



 **Where Ideas Meet Industry**

# PCM<sup>+</sup>

Radiodetection's world leading  
Pipeline Current Mapping system



Operation Manual | Issue 4 | October 2009



**Radiodetection**  
AN SPX COMPANY

90/PCMPPLUS-APP-ENG/04

# Preface

## Before you begin

Please read this user manual before attempting to use the PCM+ Receiver and Transmitter. Note that this manual and all its contents are subject to change. Radiodetection products are under continuous development.

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](http://www.radiodetection.com) for the latest information about the PCM+ product family, including this manual.

## Important Notice

Radiodetection Receivers detect almost all buried cables and most conductors, but there are some which do not radiate signals and which Radiodetection Receivers cannot detect. Radiodetection receivers do not indicate whether a signal is from a single cable, several buried side by side or one above another.

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

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

Ni-Cad batteries should be disposed of in accordance with your Company's work practice, and/or the relevant laws or guidelines in your country.

The operation of any cable and pipe locator may be affected when used in close proximity to ferrous materials such as manhole covers and parked cars. Keep a one or two meter distance from these objects when taking critical measurements such as depth and current readings. If an operator stands too close to the Receiver when wearing steel-toe capped boots may also affect the readings.

This instrument, or family of instruments, will not be permanently damaged by reasonable electrostatic discharge and has been tested in accordance with IEC 801-2. 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.

## 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 Radiodetection headquarters.

For more information go to [www.radiodetection.com](http://www.radiodetection.com) or contact your local Radiodetection representative.

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# Section 1 – Introduction

## 1.1 About this manual

This manual provides pipeline surveyors with comprehensive operating instructions for the PCM<sup>+</sup> Transmitter and Receiver system. Before operating the PCM<sup>+</sup> system it is very important that you read this manual, noting all safety warnings and procedures.

Note this manual introduces Radiodetection's PCM<sup>+</sup> SurveyCERT™ PDA and PC software applications but does not provide any installation or operating instructions. The software manual is available to download at [www.radiodetection.com/pcm+](http://www.radiodetection.com/pcm+).

Following is an overview of the PCM<sup>+</sup> system and a brief introduction to the PCM<sup>+</sup> receiver and transmitter.

## 1.2 Manual outline

- Sections 2 and 3 provide a detailed explanation of the transmitter and receiver features.
- Section 4 provides an overview to basic locating using the PCM<sup>+</sup> system and includes several procedures and examples.
- Section 5 introduces the PCM<sup>+</sup> receiver's measurement and recording utilities.
- Section 6 provides several real-world applications of PCM<sup>+</sup> use in the field.
- Section 7 introduces the PCM<sup>+</sup> A-Frame.
- Section 8 explains how to interpret logged results.
- Section 9 introduces the basic concept of the PCM<sup>+</sup> SurveyCERT™ PC and PDA software.
- Section 10 is an appendix that provides advanced configurations and specification details.

## 1.3 Overview of the PCM<sup>+</sup> System

Radiodetection's Pipeline Current Mapper (PCM<sup>+</sup>) system enables the pipeline industry surveyor to overcome the limitations of existing techniques used in evaluating the effectiveness of cathodic protected pipes. This new technology enables shorts caused by contact with other metallic structures and coating defects to be identified.

Traditional Cathodic Protection (CP) surveys measure the voltage potential of the pipe with respect to the earth around it to show that the pipe is protected against corrosion. Some pipes, due to coating degradation or damage have low protection voltages and are at risk of increased corrosion damage. Simple Ohms law shows that adding more current will cause more voltage, but higher rectifier output voltages have been shown to speed the degradation of coatings. Another side effect is that more current flowing can cause embrittlement of the pipeline metal leading to premature (and possibly catastrophic) failures.

The PCM<sup>+</sup> provides a new method to locate faults and poor coating that is draining the current, resulting in improved potentials and minimising damaging side effects. A PCM<sup>+</sup> with the addition of the new A-Frame can perform a Close Interval Potential Survey (CIPS) as current flow and voltage potentials are related but other factors vary this relation.

### PCM<sup>+</sup> System features

- Consists of a portable transmitter and a handheld receiver. The transmitter applies a special near DC signal to the pipeline.
- The receiver locates this unique signal on the pipeline and displays the signal's current magnitude and direction without connection to the pipeline.
- 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 an accurate evaluation of the condition of the coating of a section of pipe.
- Reduces false indications and thereby minimizes unnecessary excavations.
- Provides data logging and on-site review of readings via Bluetooth® to a PDA or PC to enable graphs to be generated.
- Can be supplied with an accessory A-Frame, and used to pinpoint coating defects.
- 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.
- Is designed for the Pipeline Industry with guidance and support from Gas Industry leaders.
- The PCM+ is one part of the Radiodetection Pipeline Product range, which also includes the Stray Current Mapper and Smart Interrupter.

## **PCM+ Transmitter**

The PCM+ system's specialized constant current high-power 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 transmitter has three operating modes that enable both distribution and transmission pipeline systems to be effectively mapped.

Connecting the PCM+ is straightforward, and the transmitter's current reading LCD and power indicating LEDs help the operator to choose the best settings for the specific pipeline application.

For PCM+ Transmitter operating instructions, please refer to Section 2.

## **PCM+ Receiver**

The handheld receiver unit is used to locate the pipeline, even in heavily congested areas. The receiver provides the operator with a measurement of depth current strength and direction of the near DC signal applied by the system's transmitter.

The receiver makes the required calculations and instantaneously displays the results. This provides the operator with an improved method that accurately troubleshoots the CP system by pinpointing metallic contacts and locating areas of coating defects.

For PCM+ receiver operating instructions, please refer to Section 3.

# Section 2 – Transmitter Functions

The PCM<sup>+</sup> TX is a powerful transmitter, capable of sending detectable signals up to 30km (20 miles) from the connection point.

The PCM<sup>+</sup> Transmitter is housed in a rugged waterproof case. To open the transmitter, unsnap the clips located 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 by the handle.

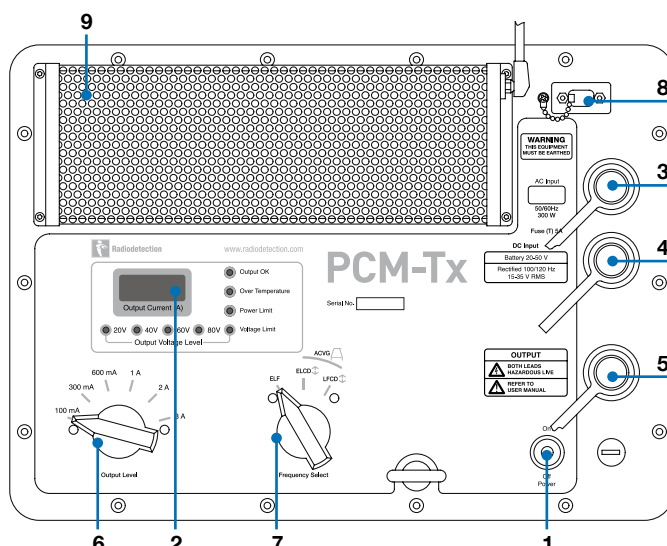
The case must remain open during operation; this allows the transmitter to remain at optimal temperature.

Before closing the case, disconnect all cables and keep them away from the heat sink and the support strut.

## 2.1 Transmitter Control Panel

1. On/Off switch
2. LCD and LED indicators. Indicates the current output in amps and provides critical feedback on the TX's operation
3. AC Input socket
4. DC Input socket
5. Output lead socket
6. Output Level Selector: Select the output level in amps
7. Frequency Selector: Selects the frequency
8. Serial Port: For service personnel only
9. Heat sink: Vents heat from the transmitter during operation

Figure 2.1: Tx Facia



## 2.2 Frequency Select

The LCD displays the selected 4Hz output current in amps.

The three-position rotary switch selects the applied mapping frequencies as follows:

### ELF Transmission Lines

ELF maximum range.

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

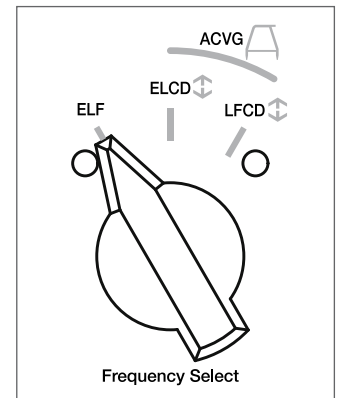


Figure 2.2: Frequency Selector

### ELCD Transmission and Distribution Lines

ELF current direction, medium range.

- 35% 4Hz
- 30% 8Hz (current direction)
- 35% ELF (128Hz or 98Hz)

### LFCD Distribution Lines

LF current direction, alternative frequency.

- 35% 4Hz
- 30% 8Hz (current direction)
- 35% LF (640Hz or 512Hz)

The 4Hz mapping frequency is always present.

The operator has a choice of selecting the locate frequency and current direction indication if required for identification in congested areas or for faultfinding.

## 2.3 Output Current Select

This rotary switch allows users to select six different 4Hz current settings. These are 100mA, 300mA, 600mA, 1A, 2A and 3A.

When the PCM<sup>+</sup> transmitter is in operation, the selected current will remain at a constant level, unless input power supply limit is reached.



## 2.4 Warning Lights and indicators

Output voltage indicated by yellow output voltage level 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

The Voltage Limit LED indicates that the Transmitter has reached its 100V output voltage limit. When this happens the resistance of the pipe or ground connection is too high. Check all connections to correct this problem.

**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.**

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 switched on for very long periods.

## 2.5 Display

The 3 digit DISPLAY displays the 4Hz signal current in amps that is being delivered onto the pipe.

Transmitter status indicated by the following LEDs:

GREEN	Output OK
RED	Over Temperature
RED	Power Limit
RED	Voltage Limit

### Over Temperature

If the transmitter temperature exceeds its recommended limits it will automatically shut down. Wait until the transmitter has cooled before you recommence operation.

### 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 until the GREEN Output OK LED illuminates. Allow a few seconds to settle between selections.

## 2.6 Signal Connection

**Warning! Appropriate safety procedures must be followed before removing pipeline CP connection.**

**Switch the PCM transmitter OFF before handling connection leads.**

### Procedure

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 PCM Receiver 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.

### Using portable transmitters

In some circumstances, you may have to use a portable transmitter such as the RD4000T3; RD4000T10 or the RD7K/8K TX range to produce a stronger locate signal. For example, the ELF signal from the PCM<sup>+</sup> Transmitter maybe inadequate when:

- The receiver is a very long distance from PCM transmitter or when.
- Locating distribution pipes from buildings where isolation joints are fitted.

Users can connect the portable transmitter to the pipeline/network at a test point or isolation joint. You can use either the direct connection and induction methods for 8kHz location modes. PCM<sup>+</sup> 4Hz measurements can be taken if the PCM<sup>+</sup> Transmitter is switched on.

**Note that when using a portable transmitter, the PCM<sup>+</sup> Tx transmitter must not be set to the LF frequency.**

## 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.

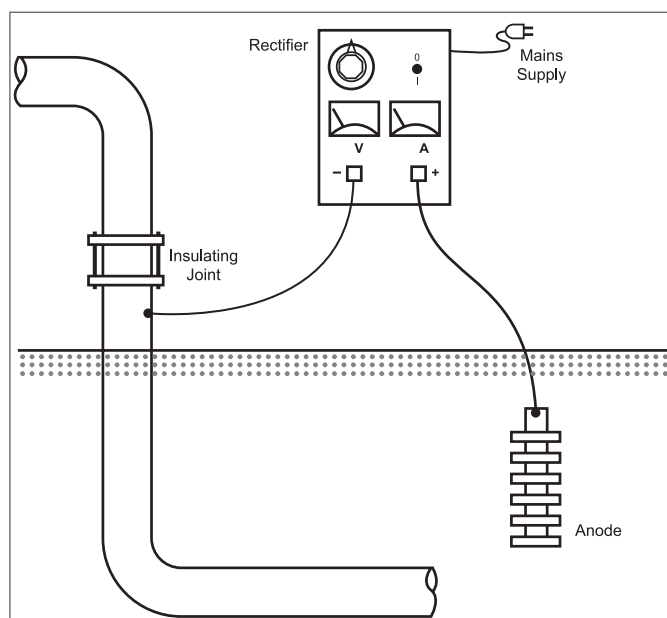


Figure 2.3: Rectifier connection to pipeline

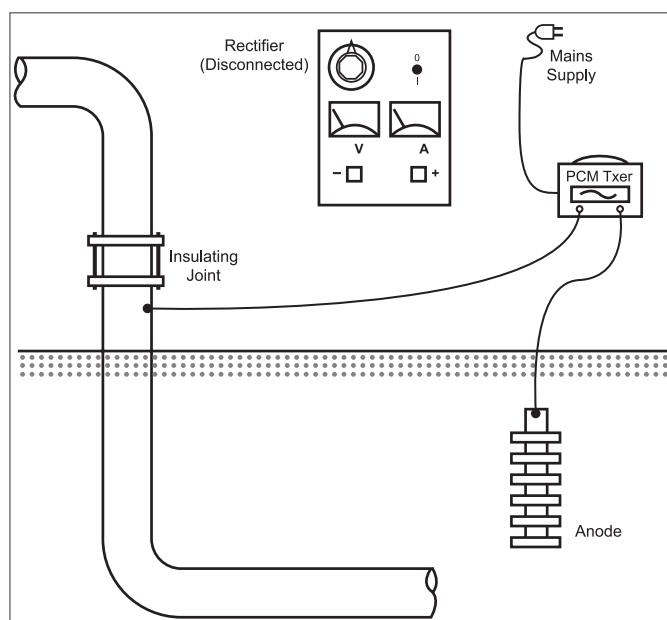


Figure 2.4: PCM connection to pipeline

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

Failure to disconnect cables from rectifier will cause unstable PCM<sup>+</sup> signals, and may cause possible damage to the PCM<sup>+</sup> transmitter.

Connect the PCM<sup>+</sup> transmitter to the cables, white lead to pipeline cable, green lead to anode cable. Use the mains power supply for the transmitter.

If Isolation Joints are not used the PCM<sup>+</sup> 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<sup>+</sup> transmitter lead to one of the pipeline cables, and the green connection lead to the anode cable. Use the PCM<sup>+</sup> receiver to help identify the cables to the individual pipelines.

If the PCM<sup>+</sup> 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 PCM<sup>+</sup> current, so using the PCM<sup>+</sup> Receiver 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.

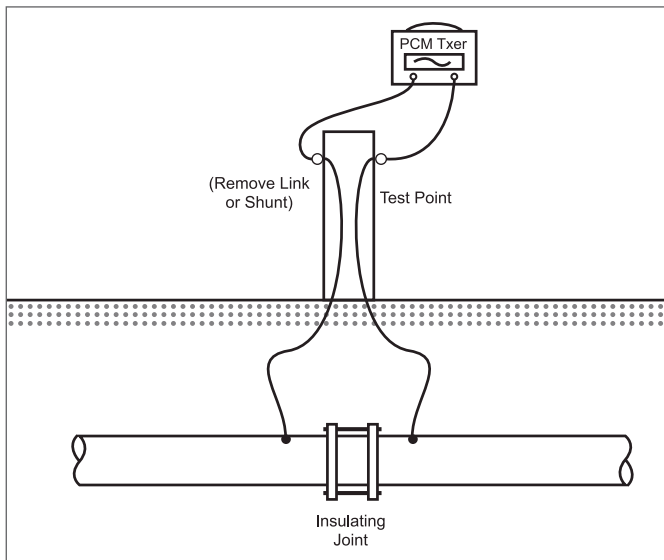
## When a rectifier is not available

### Test Points

At some test points there are Isolation Joints with cables to the surface.

Connect the PCM<sup>+</sup> 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.

**Note:** Make sure that the pipes run in opposite directions. If your connections are on pipes in the same direction this may affect the survey results.



**Figure 2.5: PCM connection using test point**

## Sacrificial Anodes

You can use sacrificial anodes as a grounding point for the PCM<sup>+</sup> transmitter. This type of connection can be used when there are no isolation joints.

**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<sup>+</sup> current loss.

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

Connect the white cable from the PCM<sup>+</sup> transmitter to the pipeline connection, and the green cable from the PCM<sup>+</sup> transmitter to the anode.

**Note:** If the anode is heavily depleted it will be high resistance, and the PCM<sup>+</sup> 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 PCM<sup>+</sup> transmitter.

Whatever grounding is used for the PCM<sup>+</sup> 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 PCM<sup>+</sup> 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.

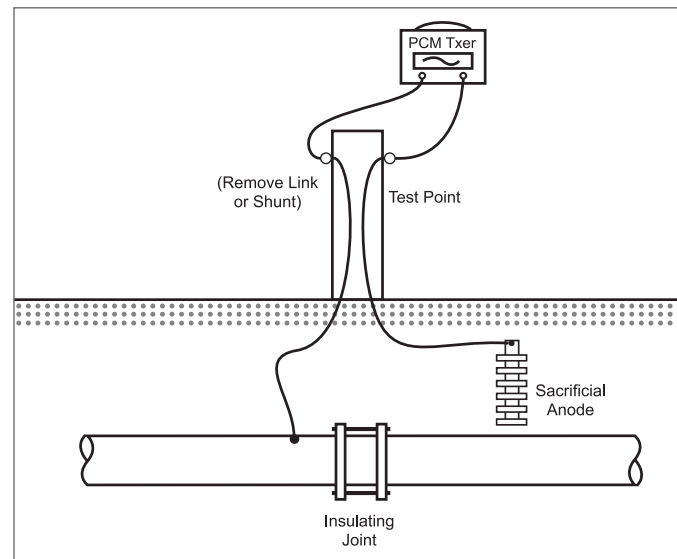
Streams, drainage ditches, dykes, marshes, or any mass of water can be used to ground the transmitter.

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<sup>+</sup> transmitter. However this will cause all electrical cables in the area to carry the PCM<sup>+</sup> Transmitter signal.

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



**Figure 2.6: PCM connection using sacrificial anode for grounding**

## 2.7 Power Supply Connections

Switch transmitter OFF before connecting to either:

- 230V (110V) AC supply
- 20-50V DC source
- 15-35V rectified source
- 230V (110V) AC Supply or Generator.

**Warning!** The equipment must be earthed through the plug.

The transmitter is rated at 300W at 230V AC 50Hz (110V AC 60Hz)

Connect the mains power lead to the rectifier, or use 230V (110V) generator that provides 300W or more for the transmitter to operate at its maximum output capacity

## Vehicle DC to AC Inverter

Power supply from a vehicle DC to AC inverter which provides 300W or more at 230V (110V) from 12/24V DC, can also be used.

## DC Supply

This allows the PCM<sup>+</sup> transmitter to be powered from two 12V or one 24V-auto batteries.

## 20-50V DC and 15-35V rectified AC supply

The input voltage range is 20-50V DC (14-35V rectified AC). The current drawn from the supply will be a maximum of 5A.

Ensure that the rectifier is switched off.

Then connect the black lead to the negative supply and the red lead to the positive supply, and switch the receiver on.

If the supply cannot provide 5A, this will be indicated by the power limit warning light.

Turn the six position, Current Select switch to the minimum position and switch on the PCM<sup>+</sup> Transmitter. Progressively increase to obtain a current output setting which does not overload the input.

Maximum output power is dependent upon voltage. For example, on a particular pipe an input voltage of 20V may only allow a maximum output of 300mA, whereas an input voltage of 50V may allow an output of 3A.



The transmitter DC input is protected against reverse polarity and over-voltage, and will not operate unless connected correctly.

# Section 3 – Receiver Operation

This section provides operating instructions for the PCM<sup>+</sup> receiver. The handheld receiver unit is used to locate the pipeline, even in heavily congested areas such as conduits.

**Note:** Before you attempt any survey, set the PCM<sup>+</sup> receiver to match your country's power distribution frequency (50 or 60Hz) and your preferred units of measurement. See Section 3.3 for instructions.

## 3.1 Control panel and LCD features

1. On / Off Key. Momentary press to access menu options and to set user settings. Holding down the Function key on power up will display PCM<sup>+</sup> software version and last calibration date.
2. Numeric Signal Display: Provides a numeric representation of the signal response in a percentage.
3. Frequency / Mode Indicator: Displays the selected frequency or operating mode.
4. Left / Right Arrows: Indicates direction of target line; available in Null mode only.
5. Numeric Display: Displays the current gain value. Also Log file index.
6. Power Mode: Indicates when Power mode selected.
7. Bar Graph: Displays signal strength.
8. Fault Find 8KFF or ACVG using the Radiodetection A-frame.
9. Antenna Display: Narrow Peak (twin horizontal antenna), Null (vertical antenna).
10. Battery Level: Displays battery level. No locate is possible at minimum (zero bars).
11. Depth or Current Display: Displays depth or current as applicable.
12. Current Direction / Fault Find Arrows: Indicates the direction along the pipe / utility to the measured fault. In ELCD or LFCD mode they identify outgoing current (4 / 8Hz) from the PCM transmitter.
13. Antenna Select Key. Press and release selects Peak or Null mode. Sustained key press initiates a 4Hz current measurement.
14. Gain Controls / Accept or Reject 4Hz current measurement. Sustained hold of gain-up or gain-down in steps of 1dB increment / decrement.
15. Function Key: Press and release to select the required frequency / operating mode. Sustained press toggles between depth measurement and locate current.
16. Line  or accessory .
17. Bluetooth: Indicates when Bluetooth is switched on.

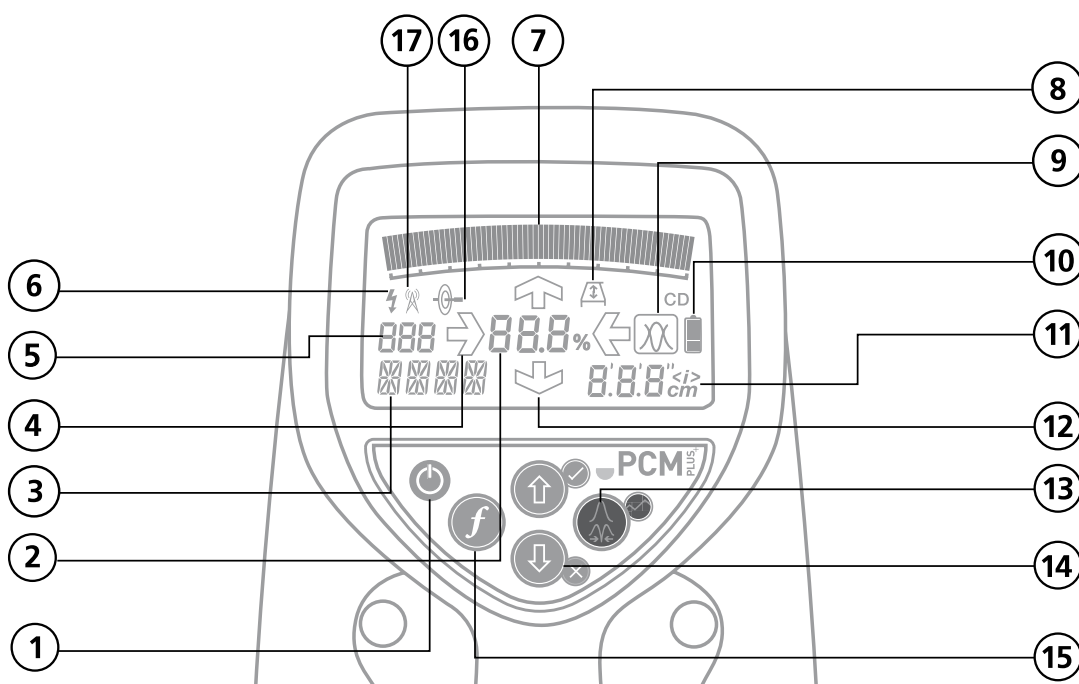


Figure 3.1: Receiver Controls

## 3.2 Software revision and calibration date

The current software revision and last calibration date can be accessed on the PCM+ receiver. To do this hold down the Function key while switching on the PCM+. The screen will momentarily display the following:

- Date of last calibration in the format month/year
- Software revision number

**Note:** Calibration date is the bottom number.

## 3.3 Setting Controls

The Setting Controls allows the user to configure the PCM+ receiver's configuration settings.

When the receiver is switched on, momentarily press the On/Off key to enter the menu options.

When the menu appears, use the Up and Down keys to scroll through available features.

To select a required setting, press the On/Off key and then use the Up and Down keys to scroll through the available options.

### Selectable Options

1. Volume: 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.**

2. BLUT. Bluetooth option menu. Select Off to switch Bluetooth radio off. Select Auto to switch Bluetooth on; note in Auto mode the Receiver will connect to a paired device. Select Pair to pair the receiver to a compatible Bluetooth device.
3. SEND: Sends logged data over a *Bluetooth*® connection into Radiodetection's SurveyCERT application.
4. DEL?: Erases the data log file.
5. BATT: Select either Alkaline or NiMh batteries.
6. PWR?: Selects the power mode frequency to either 50 or 60Hz.
7. UNIT: Select either Metric or Imperial measurements.
8. SIGL: Select either NORM or LOW. NORM is sufficient for most applications. Select LOW if working in poor conditions.
9. TIME: Selects time for the inactivity timer and can be set to OFF, 5 mins, 10 mins or 20 mins.

10. VIEW: Allows the user to review stored log data.
11. ACCE: Selects either SDDA (submersible double depth antenna) or STH (stethoscope) accessories.

## 3.4 Batteries

The LCD provides a battery level indicator. When battery replacement is necessary, display shows flashing battery symbol. The expected battery life with normal use is 30 hours. When using alkaline batteries always use good quality batteries.

To replace batteries unlatch the battery compartment cover and slide out the tray. Insert two D-cell Alkaline or Ni-Cad batteries.

**Note:** When installing batteries always observe the correct battery polarity as indicated on the battery holder.

## 3.5 Operating Frequency Modes

Press the Function key 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 PCM+ receiver.

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

The PCM+ transmitter does not output an 8kHz signal. This can be supplied using Radiodetection battery powered transmitters.

### Extra Locate Modes

Power: Detects 50Hz/60Hz from power cables.

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

### Left/Right Indication

Indicates direction to pipe centre in Null mode.

This is useful for fast pipe tracing and checking for interference.



## Touch Gain Control and Bargraph

Control of the gain is via the up and down arrows increase or decrease PCM<sup>+</sup> 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; touch the gain control once counter clockwise to reduce to 60% of full scale.

### 3.6 Depth measurement

The depth measurement is automatically displayed in all modes except 8KFF and ACVG. Depth measurements are displayed as follows:

- 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 PCM<sup>+</sup> must be directly over a pipe with the blade at right angles to the target.

### 3.7 Locate current

Locate current is displayed automatically and can be displayed in CPS, ELF, ELCD, LFCD and 8kHz modes. Press and hold the function key to toggle between depth and locate current. Locate current will be displayed in mA.

### 3.8 Recording measurements

When a PCM<sup>+</sup> reading is taken and saved, the datalogger in the PCM<sup>+</sup> will store the log number, PCM<sup>+</sup> current in mA and dB, current direction, depth, phase angle and locate current. When linked to a GPS compatible PDA running SurveyCERT™, the datalog is updated with the GPS position and time stamp.

The PCM<sup>+</sup> can store up to one thousand datalogs in the receiver's memory.

## Taking a Pipeline Current Measurement

To achieve accurate results the receiver must be kept as still as possible and directly over the pipeline while taking readings.

When taking measurements the white arrow on the bottom of the magfoot should be pointing away from the transmitter.

- Press and hold the Antenna Select key to initiate the PCM<sup>+</sup> current measurement.
- The signal strength bargraph will scroll across the screen and after 4 seconds the measurement cycle is complete. The reading will remain on the display until it is saved or rejected.

**Note:** Before the reading is saved or rejected the 4Hz current reading is a 'live' reading. This is particularly useful as fluctuations in readings may indicate the presence of interference. The user may choose to save the reading or move to another point along the pipeline. If the 4Hz current reading is fluctuating the user can go into the menu, select SIGL and select 'LOW'. This feature is useful in areas where there may be interference, in this mode the measurement cycle will be longer than 4 seconds.

Once a measurement cycle has been initiated the PCM<sup>+</sup> provides the user with the ability to 'hold' the reading and decide whether to save the reading or return to a 'live' reading. To 'hold' a measurement reading, carry out the following:

- When the 4Hz measurement cycle has completed momentarily press the Antenna Select key, the 4Hz current reading will now be frozen. To return the 4Hz reading to a 'live' condition press the Antenna Select key.
- To accept the reading press the Up arrow or to reject the reading press the Down arrow key.

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

## Saving or rejecting readings

Once a PCM<sup>+</sup> current reading has been obtained a log number 1-1000 is shown in centre-left of the display. This is the log number that will be used if the reading is saved.

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

Once the log is saved or rejected, the PCM<sup>+</sup> Receiver will return to its previous locator mode.

## Sending readings to a PDA or PC

When a reading is saved the data is automatically saved within the locator. If the data is to be sent to a PDA or PC the PDA or PC should have Radiodetection's **PCM+ SurveyCERT™** application installed and the PCM+ must be paired with either of the devices that is being used.

For details of using Radiodetection's **PCM+ SurveyCERT™** application go to [www.radiodetection.com/pcm+](http://www.radiodetection.com/pcm+).

## Uploading data

Note: To upload PCM+ saved results, Radiodetection's **PCM+ SurveyCERT™** application is required on the target PC or PDA. Please refer to Section 9 for further details. **PCM+ SurveyCERT™** is a free application available for download at [www.radiodetection.com/pcm+](http://www.radiodetection.com/pcm+).

The PCM+ provides the user with the opportunity to send data from the locator to a PDA or PC as the data is saved or by uploading the entire log to a PDA or PC at a later date.

Once the SurveyCERT™ application has been loaded onto the PDA or PC the PCM+ must be paired with the PDA or PC to transfer data from the PCM+.

For details of using Radiodetection's **PCM+ SurveyCERT™** application go to [www.radiodetection.com/pcm+](http://www.radiodetection.com/pcm+).

## Erase All Stored Datalogs

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

- Momentarily press the On/Off key to enter the PCM+ menu.
- Scroll through the menu options until DEL? is displayed.
- Momentarily press the On/Off key and you will be given a choice, either NO or YES. To delete all stored logs use the Up/Down key to select YES and momentarily press the On/Off key.

## Review Mode

Saved data within the PCM+ can be reviewed.

To review stored logs carry out the following:

- Momentarily press the On/Off key to enter the menu and scroll through the menu options using the Up/Down keys until VIEW is displayed.
- Momentarily 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 review mode press the On/Off key once.

## Overwriting saved logs

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

- Momentarily press the On/Off key to enter the menu.
- Scroll through the menu using the Up/Down keys until View is displayed.
- Momentarily press the On/Off 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. 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 4 – Basic Locating

If the PCM+ transmitter is connected and switched on, locate using the ELF or LF frequency modes. If no transmitter is connected use either 50/60Hz to detect power or CPS to locate 100/120Hz from CP system.

Switch on the PCM+ receiver and use the Function key to select operating frequency to locate the pipeline.

## 4.1 Pinpointing a Target Line

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

## 4.2 Peak Procedure

Adjust the PCM+ Receiver sensitivity to half scale. If the bar graph is full, press the down arrow; this will reduce sensitivity and the bar graph to 60%. It may be necessary to adjust the gain during the procedure to keep the bar graph on scale.

1. Hold the detection blade near the ground and with the blade vertical.
2. Make traverses from side to side of the pipeline and define the point of maximum response.
3. Turn the Receiver around as if it is a pivot. Stop at the maximum response and note receiver direction. Reduce sensitivity if necessary.
4. Continue to rotate receiver until display shows zero response; the blade is now parallel with the pipeline, and this shows the exact direction of the pipeline. Rotate the receiver through 90 degrees. The response is now at a maximum.
5. Move the Receiver gently from side to side to define the exact position of the peak response. The detection blade will then be directly over the pipeline and at right angles to it.
6. Mark the pipeline position.

## 4.3 Null Procedure

Follow the procedure for pinpointing with a peak response and mark the position.

Switch to null response and follow the left/right arrows. Note the position of the null response over the target.

If the positions of the peak and the null pinpoints correspond, it can be assumed that the pinpoint is precise. If the positions do not correspond, the pinpoint is not precise. Note that both peak and null pinpoints will show an error to the same side. True position will be close to peak position.

Accurate PCM+ results are only obtained when the Peak and Null positions are within 15cm (6 inches) of each other.

Effects of interference from parallel pipes and valves on the Peak and Null positions.

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

When searching for a service, 'Tie-ins' or 'L' then perform a box sweep of the area. Walk to the side of the pipe, turn the gain up until a 50% reading is obtained.

When walking around the box remember to keep the PCM+ Receiver in position so that the blade is never in line with the pipe.

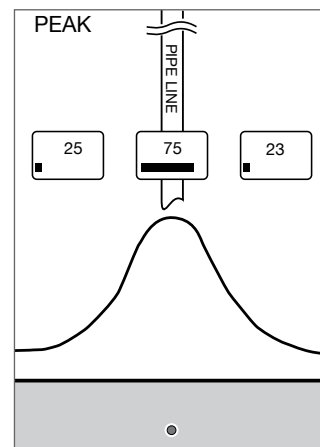


Figure 4.1: Peak mode

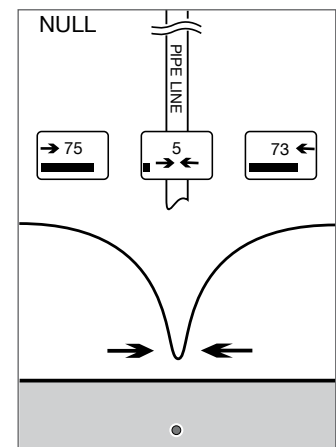


Figure 4.2: Null mode

## 4.4 Depth and Current Measurement

When taking depth and current measurements, it is important to position the PCM+ directly above the pipeline and at 90° to its estimated direction.

**Note: In Null mode depth, locate current and 4Hz current measurements are not available.**

Pipeline depth measurements can be taken in all of the location frequencies except 50/60Hz Power frequency mode.

Locate current and 4Hz current measurements can be taken in the ELF, LF, CPS and 8kHz location frequencies.

On a slope the attachment allows a certain degree of adjustment to help maintain this position.

Try to flatten the ground so that PCM<sup>+</sup> magfoot is parallel to the pipeline.

Note that positioning the PCM<sup>+</sup> at angles other 90° may result in inaccurate depth and current measurements.

**Note: Accurate PCM<sup>+</sup> results rely on accurate depth measurement. As magnetic field distortion is likely at T intersections, junctions, bends or depth changes of the pipeline, try to avoid taking PCM<sup>+</sup> measurements above these points.**

## 4.5 Current Direction

The PCM<sup>+</sup> transmitter is capable of outputting a CD (current direction) signal and this is available in the ELCD and LFCD modes. In either of these modes the transmitter outputs an 8Hz signal which 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.

When a measurement is taken in either ELCD or LFCD mode, direction arrows are displayed on the PCM<sup>+</sup> display. When locating and taking measurements on the target pipeline, by default, the CD arrow will point back towards the transmitter. On some applications the PCM<sup>+</sup> output signal can leak or couple onto an adjacent pipeline and in this condition the CD arrow will point away from the transmitter.

## 4.6 Mapping Current Measurements

### Obtaining and understanding results

A current flowing on a buried conductive structure produces a magnetic field directly proportional to the magnitude of the applied current. By resolving components of the magnetic field from above surface the original current can be precisely determined.

At the heart of the PCM<sup>+</sup> system is the current mapping near DC signal applied by the transmitter. A pipeline's electrical characteristics of current attenuation and distribution at this very low frequency (4Hz) signal are virtually the same as they are for the Cathodic Protection current from the rectifier.

The PCM<sup>+</sup> Receiver contains a precision; high performance sensor known as a magnetometer which remotely detects and measures very low frequency magnetic fields. Advanced signal processing technology provides push button current measurement (and direction) of the near DC (4Hz) signal and a datalogging function

enables graph of current loss against distance to be plotted after downloading to the PC or PDA.

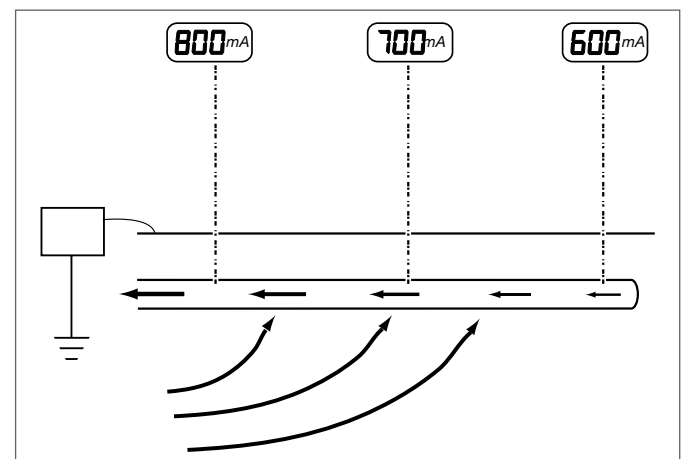


Figure 4.3: Pipeline current flow

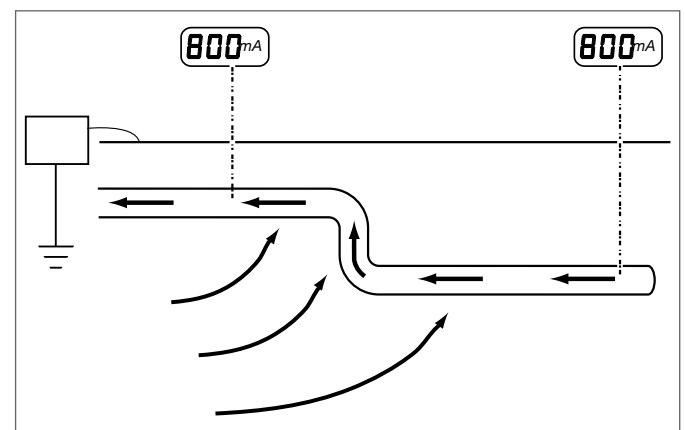


Figure 4.4: Pipeline current flow

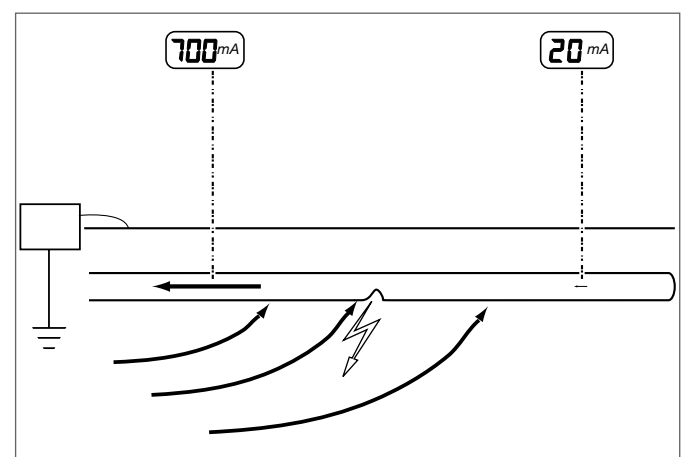


Figure 4.5: Pipeline fault

In all diagrams, the arrows indicate the direction of current flow to the transmitter.

The PCM<sup>+</sup> 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 PCM+ Receiver 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 PCM+ current will be virtually proportional to the amount of CP current being used at the fault.

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

## 4.7 Using dBmA for Pipeline Current Mapping

The PCM+ Receiver displays current as mA, and when results are saved to the internal datalogger, both mA and dBmA are stored in memory.

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 PCM+ 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.

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

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

### Example

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.

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.

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

Note that the graph showing mA (Figure 4.8) at first glance suggests that the faults are of diminishing magnitude. The graph showing dBmA 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.

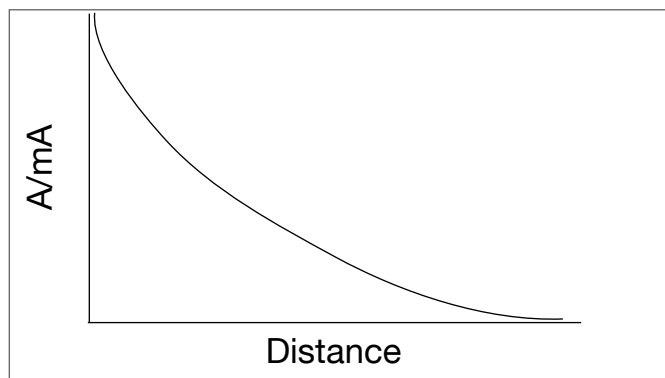


Figure 4.6: mA fault graph

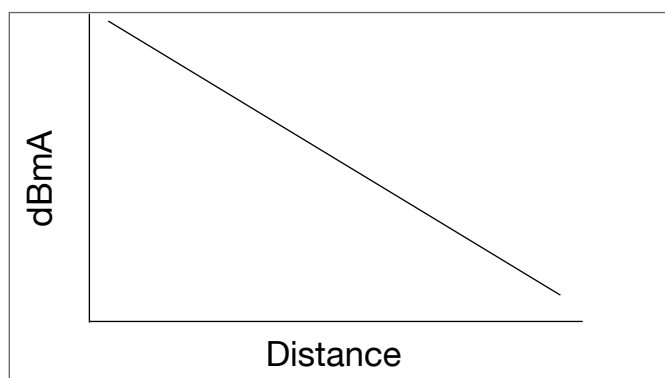


Figure 4.7: dBmA fault graph

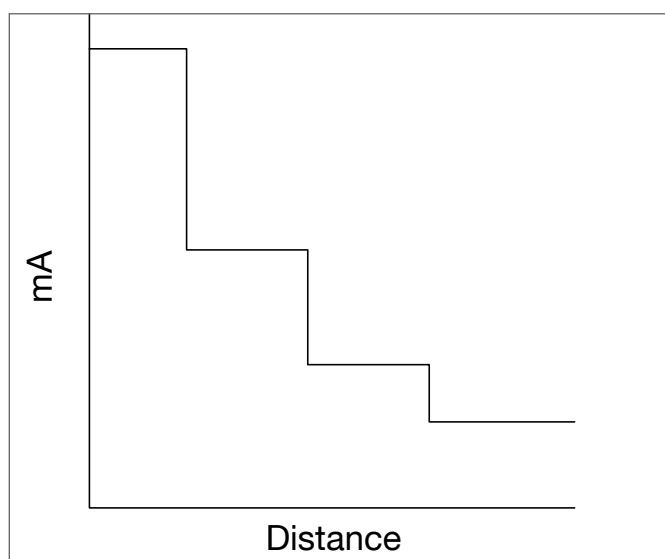
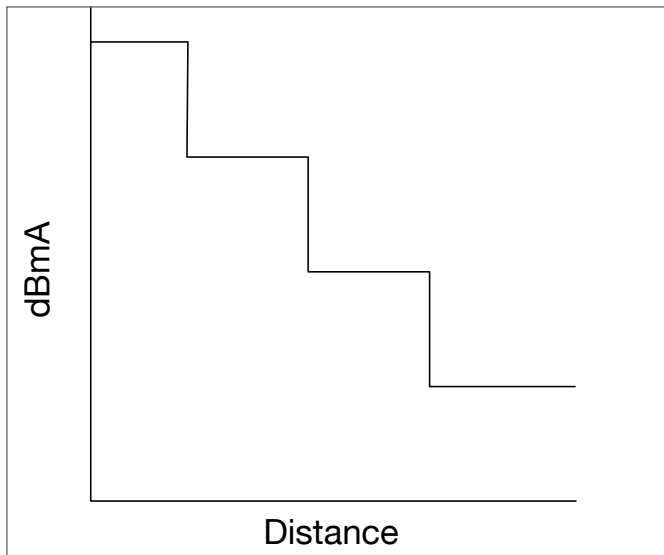


Figure 4.8: mA fault graph



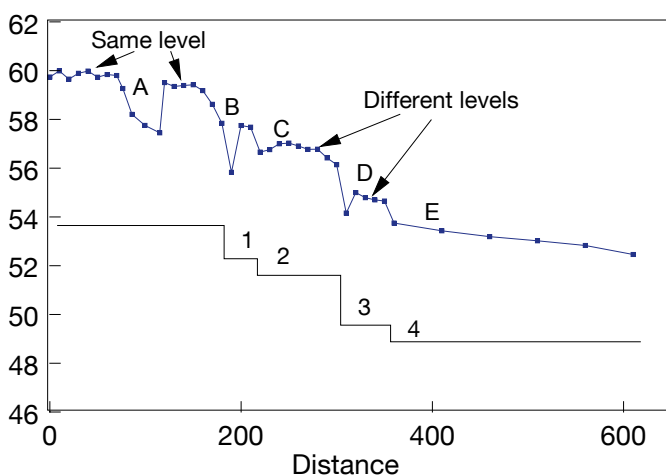
**Figure 4.9: dBmA fault graph**

In figure 4.10, 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.

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 PCM+ A-Frame should now be undertaken so as to pinpoint the exact position of the faults.



**Figure 4.10: Collected data and interpreted results**

# Section 5 – Taking Measurements

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

## 5.1 Pipelines and Distribution Systems

### Basic Technique

#### 'Tie-ins' and 'L'

The current will be split between the 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).

The current will be split between the 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 PCM<sup>+</sup> in locate mode to relocate it.

### 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.

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.

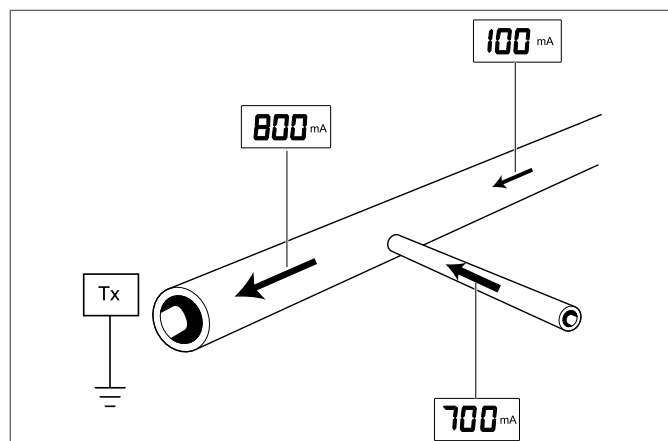


Figure 5.1: Tie line 1

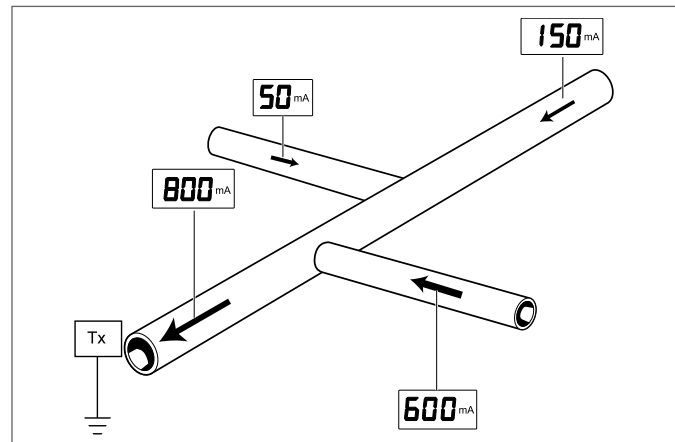


Figure 5.2: Tie line 2

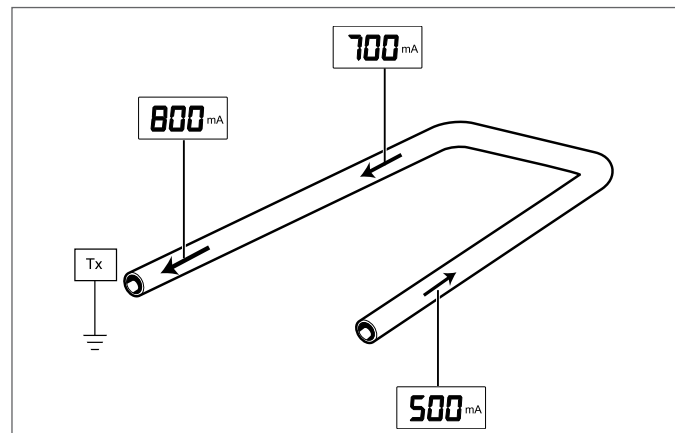


Figure 5.3: Loop

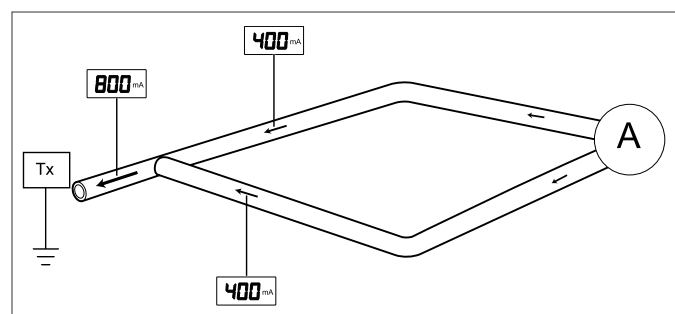


Figure 5.4: Looped system 1

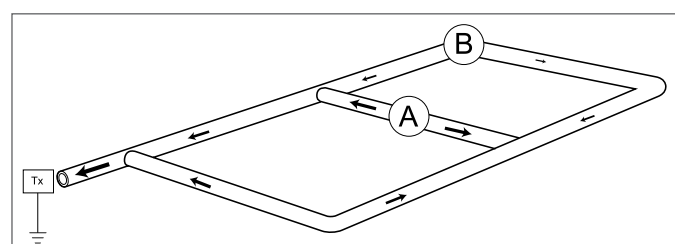


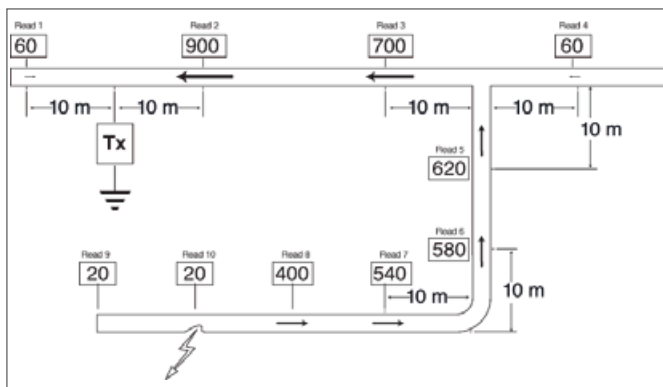
Figure 5.5: Looped system 2

## Taking Measurements – Distribution Systems

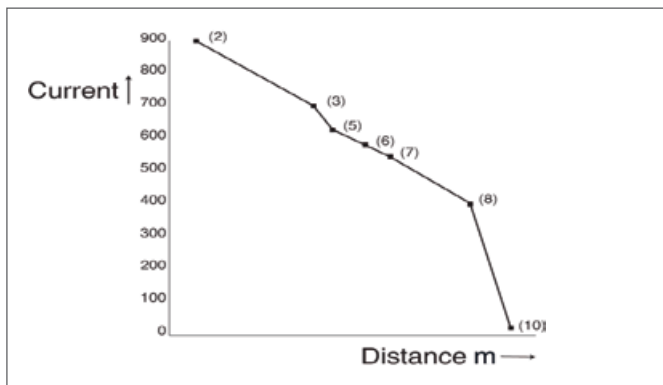
Below are some typical results, which can be found from using the PCM+ for CP system diagnosis on a distribution system.

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 PCM+ and distances to prevent interference have been included. By working around the map a short was quickly and easily detected.



**Figure 5.6: Distributed system**



**Figure 5.7: Interpreting distributed systems**

## 5.2 Pipelines and Pipeline defects

### Interpretation of Readings and Graphs

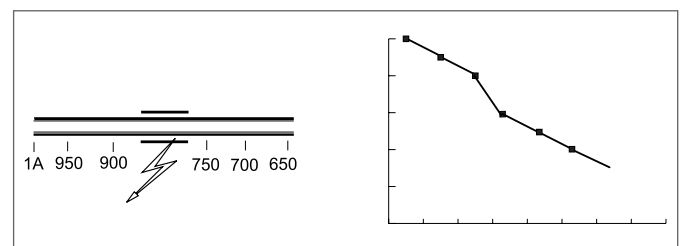
Pipe coating in good condition is shown as very little loss of current.

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

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

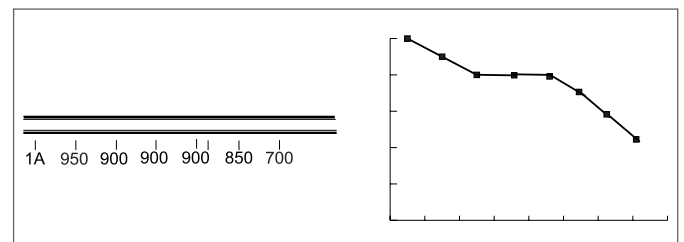
The effect of a short or contact with another service is a sudden current loss.

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



**Figure 5.8: Poor coated steel shield**

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



**Figure 5.9: Perfect coating**

# Section 6 – Applications

This section demonstrates how surveyors can use the PCM+ system in real-world situations.

## 6.1 Parallel Pipes

New distribution pipe with the old pipe running parallel and about 30cm (12 inches) away.

A 1 Amp signal was applied

To make the explanation easier the pipe has been divided into section A & B. This is demonstrated in Figure 6.1.

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.

To verify the fault location the transmitter was repositioned to the other end of the pipeline and 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 6.4 illustrates this effect.

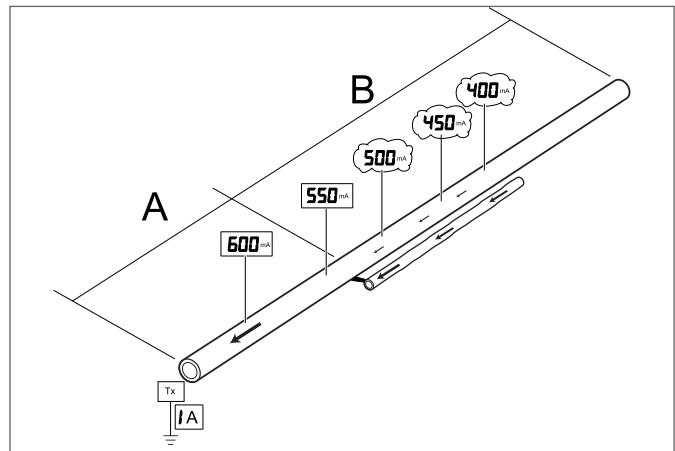


Figure 6.1: Parallel Pipes Example 1

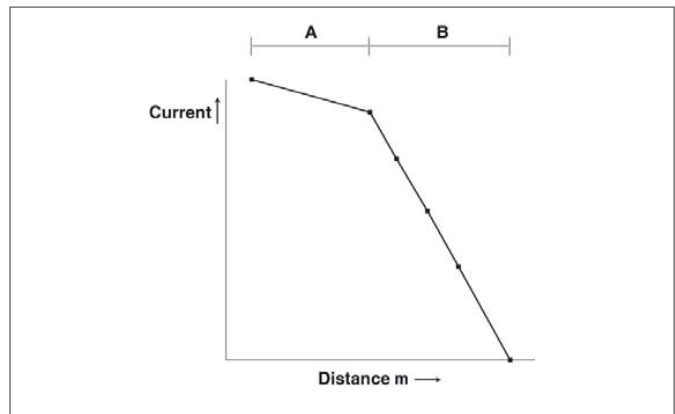


Figure 6.2: Example 1 interpretation

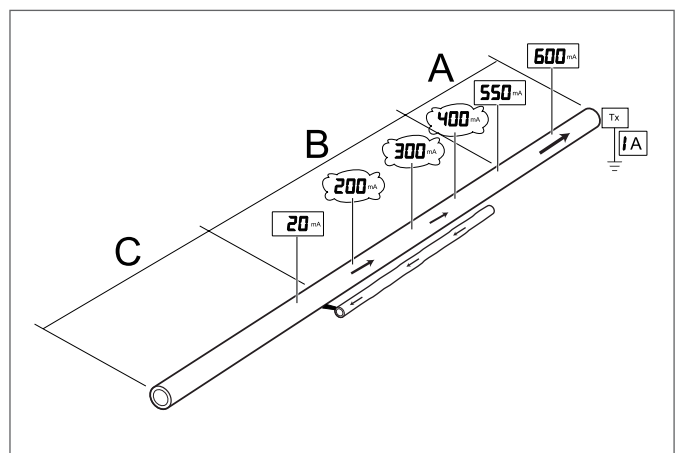


Figure 6.3: Parallel Pipes Example 2

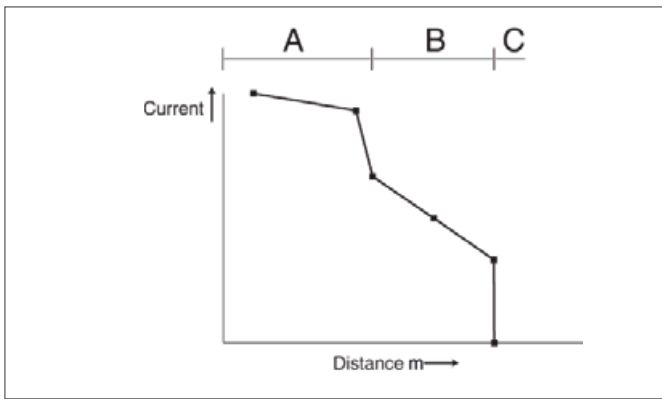


Figure 6.4: Example 2 interpretation

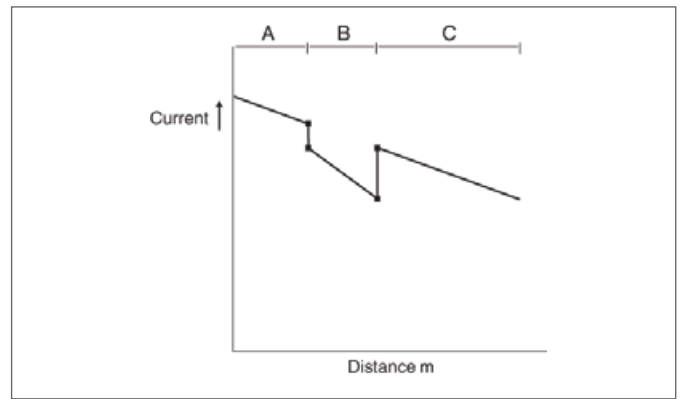


Figure 6.6: Example 3 interpretation

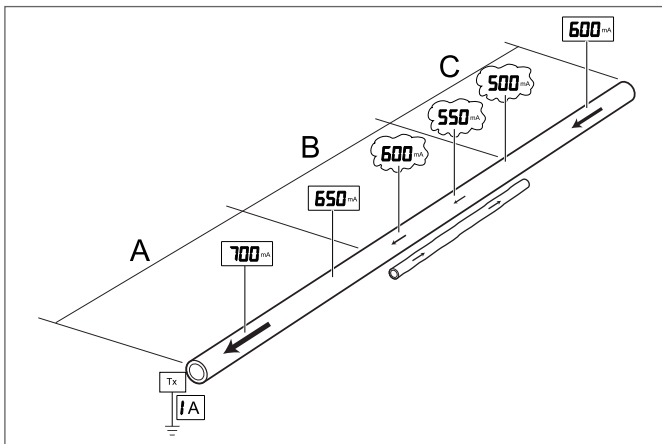


Figure 6.5: Parallel Pipes Example 3

## Example

This example (Figure 6.5) 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 6.6 illustrates this effect.

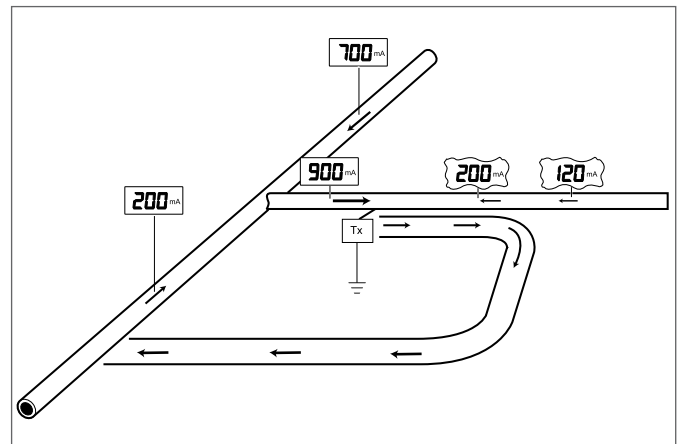


Figure 6.7: Angled Pipes Example 1

## Example

This example (Figure 6.7) 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.

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.

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.

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.

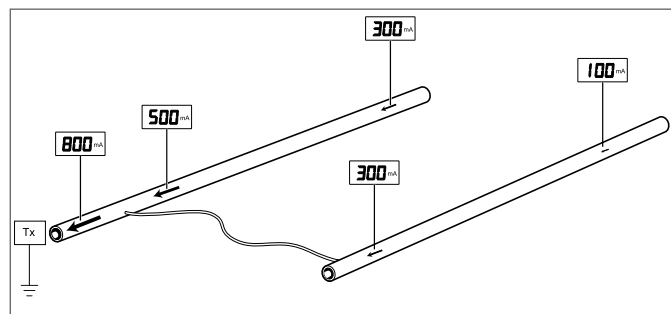


Figure 6.8: Parallel Pipes Example 4

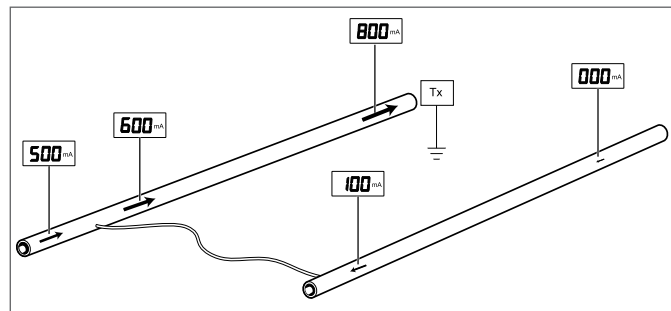


Figure 6.9: Parallel Pipes Example 5

# Section 7 – PCM+ A-Frame

This section provides users with operating instructions for the PCM+ accessory A-Frame.

## 7.1 About the A-Frame

The accessory A-Frame is used with the PCM+ receiver to precisely pinpoint coating defects and isolation faults.

The A-Frame spikes need to make good electrical contact with the ground, preferably with damp, conductive earth.

The PCM+ receiver display indicates direction to the fault, using the CD direction arrows, and this makes fault position easy to locate.

The PCM+ 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 PCM+ datalogging facility, recalled, and uploaded via Bluetooth to a PDA and then later to your PC or PDA.

## 7.2 Operation

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

There are 2 fault find modes on the PCM+ receiver, which can be used with the A-Frame:

- ACVG
- 8KFF

On the PCM+ receiver 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-3 and Tx-10.

**Note:** With the Accessory A Frame plugged in, it is not possible to take PCM+ Current readings.

1. Plug the 3 pin connection lead into the A-Frame, and the multipin connector into the accessory socket on the front of the PCM+ Receiver.
2. Locate the pipeline using any one of the locate frequencies. Position the A-frame above and in line with the pipeline, and the spike marked with green tag away from the transmitter connection point, red spike tag towards transmitter.

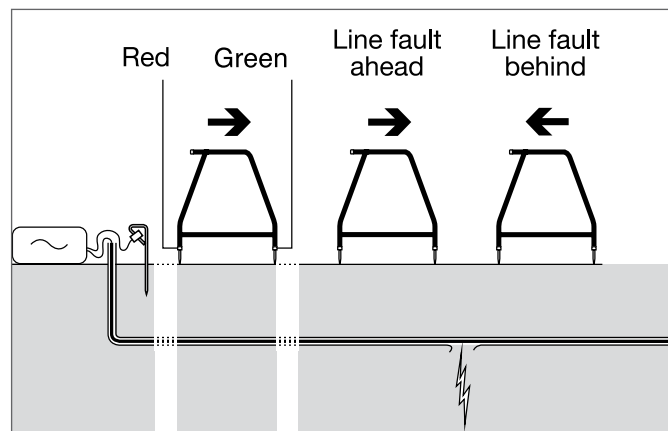


Figure 7.1: A-Frame Fault-Finding

3. On the PCM+ receiver select ACVG or 8KFF using the function key, the A-Frame symbol will appear on the LCD
4. Push the A-Frame spikes into the ground to take a reading. It will then automatically adjust its signal level and calculate the current direction towards the fault and the dB microvolt reading. Note that the gain numbers will flash during calculations. No user adjustment is necessary.
5. Display arrows indicate PCM+ transmitter current direction through the ground, for user convenience this is arranged to display direction to fault. If no arrows are displayed there is unlikely to be a fault close by, and there is too little current in the ground to activate the fault direction arrows, or by chance the A-Frame is directly over a fault.

Make sure that there is good ground contact. Pouring a small amount of water on a road surface will improve results.

The display also indicates the dB microvolt reading. If reading is around 30 or less, there is unlikely to be a fault nearby.

- Move further along the pipeline and make ground contact with the A-Frame spikes again. When a new position gives CD arrow indication forwards, and the next gives CD arrow indication backwards, the operator has walked over a fault. A numerical dB microvolt reading of around 60 can be expected.
- Move backwards along the pipeline taking tests at 1 meter intervals. See that the numerical dB microvolt reading value rises, briefly falls, and rises again, before gradually reducing. The CD arrows will also change direction either side of the fault point.

- Retest by taking small movements forwards or backwards until the position is found where the arrows just change direction, and the dB microvolt reading is lowest. This will confirm the fault is directly under the centre of the A-Frame.

Turn the A-Frame through 90 degrees so that it is now across the pipeline.

Repeat previous stage. The fault point is now exactly under the centre of the A-Frame.

Mark this point with a wooden stake or paint.

Continue along the pipeline section until all faults have been found and marked.

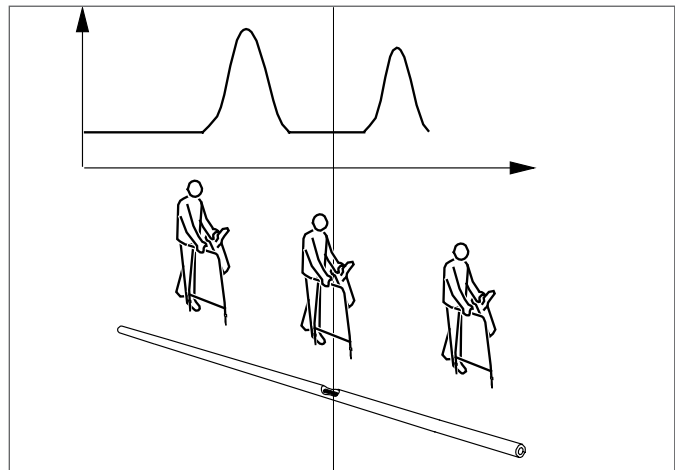


Figure 7.2: A-Frame Fault-Finding

## 7.3 Comparing Fault Severity

To determine the severity of the fault, and compare different faults on the pipeline to decide repair priorities, take the dB microvolt 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 dB microvolt reading, or save it in the datalogger 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.

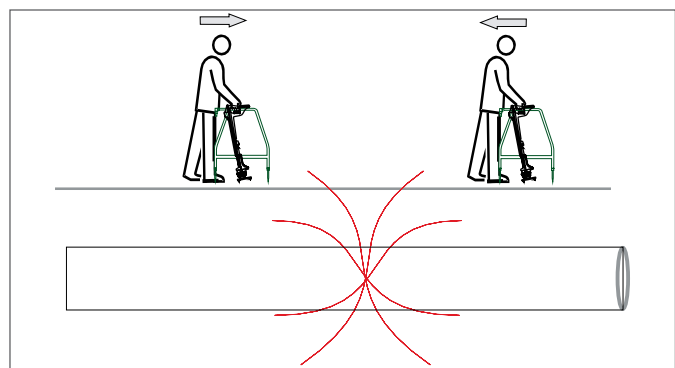


Figure 7.3: Locating the fault

## 7.4 Saving PCM+ FF Readings

You can record and store up to one thousand A-Frame results. Take readings at regular intervals, or write down the distance between measurements and the log number. To save readings keep the A-Frame in ground contact and press the Antenna Select key. The direction arrow to fault and the dBuV reading can be saved or rejected by pressing the Up/Down arrow keys.

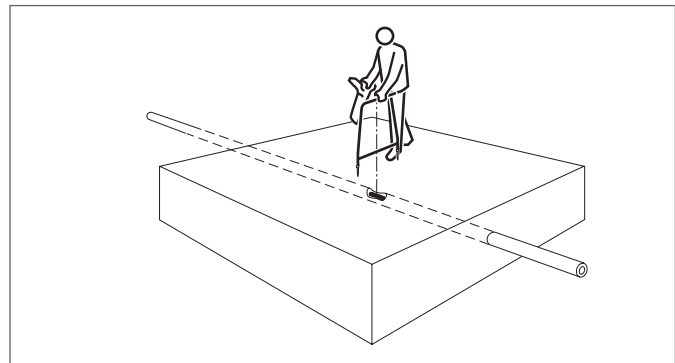


Figure 7.4: Taking a reading

## 7.5 Data Upload – PCM+ FF Data

If you've established a link to your PDA – and you have enabled Bluetooth – each log will be sent automatically to your PDA when the reading has been 'saved'. Alternatively you can send the data to your PDA or PC when the survey is complete.

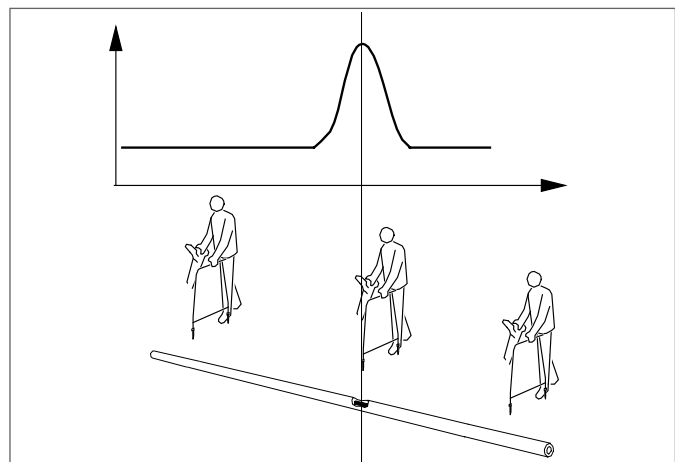


Figure 7.5: Comparing fault severity

# Section 8 – Interpreting Results

**This section provides an overview of interpreting results generated by the PCM+ Receiver.**

## 8.1 Introduction

The principle of the PCM+ 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 and null signals coincide. If in doubt check for field distortion by taking a depth reading and then raise the receiver a known height, for example 0.5M, and confirm the depth measurement increases by the corresponding amount.

As the PCM+ 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 PCM+ 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 PCM+ readings will not be accurate.
- In LF – and with a locate reading current below 2mA – the PCM+ reading will not be accurate.

## 8.5 PCM+ Current.

PCM+ current results depend on locate current. If the PCM+ 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 PCM+ Transmitter locate frequency.

## 8.6 Direction Arrows

The direction arrow indicates current flow to the transmitter.

A direction arrow will not be displayed if the transmitter is set to the ELF (4Hz and 128Hz) mode.

A direction arrow will not be displayed if the PCM+ Receiver is unsure of the current direction. However the current reading will still be accurate.

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

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.

Graph 'C' shows what would be expected in the real situation if PCM+ 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.

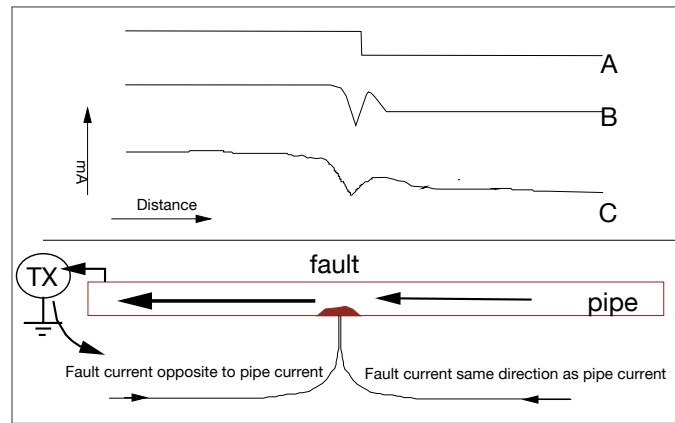


Figure 8.1: Interpreting results

# Section 9 – PCM+ SurveyCERT™ Software for the PC and PDA

Radiodetection has engineered the PCM+ system for interoperability with GPS receivers and industry-standard GIS applications.

PCM+ SurveyCERT™ is a Radiodetection application for PDA's and PC's that can read and chart logged data from the PCM+ receiver in real-time. The application is also available in a desktop viewer for Microsoft Windows® XP™. This version is optimized for larger screens but includes all the features of the PDA version, including the ability to import logged data from the receiver via a USB Bluetooth dongle.

Radiodetection recommend using a USB Bluetooth dongle when transferring data from the PCM+ receiver to a PC.

For further information on PCM+ SurveyCERT™ and how to install PCM+ SurveyCERT™ onto your PDA or PC go to [www.radiodetection.com/pcm+](http://www.radiodetection.com/pcm+).

## System Requirements

### Pocket PC

Windows Mobile 6 or earlier.

Bluetooth.

GPS receiver (Optional).

### PC

Microsoft Windows XP Professional with Service Pack 2.

USB Bluetooth dongle (Optional).

Microsoft .Net framework (or Visual C++ Redistribution Package).

# Section 10 – Appendix


## 10.1 Technical Specifications

### PCM+ Receiver

#### Mapping Modes

ELF	Extra Low Frequency	4Hz+128Hz/98Hz
LF	Low Frequency	640Hz/512Hz
8kHz	Standard locate frequency from battery powered Radiodetection transmitters	

#### Locate Modes

	Detects 50Hz/60Hz from power cables	
CPS	Detects 100Hz/120Hz ripple from CP transformer rectifier	
8kHz	Standard locate frequency from battery powered Radiodetection transmitters	

#### Receiver Features

Dynamic Range:	140dB
Selectivity:	120dB/Hz
Range from Tx:	30km (19 miles)
Depth accuracy: metric (imperial)	$\pm 2.5\% \pm 0.01\text{m (1")}$ from 0.01m (1") to 1m (3ft); $\pm 5\% \pm 0.01\text{m (1")}$ from 1m (3ft) to 3m (10ft); $\pm 8\% \pm 0.01\text{m (1")}$ from 3m (10ft) to 5m (16.5ft)
Current accuracy:	$\pm 3\% \pm 0.01\text{m (1")}$ from 0.01m (1") to 1m (3ft); $\pm 6\% \pm 0.01\text{m (1")}$ from 1m (3ft) to 3m (10ft); $\pm 10\% \pm 0.01\text{m (1")}$ from 3m (10ft) to 5m (16.5ft)
Locate accuracy:	$\pm 2.5\%$ of depth
Weight:	3.3kg (7.2lb)
Batteries:	2 D cells (Alkaline or NiMh)
Environmental:	IP54
Approvals:	CE, Bluetooth® compliant

#### Peak/Null Features

Used to pinpoint target line

Selectable peak & null response

Gain control: Via keypad auto & manual

### PCM-Tx Transmitter

#### Frequency Select

Current Direction (CD) provides a positive identification of the 'out-going' current and provides a method of locating pipe faults using the A-Frame.

The three position switch selects the following mapping frequencies:

ELF	Maximum range for Current Logging 4Hz + 98Hz/128Hz
ELCD	Standard Current Logging with CD (4Hz + 8Hz) CD + 98/128Hz
LFCD	Improved depth, position and current logging accuracy with respect to ELCD. Shorter range operation (4Hz + 8Hz) CD + 512Hz/640Hz

\*The 4Hz mapping frequency is always present and the current is shown on the LCD. The operator has a choice of selecting the locate frequency and current direction indication if required for identification in congested areas or for fault finding.

Case construction: High impact engineered plastics

Weight: 15.2kg (34lb)

Size: 47 x 37 x 19cm (18.5 x 14.5 x 7.5 inch)

Environmental: NEMA 3R and IP55 – lid open;  
NEMA 6 and IP67 – lid closed

Approvals: CE

#### Current Select

The six position (current select) rotary switch selects the following 4Hz current settings:

100mA, 300mA, 600mA, 1A, 2A, 3A. When the PCM Transmitter is in operation, the selected current will remain at a constant level, unless the input power supply limit is reached.

**PCM Attachment (A-frame)**

A-frame for detection of sheath faults on buried pipes and cables.

(Includes PCM+ connection cable).

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Weight:	1.55kg (3.4lb)
Size:	8.5 x 59 x 4.5cm (33 x 39.3 x 1.7 inch)

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## World leaders



Radiodetection is a proud member of the SPX group of companies, which provide technical products and service solutions worldwide.

Radiodetection and its associated companies specialize in the design and manufacture of products for the location and maintenance of underground pipes and cables. Our aim is to be viewed as the supplier of choice of 'high performance' quality equipment using advanced product technologies. We are also committed to both design innovation and customer support.

## Technical support



Radiodetection equipment users have easy access to technical support. A call to your regional representative, or the Radiodetection head office, will put you in contact with our team of field-experienced technical experts.

## Servicing and repair



Radiodetection has a team of factory-trained service technicians and dedicated service facilities. Turnaround is fast, and costs are very competitive.

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Product training for your operators and training personnel is available on your site, or at Radiodetection's headquarters. Training is with qualified instructors and each trainee receives a certificate to confirm they have received the training.

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