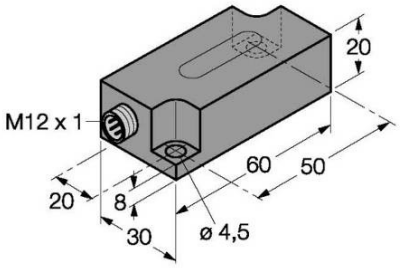
Terminal assignment



Direction of Inclination



Dimensions



APPENDIX M, Hook Height DISRCI4100 Display Option

Operating Instructions (Hook Height)

The following explains the Hook Height Encoder. These instructions apply to both main and auxiliary Hook Height Encoders.

Overview

This RCI-4100 has an integrated Hook Height controller designed to indicate main/auxiliary hook height.

The Hook Height controller works independently from the normal Rated Capacity Indicator mode of the RCI-4100 system. It is comprised of the following components integrated into the system:

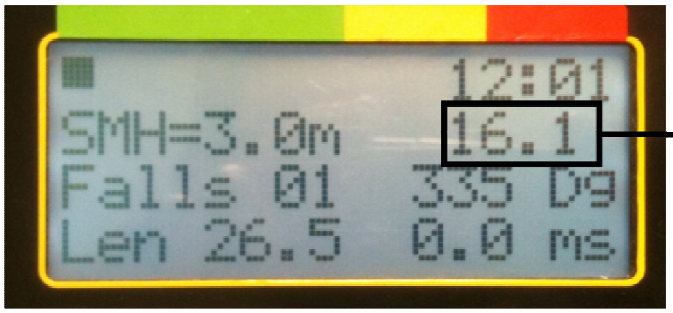
- Winch Encoder. The winch encoder is used to monitor the winch and hook height. The encoder is usually fitted with a suitable drive gear and meshed directly with the crane's winch. Specifications for the H-38 incremental encoder are at the end of this appendix.
- Boom Angle Sensor. In addition to its normal function to the Rated Capacity Indicator mode, the main boom angle sensor is also used in combination with the winch encoder to monitor hook height.

Note: Hook Height indication is not a linear measure. The height at either calibration point will be correct but at other heights is not linear and may not be accurate.

Operation

Display

Hook height (for the selected winch) is displayed in the upper display. The picture below illustrates the hook height display.



Note: If the RCI-4100 system also has the RSZ option installed, RSZ messages (eg “OBSTACLE”) may overlay the Hook Height reading.

Calibration

Step 1) Lower the hook to the ground level
Step 2) Enter function code “Calibrate Main Hook Height”, use up/down arrows to select “0.0” and press “Enter”.
Step 3) “0 DONE” will appear on the display, then “HOOK UP” will appear.
Step 4) Lift the hook to a known height
Step 5) Use up/down arrows to select actual height and press “Enter”.
Step 6) Enter function code “View Main Calibrated Hook Height Input” and confirm that height is accurate and that height changes when the hook is moving up and down.

Repeat for the Auxiliary using function code “Calibrate Auxiliary Hook Height” to calibrate and “View Auxiliary Hook Height Input” to view.
Refer RCI System Configuration Documents in Attachments for applicable function codes.

Reset

The height encoder can be easily reset to ground level (0.0) at any time.
To reset height select appropriate winch, then press and hold “UP” and “DOWN” buttons together. After a few seconds hook height will reset to “0.0”.

Fault Finding

Function codes “View Uncalibrated Main Hook Height Input” (Main) and “View Uncalibrated Auxiliary Hook Height Input” (Auxiliary) display uncalibrated data from the encoders. The displayed numbers should change as the encoder rotates. This can be useful to ensure correct operation of the encoder and also for fault finding.

Periodic System Testing

Hook height should be re-calibrated whenever boom length is changed.
Hook height should be reset whenever crane tower height is changed.
There is no periodic testing or re-calibration required.

H-38 Incremental Encoder Specification

Explosion Proof Slew Encoder
Part Number: ENCH38D
For RCI-4100 systems
CENELEC EExd IIB T4
ATEX Certificate: Demko 04 ATEX 0335698

General

The H38 is an explosion proof version of the field-proven H25 encoder series. The H38 is UL certified for NEMA Class 4X and 6 (outdoor non-hazardous locations) and Class 4X and 13 (indoor non-hazardous locations) and Class 1, Group D, Division 1 or Class 2, Division 1 Group E, F, and G rating for use in hazardous locations.

It features a standard shaft seal, double bearing seals, and a cast aluminum housing with hard anodized and dichromate sealed finish. The H38 is suitable for use in petroleum service industries, solvent refining operations, spray painting applications, and explosive dust environments.

Environmental Specifications

Enclosure Rating: NEMA 4X & 6 (IP66), outdoor Non-Hazardous locations, NEMA 4X & 13 (IP66),

indoor Non-Hazardous locations

Temperature: Operating, -40 to +70º Celsius

Shock: 50 g's at 11 msec

Vibration: 5 to 2000 Hz @ 20 g's

Humidity: 100% RH

Hazardous Area Rating: Underwriters Laboratories listed for use in hazardous locations; NEMA Enclosure 7. Class 1, Group C & D, Division 1, NEC Class 2 circuits only, or Class 2, Groups E, F, and G

Mechanical Specifications

Shaft Diameter: 3/8" nominal

Shaft Loading: Up to 40 pounds axial and 20 pounds radial applied 1/4" from housing

Shaft Runout: 0.0005 T.I.R.

Starting Torque at 25°C: 4.0 in-oz (max)

Bearings: Class ABEC 7 standard

Shaft Material: 303 stainless steel

Enclosure: Die cast aluminum, hard anodized, dichromate sealed finish. Shaft seals and sealed bearings are standard to achieve environmental ratings.

Bearing Life: 2 X 108 revs (1300 hrs at 2500 RPM) at rated load.

Maximum RPM: 10,000 RPM

Moment of Inertia: 4.1 X 10–4 oz-in-sec2

Weight: 64 oz typical (approx 4 lbs)

Electrical Specifications

Code: Incremental or Absolute

Output Format: 2 channels in quadrature,

Cycles per Shaft Turn: 30 per turn

Supply Voltage: 5 to 28 VDC

Current Requirements: 100 mA typical +output load, 250 mA (max)

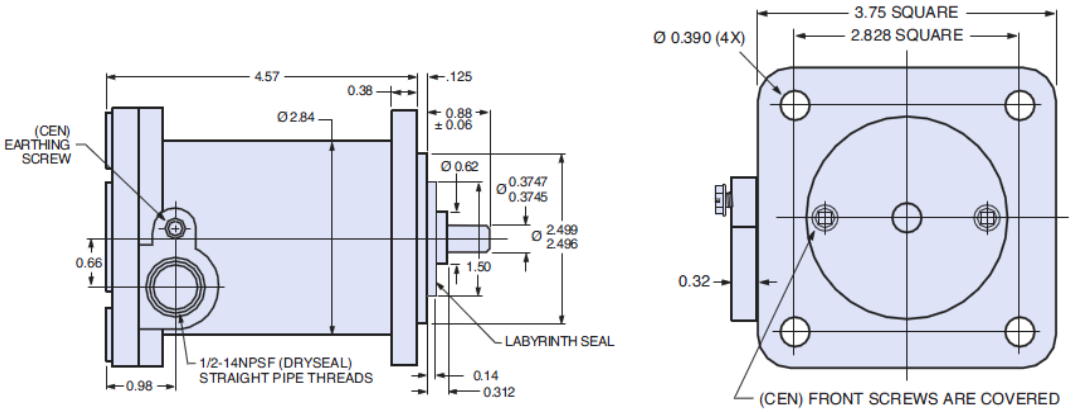
Voltage/Output: 5–28 VDC in, Vout = 5 VDC

Protection Level: Reverse, overvoltage and output short circuit

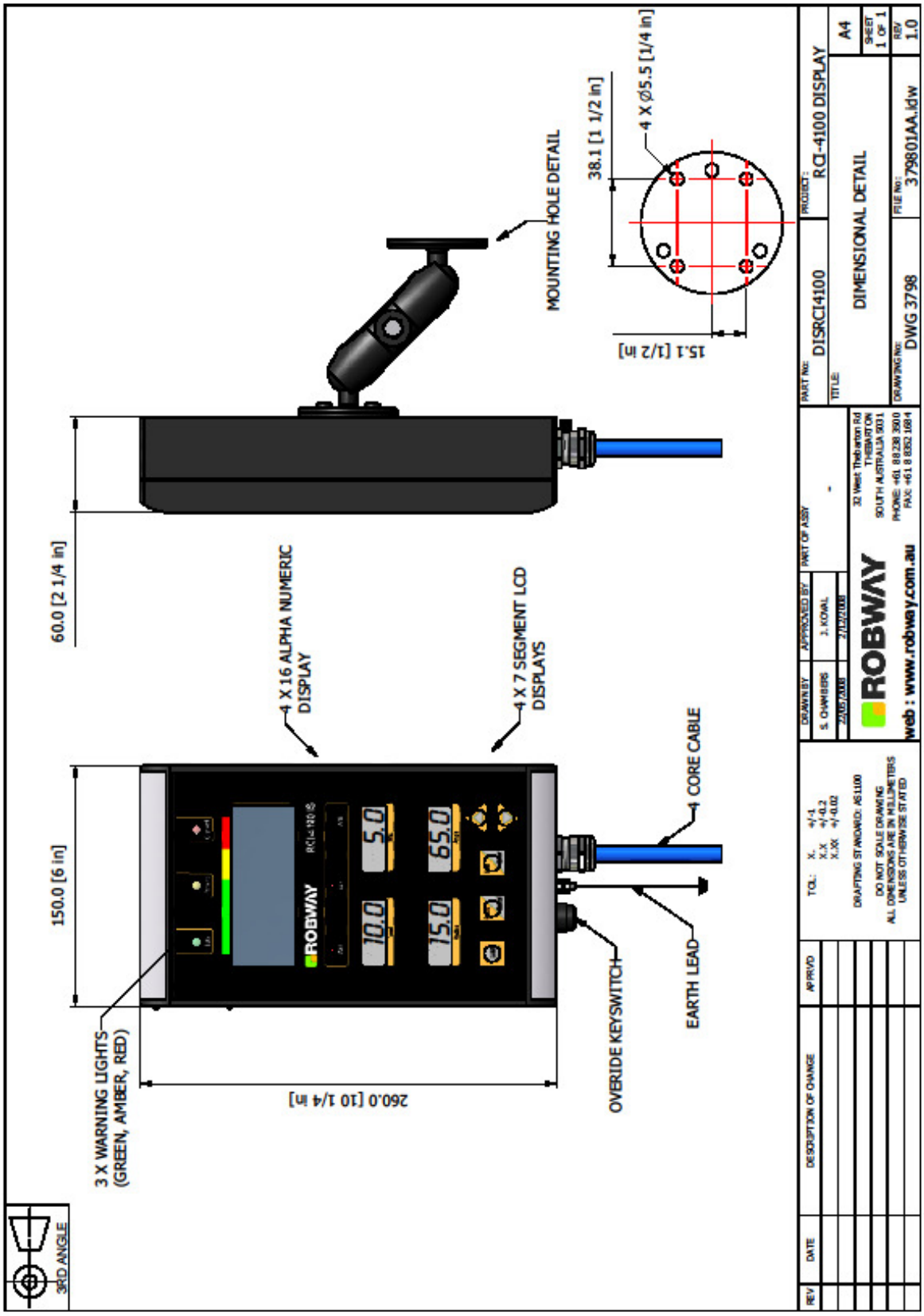
Frequency Response: 100 KHz, Up to 1MHz with interpolation option

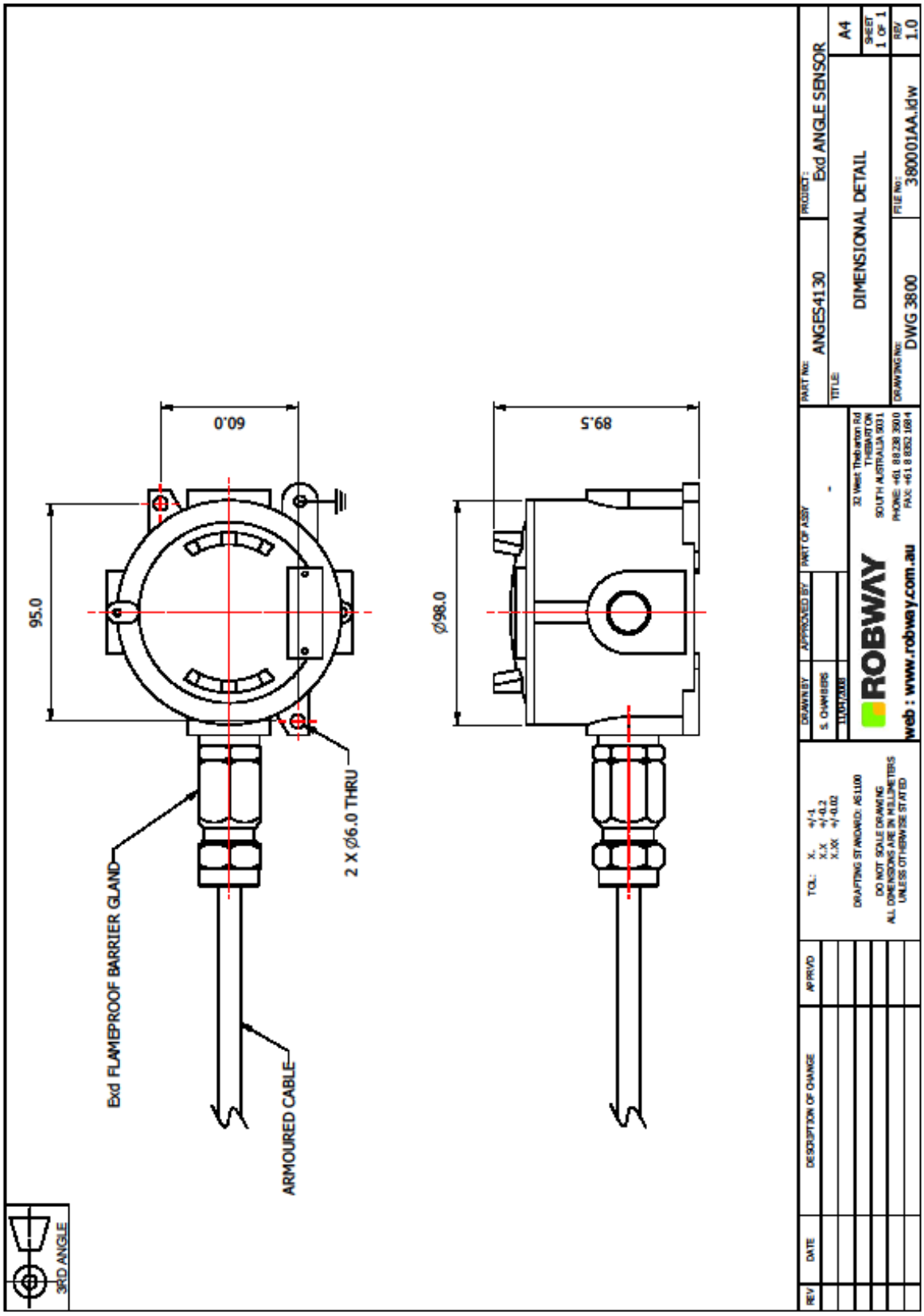
Termination Type: Compression type, UL recognized. Accepts AWG 14 to 22, stranded wire, strip 1/4"

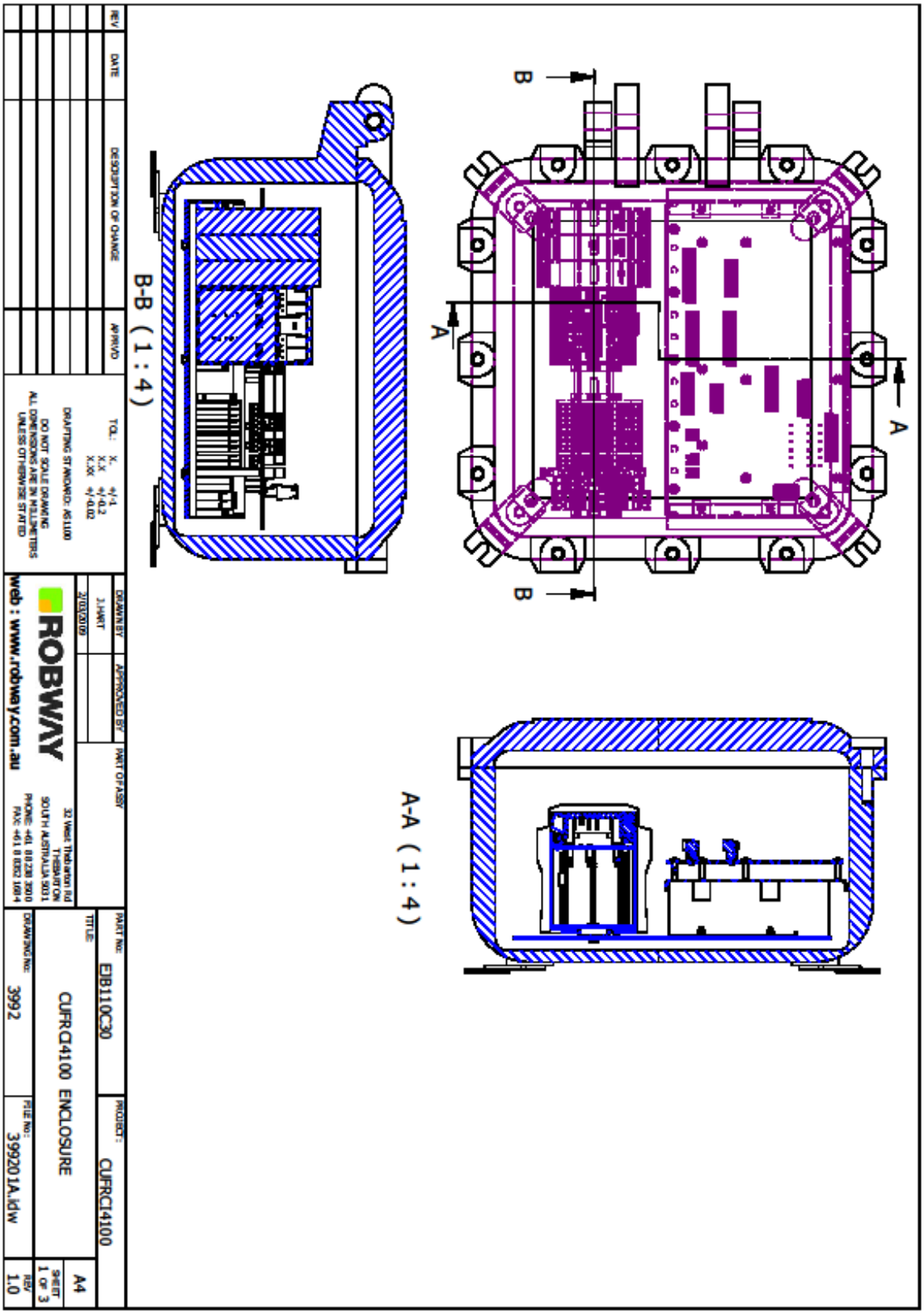
CEN

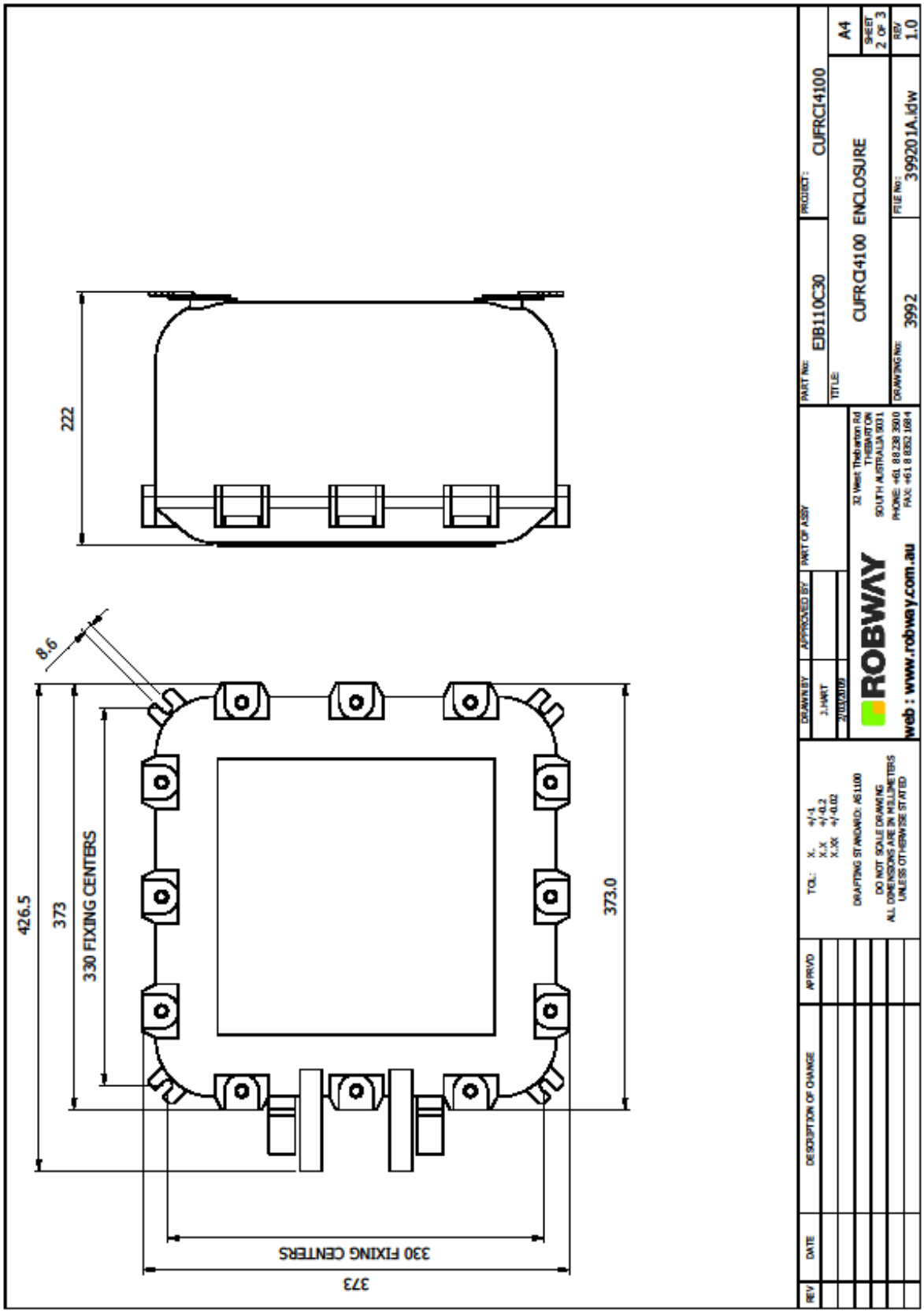


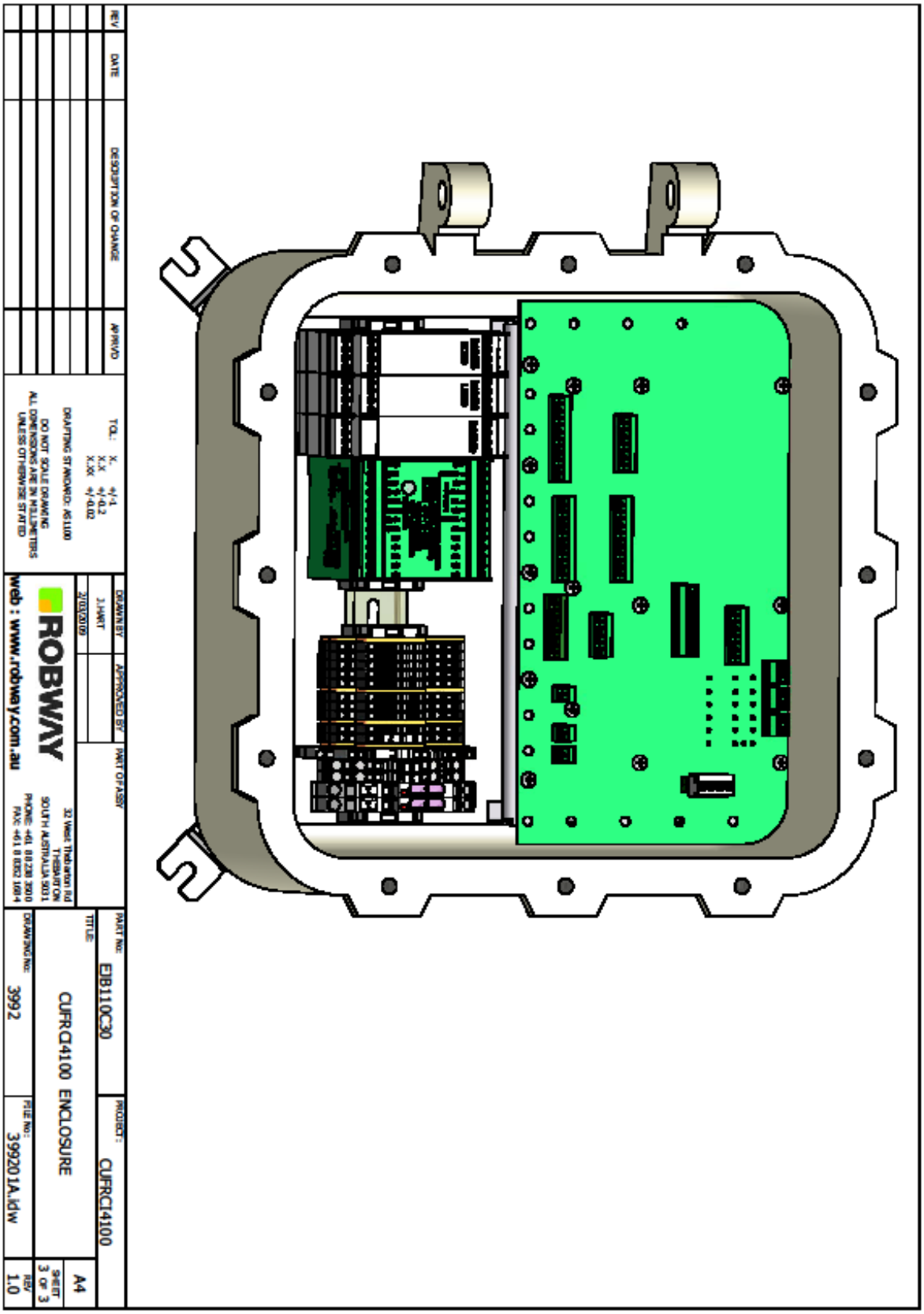
APPENDIX N, System Drawings

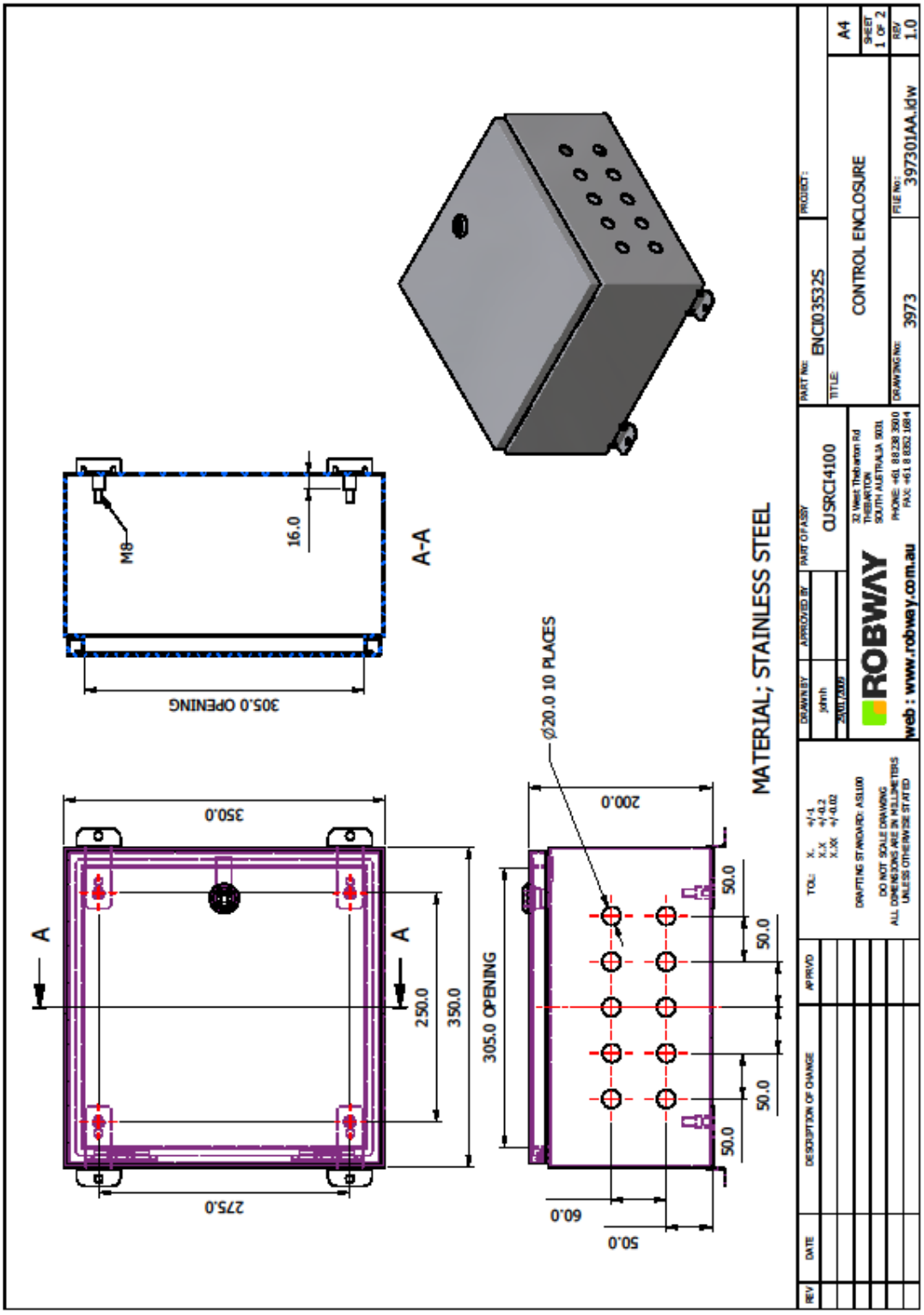


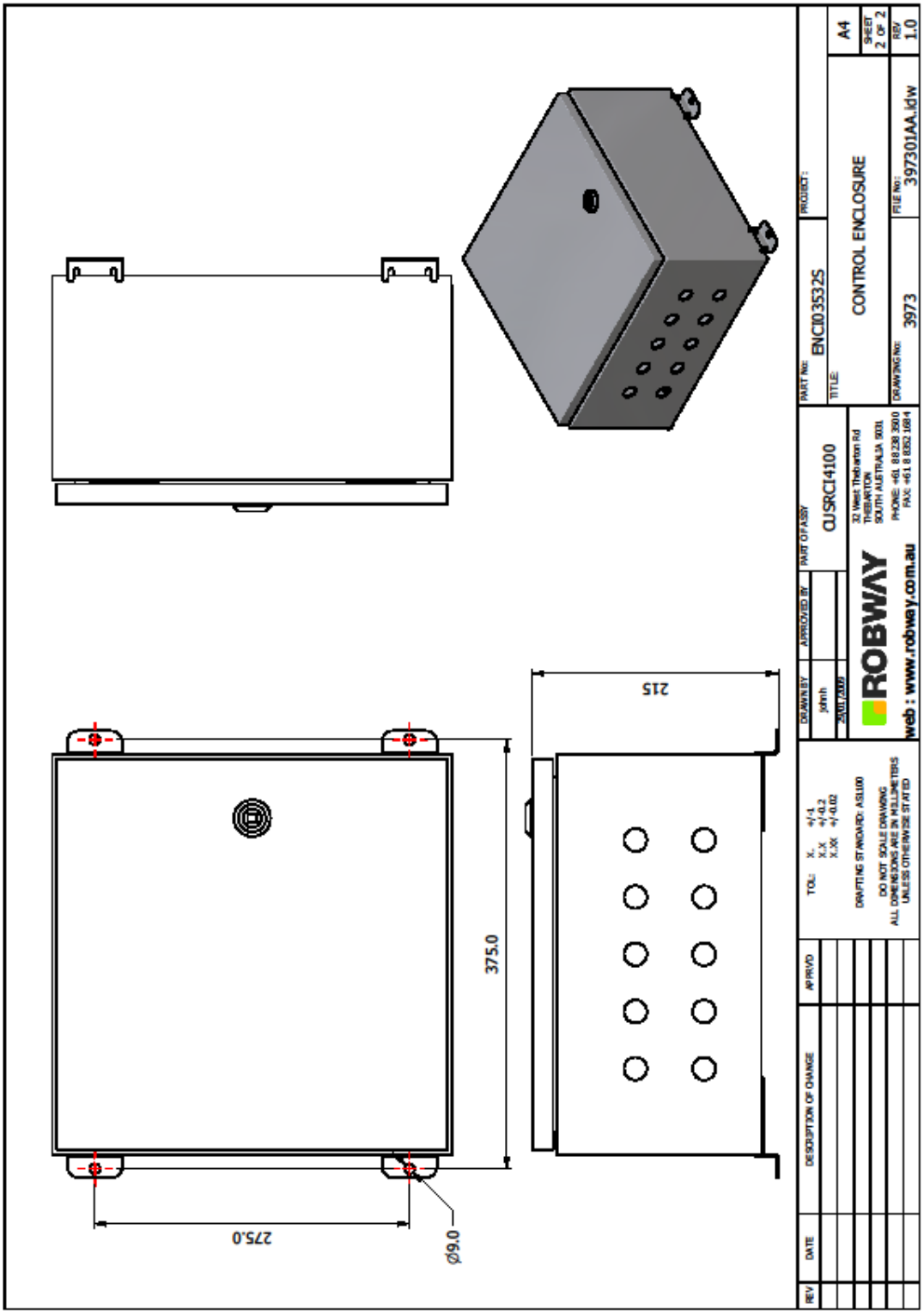


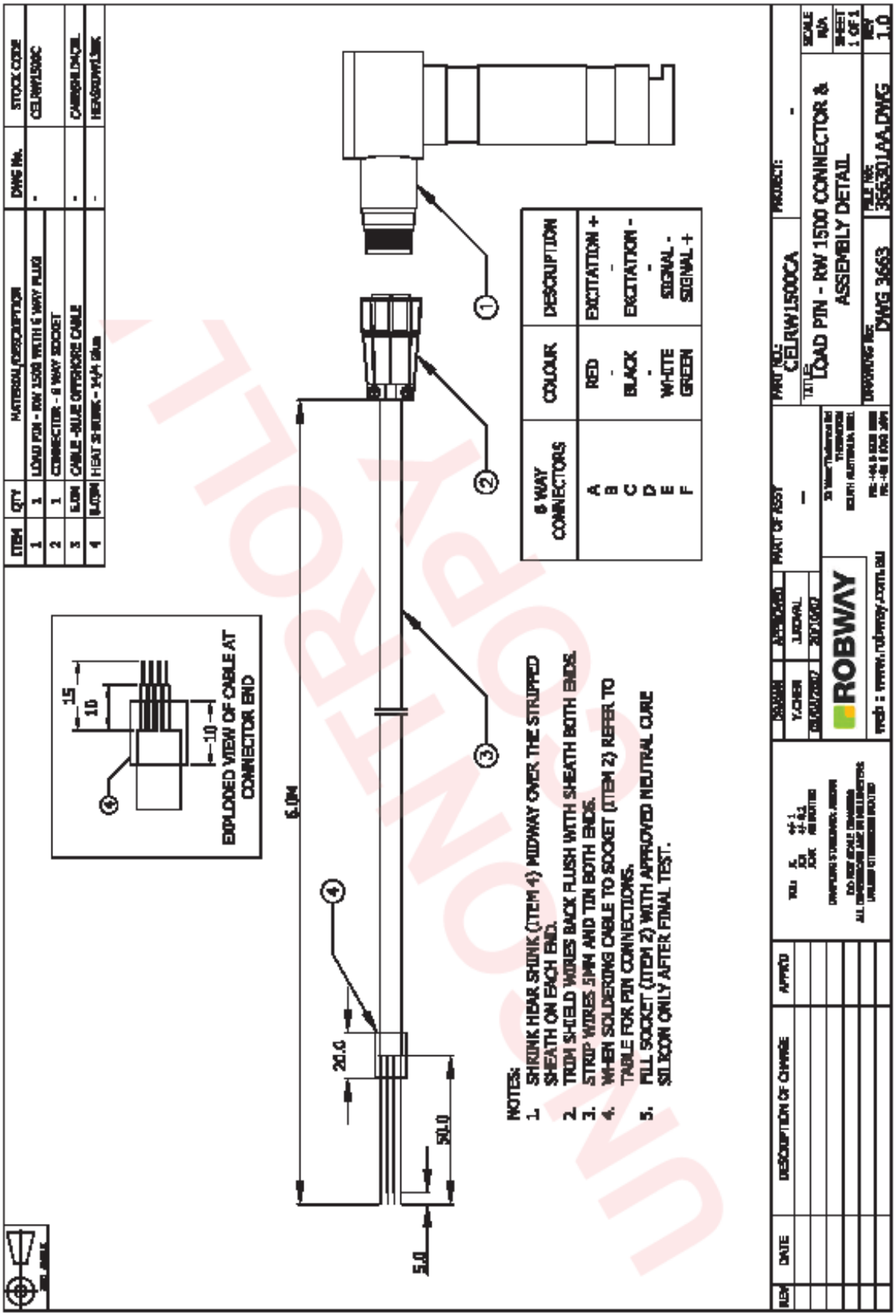












APPENDIX O, Hook Height and Winch Speed RCI1550 Display Option

INTRODUCTION

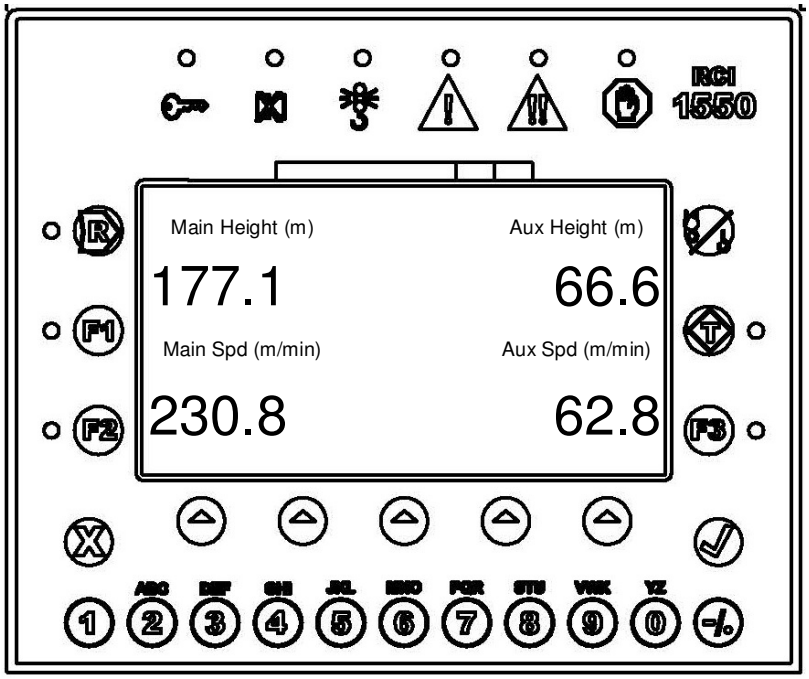
The RCI-4100 system may be fitted with a winch speed monitoring system to provide winch speed and hook height information. Both the main winch and the aux winch can be monitored. This option is only available for safe cabin cranes.

OPERATION

Assuming the system has been installed and calibrated properly the DISRCI1550 display will provide the following data to the crane operator:

Main Hook Height in meters	Main Hoist Rope Winching Direction and relative height	Aux Hoist Rope Winching Direction and relative height	Main Hook Height in meters
Main Winch Speed in meters per minute			Main Winch Speed in meters per minute

There are no user features accessible in the DISRCI1550 Display



The operator has the option to reset the zero height point using the DISRCI4100 Screen. To set the hook height zero point perform the following steps:

Step 1) Select the desired winch; main or aux

Step 2) Place the hook on the desired zero point such as the crane deck.

Step 3) Simultaneously press the UP and DOWN arrows on the DISRCI4100 display for 2 seconds

Step 4) Confirm that the DISRCI1550 Display now reads zero height at this position.

THEORY

The system operates as follows:

- Two inductive proximity switches are bolted alongside the main hoist winch drum with ferrous targets welded to the winch drum in quadrature formation.
- Two inductive proximity switches are bolted alongside the aux hoist winch drum with ferrous targets welded to the winch drum in quadrature formation.
- The two signals from each winch drum are cabled back to the RCI-4100 controller quadrature digital inputs. The up/down counting is done in the 4100 controller on-board CPLD logic which the application software reads with every software cycle.
- The application software has function codes to allow the hook height readings to be calibrated through the DISRCI4100 Display. Calibration MUST be performed in meters.
- The application software computes the hook height and winch speed based on winch rotation, boom angle, and calibration data.
- Data is transmitted to the DISRCI1550 display via an RS-485 data link.
- The DISRCI1550 Display is hard-coded to display hook height in meters and winch speed in meters per minute.

NOTE The system uses incremental encoders. If the crane is operated with the RCI-4100 powered off then each hook zero setting will need to be reset.

NOTE The payout counting algorithm and calibration does not take into account the winch drum number of layers and wraps per layer so there will be some non-linearity and inaccuracy due to this. The boom angle is factored into the calculation but there may be a slight difference in the zero point between high boom angle and low boom angle.

SYSTEM COMPONENTS REQUIRED

The components required for adding Hoist Winch Monitoring capability to the 4100 are identified in the following table:

LSI-Robway Supply

Qty	Order Code	Description	Location
1	DISRCI1550	Display	Crane Cabin
1	CABD2091/10M	Cable Assembly, Display to 4100 controller	Crane Cabin
4	SWIPROX12	Proximity Switch, NPN, Normally open, 5m cable	Hoist Winch
2	JUNBOX4320-8-1	Junction Box, Hoist Winch Proximity switches	Hoist Winch
2	CABSHLD4C10-15M	Cable Assembly, Junction box to 4100 controller	Hoist Winch

Customer Supply

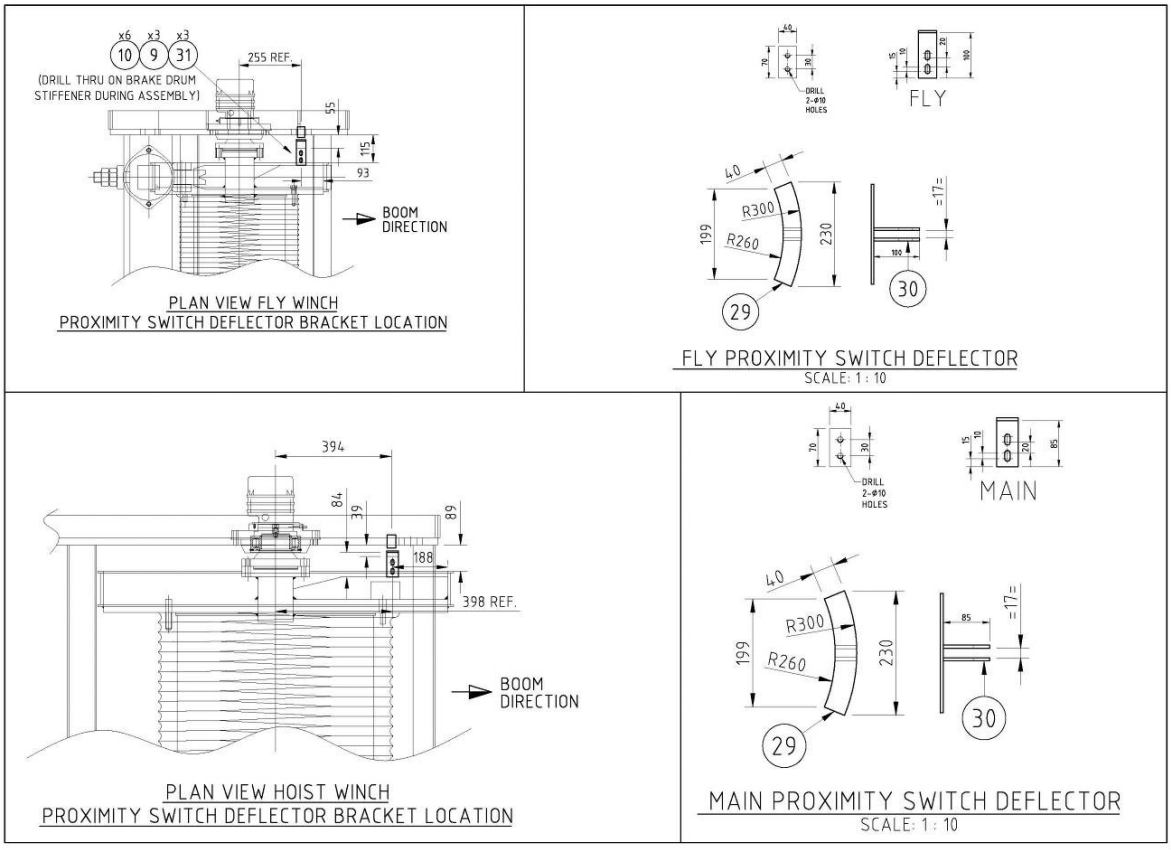
Customer must supply inductive targets and mounting brackets for proximity switches and junction boxes.

INSTALLATION

NOTE The system may only be used in safe-cabin installations.

NOTE See relevant system GA for wiring details.

Winch Proximity Switch Installation Customer Detail



CALIBRATION

NOTE: Calibration is performed through the function code menus in the DISRCI4100 Display. There are no user settable parameters in the DISRCI1550 Display.

Calibration MUST be performed in meters. The following function codes are used to calibrate hook height for the main hoist rope and for the auxiliary hoist rope.

Typical Function Code Listing (numbers may vary by crane)

F-15 VIEW UNCALIBRATED MAIN HOOK HEIGHT INPUT
F-16 VIEW CALIBRATED MAIN HOOK HEIGHT INPUT
F-17 CALIBRATE MAIN HOOK HEIGHT

F-18 VIEW UNCALIBRATED AUX. HOOK HEIGHT INPUT
F-19 VIEW CALIBRATED AUX. HOOK HEIGHT INPUT
F-20 CALIBRATE AUX. HOOK HEIGHT

CALIBRATING MAIN HOOK HEIGHT
DO NOT LUFF BOOM DURING THIS PROCESS

Step 1) Luff up to high boom angle where main and aux are over the crane deck. Select Main Winch
Step 2) Place hook on crane deck, this will be zero height point.
Step 3) Enter Function Code Menu
Step 4) Scroll to F-17 using up/down arrows
Step 5) Press Enter to set zero height automatically.
Step 6) Display will prompt to hoist up to high hook. (“Hook Up” message)
Step 7) Press Enter
Step 8) Using up/down arrows set reading to actual hook height in meters above initial zero setting
Step 9) Press Enter
Step 10) The DISRCI1550 Display will now display Main hook height in meters.

CALIBRATING AUX HOOK HEIGHT
DO NOT LUFF BOOM DURING THIS PROCESS

Step 1) Luff up to high boom angle where main and aux are over the crane deck.
Step 2) Place hook on crane deck, this will be zero height point.
Step 3) Enter Function Code Menu
Step 4) Scroll to F-20 using up/down arrows
Step 5) Press Enter to set zero height automatically
Step 6) Display will prompt to hoist up to high hook. (“Hook Up” message)
Step 7) Press Enter
Step 8) Using up/down arrows set reading to actual hook height in meters above initial zero setting
Step 9) Press Enter
Step 10) The DISRCI1550 Display will now display Aux hook height in meters.

PERIODIC SYSTEM TESTING

- There is no periodic testing required.
- If the winch ropes are altered then the hook zero must be reset.
- If the system is powered off and the crane is operated the hook height zero must be reset.

ATTACHMENTS, RCI System Configuration Documents