The "FISH" Quad Hand Sensor

Physics and Media Group
MIT Media Laboratory
20 Ames Street E15-022
Cambridge, Mass 02139-4307
(617) 253-2383
phm@media.mit.edu

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HOW TO CALIBRATE A FISH
Thomas G. Zimmerman
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INTRODUCTION

The Fish produces an electric field between a transmitter antenna and receiver antenna, and measures the displacment (a.c.) current arriving at each receiver antenna. As a grounded object (like a hand) enters the electric field, a portion of the electric field is shunted to ground, decreasing the current detected by the Fish. The displacement currents are extremely small, on the order of nanoamps (billionths of an amp). The Fish uses synchronous detection to detect only the frequency and phase it is transmitting. For a given receiver cable lenght and antenna size, there is an optimum operational frequency. If several cable lenghts are used a frequency which maximize the average of all the receiver channels is selected, and the phase of each receiving channel is adjusted to maximize the channel output.

The analog detection circuitry in the Fish can detect the electric field with a sensitivity and dynamic range that exceeds the range of the analog to digital converter in the Fish. The gain

and offset of each receiver channel is adjusted to allows the user to define the operating range of the Fish.

CALIBRATION

1) Identify the fourteen potentiometers (14) on the board. They are:

Name	Qty	Function	Turning CW increases
Freq	1	Transmission frequency (5-90kHz)	Frequency
Drive	1	Transmitter power (0 to 20v peak-to-peak)	Power
Phase	4	Phase of the receiving circuit(0 to 180 deg.)	Phase Angle
		(Compensates for different receiver cable lenghts)	
Offset	4	Pre-gain offset (0 to 1 volt).	Offset
Gain	4	Gain of output.	Gain

2) Plug in the unit and establish communications, continuously reading the sensor values with no object in the field. Turn all the pots clockwise (CW) until they click. They are 20 turn pots, so this may take a while.

3) Turn the Freq counterclockwise (CCW) until the output of the receivers peaks. If the output clips (goes to fullscale), turn the Offset for that channel CCW until the output is about half scale (i.e. reading 128).

4) FOR CABLES OF SIGNIFICANTLY DIFFERENT LENGHTS OR CONSTRUCTION. If the capacitance of the cables differ significantly, there will not be a frequency where all the outputs are maximum. Instead select a compromise frequency optimized for all the receivers, such that no channel is exceedingly weak. Once this frequency is chosen, rotate the Phase pots of each channel CCW to maximum the output.

5) Adjust the Offset of each channel so the output is full scale. The Fish is now set at it's maximum sensitivity (i.e. the Gain is maximum, fully CW). As you put you hand in the field, the output should decrease. The Offset can be adjusted to set a zero or full scale point as desired. If there is not enough dynamic range, i.e. the detecting area is too small, decrease the sensitivity by turning the Gain of the offending channel CCW. The offset will probably need to be readjusted. Typically this fine tuning of working range and sensitivity requires several iteration of adjusting Gain and Offset.

6) To make an adjustment to the overall gain of the system, the transmit power can be reduced by rotating Drive CCW. This is only advised when the Gain has been reduced to minimum, since decreasing the transmit power will result in a lower signal-to-noise and slightly more noise in the detected signal.

SMALL BOX SPECIFICATION
Thomas G. Zimmerman, Joshua R. Smith
V1.4 7/20/94
SMALL BOX COMMUNICATION PORTS
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There are three ports on the small box; RS-485, RS-232, and MIDI. RS-485 is a balanced party line, ie. transmitters and receivers use the same pair of balanced lines. Up to 16 small boxes (power allowing) can be connected together using the RS-485 port. The RS-232 port has two single-ended lines, one for transmit and one for receive. RS-422 (like on the Macintosh) is a balanced line and can be connected to the small box's RS-232 by grounding one line of the balanced pair. The MIDI connector is output (transmit) only. The connectors are as follows;

Function	Type	Quantity
RS-485	RJ-11/6	2 (connected in parallel)
RS-232/422	D-9	1
MIDI OUT	DIN-5	1
POWER	DIN-5	1

CONFIGURATION   SWITCHES   AND   JUMPERS
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There are 8 user programmable switches and a jumper on the small board for setting the baud rate and communication protocal. The jumper tells the processor what type of crystal is installed. The eight switches correspond to a byte read by the microprocessor:

b7	b6	b5	b4	b3 b2 b1 b0
serial/MIDI	baud	output format (ASCII/Binary)	velocity mode off/on	device address (1-16)

The state of the switches select the following;

J1	b7 b6 b5	Baud rate	Protocal	XTAL (MHz)	Format	Cycle time
short	0 0 0	9600	RS-232	8.0	ASCII	polled
short	0 0 1	9600	RS-232	8.0	binary	polled
short	0 1 0	125k	RS-485	8.0	ASCII	polled
short	0 1 1	125k	RS-485	8.0	binary	polled
short	1 0 0	31.25k	MIDI	8.0	binary	1 ms
short	1 0 1	31.25k	MIDI	8.0	binary	10 ms
short	1 1 0	31.25k	MIDI	8.0	binary	20 ms
short	1 1 1	31.25k	MIDI	8.0	binary	40 ms

open	0 0 0	19.2K	RS-232	7.3728	ASCII	polled
open	0 0 1	19.2K	RS-232	7.3728	binary	polled
open	0 1 0	38.4K	RS-232	7.3728	ASCII	polled
open	0 1 1	38.4K	RS-232	7.3728	binary	polled

XTAL refers to the crystal installed on the small box printed circuit board.
J1 indicates the value of the jumper 1, short means the jumper pins are tied together. A short registers as a 0 on PA0, open registers as a 1 on PA0.

b5	Output format
0	Ascii
1	Binary

b3 b2 b1 b0	Device Address
0 0 0 0	0
0 0 0 1	1
. . . .	.
1 1 1 1	15

USER PORT
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The user port (a row of pins) contains the following; regulated power
(+12v, -12v, +5v, each max 100mA), eight digital output, and four analog input.

Pin	Function
1	Analog Input #1
2	Analog Input #2
3	Analog Input #3
4	Analog Input #4
5	Digital Output B0 (lsb)
6	Digital Output B1
7	Digital Output B2
8	Digital Output B3
9	Digital Output B4
10	Digital Output B5
11	Digital Output B6
12	Digital Output B7 (msb)
13	+12 volts (100mA max)
14	-12 volts (100mA max)
15	+5 volts (100mA max)
16	Ground

ASCII SERIAL FISH PROTOCOL
      Joshua Smith
         7/14/94

9600 BAUD, no parity, 8 data bits, 1 stop bit.

You: Smallbox: Description:

0   000<CR>   Value of sensor 1: possible range is 000 to 255
1   000<CR>   Value of sensor 2
2   000<CR>   Value of sensor 3
3   000<CR>   Value of sensor 4
R   000 000 000 000<CR> Value of all 4 sensors

Remarks:

Your commands and its responses are ASCII characters. So the character 0 is ASCII 48, space is 32, and <CR> is 13. Note that <CR> is NOT followed by a linefeed.

MIDI FISH PROTOCOL Joshua Smith
10/21/94

The Fish transmits the values of the four receive channels as MIDI control change commands. The controller numbers are 21-24, for channels 1-4. Each channel is transmitted only when it changes. The Fish outputs data at a very high rate, so application programs may have to "downsample," throwing unwanted MIDI messages away.

CALIBRATION SOFTWARE INSTALLATION

Henry Chong
7/20/94

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The software consists of one stand-alone executable, DOSQUAD.EXE.

PRECAUTIONS
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A couple of words of caution. DOSQUAD.EXE should be executed within the DOS environment and not through the DOS prompt option of the Program Manager of WINDOWS. There seems to be a bug currently either on the part of the calibration software or WINDOWS which may cause serial port reading errors. DOSQUAD.EXE can either be executed from the floppy disk by typing "DOSQUAD" at the prompt, or it can be

copied to a desired destination directory on a hard drive and executed from there with the same command. During the execution of DOSQUAD, DO NOT disconnect the RS-232 serial port connection, the power supply, or reset the FISH as it may cause the computer to hang. Be sure to terminate the execution of the application prior to disconnecting or resetting the FISH.

INSTRUCTIONS
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1. Before executing the software, please make sure the power connections
to the FISH and the RS-232 connection from the FISH to the computer are secure.

2. At the prompt, type "DOSQUAD" to execute the program.

3. Press any key to continue after the first page.

4. On the second page, at the "COM PORT:" prompt, type the number of the serial port to which the FISH is connected and then the return key.

5. To halt the execution of the program, type 'q'.

AUDIO INDICATION
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While the program is executing, the user has the option of using an audio indicator. The audio indicator will rise and fall in frequency according to the rise and fall of the raw values of the signal. Typing the number of the channel will enable the audio indication of that channel. To discontinue audio indication, type the letter 's'.