

POLAROID
ULTRASONIC RANGING SYSTEM HANDBOOK
APPLICATION NOTES/TECHNICAL PAPERS

ULTRASONIC RANGING SYSTEM

Description, operation and use information for conducting tests and experiments with Polaroid's Ultrasonic Ranging System components.

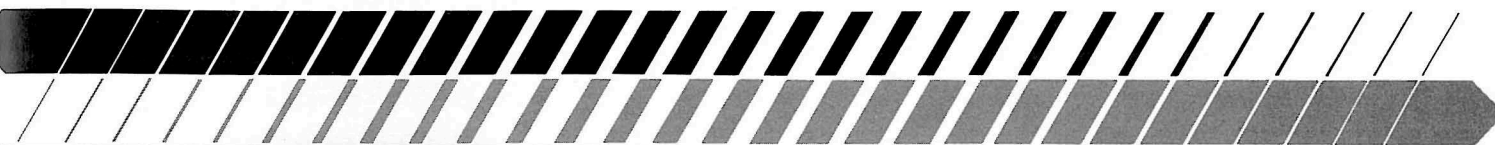


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POLAROID ULTRASONIC RANGING UNIT

Introduction

The purpose of this manual is to familiarize you with the Polaroid Ultrasonic Ranging Unit. It is intended to provide enough detail so that you can easily conduct tests and experiments with this device to determine its suitability to your needs.

This kit is intended for experimental use only.

The first section of this manual is a brief overview of the major components of the system and their functions. The second section contains the information you will need to operate and interface with this device. In addition, typical waveforms, timing diagrams, schematics and characteristic graphs are included.

Section three describes the experimental demonstration board included in this kit. This board will enable you to immediately begin your evaluation of the ranging unit with a minimum of effort.

At the end of this manual, you will find technical specification sheets. We at Polaroid look forward to your continued interest in our ultrasonic products as well as the other Polaroid products included in this kit.

Please note that components other than the ultrasonic transducer are available for sale.

This kit comes complete with:

- (1) 1-Polaroid Instrument-Grade Electrostatic Transducer Part No. 604142
- (2) 1-Polaroid Ultrasonic Ranging Board (modified)
 single-frequency Part No. 607089
- (3) 1-Experimental Demonstration Board
- (4) 1-Polaroid Circular Polarizer
- (5) 2-Polaroid Polapulse Batteries Part No. 604152
- (6) 1-Polapulse Battery Holder Part No. 604145
- (7) 1 Cable Assembly Part No. 604789
- (8) Assorted Connectors and Wires

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I—GENERAL DESCRIPTION

Two primary components comprise the Polaroid Ultrasonic Ranging Unit: they are an acoustical transducer and ranging circuit board (Figure 1).

Together these components are capable of detecting the presence and distance of objects within a range of approximately 0.9 feet to 35 feet. In operation, a pulse is transmitted toward a target

and the resulting echo is detected. The elapsed time between initial transmission and echo detection can then be converted to distance with respect to the speed of sound. For a transmitted pulse to leave the transducer, strike a target two feet away, and to return to the transducer, requires an average time lapse of 3.55 milliseconds.

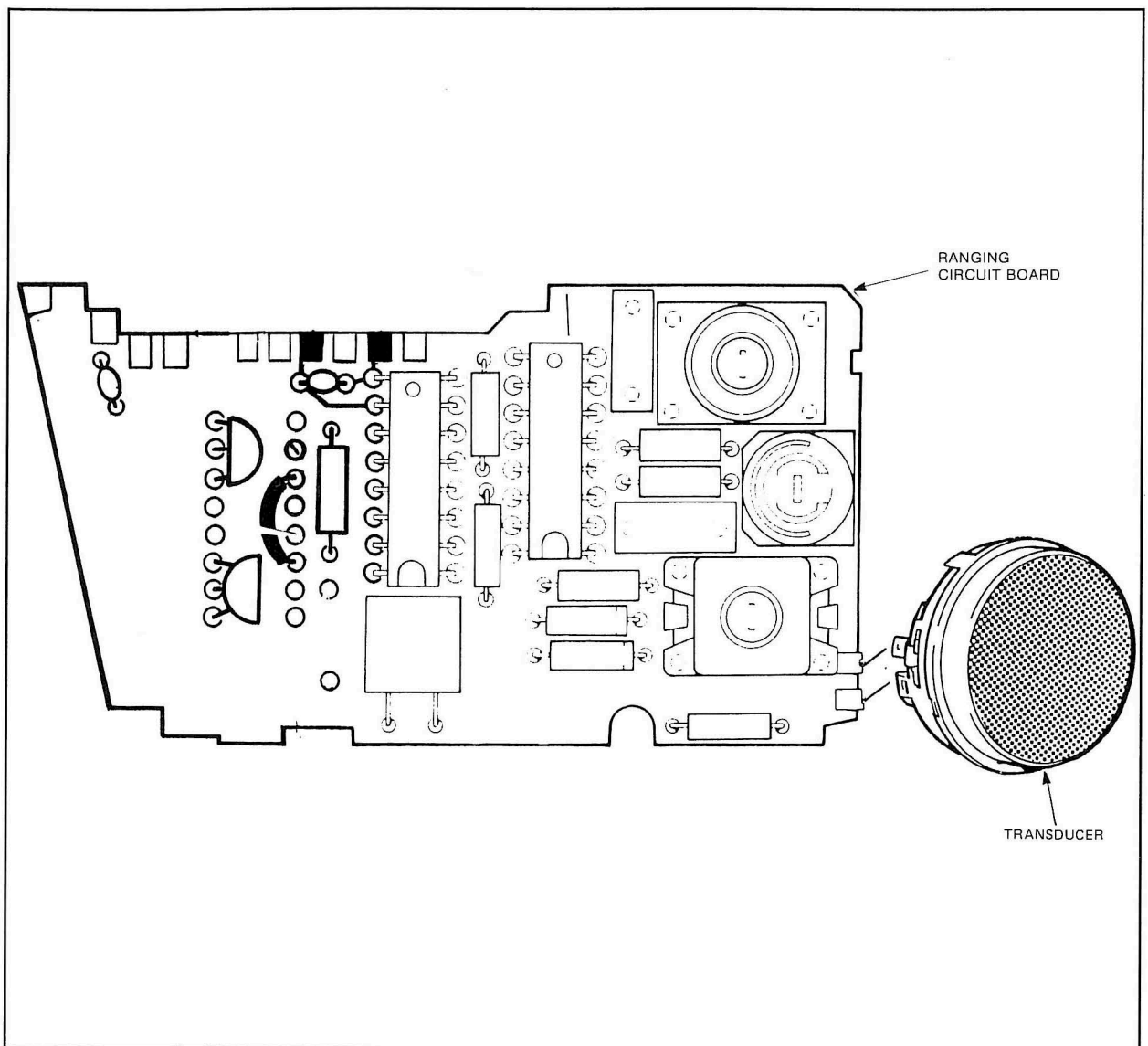


FIGURE 1. BLOCK DIAGRAM — RANGING CIRCUIT BOARD/TRANSDUCER

The principal component in this device is the transducer (Figure 2), which acts as both loudspeaker and microphone. It has been designed to transmit the outgoing signal and also to function as an electrostatic microphone in order to receive the reflected signal (the echo). Its diameter determines the acoustical lobe pattern, or acceptance angle, during the transmit and receive operation. A special, Polaroid manufactured foil is stretched over a grooved plate, forming the moving element which transforms electrical energy into sound waves and the returning echo back into electrical energy. The grooved, metallic backplate in contact with the insulating side of the foil forms a capacitor which, when charged, exerts an electrostatic force to the foil. The foil is pliable, capable of resisting harsh environments, and an excellent electrical conductor.

NOTE: Polaroid Corporation offers three electrostatic transducers for sale; Instrument Grade, Environmental Grade and the 7000 Transducer. The Instrument Grade transducer is included in this kit to meet the performance demand of the ultrasonic circuit board to range between 0.9 feet and 35 feet.

Under no circumstances should the user attempt to open or rebuild the transducer as this will change its acoustical characteristics.

WARNING: Be certain that the transducer is properly connected to the ranging circuit board before applying power. Applying power to the board with the transducer disconnected may damage the board.

When the unit is activated, the transducer emits a sound pulse, then waits to receive the echo returning from whatever object the sound pulse has struck. The emitted pulse is a high-frequency, inaudible "chirp," lasting for about one millisecond and consisting of fifty-six pulses.

The ranging circuit board electronics (Figure 3) control the operating mode (transmit/receive) of the transducer. It is comprised of three major

sections, which control transducer operation and allow the information gathered by it to be used as desired. Among the sections are: a digital circuit, an analog circuit and a power section.

Powered by a 6 VDC supply, capable of 1 millisecond current surges of at least 2.5 amps, an appropriate drive circuit initiates the transmission of an ultrasonic pulse by the transducer (Figure 4). (Several drive circuits are described later in this book.)

A ceramic resonator-controlled clock in the digital circuit generates the pulse transmitted by the transducer.

After generating the "Chirp," the operating mode of the transducer changes, in effect, from loudspeaker to microphone to detect the returning echo. Upon receiving the echo, the transducer converts the sound energy to electrical energy, which is amplified by the analog circuit, then detected by the digital circuit to produce the echo received signal.

WARNING: A 300 volt signal is applied across the transducer each time a "chirp" is transmitted. Anyone contacting this signal during transmission will feel a noticeable, but harmless, shock.

Because of the reduction in return signal strength (echo) over longer distances (return signal power at 35 feet is almost a million times weaker than at 3 feet), a dual role is played by the amplifier within the analog circuit. In addition to processing the echo, the amplifier also performs the function of maintaining a tailored sensitivity over the entire operating range (distance covered) of the system. Lower amplification is needed for close echoes, while higher amplification is needed for distance echoes. The change in amplification is accomplished by increasing the gain and the Q of the amplifier in eight steps, out to 13.3 feet, and then by increasing just the gain of the amplifier, again in eight steps, beyond 13.3 feet. For optimum performance, a tailored sensitivity over the entire operating range is important and necessary.