Mekatronix

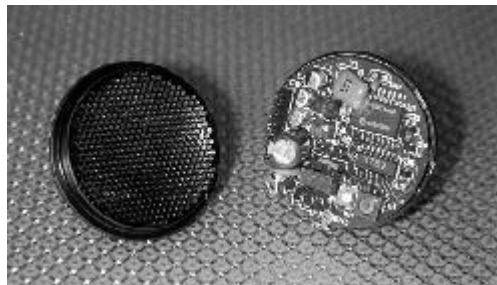# Ultrasonic Sonar Transducer

Users Manual

by

Keith L. Doty

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 Mekatronix™ espouses the view that the personal autonomous agent will usher in a whole new industry, much like the personal computer industry before it, if modeled on the same beginning principles:

- Low cost,

- Wide availability,

- Open architecture,

- An open, enthusiastic, dynamic community of users sharing information.

Our corporate goal is to help create this new, exciting industry!

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MEKATRONIX™   Ultrasonic Sonar Users Manual

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1   Introduction

This users manual provides general guidelines and suggestions in using the Mekatronix Ultrasonic sonar sensor module MUST01™ in many measurement applications. If further technical information is required, please contact Mekatronix technical support at tech@mekatronix.com. Refer to Figure 1 frequently as your read this manual. That figure shows the placement of the different adjustment potentiometers and the 7-pin male header for connecting the sonar system to Mekatronix robots or Mekatronix microcontroller applications.

2   Connector Interface

The MUST01™ comes with a 10inch, 3-wire, *sonar interconnect cable* that possesses a seven pin female connector at one end and a three pin female connector at the other. The seven pin female connector has only three wires attached. Pin one on the transducer's 7-pin connector, the power pin, connects to the center wire (usually white). Pin 2, the ground pin, connects to an outside wire (usually black). Pin 6 connects to the other outside wire (usually gray). The other four pins float and have no attached leads.

The three pin connector inserts into any of the 3-pin male analog input headers on the MTJPRO11™, MSCC11™ microcontrollers or the MRSX01™ sensor boards.

2.1   MUST01™ Connector Pin Description

Pin #	Description
1	Power supply; requires 8-16 VDC regulated with 30 mA current capacity.
2	Common: Return for DC power supply, TTL outputs and clock signals.
3	External trigger: Accepts TTL compatible logic level clock signals (0 to 5VDC).
4	Trigger enable: Allows Mini-A to accept external trigger signals. Enable by connecting pin 4 to common.
5	Clock out: Delivers a TTL compatible clock signal (0 to 5 VDC).
6	Analog output: 0 to 5 VDC proportional to distance of target.
7	No pin (cut off for easy identification of pin seven).

3   General Installation Procedures

1. Always mount the Mekatronix MUST01™ in a suitable, dry location.

CAUTION!

> THE MUST01 HAS ONLY BEEN DESIGNED FOR INDOOR OR PROTECTED ENVIRONMENTS! EXCESSIVE MOISTURE IN THE CIRCUIT BOARD/TRANSDUCER AREA WILL RESULT IN DAMAGE AND IMPROPER OPERATION OF THE UNIT, AND WILL VOID ALL MANUFACTURERS WARRANTIES!

2. Mount the sensor as far off the ground as possible to minimize ground reflections.

3. Adjust gain to minimum setting required to insure reliable target detection. Excessive gain may result in false detection. Section 4.2 provides detailed procedure for adjusting gains.

4. Mount the unit in a location where environmental interference sources are minimized (example: EMI sources, air nozzles, excessive air turbulence, etc.).
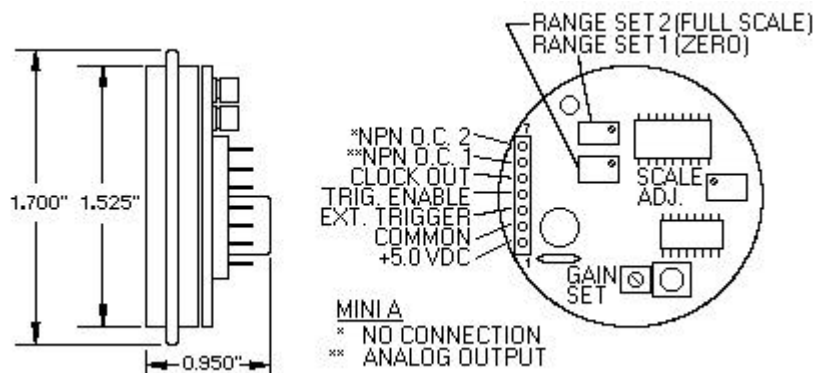
Figure 1. Dimensions of the transducer and the location of the adjustment potentiometers on the circuit board mounted in back of the transducer.

3.1   Mounting the Sonar Module on the TJ, TJ PRO and TALRIK Robots

If you have the ARGOS pan or pan-tilt head and you have purchased the sonar mounting plate, just glue the plate to the head and slip the sonar through the hole in the plate and clip it down. For the TALRIK you will need the sonar mounting plate.

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Attach the Mekatronix sonar interconnect cable to the 7-pin connector on the MUST01. The 7-pin connector inserts onto the MUST01™ 7-pin header (Figure 1) with the center wire connecting to the pin one, the power pin. Reversing the connector will not power the sensor and should not cause any damage, but refrain from developing a bad habit!

Insert the 3-pin connector onto an available the 3-pin analog header on the robot controller board Refer to the robot specific Mekatronix assembly manual for location of the analog headers on the MSCC11™ (TJ™), MTJPRO11™ (TJ PRO™) and MRSX01™ circuit boards. Port- E (PE0, PE1, PE2, PE3, PE4, PE5, PE6 and PE7) on the MC68HC11 microcontroller constitute the analog inputs.

CAUTION!
DO NOT STEP THE PINS! YOU WILL DESTROY THE SONAR SENSOR IF YOU REVERSE POWER (MIDDLE PIN WITH WHITE WIRE) AND GROUND (OUTSIDE PIN WITH BLACK WIRE). THIS IS NOT POSSIBLE IF YOU INSERT THE THREE PINS INTO THE THREE SLOTS.
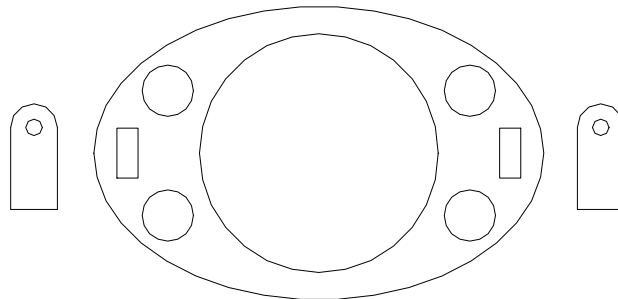

Figure 2. Sonar mounting plate and the two side support tabs that fit on the Tilt mechanism of the Mekatronix two-axis, pan-tilt head. The tabs glue into the slots on the side. The holes in the tab allow for inserting 4/40 machines screws to attach the head to the Tilt mechanism support bars. Other ARGOS heads also mount the Sonar. Check Mekatronix web site for other options

4   Testing and Calibrating the MUST01

You can test the MST01 using any one of the microcontrollers or robots listed in Table 1.

Table 1 Mekatronix systems for testing the MUST01

Mekatronix Part	Mekatronix Part
MINDSTAMP	TJ
MSCC11	TJ PRO
MTJPRO11	TALRIK II
MRC11	ROBOBUG

Connect the sonar and the one of the PortE analog input channels with a F7W3F3 connector, i.e. a 7-pin female at one end (F7) and 3-pin female (F3) at the other end joined by a three-wire (W3) cable (Figure 3). The C program below displays the sonar reading. You can calibrate the sonar using this program.
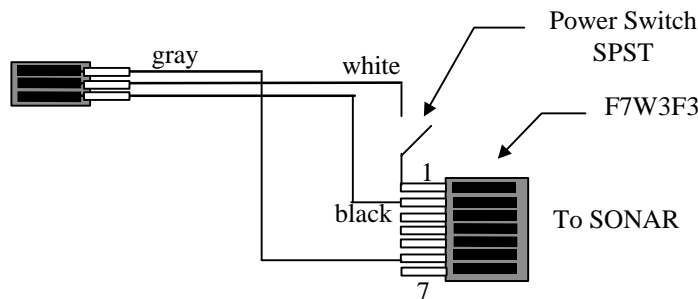

Figure 3. The 7-pin female connector fits into the sonar header. The white wire connects 5volts DC to Pin-1 of the SONAR header. The black wire is common and the gray wire is the analog output signal of the sonar. The three pin female connector fits onto a male header on any available analog channel. The MSCC11, MTJPRO11, TJ, TJ PRO, ROBOBUG and TALRIK II already have such headers on their analog channels (PORTE). The MRC11 only has the analog input pin available on the 60 pin header so the F3 connector will not work on it. For the MRC11 you will have to connect to power and ground at non-adjacent pin locations. The power switch in series with the white wire allows you to turn the SONAR sensor off when not being used or during program development.

4.1   C-Program to Display Sonar Reading

Assume the F3 connector fits over the 3-pin male header connected to analog channel two, i.e., PORTE pin-2 (PE2). The following program written for a MTJPRO11 MINDSTAMP microcontroller will display the sonar reading. For other Mekatronix robots or controllers simply

replace <msbase.h> by the associated "base" header file for the particular product. These are listed in Table 2.

Table 2 Header Files for Sonar Test Program

Part	Header File to Use
MSCC11	`<tjbase.h>`
MTJPRO11	`<tjpbase.h>` or`<msbase.h>`
MRC11	`<tkbase.h> or <msbase.h> or <tjpbase.h>`
TJ	`<tjbase.h>`
TJ PRO	`<tjpbase.h>`
TALRIK II	`<tkbase.h> or <msbase.h> or <tjpbase.h>`
ROBOBUG	`<tjbase.h>`

//Sonar Test Program: useful for testing and calibration

```
//Header files
#include <msbase.h>
#include <stdio.h>

void main(void)
{
//Initialize the Analog-to-Digital-Converter and the serial communications
// interface
  init_analog();
  init_serial();

  CLEAR_SCREEN

  while(1)
  {
    HOME_SCREEN
  //Print the value of the analog channel two, assumed to be the sonar.
    printf( "SONAR VALUE =     \b\b\b\b%d", analog(2));
  }
}
```

After downloading the ".s19" file for the compiled program, open *Terminal* in the IDE to receive the input generated by the last line. Each time you want to make a new reading, simply press reset and the program runs again.

4.2   Sonar Calibration Procedures

Sonar calibration may be performed manually with a voltmeter or with the above program serving as your voltmeter! After establishing the range setting potentiometers, you can aim the sonar a flat wall and measure its response at various distances and potentiometer settings to calibrate accuracy.

1. Apply power to the unit.

2. Allow several minutes warm-up time before calibration.

3. Set gain control to 50% (Fig. 1). Do this by turning the Gain-Set potentiometer fully counterclockwise and then rotate half the distance to the full clockwise position.

4. Program: Observe reading on screen of computer.

    Manual: Connect a DC voltmeter to sensor: + lead to pin 6, - lead to pin 2.

5. Rotate the zero-adjust pot fully counter-clockwise (12-turn pot).
    Watch the readings (manual or program) as you do this.

6. Place target at maximum desired distance. Adjust full-scale pot to 5 VDC. (Program output reads close to 255.)

    ALWAYS ADJUST THE FULL SCALE POT FIRST, THEN ADJUST THE ZERO ADJUST POT.

7. Place target at minimum desired measurement distance (about 6inches or 150mm). Rotate zero-adjust pot clockwise to 0 VDC (Program output reads close to 0).

8. Test the 0 and 5 volt settings by slowly moving the target from minimum to maximum positions. If minor adjustments are required, always adjust the full-scale pot first, then the zero-adjust pot.

9. To calibrate the gain setting, place the target at the <u>maximum</u> desired detection distance. Rotate the gain control fully counterclockwise. <u>Slowly</u> rotate gain-control clockwise until detection occurs. Rotate an additional 1/16 turn.

10. *Note:* Always calibrate gain control for minimum gain required for reliable detection. Excessive gain may result in false detection.

5   Appendix: Technical Specifications

5.1   RANGE

6" to 10' adjustable- +0.1% accuracy over entire range at stable temperatures; Switch point and analog outputs are temperature compensated. Custom ranges of 1" to 40' are available.

5.2   BEAM ANGLE

15 degree nominal; Single beam, cone-shaped pattern diverges approximately 2.6' at maximum range (10').

5.3   REPETITION RATE

1O Hz astable; May be externally triggered.

5.4   OUTPUT RESPONSE TIME

0-5 VDC analog output is filtered to the approximate formula:

$$V_{out} = 0.9(V_{new\ value}) + 0.1\ (V_{past\ avg.\ value})\ .$$

OUTPUTS

0-5 VDC analog output with fully independent zero and span adjustments over entire operating range.

OPERATING TEMPERATURE

Operating -40º to 85ºC (-40º to 185ºF).

ENVIRONMENT

Indoor or protected outdoor environments; Highly insensitive to temperature, humidity and pressure changes; Withstands high audio and EMI/RFI levels; Must be protected from excessive moisture in outdoor applications.

SIZE

1.700" overall diameter; 0.950" depth; 1.525" transducer face diameter.

WEIGHT

Approximately 0.6 ounces.

POWER REQUIREMENTS

5 VDC; 30 ma maximum current.

MOUNTING

Mount in 1.575" diameter hole; use RTV silicone or edge clips to secure in place.

Specifications, features and options subject to change without notice.