EThер NDE Application Note: AP001

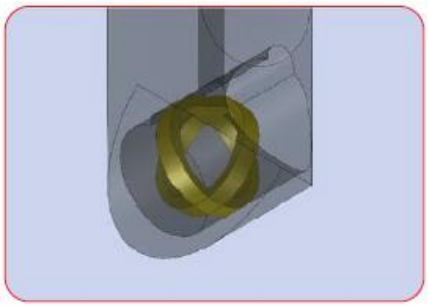
EDDY CURRENT WELD INSPECTION

An Introduction to Weld Probes

Eddy Current Weld Probes are specifically designed for the task of weld inspection of non-ferrous welds and steel structures.

PROBE ANATOMY

Probes are built with two orthogonal interleaved coils. The coils positioning is critical to producing signals as required in the inspection procedure.



Our probes can detect surface cracks on a weld with a non-conductive surface coating on it of up to 2mm. The specific design of the probe allows the inspection of welds with uneven surfaces and coatings on them.

WHY USE EDDY CURRENT WELD PROBES FOR WELD INSPECTION?

When welds are coated the inspection becomes more complicated when using other methods to Eddy Current (EC); for example: MPI and Dye Penetrant Inspection require the removal of the coating before inspection, costing both money and time. Eddy current (ECT) Weld Probes allow welds to be efficiently inspected for near-surface cracks because the weld can be inspected through paint or metallic coatings.

SO WHY USE A SPECIAL WELD PROBE?

Firstly, by using a differential coil configuration, Eddy Current Weld Probes allow inspection without the need to remove any coating / paint. Also Weld Probes are very sensitive to lift-off and variations in material properties caused by the heat affected zone through a simple absolute probe offering Low lift-off sensitivity variation; 8 dB per mm as compared with the pencil probe at 40 dB per mm. This gives minimal spurious signals caused by lift-off because of differential connection.

Benefits of using an Eddy Current Weld Probe

- An approved method to replace MPI.
- Has approval from many certifying authorities and many training facilities.
- A good option for rope access inspectors - no need for high cost scaffolding also.
- Can detect cracks through surface coatings.
- Application specific design to suit the client's needs.
- Cost and time effective.

APPLICATIONS

OFFSHORE
Widely used for Weld Inspection, replacing MPI due to not needing to remove surface coatings. Ideal for Rope Access inspection needs.

RAIL
Used in the manual inspection of defects in rails and wheels. Axle Inspection evidence shows greater reliability that UT. Weld inspection on chassis and bogeys.

NUCLEAR
Widely used in the Nuclear NDT industry.

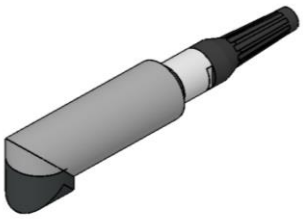
CONVENTIONAL MANUAL INSPECTION AND WITH AUTOMATED SCANNERS
- Bridges
- Steel Framed Buildings
- Prison Bars detecting saw cuts.
- Overhead Traffic Lights
- Amusement Rides

PROBE SELECTION

The following range of *ETher NDE* Weld Probes is available in a number of different sizes and frequencies, all with minimal lift-off signal. They can detect surface breaking fatigue cracks through 2mm of surface coating material and are therefore less expensive and quicker to use than other techniques.

1. **Standard Weld probes – Bridge**

Straight



90° Inline

90° Transverse

Application: Differential Weld probes - for in-service inspection of welded structures.

Specification:
- Straight, 90deg Inline, 90deg Right Angle
- Diameters, 11.0 (Small), 16 (Medium), 32mm (Large)
- Disconnectable and integral probe cables
- Cable lengths from 1.5 to 50meters
- Frequency range 100kH, 20kHz, 100-600kHz
- Minimal lift off signal, can find cracks though paint, oil and conductive and non-conductive coatings
- Made from hard wearing PET
- Stainless steel and ceramic tips available on request

Notes:
100 kHz probes used on standard ferrous welds
100-600 kHz probe can be used on Aluminium and Stainless Steel welds
20 kHz probe can be used on multi-surface applications and Duplex

Standard Weld Probe Coding System

PWS100S015L12

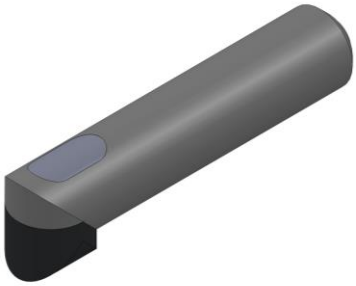
PW	Probe Weld (Plastic)
S	Dia 11.0mm (Small)
M	Dia 16.0mm (Medium)
L	Dian 32.0mm (Large)
100	100kHz (Standard)
020	20kHz Enhanced
106	100-600kHz Multi-surface (Aluminium and Stainless Steel welds)
S	Straight
I	90 deg Inline
R	90 deg Transverse
000	Disconnect (See page 36)
015	1.5m Cable
050	5.0m Cable
100	10.0m Cable
500	50.0m Cable
1000	1000.0m Cable
L7	7 Way Lemo – Hocking Locator
L12	12 Way Lemo – WeldCheck/AeroCheck/Vantage G2, ETi
J6	6 Way Jaeger – Hocking QuickCheck, 1.1
A4	4-way Amphenol – Zetec
C3	3-way Cannon -
L14	14 Way Lemo - Vantage G1
W	Water Proof (see page 37)
C	Ceramic (High Temp) (see page 38)
S	Stainless Steel Tip (see page 38)

Example: PWS100S015L12

Part Number: Probe, Weld, Dia. 11.0mm (Small), 100kHz, Straight, 1.5m Cable, Lemo 12-Way.

Other options available on request.

2. Disconnect Weld Probes – Bridge



A full range of disconnectable weld probes available for quick interchange.

Example probe coding:

ETher NDE Part No.	Description	Centre Frequency	Configuration
Probe, Unshielded, Broad Band			
PWS100S000	Probe, Weld, Small (11.00mm), Straight, Disconnect	100kHz	Bridge – Lemo 4-Way
PWM100S000	Probe, Weld, Medium (16.00mm), Straight, Disconnect	100kHz	Bridge – Lemo 4-Way
PWL100S000	Probe, Weld, Large (32.00mm), Straight, Disconnect	100kHz	Bridge – Lemo 4-Way

Leads to fit above probes:

ETher NDE Part No.	Description	Instrument	Connector Instrument End	Connector Probe End	Cable Length	Configuration
ALL12-L04-015B	Lead	WeldCheck/ AeroCheck/ETi/ Hocking	Lemo 12-Way	Lemo 4-Way Plug	1.5m	Bridge
ALL07-L04-015B	Lead	Hocking	Lemo 7-Way	Lemo 4-Way Plug	1.5m	Bridge

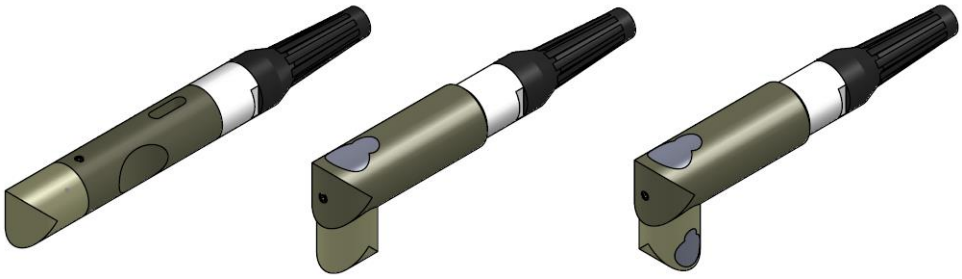
3. Under Water Weld Probes – Bridge

Application: Under water In-service inspection of welded structures, max length 100meters.

Example probe coding:

EThер NDE Part No.	Description	Frequency	Type
PWM100S500L12W	Probe, Weld, Medium, Dia 16.00, 100kHz, Straight, 50m Cable, Lemo 12-Way, Water Proof	100kHz	Bridge
PWM100S500J6W	Probe, Weld, Medium, Dia 16.00, 100kHz, Straight, 50m Cable, Jaeger 6-Way, Water Proof	100kHz	Bridge
PWL100S500L12W	Probe, Weld, Large, Dia 32.00, 100kHz, Straight, 50m Cable, Lemo 12-Way, Water Proof	100kHz	Bridge
PWL100S500J6W	Probe, Weld, Large, Dia 32.00, 100kHz, Straight, 50m Cable, Jaeger 6-Way, Water Proof	100kHz	Bridge
PWM100S1000L12W	Probe, Weld, Medium, Dia 16.00, 100kHz, Straight, 100m Cable, Lemo 12-Way, Water Proof	100kHz	Bridge
PWM100S1000J6W	Probe, Weld, Medium, Dia 16.00, 100kHz, Straight, 100m Cable, Jaeger 6-Way, Water Proof	100kHz	Bridge
PWL100S1000L12W	Probe, Weld, Large, Dia 32.00, 100kHz, Straight, 100m Cable, Lemo 12-Way, Water Proof	100kHz	Bridge
PWL100S1000J6W	Probe, Weld, Large, Dia 32.00, 100kHz, Straight, 100m Cable, Jaeger 6-Way, Water Proof	100kHz	Bridge

4. High Temp Ceramic Tipped Weld Probes – Bridge



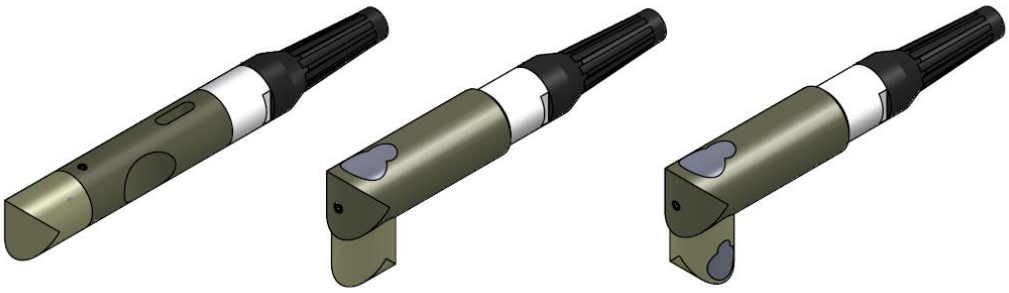
Straight **90° Inline** **90° Transverse**

Application: In-service inspection of welded structures, works to a touch temperature of 200degC.

Example probe coding:

EThер NDE Part No.	Description	Frequency	Type
PWM100S015L12C	Probe, Weld, Dia 16.00mm (Medium) 100kHz, Straight, 1.5m, Lemo 12-Way, Ceramic	100kHz	Bridge

5. Stainless Steel Tipped Weld Probes – Bridge



Straight **90° Inline** **90° Transverse**

Application: In-service inspection of welded structures, with high wear resistance.

Example probe coding:

Ether NDE Part No.	Description	Frequency	Type
PWM100S000S	Probe, Weld, Dia 16.00mm (Medium) 100kHz, Straight, Disconnect, Stainless Steel Tip	100kHz	Bridge

6. Miniature Weld Probes – Bridge

Straight **90° Inline**

Application: In-service inspection of welded structures, 100 kHz, for those hard to reach/confined space inspection areas.

Example probe coding:

Ether NDE Part No.	Description	Frequency	Type
PW001	Probe, Special, Weld, Dia 6mm (Miniature), Right Angled, 100kHz, 15mm = Drop, 152mm (6") = Total Length, Disconnect.	100kHz	Bridge

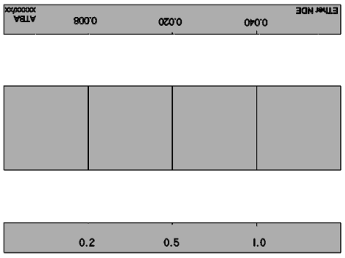
Leads to fit above probes:

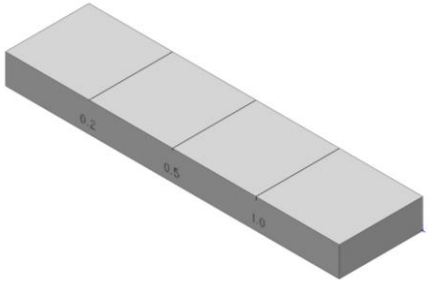
Ether NDE Part No.	Description	Instrument	Connector Instrument End	Connector Probe End	Cable Length	Configuration
ALL12-L04-015B	Lead	WeldCheck/ AeroCheck/ETi/ Hocking	Lemo 12-Way	Lemo 4-Way Plug	1.5m	Bridge
ALL07-L04-015B	Lead	Hocking	Lemo 7-Way	Lemo 4-Way Plug	1.5m	Bridge

7. **Flat Faced and Stainless Steel Dome Faced**

Test Blocks

General Purpose with Slots





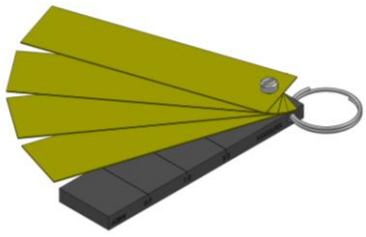
Application:

Test blocks – general purpose with 0.2 (0.008”), 0.5 (0.020”) and 1.0mm (0.040”) slots to enable correct calibration.

Test Block Coding:

Ether NDE Part No.	Description	Material
Accessory, Test Block,		
ATBF	Accessory. Test Block, Ferrous (Steel EN1A), 0.2, 0.5, 1.0mm slots	Ferrous (Steel EN1A)
ATBS	Accessory. Test Block, Stainless Steel 304, 0.2, 0.5, 1.0mm slots (AUSTENITIC)	Stainless Steel
ATBS316	Accessory. Test Block, Stainless Steel 316, 0.2, 0.5, 1.0mm slots	Stainless Steel 316

Weld Probe Test Block



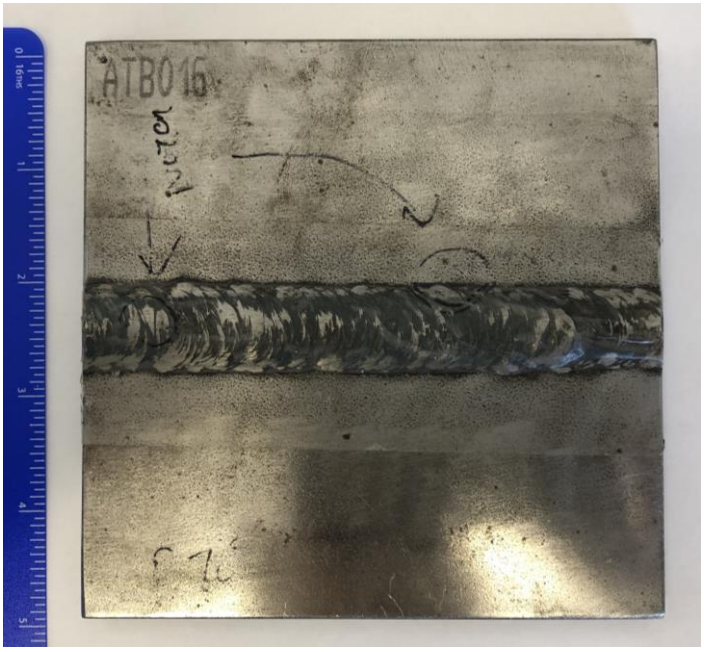
Application:

Weld probe test block – coating thickness calibration standard with 0.5 (0.02”), 1.0 (0.04”) and 2.0mm (0.08”) slots including 4 x 0.5mm (0.02”) shims, used in conjunction with broad band (paint) probe PUB100k to set sensitivity levels before weld inspection.

Test Block Coding:

Ether NDE Part No.	Description	Material
ATBW	Accessory. Test Block, Weld Probe, Ferrous (Steel EN1A) + 4 x 0.5mm Shims, 0.5, 1.0, 2.0mm slots	Ferrous (Steel EN1A) + 4 x 0.5mm Shims
ATBWDUP	Accessory. Test Block, Weld Probe, Duplex, 2205 4 x 0.5mm Shims, 0.5, 1.0, 2.0mm slots	Duplex + 4 x 0.5mm Shims

Weld Probe Demo Crack Specimen



Ether NDE Part No.	Description
ATB016	Test Block WeldCheck Demo Crack Specimen - Plate with two cracks, Type A and C - Toe and Cap Plates are 5" x5", 1/4" thick with false ground crown. Standard crack size 1/4" Long x 0.040" deep.

EDDY CURRENT WELD INSPECTION

In-Service Inspection of Coated Steel Welds Using Eddy-Current Techniques

The WeldCheck range is designed for flaw detection and evaluation using the Eddy Current non-destructive testing (NDT) inspection method particularly for use (but not exclusively) in Eddy Current Weld Inspection to “ISO 17643:2015 Eddy current examination of welds by complex plane analysis” (was BS EN 1711).

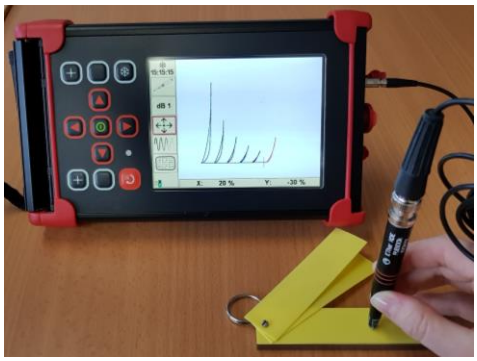
ETher NDE recommends the following probe package to perform Weld Inspections according to the British Standard EN ISO 17643:2015.

KAWEL001 - KIT, Weld, Probes + Accessories. Including:

Probe, Weld, DIA 16.00mm (Medium) 100kHz, , Straight, Disconnect	PWM100S000	1
Probe, Unshielded, Broad Band, 100k , (35kHz-250kHz), BNC	PUB100K	1
Accessory. Test Block, Weld Probe, Ferrous , (Steel EN1A) + x4 0.5mm Shims, 0.5, 1.0, 2.0mm slots	ATBW	1
Accessory, Lead, Lemo 12-Way - Lemo 4-Way, 1.5m (Bridge)	ALL12-L04-015B	1
Accessory, Lead, Lemo 00 to BNC, 1.5m	ALLCX-B02-015A	1
Accessory, Butterfly PTFE Tape (Pack of 30)	AW003	1
Accessory, Deluxe Probe Case PHDC1	AC002	1

TEST PROCEDURE

1. Procedure for measuring coating thickness and material comparison relative to calibration block



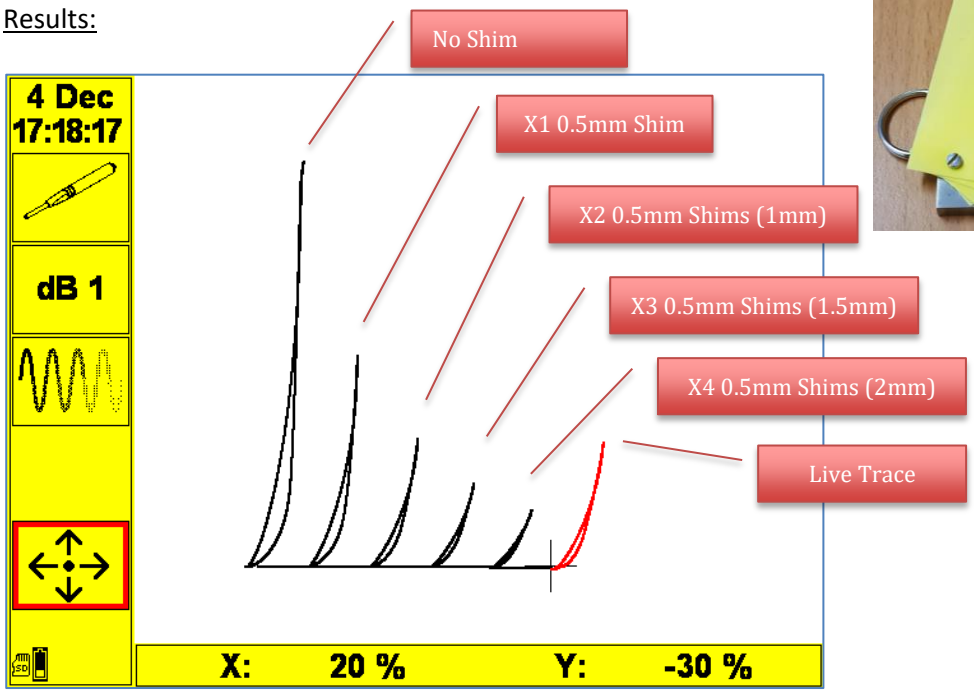
Equipment required:
Probe: Unshielded, Broad Band, 100k - PUB100K
Accessory: Lead, Lemo 00 to BNC, 1.5m - ALLCX-B02-015A
Steel Test Block with 3 slots: 0.5, 1.0, 2.0mm and 4 - 0.5 mm shims - ATBW

Setup:

1. Connect probe to cable and connect to the instrument.
2. Switch instrument on.
3. Use the cursors to scroll the menu until Load & Save is highlighted, press Enter key. Use the up down cursor to select PAINT WELD, select the load icon and press Enter.
4. The main Operating screen will appear as soon as the setup has been recalled.
5. Place the probe on the test block and Press Balance
6. Select the offset Icon on the front panel.
7. Adjust gain and phase as required to set the lift off vertical by either using the Probe Phase Item or the Quick-Menu.
8. Then moving the X Offset create the trace for the 4 shims.
9. Set Trace function on and store trace (this gives a black version of the image) to enable easy comparison.

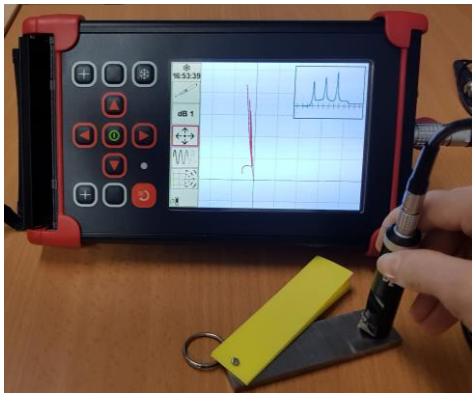
- CH1 -		Summary - Alarm -		- Probe -	
Freq	100 kHz	Source	1st	Drive:	0 dB
Phase	90.0 °	Action		Type	Absolute
Gain X	17.0 dB	Stretch	500ms	Load	Auto
Gain Y	17.0 dB	Type	Off	- Panes -	
Input gain:	12 dB	- Offset -		Pane 1	XY
High Pass	DC	P1 XY	-30,-30 %	Source	Ch 1
Low Pass	11	P2 XY	0,-25 %	Pane 2	Off
				Source	Ch 1

Results:



Material and Coating Thickness Variations Using the Absolute Coil

2. Procedure for testing welds in ferritic materials



2.1 Calibration

The calibration block material should be similar to the test piece.

Equipment required:

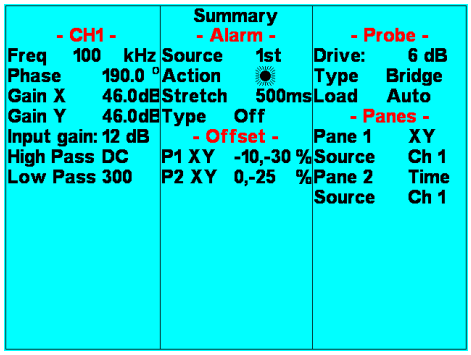
Probe: 100 kHz Weld Probe Bridge – PWM100S000

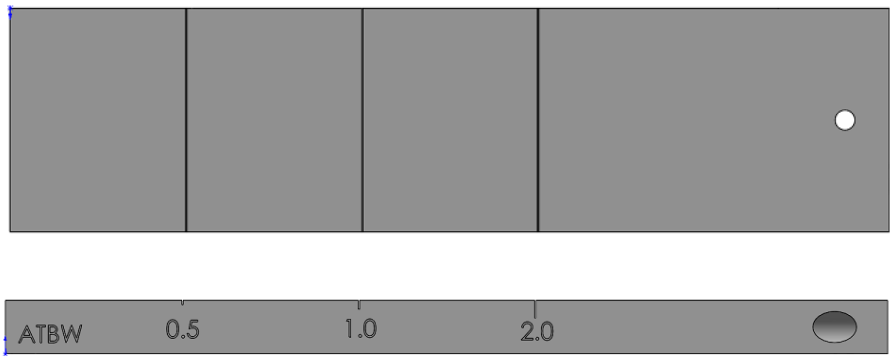
Accessory: Lead, Lemo 12-Way to Lemo 4-Way Bridge Type – ALL12-L04-015B

Steel Test Block with 3 slots: 0.5, 1.0, 2.0mm and 4 - 0.5 mm shims - ATBW

Setup:

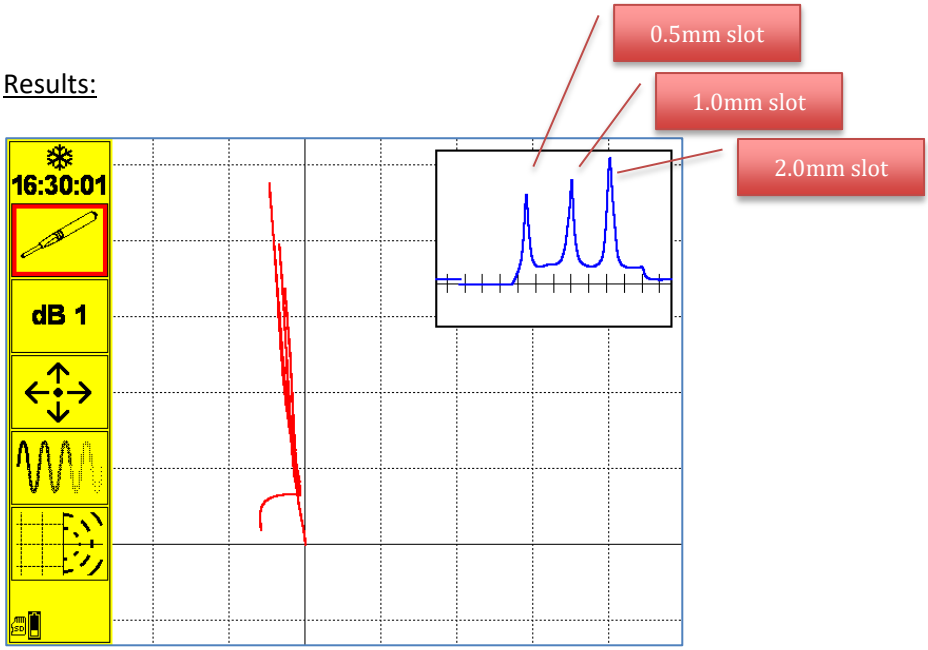
1. Connect probe to cable and connect to the instrument.
2. Switch instrument on.
3. Use the cursors to scroll the menu until Load & Save is highlighted, press Enter key. Use the up down cursor to select Weld 100 kHz, select the load icon and press Enter.
4. The main Operating screen will appear as soon as the setup has been recalled.
5. Place the probe on the test block and Press Balance
6. Move the probe over the defects.
7. If more or less sensitivity is required, use the Gain (dB key) or Quick-Menu to increase or decrease signal amplitude as required.
8. Adjust the phase to set the defect signal vertical by either using the Probe Phase Item or the Quick-Menu
9. Carry out scan of component.





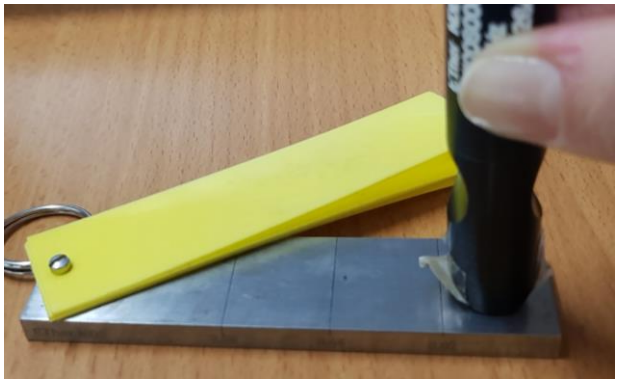
Calibration Block with 0.5, 1.0 and 2.0mm Deep Spark Eroded Slots

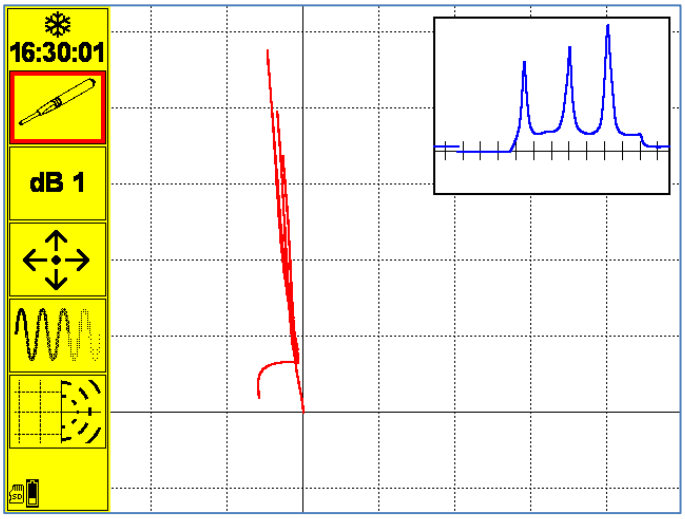
Results:



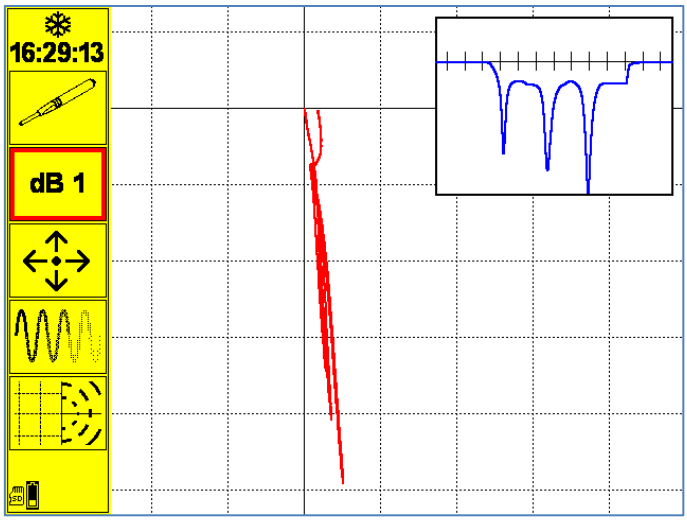
NOTE:
The phase angle of the defect signals is relative to the orientation of the defect to coils. See below.

Tangential, side view:

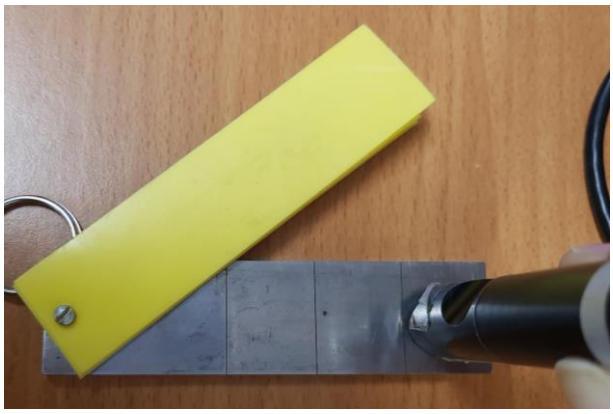


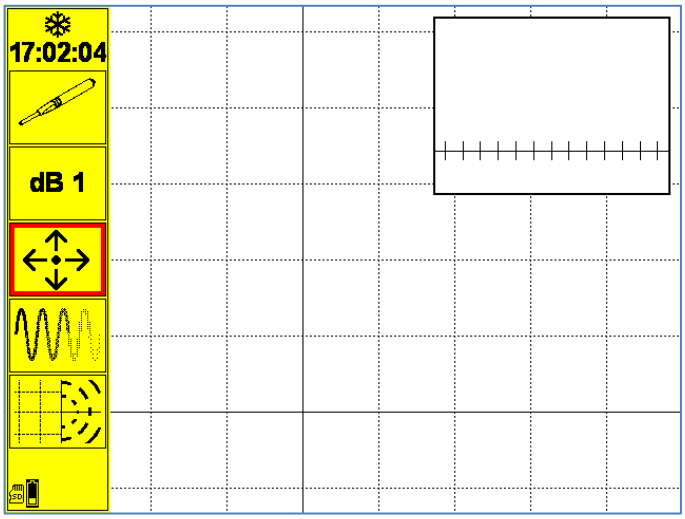


Tangential, front and rear view:

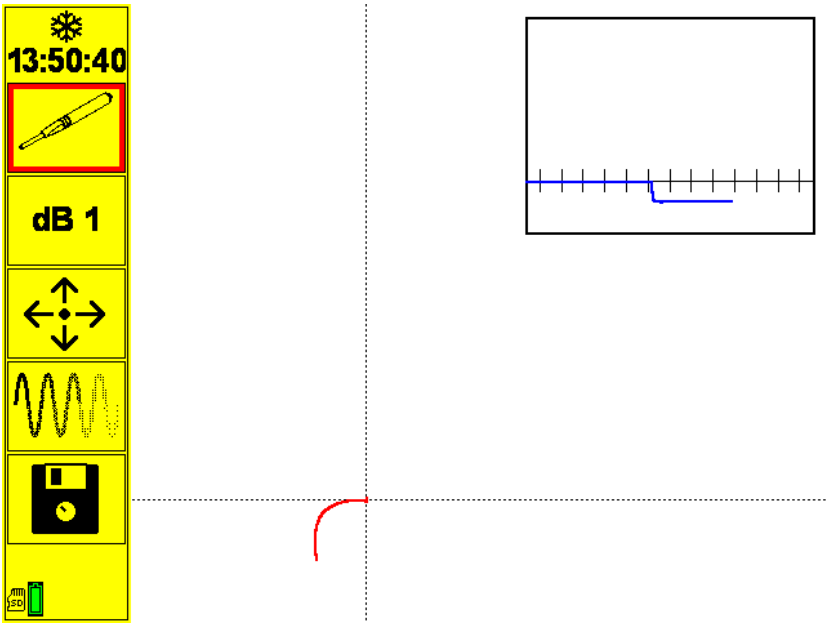


NO defect will be detected if the probe is 45° to the defect:





Lift Off signal:

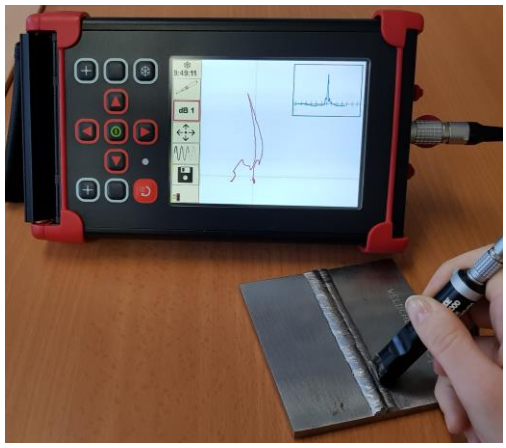


The inspection procedure requires a certain workflow of scanning. It is also important to remember that the active part of the probe is 3mm x 3mm. The procedure is explained below.

2.2 Scanning

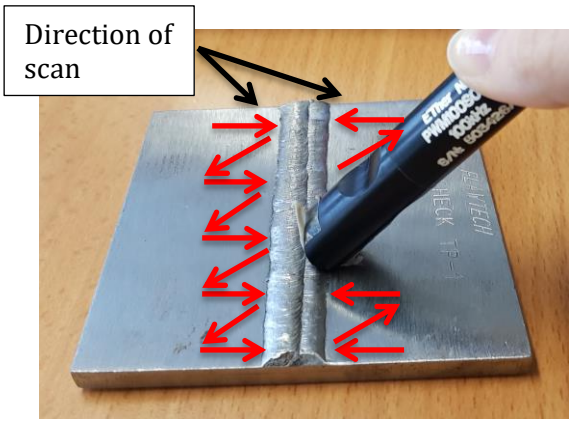
The probe should be moved perpendicular to the main direction of the defect, if this is unknown or if the defect has different directions, two scans should be performed, one perpendicular to the other.

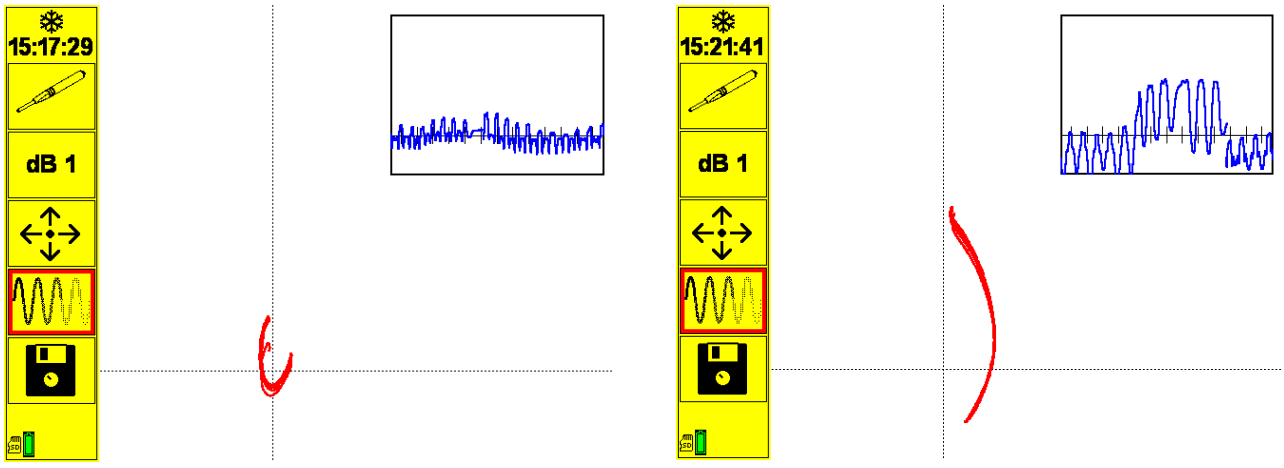
- CH1 -		Summary		- Probe -	
		- Alarm -			
Freq	100 kHz	Source	1st	Drive:	6 dB
Phase	190.0 °	Action		Type	Bridge
Gain X	46.0dB	Stretch	500ms	Load	Auto
Gain Y	46.0dB	Type	Off	- Panes -	
Input gain:	12 dB	- Offset -		Pane 1	XY
High Pass	DC	P1 XY	-10,-30 %	Source	Ch 1
Low Pass	300	P2 XY	0,-25 %	Pane 2	Time
				Source	Ch 1



In order to scan the material, multiple scans need to performed. These are:

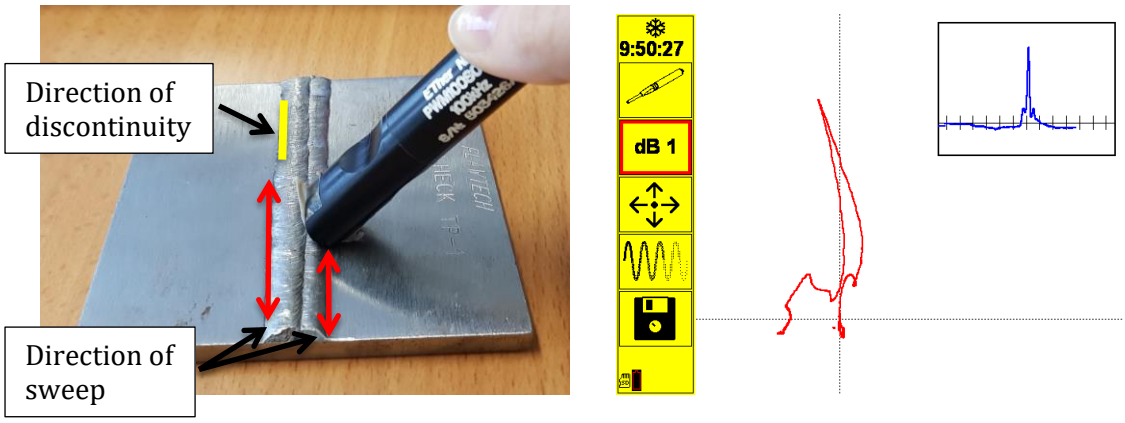
2.2.1 Zig zag scan in the heat affected zone along the length of the toe



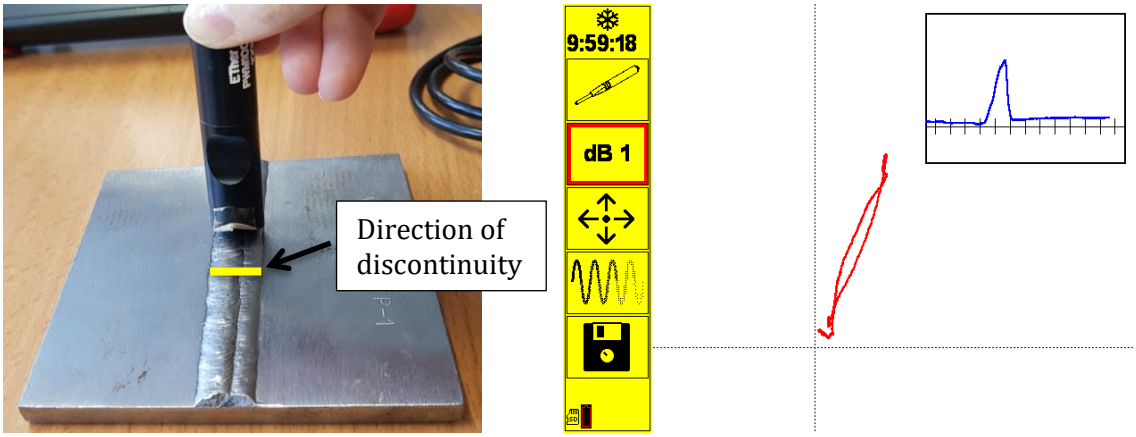


Defect FREE signal **DEFECT signal**

2.2.2 Sweep along the toe



2.2.3 Scan of the weld surface



NOTE:
The detectability of the discontinuities may be affected by:

- The material of the calibration block
- Conductive or non-conductive coating, which reduce the sensitivity of the test
- Orientation of coils to the discontinuity
- Geometry of the component