

# HIGH FREQUENCY NON-CONTACT ULTRASONIC DISTANCE/LEVEL MEASUREMENT

Comparison of Observations from a Conventional Pulsar/Receiver and NCA 1000 in Conjunction with Phenomenally High Transduction Transducers

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This is a self-explanatory note intended to prove its title—patents pending and in process. However, an observation relative to the accuracy of time of flight (tof) measurement by NCA 1000 is necessary. Under ambient conditions, the worst case tof accuracy is +/- 50ns, which corresponds to distance measurement accuracy of +/- 0.017mm ( $d = \text{tof} \times V_a$ , velocity in air). Under closed (even partially closed) conditions tof is +/- 1ns, or distance measurement accuracy, +/- 0.0003mm.

Function of this note is also to introduce this extraordinary feat to the level sensing and thickness measurement applications for their benefits. The author will be pleased to entertain any question.

## EXPERIMENTAL SET UP

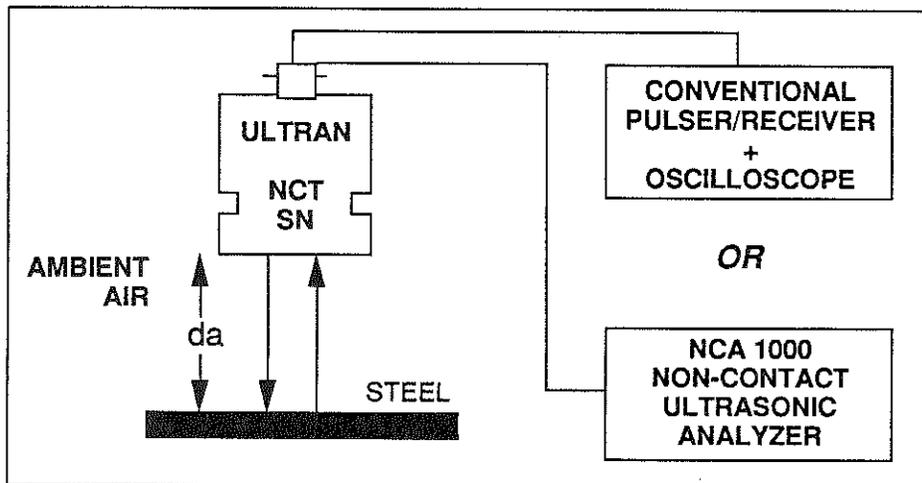


Fig. 1. Experimental set up for non-contact distance/level measurements between transducer and a reflecting surface (besides steel any other solid or liquid surface will also reflect ultrasound.) In order to generate significant observations and to make systems comparison, at a given time, either conventional pulser/receiver, or NCA 1000 system was used. Various observations were made by changing  $d_a$ , the distance between the transducer to the reflecting surface.

**EQUIPMENT, SET UP, AND OBSERVATIONS**

**Transducers**

NCT-5010: Non-Contact Transducer, nominally 1.0MHz, and 12.5mm active area diameter.  
 NCT-5020: Same as above, except 2.0MHz  
 NCT-5030: Same as above, except 3.0MHz

**Conventional Pulsar/Receiver**

Excitation: 200V -ve spike. Receiver bandwidth: 1kHz to 35MHz. Gain: As noted in figures 2 and 3.  
 Signal Average: 16. Number of acquisitions and SNR (Signal to Noise Ratio without signal averaging): As in figures 2 and 3 captions. Full signals were too crowded for long distance measurements, therefore, only the main portions are shown, figures 2 and 3.

**NCA 1000**

Synthesized and calibrated for each frequency. Signal Average: 16. Gain & other parameters: Automatically set by the instrument. SNR (with 1 average): As in figures 4, 6, 8 and 10 captions.

**OBSERVED PARAMETERS**

Realtime traces showing the reflected signal, da, Gain, and SNR.

**CONVENTIONAL PULSER/RECEIVER OBSERVATIONS—FIGURES 2 & 3.**

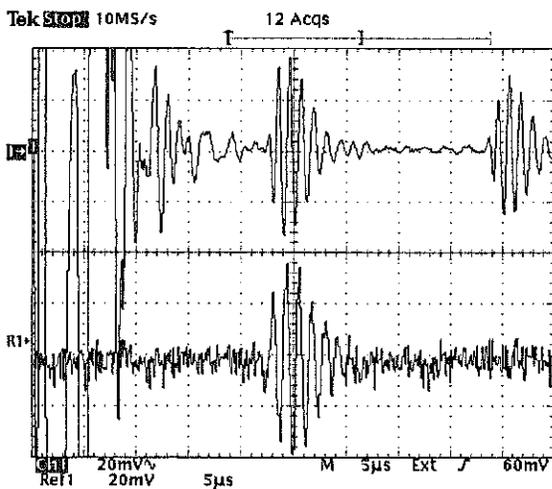


Fig. 2. NCT-5010. 1.0MHz.

Top Trace: da = 3.96mm, Gain: 30dB, SNR: 30dB.

Bot. Trace: da: 153.5mm, Gain: 70dB, SNR: 12dB.

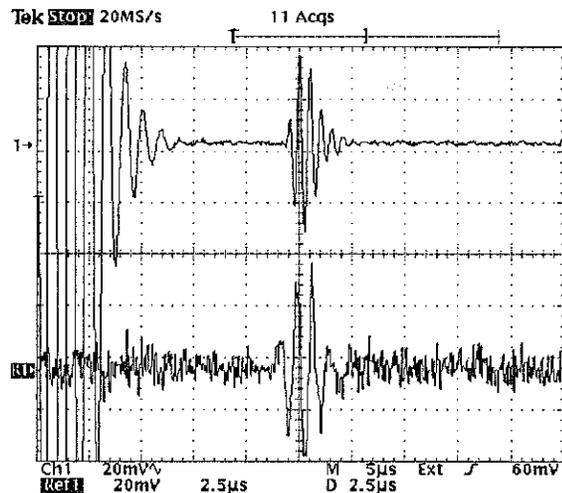


Fig. 3. NCT-5030. 3.0MHz

Top Trace: da = 4.14mm, Gain: 26dB, SNR: 26dB.

Bot. Trace: da: 51.75mm, Gain: 70dB, SNR: 10dB.

NCA 1000 OBSERVATIONS—FIGURES 4, 5, 6, 7, 8, 9, 10, and 11.

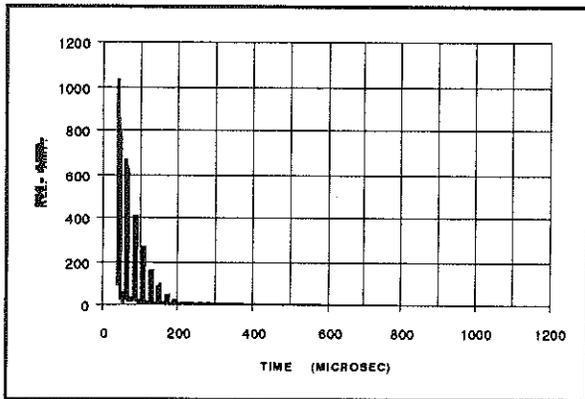


Fig. 4. NCT-5010. 1.0MHz full signal.

da = 6.67mm. Also showing da multiples.  
 Gain: 5dB. SNR: 44dB.

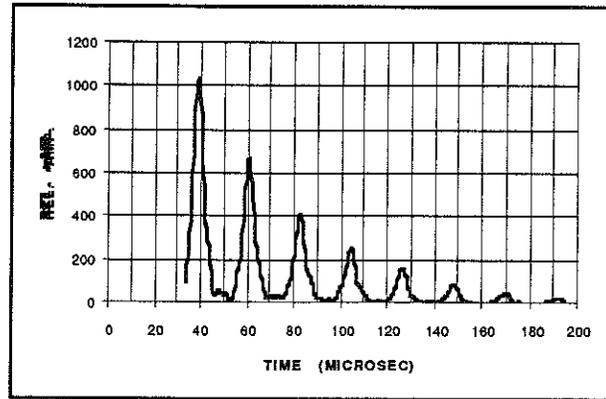


Fig. 5. Same as Fig. 4, except shows reflected signal details.

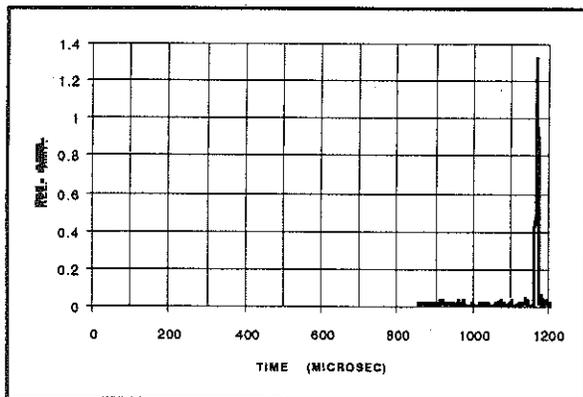


Fig. 6. NCT-5010. 1.0MHz full signal.

da = 201.25mm  
 Gain: 74dB. SNR: 22dB.

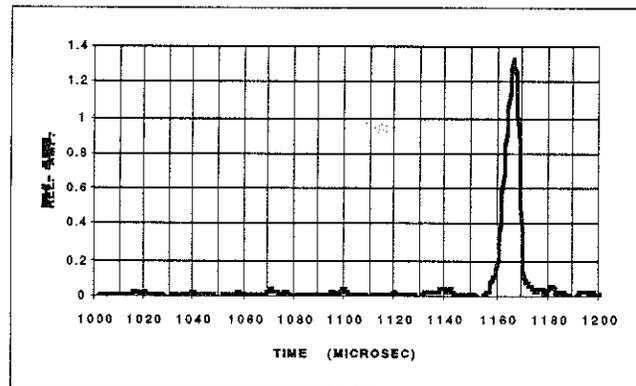


Fig. 7. Same as Fig. 6, except shows reflected signal details.

Estimated range of measurement with NCT-5010 and NCA 1000: <2mm to >250mm.

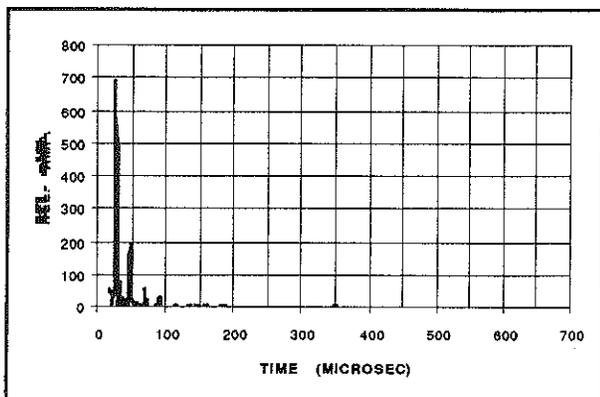


Fig. 8. NCT-5020. 2.0MHz full signal.

$d_a = 4.26\text{mm}$ . Also showing  $d_a$  multiples.  
Gain: 5dB. SNR: 34dB.

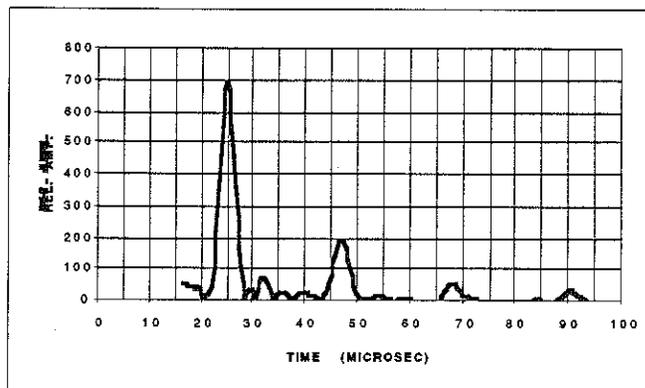


Fig. 9. Same as Fig. 8, except shows reflected signal details.

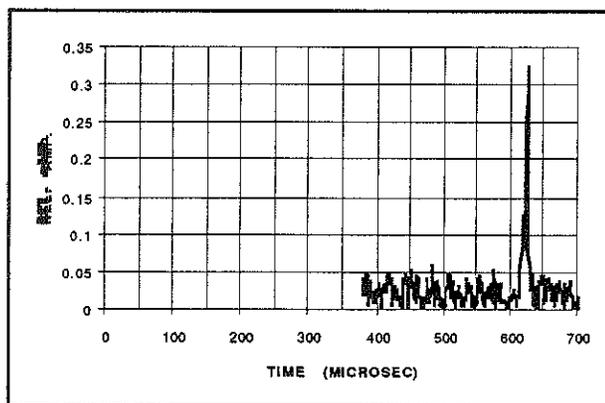


Fig. 10. NCT-5020. 2.0MHz full signal.

$d_a = 107.57\text{mm}$   
Gain: 79dB. SNR: 14dB.

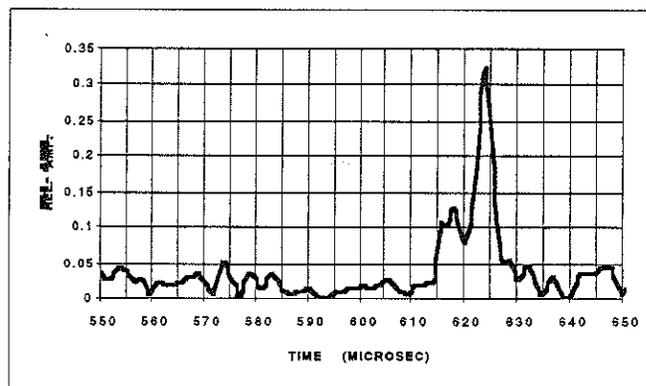


Fig. 11. Same as Fig. 10, except shows reflected signal details.

Estimated range of measurement with NCT-5020 and NCA 1000: <0.5mm to >120mm.

While comparing these observations it should be clear that non-contact transducers are, indeed phenomenally high transduction. Otherwise it is hard to imagine propagation of 3.0MHz in air (without high power excitation and amplification) to a distance >50mm, Fig. 3. Also while comparing conventional and NCA 1000 instruments, it is obvious that the latter can be used to measure much longer distance, and more accurately, even at higher frequencies.

NCU-DIST-299 MCB: cbm

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