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From : MT-AMSI

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Subject: Testing Results of Magnetostrictive Ultrasonic Sensor Cables for Signal Loss

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Attached for your information are the testing results of different lengths of signal cable for use with a magnetostrictive ultrasonic sensor system. The purpose of this test was to determine the magnitude of signal loss introduced when increasing the length of the signal cable.

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Magnetostrictive Ultrasonic Signal Strength Test
Using RG58C/U Coaxial Cable

by

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Test Objective

The purpose of this test was to determine the signal strength and resolution losses of a magnetostrictive ultrasonic system with an extended signal cable. The cable of interest carries electrical signals between the pulse generator/receiver and the magnetostrictive transducer. It was desired to determine the loss introduced by different lengths of the signal cable (6', 100', and 200').

Test Setup

The magnetostrictive ultrasonic system consisted of a pulse generator/receiver, a magnetostrictive transducer, an acoustic waveguide, and a computer to operate the pulse generator/receiver and oscilloscope software. The pulse generator/receiver was a Matec Standalone Board installed in a computer with version 1.00.003 application software. The oscilloscope software was GageScope Professional Edition version 3.5 also configured to operate with an installed I/O card. The transducer was a Panametrics ETV 100, and the waveguide was a 0.055" diameter X 16" long Remendur wire (GE Infrastructure, Inc).

The three cable specimens were RG58C/U coaxial cable from L-Com, and each was set up for test in a coiled and uncoiled configuration. A coiled configuration connects system components while having the excess cable wound in a circular arrangement (Figure 1). An uncoiled configuration connects components with the excess cable unraveled and spread out such that there is a minimum amount of contact between any portions of the cable (Figure 2). These coiled/uncoiled configurations were used to investigate the existence of any signal interference or degradation. Additional properties of RG58C/U cable are shown in Table 1.

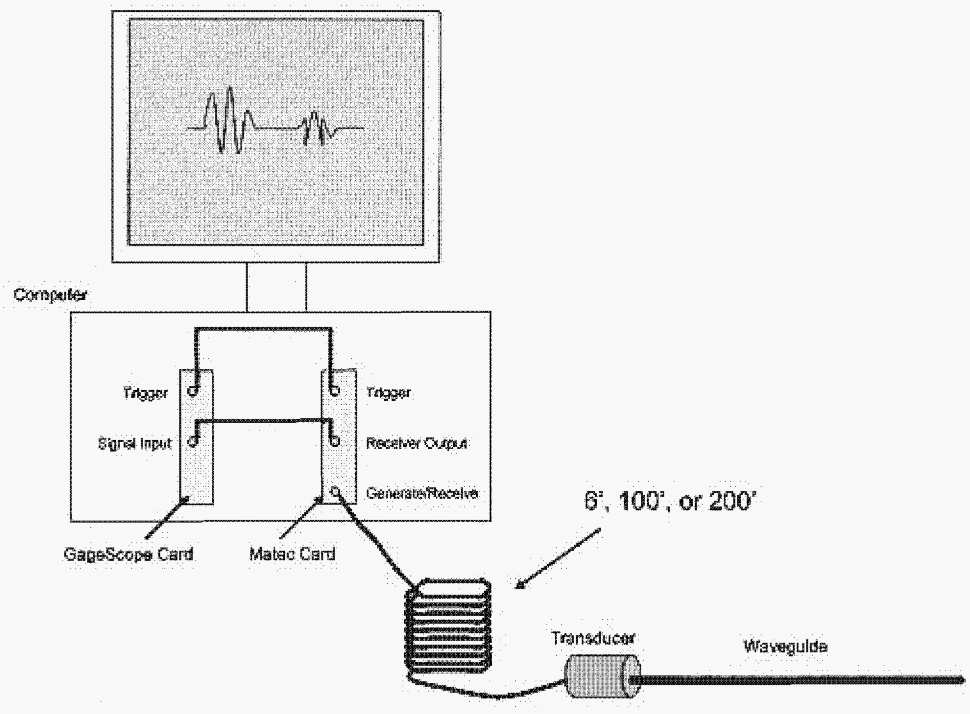

Figure 1. Coiled Cable Configuration

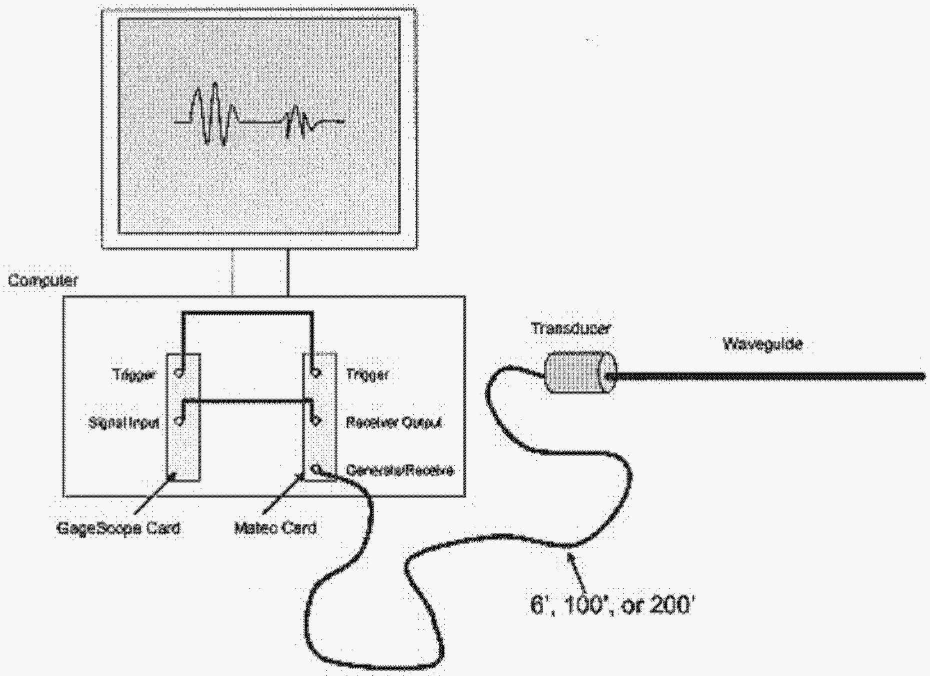

Figure 2. Uncoiled Configuration

Table 1. RG58C/U Properties

Impedance:	50 Ohm
Operating Temperature:	-40°C to 85°C
Center Conductor:	20 AWG Tinned Copper
Shielding:	Tinned Copper Braid (95% Coverage)
Insulation:	Polyethylene
Jacket:	PVC

Test Operation

First, data was obtained from the ultrasonic pulse-echo system with the coiled 6' cable connecting the transducer to the pulse generator/receiver. An electric pulse supplied to the magnetostrictive transducer by the Matec card generates an acoustic pulse in the Remendur wire. The pulse propagates the entire length of the rod, reflects off of the end of the rod, and returns. When the acoustic pulse returns to the transducer, an electric pulse is sent to the Matec receiver. The acoustic pulse will continue to propagate and reflect in the rod until it is completely dampened. The Matec card is configured to continuously pulse the transducer at a set repetition rate.

The initial supplied pulse and the pulses corresponding to the reflections were displayed as a waveform in the oscilloscope window (Figure 3). The Matec and GageScope parameters were optimized such that the waveform exhibited clearly defined pulse bundles with minimal noise. These

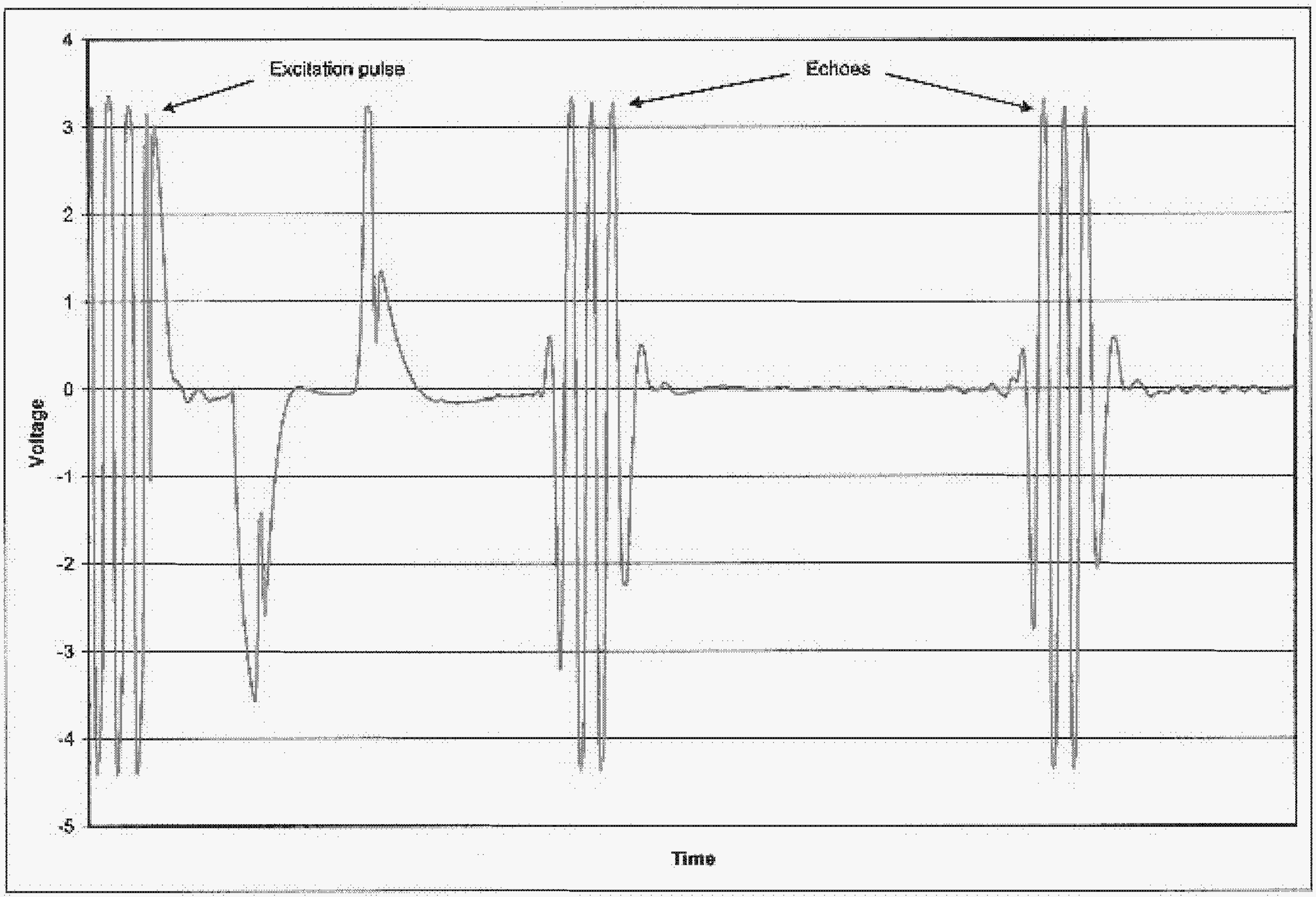

Figure 3. Pulse-Echo Waveform

parameters can be seen in Tables 2 and 3. Portions of the resultant waveform corresponding to the excitation pulse and the first echo were isolated in GageScope by creating a subchannel for each. The sampled data from each subchannel was then extracted to later obtain the maximum peak-to-peak amplitude of each pulse and echo, and the full width at half maximum (FWHM) for each echo (Figure 4).

The measurement procedure was conducted once for each of the following cable configurations: 6' coiled, 6' uncoiled, 100' coiled, 100' uncoiled, 200' coiled, 200' uncoiled. When switching the cables between each test, effort was made to not disrupt the waveguide/transducer coupling.

Test Data

The magnetostrictive ultrasonic system was tested with six different signal cable configurations. Table 4 displays the pulse-echo amplitude information, and the calculated FWHM and gain for each cable configuration when increased from the respective 6' coiled and uncoiled configurations. FWHM was calculated as the time elapsed between the two points (one for rising and one for falling) that are half of the maximum magnitude of the central pulse in each reflection bundle. Gain was calculated as $20*\log_{10}(V_A / V_6)$ where V_A is the amplitude of the signal when using the longer cable, and V_6 is the

Table 2. GageScope Parameters

CS14100		
CS14100 Tab	Trigger Tab	Depth
Sample Rate - 50Ms/s	CH01	Total – 512k
SuperRes - Unchecked	Rising Edge	PreTrig - Unchecked
Single/Dual - Dual	742 mV	PostTrig – Checked – 180032
		Course/Fine – Fine
		MulRec - Unchecked
Channels		
CH01		
CS Input Tab	Drawing Tab	
Range – ±5.0 V	Method – minmax	
Probe – x1	Connect Dots - Checked	
DC Coupling		
Impedance - 1 Mohm		
CH03 (Tools>Subchannel>Source>CH01)		
Subchannel Tab	Drawing Tab	
Start Trigger– 0	Method – minmax	
End Trigger – 1600	Connect Dots – Checked	
	Align by Trigger	
CH04 (Tools>Subchannel>Source>CH01)		
Subchannel Tab	Drawing Tab	
Start Trigger– 7200	Method – minmax	
End Trigger – 9700	Connect Dots - Checked	
	Align by Trigger	

Table 3. Matec Parameters

Msbca		
Gain – 49.5 dB	RepRate – 13.000 ms	Trigger - Intern
Pulse Width – 19.38 µs	RxTx – Pulse Echo	Frequency – 0.150 MHz
Rectify – None	Voltage – High	LP Filter – None
Output Level – 95%	Hardware Present - Checked	Base Address – 0300, 768

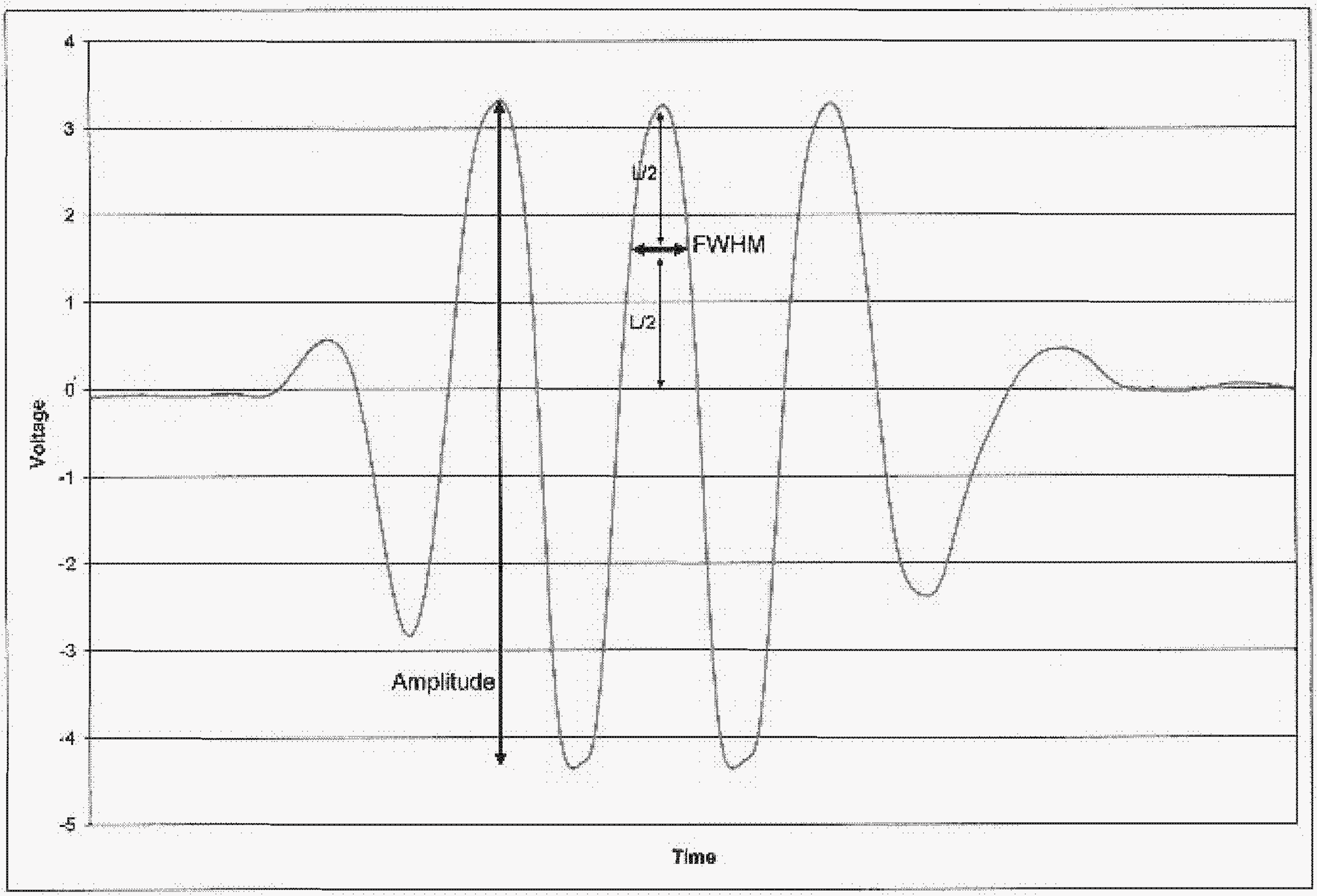

Figure 4. Amplitude and FWHM of Echo

Table 4. Pulse-Echo Data

	6' Coiled		6' Uncoiled		100' Coiled		100' Uncoiled		200' Coiled		200' Uncoiled	
	Pulse	Echo	Pulse	Echo	Pulse	Echo	Pulse	Echo	Pulse	Echo	Pulse	Echo
Peak (v)	3.3490	3.3270	3.3374	3.3282	3.3368	3.3368	3.3405	3.3417	3.3386	3.3350	3.3496	3.3221
Trough (v)	-4.4141	-4.3591	-4.4088	-4.3591	-4.4159	-4.3677	-4.4232	-4.3732	-4.4232	-4.3695	-4.4287	-4.3658
Amplitude (v)	7.7631	7.6862	7.7462	7.6874	7.7527	7.7045	7.7637	7.7149	7.7618	7.7045	7.7783	7.6880
Amplitude Gain from 6' (dB)	-	-	-	-	-0.0116	0.0207	0.0196	0.0310	-0.0014	0.0207	0.0360	0.0007
Full Width at Half Max (µs)	-	2.44	-	2.42	-	2.46	-	2.46	-	2.46	-	2.42

amplitude of the same signal when using the 6' cable. Table 5 displays the mean values of the measurements and calculations.

Table 5. Mean Values

	Pulse	Echo
Peak (v)	3.3420	3.3318
Trough (v)	-4.4190	-4.3657
Amplitude (v)	7.7610	7.6976
Amplitude Gain from 6' (dB)	0.0107	0.0183
Full Width at Half Max (μs)	-	2.44

Test Evaluation and Conclusion

Increasing the signal cable length from 6' to 200' did not introduce a significant or noticeable loss to the signal strength of the ultrasonic system. Also, the coiled/uncoiled configurations had no measurable effect on signal strength. There was no linear trend corresponding to a reproducible attenuation associated with different lengths of cable (Figure 5). Amplitude measurements averaged 7.761 volts and 7.698 volts for the pulses and echoes respectively, and differed by small voltages on the order of tens of millivolts. This corresponds to signal losses, and also gains, of 0.04 dB or less. These variations in amplitude could be the result of external noise due to the fact that they are so small (<1%) and appear to be of random nature. The mean FWHM was 2.44 μs and varied by tens of nanoseconds, corresponding to changes of less than 2%. This also does not appear to be directly related to cable length.

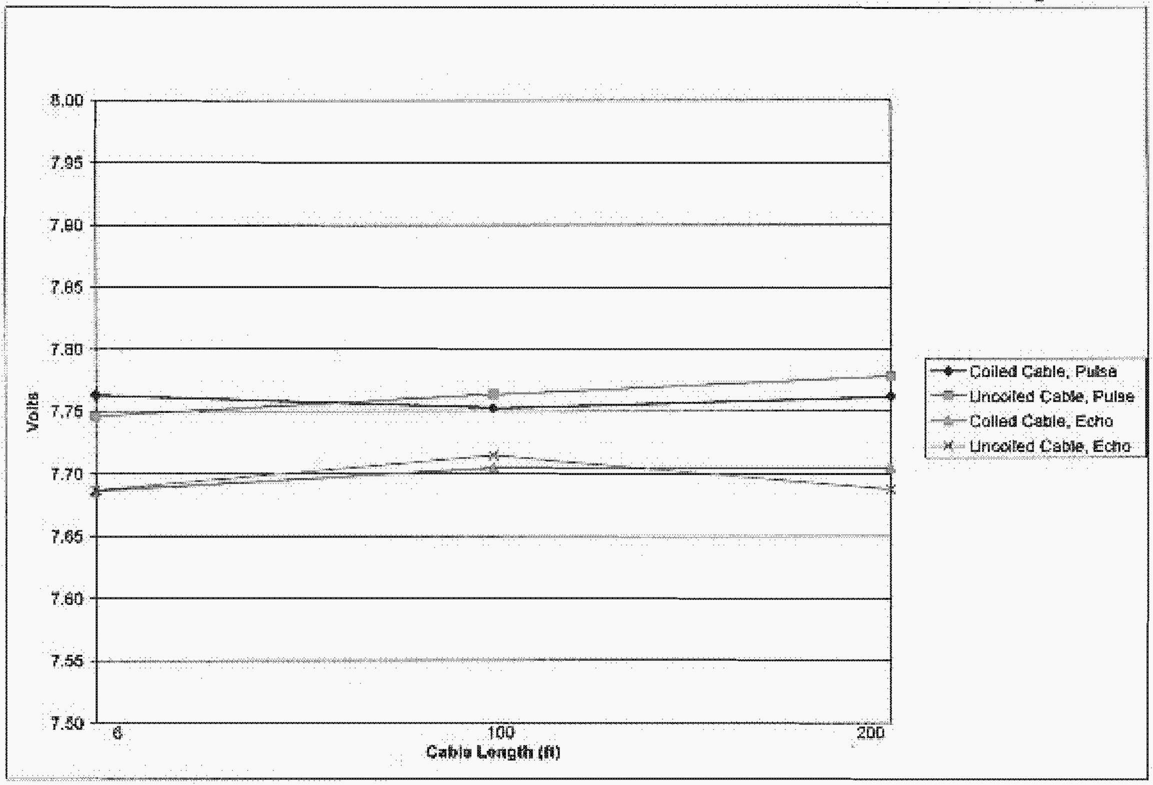

Figure 5. Signal Amplitude vs. Cable Length