C.SCOPE
M-SCAN
USER GUIDE

Contents

Get Started

Brief Instructions for Use

1. Insert batteries in the holder ensuring they are in the correct orientation before re-inserting the holder so the contacts touch.

2. Remove any metal items (rings, watches, etc) and electronic devices (e.g. mobile phones) from about your person.

3. Turn the M-Scan on by pressing ON/OFF ⏻.
The display should come on.

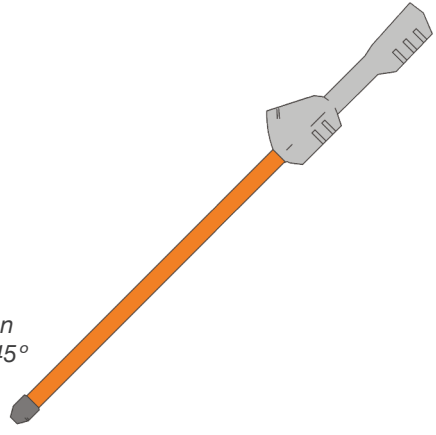
4. Hold the M-Scan in one hand at 45° to the ground and move slowly across the area to be searched marking places where the audio pitch increases.

5. Follow a grid pattern over the area.

6. When the area has been covered and any ferrous material locations identified return to each location to pinpoint the item and determine the size more precisely.

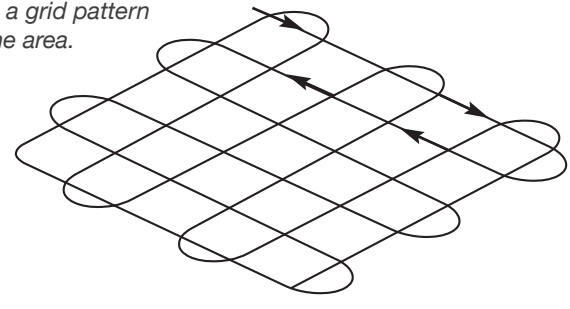
7. If too many objects are found the sensitivity is too high, or there is trash in the ground. Raise the M-Scan off the ground by 20 inches or 0.5 m and search again.

More detail can be found in the following pages. We recommend reading this User Guide and the Application Notes in full in order to achieve the best results from the M-Scan.



Hold the M-Scan in one hand at 45°

Follow a grid pattern over the area.



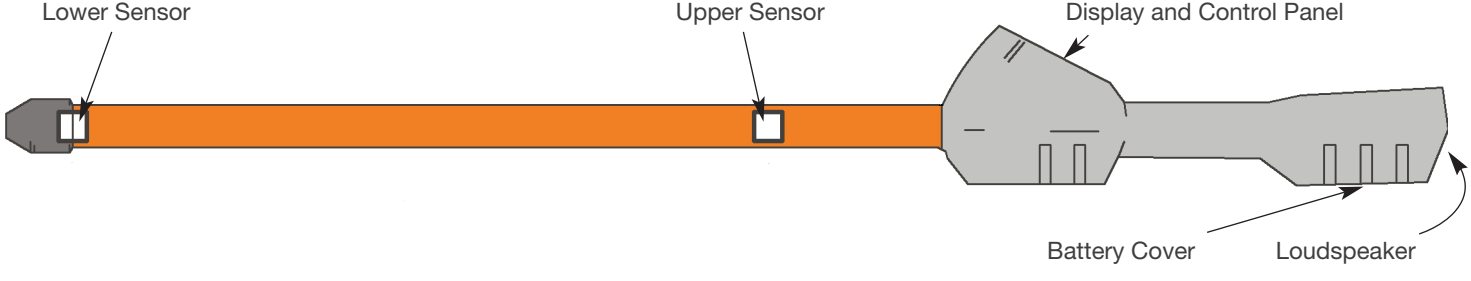
Features

The C.Scope M-Scan magnetic locator is a flux-gate magnetometer. It responds when it detects ferromagnetic material (material that is able to be magnetised, such as iron) by increasing the audio frequency to a higher pitch as the object is approached and passed. It is not affected by other objects without a magnetic property. Gold, silver, copper, aluminium and most other metals have no significant magnetic property so are not detected.

The M-Scan is made to withstand heavy site use.
The plastic housing is manufactured from high-impact ABS and the sensor tube is manufactured from lightweight aluminium. There is a liquid crystal display and loudspeaker to give visual and audible outputs. There are four main user controls, on/off, volume up/down, sensitivity up/down and an ‘erase’ button that can be used to mask nearby disturbances allowing the user to search near a steel fence, for instance.

The sensitivity setting controls the effective depth that the M-Scan will find a ferromagnetic object. The M-Scan uses eight AA batteries in the sealed battery compartment giving approximately 100 hours of typical use (with high quality batteries). The standard kit includes a padded carrying case with shoulder strap.

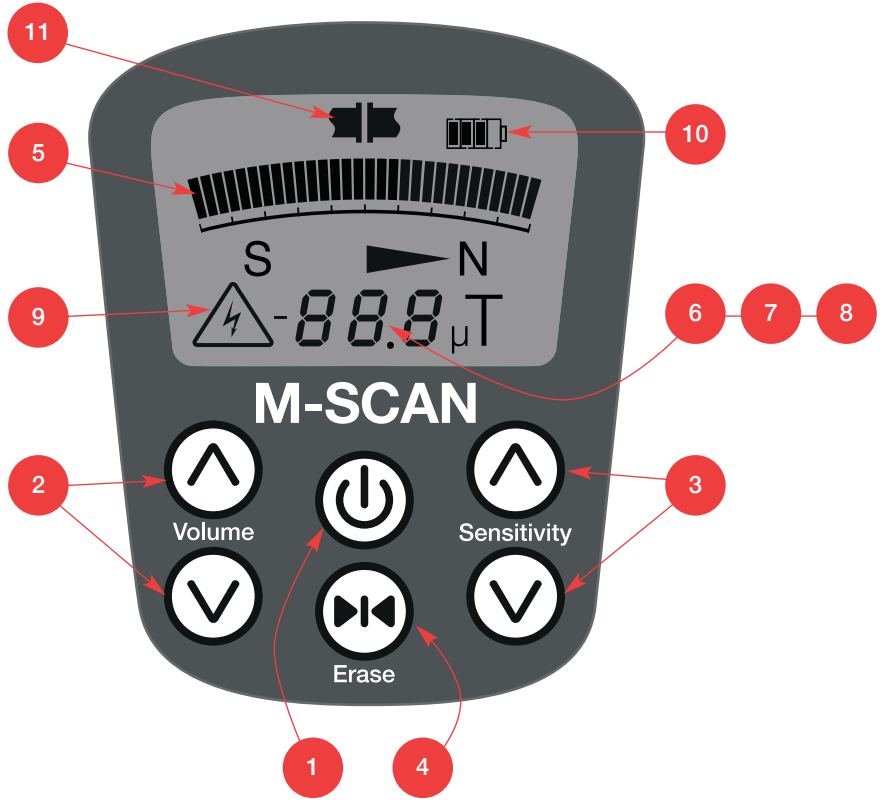
The display shows the field strength in units of micro Tesla (µT). There is an analogue bar graph showing signal strength, a four segment battery indicator, and a flashing power line alert indicator. It also displays the North/South polarity of the detected object.



Controls

1. Power On/Off
2. Volume Up/Down
3. Sensitivity Up/Down
4. Erase Button
5. Bar graph
6. Sensitivity Indicator
7. Volume Indicator
8. Digital Signal Indicator
9. Power Line Warning
10. Battery Indicator
11. Flange Symbol

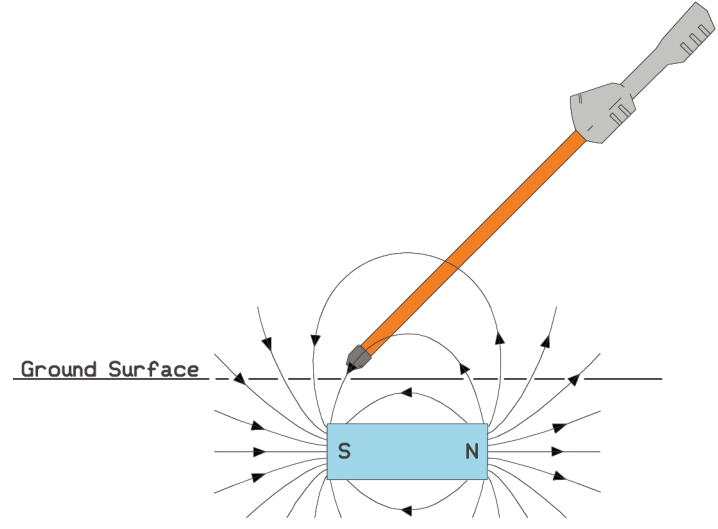
Refer to Application Note 2 (page 13)



How the M-SCAN Works

The M-Scan finds ferromagnetic objects by sensing the magnetic field radiated by the object. The locator contains two sensor coil assemblies that are spaced apart and their outputs electronically finely balanced. This is done so that the M-Scan can correct for the ever-present magnetic field on the earth. The two sensors measure the same field due to the earth because both the coils are relatively close so they experience the same magnetic lines of force. The earth's magnetic lines of force can be regarded as generally parallel but when a ferromagnetic object is nearby the field strength and direction of the magnetic lines upon each sensor is slightly different. This is enough to disturb the critical balance allowing the M-Scan to produce a different signal.

When no ferromagnetic objects are present, the speaker emits a steady low frequency tone but as the M-Scan gets closer to a ferromagnetic object the audio pitch increases until the strongest signal from the object is directly under the end of the sensor tube. The pitch is maximum over the strongest signal and then decreases as the M-Scan is moved away. (For a more detailed description of the way the field of an object affects the M-Scan please refer to the Application Notes in this manual.

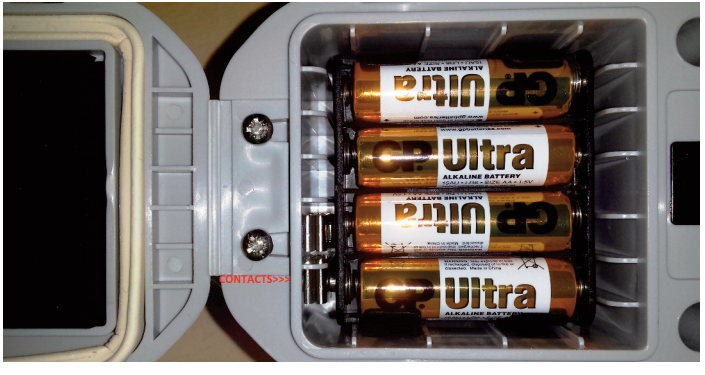


Batteries

The battery compartment is located on the underside of the M-Scan. Use a coin to rotate the latch anti clockwise 90° to undo.

Remove the battery holder and fit eight AA alkaline batteries in the holder before repositioning in the compartment. Take care to ensure that each battery is in the orientation shown on the holder (batteries should alternate) and that the holder is gently pushed to the base of the compartment so the battery holder contacts touch the mating contacts in the compartment. Do not force the battery pack into the compartment – check it is not the wrong way around.

Close the compartment and turn the latch 90° clockwise to lock.



When it is time to replace the batteries, change all eight together to prevent unnecessarily discharging good batteries alongside poorly charged ones.

Do not keep batteries in the M-Scan when it is in storage or if the batteries are in a discharged state.

Basic Operation and Description

Preparation

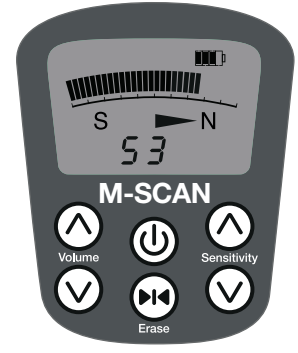
Remove any metallic object such as a wrist watch, bracelets or large buckles and keep the sensor tube away from footwear to prevent false signals as these items may contain magnetic material. Mobile phones, some headphones and other electronic products may also contain magnets that can interfere with the magnetic field nearby causing spurious results.

Press the ON/OFF ⏻ button once to turn the M-Scan on. (It can be turned off by pressing it once again).

Check that the battery symbol (on the top right of the display) shows at least two bars before commencing the search. The M-Scan will work with one segment showing but it is not recommended.

Sensitivity

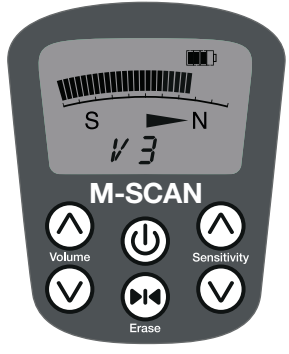
There are four possible settings. The lowest is S1, rising to S4. Sensitivity always comes on at the third highest setting, S3, and can be varied using the **Sensitivity Λ** and **Sensitivity V** buttons. When **Λ** or **V** is pressed the display will momentarily show the new setting (eg S2).



Basic Operation and Description

Volume

The volume can be adjusted using the **Volume Λ** and **Volume V** buttons.
There are eight possible volume settings,
V1 is the quietest and V8 is the loudest.
The display will momentarily indicate the new setting (eg V5) in the bottom centre.



Audio Indication

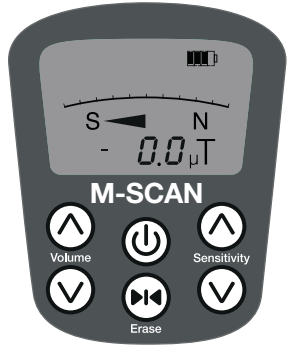
When no ferrous metal is present, the sound heard will be a low frequency tone. When the M-Scan is brought near to ferromagnetic material, such as an iron cover, the frequency of the audio tone will increase.

There is a standard headphone 3.5mm jack socket under the cover on the base of the M-Scan. The audio from the load speaker is not cut out when headphones are connected.
Care should be exercised when choosing headphones as some may interfere with the operation of the M-Scan.
Only use headphones recommended by C.SCOPE.

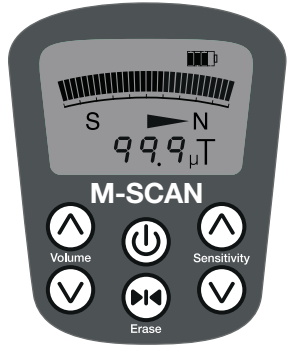
Basic Operation and Description

Visual Indication

When no ferromagnetic material is close, the M-Scan display will show a very low field strength reading in µH and the analogue bar graph will be at 0 or very low.



When nearing ferromagnetic material the field strength will increase up to a maximum reading of 99.9uH.
The analogue bar graph will also indicate full scale.



North / South Polarity

An arrow ► pointing towards the N indicates north polarity field has been detected from the object (lower image left).
An arrow ◄ pointing towards the S indicates south polarity field has been detected (top image left).
Many larger objects will show both polarities at opposite ends of the object as it is traversed.
(See Applications Notes in this manual.)

Depth

The depth of buried objects can be estimated by comparing signal strengths. A low signal strength indicates a very small amount of ferromagnetic material or a deep buried object. If the signal is very broad this also indicates a deeply buried object. If the sensitivity is reduced or the M-Scan is lifted up 0.5m (1.5 ft) and the object traversed again and the signal disappears then it is likely the object is relatively shallow or small.

Pinpointing

For larger targets it is best to lower the sensitivity to aid pinpointing.

Basic Operation and Description

Power Line Indicator

The electromagnetic fields radiated and detected by the M-Scan from 50 or 60 Hz power lines are indicated by the triangular warning sign in the bottom left of the display. The end of sensor tube needs to be close to conductors exhibiting mains voltage in order to be detected so caution is always necessary.

Notes:

1. Shielded cables (e.g. those in a steel conduit or armour) will not be indicated.
2. There indication of power lines is visual on the display.

Erase

When nearby large metal objects, such as fencing or a shipping container, swamp the M-Scan with signal it is possible to mask out the background field by pressing the Erase button ▶◀ to make it function in this high field situation. The display will momentarily show the letters ‘ tun ’ to confirm that the erase has been activated and the M-Scan has re-zeroed. It may also be necessary to decrease the sensitivity to totally remove strong interference.

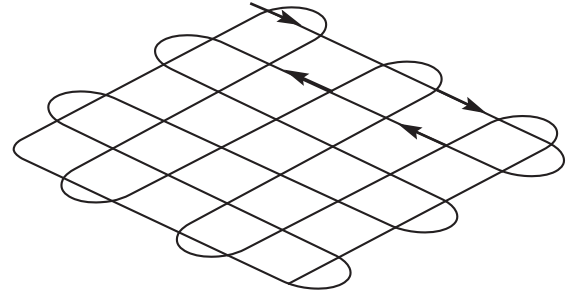
To turn the erase function off and return to the manufacturer pre-set zero, press the power on/off button twice. If difficulty is experienced re-zeroing the M-Scan reduce the sensitivity and retry.

Submersion in Water

The sensor tube section of the locator can be submerged into water but not further than where the tube enters the body of the M-Scan. The plastic housing should be kept out of water at all times.

Searching

Hold the M-Scan at 45° to the ground. Scan from side to side keeping the end of the sensor tube at the same distance from the ground. Move over the ground in a searching pattern while sweeping from side to side marking any objects found and then continuing the search. It is best to do this grid search again at 90° to the first search. Once the selected area has been searched the objects found can be pinpointed by holding the M-Scan vertically and traversing the object in one direction and then across it at 90° to find the centre.



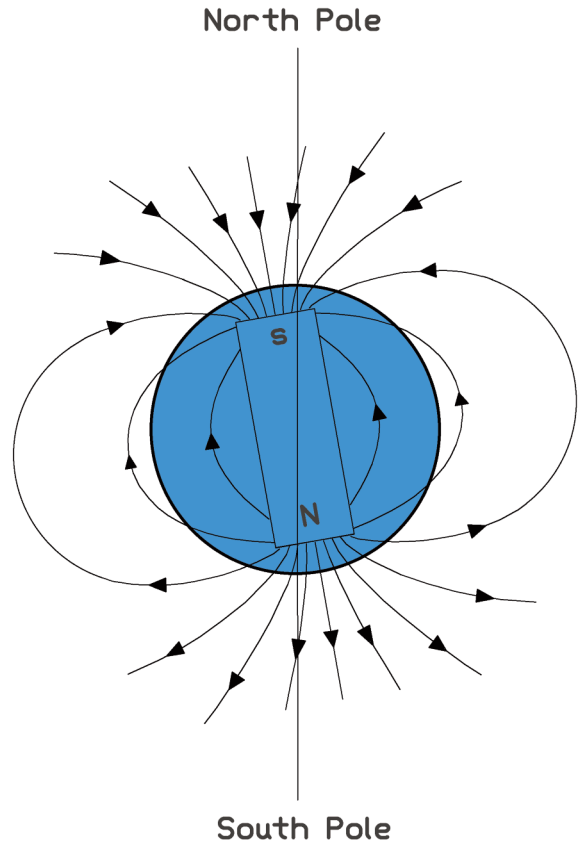
Different targets will give different signal profiles and with experience it is possible to identify the size and shape of the objects found. More details are in the Application Notes.

Application Note 1. Understanding the M-Scan Magnetometer

The C-Scope M-Scan magnetometer is designed to detect the presence of iron and steel objects by sensing the magnetic field which surrounds them. The Earth's magnetic field is ever present, and the instrument cancels this background field out, so that small variations in field can be detected.

The strength and direction of the Earth's field varies geographically as a result of local geology, and latitude. At the equator the field is horizontal, but at the North and South magnetic poles, it is vertical – a compass needle will try to point straight down. In between these two extremes the Earth's field (and a compass needle) dips down in the Northern hemisphere or goes up in the Southern hemisphere.

Figure 1 The Earth's magnetic field lines dip toward the North and South poles.



Application Note 1. Understanding the M-Scan Magnetometer

The mineralogy of the surrounding rock may also cause local variations – even the complete reversal of the field in some rare cases.

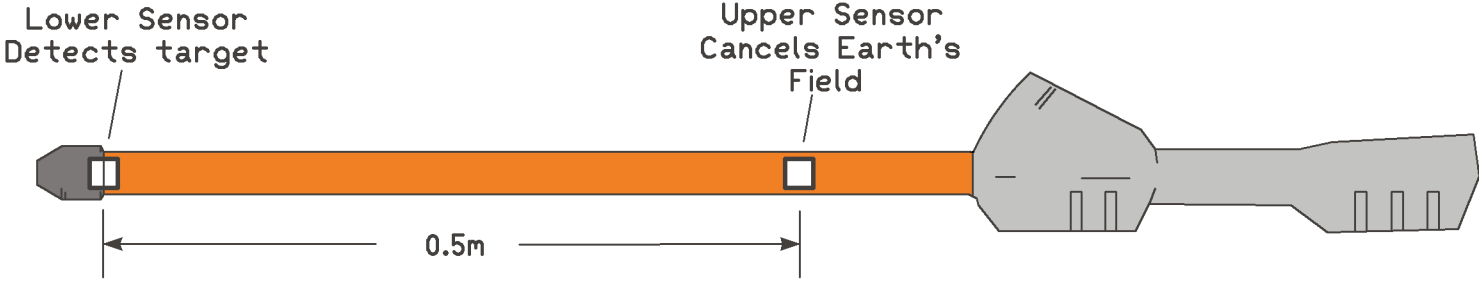
A representation of the Earth's magnetic field is shown in *Figure 1*. Note that Magnetic North is a few degrees away from True North and that the Magnetic North Pole is actually a 'south pole'. The arrows on the magnetic field lines show the direction which a compass needle placed on that line would point. Opposites attract, and the north-seeking pole of the compass needle is attracted to a south-seeking pole in the planet's core.

The strength and direction of the Earth's field also varies with time. The Earth's molten iron core is in constant motion, and the position of the North and South poles on the planet is gradually changing. Map makers mark the deviation (and the rate of change of this) on their maps.

The field also varies as a result of the interaction of the planetary magnetic field with the solar wind and, at times, this can make the field noisy and unpredictable. The M-Scan compensates for all these changes to make finding objects in the ground easier.

The M-Scan has two sensors in the long metal tube, spaced approximately 20 inches/ 50cms apart. The upper sensor, that is the one closest to the control housing, mainly picks up the "background" field - usually the Earth's magnetic field - and the electronics uses this to cancel out the background field. The lower sensor is closest to the ground, and is more strongly affected by the field from target object in the ground. This differential arrangement is sometimes referred to as a "gradiometer". It makes the M-Scan insensitive to the Earth's field, whatever its orientation and strength.

Figure 2 The C-Scope M-Scan with two sensors spaced apart.

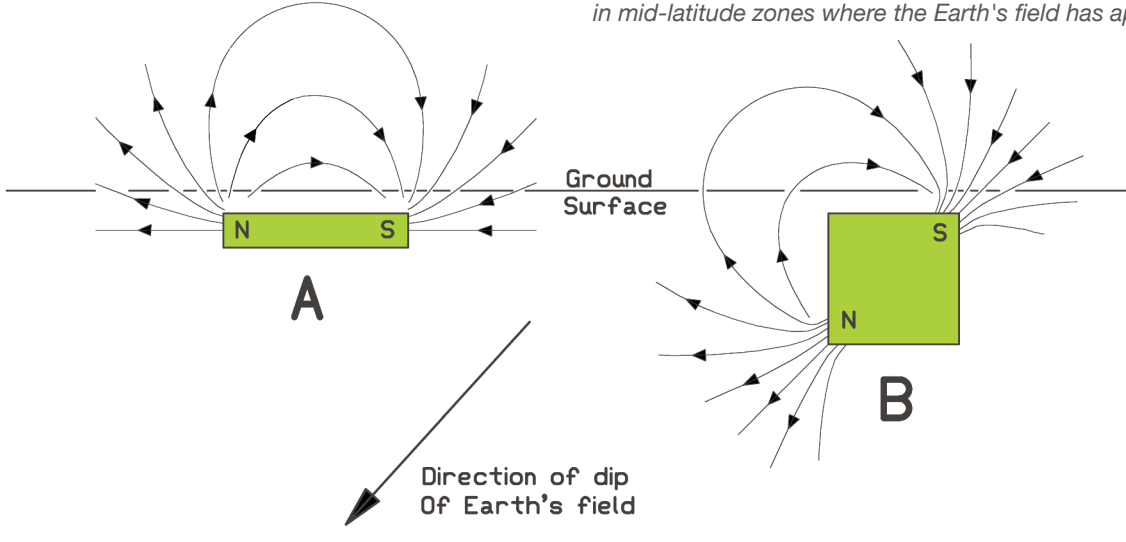


Application Note 2. How Objects Appear to a Magnetometer

Iron objects tend to concentrate the magnetic field lines around them distorting the Earth's field. The magnetic field produced by an iron object will tend to follow the same orientation as the Earth's field, and, if the object is moved, it will usually realign with the new direction of the Earth's field, because iron does not form a strong permanent magnet.

If the iron object is flat in shape and horizontal (A), it will appear to be rather like a horizontal bar magnet, and will form a North Pole on its North side and a South Pole of similar strength on the opposite side. However if the object has appreciable size in a vertical direction (B), the bar-magnet will appear to be tilted to match the earth's field. In this case the North Pole will be deeper than the South Pole and, at the ground's surface it will not be so strong. In this way we may find peaks of different strength on either side of an iron object.

Figure 3 Diagram shows how the vertical thickness of a buried object may cause an asymmetric response at the surface in mid-latitude zones where the Earth's field has appreciable dip.



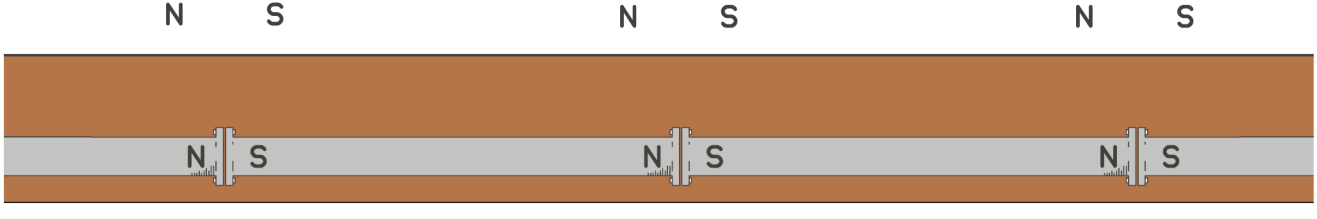
Application Note 2. How Objects Appear to a Magnetometer

Iron and steel act differently. Steel objects may take on a permanent magnetism, which may not line up with the Earth's field, and may be much stronger in intensity. Magnetic survey pins, for example, can be found at a distance of several yards/ metres. A buried steel rod, orientated vertically may appear to have only one magnetic pole, either North or South, as the opposite pole maybe sufficiently deep as not to show up at all.

Where iron or steel pipe work runs across a site, this may produce a series of north and south poles along the length of the pipe. Where iron pipe has flanged joints each section of pipe may behave as a separate magnet. The joints may show up on the surface as an abrupt change from North to South. For this reason the M-Scan has a 'flange' symbol which appears on the display whenever there is a change from North to South or vice versa. With careful use of the M-Scan, and knowledge of the pipe-section lengths, it may be possible to locate the flanged joints. In some industries it can be useful to target excavations on the pipe joints where leaks may develop.

Steel pipes can also display magnetic reversals along a single length which do not always appear at joints or junctions. This is due to the pipes having taken on permanent magnetism during manufacture or use.

Figure 4 An iron pipe run may appear as a series of long bar-magnets with abrupt changes from North to South at the joints or flanges of the pipes.



Application Note 3. Depth

It is sometimes possible to judge the depth of an object by the “shape” of the response. Small, shallowly buried objects may produce the same strength of signal as a larger, more deeply buried object, but the deep object will produce a broad peak, while small shallow objects produce sharper, narrower peaks as the end of the sensor tube is moved over them. Some differentiation between “surface trash” and deeper targets may be possible.

Cluttered environments with many services running close together and crossing one another may produce a confused pattern of responses, and additional methods of identification may be required in these circumstances (for other locating products see www.cscopelocators.com).

In areas of past industrial or domestic use the soil can become contaminated with pieces of iron and steel which makes detection difficult. It is recommended that the search is repeated at a lower sensitivity or with the M-Scan raised 0.5m (1.5 ft) so small objects close to the surface are not detected.

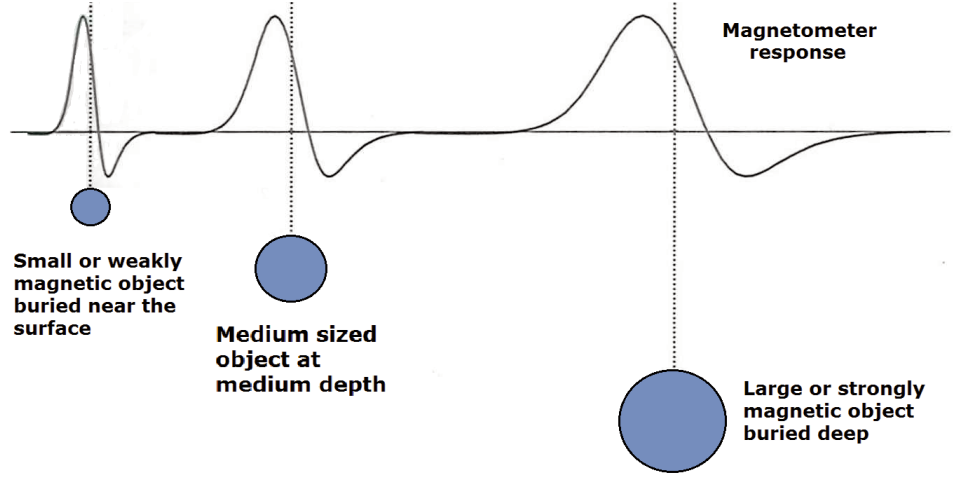


Figure 5 Magnetometer response for objects buried at different depths. The amplitude of the response may be the same, but the width of the response may be broader, indicating that the object is further away from the sensor.

Application Note 4. Using near Large Ferrous Objects

A feature of the M-Scan is the ‘Erase’ button. The instrument is balanced during manufacture to produce a response close to zero in Earth’s field. In some cases it is useful to offset this field towards the North or South to compensate for a large magnetised or magnetisable object such as chain link fencing or a nearby vehicle that may have a large magnetic presence. By doing this compensation it can help when locating targets close to another ferrous object or structure.

If the Erase button is pressed the instrument will re-zero itself and the offset will remain even if the sensitivity level is changed.

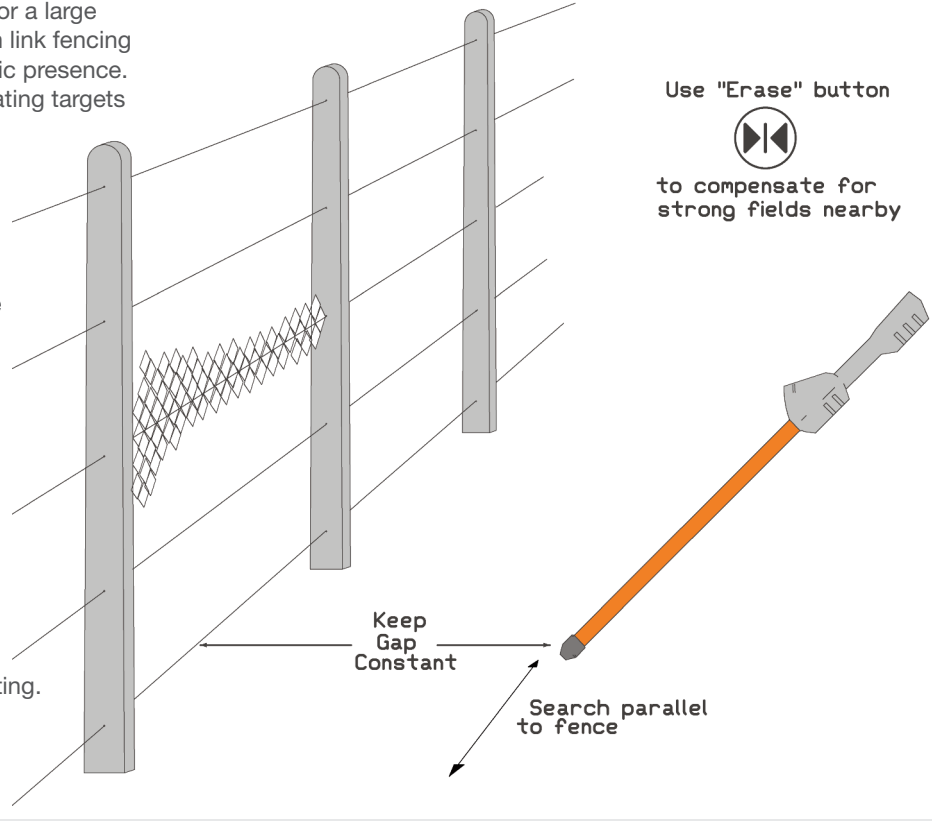
The Erase button can be pressed more than once and each time the unit will re-zero itself.

There may be times when the interfering field is so strong that a zero balance is not possible, and in such cases, another attempt should be made after the sensitivity level has been reduced.

When using this feature keep the M-Scan a constant distance and angle from the large structure.

To turn off the Erase function press the on/off button twice to return the M-Scan to its initial setting.

Figure 6 A feature of the M-Scan is the ‘Erase’ button, which cancels interfering fields from nearby objects such as chain-link fencing.



Application Note 5. Finding the Centre of a Target

The sensors in the M-Scan are orientated along the axis of the tube. When the tube is placed at right-angles to a magnetic field (*Figure 7* **A**) no field will be detected. When the magnetic lines of flux are parallel to the tube (*Figure 7* **B**) the strongest response will be obtained. When the M-Scan is held at an angle to the ground the point of maximum reading may not be directly over the object.

This also has relevance in mid-latitude regions of the world, where the Earth's field dips down at an angle, and buried objects may produce a field which is at an angle relative to the sensor tube, even if the tube is held vertically.

The signal peak will be detetced off centre where the lines of flux are parallel to the sensor tube (*Figure 7* **B**). It is important to traverse objects from right to left and left to right so that a picture of what is below the ground surface can be visualised and the centre of the target determined.

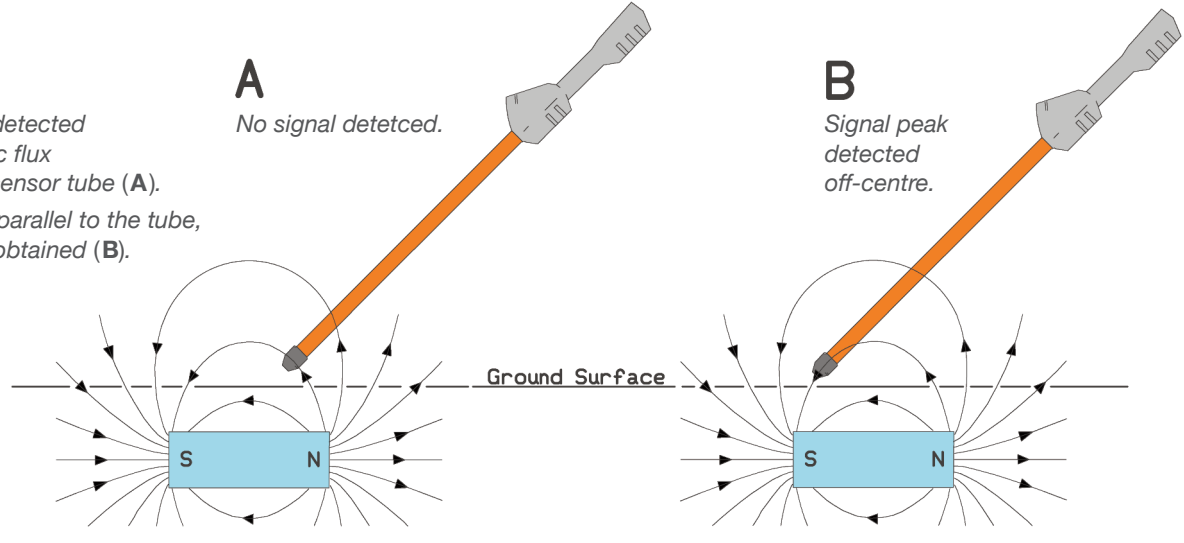


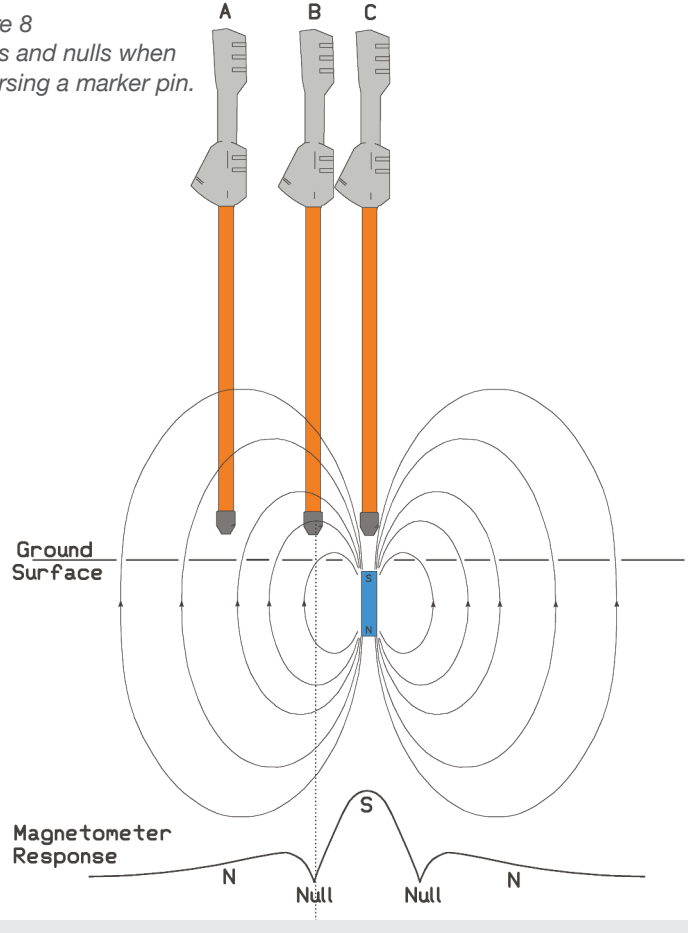
Figure 7
No magnetic field will be detected when the lines of magnetic flux are at right-angles to the sensor tube (**A**).
When the lines of flux are parallel to the tube, maximum reading will be obtained (**B**).

Application Note 5. Finding the Centre of a Target

A single magnetic marker pin that is close to the surface can appear to have multiple peaks as the M-Scan is traversed across it.

In Figure 8 there are two smaller, but detectable, side lobes (A) either side of a central main peak (C) when using the M-Scan vertically to find a magnetised marker pin. Note there is a null either side of the centre (B) where the lines of magnetic flux are at right angles to the sensor tube.

Figure 8
Peaks and nulls when traversing a marker pin.



C.SCOPE INTERNATIONAL LTD
Kingsnorth Technology Park
Wotton Road
Ashford
Kent
TN23 6LN
Tel: +44 (0) 1233 629181
Fax: +44 (0) 1233 645897

info@cscope.co.uk
www.cscopelocators.com

Part No B1091E Issue 1

C.SCOPE