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TAC-2

TAC-2 Assembly Manual

Contents

INTRODUCTION

The “Totally Accurate Clock” TAC-2 printed circuit board (PCB) is intended to serve several purposes:

- It provides a “universal” electrical and mechanical interface for a number of common OEM board-level GPS receivers including specifically:
  - Garmin GPS-20
  - Motorola Oncore
  - Trimble SK8
- It provides interfaces for the 1 pulse-per-second (1PPS) signal generated by these receivers:
  - Low-impedance, fast rise-time 1PPS signals for “laboratory” applications.
  - RS232 level 1PPS signals for computer applications.
  - Specialized 1PPS interfaces for an add-on PCB that will stabilize a low-cost crystal oscillator to an accuracy ~ 1 part-per-billion
- It provides several different power supply options to make use of your GPS receiver easier. The power interface is similar to (and compatible with) those used for computer disk drives:
  - A low-cost, (7805-type) regulator.
  - A high-efficiency switching power supply.
  - Direct 5 volt power.

- It has provision for an Uninterruptable Power Supply (UPS) to buffer the GPS receiver through brief power outages.
- It provides Battery Backup so the GPS receiver can wake up "smart."
- It can provide isolated power for an amplified GPS antenna.

Since the TAC-2 has so much flexibility, there are several options you will have to choose from during construction. The "base" implementation will satisfy the needs of many radio amateurs with support for the Garmin GPS-20 and Motorola ONCORE Basic receivers. A few jumper changes enable support for the Motorola ONCORE VP/UT receiver. Some added parts and some more jumper changes are needed if you plan to use a Trimble SK-8. Your first decision is to determine which GPS receiver you plan on using with your TAC-2 and which options. Once you have chosen then carefully follow the construction instructions. In the future if you change GPS receiver or want to add an option, it can be added later.

NOTES:

- Please check the shipment for any possible errata sheet(s) and/or additions/corrections to instructions provided in this manual.

- Please read the Construction Notes prior to starting assembly.

- Determine which GPS receiver and options you plan to install. Then find and read your GPS receiver installation and options before starting assembly.

Overall, construction and check-out of the TAC-2 will probably take you only an evening or two. Warm up your soldering iron, take your time, and enjoy!

ACKNOWLEDGEMENTS

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Bob Stricklin, N5BRG, Tester
Jim Neely, WA5LHS, Tester
John Ackermann, AG9V, Tester
Frank Perkins, WB5IPM

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 TAC-2 which are independent of the GPS receiver or options you plan to install.

Resistors
1/4 watt, 5% carbon film:

[_] 1 R1	1 Megohm (brown-black-green-gold)
[_] 1 R2	470 ohm (yellow-violet-brown-gold)
[_] 1 R6	180 ohm (brown-gray-brown-gold)
[_] 1 R6	1 Kohm (brown-black-red-gold)

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

[_] 1 RP1	4 x 2.2k ohm (750-83-R2.2K)
[_] 2 RP2,RP3	4 x 10k ohm (103)
[_] 2 RP4,RP5	4 x 47 ohm (770 83 470)

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.

[_] 14	C1,CB1-4,6-14	0.1 uF (104) Mylar or Monolithic
[_] 1	C2	470 pF (471) Mylar or Monolithic
[_] 8	CT1-8	1 uF or 2.2 uF Electrolytic or Tantalum capacitors

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	U1	74HC132(14 pin)
[_] 1	U2	MAX232, ISL232CPE, TC232CPE(16 pin)
[_] 2	U3,U4	74AC04 (14 pin)
[_] 1	U6	LM7805 3-terminal Regulator

Diodes

[_] 8	D1-7,D10	1N4148 Silicon Signal Diode
[_] 2	D8,D9	1N4002 Silicon Power Diode
[_] 1		LED

Radio-frequency Choke

[_] 1	RFC1	6.8 uh choke

Sockets and Connectors

[_] 3	U1,U3,U4	14-pin DIP IC Sockets
[_] 1	U2	16-pin DIP IC Socket
[_] 1	P7	4 pin polarized MOLEX header
[_] 3	P1-3	2x5 pin Male Header
[_] 1	JP9	1x5 pin Male Header
[_] 1	JP11	1x2 pin Male Header
[_] 1	P7	Header Receptacle 4-pin 0.1" Housing
[_] 5	P7	Pins for Header Receptacles
[_] 10		2-pin push-on jumpers

Miscellaneous

[_] 1		PC Board, TAC-2 Rev. C
[_] 1		Assembly Manual (This Document)
[_] 1		Software Disk
[_] 1		Software Operating Manual
[_] 1	U6	Heatsink
[_] 1	P1	DE-9S IDC cable and connector assembly
[_] 4		3/8" 4-40 threaded standoffs for GPS receiver
[_] 4		3/4" 4-40 threaded standoffs for TAC-2 PCB
[_] 17		1/4" 4-40 screws
[_] 1		#4 lockwasher
[_] 1		4-40 nut

Specific Configuration and Options:

Depending on the GPS receiver and options you will be installing, you need the following parts.

Motorola ONCORE Basic receiver:

[_] 1	P4	2x5 pin Male Header
[_] 1		1_" long IDC cable assembly with 2x5 connectors.

Motorola ONCORE VP/UT receiver:

[_] 1	J1	2x5 pin Female Header
[_] 1	JP3	1x3 pin Male Header

Trimble SK-8 receiver:

NOTE: The following parts are supplied as a separate parts option for Trimble SK-8 receiver users. If you are installing a SK-8 and did not receive these parts notify the TAPR office.

[_] 1	U5	7555 Integrated Circuit (8 pin DIP)
[_] 1	U5	8-pin DIP Socket
[_] 1	Q1	2N3906 PNP transistor
[_] 1	R9	1 Megohm Resistor (brown-black-green-gold)
[_] 1	C4	0.1 uF Capacitor (104)
[_] 1	CB5	0.1 uF Capacitor (104)
[_] 1	J2	2x5 pin Female Header
[_] 1	JP2	2x5 pin Male Header
[_] 1	JP3	1x3 pin Male Header
[_] 1	JP4	2x4 pin Male Header

Garmin GPS-20 receiver:

[_] No extra parts are needed

CONSTRUCTION NOTES:

You are now ready to begin construction of the TAC-2. It is recommended that when assembling the TAC-2, 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.

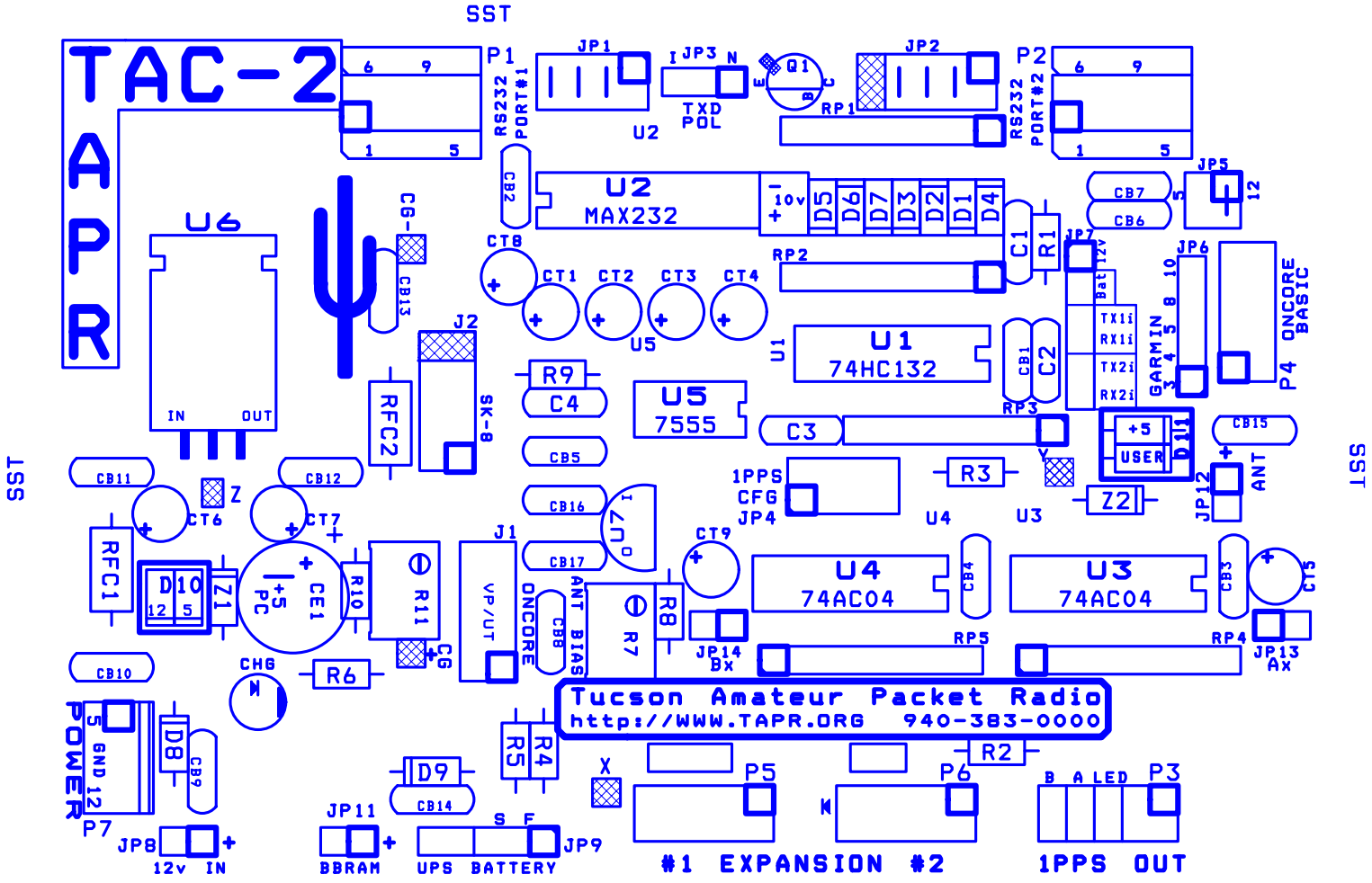
In addition to the soldering iron and solder, you will need small flush or semi-flush cutting pliers and small-tipped long nosed pliers. A magnifying glass may prove helpful to identify the values of the small components.

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.

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 TAC-2 (depending on which type of GPS receiver you have) 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.



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.

[_] 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.

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.

[_] U1 14-pin
[_] U2 16-pin
[_] U3 14-pin
[_] U4 14-pin

If you will be using a **Trimble SK-8** receiver, then also install this socket now:

[_] U5 8-pin

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.

Install the following 5% resistors:

[_] R1 1 Megohm (brown-black-green-gold)
[_] R2 470 ohm (yellow-violet-brown-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 (6 total)

If you will be using a **Trimble SK-8** receiver, then also install:

[_] R9 1 Megohm (brown-black-green-gold)

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

[_] OK so far.

SIP (Single Inline Package) Resistors

These are used in the TAC-2 are symmetric and not polarized. It is recommended that you match the dot or Pin 1 on the resistor with the pad marked with a square on the silkscreen. All RPx Resistor Packs are 8-lead parts containing 4 identical resistors. 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 6 pins (just like you did by soldering the corner pins on the IC sockets).

[_] RP1 4x2.2k ohm
[_] RP2 4x10k ohm
[_] RP3 4x10k ohm

[_] Solder the leads (24 total)

[_] RP4 4x47 ohm
[_] RP5 4x47 ohm

[_] Solder the leads (16 total)

RF Chokes

[_] RFC1 6.8 uh

[_] Solder and clip the leads (2 total)

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

[_] OK so far.

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:

[_] C1 0.1 uF (104)
[_] C2 470 pf (471)
[_] CB1 0.1 uF (104)
[_] CB6 0.1 uF (104)
[_] CB7 0.1 uF (104)

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

Now work in the top left-hand quadrant:
[_] CB2 0.1 uF (104)
[_] CB11 0.1 uF (104)
[_] CB12 0.1 uF (104)
[_] CB13 0.1 uF (104)

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

In the bottom half of the board:
[_] CB3 0.1 uF (104)
[_] CB4 0.1 uF (104)
[_] CB8 0.1 uF (104)
[_] CB9 0.1 uF (104)
[_] CB10 0.1 uF (104)
[_] CB14 0.1 uF (104)

[_] Solder and clip the leads (12 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.

[_] CT5 1 uF (105)
[_] CT6 1 uF (105)
[_] CT7 1 uF (105)

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

The following capacitors are immediately adjacent to U2 (MAX232). All the "+" signs should point away from U2 and toward U5/R9.

[_] CT8 1 uf (105)
[_] CT1 1 uf (105)
[_] CT2 1 uf (105)
[_] CT3 1 uf (105)
[_] CT4 1 uf (105)

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

If you will be using a **Trimble SK-8** receiver, then also install:

[_] CB5 0.1 uF (104)
[_] C4 0.1 uF (104)

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. Diodes D1 through D7 are located between RP1 and RP2.

[_] D1 1N4148 **NOTE:** The
[_] D3 1N4148 cathode band on
[_] D7 1N4148 these 4 diodes all
[_] D5 1N4148 point towards RP2

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

[_] D4 1N4148 **NOTE:** The cathode
[_] D2 1N4148 band on these 3 diodes
[_] D6 1N4148 all point towards RP1

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

NOTE: The 1N4002 diodes have heavy leads. Make sure that they get hot enough for solder to flow properly!

[_] D8 1N4002
[_] D9 1N4002

[_] Solder and clip the leads (2 total).

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 silkscreen 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.

[_] P1 2x5 pin Male Header
[_] P2 2x5 pin Male Header
[_] P3 2x5 pin Male Header
[_] JP9 1x5 pin Male Header

UPS Power

The following connector is polarized. Install it with the plastic polarizing tab away from the edge of the board and towards the diode D8, matching the silkscreen artwork. This connector matches the 4-pin connector used on many disk drives:

[_] P7 4 pin polarized MOLEX connector

If you will be using a **Motorola ONCORE BASIC** receiver (this is Motorola's original receiver, also called the PVT-6 with a PCB 100mm x 70mm in size), then also install P4 on the ***bottom*** of the PCB:

[_] P4 2x5 pin Male Header

If you will be using a **Motorola ONCORE VP/UT** receiver, then also install:

NOTE: J1 is installed on the ***bottom*** of the PCB.

[_] J1 2x5 pin Female Header
ONCORE VP/UT I/O

[_] JP3 1x3 pin Male Header
TXD Polarity Selection

If you will be using a **Trimble SK-8** receiver, then also install:

NOTE: J2 is installed on the ***bottom*** of the PCB.

[_] J2 2x5 pin Female Header
Trimble SK-8 I/O (only 8 pins used)
[_] JP2 2x5 pin Male Header
CFG #2
[_] JP3 1x3 pin Male Header
TXD Polarity Selection
[_] JP4 2x4 pin Male Header
1PPS CFG

NOTE: The headers at P5 and P6 are intended for future expansion. Don't worry about these at this time.

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

[_] OK so far.

Transistor

If you will be using a **Trimble SK-8** receiver, then also install:

NOTE: Transistors are polarized components. Match the body of the transistor with the silkscreened 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 _" above the PC board.

[_] Q1 2N3906 PNP transistor

Power Supply

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

- **7805 Voltage Regulator**
  A low-cost voltage regulator. This regulator comes supplied with the TAC-2 kit. Input voltage range is 7.5 to 12 volts.

- **PT5101 or 78SR Switcher Voltage Regulator**
  For high efficiency regulation under a wide variety of input voltages, Power Trends PT5101 or 78SR Switcher voltage regulator may be installed. Input voltage range is 7 to 26 volts.

The Power Trends Integrated Switching Regulators are available from Power Trends (1-800-531-5782 also http://www.powertrends.com) or Digi-Key (1-800-344-4539 also http://www.digikey.com). Digi-Key costs as of June 1997, US$13.13 for the PT5101 and US$18.38 for the 78SR. Digi-Key part numbers are:

PT5101A-ND - horizontal without heat tab
PT5101S-ND - vertical with heat tab
78ST105HC-ND - horizontal

- **Direct 5 volts power supply**
  A voltage regulator is not needed. Either you plan to use your own 5 volt power supply or you plan on installing your TAC-2 inside your computer and using its 5 volt power supply.

WARNING: The Motorola Oncore, Garmin GPS-20, and Trimble SK-8 receivers require +5 volts +/- 5%. Exceeding this voltage will damage your GPS receiver.

NOTE: Read ahead and decide which power supply option you plan to use before installing any parts.

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 marked Z.

Install the supplied heatsink and the 7805 to the PCB before soldering. Fasten the 7805 and the heatsink using one _" 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!

[_] Install Heatsink

[_] U6 7805 3-terminal voltage regulator

[_] F asten 7805 and heatsink to the PCB with _" 4-40 screw, lockwasher, and nut.

[_] Solder in place

PT5101 or 78SR Switcher Voltage Regulator

See Section **8.5 High-efficiency Switching Power Supply Option** for parts listing and instructions for installing this option.

Direct 5 volts power supply
Using a cut-off lead from a resistor or capacitor, install a jumper between the **"+5PC"** hole and the **"+"** hole of CE1.

[_] Jumper installed

WARNING: The Motorola Oncore, Trimble, Garmin GPS-20, and Trimble SK-8 receivers require +5 volts +/-5%. Exceeding this voltage will damage your GPS receiver.

Installation of specific parts

Your TAC-2 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 TAC-2 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.

Supplied with your TAC-2 kit is a 4-pin connector and pins. Follow the directions below depending on the Power Supply option you chose above. Or, if you prefer, you can use the disk drive power connector from an ordinary PC power supply.

7805 Voltage Regulator or PT5101 or 78SR Switcher Voltage Regulator:
[_] Assemble the 4-pin connector with ground to pin 3 and positive voltage applied to pin 4. (Pin 1 is towards U6)

Direct 5 volts power supply:
[_] Assemble the 4-pin connector with ground to pin 2 and positive voltage applied to pin 1. (Pin 1 is towards U6)

WARNING: The Motorola Oncores, Garmin GPS-20, and Trimble SK-8 receivers require +5 volts +/- 5%. Exceeding this voltage will damage your GPS receiver.

[_] Apply power to the TAC-2 PCB.

Using a voltmeter measure the following voltages:

[_] +5 volts at pin 14 of U1
[_] +5 volts at pin 16 of U2
[_] +5 volts at pin 14 of U3
[_] +5 volts at pin 14 of U4

If you will be using a **Trimble SK-8** receiver:

[_] +5 volts at pin 8 of U5
[_] Remove power to the TAC-2.
[_] Voltage checks are satisfactory.

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.

First, install the MAX232 and test for +/- 10 volts.

[_] Install U2 MAX232, ISL232CPE, or TC232CPE

[_] Apply power to the TAC-2 PCB.

Using a voltage meter measure the following voltages:

[_] +10 volts at the pad between U2 and diode D5 (also on pin 2 of U2)

[_] -10 volts at the pad between U2 and diode D5 (also on pin 6 of U2)

[_] Remove power to the TAC-2.

[_] Voltage checks are satisfactory.

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

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

[_] U1 74HC132
[_] U3 74AC04
[_] U4 74AC04

If you will be using a **Trimble SK-8** receiver, then also install:

[_] U5 7555

Preliminary Operational Check

The following operational check is testing to see is a 1PPS (TTL level) signal will cause the MAX232 to switch from ~+10 V (LED on) to ~-10 V (LED off).

At this point, ***before*** installing your GPS receiver:

[_] Temporarily install a LED into P6 pin 10 and the nearby ground hole by poking the LED leads into the holes. You will see a diode symbol (|<) between the two holes. The cathode (the flat side of the LED) goes into the ground hole and the anode into pin 10. Don't solder the LED, just rely on a friction fit.

NOTE: The pin layout of P6 is shown below. Pin 1 has the bold box around it.

9 7 5 3 1
10 8 6 4 2

The following tests prove that the 1PPS output drivers are working okay:

In the GARMIN area at JP6 at the pin labeled 3 (1PPS IN), use a clipped resistor lead to temporarily jumper from pin 3 to pin 10 (+5V source).

[_] Garmin/Oncore: The LED should be on.
or
[_] Trimble SK-8: The LED should be off.

In the GARMIN area at JP6 at the pin labeled 3 (1PPS IN), use a clipped resistor lead to temporarily jumper from pin 3 to pin 8 (GND).

[_] Garmin/Oncore: The LED should turn off.
or
[_] Trimble SK-8: The LED should flash on for ~0.1 seconds.

With a voltmeter, check pin 1 on either P1 or P2.

[_] When the LED is OFF, Pin 1 should be ~-10 volt RS232 level and
[_] When the LED is ON, Pin 1 should be ~+10 volts.

With a voltmeter, verify that P3 Pins 7 and 9 are:

[_] +5v when the LED is on and
[_] 0v when the LED is off.

[_] Remove power to the TAC-2.

[_] Remove the test LED on P6.

[_] All voltage checks satisfactory.

BBRAM Battery:

NOTE: If you are installing the Garmin GPS-20 receiver, you can skip to Section 5 - INSTALLATION.

The microprocessor in your GPS receiver needs standby power for two purposes:

- To save parameters needed for operation such as the almanac data that tells the receiver which satellites are in view, your last position, receiver configuration information, etc.
- An internal clock so that the receiver knows the approximate date/time.

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

Without this information, the receiver will wake up and start searching the entire sky to try to select the appropriate GPS satellites to use. Such a "cold start" may take 15 minutes or more!

Some receivers come from the factory with the battery included. If your receiver has a battery built into it, then ignore this section (this includes the Garmin GPS-20 receivers obtained through TAPR, which already have a battery installed). Otherwise we need to configure the TAC-2 to supply the necessary BBRAM power.

For the TAC-2, we have assumed that you will be using a rechargeable BBRAM supply and we have allowed three options:

a. A "3.6 volt" NiCad battery. We have found that the batteries sold as replacements for cordless telephones are a good choice.
   - At your local Radio Shack, part no. 23-192, costing $9.95 and equipped with wires and a plug that will mate with the 2-pin connector at JP11; this battery has three coin-sized batteries in a shrink-wrap package that can be attached with double-sided tape in the U6 regulator area. A similar battery is available from DigiKey as part no. P-068 for $7.76 (call 1-800-DIGIKEY or use their web site at http://www.digikey.com to order).
   - Or, another alternative at Radio Shack (also costing $9.95) is part no. 23-281 (with tubular cells).

b. A multi-farad capacitor intended for BBRAM service such as Panasonic's "Gold" series. The TAC-2 was designed to use the 3.3 farad, 5.5 volt Panasonic (part no. EEC-W5R5D335), which is available from DigiKey as P6956 at a cost of $11.98. This "Gold" capacitor has wire leads and solders to the holes labelled "CG+" and "CG-".

c. In the original TAC, we used a standard snap-on transistor radio "9 volt" (actually 8.4v) NiCad battery and the TAC-2 preserves this option.

For options a and b the BBRAM battery is charged from a +5v source while for option c you need to use a higher charging voltage, +12v. Thus you need to place D10, the 1N4148 diode, in the proper location:

NOTE: Diode D10 is a polarized component. The diode band must match the band shown on the PCB's silk screen.

[_] For a 3.6v NiCad Battery (option a) or a 5.5v "Gold" Capacitor (option b), install D10, 1N4148 diode, in the +5v position label as **5**.
or
[_] For 8.4v NiCad Battery (option c), install D10, 1N4148 diode, in the +12v position label as **12**. (**NOTE:** This will ***not*** work if you have selected the "+5PC" direct power supply option, omitting the U6 regulator).

If you are installing a 3.6 volt NiCad battery (option a):

[_] Install a 2-pin Male header at P11
[_] Cut the jumper across LED1 on the bottom of the circuit board
[_] Install the LED (the same one you used for testing earlier). This is a polarized component and the flat side of the LED's molded body goes towards R6.

Install R6 as indicated below depending on the BBRAM option:

[_] Install a 180 ohm (brown-gray-brown-gold) resistor at R6 if you are using a 3.6 volt NiCad battery,
or
[_] Install a 1k ohm (brown-black-red-gold) resistor at R6 if you are using a "9 volt" battery.

If you are installing a "Gold" Capacitor (option b):

[_] Install a 180 ohm (brown-gray-brown-gold) resistor at R6.

NOTE: The capacitor is a polarized device—the "+" lead goes to the point labeled "CG+" and the "-" lead goes to "CG-". The capacitor's leads should be bent so it will fit under the U6 regulator. The body of the capacitor will extend approximately 1/2" beyond the end of the circuit board.

[_] Install the "Gold" capacitor on the ***bottom*** side of the circuit board.

Now test the BBRAM and its charger:

[_] Temporarily plug the battery into P11 for testing (option a). ***Observe polarity!***

[_] With a voltmeter, see if the battery/capacitor has any charge at all. The "CG+" pad is a convenient test point.

[_] Apply power to the TAC-2 PCB.

[_] If you installed the "Charge LED," it should be glowing.

[_] The BBRAM voltage should be slowly increasing. Depending on the initial charge level, it may take several hours to fully charge the battery/capacitor.

[_] Remove power to the TAC-2.

[_] All voltage checks satisfactory.

[_] OK so far

INSTALLATION

This section deals with the installation of the GPS receiver of your choice.

Garmin GPS-20

If the Garmin GPS-20 was purchased from TAPR, you received a power/data cable with connector shell and pins. Assemble this cable according to the assembly information that came with the GPS-20. Construct the cable approximately 1 _" with the following 5 wires:

3 - 1PPS output
4 - Serial Data output
5 - Serial Data input
8 - Ground
10 - +5 VDC (+/- 5% at 180 mA)

These 5 wires will connect to the TAC-2 PCB at JP6.

[_] Solder the cable assembly into JP6 pin-for-pin on the ***top*** or ***bottom*** side of the TAC-2 PCB.

[_] Install four 3/8" 4-40 threaded standoffs on the ***top*** or ***bottom*** side of the TAC-2 PCB using four _" 4-40 screws. Look for the mounting holes with the letter "G" next to them.

[_] Install the Garmin GPS-20 receiver onto the standoffs making sure that the antenna connector is facing away from the TAC-2 PCB. Use four _" 4-40 screws.

[_] Plug in the power/data cable connector into the GPS-20.

[_] Skip to the **OPERATION** section.

Motorola Oncore Basic

[_] Install four 3/8" 4-40 threaded standoffs on the ***bottom*** side of the TAC-2 PCB using four _" 4-40 screws. The mounting holes are the four corners of the TAC-2 PCB.

[_] Install the Motorola Oncore Basic receiver onto the standoffs making sure that the antenna connector is facing away from the TAC-2 PCB. Use four _" 4-40 screws.

[_] Plug in the 1" long IDC cable assembly into P4 and the receiver's 10-pin header. Be careful to observe pin 1 of the TAC-2 goes to pin1 of the Oncore Basic.

[_] Skip to the **OPERATION** section.

Motorola Oncore VP/UT

NOTE: The next two steps will reverse the TXD polarity from normal to inverted as needed by the Oncore VP/UT receiver.

[_] On the bottom of the PCB, cut the default trace across pins 1 and 2 (from center pin to **I**) of JP3 with a sharp hobby knife.

[_] Install a 2-pin push-on jumper between pins 2 and 3 (from center pin to **N**) of JP3.

[_] Install four 3/8" 4-40 threaded standoffs on the ***bottom*** side of the TAC-2 PCB using four _" 4-40 screws. Look for the mounting holes with the letter "M" next to them.

[_] Install the Motorola Oncore VP receiver onto the standoffs making sure that the antenna connector is facing away from the TAC-2 PCB. Use four _" 4-40 screws.

[_] Skip to the **OPERATION** section.

Trimble SK-8

NOTE: The next two steps will reverse the TXD polarity from normal to inverted as needed by the Trimble SK-8 receiver.

[_] On the bottom of the PCB, cut the default trace across pins 1 and 2 (from center pin to **I**) of JP3 with a sharp hobby knife.

[_] Install a 2-pin push-on jumper between pins 2 and 3 (from center pin to **N**) of JP3.

[_] On the bottom of the PCB, cut the default traces across pins 3 and 4, 5 and 6, and 7 and 8 of JP2

[_] Install three 2-pin push-on jumpers between pins 3 and 4, 5 and 6, and 8 and 10 of JP2

[_] On the bottom of the PCB, cut the default traces across pins 1 and 3, 3 and 5, and, 8 and 10.

[_] Install two 2-pin push-on jumpers between pins 1 and 2 and between 3 and 4.

[_] On the bottom of the PCB, in the area under D1-D7, cut the two circuit board jumpers labeled "T."

[_] Install four 3/8" 4-40 threaded standoffs on the ***bottom*** side of the TAC-2 PCB using four _" 4-40 screws. Look for the mounting holes with the letter "T" next to them.

NOTE: The Trimble SK-8 has an 8-pin (2x4) grid power+I/O connector and connector J2 on the TAC-2 has 10 pins. The receiver uses only the "bottom" 8 pins. The two unused pins (nearest to U2) are cross-hatched on the silk-screen.

[_] Install the Trimble SK-8 receiver onto the standoffs. Use four _" 4-40 screws.

[_] Skip to the **OPERATION** section.

OPERATION

[_] Plug in the DB9F IDC cable and connector assembly into P1 with the cable facing away from the TAC. The IDC connector has a molded arrow to designate pin 1.

[_] Connect your GPS receiver to an external antenna.

[_] Connect the TAC-2 to your Personal Computer.

[_] Apply power to the TAC-2.

NOTE: If this is the first time the GPS receiver has been powered up in this location, it will take 15-20 minutes to acquire a fix. Until that time, the 1PPS signal will not be available.

[_] Load and configure the program ***Showtime*** according to the accompanying instructions - ***Operation of your TAC-2***.

[_] Upon start up of ***Showtime***, once per second beeps should be heard and then time displayed on the screen.

[_] This completes the assembly of your TAC-2! Congratulations! At this point you may install the TAC-2 in a suitable enclosure. Suggested enclosure methods are available on the enclosed flyer.

THEORY OF OPERATION

1:SHEET 1 - RS232 I/O:

1a: RS232 Port #1 (P1) The main (computer) RS232 Port#1 is handled by U2, a generic MAX232-like chip, which has two RS232 line drivers (TX1 & TX2) and two RS232 line (RX1 & RX2) receivers. The line drivers and line receivers are all inverting devices. TX1 generates the TXD RS232 data signal sent to the host computer. TX2 generates a 1PPS RS232 signal sent to the computer on the DCD handshaking line. P1 is a 10-pin connector designed to be routed to a DB9 female connector to interface directly with a PC-AT standard port. The 10th wire is available as a "frame ground" for the metallic shell on the DB9 connector. The RX1 section of the MAX232 receives RS232 data from the PC. RX2 is used as an inverter as described later in section 1e below. The unused pins on P1 are available on solder pads adjacent to the connector in case they are needed for a custom application. The jumper area JP1 permits the P1 connection to be "swapped" without the need for a null modem. Cutting the default traces associated with the DB9's pins 2 and 3 permits swapping TXD and RXD. In addition, the 1PPS signal can be changed from the default DCD line to RI.

1b: RS232 Port #2 (P2) The second RS232 port is intended for use with either an RTCM SC104 DGPS beacon receiver or as a connection to a second host computer. The connector P2 provides an interface to a standard DB9 RS232 port. The jumper area JP2 permits the P2 connection to be "swapped" without the need for a null modem. Cutting the default traces associated with the DB9's pins 2 and 3 permits swapping TXD and RXD. In addition, the 1PPS signal can be changed from the default DCD line to RI.

NOTE: JP1 and JP2 serve identical functions for ports P1 and P2. However, JP2 has a 10-pin header and JP1 has an 8 pin header. The extra two pins on JP2 (with cross-hatching on the silk-screen) are used for configuration of receivers (like the Trimble SK-8) that have two independent RS232 ports (typically with one for command/control and the second for NMEA output and RTCM inputs. The remaining discussion applies to receivers with a single serial port (like the Garmin GPS-20 and Motorola ONCORE).

U1A is a Schmidt trigger used as an RS232 line receiver. Diodes D1 & D2 along with R1 prevent the input to U1A from going above +5v or below zero volts (the gate inputs on U1 are internally diode protected, but I decided it was best to provide additional protection). RP1A sets the default when Port#2 is not used to a logic zero.

1c: Port#2 "squelch" Port#2 is enabled only if its second input (pin 2) is high. If there is any activity on the Port#1 RXD input, diode D3 pulls this pin low, disabling Port#2 RXD. This pin stays low for a time interval determined by the R2C1 time constant (~10 msec for the parts values shown). In addition, this port can be disabled from the expansion port by pulling the RX Holdoff line low.

1d: Combining the RXD signals U1B serves as an or-gate to combine the RXD signals from Ports #1 and #2. A 3rd input to the or-gate is provided by D4 and RP1D so that an embedded processor connected to the expansion port can send signals to the GPS receiver. U1B re-inverts the signals (zero low, one high) and is sent directly to the GPS receiver's RS232 input (Sheet 3) as GPS RXD.

NOTE: Both the Motorola ONCORE BASIC and Garmin receivers have "RS232" inputs. However both work just fine when driven by 0/+5 v CMOS logic without converting it to "real RS232". Also on Sheet 3 is an optional inverter to handle the Motorola ONCORE VP, which uses inverted TTL logic levels.

1e: TXD signals from GPS to Ports #1 and #2 U1C functions as an inverter for the GPS receiver's RS232 TXD output signals. For the ONCORE VP with inverted TTL levels, the RX2 section of U2 is used as an inverter and the jumper JP3 needs to be changed from the default. The second input on U1C is normally pulled high through RP1B, but the embedded microprocessor can squelch TXD by pulling the TX Holdoff line low. The diode D5 and pullup resistor RP1C allow inverted data from the expansion port to be sent to the host PC.

2: SHEET 2 - 1PPS I/O

2a: The "normal" 1PPS Output Path The GPS receiver is assumed to have a positive-going 1PPS pulse that is "wide" (100 msec for the GPS-20, 200 msec for the Motorola receivers) that has a rising edge coincident with the UTC second (the pulse can be offset by know amounts in the Motorola receiver). This signal is first inverted in U3B (a 74AC04 is chosen for U3 to provide a low propagation delay and high output drive) to make 1PPS INV. The 1PPS INV signal directly drives the U2 TX2 section to make the DCD 1PPS signal. U3C re-inverts the signal to drive a front panel LED via R4 and to provide a buffered wide 1PPS signal to the expansion port. U3D+E+F are paralleled via RP2A+B+C to provide a buffered 1PPS signal to the user. [Note - the original TAC had two such 74AC04-derived drivers].The Schmidt trigger U1D provides a clean, well defined negative-going 1PPS signal called INV PULSE. The pulse goes negative coincident with the GPS UTC second and stays negative for a time interval determined by the C2+RP2G network (plus the negligible propagation delay through U3B) set at about 5 usec.

All the 1PPS outputs appear on the 10-pin header P3. If an IDC cable is used, the cable can be stripped into wire pairs to go to the various external connections. Alternately, several 2-pin headers can be used for the interconnections.

2b: Alternative 1PPS Inputs While the Motorola and Garmin receivers have similar "user friendly" 1PPS signals, not all receivers are so convenient. For example, the Trimble SK-8 has a negative-going 1 usec wide 1PPS signal driven by an open collector transistor. The optional JP4 and U5 circuitry are available to accommodate this case. If the default jumper on JP4 (between pins 1-3-5-7) is cut between 1 and 3, and jumpers 1-2 and 3-4 are added, then R3 provides the needed pullup for the SK-8's open collector output. U5 (a CMOS 555 timer) then functions as a one-shot to provide the desired "wide" positive-going 1PPS signal with a width determined by the R9+C4 timing network. In the event of a narrow positive-going pulse, JP4 has pins 3-5-7 jumpered to allow U4A to invert the signal. U4A's output is sent to U5 by jumpering pins 4-6 and U5 functions as described above. If there is a triggering problem with U5, add C3 (0.1 uF) and cut the default jumper across it in order to insure that U5 is "hit" with a clean, negative going pulse.

3: Sheet 3 - GPS Receiver and Expansion I/O

3a: ONCORE BASIC To connect an ONCORE BASIC receiver, a 10-pin header is installed at P4 (note that Motorola uses a non-standard pin numbering convention for the BASIC. Sheet 3 shows pin numbers on P4 that match Motorola's documentation.). The BASIC has an on-board DC-DC power converter so its power can be either +5V or +12V. The jumper area JP5 defaults to the +12v connection, but can be changed if desired. The 4 mounting holes for the BASIC match the holes in the corners of the TAC-2 PCB and it was my intention that the BASIC receiver be mounted below the TAC-2 PCB. It is to be connected with a short (~1.5") 10-pin IDC cable between the receiver and P4.

3b: ONCORE VP To connect a ONCORE VP, the user should install a 10-pin socket at J1. The VP will then have its mounting holes match 4 of the holes on the TAC-2 PCB. Since the VP uses inverted TTL levels on its serial port, the user adds the optional inverter consisting of Q1, R6 and R7. The user also must insure that the jumper JP3 (Sheet 1) is changed to inverted.

3c: Garmin GPS-20 The Garmin power+I/O connector is less convenient to use than for the Motorola receivers, and the user will have to prepare a short (~2") 5-wire cable with the Garmin connector on one end. The other end solders to the TAC-2 PCB at JP6. The silk-screen on the TAC-2 PCB identifies the appropriate pin numbers for the Garmin connector. JP6 is also used as an interface area for any other receivers. The mounting holes for the Garmin match holes on the TAC-2 and the Garmin can be mounted either above or below the TAC-2 PCB.

3d: Trimble SK-8 [need so words here]

3e: Expansion I/O P5 and P6 provides connections for other "widgets." I have in mind a clock display module and a disciplined oscillator module that will use these connectors. These are three 1PPS signals (plus-going, minus-going and 5 usec wide pulse as described on Sheet 2), the TXD+RXD+ squelch signals (described on Sheet 1) and DC power. P5 has 3 uncommitted pins for expansion.

4. Sheet 4 - POWER

4a: The "+5" Power supply The main +5v power for the GPS receiver and the TAC-2 logic is obtained using a standard TO-220 7805-type regulator at U6. The TAC-2 PCB has a generous amount of metal to act as a heatsink, but there should be room for a finned radiator if needed.

Experience has shown that it is desirable to allow for trimming of the "+5" supply voltage. At least one GPS-20 receiver required about +5.2v to function properly. Therefore I allowed for a "+6v" bus which can be dropped to +5 in one or two 1N4001 diodes at D7+D8. In order to "tweak" the 7805 to the desired voltage, the "ground" of U6 (and the heatsink) is allowed to float above true ground by a resistor (or a diode) at R9, with the voltage tweaked by the R8+R9 network.

4c: Battery Backup Option This circuit is cloned from the original TAC. Many of the ONCORE receivers don't come with batteries (which keeps BBRAM alive and keeps a 32 kHz oscillator + clock alive). So we have used either 9v or 5v NiCd cells in our production TACs. D9 + R10 + P6 allows me to keep this as an option. The TAPR Garmins have a battery already, so this is not needed for that application.

4d: Antenna Bias Option This circuitry lets us supply special antenna bias voltages for some applications. The circuit is pretty self-explanatory.

TAC-2 User Options:

RS232 I/O pin selection (JP1 and JP2)

+5V supply "tweaker" (R10 and R11)

Using Other Receivers (JP4, C3, R3)

UPS = Uninterruptable Power Supply (JP9, D9, R4 and R5):

If you are using +12v input power (and not the +5PC direct power option), The TAC-2 has the ability to provide battery power so that the GPS receiver continues to operate through a brief power interruption. This involves an external battery connected to JP9 with charging rates determined by R4 and R5.

High-efficiency Switching Power Supply Option:

The Power Trends Integrated Switching Regulators are available from Power Trends (1-800-531-5782 also http://www.powertrends.com) or Digi-Key (1-800-344-4539 also http://www.digikey.com). Digi-Key costs as of June 1997, US$13.13 for the PT5101 and US$18.38 for the 78SR. Digi-Key part numbers are:

PT5101A-ND - horizontal without heat tab
PT5101S-ND - vertical with heat tab
78ST105HC-ND - horizontal

You require the following parts:

[_] 1 U6	Power Trends PT5101 or 78SR Switching Regulator
[_] 1 CE1	220 uF Electrolytic Capacitor
[_] 1 Z1	6.2V Zener Diode
[_] 1 RFC2	6.8 uh choke

Install the following components in the same manner as stated above for capacitors, diodes, and chokes.

NOTE: CE1 and Z1 are polarized components.

[_] CE1	220 uF Electrolytic Capacitor
[_] Z1	6.2V Zener Diode
[_] RFC2	6.8 uh choke

Bend the leads of the Power Trends PT5101 or 78SR Switcher 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. Fasten the voltage regulator using one _" 4-40 screw, lockwasher, and nut.

NOTE: Some PT5101's already have the leads bent. Some PT5101's have a mounting tab that matches the crew holes at the top of the PCB. The 78SR have mounting/grounding pins that match the two mid-size holes and they are soldered in place. If you have a PT5101 with no mounting tab, then use either double-sided tape or a glop of glue to mount the device.

[_] U6	Power Trends PT5101 or 78SR Switching Regulator

Antenna Preamplifier Power (U7, D11, JP12)

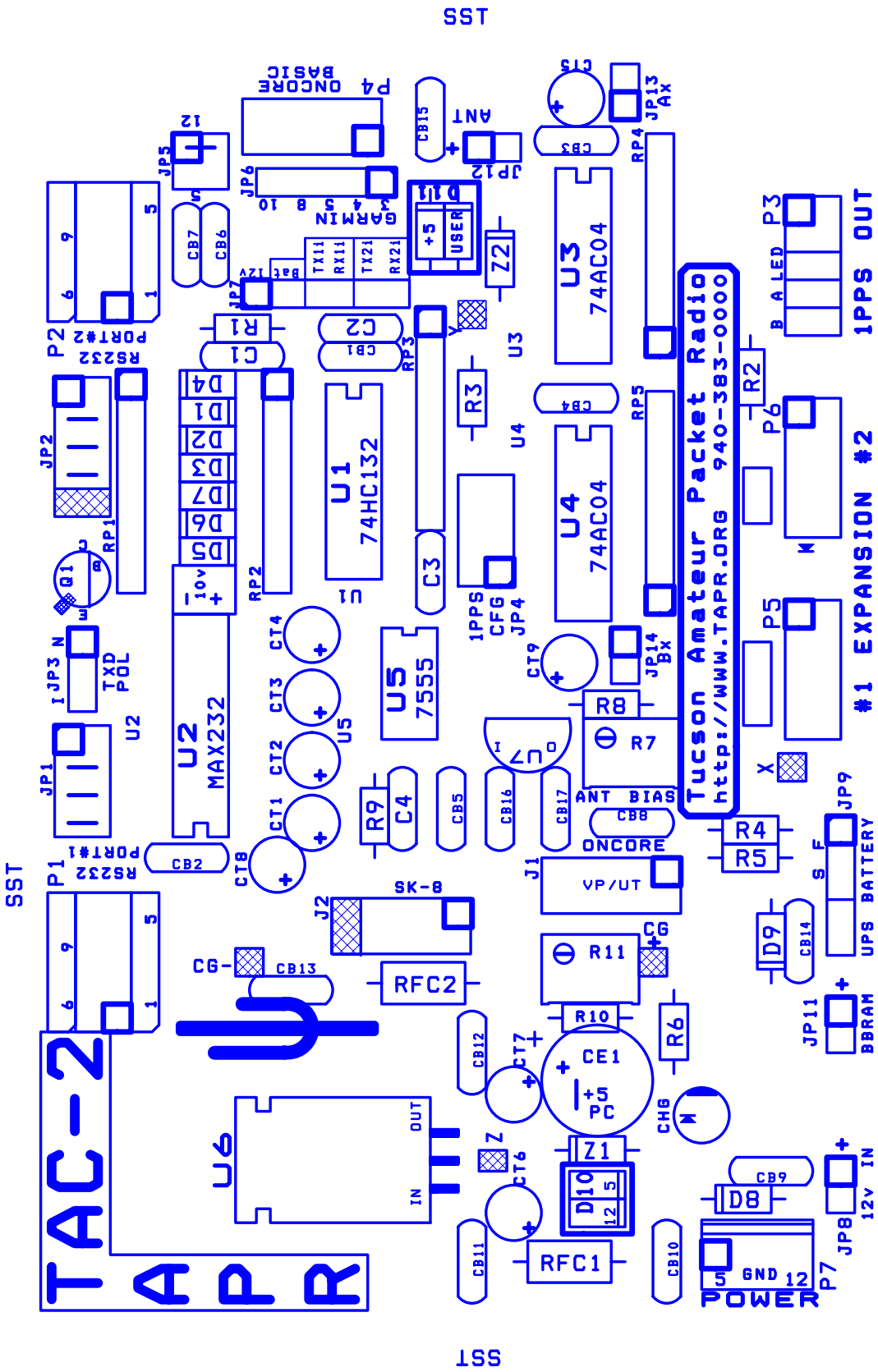
You require the following parts:

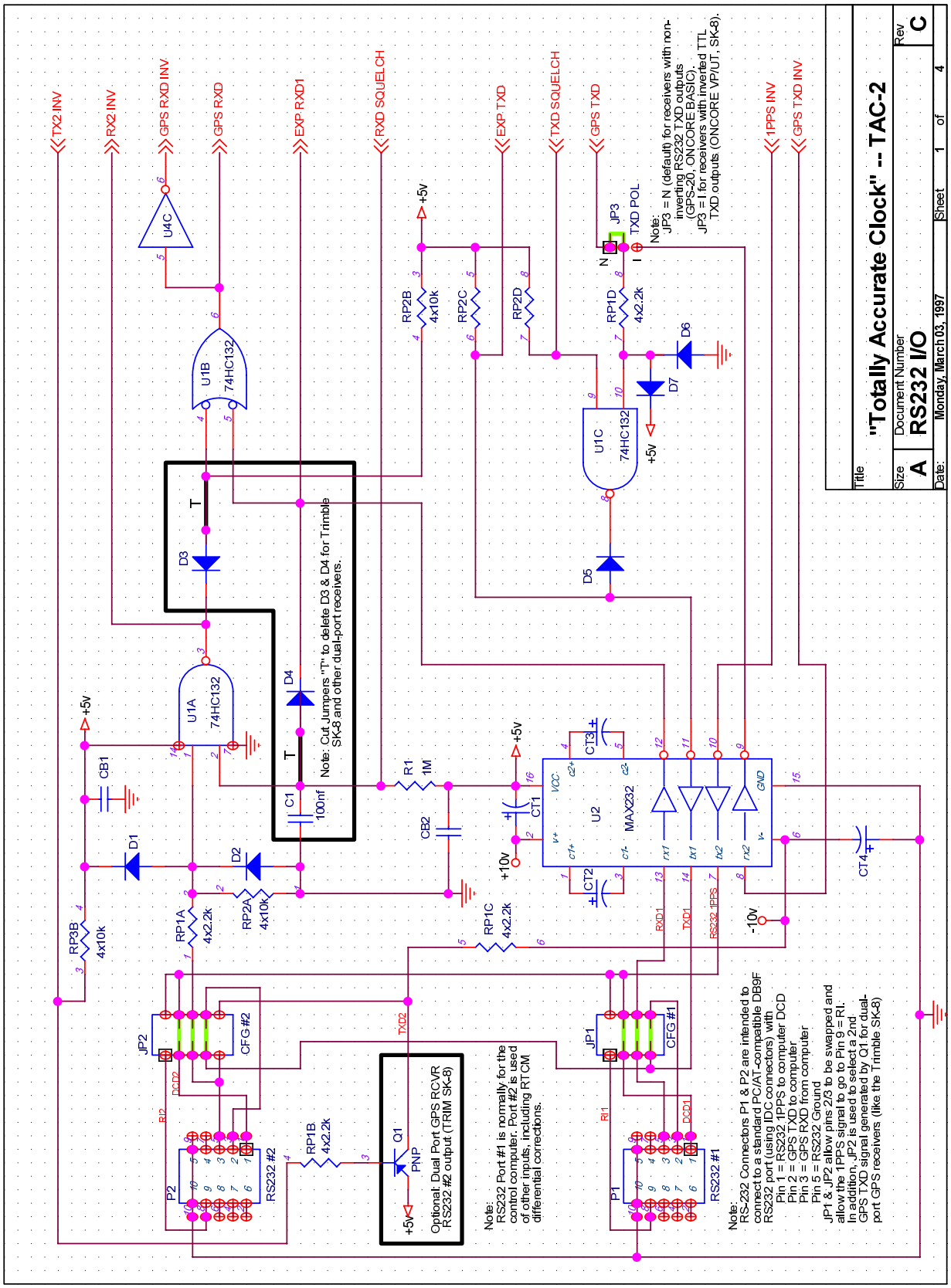
[_] 1 U7	LM78L05 3-terminal voltage regulator
[_] 1 D11	1N4002 Silicon Power Diode
[_] 3 CB15-17	0.1 uF Capacitor (104)
[_] 1 CT9	1 uF Electrolytic or Tantalum Capacitor
[_] 1 R7	500 ohm potentiometer
[_] 1 R8	470 ohm resistor (green-brown-brown-gold)
[_] 1 JP12	1x2 pin Male Header
[_] 1 Z2	Zener Diode (optional, voltage as required)

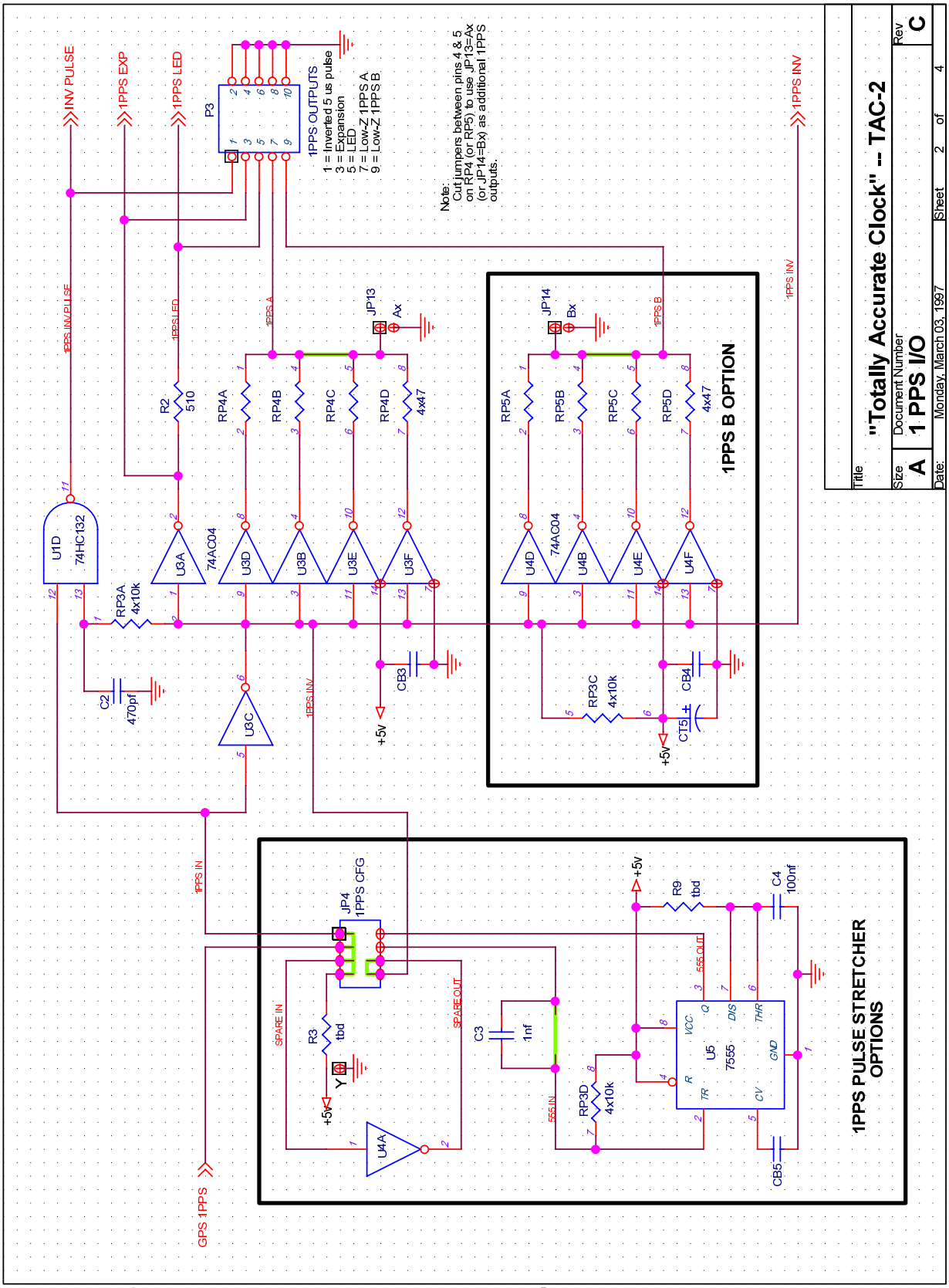
Install the components in the same manner as stated above for capacitors, diodes, and chokes.

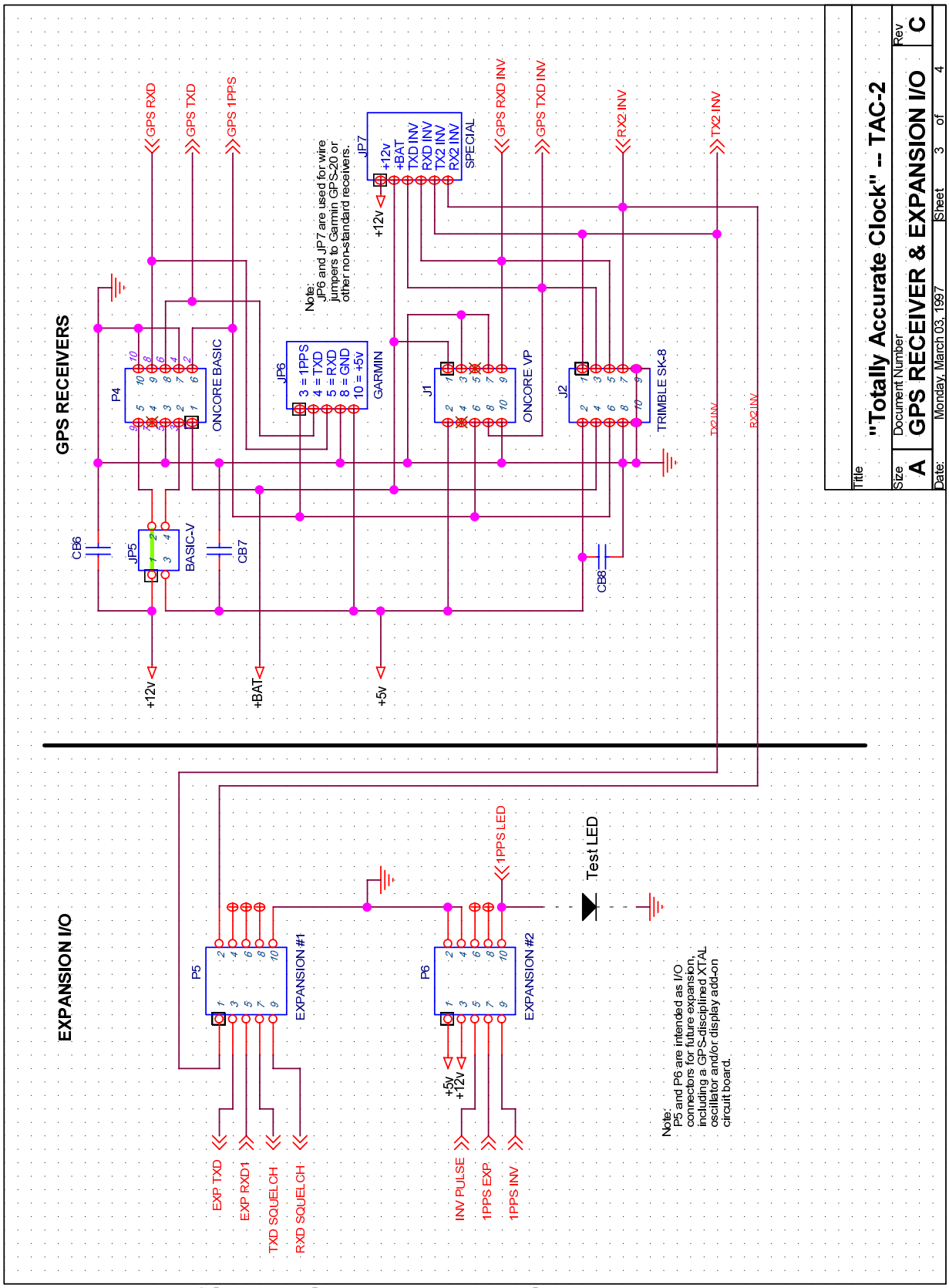
Ax/Bx Extra 1PPS outputs (JP13 and JP14)

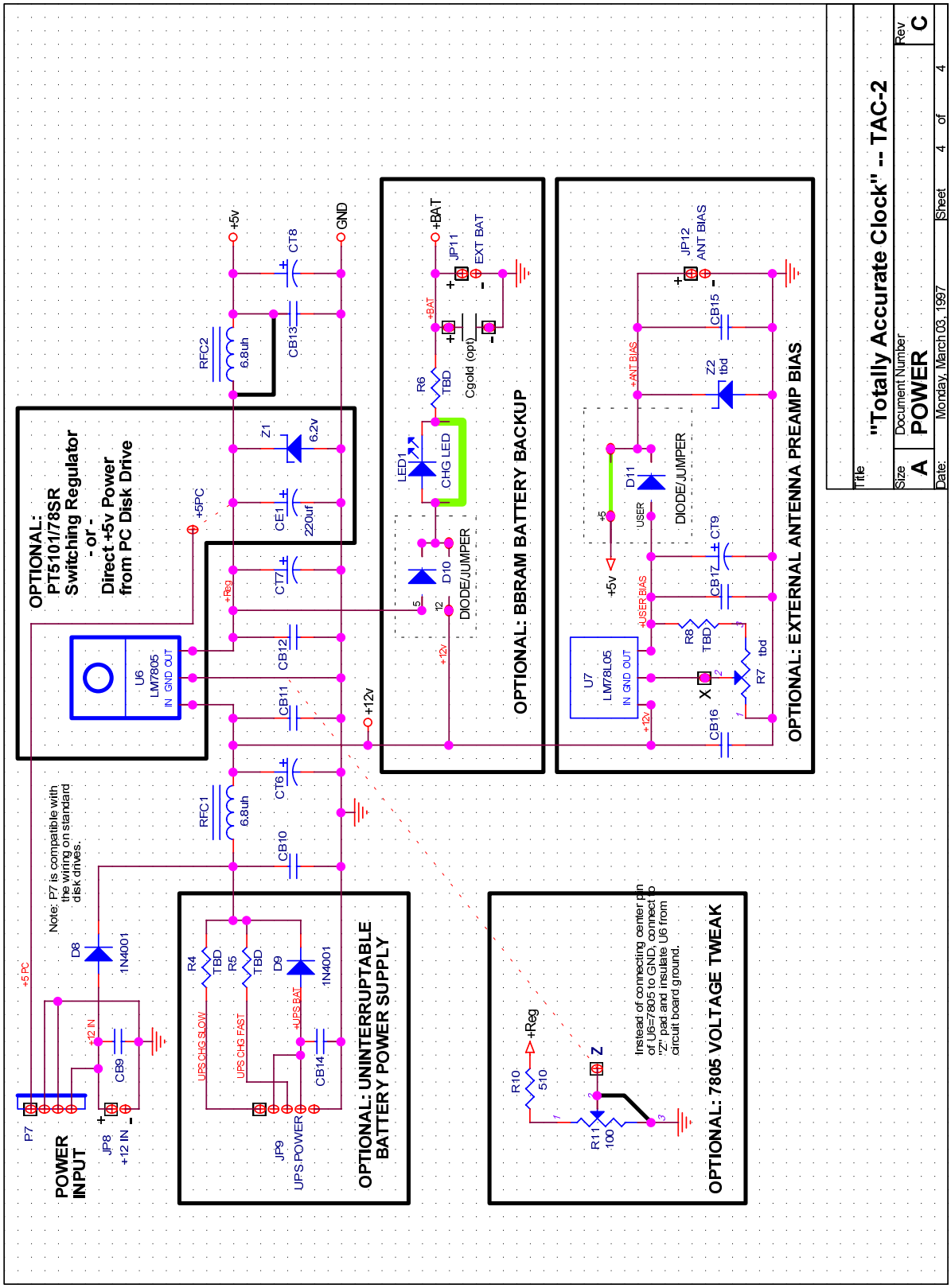
Extra RF bypassing


TAC-2
APR
Tucson Amateur Packet Radio
http://WWW.TAPR.ORG 940-383-0000
#1 EXPANSION #2
1PPS OUT
SST
U1 74HC132
U2 MAX232
U3 74AC04
U4 74AC04
U5 7555
U6
P1 RS232 PORT#1
P2 RS232 PORT#2
P3 B A LED
P4 ONCORE BASIC
P5
P6
P7 POWER
GARMIN
ONCORE
VP/UT
SK-8
RFC1
RFC2
CE1
ANT BIAS
UPS BATTERY
BBRAM
12v IN
TXD POL
1PPS CFG
USER
GND


"Totally Accurate Clock" -- TAC-2
RS232 I/O
Document Number
Size A
Rev C
Date: Monday, March 03, 1997
Sheet 1 of 4
TX2 INV
RX2 INV
GPS RXD INV
GPS RXD
EXP RXD1
RXD SQUELCH
EXP TXD
TXD SQUELCH
GPS TXD
1PPS INV
GPS TXD INV
U1A 74HC132
U1B 74HC132
U1C 74HC132
U4C
U2 MAX232
JP1
JP2
JP3
TXD POL
CFG #1
CFG #2
P1
P2
RS232 #1
RS232 #2
Q1 PNP
Note: Cut Jumpers "T" to delete D3 & D4 for Trimble SK-8 and other dual-port receivers.
Note: JP3 = N (default) for receivers with non-inverting RS232 TXD outputs (GPS-20, ONCORE BASIC). JP3 = I for receivers with inverted TTL TXD outputs (ONCORE VP/UT, SK-8).
Note: RS232 Port #1 is normally for the control computer. Port #2 is used of other inputs, including RTCM differential corrections.
Optional: Dual Port GPS RCVR RS232 #2 output (TRIM SK-8)
Note: RS-232 Connectors P1 & P2 are intended to connect to a standard PC/AT-compatible DB9F RS232 port (using IDC connectors) with Pin 1 = RS232 1PPS to computer DCD Pin 2 = GPS TXD to computer Pin 3 = GPS RXD from computer Pin 5 = RS232 Ground JP1 & JP2 allow pins 2/3 to be swapped and allow the 1PPS signal to go to Pin 9 = RI. In addition, JP2 is used to select a 2nd GPS TXD signal generated by Q1 for dual-port GPS receivers (like the Trimble SK-8)


"Totally Accurate Clock" -- TAC-2
Size A
Document Number 1 PPS I/O
Rev C
Date: Monday, March 03, 1997
Sheet 2 of 4
1PPS B OPTION
1PPS PULSE STRETCHER OPTIONS
1PPS OUTPUTS
1 = Inverted 5 us pulse
3 = Expansion
5 = LED
7 = Low-Z 1PPS A
9 = Low-Z 1PPS B
Note:
Cut jumpers between pins 4 & 5
on RP4 (or RP5) to use JP13=Ax
(or JP14=Bx) as additional 1PPS
outputs.
INV PULSE
1PPS EXP
1PPS LED
1PPS INV
GPS 1PPS
1PPS IN
SPARE IN
SPARE OUT
555 IN
555 OUT
+5v
U1D 74HC132
U3A 74AC04
U3B 74AC04
U3C 74AC04
U3D 74AC04
U3E 74AC04
U3F 74AC04
U4A 74AC04
U4B 74AC04
U4D 74AC04
U4E 74AC04
U4F 74AC04
U5 7555
P3
JP4 1PPS CFG
JP13 Ax
JP14 Bx
R2 510
R3 tbd
R9 tbd
RP3A 4x10k
RP3C 4x10k
RP3D 4x10k
RP4A 4x47
RP4B 4x47
RP4C 4x47
RP4D 4x47
RP5A 4x47
RP5B 4x47
RP5C 4x47
RP5D 4x47
C2 470pf
C3 1nf
C4 100nf
CB3
CB4
CB5
CT5


GPS RECEIVERS
EXPANSION I/O
P4
ONCORE BASIC
JP5
BASIC-V
CB6
CB7
JP6
3 = 1PPS
4 = TXD
5 = RXD
8 = GND
10 = +5v
GARMIN
Note:
JP6 and JP7 are used for wire jumpers to Garmin GPS-20 or other non-standard receivers.
JP7
+12v
+BAT
TXD INV
RXD INV
TX2 INV
RX2 INV
SPECIAL
J1
ONCORE VP
J2
TRIMBLE SK-8
CB8
GPS RXD
GPS TXD
GPS 1PPS
GPS RXD INV
GPS TXD INV
RX2 INV
TX2 INV
+12v
+BAT
+5v
P5
EXPANSION #1
P6
EXPANSION #2
Test LED
1PPS LED
EXP TXD
EXP RXD1
TXD SQUELCH
RXD SQUELCH
INV PULSE
1PPS EXP
1PPS INV
+5v
+12v
Note:
P5 and P6 are intended as I/O connectors for future expansion, including a GPS-disciplined XTAL oscillator and/or display add-on circuit board.
Title
"Totally Accurate Clock" -- TAC-2
Size
A
Document Number
GPS RECEIVER & EXPANSION I/O
Rev
C
Date:
Monday, March 03, 1997
Sheet
3
of
4


"Totally Accurate Clock" -- TAC-2
Title
Size A
Document Number POWER
Rev C
Date: Monday, March 03, 1997
Sheet 4 of 4
POWER INPUT
P7
JP8 +12 IN
+5 PC
+12 IN
Note: P7 is compatible with the wiring on standard disk drives.
D8 1N4001
CB9
OPTIONAL: PT5101/78SR Switching Regulator - or - Direct +5v Power from PC Disk Drive
U6 LM7805 IN GND OUT
+5PC
RFC2 6.8uh
CB13
CT8
+5v
GND
Z1 6.2v
CE1 220uf
CT7
+Reg
CB12
CB11
+12v
OPTIONAL: UNINTERRUPTABLE BATTERY POWER SUPPLY
R4 TBD
R5 TBD
UPS CHG SLOW
UPS CHG FAST
D9 1N4001
+UPS BAT
JP9 UPS POWER
CB14
RFC1 6.8uh
CT6
CB10
OPTIONAL: BBRAM BATTERY BACKUP
LED1
CHG LED
R6 TBD
+BAT
JP11
EXT BAT
Cgold (opt)
D10
DIODE/JUMPER
OPTIONAL: EXTERNAL ANTENNA PREAMP BIAS
U7 LM78L05 IN GND OUT
+5v
D11
USER
DIODE/JUMPER
+ANT BIAS
JP12 ANT BIAS
CB15
Z2 tbd
+USER BIAS
CB17
CT9
R8 TBD
R7 tbd
CB16
OPTIONAL: 7805 VOLTAGE TWEAK
R10 510
+Reg
R11 100
Z
Instead of connecting center pin of U6=7805 to GND, connect to "Z" pad and insulate U6 from circuit board ground.