

Introduction

Butt welds are one of the simplest types of welded joint, and one of the most suitable welds for Time-of-Flight Diffraction (TOFD) inspection. Made by joining the ends of two materials on the same plane on Plate to Plate or Pipe to Pipe for example, this method of welding is suitable for high thickness ranges and for joining dissimilar metals.

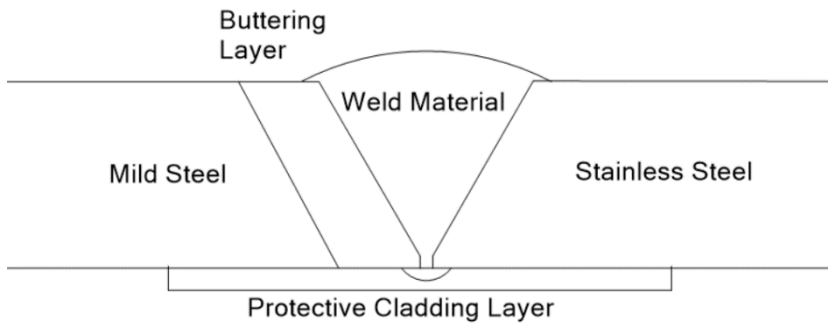


Figure 1 – Example of a complex butt weld with dissimilar metals

TOFD is an ultrasonic inspection method developed for the nuclear industry. It is highly effective in detecting cracks, Lack of side wall fusion, slag inclusions, and weld root corrosion and very accurate in defect sizing. This makes TOFD a powerful tool in defect monitoring, allowing for accurate defect expansion rates over time with multiple repeat inspections.

TOFD utilises a pair of probes and wedges in a send and-receive setup. The probes are placed on either side of the weld, facing each other at a specific distance apart. The transmitter introduces sound into the material, and the receiver picks up any tip-diffracted signals from defects in the material.

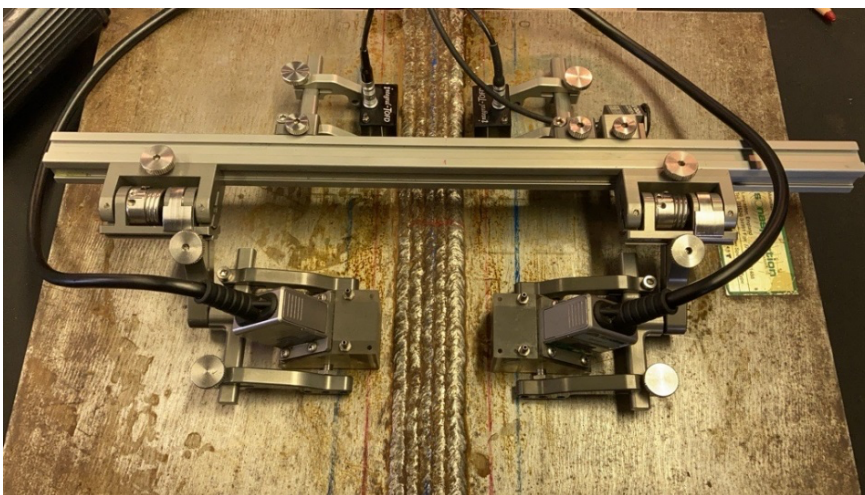


Figure 2 – TOFD setup on a Butt weld sample in a multi-group setup with PA (Phased Array)

Industries

- Chemical & Petrochemical Sector
- Oil & Gas Sector
- Nuclear Energy Sector
- Wind Power Renewables Sector
- Military Sector
- Maritime Shipping Industries
- Pharmaceutical Sector
- Construction and Infrastructure
- NDT Service Providers

Application

- Weld Inspection
- Plastics Inspection
- Storage Vessel Inspection
- Material Bonding Inspection
- Asset Integrity
- Flaw Detection and Evaluation

Typical Parts

- Pipeline Circumferential and seam welds
- Storage vessel shell, floor, and roof welds
- Infrastructure welds
- Plastic pipe welds

Inspection Techniques

- TOFD
- Multi-scan TOFD and/or PA when necessary

Features and Benefits

- Highly accurate defect sizing because the contour edges of the indications come from the diffraction tip signals.
- Defects can be detected regardless of orientation and volume. E.g.: Crack detection and precise height position:
- Repeatable encoded inspections for monitoring defect expansion rates.
- Large length of weld can be inspected in a single shift.

Tip Diffractions

TOFD inspection relies on the detection of 'tip-diffracted' signals emitted by defects (see Figure 3); all discontinuities within the material emit tip-diffracted signals when hit by an ultrasonic pulse; these signals are very low amplitude when compared to a reflected signal. Tip diffracted signals offer two main advantages when sizing and detecting defects:

1. Defects can be detected regardless of orientation in relation to the probe, this means inclusions and transverse defects can be detected with TOFD without having to run a separate transverse scan.
2. Tip diffractions emanate from the top and bottom of the defect allowing for highly accurate depth and through-wall sizing.

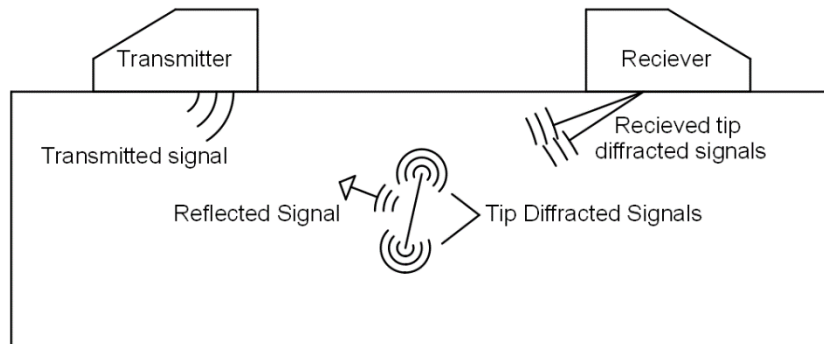


Figure 3 – Diagram showing TOFD tip diffraction detection.

TOFD Scanning on the VEO

TOFD scans on the VEO are simple to set up quickly from the start menu or by importing config files from UTStudio+. With all the settings needed to achieve a great overall data set with excellent signal-to-noise ratio and high scanning speeds. The Veo can also handle high Voltage at 400V, a 200 MHz acquisition rate, and in Multi scan mode 2 TOFD scans and up to 6 PA groups simultaneously.

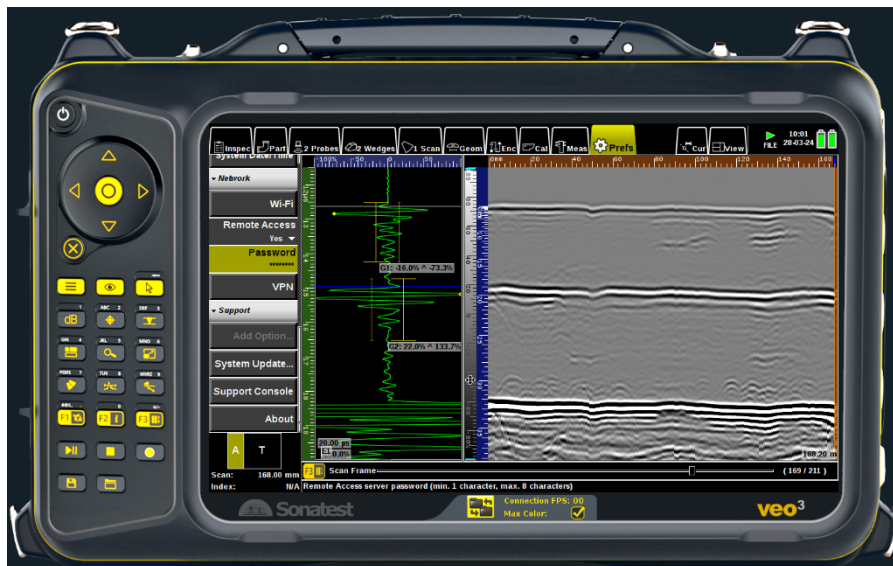
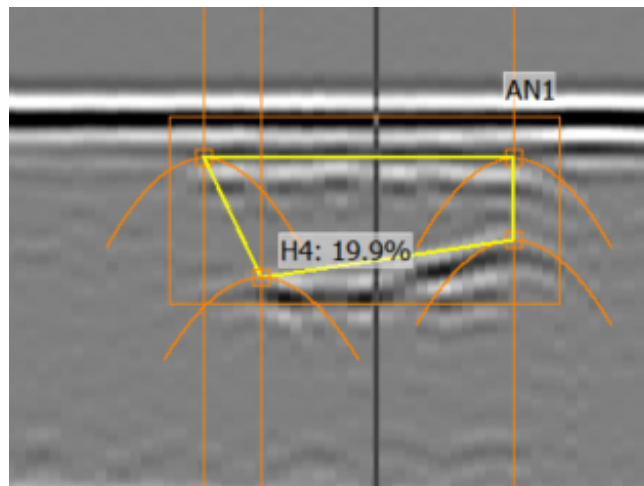
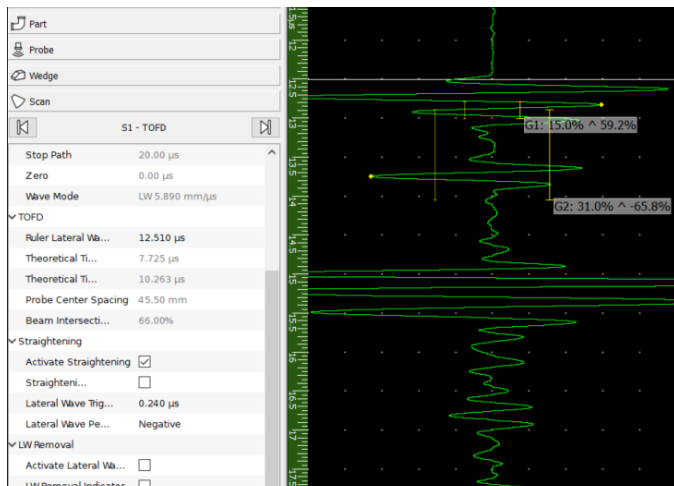


Figure 4 – TOFD Scanning on the VEO3

TOFD Data Review on UTStudio+

UTStudio+ is the Sonatest data analysis software which comes with specialist tools to help with defect identification and sizing. Annotations automatically provide the defect dimensions using hyperbolic cursor positions. PDF reports can be automatically generated holding all the inspection parameters and defect details.



Defect Measurements										General	
Scan 1	Scan 2	Δ Scan	Index 1	Index 2	Δ Index	Depth 1	Depth 2	Δ Depth	Area	Comment	C
18.55 mm	106.11 mm	27.56mm	--	--	--	6.71 mm	12.02 mm	5.31mm	115.63 mm ²	Embedded defect	

Figure 5 – TOFD data review on UTStudio+ - Post-analysis parameters, TOFD cursor contouring and annotation measurements

For further information or support, please contact the Sonatest Applications Team: applications@sonatest.com

Recommended Tool Package

Category	Part #
Acquisition Unit	VEO3 PA and TOFD data acquisition unit, follow this link for details https://sonatest.com/products/flaw-detectors-phased-array/veo3 Note: The Sonatest Prisma can carry out single scan TOFD setups.
Transducer	See the following link for the Sonatest TOFD probe and wedge choice https://sonatest.com/products/transducers/tofd You may require one or more pairs of TOFD probes to cover the inspection thickness ranges for your application.
Scanners	See the following link for Sonatest scanners https://sonatest.com/products/ultrasonic-scanners

Get in touch with your local Sonatest expert, available in more than 50 countries over 5 continents!



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