

Ultrasound Range Finder

PCB Version 1.0

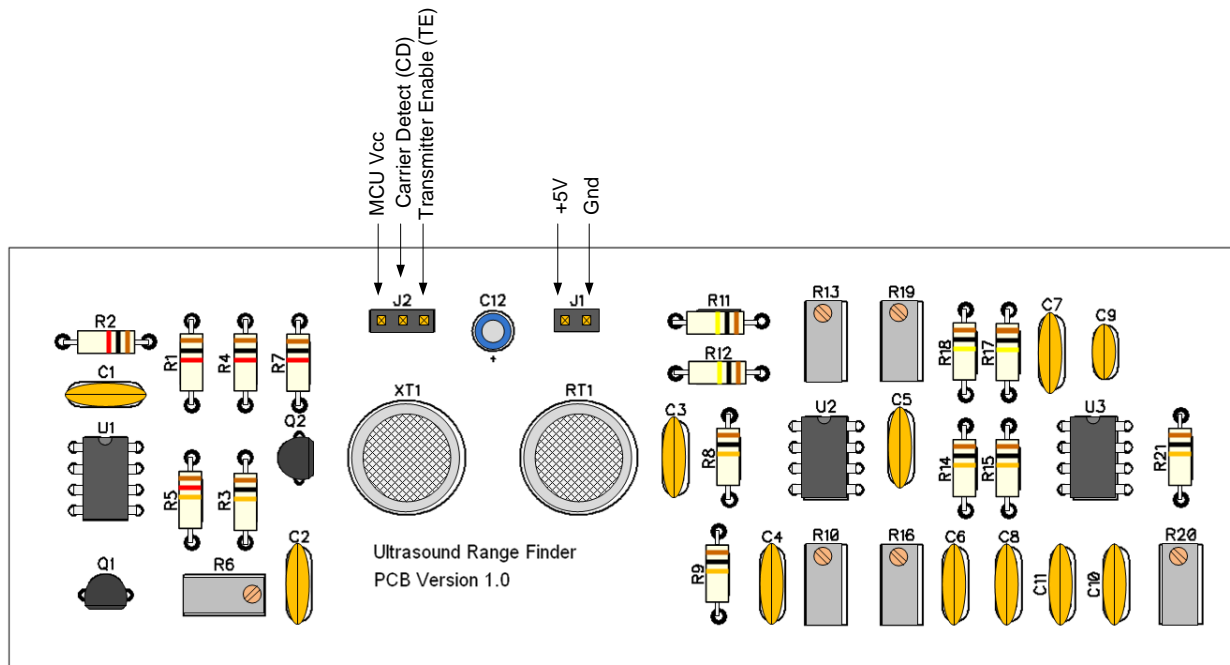
Features

- 4.5V to 9V Power Supply Range
- 30° Transmitter Beam Angle
- 30° Receiver Response Angle
- Ultra High Gain (A=2500) Low Noise AF Amplifier
- Precision PLL Band-Pass Detector
- Onboard 40Khz Oscillators
- 10ft Range and 5Khz Receiver Bandwidth
- 100mA Open Collector Digital Output
- Interfaces easily with 3V and 5V logic

Applications

- Robotic Obstacle Sensors
- Automotive Backup/Parking Collision Avoidance Indicators
- Manufacturing Conveyor Counters and Proximity Sensors
- Alarm System Motion Detectors
- Automatic Door Openers

Connection Chart



Transmitter with Onboard Oscillator

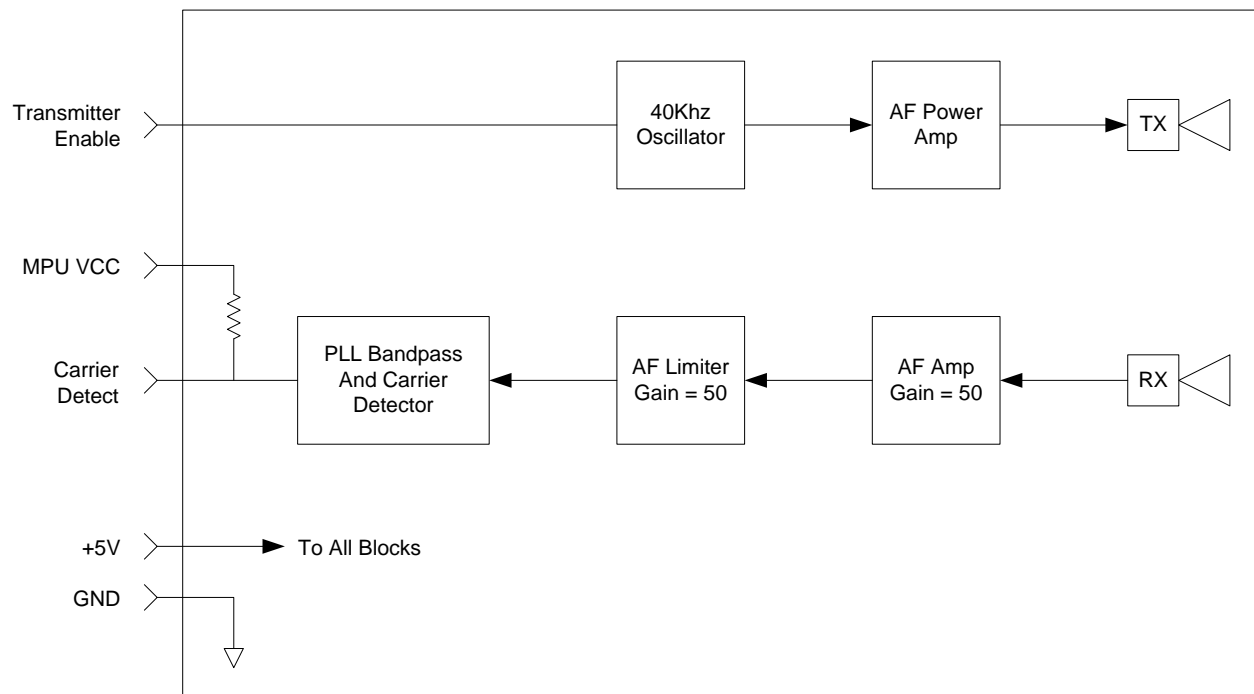
Receiver with AF Amplifier and PLL Band-Pass Detector

Range Finder Functional Description

The Ultrasound Range Finder is a complex device capable of simultaneous transmission and reception of highly directional 40KHz ultrasound. The transmitter and receiver use piezoelectric transducers which exhibit a sharp band-pass response ($Q = 40$) and center frequency of 40KHz. This band-pass response permits the range finder to operate without complex analog filters, requiring only AF amplification/limiting and a PLL detector. The internal oscillators and detectors offload work from the external processor and simplify software development. And the interface design permits the range finder board to be connected to a variety of MCU modules.

40KHz Oscillator

The 40KHz ultrasound carrier for the transmitter is created by a relaxation oscillator implemented with a 555 timer. The oscillator can be enabled and disabled under microprocessor control by sending a logic level HIGH on the Transmitter Enable pin. Any suitable logic high voltage (3v, 5v, etc.) may be used to turn the transmitter on. The oscillator signal is amplified by the AF Power Amp and sent to the piezo ultrasound transmitter. The Transmitter Enable pin can be used to send an ultrasound pulse of any length between 250 μ S and infinity. The transmitter requires only 50 μ S to generate a stable output once the Transmitter Enable signal has been received.



Ultrasound Range Finder Block Diagram

AF Amplifier

Ultrasound reflections from the transmitter are received by a piezoelectric ultrasound receiver. The output of the ultrasound receiver is in the μV range requiring amplification before it can be used by the detector. The first stage AF amplifier provides a fixed gain of 50 and has been designed with a 'T' feedback circuit that allows high gain, high input impedance, and low noise. For maximum stability and sensitivity, the AF Amplifier uses a precision op-amp with 10MHz gain bandwidth, $12\text{V}/\mu\text{S}$ slew rate, 104 Meg ohm input impedance.

AF Limiter

The range finder provides an AF limiter with gain of 50 for preventing false triggering of the carrier detector caused by distant ultrasound sources or Johnson-Nyquist noise typical of high gain amplifier stages. Total gain of the two amplifier stages is 2500 which is more than sufficient to detect large objects approximately 10ft feet away. For maximum stability and sensitivity, the AF Limiter uses a precision op-amp with 10MHz gain bandwidth, $12\text{V}/\mu\text{S}$ slew rate, 104 Meg ohm input impedance.

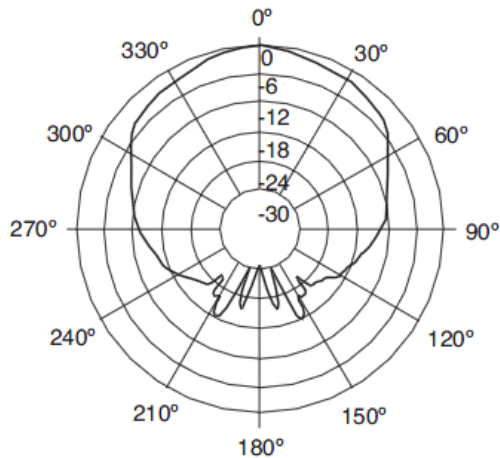
PLL Band-Pass Detector

Although the ultrasound transducers provide a sharp roll-off from their 40KHz center frequency, the roll-off is not enough to prevent unwanted frequencies from being amplified and presented at the output. To detect only the 40KHz carrier, a Phase Locked Loop is employed which provides the equivalent of a band-pass filter representing ideal roll-off response and 5KHz bandwidth. The PLL is internally coupled to a Phase Detector that provides a digital open collector output capable of sinking 100mA. The output offers low impedance when the PLL locks onto the transmitter signal and high impedance when the PLL is not locked. The output can swing between .4V (typical) and any suitable logic high voltage (3v, 5v, etc.) by attaching the external device VCC to the range finder board VCC pin.

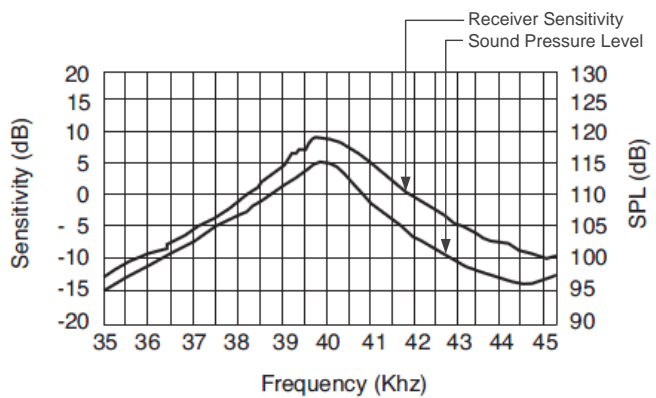
Technical Specifications

Parameter	Minimum	Typical	Maximum	Units
Supply Voltage	4.5	5.0	9.0	V
Supply Current	25	30	45	mA
Transmit Pulse Width	250	1000		μS
Transmit Logic High Voltage	2.5	5.0	9.0	V
Transmit Logic Low Voltage	0.0	0.4	0.7	V
TX/RX Carrier Frequency		40		kHz
RX Carrier Bandwidth		5		kHz
Detector Response Time	300	500	750	μS
Detector Saturation Voltage (30mA)		0.2	0.4	V
Detector Saturation Voltage (100mA)		0.6	1.0	V
Output Fall Time		30		nS
Output Rise Time		150		nS

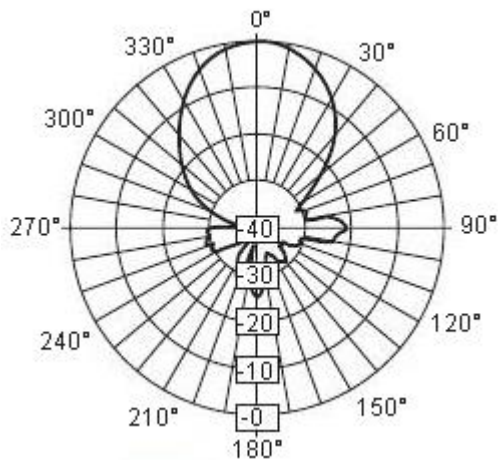
Receiver Response Angle



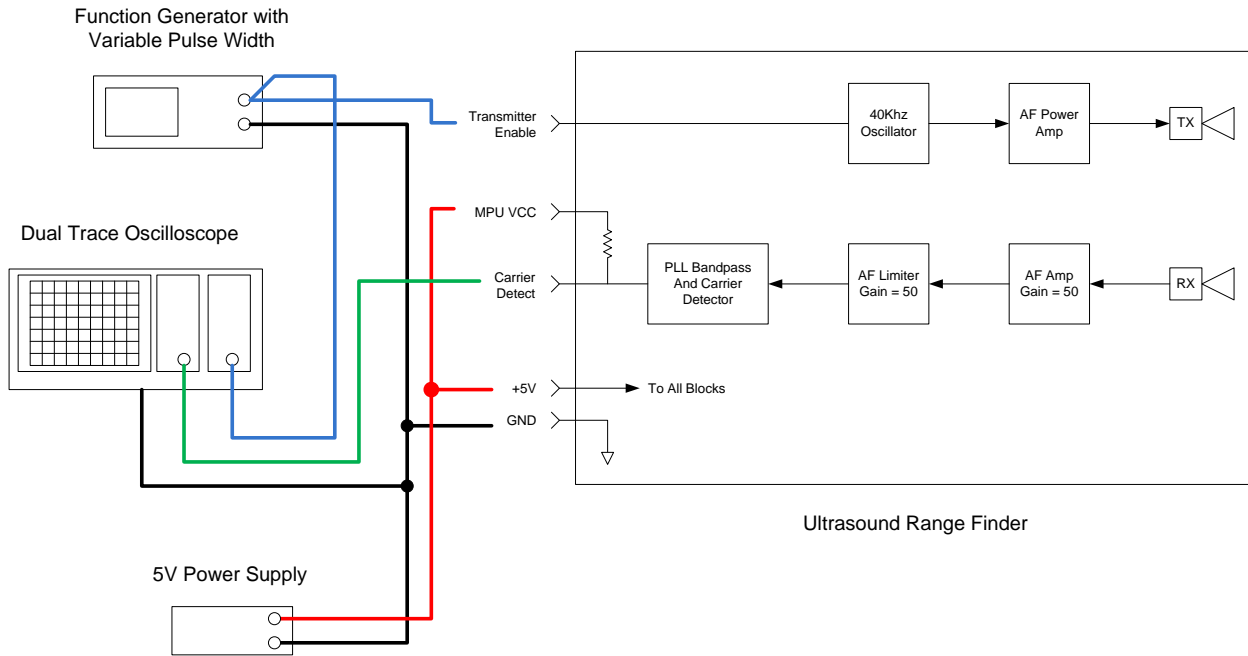
Receiver Sensitivity



Transmitter Beam Angle

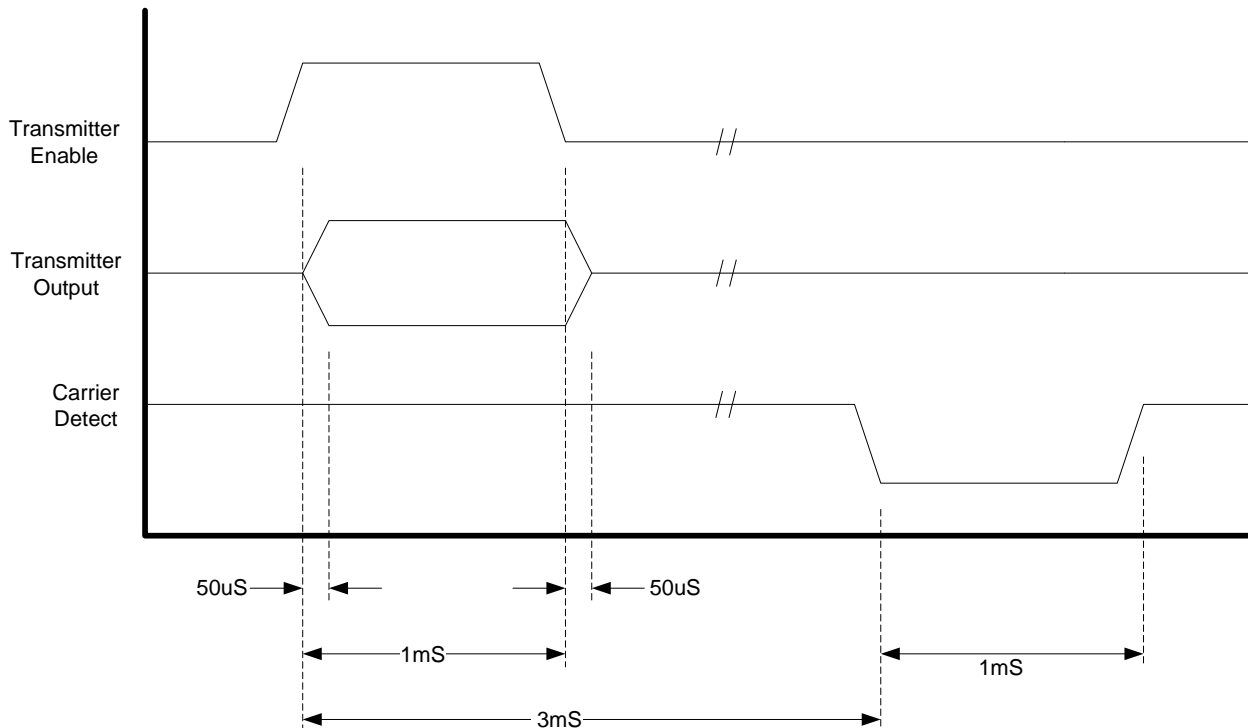


Test/Evaluation Environment

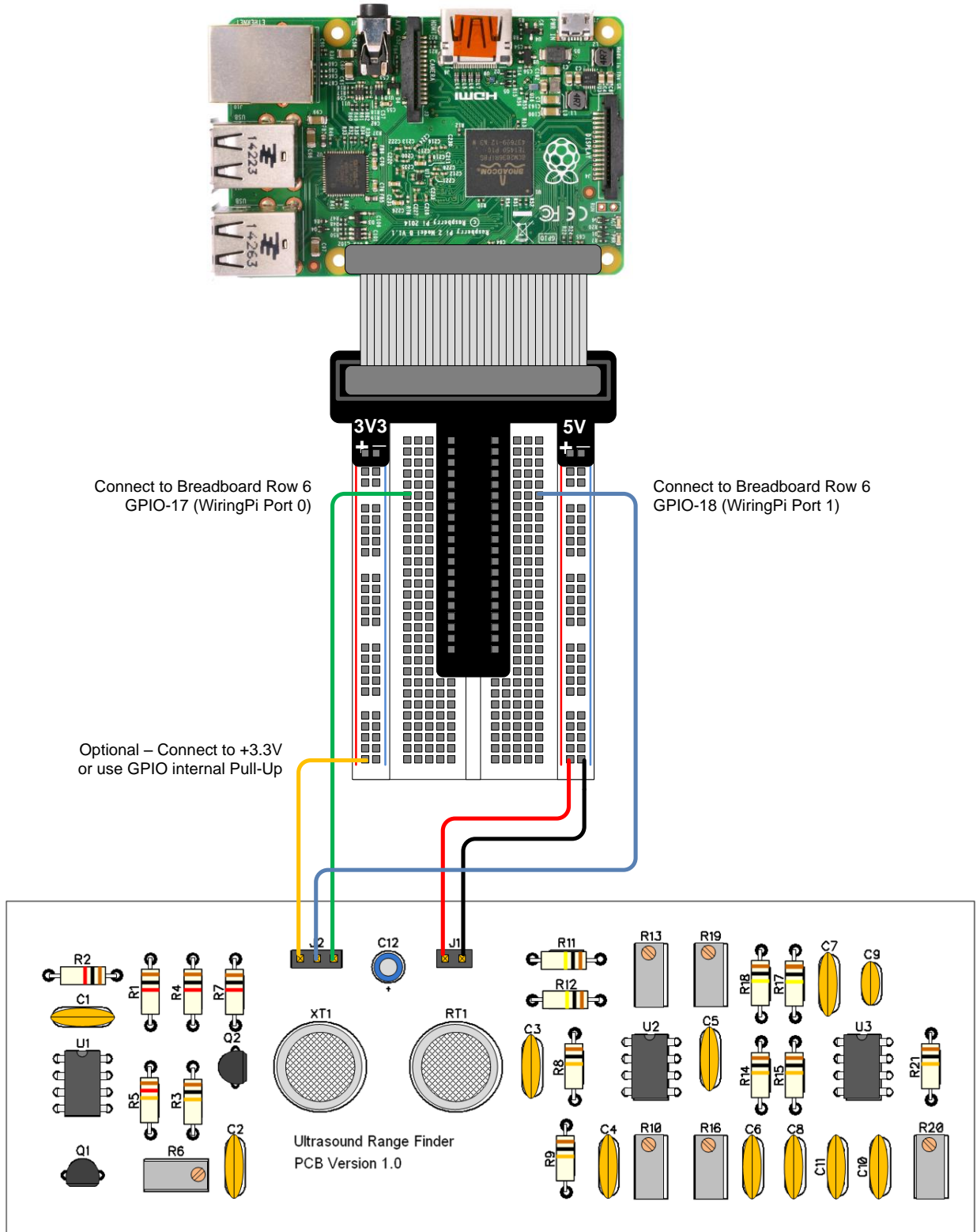


Conditions: Function Generator set for square wave pulse with 1mS on time and 100mS cycle time. Flat target placed 50cm from range finder.

Test Timing Diagram



Typical Application – Raspberry Pi Range Measurement



Typical Application - MSP430 Range Measurement

