

Elcometer 701

Live Cable Locator

&

Cable Avoidance Tool

Operating Instructions



This product meets the Electromagnetic Compatibility Directive and the Low Voltage Directive.

This product is suitable for use only in industrial environments according to EN 61000-64.

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A copy of this Instruction Manual is available for download on our Website via www.elcometer.com.

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ABOUT THE ELCOMETER 701

Thank you for purchasing this Elcometer 701 Pipe and Cable Locator. Welcome to Elcometer.

Elcometer are world leaders in the design, manufacture and supply of inspection equipment for concrete and coatings.

Our concrete inspection products include a comprehensive range of concrete, and civil engineering inspection equipment. Our coatings products cover all aspects of coating inspection, from development through application to post application inspection.

Your Elcometer 701 Pipe and Cable Locator is a world beating product. With the purchase of this product you now have access to the worldwide service and support network of Elcometer. For more information visit our website at www.elcometer.com

1 ABOUT THE ELCOMETER 701

The Elcometer 701 Pipe and Cable Locator provides simple and user-friendly location, orientation and depth of underground lines, such as cables and pipes, or the location of non-metallic pipes using the optional sonde^a.

The Elcometer 701 can be used to search/probe areas for unknown lines or for locating specific lines.

The locator consists of two instruments; a transmitter (Tx) and a receiver (Rx).

Both instruments are constructed robustly for use in poor weather and in harsh environments and feature user-friendly operation with a minimum number of controls.

1.1 Features

1.1.1 The Receiver (Rx)

- Can be used with or without the transmitter:
 - Power Grid mode (without transmitter)
 - Radio mode (without transmitter)
 - Transmitter mode (with transmitter)
- Automatic depth determination when used with the transmitter
- Semi-automatic depth estimation when used without the transmitter
- Sensitivity level can be adjusted automatically or manually
- Illuminated display for use in dark environments

1.1.2 The Transmitter (Tx)

- Transmits a 33 kHz signal which is coupled into the line by:
 - Induction, via the integrated antenna
 - Direct connection, via the measurement cable and alligator clip or via accessories such as the transmitter clamp or adaptor cable
- Transmitter power; 0.1 W or 0.5 W - selectable
- Signal output; continuous or pulsed - selectable



a. Optional sonde - see "Spare parts and optional accessories" on page 28.

1.2 What the box contains

- Elcometer 701 Rx (receiver)
- Elcometer 701 Tx (transmitter)
- Measurement cable (2 m), 2 x
- Alligator clip, 2 x
- Earth spike
- Batteries for receiver, 10 x
- Batteries for transmitter, 6 x
- Operating instructions
- Nylon carrying bag

The Elcometer 701 is packed in a cardboard package. Please ensure that this packaging is disposed of in an environmentally sensitive manner. Consult your local Environmental Authority for further guidance.

To maximise the benefits of your new Elcometer 701 Pipe and Cable Locator please take some time to read these Operating Instructions. Do not hesitate to contact Elcometer or your Elcometer supplier if you have any questions.

2 SAFE USE OF THE INSTRUMENTS



The instruments should be used with care. Follow the instructions given in these Operating Instructions. Read and understand all warnings.

• Direct connections to live cables

Direct connections to live cables should be made by qualified personnel only.

• Lines without a signal

The Elcometer 701 Receiver can only locate lines which emit a signal; lines which do not emit a signal will not be located. If no lines have been found, it is important to always exercise extreme caution when digging.

3 GETTING STARTED

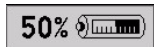
3.1 Fitting batteries



3.1.1 Receiver (Rx)

The receiver is powered by 10 alkaline 'AA' batteries.

The status of the batteries in the receiver is checked upon start-up and indicated in the display



During operation, the receiver checks the battery strength at regular intervals. If battery capacity falls below 10% of the threshold value, an audible warning signal is given and the current status of the batteries is shown in the upper part of the display.

In order to replace the batteries, the battery compartment cover must be removed.

GETTING STARTED

To release the battery compartment cover, push the rubber button away from the instrument handle and then lift away the cover.

The batteries are contained in an enclosure which must be removed from the instrument for access.

Place the batteries in the enclosure ensuring correct polarity - refer to the diagrams on the enclosure.





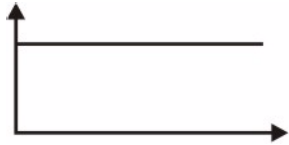
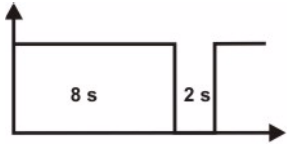


3.1.2 Transmitter (Tx)

The transmitter is powered by 6 alkaline 'D' batteries

The batteries in the transmitter have to be replaced as soon as the red LED battery indicator starts to blink (see page 6).

Should this occur while the user is busy locating a line with the receiver, there will be a change in the signal at the receiver:

Signal	Normal signal	Signal when batteries are weak
Pulsed 		
Continuous 		

The batteries are located behind a cover on the base of the instrument. To release the cover, use a coin or screwdriver to rotate the two screws a ¼ turn anticlockwise and then lift away the cover.

The batteries are contained in an enclosure which must be removed from the instrument for access.

Place new batteries in the enclosure ensuring correct polarity - refer to diagrams on the enclosure (note that all the batteries are fitted in the same direction).

3.2 Battery care

Remove the batteries from the instruments if they are to remain unused for a long period of time. This will prevent damage to the instruments in the event of malfunction of the batteries.

Alkaline batteries must be disposed of carefully to avoid environmental contamination. Please consult your local Environmental Authority for information on disposal in your region.

Do not dispose of any batteries in fire.

3.3 The Receiver (Rx)

3.3.1 Parts of the instrument

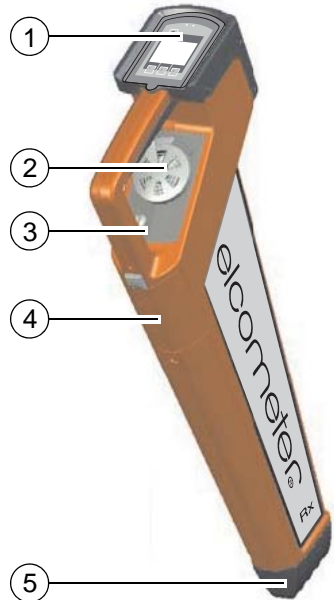
1. Control panel with display
2. Speaker with volume control

The speaker gives various acoustic signals (e.g. beeps with modulating pitch relative to the signal strength).



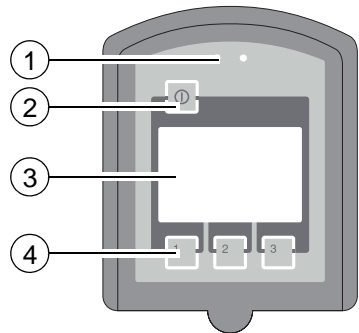
When the receiver is switched on, the volume is set at a standard level. The receiver will only start with the volume at a different level if the volume has been increased manually before switching off the receiver.

3. Headphone socket (3.5 mm connector)
4. Battery compartment
5. Floor cap (protects the end of the instrument case).



3.3.2 Receiver control panel

1. Light sensors
Light sensitive photo cells to regulate the display lighting automatically.
The display lighting can be activated manually for one minute by briefly covering the light sensor.
2. On/Off switch
Press to switch on or off.
The receiver will also switch off automatically after approximately 7 minutes of inactivity.
3. Display
Provides a visual indication of reception strength, line depth, mode of operation, battery status and menu items.
4. Control buttons^b



Button # 1	Button # 2	Button # 3
<ul style="list-style-type: none"> • Starts measuring depth • Decreases receiver sensitivity 	<ul style="list-style-type: none"> • Adjusts receiver sensitivity • Starts measuring depth 	<ul style="list-style-type: none"> • Selects the operating mode • Increases receiver sensitivity

b. The function of buttons 1, 2 and 3 depends upon the status of the system

GETTING STARTED

3.4 The Transmitter (Tx)

1. Accessory connector sockets

These sockets are used to create a direct galvanic connection to the target line or to create a connection using a special connection set (e.g. transmitter clamp or house connection set - see "Spare parts and optional accessories" on page 28).

2. Battery status indicator

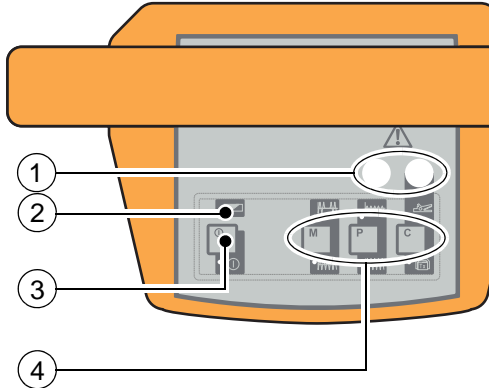
When the battery status indicator is red, the batteries need to be replaced.

3. On/Off button

Press and hold to switch on. Press again to switch off.

All appropriate LEDs blink when the transmitter is on, depending on operating function.

4. Control buttons^c








Button M	Button P	Button C
<ul style="list-style-type: none"> Switches between <i>continuous</i> and <i>pulsed</i> signal output 	<ul style="list-style-type: none"> Switches between signal power levels (<i>0.1 W</i> or <i>0.5 W</i>) 	<ul style="list-style-type: none"> Switches between <i>inductive</i> and <i>direct</i> signal coupling

c. The function of buttons M, P and C depends upon the status of the system

3.5 When do I need to use the transmitter?

The receiver can be used with or without the transmitter.

The table below illustrates the capabilities of the receiver when used with and without the transmitter.


 Receiver (Rx)				 Transmitter (Tx)	
Signal detection mode	Locates			Measures depth	Is it used?
	Electrical Cables	Metallic Pipes	Non-metallic pipes		
 Radio	✓	✓	✗	✗ ^a	✗
 Power Grid	✓	✗	✗	✗ ^a	✗
 Transmitter	✓	✓	✓	✓	✓

- a. An estimate of depth *is* available in this mode (by manual measurement), however automatic and more accurate depth measurement can be obtained when using the receiver in 'Transmitter' mode together with the transmitter.

4 TRANSMITTER - USE, SETUP AND SIGNAL COUPLING

4.1 Using the transmitter

Follow the steps listed below in order to prepare the transmitter to search for lines in conjunction with the receiver:





Step	Action	Page
1.	Decide whether the transmitter signal is going to be coupled to the line by induction or by direct connection. <ul style="list-style-type: none"> • If coupling by induction, place the transmitter on the site to be searched. • If coupling directly, connect the transmitter to the line to be located by the most suitable method. 	10-15 14 10-15
2.	Switch on the transmitter.	6
3.	Select the desired signal characteristics using the P and M buttons. A green LED indicates that the respective setting is active.	9
4.	Select the desired operating mode using the C button. In direct mode, an LED next to the  symbol indicates how good the connection to the line is: <ul style="list-style-type: none"> • Green blinking: good (low-resistance) connection • Alternating red and green: sufficient connection • Red blinking: poor/no (high-resistance) connection 	9

Your transmitter is now set up and transmitting signals. Now you can use the receiver to locate metallic conductors - see "Receiver - use, adjusting sensitivity and setup" on page 16.

4.2 Transmitter setup options



4.2.1 Signal characteristics

The characteristics of the transmitter output signal can be configured by the user to meet the specific requirements of either the line to be located or the site to be surveyed:

Symbol	Description	Notes	Button
	Pulsed signal	As it is more easily distinguished from other signals, the pulsed signal is helpful for locating when there is interference within the frequency range of the transmitter. This also helps to conserve the batteries. Note that depth measurements cannot be made using a pulsed signal	M
	Continuous signal	This signal type has to be activated before a taking a depth measurement.	M
	Low power	0.1 W (prolongs battery life)	P
	High power	0.5 W	P

4.2.2 Operating modes

The transmitter can be used in the following modes:

Symbol	Mode	Notes	Button
	Induction	In this mode of operation the transmitter's signal is emitted through the integrated antenna and is thereby inductively coupled with any metallic lines located within a certain radius.	C
	Direct connection	In this mode of operation the signal is directly coupled with a metallic line via the measurement cable which is inserted into the connectors on the front panel of the transmitter. Transmitter clamps, alligator clips or power socket adaptors (for example) may be used to connect the measurement cable to the lines.	C

TRANSMITTER - USE, SETUP AND SIGNAL COUPLING

4.3 Options for direct and inductive signal coupling

There are four methods of coupling the signal from the transmitter to the line:

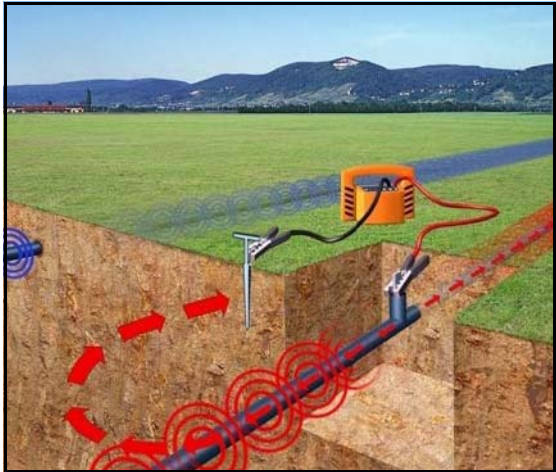
- Direct coupling to cables and pipes (see below)
- Coupling using special connection accessories (see page 13)
- Inductive signal coupling (see page 14)
- Signal coupling in non-metallic pipes (see page 15)

4.3.1 Direct coupling to cables and pipes

Direct galvanic coupling is practical for cables which are easily accessible and free of current.

The method of connection is dependent upon the position and nature of the lines (e.g. insulation, cable conduit, accessibility of the cable ends) - see the following pages for examples of direct coupling methods.

Direct coupling presents a reliable option for selective cable location, as the signal can be coupled to a specific cable with virtually no loss.



If the lines being located are energised, the following five safety precautions must be taken *before* connecting the transmitter:

Five safety precautions:

1. Disconnect power^a from the line.
2. Secure against reconnection.
3. Check to ensure no voltage present.
4. Make each connection and short circuit the line.
5. Cover or block access to adjacent components which are energised.

a. If disconnection is not possible, use the transmitter clamp method - see "Coupling via transmitter clamp" on page 13.

TRANSMITTER - USE, SETUP AND SIGNAL COUPLING

- **Single-wire lines or pipes (with or without insulation against earthing)**



The distance between the earth spike and the ends of the connected lines should be as great as possible.

Note: *It is possible that the return current will couple to adjacent lines, which could result in these lines also being detected.*

- **Single-wire cable with metallic screen and earthing insulation**



Short circuit between internal conductor and screen at the end of the cable, earthing at the beginning and end of the cable.

Note: *If the earth connections made are unfavourable, the current in the internal conductor and the return current in the screen will cancel each other out. Under certain circumstances this can prevent the cable from being detected. [Alternatively, a connection without an earth connection can also be made.]*

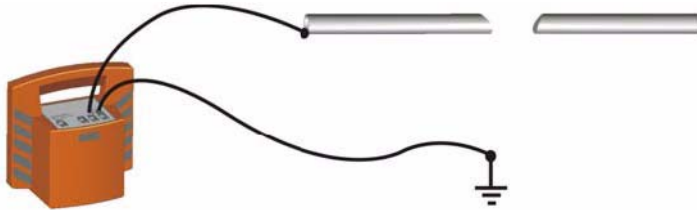
- **Multiple-wire cable (internal conductor connected or disconnected) with metallic screen and earthing insulation**



Similar application to single-wire lines or pipes [connected screen, not inner lines].

TRANSMITTER - USE, SETUP AND SIGNAL COUPLING

• **Metallic conduit (with or without insulation against earthing)**



The earth spike and the conduit should be spaced as far apart as possible. Under certain circumstances, optimum positioning of the earth spike may require several attempts.

• **If a return wire is available**



The spacing of the return wire should correspond to at least 10 times the depth of the line being located.

• **Pair of wires (with or without screen) with short circuit at the end of the cable**



For twisted pairs of wires (with a length of lay of the twist greater or equal to the laying depth), the orientation of the cable can be easily determined:

- Adjacent lines which are horizontal to each other: *Minimum* of the reception signal.
- Lines situated on top of each other vertically: *Maximum* of the reception signal.

4.3.2 Coupling using special connection accessories

• Coupling via adaptor cable

(The house connection set described in this section is an optional accessory - see "Spare parts and optional accessories" on page 28)

The signal from the transmitter can be directly coupled to plug sockets, cable TV connections and telephone jacks with the aid of a suitable adaptor cable. In doing so, it is not necessary to disconnect the lines.

Elcometer offers a ready made house connection set for this type of coupling.



• Coupling via transmitter clamp

(The transmitter clamp described in this section is an optional accessory - see "Spare parts and optional accessories" on page 28).

The transmitter signal can be coupled to cables which are easily accessible with the aid of a transmitter clamp. It is not necessary to disconnect the cables.

By ensuring that the transmitter clamp is completely closed around the cable, only a small leakage field will be generated. This can significantly reduce the unwanted coupling of the signal to neighbouring lines.

Ideally the cables must be grounded at both ends; but even if they are not grounded at one end, selecting high power transmitter output will assist easy location.



TRANSMITTER - USE, SETUP AND SIGNAL COUPLING

4.3.3 Inductive signal coupling

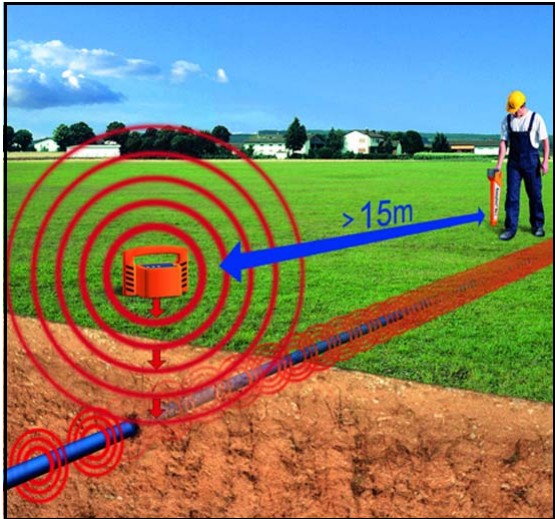
For lines which are not easily accessible, the signal from the transmitter has to be inductively coupled via the integrated antenna.

This is highly recommended if unknown lines are to be located (e.g. at a construction site).

To determine the orientation of a specific line, the transmitter has to be positioned directly above the line as shown in the following illustration. The best signal coupling is achieved when the handle of the transmitter housing is aligned with the lay of the line.

When locating lines using inductive signal coupling, the following guidelines should be observed:

- As the signal can be coupled to other conductors when using inductive coupling, direct coupling (see pages 10-13) of the transmitter is always preferable when locating lines selectively. Inductive signal coupling should only be chosen in cases where the line being located is not easily accessible.
- While taking measurements, make sure that a distance of at least 15 m is always maintained between the receiver and transmitter in order to prevent the coupling of the transmitter's signal through the air.
- When searching for unknown lines at a site, the position of the transmitter has to be changed at least once by one metre and 90°.
- It is also a good idea to position the transmitter at visible cable ends such as at distribution boxes or light poles.



4.3.4 Signal coupling in non-metallic pipes

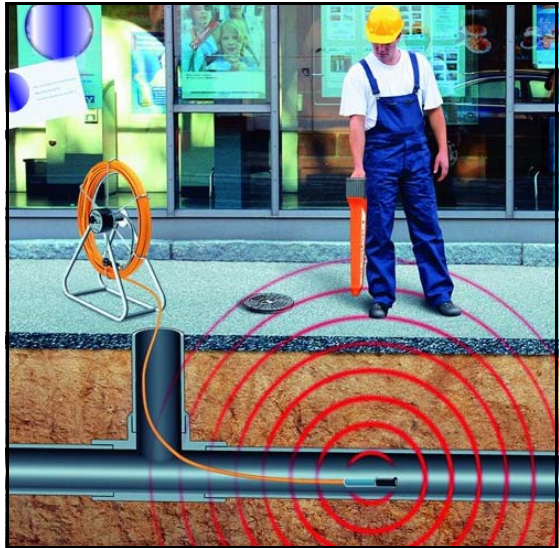
(The Probe described in this section is an optional accessory - see "Spare parts and optional accessories" on page 28).

With the aid of the Probe, the signal from the transmitter signal can be transmitted through non-metallic pipes.

To do this, the probe has to be pushed into the pipe using a flexible cable.

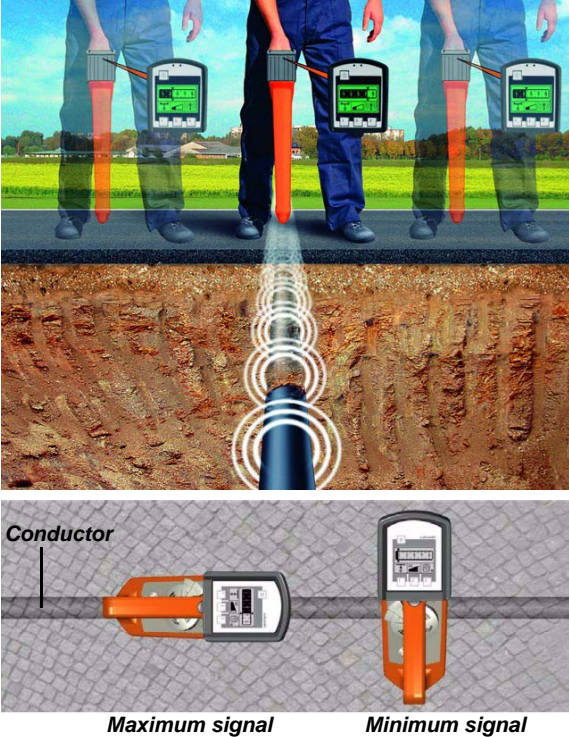
When locating non-metallic pipes, the following guidelines should be observed:

- Practice locating the Probe before pushing it into the drain or duct.
- The strongest signal will be detected when the receiver is above and perpendicular to the probe (as shown in the picture).



5 RECEIVER - USE, ADJUSTING SENSITIVITY AND SETUP

5.1 Using the receiver

Step	Action	Page
1.	If the site is to be searched with the aid of the transmitter, the transmitter must be switched on and set up before proceeding.	8
2.	Switch on the receiver.	5
3.	Select the desired operating mode by pressing button # 3. The symbol for the currently selected operating mode is shown in the lower right-hand corner of the display.	18
4.	<p>Hold the receiver in front of the body in an upright position and as close to the ground as possible. When the transmitter is brought directly over a metallic conductor, the maximum signal strength will be measured. If the receiver is moved away from the conductor towards the side and is not rotated while doing so, the signal will decrease proportionately.</p>  <p>The alignment of the receiver in relation to the orientation of the conductor affects the received signal strength.</p> <p style="text-align: center;"><i>Maximum signal</i> <i>Minimum signal</i></p>	
5.	Conduct a grid survey of the site. Adjust the sensitivity of the receiver if the signal level is too strong or too weak.	20 17
6.	When a conductor is located, pinpoint the strongest signal and mark the location.	

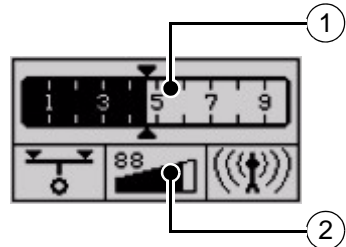
5.2 Adjusting the sensitivity level to match the received signal strength

The strength of the received signal and the sensitivity of the receiver are shown in the following segments of the display:

1. Received signal strength meter

The strength of the received signal is represented by this bargraph scale. These are relative values which are based on the sensitivity level set in the receiver.

The triangles (▼▲) above and below the scale are a visual marker for maximum values. They move towards the right as long as the signal strength increases and continue in this direction until it either levels off or decreases. The maximum marker remains in this position for 3 seconds and thus provides the user with a helpful visual aid for determining the maximum signal strength so far.



2. Sensitivity meter (gain level in percent)

The sensitivity setting of the receiver (which coincides with the total spectrum which the receiver is capable of processing) is represented by this scale. The higher the level, the more capable the receiver is of detecting weaker signals.

The numeric display above the bars shows the utilisation factor as a percent.

• Adjusting the sensitivity

Should the received signal strength bargraph provide virtually no indication, or the display is fully utilised, either a manual or automatic adjustment of the sensitivity setting of the receiver should be made.

- To adjust the sensitivity level *automatically*, press button # 2 once. The sensitivity level of the receiver will be adjusted automatically and the bargraph will fill approximately half of the scale.
- To adjust the sensitivity level *manually*, press button # 2 twice in rapid succession. The screen displays:








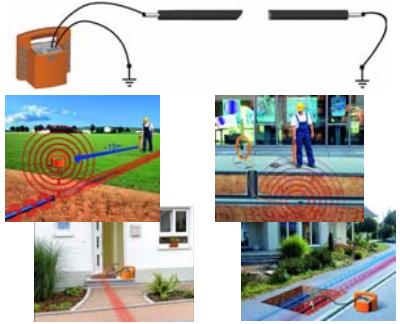
To decrease or increase the sensitivity of the receiver by one percent, press and release button # 1 (to decrease) or button # 3 (to increase). This process can be accelerated by holding down the respective button.

To exit the manual sensitivity level adjustment menu, press button # 2 twice in rapid succession. By pressing button # 2 only once, the depth measurement process will begin.

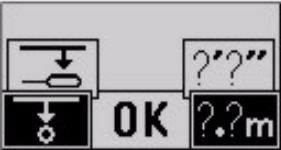




5.3 Receiver setup options

5.3.1 To select operating mode


Press button # 3 to select between the three operating modes:

Operating mode icon	Detects signals emitted by	Typical uses
	Radio	<p>For locating cables which are carrying VLF re radiated radio signals.</p> 
	Power Grid	<p>For locating mains power supply cables, through which current with a grid frequency (50 Hz/60 Hz) is flowing.</p> 
	Transmitter	<p>For locating cables or pipes, which are carrying a signal coupled from the Elcometer 701 transmitter</p> 

5.3.2 To select depth measurement type and units:

Step	Action
1.	Switch off the receiver.
2.	Press and hold button # 1.
3.	While continuing to hold button # 1, press and release the power on/off button. The instrument will switch on and then beep.
4.	Release button # 1. The screen displays: <div style="text-align: center; margin: 10px 0;">  </div>
5.	If required, to adjust the depth measurement type, press button # 1: <ul style="list-style-type: none"> •  = depth measurement using a Probe (optional accessory - see page 28) •  = depth measurement without a Probe (normal method)
6.	If required, to adjust the depth measurement units, press button # 3: <ul style="list-style-type: none"> •  = feet and inches •  = metres
7.	Press button # 2 [OK] to save the settings. The changes will remain in effect even after the receiver is switched off and back on again.

5.3.3 To select receiver power grid mode detection frequency (50 Hz/60 Hz):

Step	Action
1.	Switch on the receiver and press button # 3 until the instrument is in Power Grid mode <div style="text-align: center; margin: 10px 0;">  </div>
2.	Switch the instrument off.
3.	Press and hold button # 3.
4.	While continuing to hold button # 3, press and release the power on/off button. The instrument will switch on and then beep.
5.	Release button # 3.
6.	Press button # 1 to select 50 Hz operation or button # 3 to select 60 Hz operation.
7.	Press button # 2 [OK] to save the settings. The changes will remain in effect even after the receiver is switched off and back on again.

SURVEYING A SITE

6 SURVEYING A SITE

Your Elcometer 701 Pipe and Cable Locator is the ideal instrument to use if a site needs to be searched for cables and pipes. Typically there may be inaccurate or no information available as to the location and orientation of cables and pipes on a site planned for construction (e.g. excavation work).

When such a site is to be searched, a systematic approach should be taken. The following picture illustrates how to proceed:



Carry out a survey in **Power Grid** and **Radio** modes using a grid search pattern to cover the site and locate conductors in all directions.

If the site is to be surveyed with the aid of the transmitter used in **Induction** mode, the position of the transmitter should be changed by at least one metre and 90° after the first sweep of the site and the site should be probed again in the same manner.

A minimum spacing of 15 m between the transmitter and receiver must always be maintained.


7 DETERMINING THE DIRECTION OF A LINE

Follow the steps below to determine the orientation of a metallic conductor:

Step	Action	Page
1.	If the direction of the conductor is to be determined with the aid of the transmitter, couple the transmitter's signal to the metallic conductor in such a way that there is as little signal loss as possible and switch on the transmitter.	10
2.	Switch on the receiver.	5
3.	Select the desired operating mode by pressing button # 3. The symbol for the currently selected operating mode is shown in the lower right-hand corner of the display.	18
4.	Hold the receiver perpendicular to the position of a known metallic conductor, e.g. above a location which was marked during the probing of the site.	
5.	Rotate the receiver (through its own axis) over this location until the maximum signal strength is indicated. Result: The receiver is in line with the conductor when it is positioned where the signal is strongest, which is prerequisite for determining the direction of the line.	16
6	To determine the path over an extended distance, proceed by moving forward while maintaining the maximum signal strength. If the signal becomes weaker, check that the conductor has not changed direction or become deeper; move and/or rotate the receiver to the left and right until the maximum signal strength is detected again. Adjust the sensitivity of the receiver as needed if the signal level is too strong or too weak. It is advisable to adjust the sensitivity level manually. The path of the metallic conductor should always be followed until it exits the site being searched, and its path should be clearly marked along the way with paint/chalk or marker flags.	17

DETERMINING THE DEPTH OF A LINE

8 DETERMINING THE DEPTH OF A LINE

	Even after the depth has been determined successfully, all excavation work should be done with caution. This is particularly important if depth is measured using the manual method.
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8.1 Depth measurement - automatic

The Elcometer 701 receiver has an *automatic* depth measurement feature. This feature will only operate if the following conditions are met:

- A clear signal from the transmitter is coupled onto the conductor to be measured.
- The signal from the transmitter is continuous (not pulsed) - see “Transmitter setup options” on page 9.
- The receiver must be set to **Transmitter** mode; it will not function if set to **Power Grid** or **Radio** mode - see “Receiver setup options” on page 18.

To use the automatic depth measurement feature, follow the procedure given in section 8.4 up to step 6.

8.2 Depth measurement - manual

If the conditions described in 8.1 are not met, a rough estimate of the depth may be made using the manual method - follow the procedure given in section 8.4.

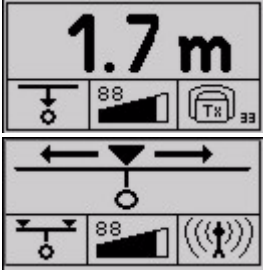
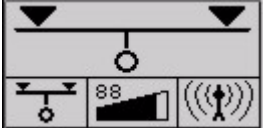
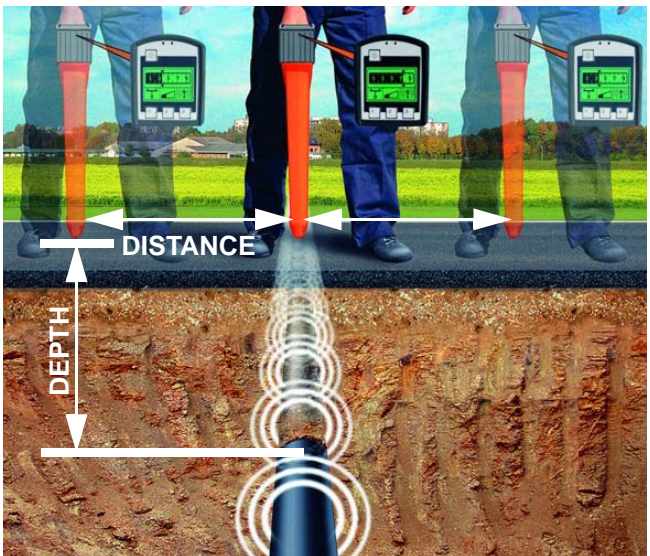
8.3 Depth measurement - non-metallic pipes

If the depth of a non-metallic pipe needs to be determined, the measurement has to be made with aid of a Probe - see “Signal coupling in non-metallic pipes” on page 15. In this instance, in order to accommodate the transmission characteristics of a probe, the receiver has a special depth measurement feature which has to be activated before depth measurement is carried out - see section 5.3.2, step 5, on page 19.

8.4 Procedure

Follow the steps below to determine the depth of a metallic conductor:

Step	Action	Page
1.	If the depth of the conductor is to be determined with the aid of the transmitter, couple the transmitter's signal to the metallic conductor in such a way that there is as little signal loss as possible and switch on the transmitter. <i>Do not forget to set the transmitter to continuous signal, not a pulsed signal when measuring depth.</i>	10
2.	Switch on the receiver.	5
3.	Select the desired operating mode by pressing button # 3. The symbol for the currently selected operating mode is shown in the lower right-hand corner of the display.	18
4.	With a steady grip, hold the receiver perpendicular to the position of a known metallic conductor, e.g. above a location which was marked during the probing of the site. The signal strength bargraph should show zero.	

Step	Action	Page
5.	<p>Rotate the receiver (through its own axis) over this location until the maximum signal strength is indicated.</p> <p>Result: The receiver is in line with the conductor when it is positioned where the signal is strongest, which is prerequisite for determining the depth of the line.</p>	16
6.	<p>Press button # 1 to begin measuring the depth.</p> <ul style="list-style-type: none"> <i>If the receiver is set to Transmitter mode, the measured depth will be shown in the display and the remaining steps in this section can be ignored:</i> <i>If the receiver is set to Radio or Power Grid mode, the screen displays:</i> 	
7.	<p>Move the receiver to one side until the screen displays:</p>	
8.	<p>Mark this spot, then move in the opposite direction to the other side of the line until the same screen is displayed again.</p>	
9.	<p>Mark this spot as well, then measure the distance between the two spots.</p> <p>Result: Half the distance between the two spots corresponds approximately to the depth of the line.</p>	

DETERMINING THE DEPTH OF A LINE

8.5 Indications and error messages

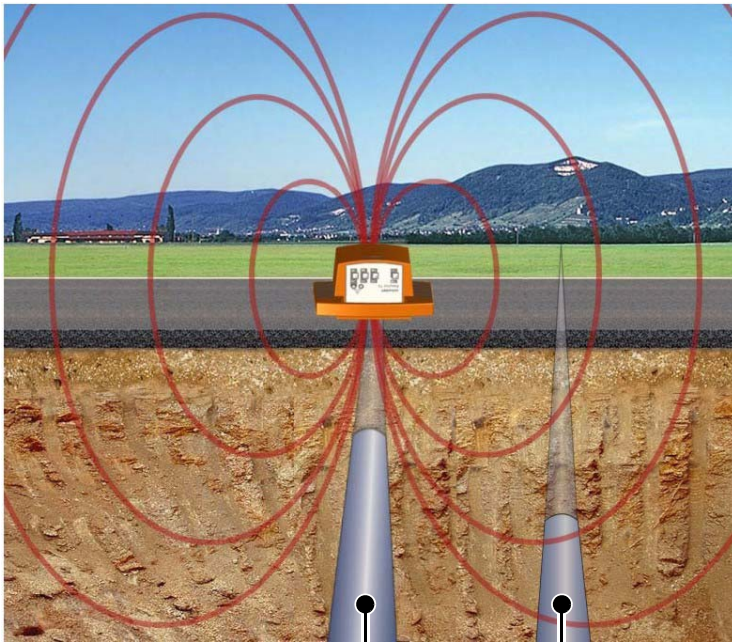
During the depth measuring process, the following symbols are used to notify the user about certain characteristics and errors:

<p>The icon shows a top-down view of a line with a receiver symbol (a circle with a vertical line) positioned to the right of the line. Below the icon is a control panel with a receiver symbol, a battery level indicator showing 88%, and a 'Tx' button with a battery icon.</p>	<p>For one of the following reasons, the depth could not be measured:</p> <ul style="list-style-type: none"> • The signal received was too weak or too irregular. • The receiver was not held steady enough during the measuring process. • The receiver was not positioned directly above the line at the beginning of the process.
<p>The icon displays '>5m' with a plus sign. Below it is the same control panel as in the first icon.</p>	<p>The depth of the metallic conductor is greater than 5 m (16 ft).</p>
<p>The icon shows a lightning bolt striking a line and a warning triangle with an exclamation mark. Below it is the same control panel as in the first icon.</p>	<p>The depth of the metallic conductor is less than 30 cm (1 ft). Such conductors must be specially marked in order to prevent damage during construction.</p>
<p>The icon shows a line with a receiver symbol in the center and arrows pointing left and right. Below it is a control panel with a receiver symbol, a battery level indicator showing 88%, and a signal strength icon.</p>	<p>The receiver was moved too far to the left or right during manual measurement of depth. Move in the opposite direction until the following symbol appears and then continue:</p>
<p>The icon shows a line with a receiver symbol in the center and arrows pointing down towards the line. Below it is the same control panel as in the first icon.</p>	

9 MASKING-OUT LINES

Under certain circumstances lines at lower depths can 'hide' deeper, adjacent lines, thus making it more difficult to locate them.

In such cases, the transmission characteristics of the transmitter can be fully utilised and the lines which have already been located can be masked out.



Line with weaker inductive coupling

Line with good inductive coupling

Follow the steps below in order to locate lines by masking-out adjacent lines:

Step	Action	Page
1.	Use the receiver and the transmitter to locate and pinpoint a buried line.	20
2.	With the receiver resting on the ground straight above the located line, have a colleague place the transmitter on its back (see picture above) near the line path (but at least 15 m away from the receiver).	
3.	Slide the transmitter across the line until the signal strength bargraph on the receiver is lowest, indicating that the transmitter is directly above the line which, therefore, is masked-out. Note that adjacent lines may not be parallel with the first line route, so sweep the receiver around in a circle about 10 m to 15 m radius from the transmitter, with the handle pointing towards the transmitter. Any metallic lines within 2.5 m of the transmitter will be coupled with the transmitted signal.	18
4.	Continue to pinpoint and determine the direction of any buried lines.	16

10 TECHNICAL SPECIFICATION

10.1 Elcometer 701 Receiver (Rx)

Frequency range	
Range 1: radio	15 kHz to 23 kHz
Range 2: power grid	50 Hz / 60 Hz (switchable) (optionally 100 Hz - contact Elcometer)
Range 3: transmitter	32.768 kHz
Sensitivity (at a depth of 1 m)	
Range 1: radio	>20 µA
Range 2: power network	>7 mA
Range 3: transmitter	>5 µA
Dynamic response range	
Range 1: radio	120 dB
Range 2: power network	135 dB
Range 3: transmitter	120 dB
Depth determination	
Depth range	0.1 m to 5 m (4 in to 16 ft)
Resolution	0.1 m
Accuracy	
Range 1: radio	±20%
Range 2: power network	±20%
Range 3: transmitter	±5% (to 2 m) ±20% (between 2 m and 5 m)
Power supply	10 x IEC R6 / AA cell / Mignon
Operating time	40 hours (intermittent use with alkaline batteries, 20°C)
Temperature range (in accordance with EN 60068-1)	
Operation	-20°C to +55°C
Storage	-30°C to +70°C
Weight	2.5 kg
Dimensions (W x H x D)	99 mm x 660 mm x 252 mm
Type of protection (in accordance with EN 60529)	
Dust and water protected	IP 67 from the lower edge of the receiver up to the lower edge of the battery compartment, and IP 56 for all parts above this.

10.2 Elcometer 701 Transmitter (Tx)

Transmitted power	0.1 W / 0.5 W (switchable)
Frequency	32.768 kHz
Power supply	6 x IEC R20 / D cell / Mono
Operating time	40 hours (intermittent use with alkaline batteries, 20°C)
Temperature range (in accordance with EN 60068-1)	
Operation	-20°C to +55°C
Storage	-30°C to +70°C
Weight	1.7 kg
Dimensions (W x H x D)	260 mm x 255 mm x 140 mm
Type of protection (in accordance with EN 60529)	
Dust and water protected	IP 56

10.3 Limit values and standards

The following limit values and standards are applicable for the *Elcometer 701 RxTx* location system:

Sinusoidal vibrations (in accordance with EN 60068-2-6)	
Peak acceleration	20 m/s ²
Frequency	10 Hz to 150 Hz
Free fall (in accordance with EN 60068-2-32)	
Max. height (packaged)	80 cm (weight up to 10 kg)
Relative humidity	max. 93% at 30°C
Atmospheric pressure	max. 4 kPa
Protection class (meets EN 61140)	III

MAINTENANCE

11 MAINTENANCE

The Elcometer 701 Pipe and Cable Locator is designed to give many years reliable service under normal operating and storage conditions.

The Elcometer 701 Pipe and Cable Locator does not contain any other user-serviceable components. In the unlikely event of a fault, the instrument should be returned to your local Elcometer supplier or directly to Elcometer.

Details of Elcometer offices around the world are given on the outside cover of these Operating Instructions. Alternatively visit the Elcometer website, www.elcometer.com

12 SPARE PARTS AND OPTIONAL ACCESSORIES

The following spare parts and optional accessories are available from your local supplier or direct from Elcometer:

Description	Sales part number
Transmitter clamp for the inductive coupling of a signal to exposed lines	TW70120491-1 (50) TW70120491-2 (100)
House connection set to couple to the mains power supply, telephone or cable TV connection	TW70120492-1 (EU) TW70120492-2 (UK) TW70120492-3 (USA)
Probe - battery powered mini-transmitter for locating non-metallic pipes	TW70120493
Sonde/Probe protection cap	TW70120537
Headphones	TW70120490

13 RELATED EQUIPMENT

Elcometer produces a wide range of metal detection and surveying equipment.

Users of the Elcometer 701 Pipe and Cable Locator may also benefit from the following Elcometer products:

- Elcometer Deep Cover Metal Detector
- Elcometer Metal Box Locators

For further information contact Elcometer, your local supplier or visit www.elcometer.com