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# Verifying and Troubleshooting:
# 6500 Sonar Ranging Module
# Series 600 Smart Sensor

## Introduction

This application note will provide you with information to help you identify and/or resolve any problems you may have with the installation and the operation of our 6500 Sonar Ranging Modules and our Series 600 Smart Sensors.

The electronic inputs and outputs for both our ranging modules and our smart sensors are basically the same, so the information for one will also usually provide the same information for the other.

Major Differences between the 6500 Sonar Ranging Module and the Series 600 Smart Sensor are:

Input Supply Voltage:

- 6500 Ranging Module: +5 VDC
- Smart Sensor: +6 to +24 VDC (contains voltage regulator)

Pull-up Resistors:

- 6500 Ranging Module – Requires external pull-up resistor on the ECHO output (and on the OSC output if used). Usually 4.7K ohms.
- Smart Sensor – Contains internal 4.7K pull-up resistors on the ECHO and the OSC outputs.

Cycle Triggering (INIT):

- 6500 Ranging Module (PID# 615078, 615080) – Requires an external trigger input into INIT to perform a read write cycle.
- Smart Sensor or the Enhanced 6500 Ranging Module (PID# 615079) – Contains an internal 5 Hz cycle clock to create INIT triggering. Can be disabled for external triggering if desired.

## Basic Operation

1. Connect power and ground to the UUT (Unit Under Test - Ranging Module or the Smart Sensor).
   - 6500 Ranging Module: +5 Volts DC @ 100 mA nominal.
   - Series 600 Smart Sensor: +6 volts to + 30 Volts DC @ 100 mA nominal
   - ✓ *Note: If the power supply cannot provide 2 Amperes of current for the 0.5 millisecond transmit period, a 500 to 1000 MFD Electrolytic capacitor between the power and ground connections to the UUT (observe capacitor polarity) can supply this current.*
2. Check for basic transmitting operation.
   A. 6500 Sonar Ranging Module: Apply a TTL Logic Level (zero to 4 volt) square wave to the INIT pin (pin 4). The square wave frequency should be between 1 Hz and 50 Hz.
   B. Series 600 Smart Sensor: Assure that the jumper is installed for the internal 5 Hz cycle oscillator.
      C. The Transducer will generate a "click" sound for each transmit cycle. This is not the ultrasonic sound wave, but it is a characteristic of ultrasonic sensors. If the transducer does not generate this "click" sound, recheck all connections. This sensor MUST transmit before it can receive a returning echo signal.

**Basic Operation (Continued)**

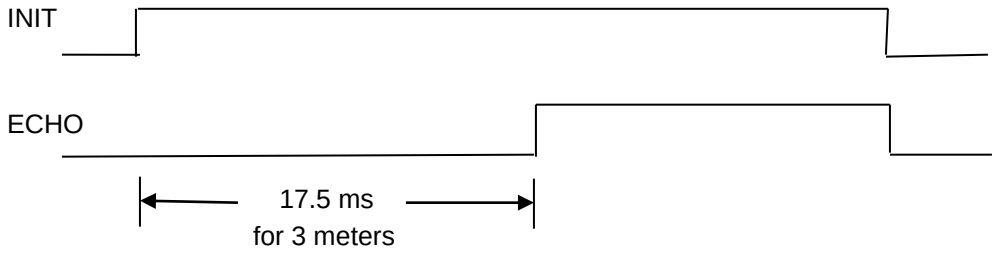
3. Check for basic ECHO return signal. To verify the 6500 ranging module or the Series 600 Smart Sensor operation, connect an oscilloscope to the circuit as follows:
   INIT:
   - 6500 Ranging Module – Pin 4
   - Series 600 Smart Sensor – Pin 5

   ECHO:
   - 6500 Ranging Module – Pin 7
   - Series 600 Smart Sensor – Pin 3

   *Note: The 6500 Sonar Ranging Module (PID# 615078) requires a 4.7K ohm pull-up resistor between the ECHO pin and Vcc (+5 VDC). The Series 600 Smart Sensor and the 6500 Enhanced Ranging Module (PID# 615079) have internal pull-up resistors, and do not require this external pull-up resistor.*

   A. Connect the oscilloscope vertical channel 1 to INIT and use this channel as the oscilloscope trigger (trigger on positive edge).
   B. Connect the oscilloscope vertical channel 2 to ECHO.
   C. Verify that the time between INIT and ECHO waveforms varies with the distance between the transducer and the target.

The INIT signal **must** remain HIGH until after receiving the ECHO signal. When INIT returns to a LOW level, the module is reset, preparing for the next write/read cycle.




The time between INIT and ECHO will be approximately 17.5 milliseconds for a 3-meter distance between the transducer and the target. This time will change as the distance between the sensor and the target changes. The change in the ECHO signal should be a smooth change and should not have any abrupt "jumps" in time. An abrupt change may indicate the reception of a side lob echo and can possibly be eliminated by changing the "Gain" of the module.

The Normal Blanking time = 2.38 milliseconds when the input signals BINH and BLNK are not used. This minimum ECHO return time of 2.38 ms. corresponds to a minimum target distance of 0.41 meters (16.1 inches) at 20° C. If you desire a shorter measuring distance, you must provide a separate BINH Blanking time. For 6 inches, the minimum blanking time is approximately 0.88 ms at 20° C. To achieve this blanking time, the signal BINH must be raised from a logic 0 (low) to a logic 1 (high) 0.88 milliseconds after INIT is raised to a logic 1 (high).

## Troubleshooting

Please disconnect any inputs to BINH and/or BLNK or the OSC output before proceeding with any troubleshooting procedures.

| Function | 6500 Ranging Module | Series 600 Smart Sensor |
|---|---|---|
| BINH | Pin 8 | Pin 6 |
| BLNK | Pin 2 | Pin 7 |
| OSC | Pin 6 | Pin 4 |
| | | |

Disconnecting BINH and BLNK eliminates any potential ground noise on these inputs, which can cause false triggering leading to other abnormal results.

Transmitting Waveforms

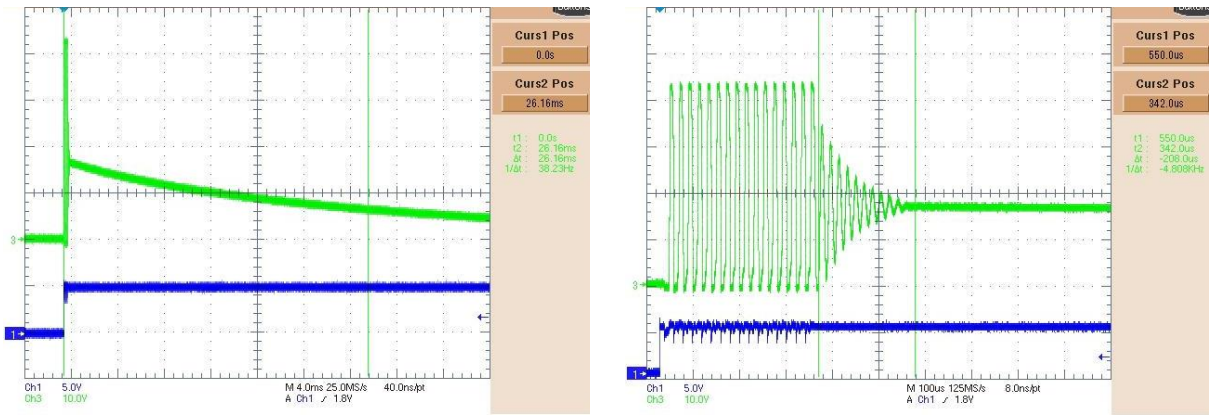
The following Transmit waveforms display the operation of a fully functioning ranging module or Smart Sensor; A transmit cycle starts when the INIT input signal changes from a logic zero to a logic one. The module transmits out 16 ultrasonic pulses at 49.4 kHz. This leaves a residue charge on the transducer of approximately 200 VDC, providing the bias for receiving the returning ECHO signal.

Due to the oscilloscope probe impedance, this voltage decays to zero over time, as shown on the transmit waveform.

Connect the oscilloscope as follows:

a) Channel 1 – INIT signal (the Blue trace). Trigger the oscilloscope on this signal

b) Channel 2 – The transmitted signal on the plus (+) connector on the ultrasonic transducer. (This signal will have a peak amplitude of approximately 400 Volts DC)

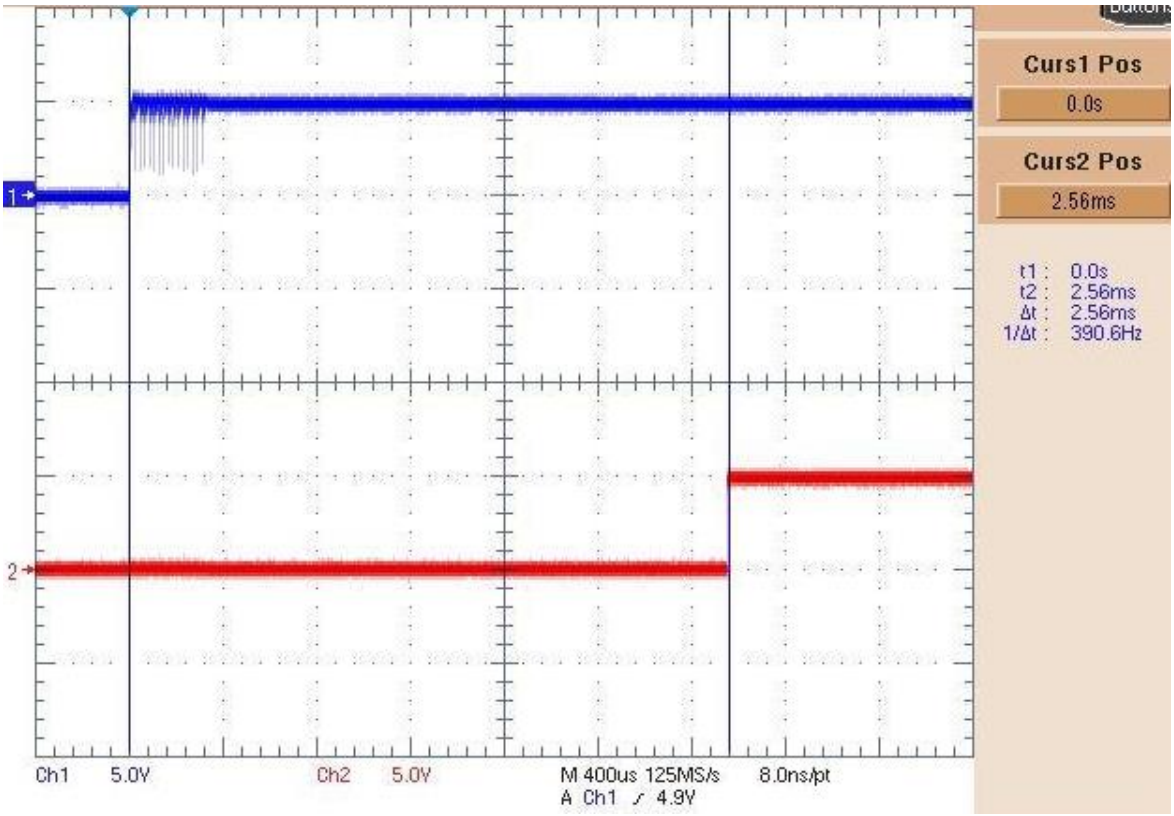



Green = Transducer (+) terminal
Blue = INIT

Receiving Waveforms (INIT/ECHO)

The following waveforms display the operation of a fully functioning ranging module or Smart Sensor. A transmit cycle starts when the INIT input signal changes from a logic zero to a logic one. This ultrasonic signal travels out to a target, and is then reflected, back to the sensor, generating a returning ECHO signal. The time of flight (TOF) timing between INIT and ECHO can then be used in calculating the distance between the sensor and the target.




Connect the oscilloscope Vertical channels as follows:

a) Channel 1 – INIT signal (the Blue trace). Trigger the oscilloscope on this signal, triggering on the waveform's rising edge.
b) Channel 2 – ECHO return signal (the Red trace).

Receiving Waveforms and Returning ECHO Adjustment Procedures

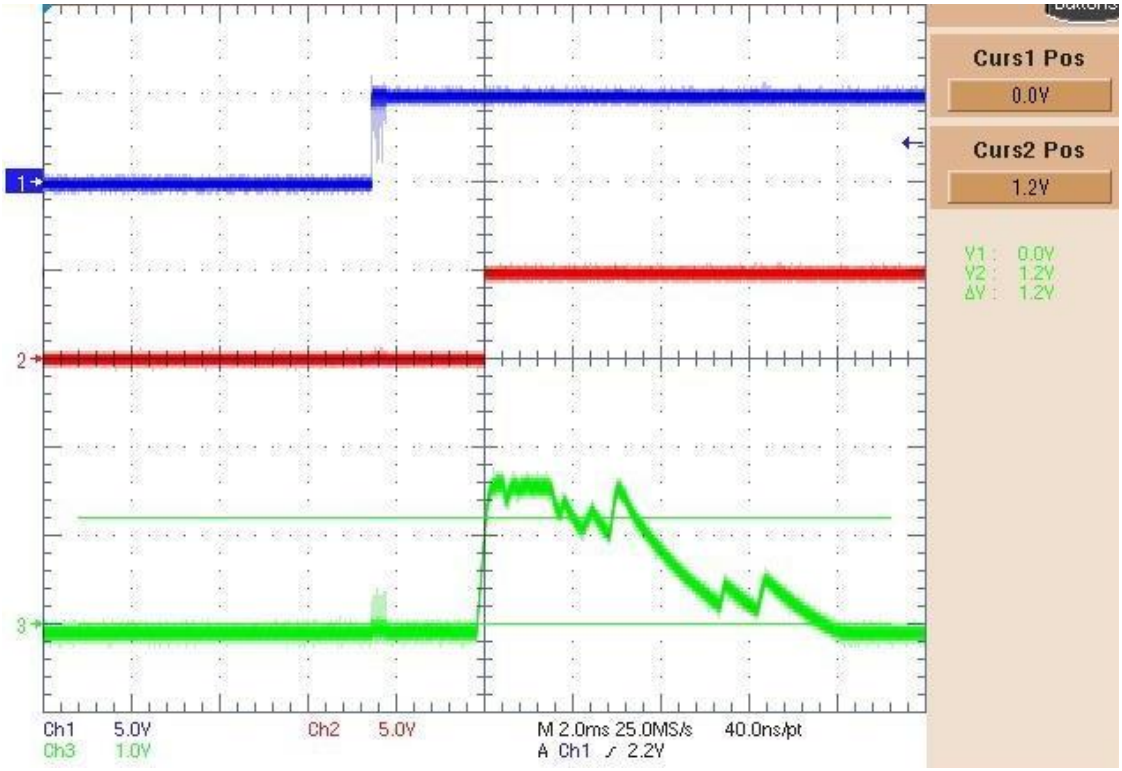
*CAUTION: The following steps should only be undertaken by personnel experienced in electronic Surface Mount Technology (SMT) troubleshooting techniques and using probes on SMT components. Incorrect probe handling can result in component damage to the sensor, voiding all warranties.*

Connect the oscilloscope Vertical channels as follows:

a) Channel 1 – INIT signal (the Blue trace). Trigger the oscilloscope on this signal, triggering on the waveform's rising edge.

b) Channel 2 – ECHO return signal (the Red trace).

c) Channel 3 – REC signal (the Green Trace) (analog chip U1 - pin 9). This signal is the processed analog received echo signal. This signal will vary in both time and in amplitude with the changing distance between the sensor and the target.




The sensor's internal electronics requires the received analog signal output of the analog chip (TL852), U1 – pin 9, to be at least a 1.2 volts peak voltage with respect to ground. When this signal becomes 1.2 volts, then the ECHO output switches from a Logic 0 to a Logic 1. If REC (the processed analog receive signal remains less than 1.2 volts, then ECHO remains in a Logic 0 state, and never switches to a Logic 1 state. Note: the INIT signal must remain at a Logic 1 (HIGH) during the acquisition cycle. When INIT returns to a Logic 0 state, then the internal circuits of the Digital Chip U2 are reset, returning ECHO to a Logic 0 (LOW) state.

The Received ECHO amplitude will vary with the distance between the sensor and the target, and with the GAIN SET potentiometer. By adjusting this potentiometer, you can set the optimum point for consistent detection at the desired distances.