Case Depth Testing System - Technical Data

4-Channel Case Depth Testing System

The ultrasonic backscattering technique is used to nondestructively evaluate and measure the case depth (SHD) of induction-heated parts.

This technique allows the detection of the transition between different polycrystalline structures due to their variation in backscattering characteristics. Acoustic backscattering increases with the increase of the particle (grain) size because the ultrasonic dispersion coefficient is proportional to the third power of the effective particle size if the condition “wavelength larger than particle size” is true. Induction hardening usually creates a fine-grained, hardened, near-surface structure that varies from the unhardened base material structure particularly regarding the particle size. While the hardened near-surface structure is very transparent to ultrasonic waves, the coarse-grained base material structures exhibit increased ultrasonic backscattering, which results in usable signal amplitudes suitable for display.

The case depth is measured by evaluating the transit time of the ultrasonic pulse when entering the material surface to the case-to-base material interface and the case depth (Rht) is computed without additional calibrations using the given sound velocity of carbon steel and the angle of incidence case with the following equation:

$$Rht = \frac{\left(v \cdot t \cdot \cos\beta\right)}{2}$$

where:

v	=	Sound velocity in carbon steel
t	=	Transit time from entry surface to the base material interface
β	=	Incidence angle (in the case)

A sharp hardness gradient in the transition area provides excellent ultrasonic data that agree very well with the Rht values determined by destructive methods, e.g., Vickers micro-hardness testing. This technique is applicable for case depths of 1.0mm (0.040”) and larger and can be used to measure the case depth in complex contoured parts, e.g., crankshaft fillets and journal radii. The reproducibility of the ultrasonic case depth data is typically within +2% of the actual case depth.

As backscattered ultrasonic signals have a distinct interference structure (due to the phase-sensitive measurement), it is necessary to average the received signal values for increased measurement data accuracy. More accurate results are obtained through “local averaging”, where the specimen (e.g., crankshaft) is turned in a predetermined angular range. During the rotation, the individual backscattered signals are summarized and then averaged.

The 4-channel cased depth test instrument is an upgraded version of the single-channel instrument. The instrument features an industrial grade notebook, desktop, or rack-mount PC and a single-channel analog transmitter with four receiving stages. The data acquisition software automatically switches up to four transducers (channels) assigned by the software settings for test locations with varying surface geometry. The software is Windows© 7 based and can be customized to individual user requirements. The ultrasonic transducers (20 MHz) and polystyrene wedges, custom-fitted to the surface geometry as specified by the purchaser, are contained in a rugged housing.

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HVUT (High Voltage Ultrasonic Testing) Board

Four- channel in time-division multiplex transmitter/receiver, independently selectable;

- Four analog filters, 5MHz, 10Hz, 20MHz & 25MHz
- A/DC 10bit resolution, 80MSps conversion rate, automatic offset calibration
- Digital down-sampling after A/DC 1/2/4 (complies to 80MSps, 40MSps, 20MSps scanning)
- Programmable memory depth, max. 4,096 samples per channel, according to 51.2µs at a sampling rate of 80MSps
- Configurable start of storage after triggering
- Selectable averaging function with 1, 2, 4, 8, 16, 32, 64, 128, 256 & 512 averages per shot
- Additional RF channel, 4,096 samples memory without averaging
- Shot-distance from 1Hz to 2,000Hz
- Transmitter voltage adjustable from 0V to 800V
- Adjustable gain from 0dB to 76dB, switchable 20dB attenuator
- Trigger: internal (time-controlled), external, manual, 2-axis coordinate interface
- I/O: CTP-trigger interface, LED, RF output
- Power consumption during operation <10W
- Power and temperature control
- Form factor PCIe card custom length, PCIe x1-slot power supply 3.3V (3A), 12V (9.6A) or external supply
- Communication via USB 2.0 interface (Type B connector)

SHD-Studio Software

The SHD-Studio software is Windows® 7 Pro (64bit) or Windows® 10 Pro (64bit) based and consist of various modes, such as:

a) ***Basic Settings***, to select Measurement Units (mm or inch), Decimals (1, 2 or 3), Report Directory, Report Template Directory, Screen Shot Directory, Materials, Transducers, Wedges, Optional Parameters, Database Backup and Change Passwords.

b) ***Setup***, to view and adjust A-Scan and hardware/software settings

c) ***Programming***, to setup Master Records and test features

d) ***Inspection***, to be used for case depth testing using previously generated Master Records

e) ***Viewer***, to view and print previously saved inspections

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Configurations

Laptop PC (P3123)

System .....Getac X500G2 Intel® Core i7-4610M 3.0GHz CPU laptop 8GB RAM laptop w/ NPAC-Slice expansion chassis
Int. Power Supply .....64HWr removable & rechargeable battery with on-line charge and hot-swap; 44WHr removable & rechargeable battery (~ 6-hrs. operation)
Ext. Power Supply .....100 to 240VAC 47-63Hz AC adapter, 52.2W
Dimensions.....430mm (16.9") length, 290mm (11.4") width, 125mm (5") height
Weight .....6.9 kg (15 lb.)

Desktop PC (P3120)

System .....Ultrasonic case depth testing system, contained in an industrial rack-mount case including HVUT board, SHD software, and interfaces for four search units. Industrial-type rack-mount case, Intel® Core™ i7-7700k (4.20GHz) CPU, 3x PCI-Express (x1) & 3x PCI-Express (x16) motherboard, 16GB RAM, 1GB NIC, 500GB & 1TB SATA HDD, Blu-ray/DVD;
Power Supply .....100 to 250VAC, 50-60Hz, 400W Active PFC
Dimensions.....425mm (16.7") width, 180mm (7.1") height, 530mm (20.9") depth
Weight .....19.9 kg (43.9 lb.)

Monitor .....22" high-contrast LCD flat panel touch screen monitor; 1920x1080 resolution; VESA mount
Power Supply .....100-240VAC, 50/60Hz, 30W max.
Dimensions.....550mm (21.5") width; 345mm (13.5") height
Weight .....9.1 kg (16.0 lb.)

Mobile Cart PC (P3119)

System .....Ultrasonic case depth testing system, cart-mounted, contained in a host PC including HVUT board, SHD software, and interfaces for four search units. Industrial-type rack-mount case, Intel® Core™ i7-7700k (4.20GHz) CPU, 3x PCI-Express (x1) & 3x PCI-Express (x16) motherboard, 16GB RAM, 1GB NIC, 500GB & 1TB SATA HDD, Blu-ray/DVD, drawer-mount keyboard w/ touchpad
Power Supply .....100 to 250VAC, 50-60Hz, 400W Active PFC
Dimensions.....425mm (16.7") width, 180mm (7.1") height, 530mm (20.9") depth
Weight .....19.9 kg (43.9 lb.)

Monitor .....22" high-contrast LCD flat panel touch screen monitor; 1920x1080 resolution; VESA mount, mounted on articulated arm
Power Supply .....100-240VAC, 50/60Hz, 30W max.
Dimensions.....550mm (21.5") width; 345mm (13.5") height
Weight .....9.1 kg (16.0 lb.)

Mobile Rack Cart .....Sturdy all steel 2"x2" tube frame w/ 5" rubber casters; height adjustable from 30" – 37 ½", with 30"x 30" laminate table top
Weight .....approx. 120 kg (264.6 lb.)