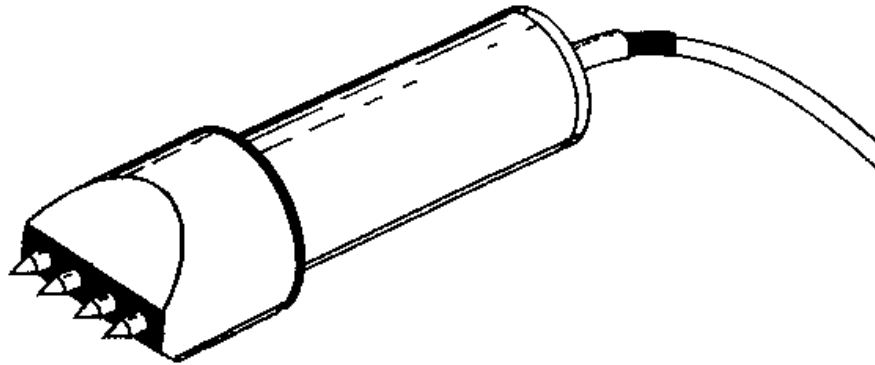


# MATELECT 4 PIN HAND HELD ACPD DEPTH PROBE

For MAT-2 Probes



## INSTRUCTION MANUAL

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# MATELECT 4 PIN HAND HELD ACPD DEPTH PROBE

*TYPE MAT-2*

*Thank you for your interest in our product, we hope that it will serve your needs and prove a reliable tool.*

This product has been designed to the highest standard in both electronic and mechanical design, with careful attention to stability, reliability and electrical safety.

The Matprobe-2 is designed exclusively for use with the CGM series of crack growth monitors which have established themselves as the world's best selling laboratory ACPD equipment by far. Matelect produce a range of other peripherals to support the CGM and have also built up many years of experience in the ACPD technique. Please contact us should you ever require further information or assistance.

This manual applies to the MAT-2 hand held probe. Other manuals can be obtained from Matelect at the address given below.

## **IMPORTANT**

*Please read these instructions carefully before you use the instrument. Please pay particular attention to the section that follows on method of use. For your reference please also read our terms and conditions of sale printed at the rear of this manual.*

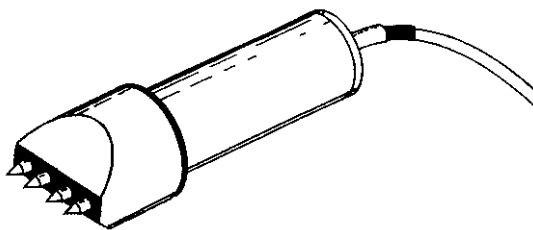
Please note that there are no user serviceable parts within the MAT-2. Never attempt to open the probe case as this will void any warranty. Please contact Matelect should you ever experience any difficulties.

## **MATELECT LIMITED**

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### 3. QUICK GUIDE TO MATPROBE-2 USE

The following procedure has been designed to allow rapid measurement of crack depth using the CGM5 and Matprobe-2 combination. The accuracy of this method is restricted to  $\pm 0.5\text{mm}$  which is sufficient for most field work needs. No prior calibration is required.

Those requiring higher accuracies must follow the procedures outlined in the main section of this handbook. These procedures require a degree of calibration.

#### **For Ferrous Materials (e.g. Plain Carbon Steel)**

1. Power up CGM5 and connect Matprobe. Abrade and clean specimen.
2. Apply Matprobe to surface and set current to 0.5 Amps, Gain to 70 dBs and frequency to 10 kHz (Phase in Auto, Offset Out, Filter Out)
3. Apply Matprobe and press down on non cracked region - record reading as 'B'
4. Apply Matprobe across crack - record reading as 'A'
5. Perform calculation  $(A-B)/B$  which gives the crack depth in cm

#### **For Non Ferrous Materials (e.g. Aluminium)**

1. Follow above procedure except set frequency to 30 kHz

#### **Notes**

The readings obtained are independent of set current and set gain so users can vary these if the signal is too low to give good accuracy or too high and being clipped.

Make sure specimen surface is bright and corrosion free - good electrical contact is a prerequisite of correct ACPD measurement.

Obtain multiple readings to increase the reliability of your measurements.

Please read the main text of this handbook and the instruction manual of the CGM5 to obtain further details on particular points of usage. Contact Matelect for advice and clarification on any aspects of ACPD measurement.

## 4. OVERVIEW

Matprobes are accessories that enable the Crack Growth Monitor (CGM) user to obtain crack depth data in the field without the need to provide permanent contact to a specimen. Spring loaded pins are utilised to form some or all of the contacts necessary for operation. The probes are designed to be used as handheld devices although it is possible to incorporate them into other apparatus to maintain fixed geometries (e.g. for use on a production line).

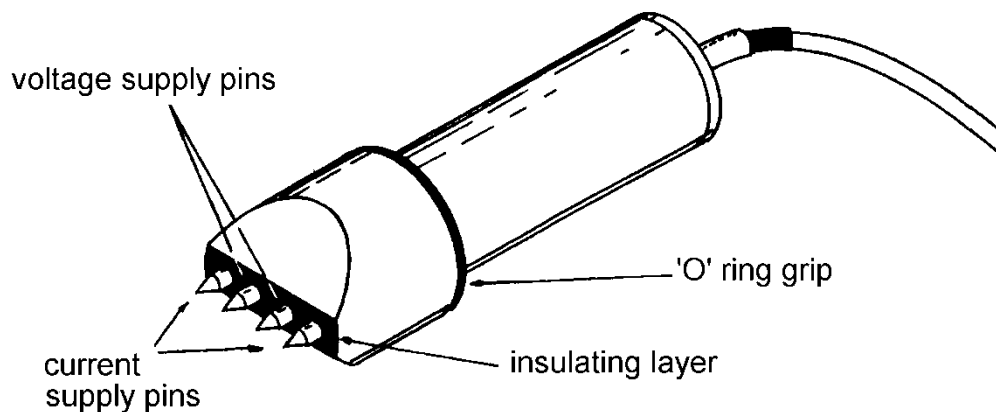
It is important to note that the CGM series of crack growth monitors have been primarily designed for accurate ACPD monitoring in controlled laboratory conditions. Crack growth resolutions of the order of tens of microns can be achieved by careful experimentation in such environments. Unfortunately use of the Matprobes to measure depth can never achieve such results and tens of millimetres is the usually accepted standard.

This instruction book applies to the Matprobe 2 (order code MAT-2)

## 5. GENERAL DESCRIPTION

The Matprobe-2 is an advanced crack depth measurement probe comprising a brass and stainless steel body that contains all the necessary contacts to pass both the current and monitor the resultant ACPD. Four spring loaded pins form the contacts. Figure 1 shows the basic configuration of the Matprobe-2. The outer pins form the current contacts, whilst the inner pins are used for the PD measurement. Both current and signal leads emerge from the top of the probe, forming a single cable that finally separates into two leads at the CGM. All leads are terminated in standard Matelect connectors as used on the CGM3 and CGM5 crack growth monitors.

### Four pin probe



*Figure 1 - Basic configuration of the Matprobe-2*

The Matprobe-2 is equipped with a number of unique features. A substantial degree of shielding is used in order to reduce the pick-up phenomenon (page 7), fixed geometry leads act to maintain signal integrity and a novel patented current focusing technique (page 8) increases the signal to crack depth ratio and positional sensitivity.

## 6. PRINCIPLE OF OPERATION

Figure 2 illustrates the principle of operation of the Matprobe-2. The current contacts pass the AC current from the CGM through the specimen and the voltage drop (ACPD) across the surface of the specimen is measured using the central pins. The value of the ACPD will obviously be dependent upon a number of factors such as the test material's resistivity, magnetic permeability, the current, gain, offset and the frequency setting of the CGM, and the presence of a defect such as a crack.

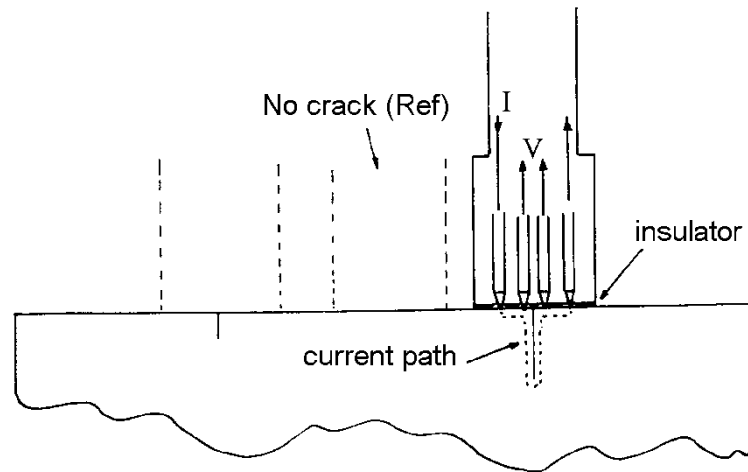


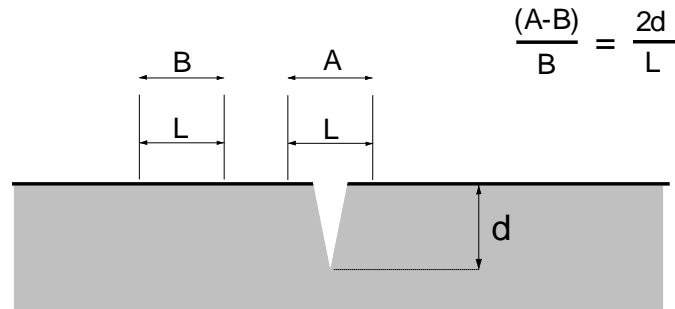
Figure 2 - Principle of Operation

In order to obtain a meaningful value of crack depth it is necessary to obtain both a value of the ACPD on a non cracked area and the value over a crack. If we assume that the AC current is largely confined to the surface of the specimen, then the ACPD measured will be proportional to the path length between the probes. Cracks act to increase the path length and a simple subtraction of the two results obtained will yield a value proportional to the crack depth.

This simple approach can be extended to give a theoretical value of the crack depth in true units. Referring to figure 3, if we assume that the spacing between the probes is 'L' mm and the depth of the crack is 'd' mm then by the treatment shown,

$$d = L \frac{(A - B)}{2B} \quad (\text{Equation 1})$$

This method has the added advantage of compensating for different materials and for changes in the material properties due to variation in temperature, since (A-B) is effectively normalised by the division by B.



*Figure 3 - Crack Depth Calculation*

Whilst the last method is the one recommended, it does not, unfortunately, lead to an absolute value of crack depth. This is primarily due to a phenomenon known as pick-up. Pick-up (PU) is a term used to describe a voltage induced in the leads carrying the ACPD signal by the action of the AC current flowing through the current carrying leads and the specimen itself. The actual ACPD voltage measured is therefore not a pure specimen signal but a resultant of the true ACPD and the PU.

Complete removal of PU is not easily achieved, although the Matprobes have been designed to minimise PU. Additionally PU varies with the frequency of the AC current used and with the geometry of the measuring system. Assuming measurements are made at the same frequency, then it is important to maintain the test geometry. In the case of the Matprobe-2 this restriction has been removed since the position of the current leads, with respect to the voltage leads, is always kept constant. Complete freedom of movement is thus possible. The Matprobe-2 is therefore considerably easier to use than traditional two pin probes.

The treatment of the PU problem is complicated and will not be discussed in detail here. Importantly, even if the PU is constant, the crack depth calculation will yield a value that depends on the strength of the PU. Consequently the calculated depth varies with the frequency of the AC current. In the case of the Matprobe-2, this variation has been found to be reasonably linear when plotted on a log scale.

Fortunately the user can still make adequate crack depth measurements as both theory and experiment indicate that the calculation yields a value that is approximately linear with actual depth for any particular frequency of AC current. A crack will therefore register half the value of another crack that is twice as long.

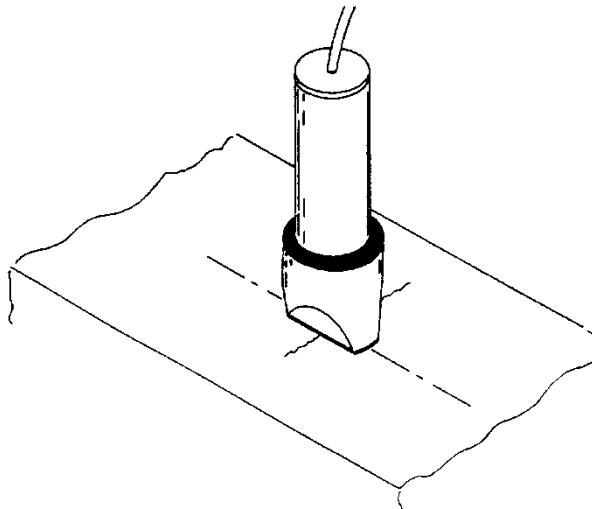
In consideration of the above it is clear that for absolute crack depth determination a method of calibration is needed. This can most easily be achieved by making a series of saw cuts within specimens of similar type and geometry, to predetermined depths. The actual depths can then be related to the calculated depths via use of the Matprobes.

## 7. CURRENT FOCUSING

Current focusing is a term that is used to simply describe a patented technique whereby the user can alter the magnitude of the ACPD in a particular area by a change in the lead configuration. It must not be confused with the PU phenomenon as it is highly advantageous and allows the user to specify the path that the AC current takes through a specimen. Current focusing technology has been incorporated into the Matprobe-2 and it acts to improve the signal to crack depth ratio and increase the positional sensitivity. Consequently crack profiles can be more accurately measured and it becomes unnecessary to apply correction factors for deep cracks. This results in a linear calibration of actual depth against measured crack depth over a substantial range of crack sizes.

## 8. METHOD OF USE

1. Connect the Matprobe-2 to the current and voltage sockets of the crack growth monitor. Switch the instrument on and set the current to about 0.5 Amps. Select a suitable frequency (depending on the specimen material). Steels usually yield adequate signals between 0.3 and 10 kHz. Non magnetic materials require higher frequencies. Remember low signals can be boosted by increasing the GAIN setting on the CGM. It is useful to note that this is better than increasing the frequency since PU rises with frequency.
2. Make sure any oxide or surface deposits have been cleaned from the areas where electrical contact is to be made. Use abrasive paper as necessary to clean the surface.
3. Place the Matprobe-2 on the specimen on a non cracked area and push down until the probe body is in contact with the specimen surface. Indication of a reliable contact is given when the LED indicator adjacent to the current adjust potentiometer on the monitor stops flashing. Additionally the user should wait until the monitor registers signal lock-in and until a steady reading on the front panel DVM is obtained. Note down the reading. Follow the same procedure for the cracked region, making sure that the voltage contact correctly straddles the crack. Perform the calculation of equation 1 (page 6) where L is 10mm. A suitable configuration for the probe and leads is shown in figure 4.



*Figure 4 - Suggested measurement configuration*

4. Use the method above to obtain a set of results for a series of standard saw cut cracks. The values obtained can be plotted as a graph and will act as the calibration for measurements on real cracks.

**Alternatively, calculation can be avoided by using the following time saving procedure.**

Once all contacts have been made and the DVM reading is steady, adjust the SET CURRENT potentiometer so that the DVM reads 1.000V. Operate the fixed 1V offset toggle switch. The display should read zero. Check that this reading is correct by removing and reapplying the probe. Adjust as necessary. Ignore variations in the least significant digit of the DVM. If the probe is now placed over the crack, the DVM will directly show the result of the above operation in mm.

## **9. PRECAUTIONS IN USE**

The reliability of the results obtained will depend on the mode of use of the Matprobe. The elimination of error due to the PU effect greatly simplifies the use of the Matprobe-2 and increases the reliability of the results. Edge effects can sometimes be a problem and the user should note that readings of crack depth taken very near the edge of a specimen can sometimes be subject to error.

The following additional precautions should be observed.

Keep the probe pins and the surface of the specimen clean and free from deposits during use. This ensures that the contact resistance between pin and specimen is kept to a minimum. Contact resistance can sometimes affect the signal value if it approaches too closely the input impedance of the CGM. Check that the insulating layer through which the pins emerge is not damaged and that the bare metal parts of the probe do not touch the specimen.

If the pins have worn tips or damage has occurred to any part of the probe or leads please do not attempt to open the probe or perform repairs. The probe has not been designed to dismantle easily. All Matprobes are warranted for 1 year and a comprehensive repair/renewal service is provided at minimum cost after expiry of the warranty. Please contact Matelect for details.

Further advice on the use and application of the Matprobe-2 can be obtained from Matelect.

## Terms and Conditions of Sale

### 1. ORDERS

All orders are subject to acceptance or rejection by Matelect Ltd. ( hereafter referred to as "the company"). No order or contract shall be deemed accepted unless and until such acceptance is made in writing by the company.

Every order or contract accepted by the company shall be subject to these terms and conditions of sale, which shall not be qualified or amended by any terms and conditions of the customer. All work is undertaken and all goods are supplied to the customer by the company on the express condition that in the event of any conflict between these terms and conditions of sale and those contained in any order or other document from the customer, these terms and conditions shall prevail.

Cancellation of orders must be made in writing to the company within ten (10) days from the date of the acknowledgement or order. The customer may be required to pay a minimum of twenty five per cent of the original order on any cancellations after the stated time.

### 2. PRICES

Prices, quotations, specifications and other terms and all statements appearing in the company's catalogues and advertisements and otherwise made by the company are subject to change in design at any time, without obligation to provide the same on units previously purchased, or to continue to supply obsolete items. The weights and dimensions shown on the sales literature are not guaranteed. Unless otherwise specifically provided in writing, the prices quoted are based upon manufacture of the quantity and types originally specified and are subject to revision when interruptions or engineering changes are caused or requested by the customer. The company shall not be responsible for typographical errors made in preparation of it's publications or for stenographic or clerical errors made in preparation of quotations. All such errors are subject to correction.

### 3. DELIVERY

The delivery date is the company's best estimate of the time the material will be shipped from it's factory and the company assumes no liability for loss, damage or consequential damage due to delays. All goods are at customer's risk from the time of the despatch thereof from the company's premises but the property therein remains with the company until payment is made in full by the customer in accordance with the Condition 4 hereof.

The company shall not be bound in any circumstances whatsoever, by any penalty clause sought to be imposed by the purchases for late delivery.

### 4. TERMS OF PAYMENT

The terms of payment are thirty (30) days net. Payments thereafter will be subject to surcharge as stated be the company at time of invoicing. Each shipment will be considered a separate and independent transaction and payment therefore shall be made accordingly.

### 5. SHIPMENTS

All prices and quotations are for sales ex works exclusive of carriage (unless otherwise stated in writing) but are inclusive of boxing and packaging within the UK.. The company shall in no circumstances be held responsible for the sufficiency of such boxing and packaging and where special boxing is specified the company may at it's own option charge therefore. The company reserve the right to choose and arrange an appropriate method of transportation.

### 6. WARRANTY

Items sold by the company are warranted only as stated below.

Subject to the exceptions and upon the conditions specified below, the company agrees to correct, whether by repair or, at it's election, by replacement, any defect of materials or workmanship which develops within twelve months after delivery of the instrument to it's original purchaser by the company or by any authorised representative provided that investigation and factory inspection by the company discloses that such defect developed under normal and proper use (unless covered by a separate agreement or guarantee written by the company).

The exceptions and conditions mentioned above are the following.

- a). The company makes no warranty concerning components and accessories not manufactured by it. however, in the event of the failure of such components or accessory, the company will give reasonable assistance to the purchaser in obtaining from the respective manufacturer whatever adjustment is reasonable in the light of the manufacturer's own warranty.
- b). The company shall be released from all obligations under it's warranty in the event of repairs or modifications being made by persons other than it's own or authorised service personnel unless such repairs by others are made with the written consent of the company or unless such repairs are minor or merely the installation of a new Matelect component.
- c). The warranty is only valid providing that the terms of payment in clause 4 are strictly adhered to.
- d). No product may be returned except with the company's permission in writing. After receiving factory authorisation, goods requiring repair or replacement should be sent prepaid to the factory in the original container properly packed accompanied by a Return Goods Authorisation, purchase order or letter stating as completely as possible the defects and the condition under which it occurred.

### 7. TAXES

V.A.T. or other Government taxes, if any, must be added to the net catalogue prices and will be shown as a separate item on quotation and invoices and shall be borne by the customer.

### 8. CONDITIONS PARAMOUNT

The company expressly disclaims any liability of whatsoever nature and in any circumstances whatsoever, to it's customers, dealers or agents, except as stated in the forgoing terms and conditions.

9. These terms and conditions of sale may be amended or altered at any time the company feel it necessary to do so.

