



OPERATOR MANUAL

ExLRT Intrinsically Safe Loop Resistance Tester



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EXLRT

XLR-104-1

Author:	<u>Giuseppe Prisco</u>	Date:	<u>12th December 2019</u>
Reviewed:	<u>Jamie Spiller</u>	Date:	<u>5th February 2020</u>
Approved:	<u>Alan Wilson</u>	Date:	<u>6th February 2020</u>

MODIFICATIONS

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1 INTRODUCTION

This manual is provided to the end user to understand the operation of the ExLRT and its associated components.

This manual does not include safety information for the ExLRT

Refer to document XLR-927

Do not operate the ExLRT without reading and understanding the Safety Manual.

The manual does not include servicing or repair literature.

There are no user serviceable parts.

2 HARDWARE

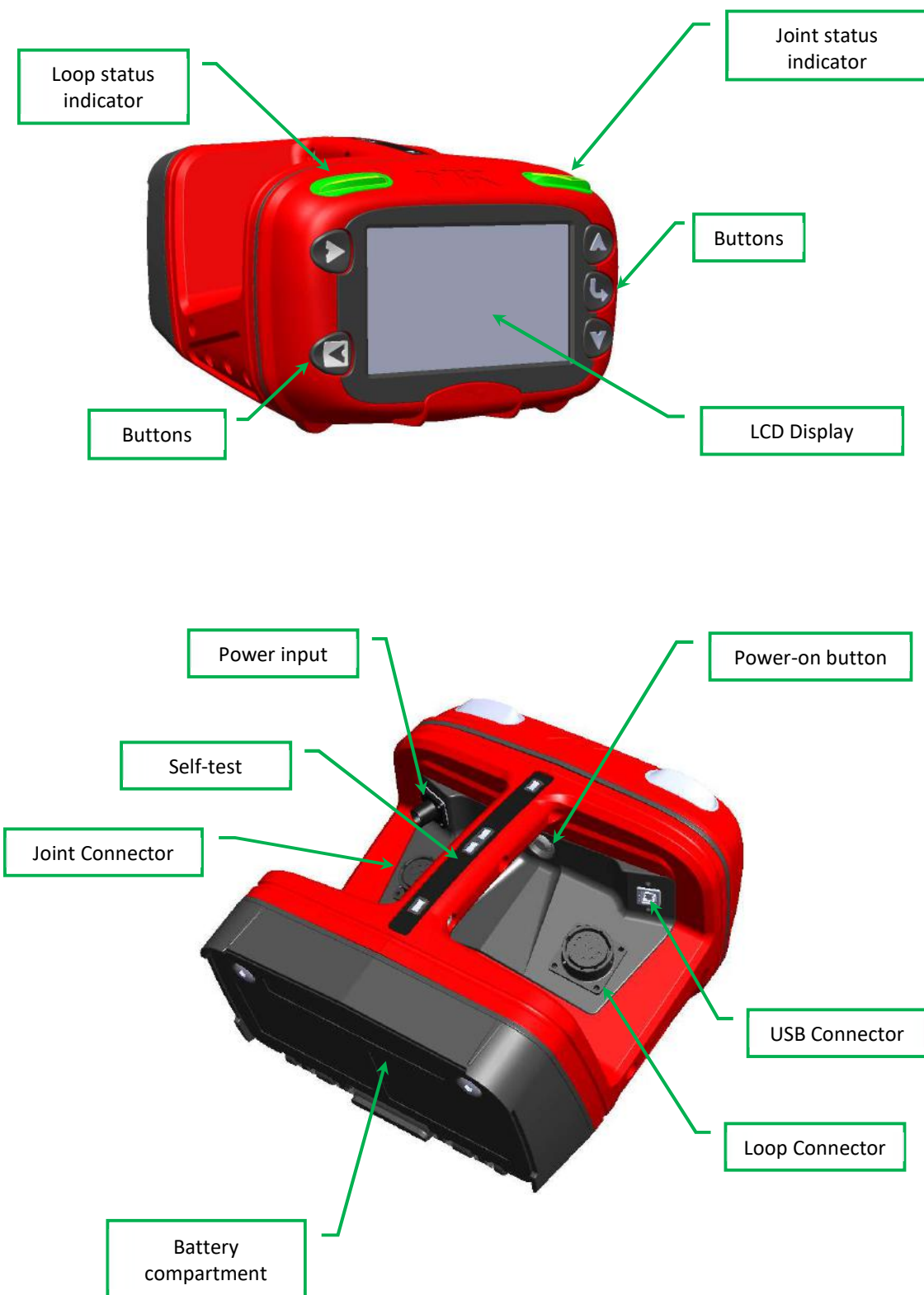
2.1 Product overview

The ExLRT is a battery-operated device that is designed to measure the resistance of complex constructed loops for the use of electrically bonding parts within structures and sub-frames. It has an additional joint mode that can measure the bond joints within the loops.

The ExLRT uses current couplers that non-intrusively couple an AC signal into the loop. A drive coupler is used to inject the signal with a known voltage and a second coupler is used to measure the current. To measure individual joints within the loop, a pair of joint probes are used to measure the voltage presented across the joint resistance. Knowing the voltage and current for each test, the ExLRT calculates the resistance.



2.2 ExLRT Overview



2.3 Buttons

Five buttons serve the following main functions

- 1) Start and Stop measurements in manual mode
- 2) Browse menus
- 3) Change/Set parameters

2.4 Indicators

Two indicators are situated on the top of the ExLRT. The left indicator shows the status of the loop measurement and the right indicator shows the status of the joint measurements. The indicators act as repeaters to the LEDs situated on the Loop and Joint cables.

The indicator colours identify the following test status.

Loop status indication	
Green Flashing	Waiting for loop test to commence
Amber ON	Loop test measuring
Amber Flashing	Paused State (Continuous mode only)
Red flashing	Loop test error
	Drive/Sense Coupler open

Joint status indication	
Green Flashing	Waiting for user to connect joint probes to UUT
Amber ON	Joint test measuring
Amber Flashing	Paused State (Continuous mode only)
Red flashing	Joint test error
	Joint test intermittent



3 CHARGING THE BATTERY

3.1 External charging

Insert the battery into the charger as shown and attach the supplied MK PSU. The table below shows the list of the LED states to indicate the state of the battery.



Charger State (Normal working condition)	LED 1 (Left)	LED 2 (Right)
Ready to Charge (Battery not installed)	Off	Green
Charging	Red	Green
Battery Inserted and fully Charged	Off	Green
NiMH Top-Off Charge/Charged	Orange	Green


3.2 Internal Charging

Simply plug the PSU into the ExLRT to charge the battery. The battery container will display flashing bars to indicate that the battery is charging.



4 USING THE EXLRT

4.1 Calibration

Calibration Verification is a method to verify the ExLRT instrumentation hardware to calibrated standards. Adjustment is performed using MK PC software and is run by a user with appropriate permissions. Once the verification is performed and the ExLRT has passed, the ExLRT will display the  icon when the correct combination of cables are connected to the ExLRT.

Calibration Warning Date:

This is set within the PC ExLRT software at the time of verification. It is used as a warning to the user when the ExLRT is due for calibration.

Calibration Expiry Date:

This is set within the PC ExLRT software at the time of verification. the Calibration will expiry once the expiry has elapsed.

5 USING THE INTEGRATED SELF-TEST FIXTURE

The ExLRT has an integrated Self-Test fixture. To test the ExLRT instrumentation, simply connect the loop and joint cables to the ExLRT and clamp the loop couplers around the handles as shown.

NOTE:

The Self-Test fixture is manufactured out of stainless steel and is not intended to be used as calibrated. The designed nominal value is 9.5mΩ but expect to see small deviations in measurement for each ExLRT manufactured. MK does not hold itself responsible if the Self-Test Loop yields a measurement outside of the tolerance due to poor care or attention of the ExLRT.



Typical loop value

9.5mΩ (+/-0.5mΩ).

Navigate through the menus to the measurement screen and take a loop test.



Typical joint value

8mΩ (+/-0.5mΩ)

To take a high value joint test, connect the joint probes to the outer points.



Typical joint value

0.2mΩ (+/-0.1mΩ)

To take a low value joint test, connect the joint probes to the inner points.

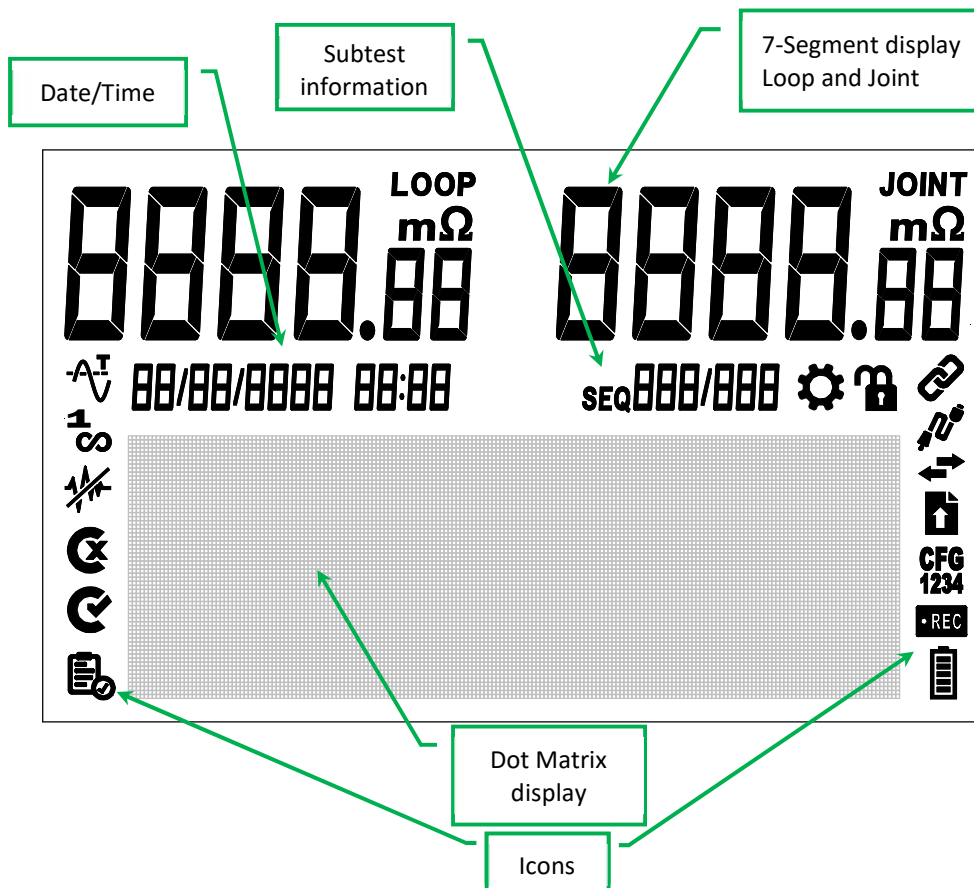
6 FUNCTIONS AND FEATURES

The ExLRT provides the following functions and features

- Manual Measurements (Two modes: Continuous and Single Shot)
 - Measures the resistances of loops and joints
 - User interface providing responsive status and error messaging to the user
- Supports multiple users
 - Login using user ID and Password
 - Up to 32 users (Setup with permissions/restrictions)
 - Up to 15 user configurations (one allocated for Customer Administrator)
- Icons showing the following status' during operation
 - Calibration
 - Battery life (including charging status)
 - Configuration Level in use
 - Measurement mode and settings
- Date and Time
- Connection to PC via USB

6.1 LCD display

The LCD is split into the following sections



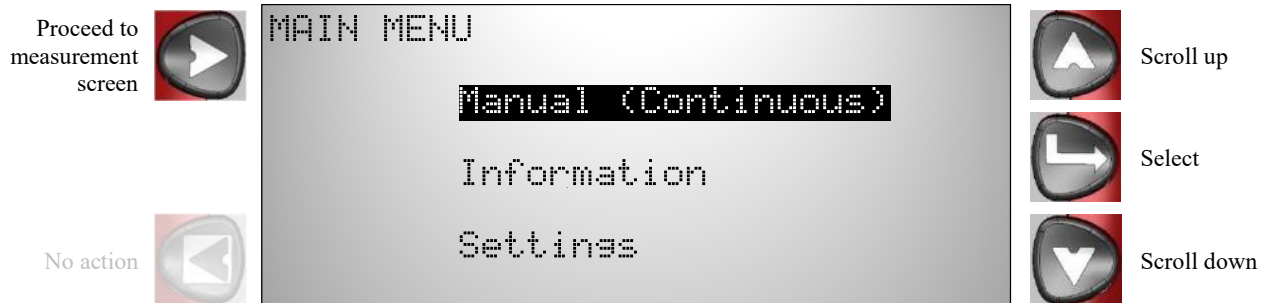
6.2 7-Segment Display and Icons description

		Loop or Joint measurement
		Date and Time
		Sequence number (Maximum of 999 subtests per test program)
LOOP	Loop Cable Connect	Appears when the loop cable is connected to the ExLRT
JOINT	Joint Cable Connect	Appears when the joint cable is connected to the ExLRT
	Link	Displayed if software has established a handshaking to the PC software either via USB or Bluetooth
	Cable	Displayed if the ExLRT has detected a cable
	Locked	Displayed if the ExLRT has expired its calibration. The icon is used to indicate to the user that ExLRT is not able perform measurements
	Unlocked	Displayed if the user type is super user or has permissions to perform measurement if the ExLRT is not calibrated
	Configuration	Level of configuration is displayed depending on user permissions
	Calibrated	Displayed when the has been Calibrated and has its associated verified cables are connected
	Not Calibrated	Displayed when the ExLRT is within calibration expiry but has at least one wrong cable plugged in
	Single shot	Displayed when the ExLRT is taking a single shot measurement
	Continuous	Displayed when the ExLRT is taking a continuous measurement
	Averaging	Displayed when averaging mode is enabled (Available in continuous mode)
	Trigger	Displayed when triggering is enabled (Available in continuous mode)
	Averaging and Trigger	Displayed when both averaging and triggering is enabled
	Self-Test	Displayed if internal self-test has passed
	Flashing	Flashing if internal self-test has failed
	Battery life	Shows battery charge level
	Charging	While charging, the battery container and bars will flash. The bars will also 'increment' as the battery is charging

8 MAIN MENU

The following options are listed in the main menu. Use the scroll up and down buttons to highlight your desired choice.


In this screen, the ExLRT will display the device/asset information if it has been programmed into the device




Proceed to measurement screen

Press the  to proceed straight to the measurement screen.

- If manual mode is set to 'Continuous', go to section 10 Continuous mode measurements
- If manual mode is set to 'Single Shot', go to section 11 Single Shot Measurements

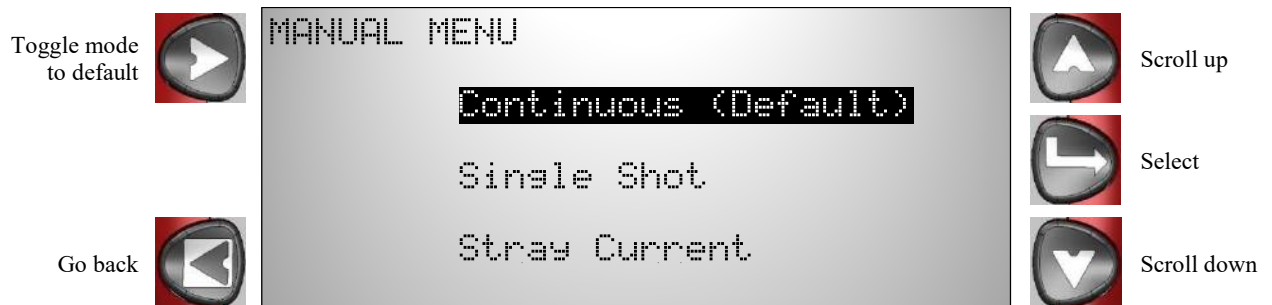
Highlight Manual and press  to proceed to the Manual Menu. Go to section 9 Manual Menu.

Highlight Settings and press  to proceed to the Settings Menu. Go to section 17 Settings Menu


9 MANUAL MENU


The ExLRT can operate in two modes, Continuous and Single Shot and each can be individually disabled, if required.

The Manual menu will display the following options with one selected to the default mode




The ExLRT will automatically highlight the mode that has been set to default. The above screen shot shows that the ExLRT default is set to continuous

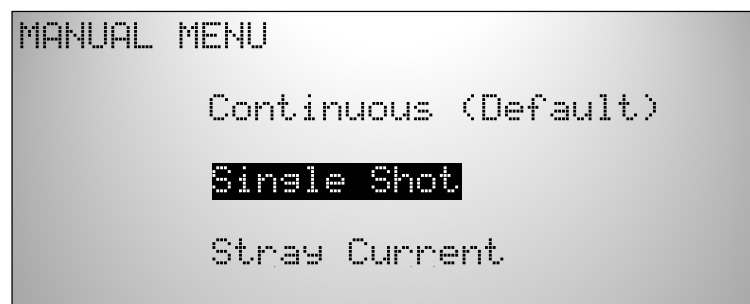
To operate in continuous mode, press select . See section

To operate in single shot mode, use the up/down buttons to highlight Single shot then press the select  button. See section 11 Single Shot


Operating the ExLRT temporarily in the non-default mode

Scroll to the non-default mode and press the select  button. Once the unit exits out of its measurement mode (manual or automatic), the ExLRT will return to the default mode.

For example, continuous mode is set to default, but single shot is highlighted as the temporary mode of operation.



Setting the default mode

To set the ExLRT default mode, scroll up or down to select the mode and press the toggle  button.

9.1 Manual measurement modes

9.1.1 Overview

Loop measurements

A loop test is performed by placing both loop couplers around a loop. If the loop couplers have been coupled incorrectly, the ExLRT will display either a DRIVE COUPLER OPEN or SENSE COUPLER OPEN. Correct coupling will allow the ExLRT to commence measurement. Valid Loop measurements are displayed as a 4-digit number with two decimal places.



If the joint measurement is not valid, the ExLRT will null the 7-segment display and show a description of the error on the dot matrix display.



Joint measurements


A joint measurement is performed by placing the joint probes onto any two parts of the loop circuit. The ExLRT will only validate the joint measurement if the joint probes are attached to the loop with good integrity and the loop couplers are coupled correctly. Valid joint measurement will be displayed as a 4-digit number with two decimal places.




If the joint measurement is not valid, the ExLRT will null the 7-segment display and show a description of the error.



10 CONTINUOUS MODE MEASUREMENTS

During continuous mode, the  icon is turned on to indicate continuous mode of operation. Measurements are continuously updated to the screen and are cleared in the event of a change in cable state or measurement error.

10.1 Starting Continuous

From the manual mode screen, press the front panel start  button to automatically initiate continuous mode.

If the joint cable is connected, then the ExLRT will commence continuous mode for both loop and joint measurements.

The ExLRT will automatically start taking loop measurements. To take a joint measurement, simply connect the joint probes to the UUT.



10.2 Pausing continuous mode measurements

To halt continuous mode measurements, press any of the red buttons on the in-line controller or a red button on either of the joint probes.

By halting the measurement, the loop and joint measurements are latched until measuring is resumed.

The ExLRT indicators will flash Amber during the pause state. This is a convenient way to quickly start/stop the measurement without opening and closing the couplers.



10.3 Resuming continuous mode

To resume continuous mode measurements, press the in-line controller green button or any of the green buttons on the joint probes. The ExLRT will return to continuous measurements.



10.4 Exiting from continuous mode

Continuous mode can be exited using the front panel stop button .

10.5 Averaging

Averaging applies to both the loop and joint measurements and can only be enabled and disabled when the ExLRT is not taking measurements.

Averaging ON

With averaging on, the following icon is displayed .

Averaging the loop and joint measurements is implemented by taking the first valid sample of the measurement then applying a sum over count method. The start of averaging occurs under the following conditions:

- 1) Start of continuous mode
- 2) Any change of state
- 3) After an error condition

During continuous mode measurements with averaging enabled, the following will be shown in the dot matrix area.

```

Loop Measuring
Joint Measuring
L: Latest:                n/a
L: Lowest:                n/a
L: Highest:              n/a
L: High/Low variation:   n/a
L: First/Latest variation: n/a
J: Latest:                n/a
    
```

If the joint probes are not connected J: Latest: will not appear.

Below is a description of the values displayed on the screen

L: Latest:	Latest loop resistance calculated
L: Lowest:	Lowest resistance recorded since commencing continuous mode, last error or change of state
L: Highest:	Highest resistance recorded since commencing continuous mode, last error or change of state
L: High/Low variation:	Difference (or pk-pk) between the last recorded highest and lowest measurements since commencing continuous mode, last error or change of state
L: First/Latest variation:	Difference between the first measurement at the start of continuous/last error or change of state to the latest measurement
J: Latest:	Latest Joint resistance (if joint cable connected)

10.6 Triggering



This feature applies to loop measurements only.

Trigger OFF

The ExLRT will not report or display any trigger condition.

Trigger ON

Triggering can be enabled with averaging on or off. The following icons will appear accordingly

	Averaging OFF, with triggering
	Averaging ON, with triggering

Method of triggering

The ExLRT can trigger in two different ways

Trigger on Percentage Value

Trigger on Resistance Limits

Both methods can be enabled at the same time or either method can be applied individually. The use of triggering is to primarily fault-find suspect loops. The ExLRT triggering feature can be used to set limits based around a given loop value. For fault-finding, any large deviation in loop resistance due to poor construction can be identified using the trip mechanism.

Trigger on Percentage

This trigger method can be set to a percentage from 1% to 100% and is defined as the percentage of loop based on the first value when continuous mode starts. For instance, take three loops and their corresponding trigger limits based on percentage of value.

11.2 Taking a measurement

Loop Test

During the loop test, the loop inline controller and the ExLRT front panel indicator will illuminate amber for the duration of the loop test. If an error has occurred during the loop test, the in-line controller and ExLRT front panel indicator will flash red with the error condition printed on the LCD screen.

To clear the screen, initiate a loop or joint test.

Joint Test


After the joint test has been initiated by connecting the joint probes to the UUT, the ExLRT will automatically start taking a loop and joint measurement. All ExLRT and cable indicators will illuminate amber for the duration of the test. After the test, the ExLRT will display the valid measurements.

After the joint test the ExLRT will re-start the joint process (probe green LED flashing).

If a joint error was detected, the joint probe red LED will flash until the user clears the error by pressing the green button again. This will return to waiting for another joint test to commence (flashing green)

If a loop error was detected, the loop in-line controller red LED will be flashing until the user clears the error by pressing either the green button on the in-line controller or the green button on the joint probe.

11.3 Exit from single shot mode

Ensure that both ExLRT front panel test status indicators are turned off and press the back  button to exit out of the manual mode and return to the main menu

12 STRAY CURRENT

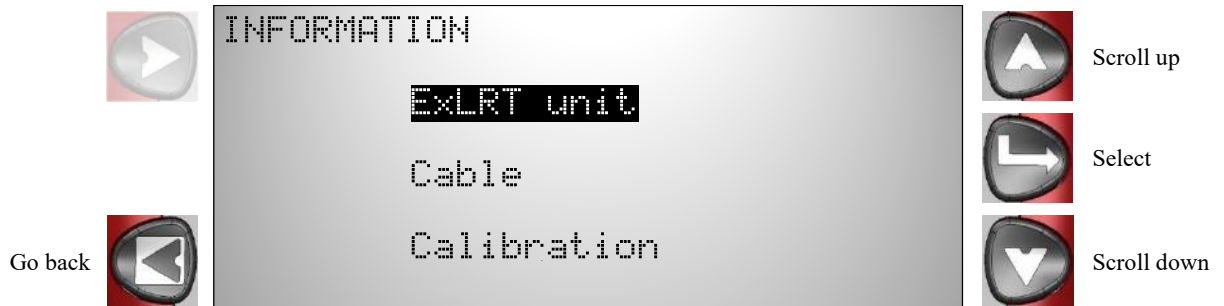
To perform a stray current measurement, simply connect the MK52 Sense Coupler to the loop and navigate into the Stray Current Measurement

Main Menu -> Manual -> Stray Current

This will give you a magnitude (in current) of induced current in the loop

13 INFORMATION MENU

The information screen will provide the following options. Use the scroll buttons to highlight the option then press the select button to enter the selected menu



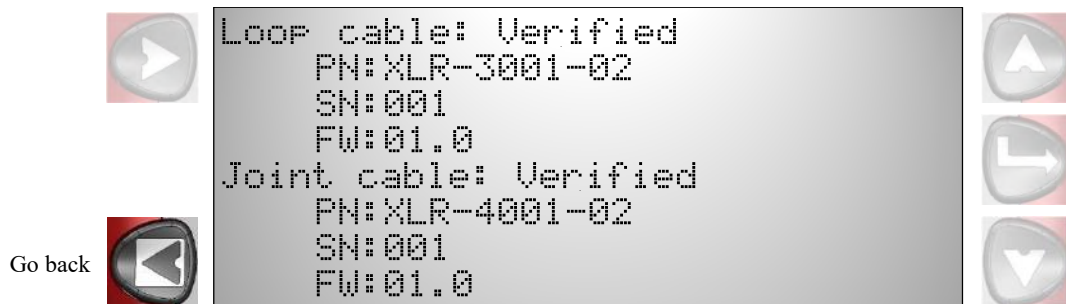
14 EXLRT UNIT



15 CABLE

Entering this screen will provide live information of the connected cables

As an example, the following screen shows tha both the loop cable and joint cable connected to the ExLRT and verified.



16 CALIBRATION INFORMATION

Calibration Information

Calibrated: 03/02/2020
 Warning: 22/02/2021
 Expiry: 03/02/2021

Press → to list verified cables

Go back

Select

CABLE	PN	SN
Loop	XLR-3000-01	0027
Joint	XLR-4000-01	0016

Go back

Select

17 SETTINGS MENU

SETTINGS

Measurement

Calibration

System

Go back to previous menu

Scroll up

Select

Scroll down

Go to section 18 to enter the Measurement menu

Go to section 19 to enter the Calibration menu

Go to section 20 to enter the Settings menu

18 MEASUREMENT

If the user has the appropriate permissions, the following parameters are available for changing for the instance of the logged in user.

Any changes within this menu will not cause permanent changes to the configuration. Expect the values to reset as defined in the configuration at the time of logging in.

Use the scroll buttons to highlight the desired option then press the button to go to the value. Once the value has been highlighted, press the button to toggle the value.

The screenshot shows a terminal-style interface for the 'MEASUREMENT' menu. The menu items are: 'Averaging?' (highlighted), 'Trisser On Percentage?' (ON / OFF), 'Trisser On Value?' (ON / OFF), and 'Change trisser limits?' (YES / NO). Navigation controls are shown around the screen: 'Toggle value when highlighted' (right arrow), 'Go back' (left arrow), 'Scroll up' (up arrow), 'Select' (right arrow), and 'Scroll down' (down arrow).

18.1 Averaging?

Toggle to **ON** / OFF to enable averaging

Toggle to ON / **OFF** to disable averaging

18.2 Trigger on Percentage?

Toggle to **ON** / OFF to enable trigger on percentage


Toggle to ON / **OFF** to disable trigger on percentage

18.3 Trigger on Value?

Toggle to **ON** / OFF to enable trigger on value

Toggle to ON / **OFF** to disable trigger on value

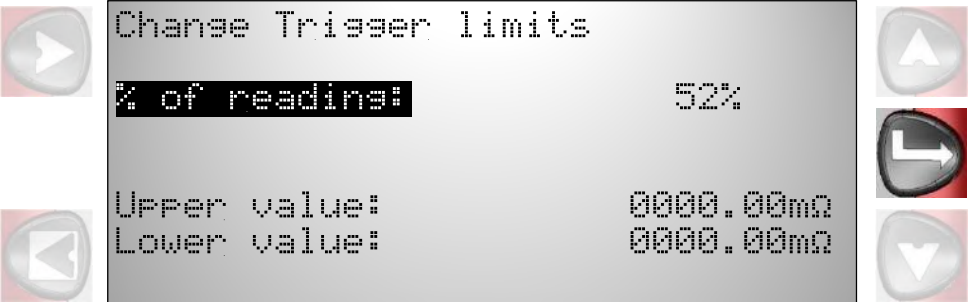
18.4 Change trigger values?

Toggle to **YES** / OFF to change the trigger settings then press the Select  button to proceed into the “Change Trigger Limits” screen






Toggle to ON / **OFF** to turn triggering off (default when entering this screen)

18.4.1 Change % of reading

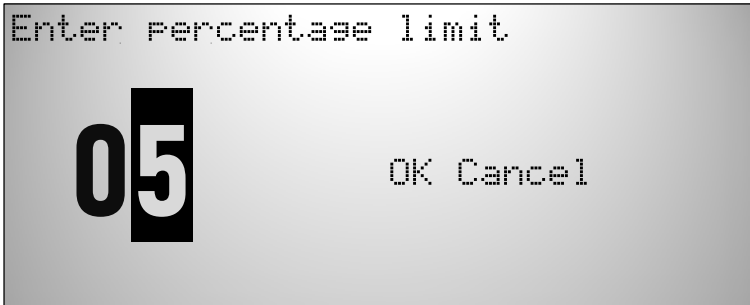
To change the value, press the select  button to enter the change value window.



The screenshot shows the 'Change Trigger Limits' screen with the following text: 'Change Trigger Limits', '% of reading: 52%', 'Upper value: 0000.00mΩ', and 'Lower value: 0000.00mΩ'. Navigation options are shown on the left and right:

- No Action:** 
- Go back to previous menu:** 
- Increase percentage:** 
- Select:** 
- Decrease percentage:** 

Change the percentage value in steps of 1% using the up/down buttons. When finished, press the OK button.



The screenshot shows the 'Enter Percentage Limit' screen with the text: 'Enter Percentage Limit', '05', and 'OK Cancel'.

Change resistance lower and upper limits

Scroll to “Lower value” and press the select button. The significant part of the resistance is highlighted as follows. Change the resistance value up or down in 1mΩ steps using the increase/decrease buttons. When finished, press the button to move on to the decimal place part of the resistance

<p>No Action </p> <p>Go back to listing </p>		<p> Increase value</p> <p> Go to lower 0000.00</p> <p> Decrease value</p>
<p>No Action </p> <p>Go back to 0000.00 </p>		<p> Increase value</p> <p> Go to upper 0000.00</p> <p> Decrease value</p>
<p>No Action </p> <p>Go back to 0000.00 </p>		<p> Increase value</p> <p> Go to upper 0000.00</p> <p> Decrease value</p>
<p>No Action </p> <p>Go back to 0000.00 </p>		<p> Increase value</p> <p> Select all values</p> <p> Decrease value</p>
<p>No Action </p> <p>Go back to previous menu </p>		<p> Scroll up</p> <p> Select</p> <p> Scroll down</p>

19 CALIBRATION

This window displays if The ExLRT will allow measurements to be taken using uncalibrated loop or joint cables. These are cables that were NOT used during the last verification process. The ExLRT user must have the appropriate permissions set in order to use this function.

```
Calibration
Uncalibrated probes NOT allowed
```

20 SYSTEM


This window displays any specific hardware setting.

```
System
Bluetooth          NOT AVAILABLE
```

21 CALIBRATION VERIFICATION

To run a verification program, the ExLRT must be controlled via MK ExLRT PC Software.

After verification and if successful, the ExLRT will be set to the following

- The ExLRT will hold a list of all cables used during the calibration process. Any other cables that connect to the ExLRT will not work and the ExLRT will show a message on the screen.
- The Calibration OK icon  will be displayed with the verified cables plugged in.