XTBM / XTBM-Pro Assembly Notes

06/01/17 (For PCB 1.30 and 1.41)

Please check for the latest version before beginning assembly.

The XTBM should be a relatively easy PCB to assemble. These assembly notes cover both the XTBM and XTBM-Pro. Because some locations are left unpopulated, please refer to the appropriate parts list. Assembly requires experience working with small components, and also the ability to correctly identify component values. A low-wattage soldering iron with a 1/16" tip is recommended. Care must be taken to not overheat the semiconductor devices. Several components have been packaged separately because identification can be difficult.

BEFORE ASSEMBLY

A few people have had trouble identifying components. The zener diodes are packaged with the other semiconductors to help identify them. It is best to keep them packaged until you are ready to install them. **You will need a magnifier to read the some of the part numbers.** Be sure you have correctly identified ALL the diodes before you begin installing them. I also recommend sorting out the capacitors and resistors before soldering any onto the board. Be careful to distinguish between 3.3K and 33K 5% resistors, and 1.0K and 10K 1% resistors.

PRINTED CIRCUIT BOARD ASSEMBLY:

Please read these Detailed Assembly Instructions before beginning actual assembly to avoid any problems. Also, please refer to the parts list, board layout, and high-resolution photograph of the assembled board while assembling your own unit:

XTBM Parts List

XTBM Version 1.3 Board Layout

XTBM Version 1.3 Board Photograph

I recommend installing all diodes first, followed by the 1/4 watt resistors. Work your way up to larger and larger components. Leave the transformer and switches (Pro version) for last.

Things to watch out for:

1) A dual-primary transformer may be supplied with the XTBM. That can be identified by it having 4 pins on both sides. A dual-primary transformer requires two short jumpers to be installed **on the reverse side of the board** to connect the primaries in parallel for 120V operation. The connections are diagramed on the silkscreen. Cut-off component leads can be used for both of the short jumpers. **Be sure to cut these leads flush with the top surface of the board so they don't interfere with the transformer.** Note that for use on 240V, both windings must be connected in series with a single jumper.

2) The 1% resistors are blue. They follow the standard color code, but have an extra digit, and the tolerance band is brown for 1%.

3) The small 220uH inductor L3 may be blue or green, and looks like a resistor. It can be identified by its resistance being about 6 ohms.

4) C3, C16, and C17 are polarized capacitors. Be very careful to get the polarity correct.

5) The 8.2uH inductors are a tight fit. I recommend installing them with the wider section at opposite ends, as shown in the high-resolution photo.

6) **CAUTION: Q2 2N7000 is static sensitive, and is very easily damaged.** R14 was changed to zener diode D13 on the version 1.1 PCB to protect Q2 when the microcontroller U4 is not in the socket. Use static handling precautions, and be sure D13 is on the board before installing Q2.

7) Be sure U5 is firmly seated because it is a tight fit under the cover. It can be bent slightly toward the rear if it still contacts the cover.

8) **IMPORTANT:** J1 pins 7-10 are not used, and pins 15 and 16 are only used for a backlit display. Your kit may contain two 6-pin headers or a single 14-pin or 16-pin header. If your kit is supplied with a 14-pin header for the reflective display, mount it at the pin 1 end of the 16-pin footprint. If your kit is supplied with two 6-pin headers, they must be installed at both ends of the footprint, leaving pins 7-10 free. **The male header goes onto the board with the LONG end up.** Install the header by first soldering just one pin. Before soldering the remaining pins make sure it is fully seated and aligned **exactly** vertical so it will mate properly when the cover is installed. To keep the header pins in perfect alignment, plug the matching connector onto the header, and don't use excessive heat when soldering the header to the board. That connector is later soldered onto the LCD assembly facing down, and also must be aligned exactly vertical.

9) There is no extra clearance between the transformer and the top cover. Be sure the transformer is firmly seated to the PCB before soldering it down. If you have installed jumpers for a dual primary transformer, they must be snipped flush with the top of the PCB. The jumpers are not needed unless the transformer has a dual primary (8 pins). Depending on the transformer manufacturer, the pin numbers may be labeled on the bobbin near the pins, or there may be a mark at pin 1. Pin 1 goes in the square pad near D6.

10) Even in the Pro version, some device locations are not populated. They were there to provide some "just in case" options during the design.

11) Since there is not much clearance under the board, all leads must be cut short – certainly no longer than 1/8" above the board.

12) **IMPORTANT:** Perhaps the most critical portion of the XTBM-Pro assembly is correctly aligning S1 and S2. These switches are installed with one insulated washer under each base between the pins to raise them slightly off the board so the buttons will extend up through the cover. Then only solder two diagonal pins. Before soldering the remaining pins, carefully align the switches so they are exactly centered in the holes drilled through the cover. As you do this, be sure the board is firmly seated onto the base and temporarily install the cover. Note how the switches must be adjusted for correct centering. Then remove the board and reheat the terminals as necessary to move the switches into correct

alignment. This can be a lengthy trial-and error process that can take a dozen or more iterations before perfect alignment is achieved. But proper alignment is necessary to provide sufficient clearance so the buttons do not rub against the top.

13) When installing the power cord, allow a little extra wire for the bend in the strain relief before squeezing it closed.

14) Remove the plastic protection before installing the LCD. The LCD mounts to the top cover with four small self-tapping screws. If the display is backlit, four insulated washers are supplied as spacers to compensate for the extra thickness of the backlit display. The washers go between each mounting post and the LCD PCB. If you have a steady hand, position the washers on top of each standoff, and with the screws already installed into the LCD assembly, carefully position it on top of the standoffs. An alternate method is to install the screws and washers on the LCD assembly, and then mate it and the cover together carefully to insure the screws slip into the holes. The process is much simpler with the reflective display because no spacers are involved. After the LCD is mounted to the top cover, back the screws off slightly (about 1/8 turn) to prevent warping the LCD PCB.

(15) The front of the PCB can be fastened to the base with two cup washers and two small self-tapping screws. To prevent warping the PCB, just tighten the screws snug enough so the cup washers aren't loose, but can be still rotated by hand. It is not necessary to fasten the back of the PCB to the base because the LCD connector holds it firmly in place.

16) If the P1/J1 connectors have been correctly aligned exactly vertical, they should mate right together as the cover is installed. The back panel can be used as a guide to align the cover as it is installed.

17) PCB version 1.41 added an alternate zero adjustment trimmer at R10 to avoid having to select the op-amps for offset prior to kitting. Your kit may contain either a 470 ohm fixed resistor or a 2.2K potentiometer for R10. For PCB versions before 1.41 the op-amps were selected to provide a zero reading with no noise on the powerline. Since the only change between 1.30 and 1.41 was the optional trimmer for R10, the layout and board photograph still show 1.30.

XTBM CHANGES FOR 240V 50Hz:

R18 is 330K 1/2W, and MOV1 is 275V for the 240V version. Also, C1 and C5 must be rated for 600VDC or 250VAC.

The transformer primaries must be wired in series for 240V with a cut-off component lead. (use the small holes).

Since the 240V plug may not be polarized, a plastic window is included to provide an extra layer of isolation. That should be trimmed to fit between the LCD mounting posts, and taped to the top cover.

RECOMMENDED ASSEMBLY ORDER:

D1, D2, D3, D4, D5 (all 1N4148)

D6, D7, D8, D13 (BAT43 & zeners)

Add 120V transformer jumpers on back if transformer has a dual primary (8 pins)

NOTE: for 240V install single jumper as shown.

NOTE: snip jumpers flush with top of board before installing transformer

R7, (R10 fixed), R19, R20, R21, R22A or R22B, R23, R24 (all 1/4W 5%)

NOTE: R22A for the XTBM < V1.10, R22B for the XTBM-Pro & XTBM V1.10+

R2, R3, R17, R26A or R26B, (R30 if backlit) (all 1/4W 5%)

NOTE: R26B is used if your kit includes the contrast adjustment R25.

R5, R6, R8, R9, R11, R12, R13, R15, R16, R27 (all 1/4W 1%)

For the Pro, R28, R29, (1/4W 1%)

NOTE: no 1/4W carbon film resistors should be left

L3, R1

D9, D10, D11, D12

R18, R4

U1, U2, U3 (dot near the square pad & be sure U2 is AD817)

DIP socket for U4

R10, R25 (if included in your kit)

2-clips for Fuse (be sure to orient so the fuse can snap in)

F1 (do it now so you don't forget)

C6, C7, C14, C13, C12, C11, C15

C20, C19, C8, C9

C4, C2, C18, C21

L1, L2 (with fat ends opposite)

TS1 (install facing board edge & make sure it is fully seated)

C5, C1, C3, MOV1 (be sure of C3 polarity)

NOTE: C5 may be a high-voltage ceramic for the 240V version

Q2 (2N7000) Be careful to prevent static damage

U5 (78L05) Do not confuse with Q1

J1 header (14-pin header starts at square pad, or install 6-pin at both ends)

CAUTION: Be sure to read item 8 above in Things to watch out for.

Q1 (IRL620)

C16, C17 (be sure polarity is correct)

X1 Transformer (pin 1 at square pad)

CAUTION: Be sure to read item 9 above in Things to watch out for.

Plug in the PIC microcontroller U4

For the XTBM-Pro, install S1 & S2 using insulated washers as spacers. Only solder two diagonal pins.

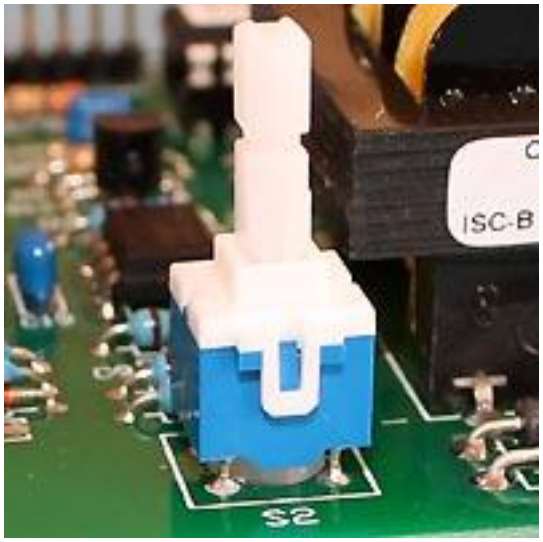
CAUTION: See photo below, and be sure to read item 12 above in Things to watch out for.

Install J2 14 pin or 16-pin socket on LCD assembly (starting at pin 1 end, and facing DOWN)

NOTE: make sure it is fully seated and exactly vertical

INTERWIRING & FINAL ASSEMBLY:

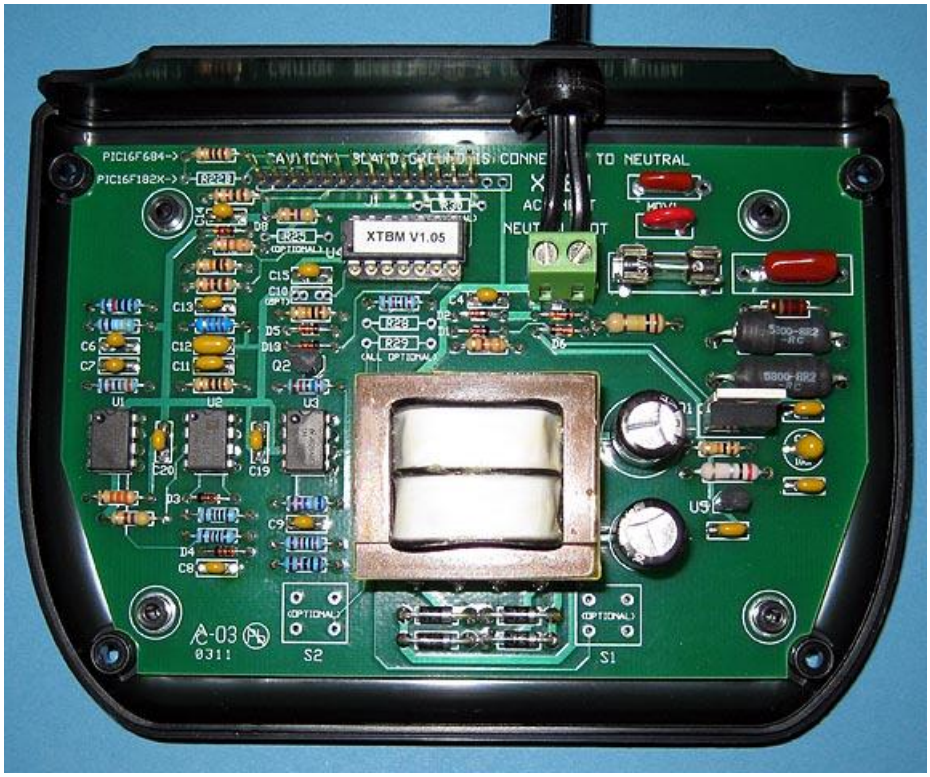
For the XTBM-Pro, be sure the switches are exactly centered in the holes drilled into the cover when the cover is installed. The alignment process is described above in the "Things to watch out for" section. Once the switches are centered, install the caps, and verify that there is clearance all around the buttons so they will not rub against the top. If not, adjust as necessary. When the switches are properly centered, solder the remaining two terminals.



Use flat washer for spacer under switch.

Carefully center switches in cover holes.

Install the power cord through the rear panel with the strain relief. Be sure to leave enough slack to make connections to the terminal strip. **Orient so the polarized plug wide prong connects to the neutral terminal on the terminal strip.**



Completed XTBM version 1.2 PCB with 14-pin header

Before mounting the LCD assembly to the top panel, plug it into the header, and apply power. Be careful because there is 120V inside the unit. The LCD should indicate the unit is functioning. If your unit indicates FAIL SELF TEST, carefully check your assembly. Self-test also checks the level of the transmitted output. It is possible for a nearby signal sucker or noise source to corrupt the signal enough to cause the FAIL SELF TEST, and you should try another receptacle on a "clean" circuit if you receive this indication.

If the display is blank or dark, and your unit has the contrast adjustment R25, rotate the adjustment as required. Adjust for good contrast with almost no background grid pattern.

If your kit included the zero adjustment for R10, you can adjust that for a zero reading if you are sure there is no noise on the powerline where the XTBM is plugged in. For best sensitivity, adjust it to just below the point where the reading changes from 0.00 to 0.01.

If you are not sure there is no noise on the powerline, with power off CAREFULLY place a jumper from the left side of R5 to the right side of R6 to short any input signal to ground. (Refer to the schematic.) Then plug the unit in and make the adjustment. Unplug it again before removing the jumper. **Caution:** You can destroy U1 if you don't do this correctly.

Assuming the unit is working, remove the plastic protection from the LCD and mount it to the top cover with the screws provided. They may be a tight fit through the LCD PCB. The backlit LCD must be mounted with insulated washers as spacers between the LCD and the mounting posts. Note that the 240V unit should have the plastic screen installed between the LCD and the cover.

Mount the PCB to the base using cup washers and small self-taping screws over the two front mounting posts. Be careful not to over tighten the screws to prevent warping the PCB.

Slip the back panel into the groove. Using the back panel as a guide, carefully install the cover. If the connectors were mounted exactly vertical, they should mate without a problem. You can look in through the side to check orientation. Install the rubber feet and label to the underside.

TEST & OPERATION:

If you have a Maxi Controller, plug both the XTBM and Maxi Controller into the same receptacle. If there is no signal sucker on that circuit, the XTBM should display voltage above 5Vpp for the Maxi Controller commands, and the decoded commands should be displayed.

Operation of the XTBM or XTBM-Pro is described in the booklet included with the unit.

Please contact me if you have any questions at: jeff@jvde.us

If you don't receive a response within 24 hours, try: xtbjeff@gmail.com

JV Digital Engineering XTB Home Page

[XTB & XTB-II/R Overview] [XTB Ordering Info] [X10 Troubleshooting Info]