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Calibration of Photocon Pressure Transducer Model No. 464-150

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CALIBRATION OF PHOTOCON PRESSURE TRANSDUCER MODEL NO. 464-150

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SUMMARY

Utilizing the techniques developed under Task I of the investigation of the calibration of microphones to be used for sonic boom evaluation,[1] three Photocon microphone systems have been calibrated. This calibration includes a measurement of the frequency response of the transducers obtained by use of an infrasonic pistonphone in the frequency range from 0.01 Hz to 10 Hz. The effect on transducer sensitivity by changes in transducer balance sensitivity was evaluated and found to vary considerably with balance meter reading. An electrostatic actuator was used to obtain both the steady state response of the transducer as well as the rise time and overshoot characteristic to a step function. Finally, utilizing the electrostatic actuator system developed for NASA to produce N-wave pressures on a microphone, the Photocon transducer response to an ideal N-wave was obtained.

INTRODUCTION

A report[1] has been prepared describing an electrostatic actuator system for producing both steady state and transient simulated

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[1] Brown, R.; and Van Houten, J. J.: Investigation of the Calibration of Microphones for Sonic Boom Measurement. Technical Report No. 0-71200/7TR-112, LTV Research Center, Western Division, 1967.

pressures on the diaphragm of a microphone. Included in this report is a procedure which provides a measure of the various characteristics of interest for a transducer being used for transient pressure measurements. This procedure has been summarized in Table I. To provide an example of the implementation of this procedure, a calibration has been performed on a Photocon pressure transducer. The results of this calibration are included in the material to follow.

TRANSDUCER CALIBRATION

Figure 1 illustrates the low frequency pressure response of three Photocon transducers. The data were obtained using the infrasonic pistonphone up to 10 Hz and a standard audio pistonphone at frequencies to 200 Hz. This calibration has been made with an accuracy of $\pm$ 0.2 dB. The remainder of the microphone pressure response, shown in Figure 2, is obtained using an electrostatic actuator. This curve is an exact representation of the microphone pressure response. Correlation between the frequency and time domain response of the microphone can also be demonstrated using the electrostatic actuator. The step function response of the transducer is also shown in Figure 2. The electrostatic actuator may be used to obtain the microphone sensitivity but to a lesser degree of accuracy.

The waveforms shown in Figure 3 illustrate the technique of simulating a complex pressure waveform utilizing the electrostatic actuator. This type of simulation is especially useful when the microphone is subjected to complex waveforms which are not easily transformed from the time to frequency domain. It can also be used as an accurate one-step procedure for calibration of a microphone to be used in a specific application such as sonic boom measurements.

The tuning sensitivity of the Dynagage system, affected primarily by the length of microphone cable, was measured using the pistonphone. The data, shown in Figure 4, indicate a change in acoustic sensitivity of approximately 4 dB while the meter reads in the green area. This is a potential source of error which should be considered when making acoustic measurements.

TRANSDUCER MOUNTING TECHNIQUES DURING FIELD APPLICATION

The Photocon pressure transducer was positioned in the pistonphone with a ground mounting board similar to those used in field applications. A fixture in the board provides a resilient mounting for the microphone and protection for the venting tube to the cavity below the microphone diaphragm. No deterioration in low frequency response as a result of the mounting procedure was observed. As long as the hole under the microphone is reasonably sized, no deterioration in low frequency response of this microphone will occur. In the event that the microphone was positioned on the ground without adequate volume provided, the venting could be "short circuited" and the low frequency response characteristics of the microphone would be altered. However, with NASA's current mounting procedure it is unlikely that this situation would exist.

TABLE I CALIBRATION PROCEDURE

STEP	PROCEDURE DESCRIPTION	INFORMATION DERIVED
1A	Infrasonic Pistonphone Calibration (2 Frequencies in Passband)	Microphone Sensitivity at 94 or 114 dB SPL
1B	Infrasonic Pistonphone Frequency Response (0.01 Hz to 10 Hz)	Microphone Low Frequency response at 94 or 114 dB SPL
2A	ESA Frequency Response (0.1 to 20,000 Hz)	a) Electronics Low Frequency Response b) Microphone Pressure Response
2B	ESA Sensitivity Calibration (2 Frequencies in Passband)	Microphone Sensitivity at Levels to 128 dB SPL for Comparison with Step 1A
3	ESA Complex Waveform Response	N - Wave Response, Rise Time Characteristics, etc.

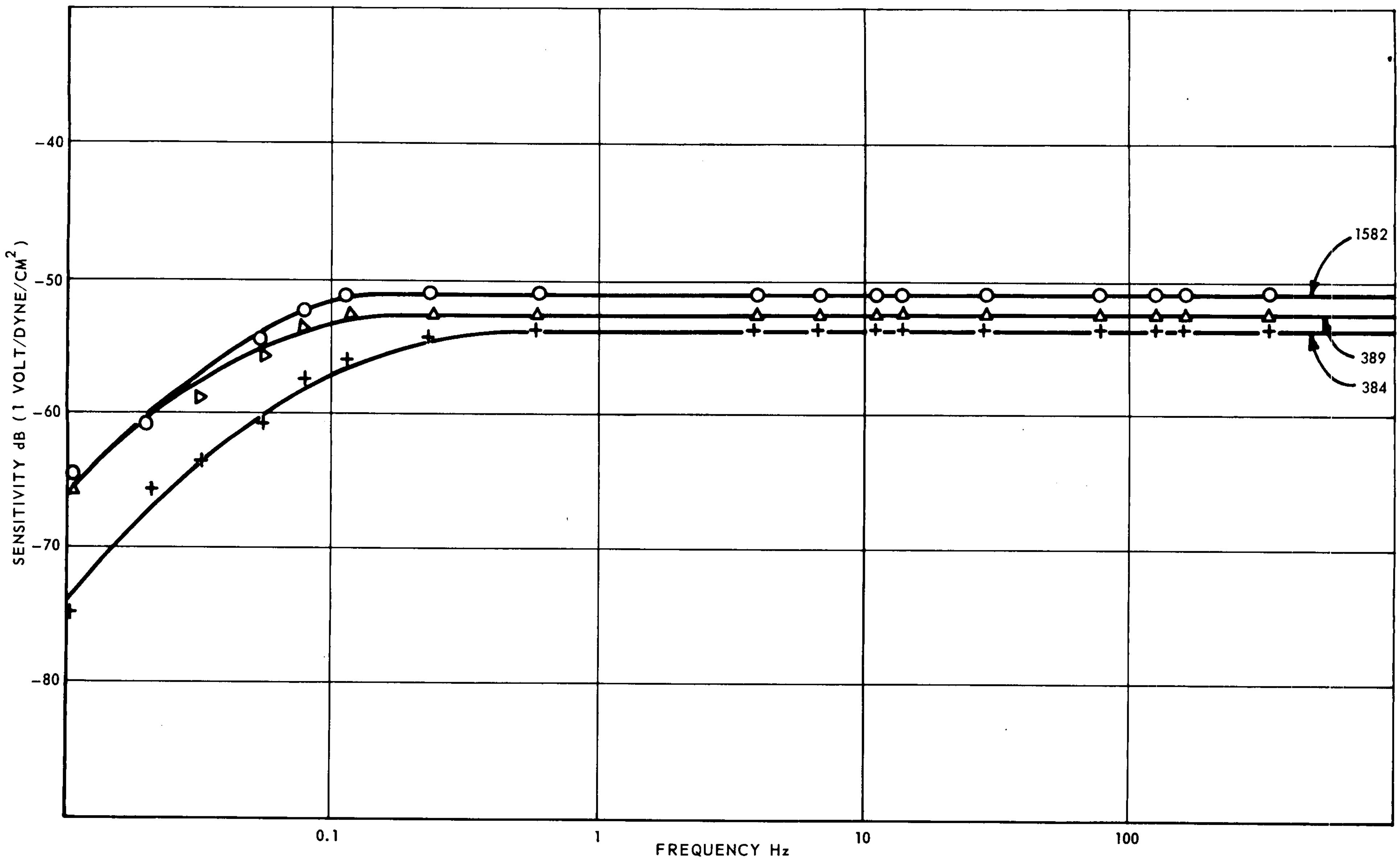
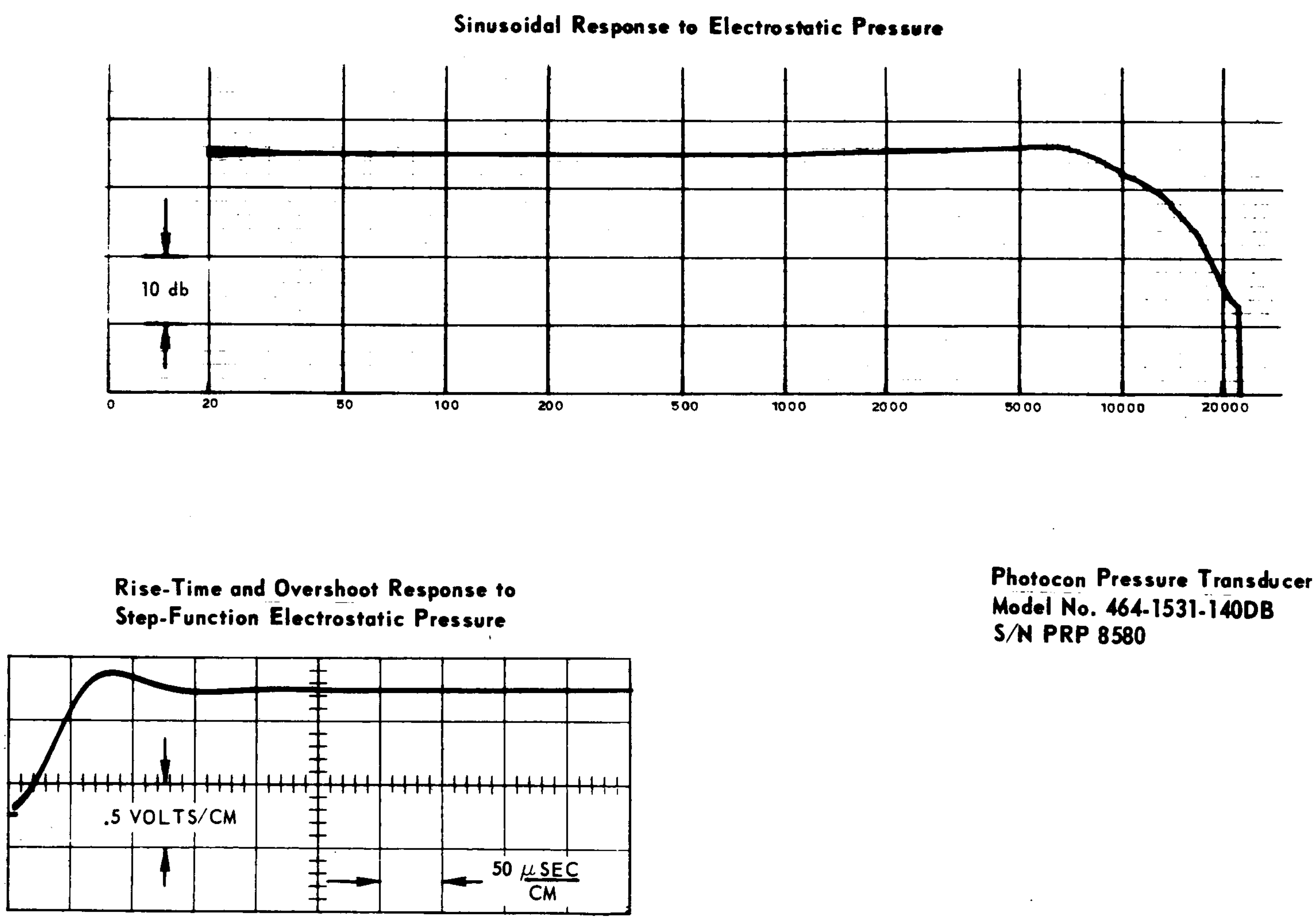
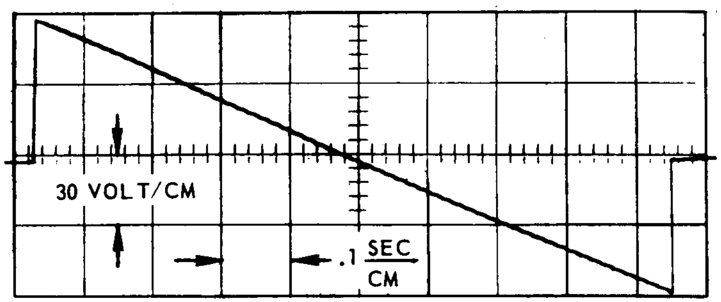


Fig. 1 Frequency Response of Photocon Pressure Transducers Model No. 464-150

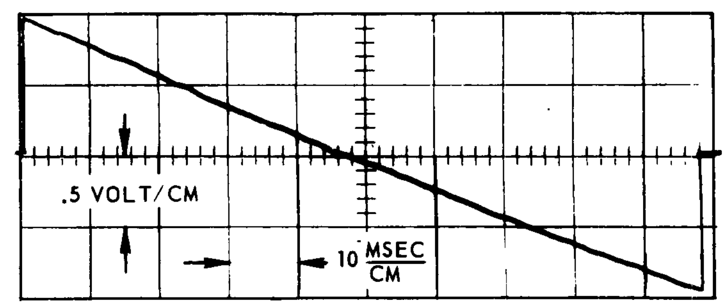


Sinusoidal and Step-Function Response of Photocon Microphone to Pressures Produced by the Electrostatic Actuator

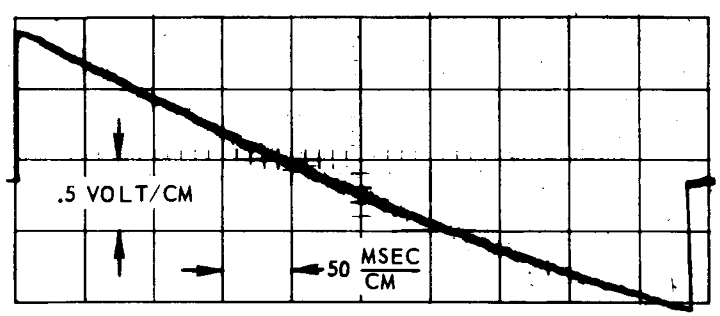
Fig. 2. Sinusoidal and Step-Function Response of Photocon Microphone to Pressures Produced by the Electrostatic Actuator



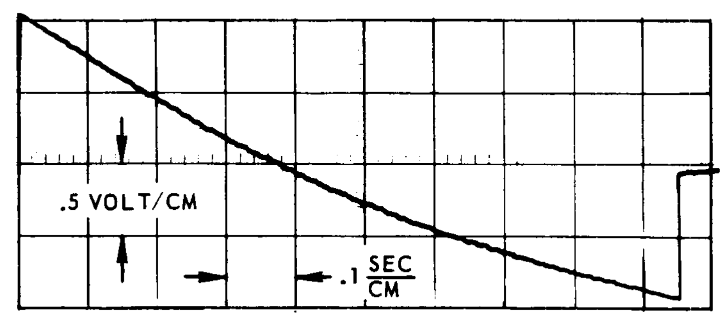
TYPICAL INPUT VOLTAGE TO ELECTROSTATIC ACTUATOR
(T_o = 1 SEC)



OUTPUT WAVEFORM (T_o = .1 SEC)



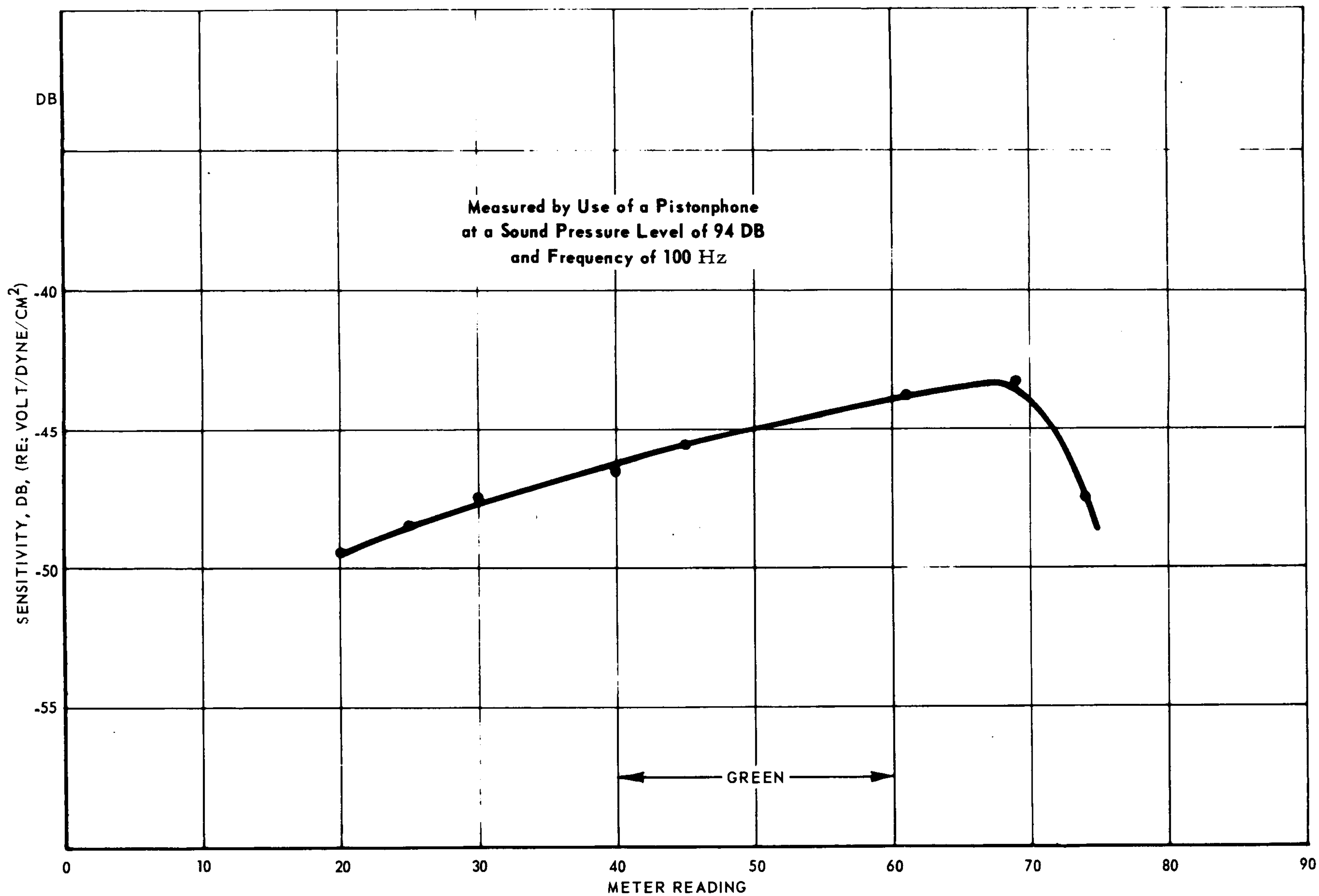
OUTPUT WAVEFORM (T_o = .5 SEC)



OUTPUT WAVEFORM (T_o = 1 SEC)

N-Wave Response of Photocon Microphone

Fig. 3. N - Wave Response of Photocon Microphone



Photocon Pressure Transducer Balance Sensitivity

Fig. 4. Photocon Pressure Transducer Balance Sensitivity