EAS FINGER BOARD
68HC11
Single Board Computer

Ver. 4/16/98

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EAS FINGER BOARD was created as a small compact general purpose embedded controller to be used for robotics, data logging, smart instruments, and custom control applications. It can run “Interactive C” and emulates many of the hardware functions of “Handy Board” by MIT. Motor functions as well as push buttons were left out of the design to keep it small, simple and versatile. All functions of the “Handy Board” can be added via expansion board, circuits of older “Rug warrior” designs as well. The Finger Board uses very common easily found parts and a low parts count to keep costs down. All mating contacts are spaced .1” apart to allow the Finger Board to plug on top of standard prototyping boards. The Finger Board comes as two separate circuit boards, the CPU board and the Communications board. It can be ordered as one board if size is not an issue.

FINGER BOARD ASSEMBLY

Construction notes

This kit requires good soldering techniques due to its small size.
Tools necessary: A fine tip soldering gun and a good wire cutter.
Recommended tools: Mechanical clamp-known as a third hand, fine solder wick to remove excess solder. A good source of information for beginners is found on the “Handy Board” web site.

An online construction manual with images is available on our web site to help in the construction of the Finger Board.

Caution: Integrated circuits are static and heat sensitive. Do not apply too much heat with your soldering iron when installing these parts. Please take precautions while handing IC’s. To protect against static electricity, ground your body before handling parts.

Note: you will find U8 referenced on the Communications board as well as the CPU board, these are two different IC’s.

We will start with the CPU board first.

CPU Board

Step 1

Start by installing the IC's. Observe proper orientation for pin 1. You may install an IC socket for U7 and U8 but do not socket U5. The installation of a socket for U5 will interfere with U3, the 256kbit ram, which will require the need for a socket. We normally do not install sockets for these IC's.

U5 - 74HC573
U7 - 74HC138
U8 - 74HC00

Note: On the parts list, there is a second part also referenced as U8. This is a MAX232 IC that is to be installed on the Communications board. Do get this mixed up with the 74HC00 IC that is installed here.

Step 2

Install capacitor C6 and the 28 pin IC socket for U3. You may need to snip off the center plastic section of the IC socket so it will fit over U5.

C6 - .1uf monolithic capacitor. The printed value on the capacitor will normally be 104, denoting a

.1uf value.
U3 - 28pin IC socket

Step 3
Install the resistor R1, R2, R3, R5 and R6. Bend the resistor so that it may stand end up on the PCB.

R1, R5, R6 - 10K ohm
R2 - 47K ohm (a 10K ohm may be substituted)
R3 - 1 Meg ohm

Step 4
Install the 52pin PGA IC socket for U4. Observe proper orientation for pin 1 before soldering.

Step 5
Install resistor R4. This is a bussed 47K sip resistor. Observe proper orientation for pin 1 before soldering. Pin 1 is usually marked with a dot. You may end up with the more common 9 resistor sip package, just cut off the last pin (pin10) before installation.

R4 - bussed 47K ohm sip resistor.
Part # 9-1-473 or 10-1-473

Step 6
Install capacitor C3 and C4.

C3, C4 - 22pf capacitor (20pf may be substituted)

Step 7
Install capacitor C1, C2, C3. Observe the polarity for C1 and C13. Place positive side closest to the silkscreened "+" symbol.

C1 - 1uf tantalum, 25 volts or greater
C2 - .1uf monolithic. The printed value on the capacitor will normally be 104, denoting a .1uf value.
C13 - 10uf tantalum, 6.3 volts or greater

Step 8
Install crystal Y1. Cut a small piece of Mylar or thin cardboard insulation to prevent a short on the pc board. Punch two small holes for the crystal leads so the insulator can fit against the bottom.

Y1 - 8Mhz crystal

Step 9
Install reset IC U1 and 5 volt regulator U2. Observe the silkscreened symbols on the PCB for proper placement.

U1 - MC34064 (Motorola)
U2 - LM7805

A low drop-out (LDO) voltage regulator can be substituted for the standard LM7805 regulator. Applications that require low current use such as a solar cell powered Finger Board or running off 4 cell batteries may need a LDO regulator.

Step 10
Install capacitor C5.

C5 - .1uf monolithic capacitor. The printed value on the capacitor will normally be 104, denoting a .1uf value

Step 11
Install capacitor C7 on the bottom side. Bend the leads over and cut to short length before soldering.

C7 - .1uf monolithic capacitor. The printed value on the capacitor will normally be 104, denoting a .1uf value.

Step 12
The following headers are normally installed on the top side of the Finger Board. Depending on your actual application, these headers can be placed on the bottom.

Headers are usually purchased in longer lengths (shown left) and cut down to the size needed. Use headers with a contact lead length of .230"(shorter style).

JP1 - Header 4x1. This should be a connector with a key to prevent installing backwards since this is where the Finger Board gets its DC input supply voltage.

JP2 - Header 7x2
JP6 - Header 2x2
JP10, JP12, JP13 - Header 2x1
JP14 - Header 3x2

Note: If you have the Finger Board PCB with attached communications board, you can hardwire JP15 and JP14 together. An easy way to do this is to hardwire one row from the top and the second row from the bottom of the board. Just make sure pin 1 goes to pin 1, etc. Be careful of shorts when placing the wires.

Step 13
The following headers are normally installed on the bottom side of the Finger Board so that prototyping boards can be used. Depending on your actual application, these headers can be placed on top.

JP4 - Header 4x2
JP7 - Header 8x2
JP9 - Header 9x2
JP11, JP8, JP16 - installed as one Header 11x2

Step 14
For “Interactive C” users who intend to run Finger Board without the Communications board connected.

Once you remove the Communications board, you must short pin 1 to pin 6 on JP14. You are essentially tying the receive pin high. You must remove this short when you connect back the Communications board. Without this connection, receive pin is left floating, your program might stop because of electrical noise. Interactive C is continuously polling the receive pin for commands. If it thinks a command is sent, it will then wait for a complete message while your program is stopped. You can create a modified IDC ribbon cable connector with pins 1 and 6 connected. Use this to plug

into JP14 once the Communications board is disconnected. A more permanent solution is to solder a 10K pull-up resistor between pins 1 and 6 of JP14 on the bottom side of the board. If you leave the Communication board connected you will not have any of these problems.

Step 15
You should wash and clean the completed board before installing U3 and U4. We use water soluble flux solder here at EAS. This permits easy board cleaning. Radio Shack sells flux removing solvent made for pc board cleaning. Take a close look at all solder joints and touch-up any joints that look bad. A 2x or 3x magnifying glass helps to find any solder bridges.

When installing the 68HC11 cpu, observe pin one polarity. It should easily be pushed in. Also observe proper pin placement when install the memory module.

U4 - MC68HC11A1FN CPU
U3 - DS1230AB/Y Dallas 256kbit (32Kbyte) battery backed static ram. Substitute a DS1244Y if a real time clock is needed. You can also use a Dallas DS1216D 28pin lithium battery socket but will need separate 256kbit 62256-100LP static memory chip

Some 52pin PGA sockets are wider than normal and the memory may not be able to fit correctly. Place a second 28pin IC socket on top of the first to raise the memory so it can clear the right edge of the PGA socket.

Place a couple of jumper shunts on JP6. This is the A/D reference input voltage. Install a shunt across pins 1 and 2 to tie VRH to 5 volts. Install a shunt across pins 3 and 4 to tie VRL to ground.

Communications Board Assembly

Step 16
Install U8 on the Communications printed circuit board. Observe proper orientation for pin 1. If you want, you can install a IC socket for U8.

U8 - MAX232CPE (Maxim)

Step 17
Install capacitors C8, C9, C10, C11, C12. Observe the polarity of the capacitors before soldering.

C8, C9, C11, C11, C12 - 10uf tantalum 16 volt. 1uf tantalum can be substituted due to the newer MAX232 specifications.

Step 18
Install resistor R7 and LED D1. The shorter lead on LED D1 is the cathode. If D1 is installed backwards, the communications board will not operate. Place the cathode side of the LED to line up with the silkscreened bar on the PCB.

R7 - 1K ohm
D1 - HLMP1790 LED

The LED is rated for 2ma. If a higher current model is substituted, the Communications board will not work. You can decide not to install the LED, since it just indicates download mode. The download mode will also be indicated on your computer screen while Interactive C is sending out the pcode.

Step 19
Install switch S1. This is a momentary push button switch that is normally-open.

S1 - Momentary normally open push button switch.

Step 20
Install connector P1 and header JP15.

P1 - Female DB9 pin connector
JP15 - Header 3x2

Note: If you have the Finger Board PCB with attached communications board, you can hardwire JP15 and JP14 together. An easy way to do this is to hardwire one row from the top and the second row from the bottom of the board. Just make sure pin 1 goes to pin 1, etc. Be careful of shorts when placing the wires.

Step 21
To connect the main CPU board to the Communications board, you will need a short length of ribbon cable and two female IDC connectors (3x2). When making the cable, make sure pin 1 line up together on both connectors. The ribbon cable length should be no more than 1 foot or communication errors may take place

Step 22
When using Interactive C, the Finger Board supports a 16x2 line LCD module connected to header JP2. To connect the LCD module, you will need a short length of ribbon cable and two female IDC connectors (7x2). When making the cable, make sure pin 1 line up together on both connectors. The ribbon cable length should be no more than 1 foot.

If you cannot locate a LCD module, you can purchase one directly from EAS. The cable is included in the price.

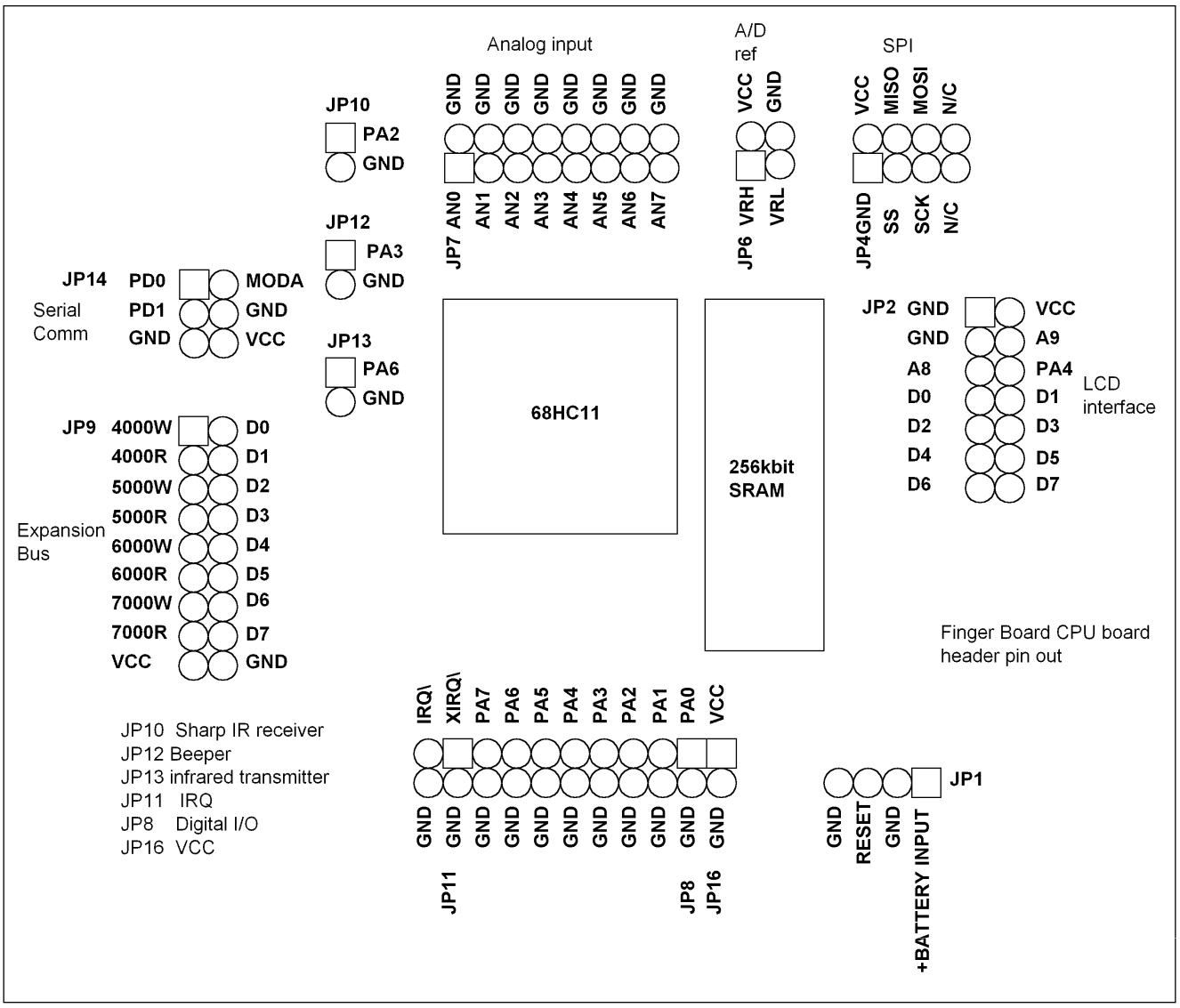
PARTS LIST FOR FINGER BOARD

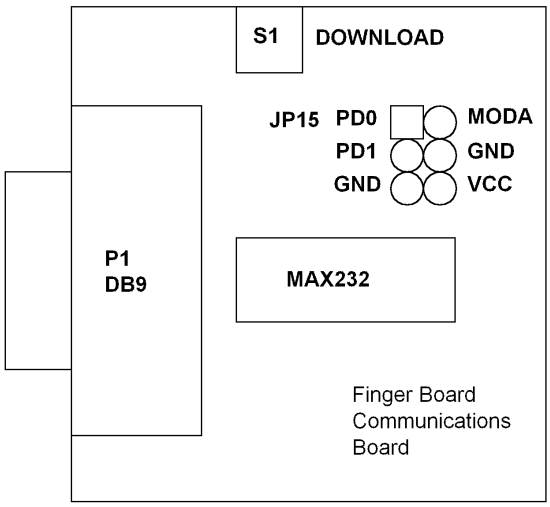
Bill Of Materials, all parts can be found from Radio Shack, Digikey, and Jameco.
All resistors ½ Watt or less. All similar parts found on “Handy Board” can also be used on Finger Board.

Item #	Quantity	Part Reference #	Description
1	1	C1	1uf tantalum capacitor, 25 volts or greater
2	1	C2	.1uf monolithic capacitor
3	2	C4,C3	22pf capacitor (20pf can be substituted)
4	3	C5,C6,C7	.1uf monolithic capacitor
5	5	C8,C9,C10,C11,C12	10uf tantalum capacitor, 16 volt (1uf can be substituted)
6	1	C13	10uf tantalum capacitor, 6.3 volt
7	1	D1	HLMP-1790 LED (2ma rating)
8	1	JP1	Header 4x1
9	1	JP2	Header 7x2
10	1	JP4	Header 4x2
11	2	JP11,JP6	Header 2x2
12	2	JP7,JP8	Header 8x2
13	1	JP9	Header 9x2
14	4	JP10,JP12,JP13,JP16	Header 2x1
15	2	JP14,JP15	Header 3x2
16	1	P1	Female DB9 pin connector
17	3	R1,R5,R6	10K ohm resistor
18	1	R2	47K ohm resistor (10K ohm can be substituted)
19	1	R3	1Meg ohm resistor
20	1	R7	1K ohm resistor
21	1	S1	Momentary normally open push button switch
22	1	U1	MC34064P-5 (Motorola)
23	1	U2	LM7805 (+5 volt regulator)
24	1	U3	DS1230AB/Y Dallas 256kbit (32Kbyte) battery backed static ram. Substitute a DS1244Y if a real time clock is needed. You can also use a Dallas DS1216D 28 pin lithium battery socket but will need separate 256kbit 62256-100LP static memory chip
25	1	U4	MC68HC11A1FN CPU (Motorola)
26	1	U5	74HC573
27	1	U8	74HC00 (found on CPU board. Referenced as U6 on Finger Board schematic)
28	1	U7	74HC138
29	1	U8	MAX232CPE (Maxim, found on Communications board)
30	1	Y1	8Mhz Crystal - Series
31	1	R4	47Kohm bussed resistor pack. (Part# 9-1-473 or 10-1-473)
32	1	U3	28 pin socket
33	1	U4	52 pin PGA socket
34	2		3x2 Female IDC connectors
35	1		Ribbon cable - 1 foot length, 6 conductor
36	1	Optional	16x2 character LCD module
37	1	Optional	Beeper - 5 volt TTL level

Additional items:
½" 4-40 plastic standoffs for mounting.
2 jumper shunts for JP6
Use headers with a contact lead length of .230"(shorter style) for expansion boards.

CONNECTING TO THE FINGER BOARD





Headers are counted in the same pattern as drawn on the schematic diagram. When possible we have placed the label closest to pin 1 on the printed circuit board. Pin 1 is marked with a square pad. See silkscreen top view drawing. We will have interface projects on our web that will show how to connect certain peripherals.

JP1 is the DC input connector used to power the Finger Board. You can use any voltage from 6.3 to 18 volts. 1 and 2 are the input power pins. Pins 3 and 4 are for an optional externally connected normally open push-button switch. This provides a convenient reset when power cannot be cycled.

Pin	Function
1	+Battery input
2	ground
3	reset
4	ground

JP2 is an Interactive C compatible LCD interface. If you have the 14 x 1 type connector on your LCD, you should be able to rewire with the pattern shown.

Pin	Function	Pin	Function
1	ground	2	VCC
3	ground	4	A9
5	A8	6	PA4
7	D0	8	D1
9	D2	10	D3
11	D4	12	D5
13	D6	14	D7

JP4 is an SPI high-speed serial peripheral interface. There are lots of industry SPI compatible devices that can be attached to this port.

For those who wish to connect two Finger Boards together using the SPI port, you must not connect pin 2 (VCC) together between the Finger Boards. Doing so will short out the voltage regulators. You can use a straight through IDC ribbon cable but cut out pin 2 from one or both of the JP4 headers.

For other SPI devices, pin 2 can be used to supply +5 volt power. The 5 volt source is taken from the onboard 7805 voltage regulator.

Pins 7 and 8 on the header are not connected. They can be wired up to user determined chip selects.

Pin	Function	Pin	Function	
1	ground	2	VCC	n/c not connected
3	SS	4	MISO	
5	SCK	6	MOSI	
7	n/c	8	n/c	

JP6 analog A/D reference input voltage. For normal use, pins 1 and 2 are shorted and pins 3 and 4 are shorted together using jumper shunts. See "M68HC11 Reference Manual" for further info.

Pin	Function	Pin	Function
1	VRH	2	VCC
3	VRL	4	ground

JP7 is the 68HC11 8-bit A/D analog input port. Input voltages between 0 and 5volts can be applied to the A/D. Grounds are provided for each analog input.

Pin	Function	Pin	Function
1	AN0	2	ground
3	AN1	3	ground
4	AN2	5	ground
6	AN3	6	ground
7	AN4	8	ground
9	AN5	10	ground
11	AN6	12	ground
13	AN7	14	ground

JP8 is PORT A on the 68HC11. This is an 8-bit digital input/output port. Reading the "M68HC11 Reference Manual", by Motorola will give information on how to utilize this port. In Interactive C, some of these pins are pre-assigned. By editing the library routines, you can change the pre-assigned functions.

Pin	Function	Pin	Function
1	PA0	2	ground
3	PA1	4	ground
5	PA2	6	ground
7	PA3	8	ground
9	PA4	10	ground
11	PA5	12	ground
13	PA6	14	ground
15	PA7	16	ground

JP9 is setup so you can easily enhance the Finger Board with additional circuits. You can have up to 32 memory mapped digital inputs and 32 digital outputs. Circuit diagrams are available at our Web page on how to utilize this header. Data lines are brought out as well as power and ground pins. Hexadecimal address map is shown. W is for write; R is for read.

Pin	Function	Pin	Function
1	4000W	2	D0
3	4000R	4	D1
5	5000W	6	D2
7	5000R	8	D3
9	6000W	10	D4
11	6000R	12	D5
13	7000W	14	D6
15	7000R	16	D7
17	VCC	18	ground

JP10 is a dedicated header for a Sharp IR receiver when running Interactive C.

Pin	Function
1	Sharp IR receiver (68HC11 output pin PA2)
2	Ground

JP11 is useful for external interrupt requests.

Pin	Function	Pin	Function
1	XIRQ\	2	ground
3	IRQ\	4	ground

JP12 is a dedicated header for a Piezo beeper or speaker when running Interactive C.

Pin	Function
1	+ Piezo beeper or speaker (68HC11 output pin PA3)
2	ground

JP13 is a dedicated header for an Infrared transmitter when running Interactive C.

Pin	Function
1	Infrared transmitter (68HC11 output pin PA6)
2	ground

JP14 is the serial communications header on the CPU board that is used to connect to the Communications Board.

Pin	Function	Pin	Function
1	PD0	2	MODA
3	PD1	4	ground
5	ground	6	VCC

JP15 is the serial communications header on the Communications board that is used to connect to the main CPU board.

Pin	Function	Pin	Function
1	PD0	2	MODA
3	PD1	4	ground
5	ground	6	VCC

JP16 is an available 5volt source (VCC) is taken from the onboard 7805 voltage regulator.

Pin	Function
1	VCC
2	Ground

P1 is the Communications board DB9 RS232 connector. It is a simple three wire asynchronous serial interface. When using Interactive C, set your PC serial port to 9600 baud, 1 start, 1 stop, 8 data, no parity. Use a standard serial cable to connect the PC serial port to the Finger Board. If your PC has a 25 pin serial port, use a 9 to 25 pin adapter.

Pin	Function	
1	n/c	n/c not connected
2	TxD	
3	RxD	
4	n/c	
5	ground	
6	n/c	
7	n/c	
8	n/c	

RUNNING INTERACTIVE C

Interactive C (IC) is a simple to use C compiler for the 68HC11. The freeware version of IC can be downloaded from MIT's FTP site at
`ftp://cherupakha.media.mit.edu/pub/projects/6270/interactive-c` along with a manual that can be printed out for reference. There is also more information on the "Handy Board" web page on how to use IC.

To use the Finger Board you need to connect the serial port of your PC to the serial connector P1 of the Finger Board Communications board. You should be able to run version 2.86 or the newest commercial version of IC from Newton Labs, but you must load the "Rug Warrior" version of the pcode.

When using version 2.86. Make sure ic.exe is set. Example setup by executing "ic -config" is shown:

```
C:\IC>ic -config
      Interactive C for 6811.  Version 2.860 BETA (Nov 29 1994)

IC written by Randy Sargent and Anne Wright.  Copyright 1994.
   (uses board pcode by R. Sargent, F. Martin, and A. Wright)

This program is freeware and unsupported.  It is provided as a service to
hobbyists and educators.  Type 'about' for information about support
and obtaining newer versions of IC.

Backing up C:\IC\IC.EXE to C:\IC\IC.bak
Done
Default editor:  edit
Directory where libraries reside:  /ic/libs/
Default library file (blank for none):  /ic/libs/lib_rw11.lis
Default serial device name (in the form /dev/*):  com1
Finished configuring
```

Note: lib_rw11.lis should be edited if you need to add additional library routines. The nicest thing about 2.860 is all source code is made public and can be recompiled.

To put Finger Board in download mode. You need to hit the reset switch on the power connector or just re-power Finger Board while pressing the download push button S1 on the communications board. Once you release the download push button S1, the LED D1 will turn off, indicating that the board is in download mode. This LED works the same as on the "Handy Board". Note: If you are using a reset switch you must release the reset switch first then release the download push button S1. Initially, the LED may not be on, once initial communications is established it will function normally.

Note:
For "Interactive C" users who intend to run Finger Board without the Communications board connected.

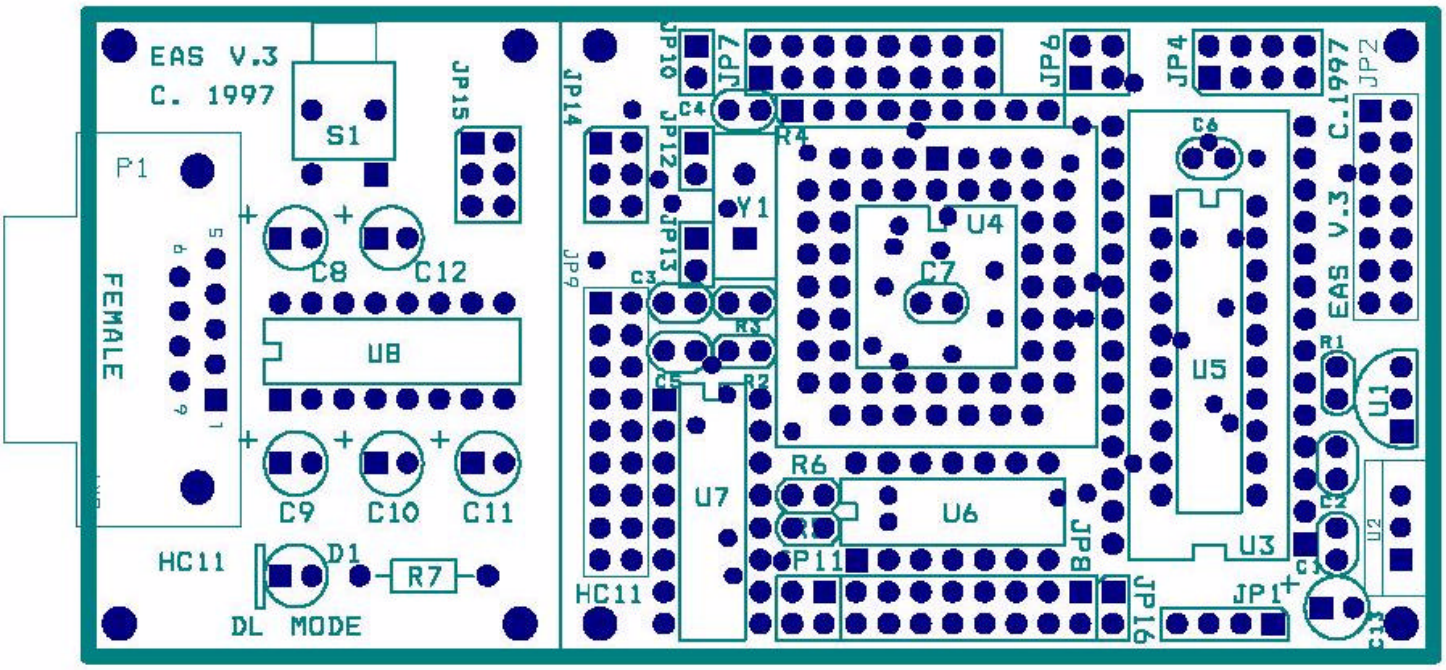
Once you remove the Communications board, you must short pin 1 to pin 6 on JP14. You are essentially tying the receive pin high. You must remove this short when you connect back the Communications board. Without this connection, receive pin is left floating, your program might stop because of electrical noise. Interactive C is continuously polling the receive pin for commands. If it

thinks a command is sent, it will then wait for a complete message while your program is stopped. You can create a modified IDC ribbon cable connector with pins 1 and 6 connected. Use this to plug into JP14 once the Communications board is disconnected. A more permanent solution is to solder a 10K pull-up resistor between pins 1 and 6 of JP14 on the bottom side of the board. If you leave the Communication board connected you will not have any of these problems.

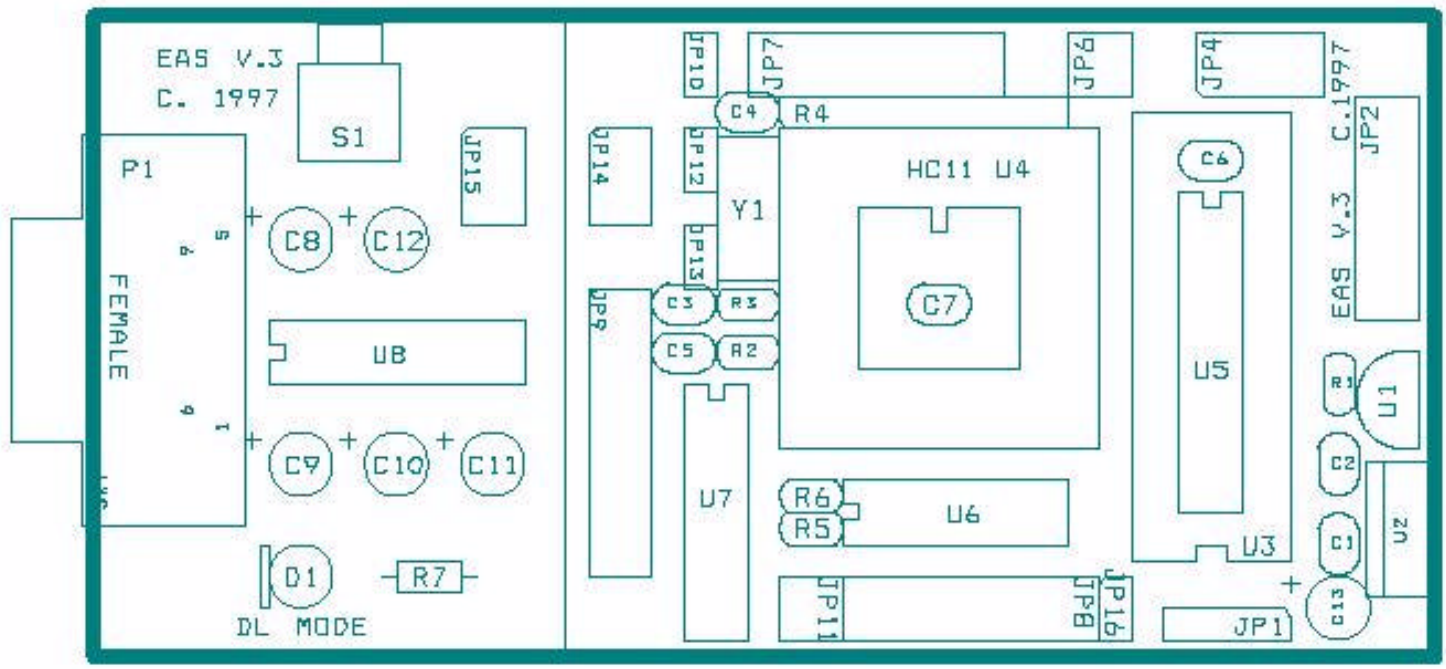
USING OTHER COMPILERS AND PROGRAMS

You can use other compilers, but you must be aware of the reset vectors location. Because of the special test mode, it is in a different location. The reset vector is BFFE,BFFF. Read the “M68HC11 Reference Manual” by Motorola for a better description. You can just use DL to download the compiled S19 records. There are C compilers on the net that can be downloaded. Small C, ICC, and GCC. For BASIC programs, you can also use SBasic, by Karl Lunt. Two very good interactive debuggers are Noice (noi25_11.zip) by John Hartman and PCbug11 (Pcbug342.exe) by Motorola. A good bootloader is Hcload by Sylvain Bissonnette. The one we have found to be very reliable is DL68hc11 by Wilfried Markenstein. All of the above programs can be found on the net.

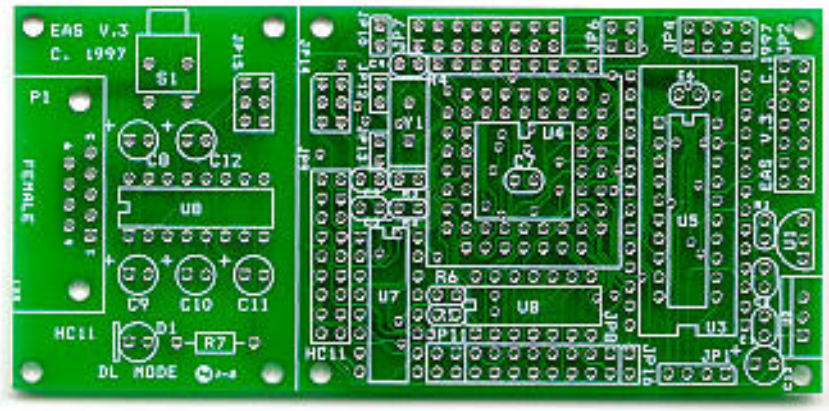
Silkscreen Top View. Pin 1 on all headers are indicated by the square pad.



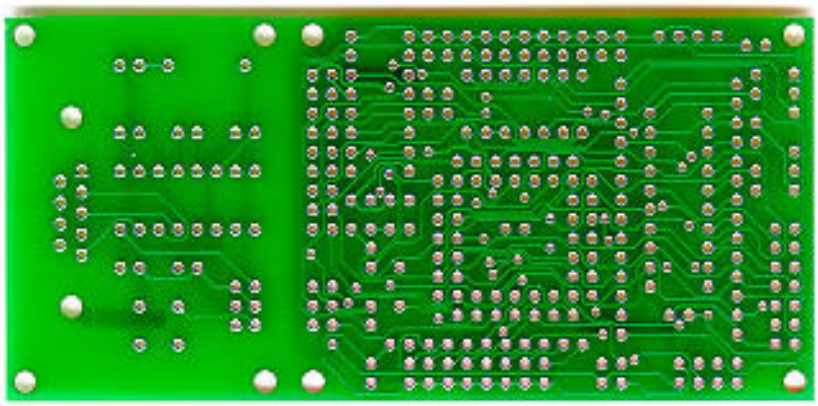
Parts placement



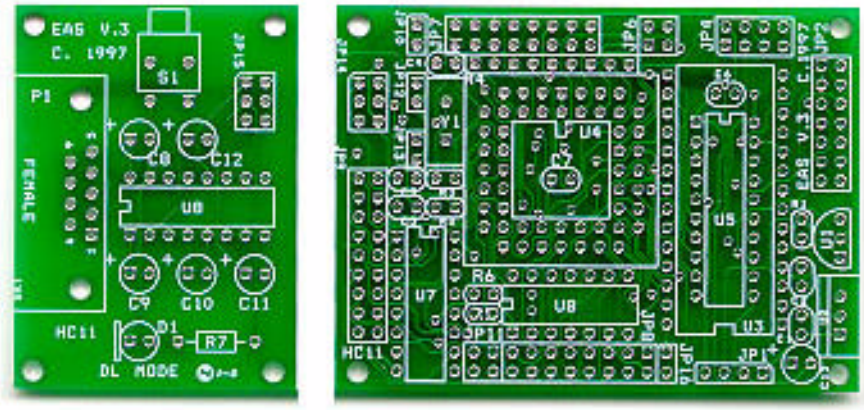
Top board



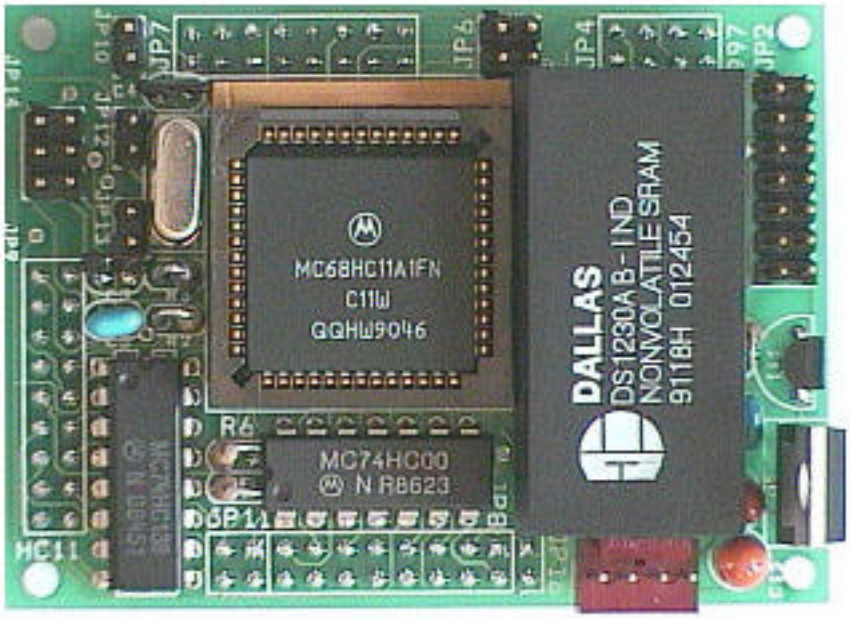
Bottom board



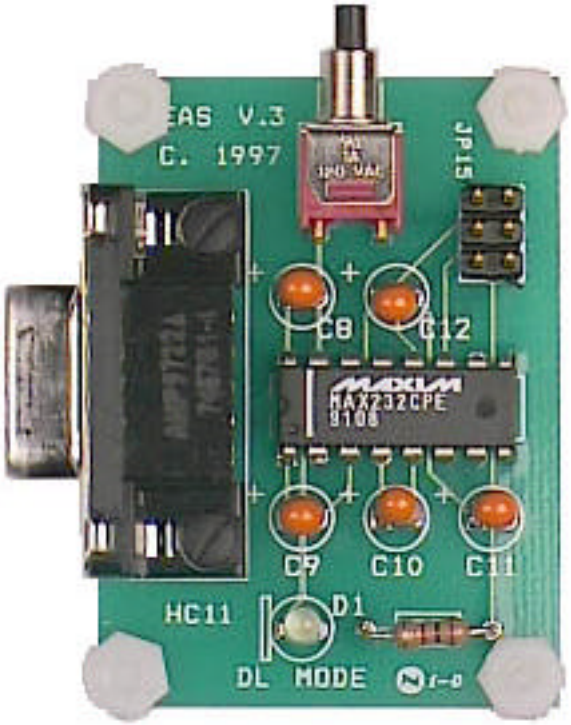
Boards Separated



CPU Board



Communications Board



FREQUENTLY ASKED QUESTIONS (FAQ)

Please check our web site for the latest version of the Finger Board FAQ.

TROUBLE SHOOTNG

If you have purchased the assembled Finger Board, it is fully tested and operational before shipping. If it fails to function properly, inspect the board for obvious physical damage. If there is damage, please contact us for replacement.

The most common problems are improperly configured communications parameters or attempting to use the wrong COM port on the PC. Verify that your communications port is working by substituting a known good serial device or by doing a loopback diagnostic. Also check your power source. The input voltage should not fall below 6.3 volts DC.

For kits,
Check for +5VCC voltage on header JP16.
Check and make sure all components are installed and properly orientated.
Check all resistor and capacitor values.
Check LED polarity.
Check IC positions.
Check Tantalum capacitor polarities.
Check for shorts.
Check for cold solder joints.
Problems communicating, remove LED D1, it’s probably in backwards.

SPECIFICATIONS:

Motorola 68HC11 CPU A0, A1, A8, E2, or E9 versions can be used
256kbit (32Kbyte) Dallas 10 year battery-backed memory module, no need to use eproms or slower eeproms.
Compact size 2" X 2.75"
Interactive C compatible LCD interface.
Network capable, SPI interface. (1 Mbaud serial peripheral interface).
Optional real time clock.

Easily expandable, using standard headers. List of Headers:
Port A of 68HC11, 8 multi function I/O pins (JP8)
Port E of 68HC11, 8 analog channels (JP7)
Memory mapped I/O, Finger Board can be easily expanded to have 32 digital inputs and 32 digital output lines (JP9)
IRQ and XIRQ lines brought out for external interrupts (JP11)
Standard serial port (P1)
SPI high speed serial interface, an easy way to attach peripherals (JP4)
LCD display (JP2)

Power requirements:
6.3 to 18volts DC. Can easily run from a 9volts DC battery.
Current consumption: 24 ma DC without communications board < 10ma in WAIT mode, or STOP mode.
30 ma with communications board

For remote data logging - using an Alkaline 9volt battery to supply power, we were able to get 19 hours using the Finger Board without the communications board, but with an attached LCD for display. The total current draw was ~25 ma. The LCD display typically draws about 1ma.

For low battery situations and Solar Cell applications. Special modifications can be made to the Finger Board. With a few easy component changes, we were able to bring the current draw down to 22ma. By changing the voltage regulator to a low dropout version, the Finger Board was able to run from 26volts down to 4.8volts. These application specific modifications will be posted on our web for those who are interested.

Dimensions:
CPU board only: 2.75" long, 2.0" wide
Communications board: 1.45" long, 2.0" wide
CPU board with attached Communications board: 4.2" long, 2.0" wide

Software:
Software and updates may also be downloaded from our WEB site.

Embedded Acquisition Systems
1565 Shrader Street
San Francisco, CA 94117
WEB http://www.hooked.net/~jfong
EMAIL jfong@hooked.net

STANDARD LEGAL STUFF

Although all of the circuits and projects provided have been thoroughly tested by Embedded Acquisition Systems (EAS). We cannot take responsibility for the circuits, nor will we take any responsibility for anything happening as a result of using any of our designs.

PERFORMANCE INFORMATION: Performance tests and ratings are measured using specific computer systems and/or components and reflect the approximate performance of EAS products as measured by those tests. Any difference in system hardware or software design or configuration may affect actual performance.

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