

# TECHNICAL DESCRIPTION

QNET

Title	Technical Description for Hardness Depth Tester, type P3123
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## Ultrasonic Backscatter Technique

Ultrasonic waves propagating in polycrystalline materials (steel) are scattered at material inter-faces with changes of density and/or elastic properties. In general, the ultrasonic waves are scattered in all directions, one part also back to the ultrasonic transducer that generated the ultrasonic pulse. The intensity of backscattered ultrasound received by the transducer depends on the ratio of geometric size of scattering geometry to the wavelength of ultrasound and on the degree of material property difference at the interface denoted by the term acoustic impedance change.

In the regime where the ultrasonic wave length is large compared to the size of scattering geometry, higher ultrasound frequencies (or shorter wave lengths) increase the intensity of ultra-sonic backscattering. Further, intensity of backscattering increases with the average effective size of the scattering geometry, for example the grain size of the polycrystalline steel. Using the appropriate frequency of about 20 MHz, the microstructure change between the hardened case (usually fine grain Martensite) and the core material (usually quenched and tempered) with coarse grained microstructure causes a distinct increase of backscattering intensity. This effect can be observed when the ultrasonic pulse crosses the interface and standard time of flight evaluation yields the depth position of the interface that corresponds to the Surface Hardening Depth (SHD), see figure below:

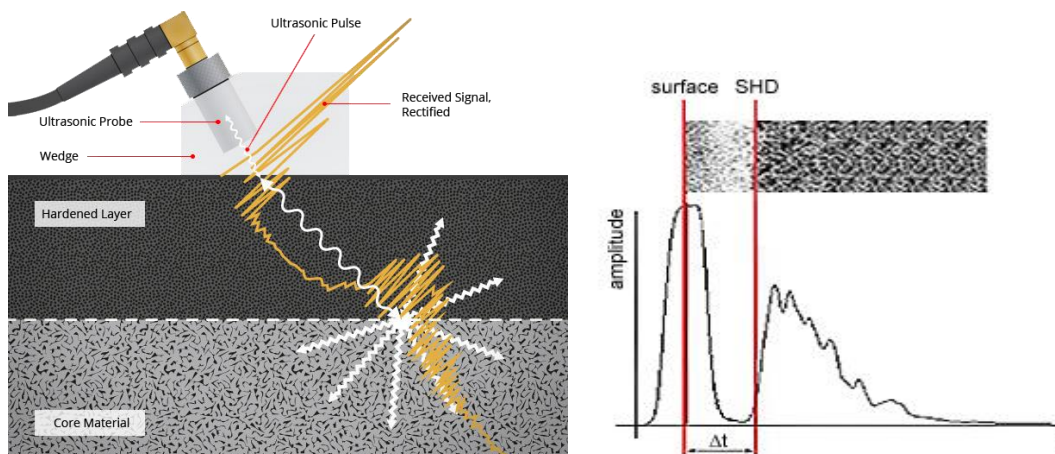


Figure 1: Principle of the Ultrasonic Backscatter Technique (UBT)

The best results are achieved under the following conditions:

- Parts are hardened inductively;
- parts are forged, not cast;
- the minimum SHD value is higher than  $\sim 1.2$  mm;
- there is a distinct interface between base material and hardened layer;
- backscattering within the base material is of sufficiently high intensity for ultrasonic frequencies of 20 MHz.

## Computer Unit

Operating System	Windows® 10, 64 Bit
Mobile Computing Platform	Intel® Core™ i5-7440HQ 2.8GHz, Max. 3.8GHz - 6MB Intel® Smart Cache Optional Intel® Core™ i7-7820HQ 2.9GHz, Max. 3.9GHz - 8MB Intel® Smart Cache
Display	15.6" TFT LCD FHD (1920 x 1080) 1000 nits QuadraClear® sunlight readable display Optional resistive touch screen
Storage & Memory	8GB DDR4 expandable to 64GBi SATA HDD 500GB; Optional SATA HDD 1TB Optional SATA SSD 512GB / 1TB
Keyboard	LED backlit membrane keyboard with integrated numeric keypad Optional LED backlit rubber keyboard
Pointing device	Touchpad with Scroll Bar
Multimedia Bay	2nd battery: 10.8V, 8700mAh Optional DVD super multi drive Optional 2nd storage: HDD 500GB / 1TB; / SSD 512 GB / 1TB
IO Interface	Serial port (9-pin; D-sub) x 2 External VGA (15-pin; D-sub) x 1 Microphone (Mini-jack) x 1 Audio output (Mini-jack) x 1 DC in Jack x 1 USB 3.0 x 4 LAN (RJ45) x 2 HDMI x 1 Docking connector x 1 WLAN and WWAN
Communication Interface	10/100/1000 base-T Ethernet Intel® Dual Band Wireless-AC 8265, 802.11ac Bluetooth® (v4.2)
Power	AC adapter (150W, 100-240VAC, 50 / 60Hz) Li-Ion smart battery (10.8V, 8700mAh) Multimedia Bay 2nd Li-Ion smart battery (10.8V, 8700mAh)
Weight & Dimensions	Mobile device: Weight ~ 7.5 kg (incl. 2 batteries) Dimensions: 41 x 32 x 12 cm
Rugged Features	Ultra-rugged notebook IP65 certified Full magnesium alloy case Shock-protected removable HDD Vibration & drop resistant MIL-STD-810G certified MIL-STD-461G certified
Environmental Specifications	Operating Temperature: 10° C – +40° C Humidity: 95% RH, non-condensing

## Test Instrument

Ultrasonic P/R Channels	4-channel E/A multiplexer, transmitter voltage generator, controllable pre-amplifier, analog/digital rectifier. Pulse / Echo mode.
Transmitter Voltage	0 V <sub>ss</sub> to 800 V <sub>ss</sub> at 50Ω
Frequency Filters	5MHz, 10MHz, 20MHz & 25MHz
Gain Range	0 dB to 96 dB
A/D Module	Analog to digital conversion at 10 bit resolution,
Digitization Rate	80 MSps conversion time
Averaging Functions	1, 2, 4, 8, 16, 32, 64, 128, 256 & 512 samples per shot
Trigger	Internal (time-controlled), external, manual & 2-axis coordinate interface
Measurement Range	Standard probe systems: SHD <sub>min</sub> : 1.2 mm, SHD <sub>max</sub> : 40.0 mm Custom probe systems: SHD <sub>min</sub> : 0.8 mm.
Measurement Repeatability	± 0.2 mm
Ultrasonic Testing Software	"SHD Studio", Windows® 7 and Windows® 10 compatible
Range Setting	No requirement for range setting after parameter setup (input of sound velocities and angle of incidence).
Signal Representation	<ul style="list-style-type: none"> <li>▪ A-Scan, in single or continuous inspection mode.</li> <li>▪ The A-Scan is represented as signal envelope.</li> </ul>
Signal Evaluation	<ul style="list-style-type: none"> <li>▪ User-friendly automatic signal evaluation.</li> <li>▪ Display of calculated SHD and time of flight while testing.</li> </ul>
Administration	Password-protected assignment of user rights: Level I (operator), level II (supervisor), level III (administrator).
Program Editor	<ul style="list-style-type: none"> <li>▪ Creation of custom inspection Programs:</li> <li>▪ Definition of test sequences for unlimited test points and features.</li> <li>▪ Use of predefined parameter sets.</li> <li>▪ Definition of tolerance limits.</li> </ul>
Setup Mode	<ul style="list-style-type: none"> <li>▪ Setup of inspection parameters.</li> <li>▪ Rapid test of different inspection parameter settings</li> <li>▪ Unlimited storage of custom parameter sets.</li> <li>▪ Export of A-scans, reports and screenshots</li> <li>▪ Expert Mode for signal evaluation</li> <li>▪ Display of real measuring point due to sound refraction</li> <li>▪ Display and export of the HF signal</li> </ul>
Inspection Mode	<ul style="list-style-type: none"> <li>▪ Usage of customized inspection programs.</li> <li>▪ Automated signal evaluation.</li> <li>▪ Signal analysis mode.</li> <li>▪ Warning in case tolerance limits are exceeded.</li> <li>▪ Entering notes or comments.</li> </ul>
Inspection Results	<ul style="list-style-type: none"> <li>▪ Review of stored test results.</li> <li>▪ Export A-scans (PDF, JPG), screenshots and test reports.</li> </ul>
Inspection Report	<ul style="list-style-type: none"> <li>▪ Custom test report design using List &amp; Label.</li> <li>▪ Print reports of stored test sequences.</li> </ul>
Line Scans	Optional: line scans using encoder interface.
Translation Tool / Languages	Translation tool to individually set language designations for buttons, labels and dialogues in the program. Currently available languages: English, German, Chinese, Spanish, French, Russian and Korean. Other languages on request.

# User Interface

## Setup Mode

**Start** (highlighted)

Report

Blend

RF Signal

Expert

Save

Load

Reset

Parameter Set: default

**A-Scan**  
Amplitude [%] vs Time [μs]

**SHD Graph**  
SHD [mm] vs Distance [mm]

SHD Value: **1,2 mm**      Time of Flight: **0,96 μs**      Graph delete

**Hardware**  
Delay: 2,2 μs      Sample Length: 20 μs  
Gain: 60 dB  
Average: 256  
Channel: 1

**General**  
Smoothing: 40  
Shape: Rectangle  
Material: Steel  
Coupling Wedge: B9461123  
Transducer: V5043

**Real Measuring Point**  
1,0 mm  
1,6 mm  
1,2 mm

**SHD Graph**  
Encoder 1      Encoder 2  
Set Zero  
X-Scale: Minimum: 0,0 mm      Y-Scale: Minimum: 2,0 mm  
Maximum: 100,0 mm      Maximum: 6,0 mm  
Increment: 1,0 mm

## Inspection Mode

SHD-Studio

Inspection      Inspection Results      Setup      Program Editor      Basic Settings      QNET

New      Continue

Pause      Report      Save

Complete Inspection      **Start** (highlighted)

Inspection Program:  
Program: Program Example  
Comment:

Transducer: V5043  
Coupling Wedge: B9461123  
SHD Min.: 1,5 mm      SHD Max.: 2,5 mm  
Channel: 1

Inspection Mode:  
Singlescan  
Encoder: 1      Number: 1  
Start: 0,0 mm      Increment: 0,0 mm

Attribute:  
✓ Attribute 1  
Attribute 2  
Attribute 3

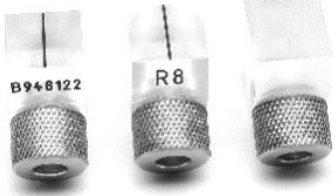

**A-Scan**  
Amplitude [%] vs Time [μs]

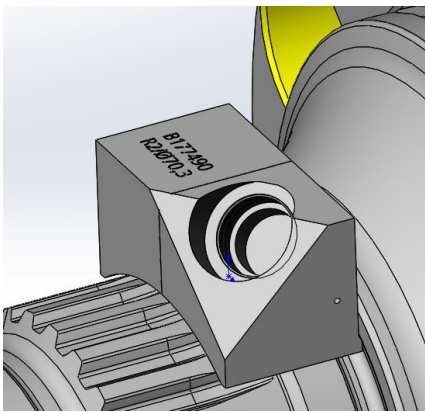
**SHD Graph**  
SHD Value: **2,1 mm**

**Real Measuring Point**  
1,8 mm  
2,7 mm  
2,1 mm











Analysis



## Auxiliary Components

Coupling Wedges		
	<p>Standard wedges for transducer type M3095 (drilling: <math>\varnothing</math> 11 mm).</p>	<p>Standard geometries:</p> <ul style="list-style-type: none"> <li>▪ flat</li> <li>▪ concave</li> <li>▪ convex</li> </ul>
	<p>Standard wedges for transducer type V3803 (drilling: <math>\varnothing</math> 6 mm).</p>	

Custom Wedge Design	
	<p>Custom wedge design for any part geometry, e.g. for the inspection of splines, grooves and undercuts.</p>

Custom Search Units	
	<p>One- / multi-channel.</p>
	<p>Custom wedge design.</p>
	<p>Inspection of pin journal and fillet radius of crankshafts.</p>

<b>Accessories</b>		
<b>Ultrasonic Transducer</b> Type V3803	Central frequency: ~ 20 MHz Oscillator: Ø 3.175 mm Housing: ~ Ø 6 mm Connector: Microdot	
<b>Ultrasonic Transducer</b> Type M3095	Central frequency: ~ 20 MHz Oscillator: Ø 3.175 mm Housing: ~ Ø 11 mm Connector: Microdot	
<b>Transducer Cable</b>	Double-shielded, high-frequency triaxial cable. Connectors: BNT / Microdot. Straight (180°) or angular (90°). Lengths: 1, 2, 3, 4, 5 or 7 m	
<b>Adjusting Standard</b> ADJ-STD	Adjusting standard for functional re-check of ultrasonic test instruments, incl. aluminum specimen and an ultrasonic probe with attached cable.	
<b>Main Battery</b> P3123-X500-BP	Removable main battery. 10.8 V, 8700 mAh.	
<b>Back-up Battery</b> P3123-X500-RB	Removable media bay back-up battery. 10.8 V, 8700 mAh.	
<b>Battery Charger</b> P3123-X500-BC	External dual-bay main battery charger.	
<b>Power Supply</b> PS150WEU	External A/C adapter. 150 W.	
<b>Industrial Power Supply</b> PSMILEU	MIL-STD-461F-certified A/C adapter.	
<b>USB Footswitch</b> USB-FS	USB footswitch to start and stop SHD measurements. Ready-to-use.	

<p><b>Couplant</b> ECHOFL-1L</p>	<p>Coupling fluid "ECHOFLUID" for high-frequency ultrasonic SHD testing. 1.0 l bottle.</p>	
<p><b>Couplant</b> ECHOTR-0.5L</p>	<p><b>Non-corrosive</b> coupling gel "ECHOTRACE" for high-frequency ultrasonic SHD testing. 0.5 l bottle.</p>	
<p><b>Safety Case</b> 1560REPL</p>	<p>Safety case incl. foam inlay for storage and transportation of test instrument P3123.</p>	