

RADIODETECTION®

PCM^x™

Radiodetection's world leading Pipeline Current Mapping System

Operation Manual

90/PCMX-OPMAN-ENG/02



SPX®

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Section 1 Preface

1.1 Before you begin

Thank you for your interest in Radiodetection's Pipeline Current Mapping System.

Please read this user manual in its entirety before attempting to use the PCM system as it contains many important safety notices and warnings.

Radiodetection products, including this manual, are under continuous development. The information contained within is accurate at the time of publication; however the PCMx Locator, PCM Transmitter, this manual and all its contents are subject to change.

Radiodetection Limited reserves the right to modify the product without notice and some product changes may have taken place after this user manual was published.

Contact your local Radiodetection dealer or visit www.radiodetection.com for the latest information about the Pipeline Current Mapping product family, including this manual.

1.2 Important notice

General

The performance of any cable and pipe locator may be affected when used in close proximity to ferrous materials such as manhole covers, steel-toe boots, mobile phones and nearby vehicles. Keep a distance of 1 or 2 m from these objects when taking critical measurements such as depth and current readings.

This instrument, or family of instruments, will not be permanently damaged by reasonable electrostatic discharge and has been tested in accordance with BS EN61326-1. However, in extreme cases temporary malfunction may occur. If this happens, switch off, wait and switch on again. If the instrument still malfunctions, disconnect the batteries for a few seconds.

Safety

 **WARNING:** Failure to comply with safety warnings can cause serious injury or death.

CAUTION: Failure to comply with safety cautions can result in damage to equipment or property.

This equipment shall be used only by qualified and trained personnel, and only after fully reading this Operation Manual.

 **WARNING:** Direct connection to live conductors is **POTENTIALLY LETHAL**. Direct connections to live conductors should only be attempted by fully qualified *personnel* using the relevant products that allow connections to energized lines.

 **WARNING:** Reduce audio level before using headphones to avoid damaging your hearing.

 **WARNING:** This equipment is **NOT** approved for use in areas where hazardous gases may be present.

CAUTION: The battery cover, the accessory cover and the headphone cover protect the locator's sockets from debris and water ingress. If they get damaged or lost, contact Radiodetection or your local service representative for a replacement one.

Batteries

 **WARNING:** Batteries can get hot after prolonged use at full output power. Take care while replacing or handling batteries.

 **WARNING:** Do not tamper with, or attempt to disassemble the battery packs.

CAUTION: If battery failure is suspected return the entire unit to an authorized repair center for investigation and repair. Local, national or IATA transport regulations may restrict the shipment of faulty batteries. Check with your courier for restrictions and best practice guidelines. Your local Radiodetection representative will be able to direct you to our authorized repair centers.

 **WARNING:** Exposing the battery to a high temperature above 60°C (140°F) may activate safety systems and cause a permanent battery failure.

Disposal



This symbol on the product, accessories or literature indicates that the product and its electronic accessories must not be treated as domestic waste, but must be disposed of professionally. It is your responsibility to dispose of your waste equipment by handing it over to a designated collection point for the recycling of waste electrical and electronic equipment. The separate collection and recycling of your waste equipment at the time of disposal will help to conserve natural resources and ensure that it is recycled in a manner that protects human health and the environment. For more information about where you can drop off your waste equipment for recycling, please contact your local city office, your disposal service or product supplier.

Please dispose of this device in a manner appropriate to the relevant legal requirements at the end of its product life.

Batteries should be disposed of in accordance with your company's work practice, and / or the relevant laws or guidelines in your country or municipality.

You are responsible for determining whether the conditions are suitable for using this device. Always carry out a risk assessment of the site to be inspected.

Follow your company and national safety procedures and or requirements when operating this equipment in any environment or workplace. If you are unsure what policies or procedures apply, contact your company or site's occupational health and safety officer or your local government for more information.

Do not use this equipment if you suspect that any component or accessory is damaged or faulty.

Use authorized accessories only. Incompatible accessories may damage the equipment or give inaccurate readings.

Keep this equipment clean and arrange for regular services with an authorized Radiodetection service center. More information can be found in the Appendix or from your local Radiodetection representative.

Do not attempt to open or dismantle any part of this equipment unless directed specifically by this manual. Doing so may render the equipment faulty and may void the manufacturer's warranty.

You are responsible for determining whether you consider the measurement results to be valid and for any conclusions that are reached or any measures that are taken as a result thereof. Radiodetection can neither guarantee the validity of any measuring results nor can we accept liability for any such results. We are on no account able to accept liability for any damage, which

may be caused as a consequence of the use of these results. Please see the Standard Warranty Terms enclosed with the product for further information.

1.3 Training

Radiodetection provides training services for most Radiodetection products. Our qualified instructors will train equipment operators or other personnel at your preferred location or at a Radiodetection location.

For more information go to www.radiodetection.com or contact your local Radiodetection representative.

1.4 Simplified EU Declaration of Conformity

Where applicable Radiodetection hereby declares that the radio equipment type "Wideband Data Transmission" is in compliance with European Directive 2014/53/EU.

Please contact Radiodetection for a copy of the full text of the EU declaration of conformity.

Section 2 Introduction

2.1 About this manual

The PCMx locator comes supplied with a PCM magnetometer attachment and while connected the locator will operate as a PCMx locator. If the attachment is removed, the locator will operate as a RD8100PDLG cable and pipe locator. This manual focuses solely on providing pipeline surveyors with comprehensive operating instructions for the Pipeline Current Mapper (PCMx) transmitter and locator system. If you wish to use the product as a RD8100PDLG you will need to use the RD8100 operation manual, available on the Radiodetection website.

Before operating the system, it is very important that you read this manual in its entirety, noting all safety warnings and procedures.

Additional documentation

The full product specification and related manuals are available to download from:

www.radiodetection.com.

2.2 Overview of the PCMx system

- Radiodetection's PCMx system enables the pipeline industry surveyor to evaluate the effectiveness of pipeline Cathodic Protection (CP) installations.
- Enables shorts caused by contact with other metallic structures and coating defects to be identified.
- Provides an accurate evaluation of the condition of the coating of a section of pipe.
- Reduces false indications and thereby minimizes unnecessary excavations.
- The PCMx provides a method to locate faults and poor coating that is draining the current, resulting in improved potentials and minimizing damaging side effects.
- A PCMx with the addition of an A-Frame can perform a Close Interval Potential Survey (CIPS) as current flow and voltage potentials are related but other factors vary this relation.
- Provides data logging and on-site review of readings and graphs via Bluetooth® to a tablet or smart phone.
- Can be supplied with an accessory A-Frame, and used to pinpoint coating defects.

- Reduces operational and maintenance costs and speeds up survey time.

2.3 PCMx system features

- Consists of two portable transmitters, a handheld locator and a magnetometer foot.
- The transmitters apply special groups of low frequency signals to the pipeline.
- The locator locates these unique signals on the pipeline and displays the signal's current magnitude and direction without having to connect the locator to the pipeline.
- The magnetometer foot maps the 4Hz signal. With the foot removed, the PCMx is automatically configured as an RD8100 PDLG cable and pipe locator.
- Accurately and easily locates and maps the pipeline even in areas where there is contact with other metallic structures, interference, or congestion.
- Provides a current profile and current direction that is virtually the same as the CP currents on the pipeline.
- Provides a categorized evaluation of holidays in pipe coating and faults in cable sheaths.
- Reduces false indications and thereby minimizes unnecessary excavations.
- Provides data logging and on-site review of readings via Bluetooth® to a phone or tablet to enable graphs to be display during the survey.
- Can be supplied with an accessory A-Frame, used to map surface voltage gradients and categorize fault severity.
- Reduces operational and maintenance costs and speeds up survey time. Eliminates the need for the operator to perform 'current spans' and manual calculations to determine CP currents along the pipeline that require connection to the pipeline.
- It is designed for the Pipeline Industry with guidance and support from Gas Industry leaders.

2.4 PCMx transmitters

- There are two transmitters, the Tx-25 PCM and the Tx-150 PCM.
- The Tx-150 PCM transmitter allows for long-range signal detection of up to 30km (20 miles). Significantly fewer pipeline connection points are needed thereby reducing the time required to evaluate a section of pipeline.

- The Tx-25 PCM transmitter has internal Li-ion batteries that allow it to operate in the field independently of external power sources.
- The transmitters have three operating modes that enable both distribution and transmission pipeline systems to be effectively mapped.
- The Tx-25 PCM transmitter also has a 1A 8kHz mode used for location of pipelines only.
- Connecting the transmitters is straightforward, and the current reading LCD and voltage indicating LEDs help the operator to choose the best settings for each pipeline application.

2.5 PCMx Locator

- PCMx locator is used to locate the pipeline, even in heavily congested areas. The locator provides the operator with a measurement of depth, current and direction of the low frequency signals applied by the system's transmitter.
- There is a magnetometer foot for PCM work, which can be removed for locator operation.
- The locator takes the required voltage and current readings, displaying the calculated 4Hz current measurement. The results can be stored internally and transferred by Bluetooth® to the mobile app to provide live graphical presentation of the survey on a mobile phone or tablet.

2.6 Mobile and tablet apps

- App for Android is available for live graphing, mapping and uploading of the survey results, which can then be sent back to the office for evaluation.
- The display provides a live graph of the dB current and dB voltage along the line and derived fault severity rating.
- A live map will be available of the survey.

2.7 eCert and Self-Test

The PCMx locator is safety equipment and checked regularly. eCert rigorously tests the locating circuitry and magnetometer foot and supplies a Radiodetection Calibration Certificate when a positive test result has been obtained.

PCMx locators incorporate an Enhanced Self-Test feature, which checks display, power, accuracy and performance of both locator and magnetometer

Section 3 Tx-25 and Tx-150 PCM Transmitter

The Tx-25 PCM is a 1A transmitter and aimed at users who want a fully portable system for use where no external power supply is available.

The Tx-150 PCM is a powerful 3A transmitter, capable of sending detectable signals up to 30km (20 miles) from the connection point.

The Tx-25 & Tx-150 transmitters are housed in rugged waterproof cases. To open the transmitter, unsnap the clips on either side of the handle. In certain situations, the air pressure within the case may need to be equalized by unscrewing the small knob located near the handle.

3.1 Transmitter control panels

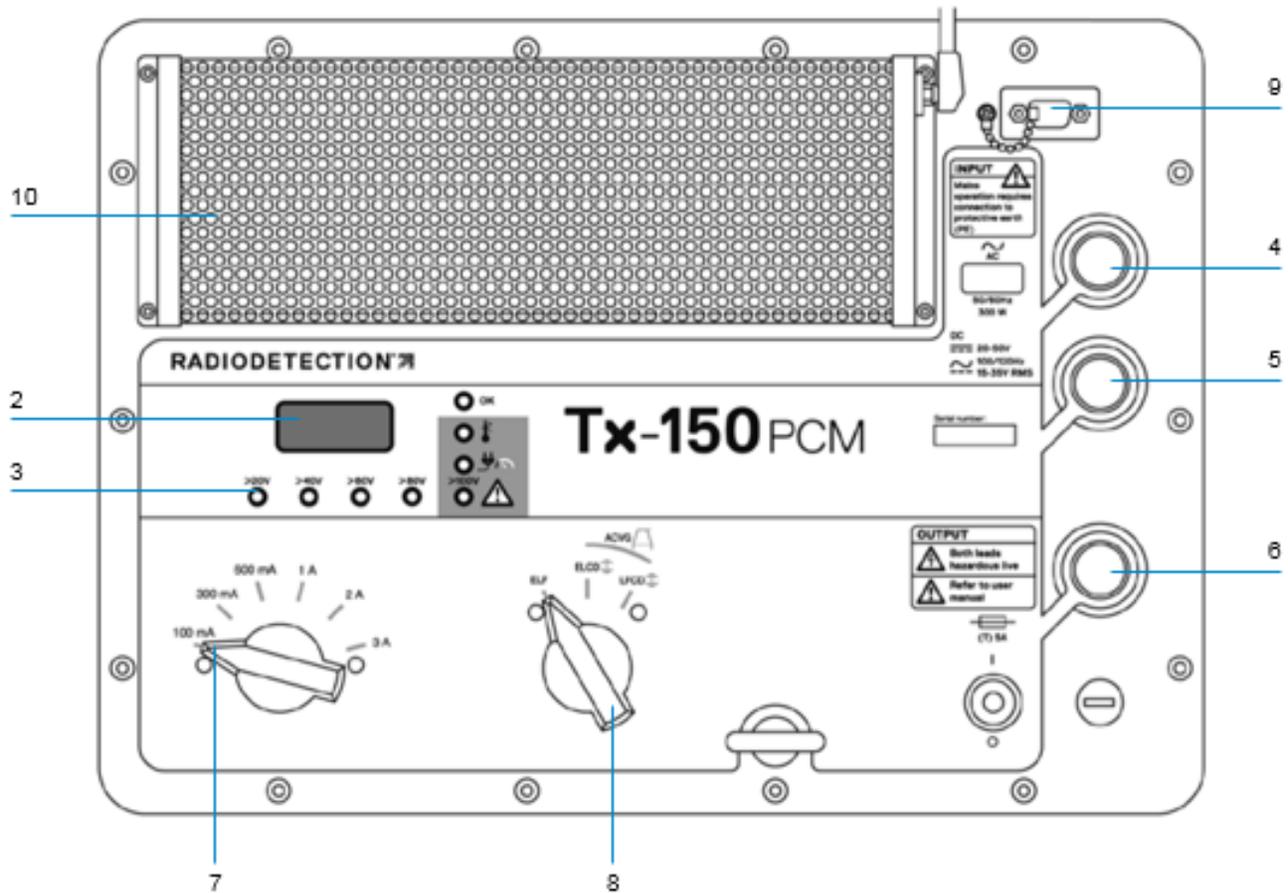


Fig. 3.1: Tx-150 PCM Transmitter

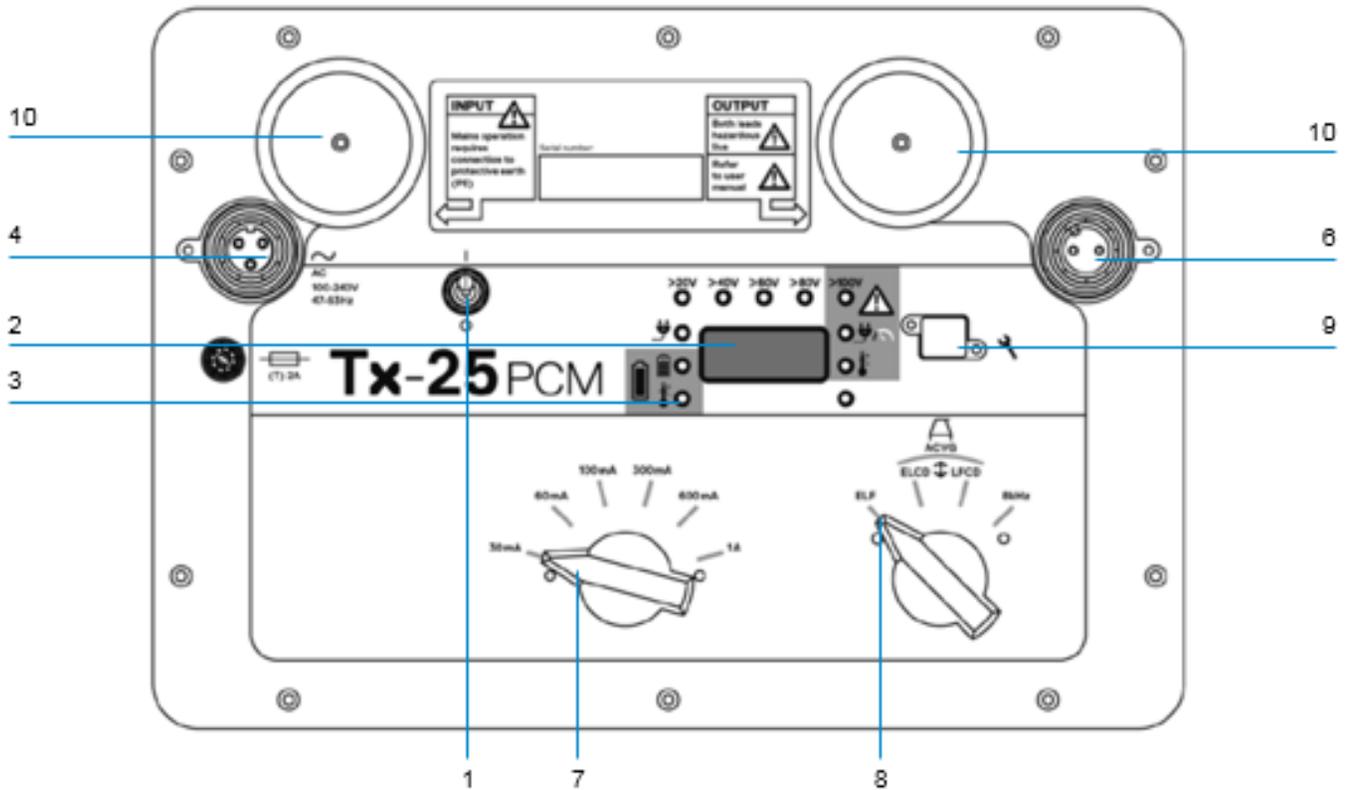


Fig. 3.2: Tx-25 PCM Transmitter

3.2 Transmitter Features

1. On/Off switch.
2. LCD display: Indicates current output, (4Hz or 8kHz) in Amps.
3. LED indicators. Provide critical feedback on the transmitter's operation.
4. AC Input socket.
5. DC Input socket (Tx-150 PCM only).
6. Output lead socket.
7. Output Level Selector: Select the output level in Amps.
8. Frequency Selector: Selects the frequency.
9. Communication Port: For service personnel only.
10. Heat sink: Vents heat from the transmitter during operation.

3.3 Transmitter Controls

Frequency Select

The 4Hz current is displayed on the transmitter display. The frequency selector switch selects the applied frequencies as follows:

Transmission Lines

- ELF** Maximum Range
- 35% 4Hz
 - 65% ELF (128Hz or 98Hz)

Transmission and Distribution Lines

- ELCD**  Medium Range
- 35% 4Hz
 - 30% 8Hz (Current Direction)
 - 35% ELF (128 Hz or 98Hz)

Distribution Lines

LFCD  An alternative frequency for congested areas - use as ELCD

- 35% 4Hz
- 30% 8Hz (Current Direction)
- 35% LF (640Hz or 512Hz).

8kHz Tx-25 only - locate signal only and no 4Hz frequency for current pipeline mapping.

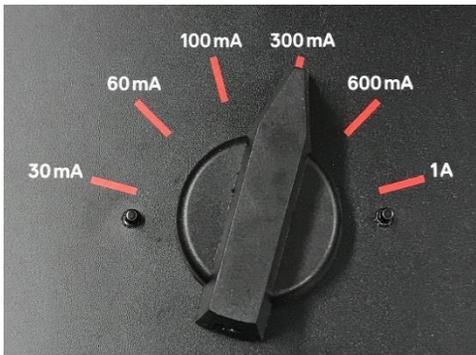
3.4 Output Current Selector

This rotary switch allows users to select different current settings. The setting you use will be determined by the type of survey that you are carrying out in terms of survey distance and condition of pipeline coating. On some applications, particularly high resistance applications such as pipelines with good coating or applications where ground conditions are not favorable it may not be possible to achieve maximum output current levels.

Tx-150 PCM 100mA, 300mA, 600mA, 1A, 2A, 3A



Tx-25 PCM 30mA, 60mA, 100mA, 300mA, 600mA, 1A



When the transmitter is operating, the selected current will remain at a constant level, unless the input power supply limit is reached.

3.5 Warning lights and indicators

Output voltage

>20V >40V >60V >80V

The output voltage for Tx-25 and Tx-150 is indicated by LEDs:

- If no lights are lit the voltage is below 20V.
- If the 20V LED is lit, the voltage applied is between 20 – 40V.
- If the 40V LED is lit, the voltage applied is between 40 – 60V.
- If the 60V is lit the voltage applied is between 60 – 80V.
- If the 80V LED is lit the voltage is between 80 – 100V.

Voltage Limit:

If the 100V Red LED is lit, the unit has gone into voltage limit - switch to a lower current setting until one of the other voltage LED's illuminates. Allow a few seconds to settle between current selections.

This may happen if the resistance of the pipe or ground is too high.

 **WARNING!** *If the pipeline being surveyed has coating that is known to be in good condition, it is probable that the voltage warning LED's will illuminate as the current is increased.*

 **WARNING:** *If the 60V/80V/100V lights are illuminated, do not use excessive voltage or current, as this may result in high current density through small holidays and coating defects. This may cause minor corrosion if the transmitter is left switch on for very long periods.*

Transmitter status

Tx-25 and Tx-150:

 **Over Temperature**

If the transmitter temperature exceeds its recommended limits it will automatically shut down. The over

temperature LED will extinguish once the unit has cooled down sufficiently.

Power Limit

This LED indicates that the external power supply is incapable of supplying the demanded power to support transmission at the selected current. The transmitter has reached its own power limit. Switch to a lower current setting.

Tx-25 only:



Power: Indicates a power supply is connected



Battery charging: Indicates when the battery is charging. Lights ORANGE when the battery level is low. Lights GREEN when the battery is almost charged. When fully charged the LED will turn off.



Battery charge temperature: Indicates when the battery is out of temperature range for charging.

3.6 LCD Display

The LCD displays the 4Hz signal current, in Amps, that is being fed into the pipe.

On startup it confirms the AC frequency setting, associated location frequencies and last calibration date. The Tx-25 PCM also displays the battery level on startup.

3.7 Power Options

Tx-150

The Tx-150 can be powered in a number of ways:

- **240 V (110 V) AC Supply or Generator**

If using a mains power supply or a portable generator the TX-150 may require a supply that is capable of supplying 650W or more. Use the supplied mains lead to connect directly to the mains supply or output of the generator.

- **Vehicle DC to AC Inverter**

It is possible to power the Tx-150 using a supply from a vehicle DC to AC inverter. This supply will need to be capable of providing at least 650W or more

- **DC or rectified AC**

Using the supplied DC lead the transmitter can be powered from two 12V auto batteries, or one 24V auto battery.

Alternatively, the rectifier can be used and will be required to supply 15-35V rectified AC. The current drawn from the supply will be a maximum of 5A.

Tx-25

- **Rechargeable battery**

The Tx-25 is fitted with a rechargeable battery. This battery can be used to power the transmitter when a mains supply is not available.

The battery can provide around 4 hours continuous use if the Tx-25 is used at full output current level and lower current output levels may be used where possible to increase battery run time.

- **240 V (110 V) AC Supply or Generator**

If using a mains power supply or a portable generator the Tx-25 may require a supply that is capable of supplying 125W or more. Use the supplied mains lead to connect directly to the mains supply or output of the generator.

When the Tx-25 is connected to a mains supply the unit will operate from this supply but at the same time charge the internal batteries.

- **DC to AC Inverter**

It is possible to power the Tx-25 using a supply from a DC source using a DC to AC inverter. This supply will need to be capable of providing 125W or more.

⚠ CAUTION: Both transmitters are earthed through the plug. When the Tx-25 PCM is charging from the mains, the case is earthed. When disconnected and powered off its internal batteries in the case is floating and earthed by connection to local ground stake.

3.8 Using Portable Transmitters

When the PCM transmitter outputs a signal it outputs a 4Hz low frequency current mapping frequency and at the same time a higher frequency locate signal. This higher frequency signal is used to locate the pipeline and also to

assist in the calculation of the 4Hz current mapping value.

AC signals can leak away from the pipeline either directly to the soil through coating defects or naturally by what is known as the capacitive coupling effect – the higher the frequency, the more leakage via capacitive coupling.

As you walk further along the pipe you may find that at some point the 4Hz current mapping value becomes erratic or unstable. This may be an indication that the higher frequency locate signal has got to a very low level and will more than likely also effect the depth readings.

If this happens you could increase the current output level of the PCM transmitter if it is not already at the maximum value, disconnect the PCM transmitter and connect further along the pipe or you may have to use a portable transmitter such as the Tx-10.

Connecting the Tx-10 to the pipe by using either the direct connect or induction method can be used to apply a locate signal onto the pipe. It will now be possible to locate the pipe and if the 4Hz current mapping signal is present from the PCM transmitter, a 4Hz current mapping value can be taken.

Note On the TX10, only 512Hz, 640Hz or 8kHz can be used as the locate frequency. If using 512Hz or 640Hz, set the PCMx to LFCD mode or 8kHz mode if using 8kHz.

Section 4 PCMx locator

Note: Before you attempt any survey, set the PCMx locator to match your country's power distribution frequency (50 or 60Hz) and your preferred units of measurement. See Section 3.3 for instructions.

4.1 PCMx Locator Features

1. Keypad
2. LCD with auto backlight
3. Speaker
4. Lithium-Ion battery pack
5. Removable magnetometer foot; used to detect the 4Hz mapping signal
6. Connector for magnetometer foot
7. Accessory connector
8. Headphone connector
9. Bluetooth® module antenna
10. USB port (inside battery compartment)



Fig. 4.1: PCMx locator

4.2 Locator Keypad

11. Power key
12. Frequency key to change frequencies
13. Up and down arrows for gain control
14. Antenna key to change antenna types
15. Survey key – taking 4Hz measurements
16. Transmitter key (Not used for PCMx operation)

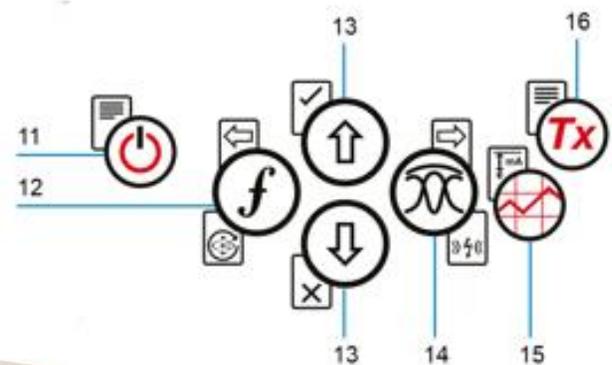


Fig. 4.2: PCMx locator keypad

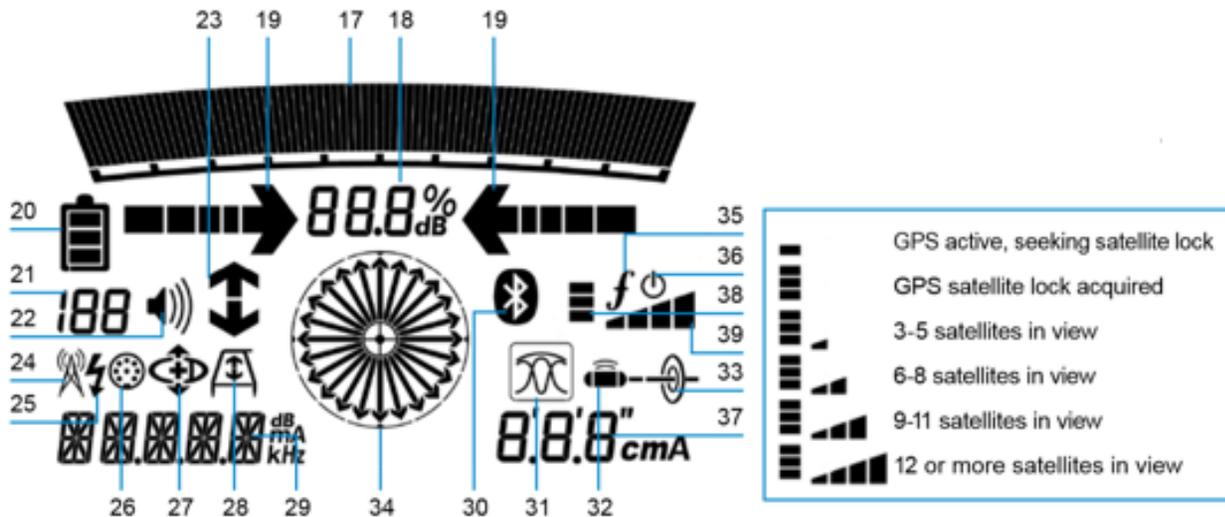


Fig. 4.2: PCMX locator screen icons

4.3 Locator Screen icons

Signal strength bar graph with peak marker.

- 17. Signal strength bargraph
- 18. Signal strength readout
- 19. Null / Proportional Guidance arrows
- 20. Battery level
- 21. Sensitivity readout / Log number
- 22. Volume level
- 23. Current Direction or Fault Find arrows
- 24. Radio Mode icon – only on RD8100
- 25. Power Mode icon
- 26. Accessory connection indication
- 27. CD Mode icon
- 28. A-Frame icon
- 29. Frequency / current / menu readout
- 30. Bluetooth status icon: Flashing icon means pairing is in progress. Solid icon indicates a connection is active
- 31. Antenna mode icon: Indicates antenna mode selection: Peak / Peak+ / Null / Broad Peak / Guidance
- 32. Sonde icon: only on RD8100
- 33. Line icon: Indicates that a line signal source is select

- 34. Compass: Shows the orientation of the located cable or sonde relative to the locator.
- 35. Transmitter communication status - iLOC™ (Tx-1, Tx-5, Tx-10 only)
- 36. Transmitter standby indicator. (Tx-1, Tx-5, Tx-10 only)
- 37. Depth readout
- 38. GPS Status.
- 39. GPS Signal quality

4.4 Locator information

The current software revision can be accessed on the PCMx locator. To do this hold down the frequency key while switching on the PCMx. The screen will momentarily display the following:

- Software revision number

4.5 Menu settings

The PCMx contains a menu structure that allows the user to access certain menu options and to set up personal preferences.

When the locator is switched on, a momentary press of the on/off key will provide access to the menu options.

Navigating the locator menu

- 1 Press the  key to enter the menu
- 2 Use the  or  keys to scroll through the menu options
- 3 Press the  key to enter the option's submenu
- 4 Use the  or  arrows to scroll through the submenu options
- 5 Press the  key to make a selection and return to the previous menu
- 6 Press the  key to return to the main operation screen

Selectable Options:

VOL – 4 levels. VOL 0 mutes the speaker and VOL 3 sets the volume to its loudest setting.

WARNING: *To avoid possible injury, always test the audio level prior to using earphones.*

DATA – Delete, Send, Enable or disable the Bluetooth® communication channel.

BT – Enable, disable, reset or pair Bluetooth® connections. Also defines the protocol used when sending data out via Bluetooth.

GPS – Enable, disable or reset the internal GPS module.

UNITS – Select metric or imperial units.

INFO – Run a Self-Test; display the date of the most recent service recalibration (M CAL) or the most recent eCert calibration.

LANG – Select menu language.

POWER – Select local power network frequency: 50 or 60Hz.

ANT – Enable or disable any antenna mode with the exception of Peak.

FREQ – Enable or disable individual frequencies.

ALERT – Enable or disable StrikeAlert™

BATT – Set battery type (Li-Ion auto-selects when connected).

ARROW – Select Null or proportional Guidance arrows in Peak+ mode.

COMPA – Enable or disable display of the Compass feature.

TIME – Set a time to turn locator off after a period of inactivity.

VIEW – Review survey measurements.

4.6 Batteries

The LCD provides a battery level indicator to indicate when the rechargeable pack requires charging or if the alkaline batteries need replacing, by showing a flashing battery symbol.

The PCMx is supplied with a lithium-ion rechargeable battery pack.

To recharge the battery

1. Connect the battery charger to a 100-240VAC mains supply.
2. Connect the battery charger to the connector on the battery pack (note, it is not necessary to disconnect the battery).
3. Switch on the power supply and disconnect it when the charge LED turns green.

The locator can also be powered by alkaline, nickel-metal hydride types. The 'Li-Ion' option will automatically be selected when the battery pack is connected to the locator. However, the battery type must be changed in the PCMx locator menu if other battery types are to be used.

Charging the battery pack

WARNING! Only use charging equipment provided by Radiodetection. The use of alternative chargers may cause a safety hazard and/or reduce the life of the battery.

CAUTION: Do not let your battery completely discharge as this may reduce its life or damage it permanently. If you are not using your equipment for a long period do charge them at least once a month. If you have left your equipment stored for longer than 1 month period and fully discharged the battery, ensure that the battery charger indicates that it is working properly, as for its instructions, and that the battery does not overheat

WARNING! Batteries can get hot after prolonged use at full output power. Take care while replacing or handling batteries.

WARNING! Do not tamper with, or attempt to disassemble the battery packs.

CAUTION: If battery failure is suspected or if the battery shows any sign of discoloration / physical damage return the entire unit to an authorized repair center for investigation and repair. Local, national or IATA transport regulations may restrict the shipment of faulty batteries. Check with your courier for restrictions and best practice guidelines. Your local Radiodetection representative will be able to direct you to our authorized repair centers. You can re-charge your batteries using the Radiodetection mains or automotive chargers.

NOTE: The charging temperature range is 0 to 45 °C, 32 to 113°F. Do not attempt to recharge your batteries outside this temperature range.

Locator Li-Ion battery pack

To recharge the locator battery pack, connect the battery charger to the DC input connector on the front of the battery pack.

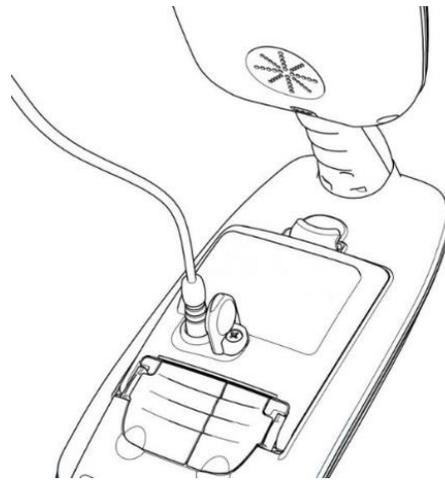


Fig. 4.3: Charging the locator Li-ion battery pack

On the PCMx locator

To connect the Li-ion battery pack unlatch the battery compartment (figure 4.4)

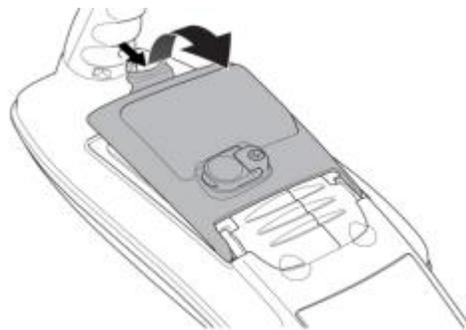


Fig. 4.4: Open the battery compartment

and plug the battery lead into the battery connector (see figure 4.5)

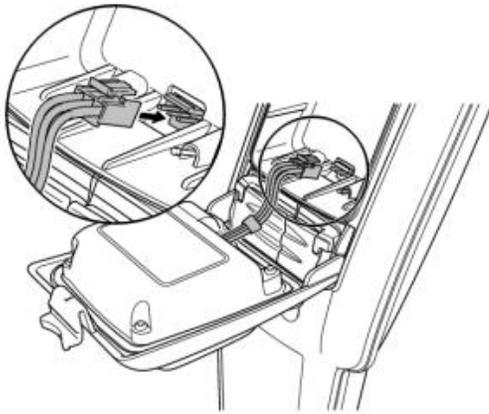


Fig. 4.5: Li-ion battery pack connection

Note: Fully charge your lithium-ion battery pack before its first use

Removing Battery Pack

1. Open the battery compartment using the release catch (figure 4.4)
2. If using a Li-ion battery pack un-plug the lead connector (see figure 4.5)
3. Lift the accessory cover slightly and press the battery retaining latch inwards. (See figure 4.6)

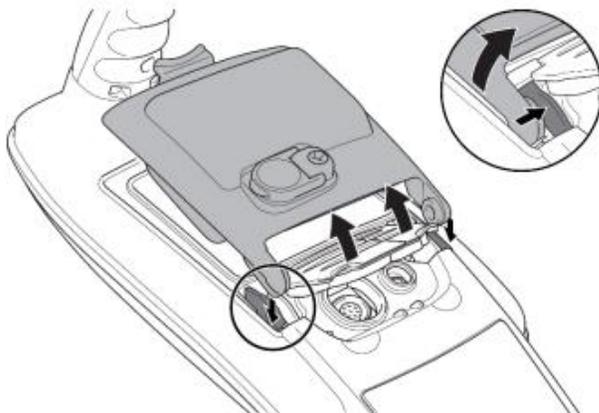


Fig. 4.6: Press the retaining latch inwards

4. Rotate the battery pack away and up from the latch
5. Repeat on the other side to release the battery pack completely then lift the battery pack away (figure 4.7)

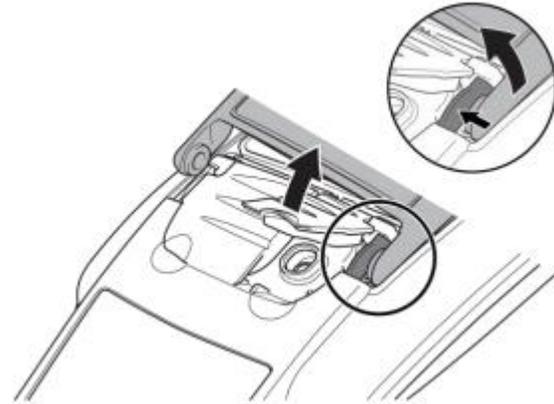


Fig. 4.7: Repeat then lift the battery pack away

To fit a new battery, lift both accessory covers slightly, then gently push the replacement pack into place until it clicks on both sides, then close the battery pack (figure 4.6).

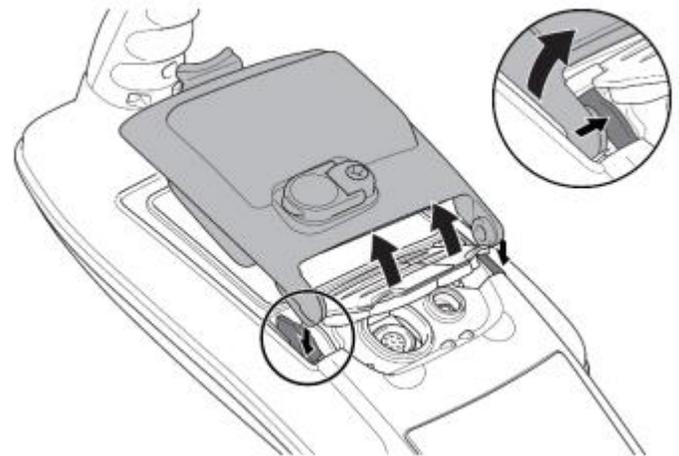


Fig. 4.8: Installing a new battery pack

Using the D-cell locator battery holder

To fit a D-cell battery tray, lift both accessory covers slightly, then gently push the battery tray into place until it clicks on both sides, then close the battery tray (figure 4.9)

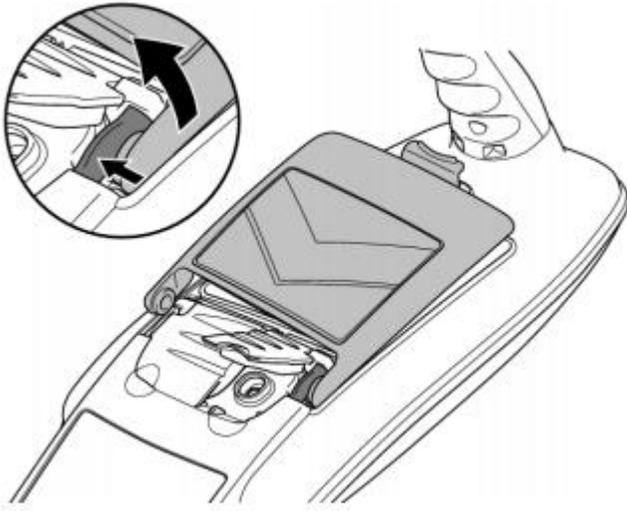


Fig. 4.9: Installing the D - Cell battery fixture

Insert two (2) good quality D-cell batteries. Note the polarity of the cells when inserting them in the battery tray.

4.7 Self-test

A self-test should be carried out weekly or before each use. It must be carried out away from large metallic objects and strong electrical signals.

To perform a self-test

1. Ensure the magnetometer foot is fitted and the batteries are fully charged.
2. Quick-press the power key to enter the menu.
3. Scroll to **INFO** and press the antenna key to enter.
4. Scroll to **TEST** and press the antenna key to select **YES**.
5. Press the frequency key to begin the test.

4.8 Bluetooth®

The PCMx is supplied with Bluetooth functionality enabling it to connect to Bluetooth mobile devices and external GPS devices.

Note: *The PCMx wireless features such as Bluetooth, maybe subject to national or local regulations. Please consult your local authorities for more information.*

Switching on Bluetooth

1. Quick-press the power key to enter the menu.
2. Scroll to the **BT** menu and press the antenna Key to enter.
3. Scroll to the **ON** option and confirm with the frequency key

4.9 Antenna modes

The PCMx locator supports 5 antenna modes to suit your particular application or the local environment.

To scroll between antenna modes, press the antenna key.



PEAK: For accurate locating, the Peak bargraph provides a visual readout of the signal strength. The Peak signal is found directly over the buried pipe.



PEAK+: Choose to combine the accuracy of the Peak bargraph with Null arrows, which can indicate the presence of distortion, or with proportional Guidance arrows for rapid line tracing – switch between them by pressing and holding the antenna key.



GUIDANCE: Proportional arrows and a ballistic directional 'needle' combine with audio left/right indication for rapidly tracing the general path of a buried utility.



BROAD PEAK: Operating similarly to Peak mode, but giving a result over a wider area. Used to detect and trace very weak signals, for example very deep utilities.



NULL: Provides a quick left/right indication of the path of a utility. As Null is susceptible to interference, it is best used in areas where no other utilities are present

4.10 Operating frequency modes

Press the frequency key 'f' to move through the choice of operating frequencies.

Mapping modes

In each of the modes below a 4Hz current measurement can be made using the PCMx locator.

ELF	Extra Low Frequency	128Hz / 98Hz
ELCD	Extra Low Frequency and Current Direction Arrows	128Hz / 98Hz
LFCD	Low Frequency and Current Direction Arrows	512Hz / 640Hz
CPS	Cathodic Protection Locate Signal	100Hz / 120Hz
8kHz	8kHz Locate Signal	8192Hz

Extra Locate Modes

Power Detects 50Hz/60Hz from power cables

CPS 100Hz/120Hz ripple from CP transformer rectifier.

Touch Gain control and Bargraph

Control of the gain is via the up and down arrows increase or decrease PCMx gain level. The lower the gain reading, the stronger the signal source.

Signal strength is shown on the bargraph.

The numerical display shows the bargraph percentage.

If bargraph indicates full scale, the numerical display indicates 99.9; press the down arrow once to reduce to 60% of full scale.

4.11 Depth measurement

The depth measurement is automatically displayed in all modes except ACVG. Depth measurements are displayed as follows and are to the center of the pipe:

- Less than 1 Meter, depth displayed in cm.
- Greater than 1 Meter, depth displayed in m.
- Less than 3 feet – distance is displayed in inches.
- Greater than 3 feet – distance is displayed in feet.

Note: To obtain accurate depth measurement the PCMx must be directly over and in line to pipe with the blade at right angles to the target.

4.12 Locate current

Locate current and depth measurement are automatically displayed and can be displayed in CPS, ELF, ELCD, LFCD and 8 kHz modes. Locate current will be displayed in mA.

4.13 GPS

The PCMx is equipped with built in GPS. If GPS co-ordinates are required to be added to survey measurements the GPS module will need to be enabled.

To enable the internal GPS, refer to section 4.5 on how to navigate the menu and use this to navigate to the GPS sub menu.

4.14 Survey Measurements

To achieve accurate survey measurements, the locator must be kept as still as possible and directly over the pipeline while taking readings.

Press and release the Survey key to initiate the PCMx measurement.

A live 4Hz current reading is now displayed. If you wish to hold the reading, a quick-press of the Antenna key and the 4Hz current reading will now be frozen. To return the 4Hz reading to a 'live' condition press the Antenna key.

 **WARNING!** When capacity is reached and the next survey measurement is taken, all previous measurements are auto erased. Always ensure all logs are saved via RD Manager or RD Maps to prevent losing data.

Note: A flashing reading means reading is marginal and should be taken again. This may be caused by moving metal or nearby vehicles.

4.15 Saving or rejecting logs

Once a 4Hz current reading has been displayed, SAVE is shown in lower-left of the display.

To save the reading press the Up arrow key and to reject the reading press the Down arrow key.

When a survey measurement is saved the data is automatically saved within the PCMx locator. If the PCMx Bluetooth is enabled the PCMx locator will automatically attempt to send out the survey measurement via Bluetooth

Note: If you do not want to send out the survey measurement to another device you can navigate through the PCMx menu and switch Bluetooth to 'OFF'.

4.16 Uploading PCMx Datalogs

Note: To upload PCMx saved results, Radiodetection's PCM Manager is required on the target PC. PCM Manager is a free Windows® Software application available for download at:

<https://www.radiodetection.com/en-gb/resources/software-downloads/pcm-manager>

The PCMx provides the user with the opportunity to send data from the locator to a PC by uploading the entire log via a USB cable. Refer to section 8.8 for details.

4.17 Erasing All Stored Datalogs

Once erased the logs cannot be retrieved.

The erase function can be used to completely erase all stored logs within the PCMx. To erase all stored logs carry out the following:

- Quick-press the On/Off key to enter the PCMx menu.
- Scroll through the menu options until DATA is displayed.
- Enter DATA menu, scroll to DEL, enter DEL and select Yes or No. Press 'f' key to confirm.

4.18 Review Mode

Saved data within the PCMx can be reviewed. To review stored logs carry out the following:

- Quick-press the On/Off key to enter the menu and scroll through the menu options using the Up/Down keys until VIEW is displayed.
- Quick-press the On/Off key and the last stored log will be displayed.
- To scroll through the stored logs press the Up/Down key.
- To exit VIEW mode press the 'f' key twice.

4.19 Overwriting saved logs

Previously saved logs can be overwritten. To overwrite saved logs carry out the following:

- Quick-press the On/Off key to enter the menu.
- Scroll through the menu using the Up/Down keys until View is displayed.
- Press the Antenna key and the last saved log will be displayed.
- Scroll through the saved logs using the Up/Down key. Once a particular log has been selected press the Antenna key and the locator will revert to the main screen.

Note: *When a measurement is taken, the log number selected to be overwritten will be displayed on the screen. Accepting the measurement will overwrite the selected log. If the measurement is rejected the next measurement taken will be stored at the end of the log file and not the log that was viewed before. Each time a log is required to be overwritten the log must be selected using the procedure above.*

Section 5 Connecting Transmitter to Pipeline

⚠ WARNING: Appropriate safety procedures must be followed before removing pipeline CP connection. Only personnel trained and qualified to work on rectifiers should remove CP connections.

Note: Always switch off the rectifier before connecting leads.

1. Disconnect both pipe and anode cables from the rectifier.
2. Ensure the transmitter is turned off.
3. Connect the White signal output lead to the pipe cable.
4. Connect the Green signal output lead to a suitable anode cable.

Note: If connections are reversed the current direction arrow on the Locator will point in the wrong direction.

Use an isolated low resistance ground such as a sacrificial magnesium anode or ground bed. When connecting to an electrical isolation joint the other pipe section can often provide a suitable ground connection.

Care must be taken when using an earth stake as the resistance is often not low enough. The stake must be positioned at least 45m (150 feet) from the pipe to ensure an even current distribution.

5.1 Transmitter to pipeline connections

Cathodic Protection Rectifier

Single rectifier providing impressed CP current to single pipeline.

Rectifier is connected to anode and pipeline. Power supply from 110/220V AC mains.

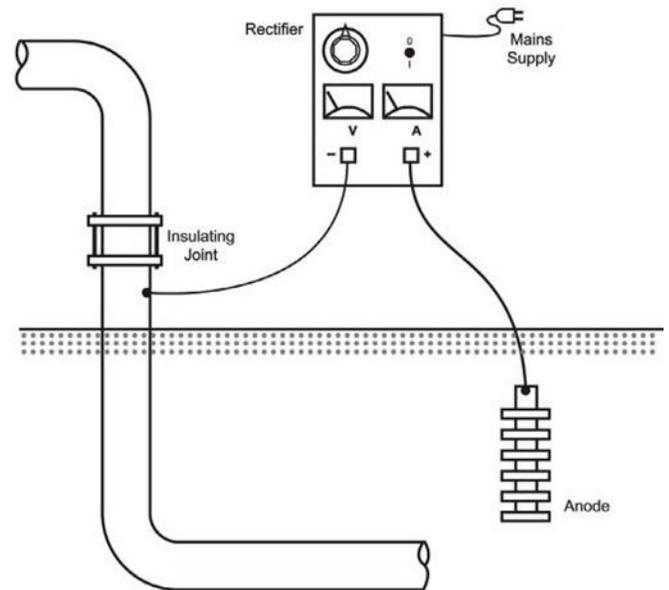


Fig. 5.1: Rectifier connection to pipeline

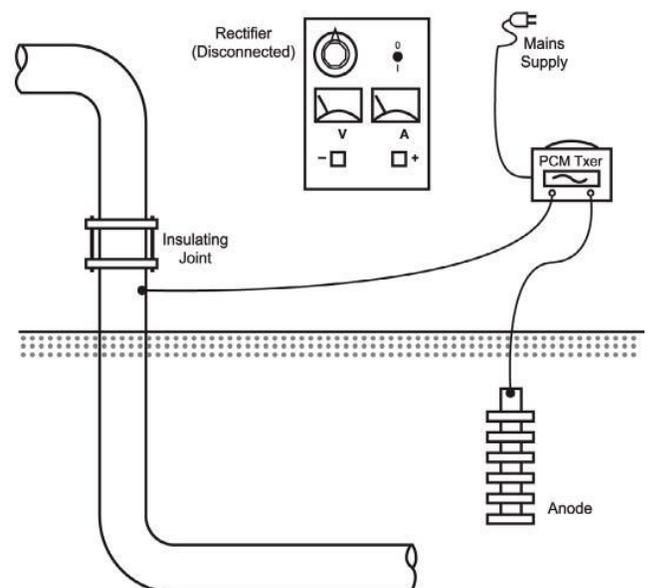


Fig. 5.2: PCM transmitter connection to pipeline

Disconnect both cables for pipeline and anode from the rectifier terminals.

Failure to disconnect cables from rectifier will cause unstable PCM signals, and may cause possible damage to the PCM transmitter.

Connect the PCM transmitter to the cables, white lead to pipeline cable, and green lead to anode cable. Use the mains power supply for the transmitter or internal batteries for Tx-25.

If Isolation Joints are not used the PCM signal will be present in both directions from the connection point.

Single rectifier providing impressed CP current to multiple pipelines.

As above, disconnect pipeline and anode cables from the rectifier.

Try to identify individual pipeline cables if they can be separated at the rectifier, so that each pipeline can be surveyed individually. This allows the maximum range to be surveyed.

Connect the white PCM transmitter lead to one of the pipeline cables, and the green connection lead to the anode cable. Use the PCMx locator to help identify the cables to the individual pipelines.

If the PCM transmitter signal is applied to more than one pipeline at a time, the signal will be divided between them, so the maximum range will be reduced.

Note: The pipe section which needs the most cathodic protection current will also have the most PCMx current, so using the PCMx Locator to measure the current on all the pipe sections fed from the rectifier will indicate the section with the worst CP faults. This is a quick and easy guide to coating quality.

5.2 When a rectifier is not available

Test Points

At some points of the test, there are Isolation joints with cables to the surface.

Connect the PCM transmitter across the isolation joint. Connect the white cable to the side of the pipeline that you want to survey, and then the green cable to the other side for the ground connection.

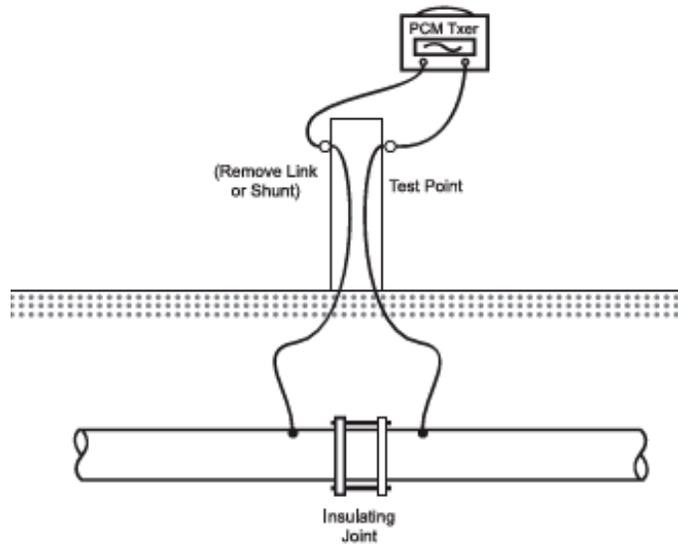


Fig. 5.3: PCM connection using test point

Sacrificial Anodes

You can use sacrificial anodes as a grounding point for the PCM transmitter. This type of connection can be used when there are no isolation joints. See Fig 5.4

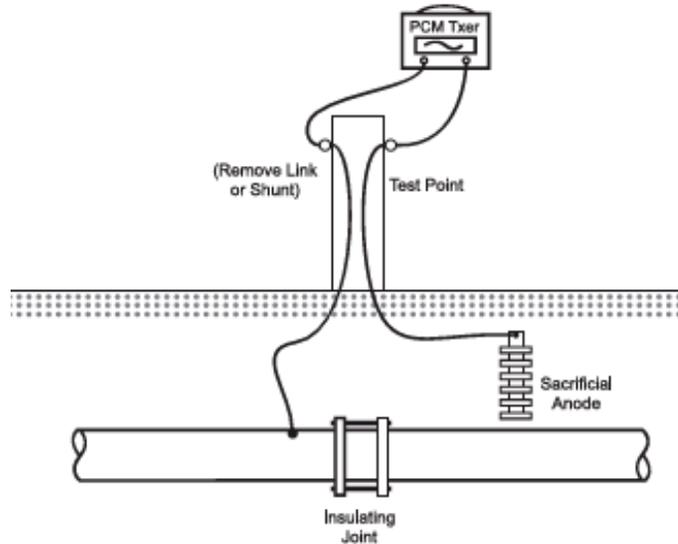


Fig. 5.4: PCM connection using sacrificial anode for grounding

Note: Some sacrificial anodes are connected directly to the pipeline and not linked to test points. These can be easily located as they cause large PCM current loss.

Disconnect the link wire from pipeline to sacrificial anode in the test point.

Connect the white cable from the PCM transmitter to the pipeline connection, and the green cable from the PCM transmitter to the anode.

Note: If the anode is heavily depleted it will be high resistance, and the transmitter signal lights will indicate higher voltage.

In this case it is advisable to use a series of long ground stakes to provide low resistance grounding for the transmitter.

Whatever grounding is used for the transmitter, it should have a resistance of less than 20 Ohms to ensure good current output from the transmitter.

Using another pipeline as a ground for the transmitter is an effective way of applying the signal.

Note: Make sure that the other pipeline runs in a different direction from the pipeline being surveyed.

Streams, drainage ditches, dykes, marshes, or any mass of water can be used to ground the transmitter.

Connect the green lead to any large metal object and submerge it in the water.

Note: Make sure that the pipeline is not running through the same wet area.

Other electrical fixtures can be used to ground the PCM transmitter. However, this will cause all electrical cables in the area to carry the PCM Transmitter signal.

If these cables run near the pipeline, they may affect the survey results.

Section 6 Surveying a pipeline

This section describes how in practice surveys should be performed.

6.1 Pinpointing a target line using Peak+ Mode

If the PCMx transmitter is connected and switched on, locate using the ELF, ELCD, LFCD or 8kHz if using the Tx-25. If no transmitter is connected use CPS to locate 100/120Hz from CP system.

Pinpointing defines the exact position and direction of a pipeline after its position is approximately known. Pinpointing is important as the depth and current readings are affected by misalignment errors.

If you wish to capture GPS data, ensure the internal GPS is switched on.

1. With the magnetometer foot attached, switch on the PCMx locator.
2. Use the  key to match the frequency mode of the locator to the operating frequency of the transmitter. If you intend to conduct a survey of the pipeline, ensure both transmitter and locator are set to one of the mapping frequencies, (ELF, ELCD or LFCD).
3. Set the antenna mode to Peak+ by pressing the antenna key. Once in Peak+, holding down the antenna key alternates between Guide or Null arrows to the Peak reading. Set to Guide arrows by holding down the antenna key; Guide momentarily appears in the lower left corner of the display.
4. Use map information or pipeline markers to determine an approximate location for the pipe. Holding the PCMx locator upright at your side, follow the Guide arrows to cross the path of the pipe. Proximity to the pipe is indicated by a rising bar graph and an increase in tone when volume is switched on.
5. Adjust the locator sensitivity to approximately 50% by pressing the up  and down  keys. This enables changes in the bar graph to be more readily seen.
6. Hold the PCMx upright and near to the ground.

7. Move it slowly from side to side and define the point of maximum bar graph response. When directly over pipe, the Guide arrows should be at minimum length with both left and right arrow heads lit.
8. To fully align the PCMx with the pipeline, rotate the locator until the compass is in the 6 O'clock position.

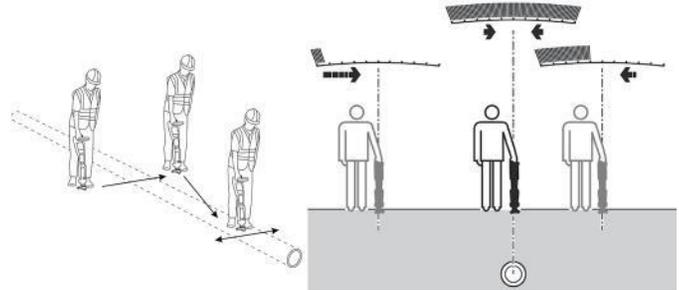


Fig. 6.1: Pinpointing a target line

Having pinpointed the pipe, the PCMx will display the depth of the pipe, (measured to the center of the pipe), and the locate signal current.

9. If you wish to take a 4Hz PCM reading at this stage, you can momentarily press the Survey key to initialize a measurement. The 4Hz PCM measurement will be displayed on the screen and this result can either be saved into the PCMx memory or rejected using either the Up or Down arrow.

6.2 Peak+ Null

You can check the validity of the pinpoint position and be alerted to possible variations in locate accuracy due to signal distortion by comparing the peak bar graph response with the Null arrows.

1. Using Peak+ Null antenna mode locate the pipe and mark the position with the maximum bar graph response.
2. Using the left and right arrows, locate and mark the position where both the left and right arrows are lit.

If the locate positions in 1. and 2. above correspond, it can be assumed that the pinpoint is precise. If the positions do not correspond, the pinpoint is not precise.

Accurate PCMx results are only obtained when the peak bar graph response and Null arrows are within 15cm (6 inches) of each other.

If the locates are different by more than 15cm (6 inches), assume that the magnetic field is distorted and take PCMx readings at a different position.

6.3 TruDepth

The PCMx locator features TruDepth™, a feature that helps to ensure the accuracy of locate or survey measurements. When the locator is not aligned correctly with the pipe direction, if the locator is too far away to the side or the signal conditions are poor for reliable results, the depth and current measurements are automatically removed from the display.

As well as non display of depth and current readings, it will not be possible to take 4Hz current measurements if the locator has not met TruDepth conditions.

Use the compass to accurately align the locator with the pipe. The compass should be in the 6 o'clock position when over and in line with the pipe. If the compass is not aligned by more than 7.5 degrees both depth and current readings will be disabled.

6.4 Current Direction (CD)

The PCMx transmitter is capable of outputting a CD (current direction) signal and this is available in the ELCD and LFCD modes. This can be used to provide direction of current flowing on the pipeline. This feature is particularly useful to identify the target pipeline, which has had the PCM signal applied to it and inform users that they are surveying the correct pipeline.

When a 4Hz measurement is taken in either ELCD or LFCD mode, CD direction arrows are displayed on the PCMx display. When locating and taking measurements on the target pipeline, by default, the CD arrow will point downwards. On some applications the PCMx output signal can find its way onto an adjacent pipeline and in this condition the CD arrow will point upwards, indicating incorrect target line.

6.5 Types of PCMx Surveys

The PCMx magnetometer foot is a high precision, high performance sensor, which detects and measures very low frequency magnetic fields. Advanced signal processing technology provides push button current measurement and direction of the 4Hz signal.

6.6 ACCA Surveys

An Alternating Current, Current Attenuation, (ACCA) survey measures the attenuation of the transmitted 4Hz signal to establish the pattern of current loss. The results can be used to establish the condition of the pipeline coating, locate faults, or find shorts caused by contact with other metal objects.

In all diagrams the arrows indicate the direction of current flow to the transmitter. The PCMx transmitter applies a current to the pipeline and this current reduces in strength as the distance from the transmitter increases. The rate of reduction depends on the condition of the pipe coating, ground resistivity and pipe electrical resistance.

The PCMx Locator compensates for depth changes during current measurements, and current readings remain constant even when the depth of the pipeline changes.

When a fault is encountered the current quickly drops. A fault will result from coating damage, contacts with other services, etc.

The loss of PCMx current will be virtually proportional to the amount of CP current being used at the fault.

See section 4.14 on how to take a 4Hz current measurement using the PCMx.

6.7 ACVG Surveys

The accessory A-Frame is used with the PCMx locator to precisely pinpoint coating defects and isolation faults.

An Alternating Current Voltage Gradient, (ACVG), survey measures the leakage current in the vicinity of the pipeline to assess the coating condition, and pinpoint coating defects. An advantage of this survey method is that it can be done on a route parallel to the pipe. For example, it may be done on a pavement or grass verge parallel to a pipe running below a road surface. It requires the use of the PCMx A-Frame accessory in addition to the PCMx locator and transmitter.

The A-Frame spikes need to make good electrical contact with the ground, preferably with damp, conductive earth. If the ground is dry or the ground is concrete it is advisable to pour water around the spikes or fit a piece of sponge to each spike and soak with water to increase the conductivity between the A-Frame spikes and the ground.

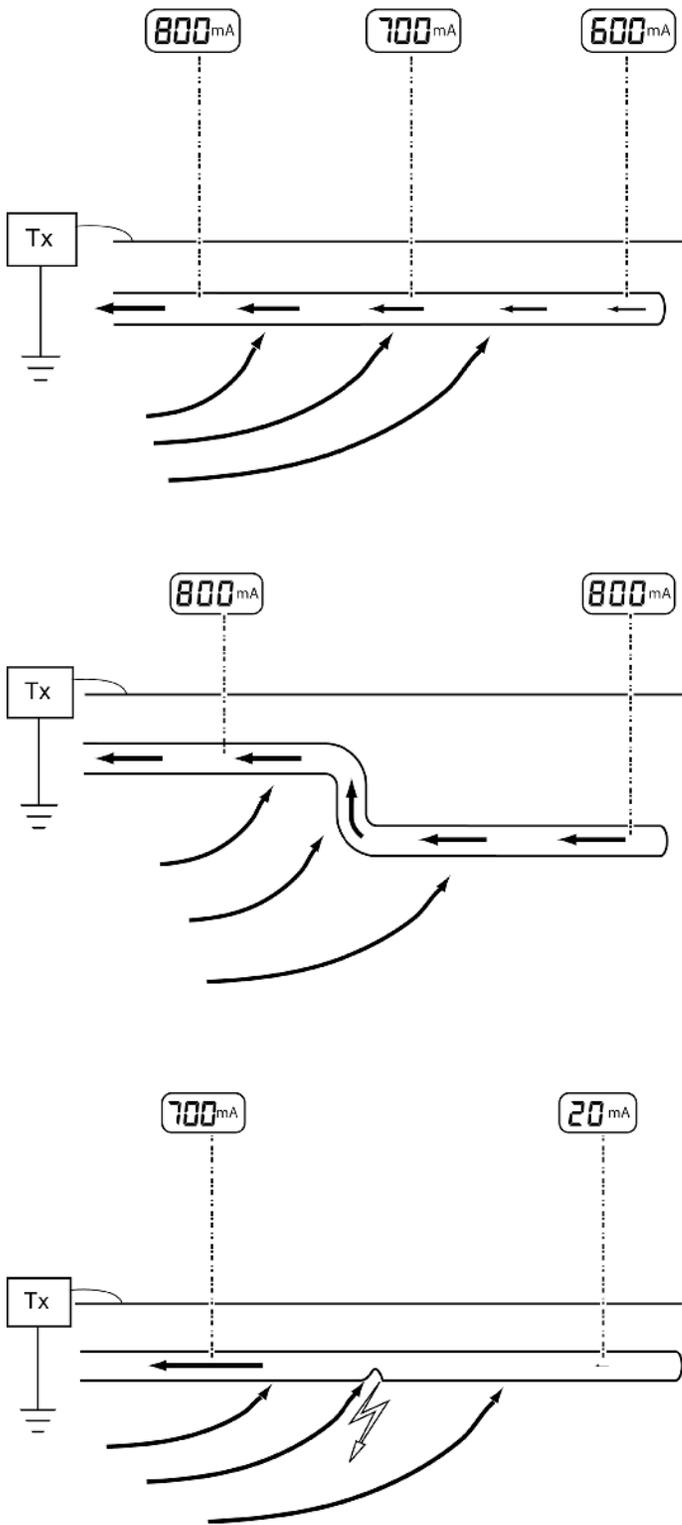
The PCMx locator display indicates direction to the fault, using the fault find direction arrows, and this makes fault position easy to locate.

The PCMx also displays the dB microvolts reading across the A-Frame spikes, and this allows a comparison to be made between different faults to determine the most severe. This numeric value along with the direction arrows can be stored in the PCMx, recalled, and uploaded via the PCM Manager application.

Method

After obtaining PCMx current loss using the 4Hz results, decide which sections of the pipeline require fault find survey.

1. Connect the transmitter to the pipeline and ground.
2. Set the PCMx transmitter to either ELCD or LFCD mode.
3. Connect the A-frame to the PCMx locator via the accessory socket, and turn on the locator.
4. The PCMx will default to ACVG mode and an A-frame symbol will be displayed.
5. Choose an appropriate starting point for your survey. If a suspected fault location has been identified from a previous ACCA survey, begin the survey approximately 60 feet, (20 meters) from the suspected fault.
6. Place the A-frame spikes in the ground above, or parallel with, the pipe. Position the green spike



Linear current loss may naturally occur along the pipeline due to the age of the pipe and coating conditions.

forwards and the red spike towards the transmitter connection point.

7. The dBuV reading and direction arrow will be displayed on the screen. Press the antenna key once to save and store the reading in the PCMx internal memory.
8. If no fault is apparent or the A-Frame is too far away from the fault, the arrows will flicker on and off and the dBuV readings will be erratic – in this situation move further along the pipeline until the fault find arrow locks on. When a fault is present, the Fault Find, (FF) arrows will display the fault direction and the dBuV readings will be stable. The dBuV reading will increase as the A-Frame is positioned closer to the fault.
9. Follow the pipeline pushing the A-Frame spikes into the ground at regular intervals and checking for FF arrows.
10. Move in the direction of the arrows. Find the point at which the arrows change direction. If the A-frame has been positioned directly above the pipe, the fault location will be directly below the middle point of the A-Frame.
11. If the measurements have been taken to the side of the pipe line, rotate the A-Frame 90° so that the green spike points towards the pipeline. Move back and forth across the pipeline to locate the fault in this direction, the intersection point will be directly over the fault.

There are two fault find modes on the PCMx locator, which can be used with the A-Frame:

- ACVG
- 8KFF

On the PCMx locator ACVG fault find uses ELCD and LFCD outputs from the PCM transmitter. 8KFF is used when using a Radiodetection transmitter such as the RD4000 T3, RD4000T10 or the RD7K/8K Tx-5 and Tx-10.

Note: With the Accessory A Frame plugged in, it is not possible to take PCMx 4Hz Current readings unless in simultaneous mode.

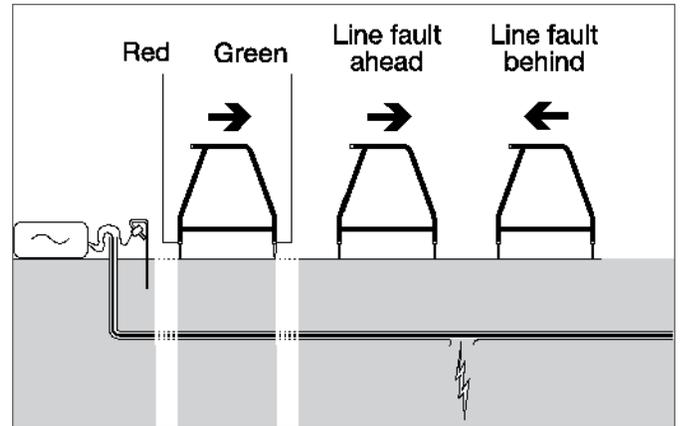


Fig. 6.2: A-Frame Fault-Finding

6.8 Comparing Fault Severity

To determine the severity of the fault, and compare different faults on the pipeline to decide repair priorities, take the dBuV readings with the A-Frame at 90 degrees to the pipeline.

Place one of the A-Frame's spikes directly above the pipeline, and the other away from the pipeline. Start approximately 1 meter from the fault position, testing at 25cm (or smaller) intervals. Note the highest dBuV reading, or save it in the PCMx and note log number.

During the survey, you can switch to locating the pipeline by pressing the function key and selecting the appropriate locate frequency.

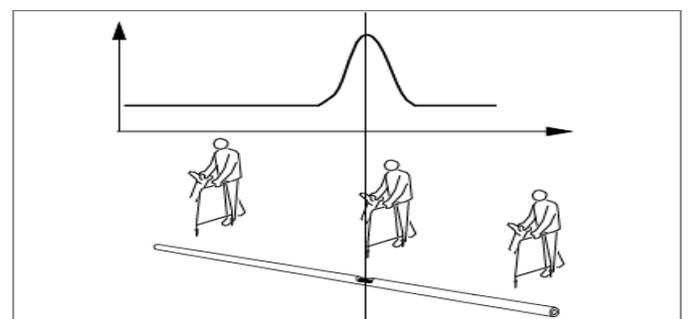


Fig. 6.3: Comparing fault severity

6.9 Simultaneous ACCA and ACVG Survey

The PCMx allows users to conduct both an ACCA and an ACVG survey simultaneously. By collecting the data in one pass of the pipeline, rather than two, survey time can be reduced significantly.

Procedure:

1. Connect the transmitter to the pipeline and ground using the procedure described previously.
2. Set the PCMx transmitter to either ELCD or LFCD mode.
3. Connect the A-frame to the PCMx locator via the accessory socket, and turn on the locator.
4. The PCMx will automatically select ACVG mode and an A-frame symbol will be displayed.
5. Press the 'f' key until the mode of the PCMx locator matches either ELCD or LFCD as chosen from the transmitter.
6. Begin your survey and with the PCMx on top and in line with pipe, together with A-frame parallel to pipe.
7. The display will show the Fault Find direction arrows and dBuV reading. Press the Antenna key once to initiate a 4Hz current reading. Note: the arrows on the display will now indicate the flow of PCM transmitter current (CD) and not the Fault Find direction arrows.
8. To save or reject a reading, press the Up or Down arrow. Both Fault Find and 4Hz current data will be saved in the log.

Section 7 Theory and Application

This section demonstrates measurement taking and possible results from surveying various pipe systems.

7.1 Basic technique

'Tie-ins' and Loops

Fig 7.1 shows current split between two lines.

i.e. $800 = 700 + 100$

The pipeline with the greatest reading indicates where the majority of current is flowing from and is the direction to follow in order to locate the fault (short or poor coating).

Fig 7.2 shows current split between three lines.

i.e. $800 = 600 + 150 + 50$

The pipeline with the greatest reading indicates where the majority of current is flowing from and is the direction to follow in order to locate the fault (short or poor coating).

Loops

If the current arrow changes direction it could indicate the pipe has changed location. Use the PCMx in locate mode to relocate it – see Fig 7.3.

Current flow within a Loop system

If all distances and coatings are equal, and the rate of loss is constant, the current measured at Point A will be zero – see Fig 7.4.

In practice, with pipes of different ages and coating the points reading zero (0) could be anywhere. The respective current readings will indicate the direction to follow – see Fig 7.5.

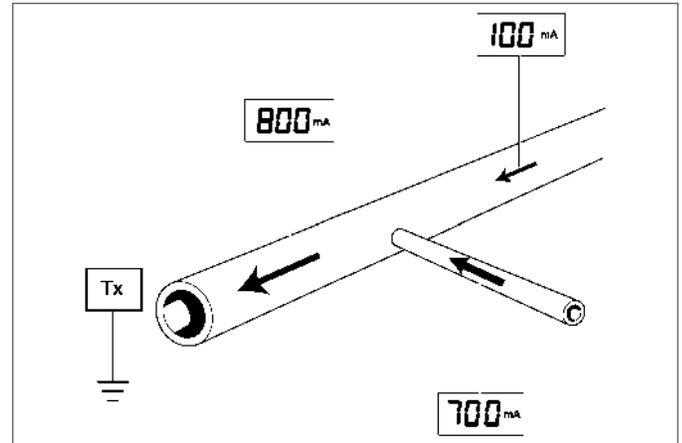


Fig. 7.1: Tie line 1

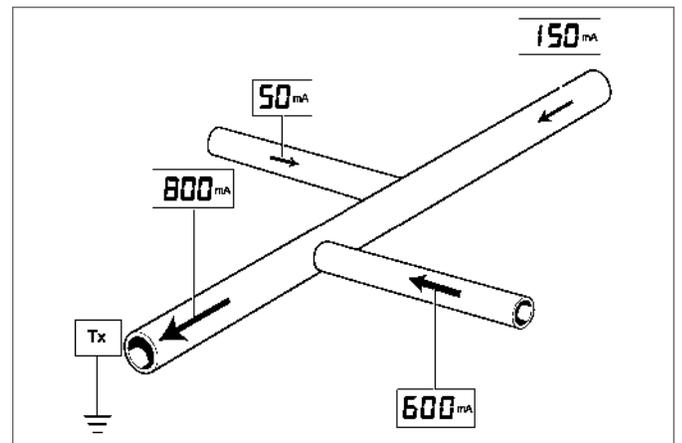


Fig. 7.2: Tie line 2

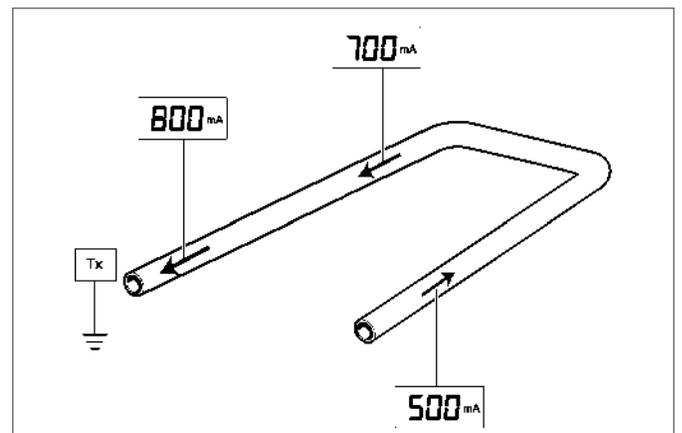


Fig. 7.3: Loop

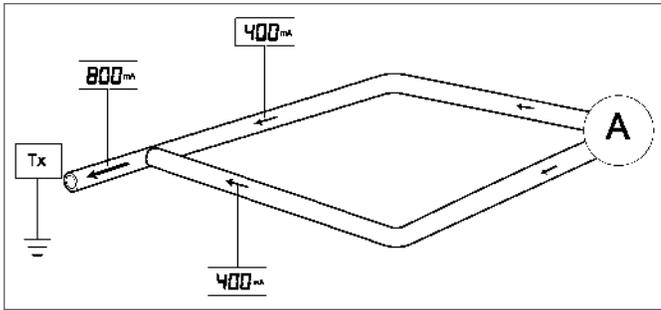


Fig. 7.4: Looped system 1

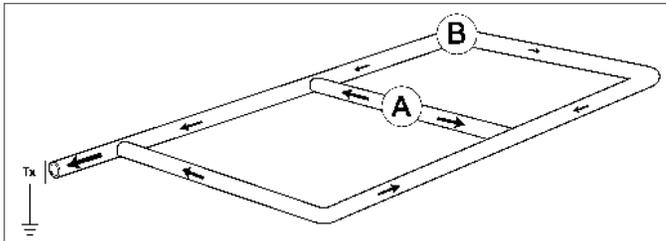


Fig. 7.5: Looped system 2

Read 2 indicated initial direction to follow.

Read 5 indicated which section on tie-in to follow.

Read 9 indicated that the short had been passed and was between Read 9 and Read 8.

Short found by dividing the distance between a good and bad read until located.

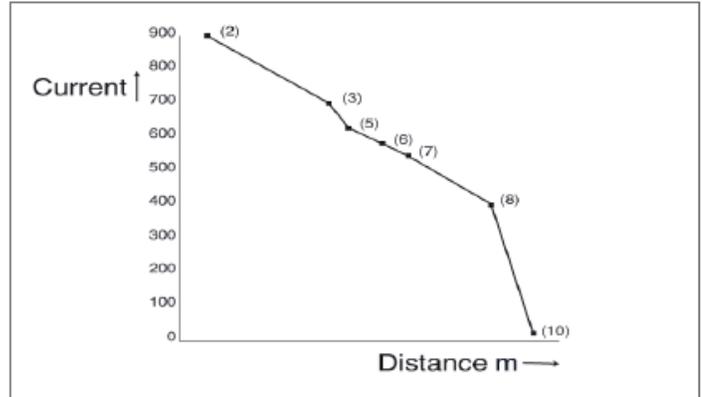


Fig. 7.7: Interpreting distributed systems

Taking Measurements – Distribution Systems

Below are some typical results, which can be found from using the PCMX for CP system diagnosis on a distribution system.

Good local knowledge and a map of the pipe network are essential to determine suitable positions to connect the PCM transmitter and where to take readings. It is worthwhile taking measurements over the complete site before concentrating on any particular area.

The following diagram is a typical street involving 'Tie-ins' and an 'L'. The readings from the PCMX and distances to prevent interference have been included. By working around the map a short was quickly and easily detected.

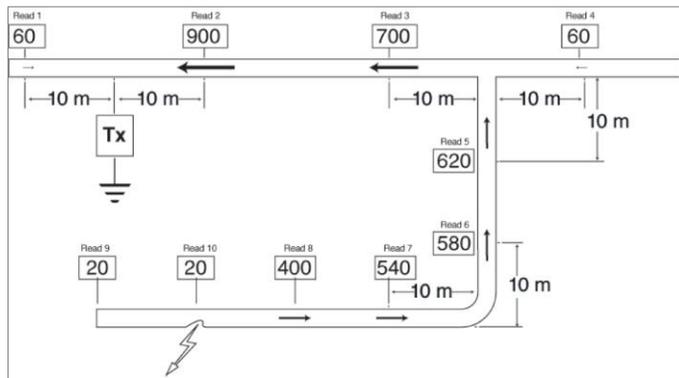


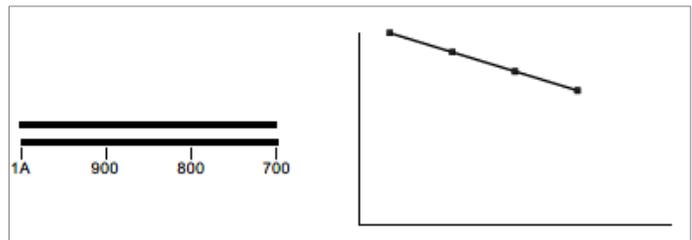
Fig. 7.6: Distributed system

In this example measurements were taken at key areas to determine direction of major current flow.

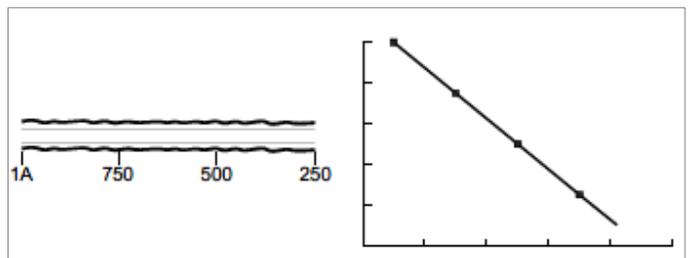
7.2 Pipelines and Pipeline defects

Interpretation of Readings and Graphs

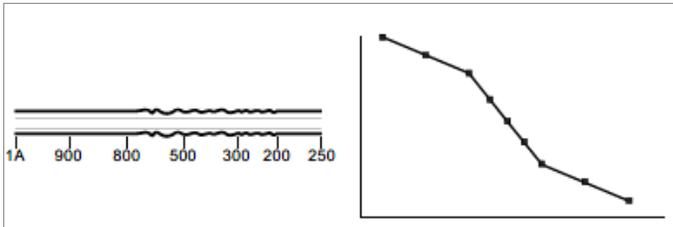
Pipe coating in good condition is shown as very little loss of current.



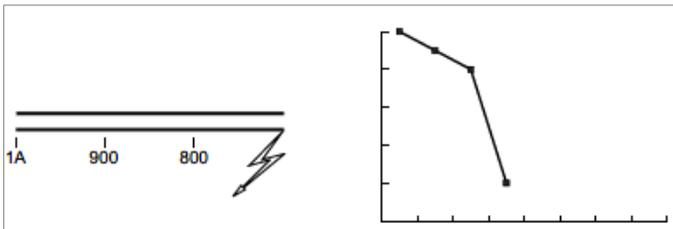
Pipe coating in poor condition is shown as a rapid loss of current.



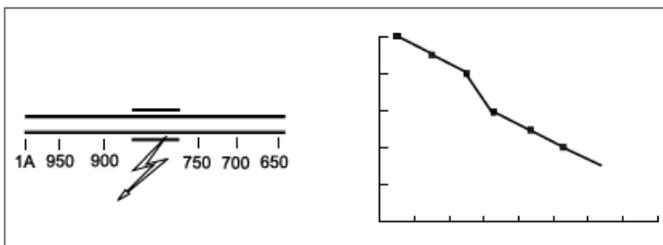
Mixture of good and poor coating, which is shown as greater current loss over the section of pipe with poor coating.



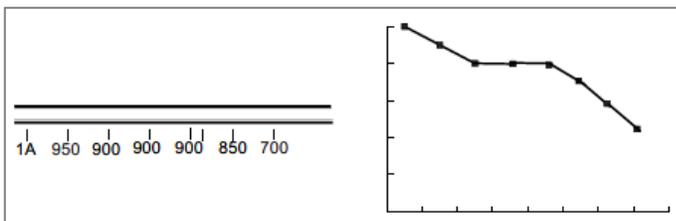
The effect of a short or contact with another service is a sudden current loss.



The effect of a poorly coated steel shield in contact with the pipeline is to show reduced current in one measurement section.



This effect is either a section of perfect coating or ground conditions that are shielding the signal in dry or rocky ground.



7.3 Parallel Pipes

Consider a new distribution pipe with the old pipe running parallel and about 30cm (12 inches) away with a 1 Amp signal applied.

To make the explanation easier the pipe has been divided into section A & B. This is demonstrated in Figure 7.8.

Example 1

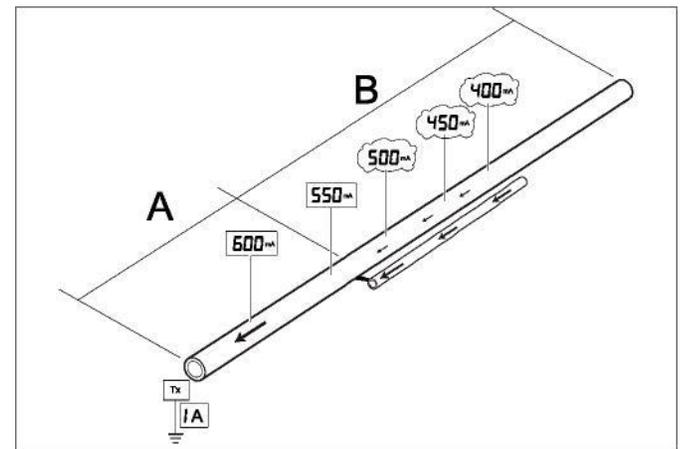


Fig. 7.8: Parallel Pipes

Section A Good peak and null locate, with peak and null locates in the same position. Results indicate a good coating on the pipe (600 and 550mA).

Section B Poor peak and null locate shifted to one side from the previous alignment. Readings start to decrease rapidly.

In this case the old pipe had been shorted to the new pipe. The poor coating on the old pipe provided a good path for the PCM Transmitter current.

This is indicated by the locate being offset to one side and the rapid decrease in current reading.

When plotted the graph illustrated this effect with the bend indicating the position of the short or contact. Figure 7.9.

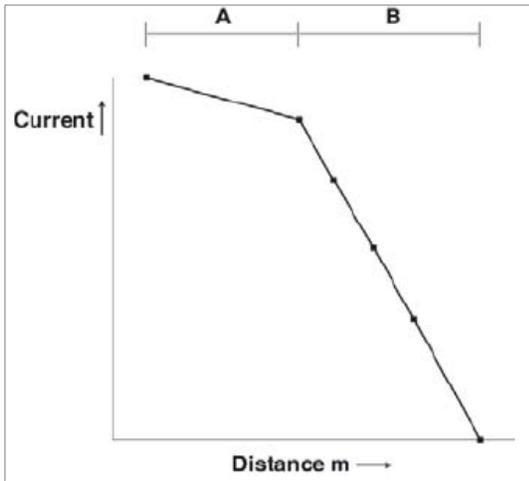


Fig. 7.9: Interpretation

To verify the fault location, the transmitter was repositioned to the other end of the pipeline. Figure 7.10.

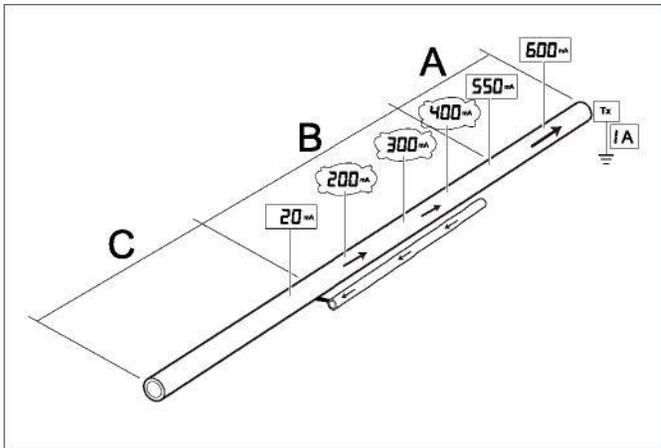


Fig. 7.10: Parallel Pipes

The following results obtained:

Section A Good Peak and Null locate, reading decreasing at a steady rate.

Section B Poor peak and Null locate with a sharp fall in current reading.

Section C Short/Contact.

The easiest path for the current to flow is down the old discarded pipe. As this is in the opposite direction to the flow on the new pipe it has a cancellation effect which accounts for the sharp drop in reading.

The short would be at the point where the current drops close to zero.

The graph in Figure 7.11 illustrates this effect.

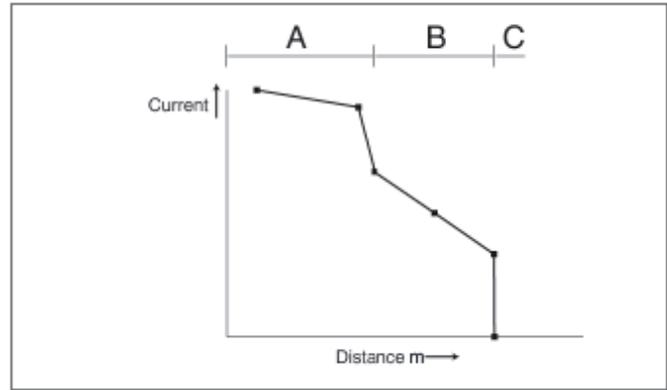


Fig. 7.11: Interpretation

Example 2

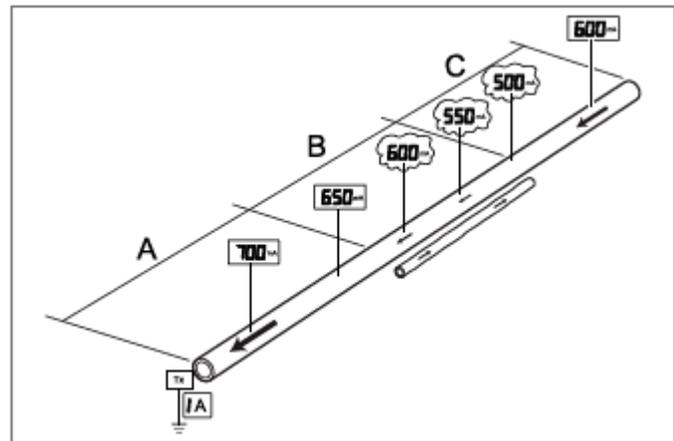


Fig. 7.12: Parallel Pipes

This example 2 (Figure 7.12) demonstrates a typical application where a short piece of parallel pipeline interfered with the result.

For ease of explanation the pipeline has been divided into three parts A, B & C.

In this situation a 1 Amp signal was applied to the new pipeline and the direction of maximum current flow followed.

Section A Good Peak and Null locate and a steady rate of decrease that indicated a good coating.

Section B Poor Peak and Null locate (outside 15cm (6 inches) requirement) and a significant drop in current reading.

Section C Good Peak and Null locate with a rise in current and then a steady rate of decrease.

Another service was found to be close to the new pipeline in Section B and had a small amount of current flowing in the opposite direction. This had a cancellation effect, which caused the current on the new pipeline to fall.

Figure 7.13 illustrates this effect.

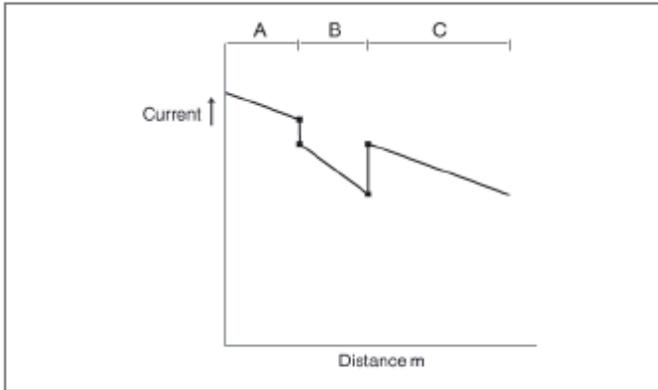


Fig. 7.13: Interpretation

Example 3

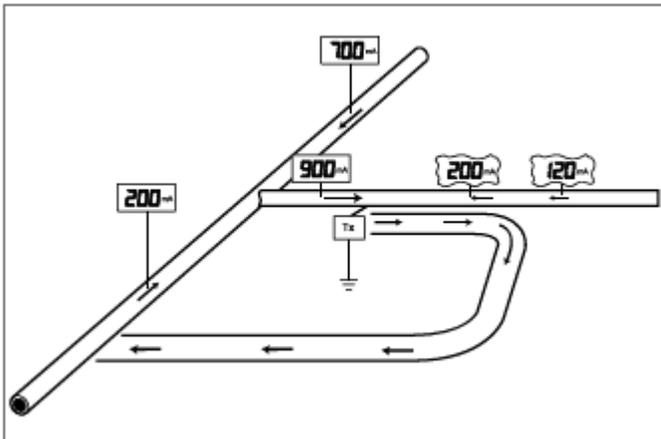


Fig. 7.14: Angled Pipes

This example (Figure 7.14) demonstrates a survey on new pipeline where the current on one side of the transmitter flowed away from the transmitter.

The PCM Transmitter was connected and a 1 Amp current selected.

A reading of 900mA was detected on one side with the arrows pointing towards the transmitter.

The other side gave a poor Peak and Null with the current pointing away from the transmitter.

Another reading was taken further away from the transmitter with the same result.

It was found that another service was shorted to the pipeline as shown and at some stage ran parallel to the new pipeline. The current on the new pipeline had no effect as it was so small compared to this other service.

Example 4

Locating bonding cables between new and old pipelines by moving PCM Transmitter to both ends of a new transmission pipeline that had an older discarded pipeline running parallel and about 3m (10') away. Figure 7.15.

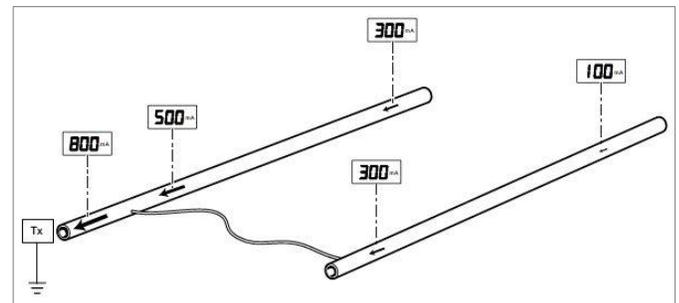
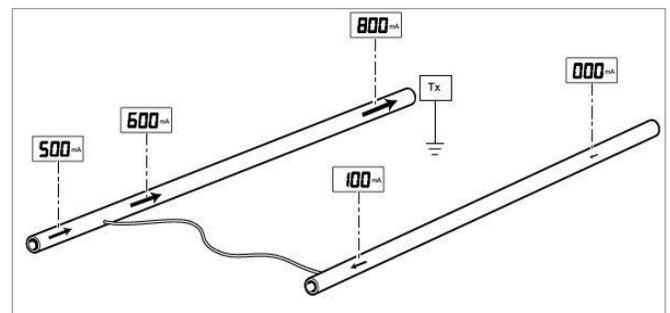


Fig. 7.15: Parallel Pipes

The PCM Tx was connected at a rectifier and a current measurement of 800 mA confirmed the direction to follow.

At a distance of about 3km (2 miles) from the transmitter, two readings were obtained, 300mA on the new pipeline and 100mA on the old pipeline. The PCM current arrows pointed towards the PCM Tx indicating that somewhere within the 3km/2 miles the new pipeline had been bonded to the old pipeline.

Fig. 7.16: Parallel Pipes



The Tx was then connected to the other end of the new pipeline and measurements taken at exactly the same positions. A reading of 800mA was detected on the new pipe, but there was no reading on the old pipeline.

As a series of readings were taken on both pipelines closer to the point of bonding, current appeared on both pipelines and with the arrows in opposite direction. This indicated that the bonding point was further ahead.

The point of bonding was located, and a measurement of 500mA, concluded that the other faults existed closer to the rectifier.

Section 8 Interpreting Result

This section provides an overview of interpreting results generated by the PCMx Locator.

8.1 Introduction

The principle of the PCMx is that the frequency used is so low (4Hz) that the effects of induced and capacitance coupling to other lines are reduced to almost zero. Also natural decay of the signal due to these effects is also reduced to almost zero.

The losses are due completely to resistive losses i.e. coating defects or contact to other structures.

8.2 Avoiding errors

Always use the standard techniques to ensure measurements are valid. Confirm that peak bar graph and null arrows coincide. If in doubt check for field distortion by taking a depth reading and then raise the locator a known height, for example 0.5m, and confirm the depth measurement increases by the corresponding amount.

As the PCMx uses such a low frequency the sources of error are much reduced. However, there are still certain circumstances that will create errors.

8.3 Identifying Interference

Errors due to locate (ELF/LF) signal distortion can result in errors in 4Hz current measurement. This is because the 4Hz current measurement process relies on depth as measured by the ELF or LF signal.

- Poor Peak and Null locate, outside 15cm (6 inch) maximum.
- Unreasonable depth measurement.
- Reading on the LCD bargraph not stable.
- Possible causes of Interference
- Parallel pipes.
- Too close to transmitter. Tie-ins, T-junctions and L bends.

Measurements at Ts, bends, abrupt changes in depth etc. should be avoided, as there will always be a degree of field distortion at these points.

- Taking readings too close to large parked vehicles, moving vehicles, boots or shoes with steel toe-caps or large metal structures.
- Taking readings near to PCMx Transmitter and anode cables or anode ground bed.

Measurements taken near the transmitter anode bed or earth stake can be misleading. This is because all the signal current passes through the earth stake or anode bed. The signal ground currents close to the transmitter are therefore significant and opposite to the pipe current.

The effect is that for the first 30 to 50 meters – and depending on ground conditions – the measured current may increase. In fact, the current on the pipe is probably at a constant level.

If it is necessary to survey this section of pipe it will be necessary to apply the transmitter at a different location and work back to this point.

8.4 Locate current

- In ELF – and with a locate reading current below 15mA – the PCMx readings will not be accurate.
- In LF – and with a locate reading current below 2mA – the PCMx reading will not be accurate.

8.5 PCMx Current

PCMx current results depend on locate current. If the PCMx current has fallen below 100mA on a long survey, it is likely that the locate current is also low. It is possible to obtain results by using a portable transmitter nearby to provide a locate signal. Use a different frequency from the PCMx Transmitter locate frequency.

8.6 Interpreting survey results

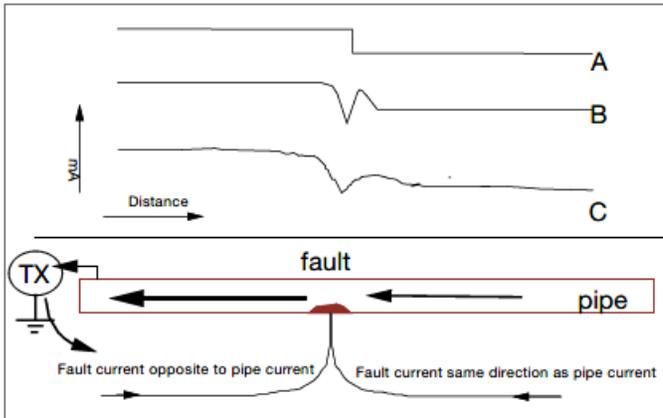
Taking a classical situation as shown in Figure 8.1, graph 'A' shows the ideal response which is a loss of signal current and a step response, but excludes any effects from fault currents in the ground.

In practice, the results obtained require some interpretation because sometimes the magnetic field detected from the

8.7 Using dBmA for Pipeline Current Mapping

The PCMx locator displays current as mA, and also saves the data logs in mA. When the datalogs are uploaded to the PCM Manager application the datalogs can be displayed and saved to file as either mA or dBmA. Please refer to the PCM Manager operation manual for details.

The AC signal current applied to a coated pipeline in perfect condition will be lost by capacitance as distance increases from the point where the signal is applied. The PCMx uses near DC signal (4Hz) for current measurement, so capacitive losses are minimal. The resulting graph drawn using mA will have an exponential slope, because there is a greater current loss rate close to the transmitter. See Fig. 8.2



pipe may be affected by other signal paths in the ground, including around the position of coating defects.

Fig. 8.1: Interpreting results

Figure 8.1 Graph 'B' shows the theoretical effects of the fault current in the ground. Note that the local fault current enters the pipe from both directions and this distorts the magnetic field around the pipeline close to the fault. A short distance from the fault the ground currents subtract from the pipe current, which is measured as current reduction. A short distance after the fault they add to the pipe current, which is measured as current increase. At some distance from the fault, current settles to a steady state.

If this local effect is observed, it is useful for detecting defects.

Figure 8.1 Graph 'C' shows what would be expected in the real situation if PCMx currents were plotted over a section of pipe with a coating defect.

Depending on the fault characteristics, the effect of the magnetic field distortion will spread over a distance of perhaps 2 to 10 meters either side of the fault, and the effect will vary depending on the type and severity of the fault.

A fault caused by the surveyed pipeline being in contact with another structure, such as another pipe or cable running across the pipeline, will show some distortion of the magnetic field directly over the contact, but is unlikely to show the rise in current after the fault.

These effects are more noticeable when the survey is performed over a short distance either side of a fault.

This highlights the need to perform surveys over a complete section before attempting a more detailed survey of suspect areas.



Fig. 8.2: mA fault graph

Converting the exponential mA result to logarithmic dBmA will show the same graph as a straight line slope. See Fig. 8.3.

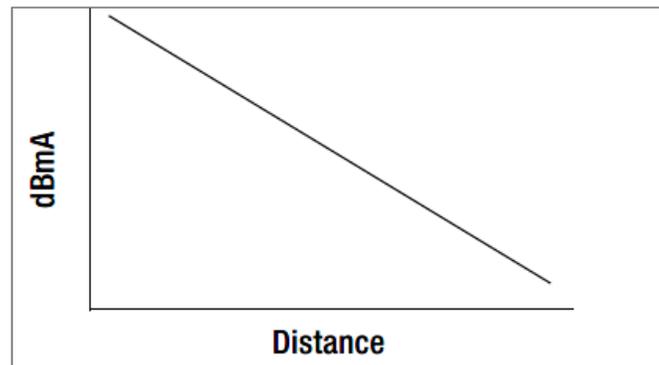


Fig. 8.3: dBmA fault graph

Displaying the results using dBmA loss per distance has the advantage that the resulting graph is easier to analyze.

There was a coated pipeline, which had three defects of equal electrical resistance, one near the beginning, the next in the middle and one at the end. If the current loss graph is prepared using mA on the vertical scale the second and third faults would be shown as progressively smaller steps in the graph. This is due to Ohms law, and the loss of current at the previous fault. See Fig. 8.4.



Fig. 8.4: mA fault graph

Using dBmA as the vertical scale would result in equal steps in the graph for equal size faults, regardless of how much current was lost at the first fault. See Fig. 8.5.

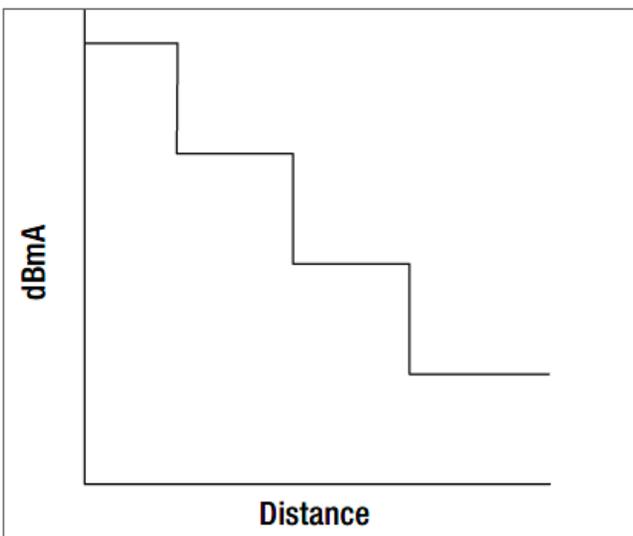


Fig. 8.5: dBmA fault graph

The graphs show three equal faults and the effects on a graph showing mA and dBmA.

Note that the graph showing mA (Fig 8.4) at first glance suggests that the faults are of diminishing magnitude. The

graph showing dBmA (Fig 8.5) clearly shows the magnitude of the faults are equal. Therefore, dBmA shows the ratio of the faults, whereas mA alone may give rise to misinterpretation of data due to the high current loss near the transmitter and lower losses further away.

In figure 8.6, the line marked 'A' to 'E' is the data collected, whilst the line '1' to '4' is the interpreted data.

Note that at position 'A' the current falls and then returns to almost its original level. This is probably due to field distortion of the locate signal possibly caused by another utility line above the pipeline and should be ignored or further investigation undertaken.

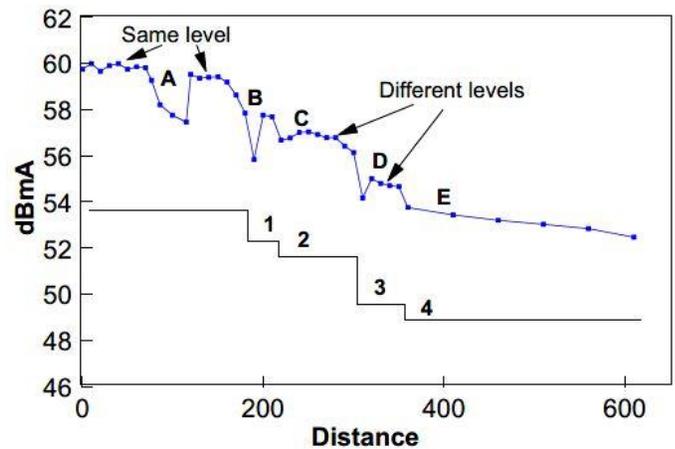


Fig. 8.6: Collected data and interpreted results

Steps 'B' to 'E' show definite steps (with some field distortion at the point of fault) and loss of signal. Note the recovered reading is less than the signal before the trouble.

Further investigations using the PCMx A-Frame should now be undertaken so as to pinpoint the exact position of the faults.

8.8 PCM Manager

PCM Manager for the PC

PCM Manager is a PC application that can be downloaded from the Radiodetection website and installed onto a PC. Once installed the PCMx locator can be connected to the PC via a USB connection. Stored PCMx survey measurements can be uploaded and used to quickly evaluate the condition and position of coating defects.

Survey measurements can be viewed and saved as CSV, XLMS and KML type files.

For more detailed information, a PCM Manager operation manual is available to view or download from the Radiodetection website and is also contained within the PCM Manager download package.

PCM Manager for mobile applications

The PCM Manager app can be downloaded from the Google Play store onto a smartphone or tablet device. PCMx survey measurements may be sent via Bluetooth into the app, allowing users to see real time data plotted onto a range of graphs.

Google Maps can also be displayed and survey measurements plotted. Features such as 'Walk To' enables operators to walk to previously plotted points on live surveys or previously completed surveys. The 'Walk Forward' feature enables operators to be alerted at pre-defined distances while surveying a pipeline.

Completed surveys may be sent via email for quick evaluation of results and can be sent as a .CSV type file.

If more accurate GPS is required, an external GPS device can be paired with the smartphone or table and used to plot survey measurements onto Google Map.

For more detailed information, a PCM Manager operation manual for the app can be viewed or downloaded from the Radiodetection website

Section 9 Maintenance

9.1 General Maintenance

The PCMx locator and transmitters are robust, durable and weatherproof. However, you can extend your equipment's life by following these care and maintenance guidelines.

General

Store the equipment in a clean and dry environment. Ensure all terminals and connection sockets are clean, free of debris and corrosion and are undamaged. Do not use this equipment when damaged or faulty.

Batteries and power supply

Use good quality Alkaline or NiMH batteries only. When using an AC adapter, use only Radiodetection approved adapters. Only use Radiodetection approved Li-Ion battery packs.

Cleaning

WARNING! Do not attempt to clean this equipment when it is powered or connected to any power source, including batteries, adapters and live cables.

Ensure the equipment is clean and dry whenever possible.

Clean with a soft, moistened cloth. If using this equipment in foul water systems or other areas where biological hazards may be present, use an appropriate disinfectant. Do not use abrasive materials or chemicals as they may damage the casing, including the reflective labels. Do not use high pressure hoses.

Disassembly

Do not attempt to disassemble this equipment under any circumstances. The locator and transmitter contain no user serviceable parts. Disassembly may damage the equipment and or reduce its performance and may void the manufacturer's warranty.

Service and maintenance

The locator and transmitter are designed to minimize the requirement for regular calibration. However, as with all safety equipment, it is recommended (and may be required by law) that they are serviced at least once a year, either at Radiodetection or a Radiodetection-approved repair center.

NOTE: Service by non-approved service centers or operators may void the manufacturer's warranty.

Radiodetection products, including this guide, are under continuous development and are subject to change without notice. Go to www.radiodetection.com or contact your local Radiodetection representative for the latest information regarding the PCMx locator and PCM transmitters or any Radiodetection product.

9.2 Transportation

Maintain a temperature range within specifications when transporting the unit. Transportation damage can occur from improper handling. The following steps are recommended to minimize the possibility of damage:

- Pack the unit in its original packing material when shipping.
- Avoid high humidity or large temperature fluctuations.
- Keep the unit out of direct sunlight.
- Avoid unnecessary shocks and vibrations.

9.3 Software Updates

From time to time, Radiodetection may release software upgrades to enhance features and improve performance of the PCMx locator. Software upgrades are free of charge. You can check if your products are up-to-date or upgrade them by using the PCM Manager software upgrade screen. Refer to the PCM Manager operation manual for further information.

E-mail alerts and notification of new software releases are sent to all registered users.

NOTE: To upgrade your software you need to have created an account within PCM Manager and have a live internet connection.

9.4 Warranty

PCMx locators are covered by a 1-year warranty as standard.

Customers can extend the warranty period to a total of 3 years by registering the PCMx within 3 months from purchase.

Registration is performed using the PCM Manager PC software application.

From time to time Radiodetection may release new software to improve the performance or add new functionalities to products. By registering, users will benefit from subscribing to e-mail alerts advising about any new software and special offers related to its product range.

Users will be able to opt out at any moment from receiving software and technical notifications or just from receiving marketing material.

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Provide best in class equipment and solutions, to prevent damage to critical infrastructure, manage assets and protect lives.

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