<u>TUC-52 Assembly Manual</u>

This document was written November 1997. Rev. 0.1
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1. INTRODUCTION

Several years ago TAPR introduced METCON, a telemetry and control system. When the design of a METCON-2 was discussed, the concept of a TAPR Universal Controller (TUC) based on the 8052 was adopted.

The TUC-52 will eventually provide PCON, METCON, and other functionality with the addition of personality boards that TAPR and hopefully others will design for the kit.

This board is to serve as a universal controller based on the 8051/8052 architecture. The TUC-52 is capable of operating with internal masked ROM or external EPROM. The unit can provide either a Harvard (separate code and data) or Von Neuman (combined code and data) addressing mode. RAM sites are provided such that up to 64K of RAM can be addressed on the board and both RAM sites may be battery backed up. There are several pre-programmed memory maps that the user can choose by placing shunts on shorting blocks. One particular memory map will allow the operation of INTEL's MCS BASIC-52, a stand alone "tiny basic" system that includes floating point calculations and a rudimentary file system for storing and retrieving basic programs as well as the ability to begin executing a user developed preprogrammed basic program at reset, without any operator intervention.

Plenty of bit I/O has been provided for so that bus signals do not need to leave the board. However provision is made for a limited bus to be conveyed to another close-by board.

(MORE NEEDED)

ACKNOWLEDGEMENTS

The Tucson Amateur Packet Radio (TAPR) TUC-52 Kit was made possible by the pioneering efforts of Paul Newland, AD7I, and the active participation of a number of TAPR members. TAPR wishes to acknowledge their contribution to this effort.

Individuals:

***David who did the board layout, John who handled production

...and the builders of the first run kits whose feedback made this version of the manual possible.

Kit Builders:

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2. PARTS LIST

This parts list is organized by quantity and part type. Please verify that all parts are present, checking the space [_] provided as you locate and verify it against this list. You may wish to take this opportunity to sort the parts into a compartmented container, such as an egg carton, muffin tin, or other container as you inventory them. This will aid you in building.

Base Configuration: The following parts are required for the base configuration of the TUC-52.

Resistors

1/4 watt, 5% carbon film:

[_] 2	R6, R15	100 ohm	(brown-black-brown-gold)
[_] 1	R18	470ohm	(yellow-violet-brown-gold)
[_] 3	R5, R8, R17	100k	(brown-black-yellow-gold)
[_] 8	R2, R3, R4, R9, R12, R13, R14, R16	10k	(brown-black-orange-gold)
[_] 2	R1, R11	1k	(brown-black-red-gold)
[_] 2	R7, R10	1M	(brown-black-green-gold)

8-pin Single Inline Package (SIP) Resistor Packs:

[_] 3	RS1, RS2, RS3	10k 9r SIP	(770-101-10K-ND or 103)

Capacitors

Capacitors may be marked in various ways. The typical markings are given but may vary. Find all that match the typical markings given and the remaining ones, if any, should become apparent by elimination.

Capacitors, Ceramic, Monolithic

[_] 21	C1, C4, C6, C11, C15, C16, C17, C19, C20, C21, C22, C23, C24, C25, C26, C27, C28, C29, C30, C31, C32	0.1uF/16v/Z5U	(104)
[_] 1	C7	0.47uF/50/Z5U	(474)
[_] 2	C12, C13	22pF/63	(22)

Capacitors, Electrolytic, Radial Lead

[_] 3	C3, C5, C8	10uF/25	
[_] 1	C9	1uF/25	
[_] 1	C2	470uF/25	

Capacitors, Tantalum, Radial Lead

[_] 1	C10	1uF/16/tant

Capacitor, Variable

[_] 1	C14, C18	45pF/var

Note: C14 is optional and not supplied in the kit.

Integrated Circuits

Integrated Circuits come from various manufacturers and may have differing prefixes and/or suffixes. For example, if the part is listed as a 74LS00, it may be marked SN74LS00N or MC74LS00P or DM74LS00N or F74LS00P or some other variation. The key is that the sequence 74LS00 appears in the part number. A four-digit number, such as 8834, indicates the year and week of manufacture and should not be confused with the part number.

NOTE: Do not handle the ICs at this time! Carefully remove the black foam carrier with ICs from the bag and verify the ICs against this list. Then return the foam with the ICs to the bag. Do not touch the ICs!

[_] 1	IC1	80C32	
[_] 1	IC2	74HC08	
[_] 1	IC3	74HC373	
[_] 1	IC4	27C256-150	
[_] 2	IC5, IC6	43256-15LP	
[_] 1	IC7	74HC4066	
[_] 2	IC8, IC16	74HC14	
[_] 1	IC9	PCF8583 (clock)	
[_] 1	IC10	PCF8581CPN (eeprom)	
[_] 1	IC11	PAL 16v8 or 18cv8	
[_] 1	IC12	74HC139	
[_] 2	IC13, IC15	82C55A	
[_] 1	IC14	UDN2595A	
[_] 1	Q1	2n3904	TO-92
[_] 1	VR1	LM7805	TO-220

Diodes

[_] 1	D8, D9	1N270
[_] 4	D1, D2	1N4002
[_] 4	D4, D5, D6, D7	1N4148
[_] 1	D3	1N5235/6.8V
[_] 1	DS1	RED LED

Sockets and Connectors

[_] 4	SK2, SK7, SK8, SK16	14p DIP socket
[_] 1	SK12	16p DIP socket
[_] 1	SK14	18p DIP socket
[_] 2	SK3, SK11	20p DIP socket
[_] 3	SK4, SK5, SK6	28p DIP socket .6"
[_] 3	SK1, SK13, SK15	40p DIP socket .6"
[_] 2	SK9, SK10	8p DIP socket
[_] 6	H18, H19, H20, H21, H22, H23	2 pin header

(We didn't supply headers for the following in the beta kit:

, -5, +5BB, +V, GND   2 pin header)

      [_] 11   H1, H2, H3, H4, H6, H7, H8, H9, H10, H11, H12   3 pin header
      [_] 1   H17   4 pin screw header (supplied as two 2 pieces)
      [_] 1   H14   50 pin (2x25) header
      [_] 2   H15   34 pin (2x17) header
      [_] 1   H16   20 pin (2x10) header (optional, not supplied?)
      [_] 1   H5   6 pin (2x3) header
      [_] 1   H13   8 pin (2x4) header

Xtals
      [_] 1   Y1   11.0592 MHz
      [_] 1   Y2   32.768 kHz

Miscellaneous
      [_] 1   PC Board, TUC-52 Rev. 3/25/97
      [_] 1   Assembly Manual (This Document)
      [_] 1   Software Disk (example software)
      [_] 1   TBAS52 Operating Manual
      [_] 1   vr1   Heatsink
      [_] 13   Z2   13 shunts
      [_] 1   BH1   bat hld (2032)
      [_] 1   1/4" 4-40 screws
      [_] 1   #4 lockwasher
      [_] 1   4-40 nut

(the 4-40 hardware didn't make it into the beta kit?)

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3. CONSTRUCTION NOTES:

You are now ready to begin construction of the TUC-52. It is recommended that when assembling theTUC-52, that you use a very fine pointed soldering tip on an iron of relatively low wattage (25 watts maximum, 15 watts is ideal). Due to the proximity of some of the traces on the PC board, solder bridges are a very distinct possibility. A low wattage soldering iron, fine pointed tip, clean rosin core solder (small size) is the order of the day. Following these points could eliminate several hours of troubleshooting (or worse). This is good practice when working on any kit.

In addition to the soldering iron and solder, you will need small flush or semi-flush cutting pliers and small-tipped long nosed pliers. A magnifying glass may prove helpful to identify the values of the small components.

Pay careful attention to the directions that follow. Keep the tip of your soldering iron bright and clean, wiping it frequently on a wet rag or sponge. Make solder joints carefully, but swiftly. Prolonged heat on a PC board, as well as too much heat, can be disastrous and can ruin a PC board. Two to three seconds should be enough time to apply heat to any joint. Joints that have ground pad connections may require a larger wattage iron to ensure faster heating for soldering.

**John's comment: too cool of an iron can cause you to have to spend too much time on a joint.

The accompanying component placement drawing shows the placement of all parts on the circuit board. Pay particular close attention to the following:

1) Read this entire document prior to starting construction of your kit. There are several final configurations for the TUC-52 and some parts may or may not require installation for your specific configuration.

2) Identifying the pins on headers - Pin 1 is identified by the square pad on silkscreen.

3) Some resistor values may seem unclear as to color and value. Be very sure of value prior to installation. Using an ohm meter to verify values is recommended.

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4. CONSTRUCTION
Check the PC Board and verify that the exposed, tinned pads are clean and shiny. If they are not, scrub the board LIGHTLY with a household cleanser (such as "AJAX" or "COMET") and rinse with clean water, then dry with a clean soft towel.

**John's comment: if you feel it is necessary to clean the board, be careful that you don't scrub off the solder mask, which is typically green in color.

[_] PC Board clean

Refer to the layout diagram in Figure 1 for clarification of parts placement. Figure 1 is also attached as a full size diagram at the end of the manual.

**John's preference: I would normally (and did) install components starting with those that lie lowest on the board. I would start with the glass diodes, then the resistors and epoxy diodes.   Following that I installed the IC sockets, then bypass caps. The reason I do that is to allow the board to lie flat on the workbench as far through the assembly procedure as possible. Even though I have a board vise, I find it easier to solder with it lying flat. I would be happy to go through the complete procedure if there is interest. Also I would recommend forming the leads for VR1 (7805).as an early step, then putting it aside for later installation. Later on other components already installed hinder fitting it in easily.

IC Sockets
NOTE: If any socket pins are bent, carefully straighten them with a pair of long-nose pliers before assembly. Some types of IC sockets have crimps in the pins to hold them in place when automatic wave-soldering is performed. These sockets may be tricky to install if you are not familiar with them. If your kit contains these sockets, you may want to straighten the pins before attempting to insert them into the PC board.

When installing IC sockets, double check to ensure that the socket is seated properly against the board with the notch matching the silkscreen. Pin 1 (nearest the socket notch) has a square solder pad. Be sure that all IC socket pins are showing on the solder side of the board. Next, tack-solder two diagonally opposite corners first (such as pins 1 and 8 on a 14-pin socket).

Then solder the remaining pins of that socket before proceeding to the next one. If you find a socket is difficult to install, remove it and double-check for a bent pin.

NOTE: Take care now to avoid solder bridges!

Install the following IC sockets.

[_] IC14   18p DIP socket
[_] IC13   40p DIP socket .6"

[_] IC1	40p DIP socket .6"
[_] IC2	14p DIP socket
[_] IC3	20p DIP socket
[_] IC4	28p DIP socket .6"
[_] IC5	28p DIP socket .6"
[_] IC6	28p DIP socket .6"

Now check your work. All leads should be soldered. There should be no solder bridges (a blob of solder that shorts two adjacent soldered connections) or cold (gray and/or grainy looking) solder connections.

[_] OK so far.

[_] IC15	40p DIP socket .6"
[_] IC12	16p DIP socket
[_] IC7	14p DIP socket

Note: H19 and H20 are almost too close to IC16 socket. Check fit of all parts before installing socket.

[_] IC16	14p DIP socket
[_] IC11	20p DIP socket
[_] IC8	14p DIP socket
[_] IC9	8p DIP socket
[_] IC10	8p DIP socket

[_] bh1 bat hld   CA2032

Now check your work. All leads should be soldered. There should be no solder bridges (a blob of solder that shorts two adjacent soldered connections) or cold (gray and/or grainy looking) solder connections. You should have no IC sockets remaining.

[_] OK so far.

Resistors
Resistors lie flat on the PC board and have a lead spacing of 0.400". You may wish to use a lead former to preform the resistor leads for neatest appearance.

[_] Save the leads from the resistors.   They will be used in a following step.

Install the following 5% resistors:

[_] R1	1k	(brown-black-red-gold)
[_] R7	1M	(brown-black-green-gold)
[_] R6	100	(brown-black-brown-gold)

Note: No silk screened legend of "100" at R6

[_] R5	100k	(brown-black-yellow-gold)
[_] R4	10k	(brown-black-orange-gold)

WARNING! Be careful when clipping leads, as they have a tendency to fly towards your eyes! Take appropriate precautions (grasp leads and wear eye protection).

[_] Solder and clip the leads (10 total)

[_] R12 10k   (brown-black-orange-gold)
[_] R13 10k   (brown-black-orange-gold)
[_] R14 10k   (brown-black-orange-gold)

[_] Solder and clip the leads (6 total)

[_] R2   10k   (brown-black-orange-gold)
[_] R18 470   (yellow-violet-brown-gold)
     Note: R18 silk screened legend is ".470K", should be "470".
[_] R3   10k   (brown-black-orange-gold)
[_] R15 100   (brown-black-brown-gold)
     Note: R15 silk screened legend is ".1K", should be "100".
[_] R16 10k   (brown-black-orange-gold)
[_] R17 100k   (brown-black-yellow-gold)

[_] Solder and clip the leads (12 total)

[_] R11 1k   (brown-black-red-gold)
[_] R10 1M   (brown-black-green-gold)
[_] R9   10k   (brown-black-orange-gold)
[_] R8   100k   (brown-black-yellow-gold)

[_] Solder and clip the leads (8 total)

Carefully check the board for solder splashes, solder bridges and cold solder joints.

[_] OK so far.

SIP (Single Inline Package) Resistors used in the TUC-52 are polarized. It is
IMPORTANT that you match the dot or Pin 1 on the resistor with the pad marked with a
square on the silk-screen. All RSx Resistor Packs are 9-lead parts. If you are supplied
with 10 pin parts, you will need to cut the pin off the end away from PIN 1 of the
package to make it fit correctly.

The resistors should end up flush with the circuit board. It is easiest to solder the end
pins first, then inspect the placement, and the solder the other 7 pins (just like you did
by soldering the corner pins on the IC sockets).

[_] RS1 10k 9r SIP   (770-101-10K-ND)
[_] RS2 10k 9r SIP   (770-101-10K-ND)
[_] RS3 10k 9r SIP   (770-101-10K-ND)

[_] Solder the leads (27 total)

Capacitors

NOTE: All capacitors should be mounted as nearly flush to the board surface as practical without stressing the leads. The first capacitors to install are located on the upper right-hand quadrant of the PCB:

Now work in the top left-hand quadrant:
      [_] C28 0.1uF/16v/Z5U   (104)
      [_] C27 0.1uF/16v/Z5U
      [_] C19 0.1uF/16v/Z5U
      [_] C12 22pF/63   (22)
      [_] C13 22pF/63
      [_] C20 0.1uF/16v/Z5U

      [_] Solder and clip the leads (12 total)

Now work in the top right-hand quadrant:
      [_] C21 0.1uF/16v/Z5U   (104)
      [_] C22 0.1uF/16v/Z5U
      [_] C15 0.1uF/16v/Z5U
      [_] C16 0.1uF/16v/Z5U

      [_] Solder and clip the leads (8 total)

Now work in the lower left-hand quadrant:
      [_] C1   0.1uF/16v/Z5U   (104)
      [_] C29 0.1uF/16v/Z5U
      [_] C4   0.1uF/16v/Z5U
            Note: C4 silk screened legend is ".1uF", should be "0.1uF".
      [_] C11 0.1uF/16v/Z5U
      [_] C6   0.1uF/16v/Z5U
            Note: C6 silk screened legend is "1uF", should be "0.1uF".

      [_] Solder and clip the leads (10 total)

Now work in the top right-hand quadrant:
      [_] C30 0.1uF/16v/Z5U   (104)
      [_] C25 0.1uF/16v/Z5U
      [_] C26 0.1uF/16v/Z5U
      [_] C17 0.1uF/16v/Z5U

      [_] Solder and clip the leads (8 total)

      [_] C7   0.47uF/50/Z5U   (474)
            Note: C7 is a double footprint part. However, the silk screen legend doesn't indicate which of the three holes must always be used. **The right most hole**

(closest to IC16) must always have a lead in it. The other cap lead may be placed in either the center or left most hole depending on the size of the part.

      [_] C32 0.1uF/16v/Z5U   (104)
      [_] C23 0.1uF/16v/Z5U
      [_] C31 0.1uF/16v/Z5U
      [_] C24 0.1uF/16v/Z5U

      [_] Solder and clip the leads (10 total)

Carefully check the board for solder splashes, solder bridges and cold solder joints.

      [_] OK so far.

NOTE: *The following capacitors are polarized.* Electrolytic capacitors (tubular metal cans with the leads coming out of one end) have the negative lead marked with a bold black band; tantalum capacitors (teardrop-shaped epoxy-covered blobs) have the positive lead marked with hard-to-read little plus (+) signs.
      [_] C14 45pF/var
      [_] C5   10uF/25
      [_] C3   10uF/25
      [_] C10 1uF/16/tant
      [_] C2   470uF/25
            Note: C2 is very close to H17, but does not contact H17.

      [_] Solder and clip the leads (10 total)

      [_] C9   1uF/25
      [_] C18 45pF/var
      [_] C8   10uF/25

      [_] Solder and clip the leads (6 total)

Now check your work. All leads should be soldered. There should be no solder bridges or cold solder connections. You should have no resistors, diodes or capacitors remaining.

      [_] OK so far.

Diodes
Diodes are polarized, with the cathode end being banded. Observe polarity when installing the following diodes. The diode band must match the band shown on the PCB's silk screen. Leads are at a 0.3" spacing.

***someone please explain this out, or explain it to me…. 300 vs. 400 vs. 500 mils
.
          Note: If using jig to bend the diodes, D1 and D2 400 mils instead of 500 mils.

[_] D1   1n4002
[_] D2   1n4002
[_] D8   1n270
[_] D9   1n270

[_] Solder and clip the leads (8 total)

Note: Drill size for D3, D4, D5, D6, and D7 are too large. Be careful when soldering.
[_] D3   1n5235/6.8v
[_] D4   1n4148
[_] D7   1n4148
[_] D6   1n4148
[_] D5   1n4148

[_] Solder and clip the leads (10 total)

[_] 1   DS1   RED LED
Note: Holes for DS1 are a tad too small. You might need to shave the leads or work to get them in the holes. Be sure you install it correctly, since it will be hard to get out later.

Carefully check the board for solder splashes, solder bridges and cold solder joints.

[_] OK so far.

Connectors
The male headers will next be installed. The plastic body of the part should rest flush with the top surface of the PC board. The short end if the pins goes into the PC board, the long end sticks up. Install them using the same procedures you used for the IC sockets. Note that the PCB silk-screen has a square to denote pin #1.

WARNING: Do not hold these parts with your fingers as they quickly get very hot while soldering in place.

**John's hint: place one or two of the shunts on the header. You can then hold the header by the shunt and not get burnt as easily. The longer closed top end style shunts work best.

[_] H14 50 pin (2x25) header
[_] H15 34 pin (2x17) header
[_] H16 20 pin (2x10) header (is this optional?)

[_] Solder the leads (94 total)

[_] H1   3 pin header
[_] H2   3 pin header

[_] H3   3 pin header
[_] H4   3 pin header

[_] Solder the leads (12 total)

[_] H5   6 pin (2x3) header
[_] H6   3 pin header

[_] Solder the leads (9 total)

[_] H7   3 pin header
[_] H8   3 pin header
[_] H9   3 pin header
[_] H10 3 pin header

[_] Solder the leads (12 total)

[_] H13 8 pin (2x4) header

[_] Solder the leads (8 total)

        Note: Silk screen legend at H18 is missing the "H".
[_] H18 2 pin header
[_] H20 2 pin header
[_] H19 2 pin header
        Note: H22 drill size is too large. Be careful when soldering.
[_] H22 2 pin header
[_] H23 2 pin header

[_] Solder the leads (10 total)

[_] H21 2 pin header
[_] H12 3 pin header
[_] H11 3 pin header

[_] Solder the leads (8 total)

[_] H17 4 pin screw header

    NOTE: Assemble the two 2 screw headers supplied into one, buy sliding the tab on one into the slot on the other. Once the screw terminal is mounted at H17 you can no longer read the silk screen legend which labels each pin. You might want to label them some other way using the enclosure.

[_] Solder the leads (4 total)

Carefully check the board for solder splashes, solder bridges and cold solder joints.

[_] OK so far.

Test Points
( )   Take four of the resistor leads and bend them into loops around a form that is between 1/8 and 3/16 (use a drill bit or small screwdriver).

This will form a test point so you don't want the loop to lie flat on the PC board. You want it to stick up a bit so that a clip lead can be attached to the loop. See the graphic below -- it shows a test point as viewed from the side of the board.

Note: Drill size for all test points are too large. Be careful when installing.
[_] Solder a test loop at -5
[_] Solder a test loop at +5BB
[_] Solder a test loop at +V
[_] Solder a test loop at GND

****John's preference: make the loop by making a turn and a half around the size of machine screw used to retain DB style connectors.

Xtals
It is now time to install the two crystal oscillators. Be careful to orient the crystals properly. Refer to the positioning also shown on the parts placement diagram.

[_] 1   Y1   11.0592 Mhz

Note: There are traces that run under Y1. When installing, be very sure that no part of the metal case of the xtal contacts the traces underneath. Since there is a good chance that the crystal will have short leads, you might not be able to have the xtal raised above the board. You might want to place a small piece of electrical tape under the crystal.

[_] Solder and clip the leads

[_] 1   Y2   32.768 kHz

[_] Solder and clip the leads

Transistor

Note: Transistors are polarized components. Match the body of the transistor with the silk-screened outline and carefully bend the transistor leads to match the hole pattern in the PC board. The bottom of the body of the transistor should be not more than ºî above the PC board.

[_] Q1   2N3904 TO-92

Note: The holes for Q1 are a tad too small, so be careful when installing.

Power Supply

At this point you need to decide which of three power supply options you plan to use:

****So, what are the choices????????????????? And how do they affect the construction.

7805 Voltage Regulator

Bend the leads of the 7805 voltage regulator in a 90-degree angle in the direction of the mounting tab so that it lies over the silk-screen outline of the device. Bend the leads such that the center leg fits into the hole that is slightly longer than the two other leads.

Install the supplied heatsink and the 7805 to the PCB before soldering. Fasten the 7805 and the heatsink using one î 4-40 screw, lockwasher, and nut.

Before soldering the 7805 to the PCB ensure that the fins of the heatsink do not touch any other components or a short may result!

Note: Holes for holes for VR1 can be too close (by about 100 mils) to body of VR1. Be sure to check this before soldering.

[_] Install Heatsink

[_] VR1 7805 3-terminal voltage regulator

[_] Fasten 7805 and heatsink to the PCB with (1) 4-40 screw, lockwasher, and nut.

[_] Solder in place

Are you Complete?
Your TUC-52 is nearly complete. Every part should be installed except the Integrated Circuits. Check your work for incorrect soldering and parts installation prior to completing the TUC-52 kit.

[_] Everything looks simply wonderful to me!

Voltage Checks

Before installing the Integrated Circuits, it is best to do a preliminary voltage check. This is a relatively easy check to make and can save you headaches later. But first you need to construct a power supply cable.

Using a voltmeter connect the gound to GND on the right side of the board and measure the following voltages

[_] +5 volts at pin 26 of IC13
[_] +5 volts at pin 8 of IC10
[_] +5 volts at +5 Header
[_] +5 volts at +5 on H17 (lower left corner of board)

Integrated Circuits
Observing static precautions and polarity, install the following ICs in their sockets. Pay particular attention to aligning the notch of the IC with the socket:

NOTE: Make sure all power is removed before installing ICs.

[_] IC14 UDN2595A
[_] IC13 82C55A
[_] IC1 80C32
[_] IC2 74HC08
[_] IC3 74HC373
[_] IC4 27C256-150
[_] IC5 43256-15LP
[_] IC6 43256-15LP

[_] IC15 82C55A
[_] IC12 74HC139
[_] IC7 74HC4066
[_] IC16 74HC14
[_] IC11 PAL18CV8
[_] IC8 74HC14
[_] IC9 PCF8583 (clock)

[_] IC10 PCF8581CPN (eeprom)

Preliminary Operational Check
The following operational check

???

BBRAM Battery:

The microprocessor in your TUC-52 receiver needs standby power for two purposes:
·   To save parameters needed for operation
·   An internal clock so that the unit knows the approximate date/time.

Such functions are usually saved in BBRAM (Battery Backed-Up RAM).

NOTE: Make sure all power is removed before installing ICs.

Now test the BBRAM
   [_] Plug the battery into BH1 for testing ***Observe polarity!***
   [_] With a voltmeter, see if the battery/capacitor has any charge at all. ????
   [_] Apply power to the TUC-52 PCB.
   [_] The BBRAM should ?????????

****John's question: does H22 need to be in for this check?

   [_] Remove power to the TUC-52.

   [_] All voltage checks satisfactory.

   [_] OK so far

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5. INSTALLATION/TESTING

This section deals with the installation and testing of the TUC-52.

<u>Configuration of Jumpers?</u>

??????????????????????????????????????

<u>Testing</u>

     [_] Using H11 (Serial Port) connect your PC using a ??? cable.
     [_] Connect the TUC-52 to your Personal Computer.
     [_] Apply power to the TUC-52.

     [_] Load and configure the program *??????*

     [_] Upon start up of the TUC-52 the following should be displayed on the
screen.

?????????????????????????????????????

     [_] This completes the assembly of your TUC-52! Congratulations! At this point
you may install the TUC-52 in a suitable enclosure. The TUC-52 will fit inside the TAPR
DSP-93 enclosure, which can be gotten from TAPR.

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6. OPERATION

????????????????????????????????????

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7. THEORY OF OPERATION

<u>**CPU and Associated Glue**</u>
IC1 is the CPU socket that holds most any member of the 8052 family that uses a 40 pin DIP package, including the Dallas DS80C320. IC1 typically is stuffed with an 80C32 (the ROM-less version of the 80C52). Y1 provides a standard clock frequency of 11.0592 MHz that allows for common baud rates on the serial UART port. C14, a variable capacitor, is provided for in the board layout but it's not expected that the component will be provided for the user.

H1 selects the source of the UART input. A shunt across pins 1 & 2 of H1 will cause the input for IC1 pin 10 to be taken from an on-board "poor man's" RS-232 receiver. A shunt across pins 2 & 3 of H1 will cause the input for IC1 pin 10 to be taken from an off-board source provided through the PORT BLOCK.

H2 is used to tell the CPU to execute code from its internal masked program memory or to get code from an external EPROM. A shunt across pins 1 and 2 of H2 will cause code to be executed from internal masked ROM of IC1. A shunt across pins 2 and 3 of H2 will cause code to be executed from external memory.

R12 and R13 are used to pull up P17 and P16 respectively so that these I/O leads can be used to communicate with I2C (pronounced EYE SQUARED SEE) protocol components (i.e., IC15 and IC16).

Part of SIP resistor RS2 is used to pull up INT1*, INT0*, T1 and T0 to ensure that these signals can be brought out to the outside world in an RF environment and not be likely to be inadvertently pulled low. It's understood that these ports already have an internal weak pull-up but the additional current source provided by RS2 is a form of insurance.

IC2 provides for the logical low OR-ing of the RD- and PSEN- signals to form the buffered PSRD* signal. Additionally IC2 provides buffering for the PSEN*, WR* and RD* signals. R14 is included to ensure that the WR- lead is pulled high during the time when the power is on but the reset signal is active. During the reset period WR- is tri-stated and its state is unknown. If it goes low it will send a write signal to any enabled RAMs. The pull-up is added to ensure it doesn't wander low during resets.

IC3 provide an address latch to capture and buffer the lower order address signals from the data bus. SIP resistor RS1 is used to pull up the open drain data bus.

<u>**Memory Sites**</u>
TUC52 provides for up to three memory sites.

IC4 is for an EPROM of either the 27c256 (32K) or 27C512 (64k) type. The amount of EPROM actually available is determined by the PAL address selector.

H3 selects the signal for pin 1 of the EPROM, IC4. A shunt across pins 1 & 2 of H3 will cause IC4 pin 1 to be at +5 volts. This is needed when a 27C256 is installed in

this socket. A shunt across pins 2 & 3 of H3 will cause IC4 pin 1 to be connected to A15. This is needed when a 27C512 is installed in this socket.

H4 selects the signal for IC4 pin 22, the output enable for the EPROM. A shunt across pins 1 & 2 of H4 will cause IC4 pin 22 to be connected to PSEN*. When in this position the EPROM will only be in the code space and not the data space of the memory map. A shunt across pins 2 & 3 of H4 will cause IC4 pin 22 to be connected to PSRD*. When in this position the EPROM will be in both the code and data space of the memory map.

IC5 is for a 32K RAM chip. The amount of RAM actually available is determined by the PAL address selector. The RAM is connected to the +5BB net for power so that it can retain memory data (if the user has installed a battery on TUC52). H5 selects the signal source for IC5 pin 22, the output enable for the RAM. A shunt across pins 1 and 2 of H5 will cause IC5 pin 22 to be connected to RD*. When in this position the RAM will only be in the data space and not the code space of the memory map. A shunt across pins 3 and 4 of H5 will cause IC5 pin 22 to be connected to PSRD*. When in this position the RAM will be in both the code and data space of the memory map. A shunt across pins 5 and 6 of H5 will cause IC5 pin 22 to be connected to PSEN*. When in this position the RAM will be in only the code space and not the data space of the memory map.

IC7 provides control of the chip select input to the RAM. When the system is under normal power conditions PF* is high and switch IC7A is closed while PF is low and switch IC7B is open, thus connecting the RAM chip-select pin to YCE*, the chip-select generated by the PAL. When normal power has been removed, PF* is low and switch IC7A is open while PF is high and switch IC7B is closed, thus connecting the RAM chip-select pin to +5BB and disabling the chip. IC7 is powered by the +5BB net and not the +5 net.

IC6 is a dual mode site (socket) that can accommodate either a 32K RAM chip or a 27C256 EPROM chip. With standard PAL programming, this part is in the address space from 8000H to EFFFH.

H6 selects the signal for pin 1 of the socket for IC6. A shunt across pins 1 and 2 of H6 will cause IC6 pin 1 to be connected to A14. This is needed when a RAM chip is installed in this socket. A shunt across pins 2 and 3 of H6 will cause IC6 pin 1 to be connected to the +5 net. This is needed when a 27C256 is installed in this socket.

H7 selects the signal for pin 27 of the socket for IC6. A shunt across pins 1 and 2 of H7 will cause IC7 pin 27 to be connected to WR*. This is needed when a RAM chip is installed in this socket. A shunt across pins 2 and 3 of H7 will cause IC7 pin 27 to be connected to A14. This is needed when a 27C256 is installed in this socket.

H8 selects the signal for pin 22, the output enable for the chip installed at IC6. A shunt across pins 1 and 2 of H8 will cause IC6 pin 22 to be connected to PSRD*. When in this position the chip will be in both the code and data space of the memory map. A shunt across pins 2 and 3 of H8 will cause IC6 pin 22 to be connected to RD*. When in this position the chip will only be in the data space and not the code space of the memory map.

H9 selects the signal for pin 20, the chip-select for IC6. A shunt across pins 1 and 2 of H9 will cause IC6 pin 20 to be connected directly to the PAL chip-select ZCE*. This is used when an EPROM chip is installed in this socket. It may also be used for a RAM chip that is not battery backed up. A shunt across pins 2 and 3 of H9 will cause IC6 pin 20 to be connected to the analog switches IC7C and IC7D, for control of the chip-select. This may be used when a RAM chip is installed in this socket.

H10 selects the source for power for the device in the socket at IC6. A shunt across pins 1 and 2 of H10 will cause IC6 pin 28 to be connected to the +5 net. This is used when an EPROM chip is installed in this socket or when a RAM that is not to be battery backed up is to be used in this socket. A shunt across pins 2 and 3 of H10 will cause IC6 pin 28 to be connected to the +5BB net. This is used only when a RAM chip is installed in this socket and the RAM is to be battery backed up.

Note also that the position of shunts on H9 and H10 must track each other for proper operation. If a shunt is installed across pins 1 & 2 of H9 then a shunt must be installed across pins 1 & 2 of H10 and then either an EPROM or RAM may be used as IC6 (but the RAM will not be battery backed up). The converse is also true. If a shunt is installed across pins 2 & 3 of H9 then a shunt must be installed across pins 2 & 3 of H10 and then only a RAM may be used as IC6.

Many different memory installations are possible with TUC52. At the bare minimum (and really never expected to operate this way) it's possible that TUC52 could operate with only internal code and data within the 8051/8052, leaving IC4, IC5 and IC6 unpopulated. More likely is that IC4 will contain an EPROM with code and that the 256 bytes of RAM internal to an 8032 will be used for read/write storage. Most simple applications can run in this mode.

Moving up the scale of complexity, the next enhancement would be to have a RAM device at IC6. In this configuration IC4 could be mapped for code space from 0H to 7FFFH while IC6 could be mapped for code AND data from 8000H to EFFFH.

When TUC52 is used for MCS BASIC-52 program development a RAM device would be added at IC5 which would be configured for data space from 0 to 7FFFH. In this case IC5 serves as working program memory while IC6 serves as the file system for storing programs and data. When TUC52 is used as a stand-alone mountaintop MCS BASIC-52 program execution system, IC6 will hold a ROM that contains the user's BASIC source code program. A ROM is used in this case instead of BBRAM because it's more reliable.

PAL Chip-Selects
An 18CV8 PAL is used at IC11 to generate chip-selects for the different devices used on TUC52. The actual memory mapping is determined by the programming of the PAL. The user selects a particular pre-programmed memory map by placing shunts on H13.

In general, XCE* (active low) selects the EPROM at IC4, YCE* (active low) selects the RAM at IC5 and ZCE* (active low) selects the RAM/ROM at IC6.

IOA* is an I/O select line (active low) that's determined by address leads from the processor. It drives one half of IC9 for I/O device selection. IOB* is an I/O select line (active low) whose state is also determined by the address signals. Additionally, IOB* can also be configured to qualify its signal with RD* or WR* being active (low). This qualification may be needed for dumb ports (like 74hc374). The IOA* and IOB* signals are always inactive (high) when PSEN* is active (low).

TABLE 1 -- ADDRESS SELECTION

Shunts A and B determine main memory mapping.

```
      SHUNTS         ADDRESS-WHEN-SIGNAL-IS-ACTIVE
      B     A     IC4 (XCE*)   IC5 (YCE*)   IC6 (ZCE*)
     ====  ====   ==========   ==========   ==========
     open  open   0000-7FFF    0000-7FFF    8000-EFFF
     open  shnt   0000-1FFF    2000-7FFF    8000-EFFF
     shnt  open   0000-3FFF    4000-7FFF    8000-EFFF
     shnt  shnt   0000-FFFF    0000-7FFF    8000-EFFF
```


Shunt C determines I/O space mapping.

```
     SHUNT  BUS-CNTL-SIGS    ADDRESS-WHEN-ACTIVE
      C     PSEN*  RD*  WR*    IOA*        IOB*
     ====   =====  ===  ===  =========   =========
     shnt   1      x    x    F800-FBFF   FC00-FFFF
     open   1      0    0    F800-FBFF   FC00-FFFF *****
     open   1      0    1    F800-FBFF   FC00-FFFF
     open   1      1    0    F800-FBFF   FC00-FFFF
     open   1      1    1    F800-FBFF   no select
```

**** RD* and WR* should never be low at same time -- this state is shown for completeness of PAL programming.

Shunt D currently has no effect on the PAL.

I/O
There are two main types of I/O for TUC52: processor I/O and memory mapped auxiliary I/O. Processor I/O is I/O provided by the processor IC itself while auxiliary I/O is that provided by memory mapped 82c55 parallel ports. First consider processor I/O.

There are two processor I/O ports available: P1 and P3 of 8 bits each. The P1 port usually provides general-purpose bit I/O while P3 has special features associated with each lead. However, the special features of P3 can always be disabled and the ports used for simple bit input/output I/O. For advanced processors (like the Dallas DS80C320) even the P1 port has special features associated with it.

The features of P3 are always as follows (in addition to general-purpose bit I/O):

```
P3.0    RXD      UART Data Input
P3.1    TXD      UART Data Output
P3.2    INT0*    Interrupt 0 Input
P3.3    INT1*    Interrupt 1 Input
P3.4    T0       Timer 0 Input
P3.5    T1       Timer 1 Input
P3.6    WR*      Bus Write (not available for bit I/O)
P3.7    RD*      Bus Read (not available for bit I/O)
```

For 80C31 devices port P1 provides only bit I/O, without special features. For 80C32 devices port P1 can provide the following special features (in addition to general-purpose bit I/O).

```
P1.0    T2       Timer 2, External Count Input
P1.1    T2EX     Timer 2, Capture/Reload Trigger Input
```

Some Philips parts also allow each of the P1 ports to serve as an independent interrupt signal.

For the Dallas DS80C320 device, port P1 can also provide the following special features (in addition to general-purpose bit I/O).

```
P1.0    T2       Timer 2, External Count Input
P1.1    T2EX     Timer 2, Capture/Reload Trigger Input
P1.2    RXDX     Second UART Data Input
P1.3    TXDX     Second UART Data Output
P1.4    INT2     Active high interrupt
P1.5    INT3*    Active low interrupt
P1.6    INT4     Active high interrupt
P1.7    INT5*    Active low interrupt
```

Auxiliary I/O is that provided by up to two 82c55 parallel ports. The first 82c55 is IC13 which has non-inverting high voltage open collector drivers connected to port A. These drivers can easily be omitted by simply replacing the driver IC with a "straight across" jumper block. Pull-up resistors, formed by RS3, are provided for port B. These too can be omitted for applications that don't need them (or don't want them). Ports A, B and C of IC13 are brought out to the PORT BLOCK for connection to another board for specific interfacing requirements.

The second 82c55 (IC15) ports are connected directly to the BUS BLOCK without any other embellishments.

Connector Blocks
There are three major connector blocks: the PORT BLOCK, BUS BLOCK and POWER BLOCK. There is one minor block: the AUX BLOCK. Only the PORT block is expected to have a connector installed on the standard TUC52 board. All other blocks are expected to be unpopulated.

The PORT BLOCK is the block that's expected to be used in almost all applications. Additional blocks will usually be unnecessary. The PORT BLOCK conveys nets for P1

and P3 from the processor as well as the three ports from the primary 82c55 (A=P4, B=P5 and C=P6). Essential power and control signals also pass through the PORT BLOCK. The only area for concern is the voltage drop on the GND, +5 and +V nets through the PORT BLOCK interconnections. If this drop is considered to be excessive then the POWER BLOCK should be used as well.

The BUS BLOCK is not expected to be used often but it is available for those applications that need its circuits. The BUS BLOCK conveys nets for the three ports from the secondary 82c55 (A=P7, B=P8 and C=P9) as well as the data bus (Dn), the low nibble of the address bus (An), the I/O chip-selects, WRITE, READ and RESET as well as additional GROUND connections.

The POWER BLOCK is used to provide a low voltage drop connection between TUC52, any interface board(s) and the external power source. At this point it's not clear if this block would always need to be used since its circuits are redundant with those provided by the PORT BLOCK. The only reason for the user to make use of the POWER BLOCK is if there is an excessive voltage drop in the +5 and/or ground nets through the PORT BLOCK.

The AUX BLOCK is not expected to be used often but it is available for those applications that need its circuits. The AUX BLOCK is a subset of the PORT BLOCK and serves as a low cost alternative for applications that don't need the 50 pin connector and cable of the PORT BLOCK.

Power Control
The power control system is the heart of the battery backup system for the RAM devices and the time of day clock (if provided). It also includes the system reset circuitry.
 Unregulated power is applied to the +V net either from the interface board through the PORT BLOCK or through the POWER BLOCK. This voltage is regulated to +5 volts by VR1. Option block H18 is provided so that the regulator can be isolated from the +5 net for those cases when the +5 net is back-fed from the interface board.

As far as the BBRAM system goes, there are three states to be concerned with. They are (State-A) when the voltage on the +5 net is so low that there is no way the CPU is going to execute code (less than 2 volts), (State-B) when there is enough voltage on the +5 net that the CPU might actually run (more than 2 volts) but we don't want it to run, and (State-C) when there is enough voltage on the +5 net that the CPU should run (about 5 volts) and we want it to run. The goal of the power control circuitry is as follows: For State-A the system should hold the BBRAM disabled and not worry about the reset signal. For State-B the system should hold the BBRAM disabled and make reset active so that the CPU won't execute code. For State-C the system should enable the BBRAM for operation and, after a one-second delay upon entering State-C, release the reset signal so that the CPU can execute code.

The voltage at the input to the regulator is sensed by D3 and Q1. In general, Q1 should be saturated only when there is sufficient voltage (about 8 volts) at the input of VR1 to ensure that the +5 net is stable at about +5 volts (that's State-C). When the voltage at +V is below about 8 volts (State-A or State-B), Q1 is cut off and the input to IC16A is

high (IC16 is powered from the +5BB net, so it's "always powered up"). In this case IC16A's output is low and C7 is discharged very quickly through D4 and R6. In this state PF (power failure active high) is high and PF* (power failure active low) is low. These PF signals go to IC7, the 74HC4066 analog switch, to ensure that the RAM chips are not selected by the PAL's chip-select outputs. Additionally, when Q1 is cut off, the output of IC16E is low causing C8 to be discharged through D5 and R9 which causes the reset signal (RST) to go active (high) as long as power is available to IC8. IC8 is powered by the +5 net and can operate correctly with as little as 2 volts as a power source. So, when a voltage is applied to +V and the +5 net starts to rise, once it gets to 2 volts or so the RST signal is in the high (active state) and won't be released until the voltage at the input to VR1 is 8 volts or more (plus the time delays caused by R6/C7 and R9/C8). Note also that during power down conditions that the output of IC16E is low so there's no current drain caused by IC16E trying to drive an unpowered IC8C's input to a logic high.

TUC52's battery backup feature only works when a source of +V is available and that +V is used to derive the +5 power source. The location of the regulator doesn't matter (i.e., the regulator can be on the TUC52 board or some other board, so long as the +V net drops below 7.5 volts before the +5 net drops below 4.5 volts). In those cases where TUC52 is powered exclusively from a source of +5 VDC and no associated +V is available, the battery backed ram feature will not work reliably. In addition, to enable the RAM devices when only +5 VDC is available, a shunt must be placed on H19. Do NOT install a shunt on H19 when a source of +V is available.

Power for the +5BB net can come from either of two sources. One is the +5 net and the other is a 3 volt battery. Both sources are combined by low voltage drop diodes (D8 and D9). The +5BB net is filtered by a tantalum capacitor (tantalum for low leakage) as well as a few standard bypassing caps. Note that no battery is required to operate TUC52, even though the RAMs and IC9, the time of day clock, are powered from the +5BB net. The +5BB net will be powered when the +5 net is powered, even if no battery is installed. The only downside of not having a battery installed is that the RAM and clock will lose their data when the power is removed from the +V net.

There is a slight difference in the R/C/D timing network for IC16B and IC8C. In the case of IC16B the goal is to get charge off C5 as fast as possible and not to get the input of IC16B low as fast as possible. In the case of IC8C the goal is to get input of IC8C low as fast as possible while discharging C8 at a more leisurely pace than that of C6. Since any low at the cathode of D5 will be sustained for tens of milliseconds there's no rush to get the charge off of C8 immediately.

In addition to having the power failure detection system generating reset signals for the CPU, resets can also be generated by a mechanical switch that the user controls (the big red button). This switch, if needed, would be connected to H21.

An additional reset signal can be developed from the received UART signal on detection of a long spacing or BREAK condition. When RXD goes low the output of IC8E goes high, charging C9 through R10. When it goes high enough IC8D's output will go low. If a shunt is installed at H20 this will cause a system reset. I've included this functionality because I've found it to be very useful for commercial systems. The "reset on BREAK" function is of great benefit when one computer controls another (or

controls many devices networked together). Rather than having someone go to each unit and push the big red button, the central computer only needs to send a spacing condition for a few seconds and all networked controllers are reset.

Clock and Non-Volatile Memory
IC9 provides for a simple time of day clock and 240 bytes of BBRAM while IC10 provides for data retention by an EEPROM. Both devices communicate with the CPU by means of the Philips I2C (pronounced EYE SQUARED SEE) protocol.

Minimal Serial I/O
IC8A and IC8B provide a "poor man's" RS-232 interface. It's not expected that this interface will take the place of a real RS-232 interface (which goes on the interface board). I decided not to put a MAX232 interface on the TUC52 board because it would have required running the TTL and RS-232 versions of the control signals twice though the PORT BLOCK. It was much simpler to have the interface board contain the RS-232 interface (or RS-422 or RS-485) and send the control signals to whatever I/O port was desired.

The "poor" interface is included for simple systems that don't make use of an interface board. Not to advance this interface as a desirable alternative to a MAX232 interface, but I've used this "poor" interface on many systems over the years and have yet to find an RS-232 device (manufactured after 1980) that it won't work with over short runs (less than 20 feet).

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8. TUC-52 User Options:

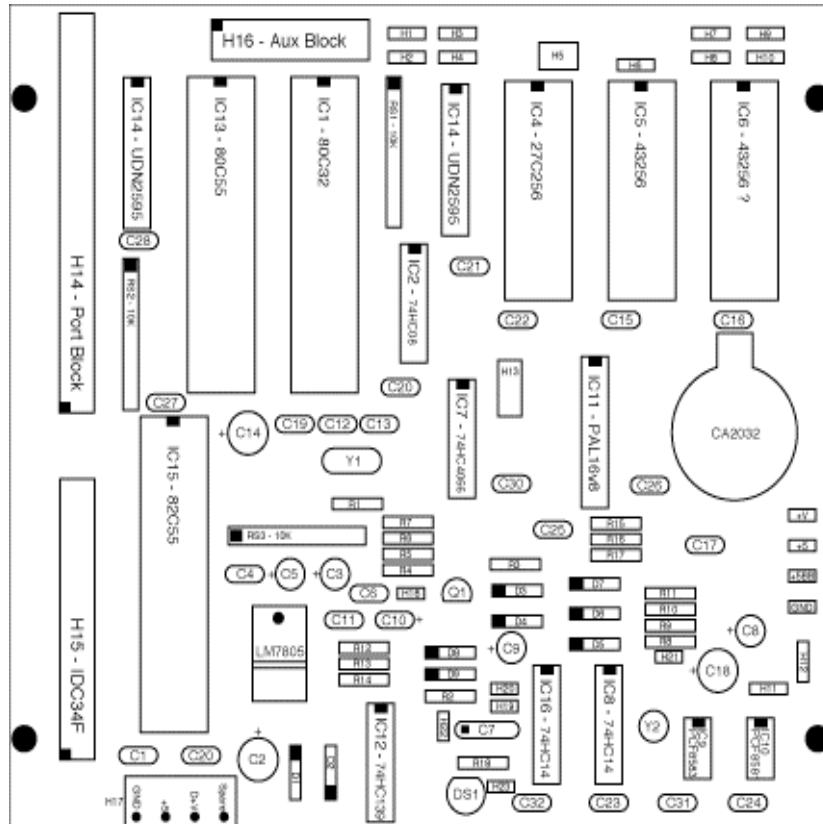
9. BOARD LAYOUT

Figure 1. Board Layout

(PICT file - not EPS file as in final doc -- thus image will look fuzzy in this doc)

Schematics (page ???)