

tx80m v4
BOM and bulid notes v4-05

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1 Introduction.

The PRS-tx80m.

Please bear in mind that this project is still changing and every build is a new version. As such, the current purpose of this document is to supply the mental hooks I need to build the current version and plan for the next one. As of 2016-11-20, version 4 is the latest completed version.

The PRS-tx80m is an 80 m transmitter for use in ARDF. It fits on a single board made by OSH Park and I build 3 at a time. It can provide output below 1 W and above 5 W and this is controlled by a pot on the PCB.

BOM format.

Items in the BOM are formatted as follows.

- **prsc-#** — **item name** — **short additional description** — **[n1]-[n2]**

Additional notes. The prsc-# is a number I use to uniquely identify a part. n1 is the number needed to build one transmitter. n2 is the number needed to build three.

2 Case.

Case, PCB, antenna connector.

- **prsc ?** — **case** — - — [1]–[3]
“Outdoor Products, Inc. Watertight Box, Large.”
- **prsc-?** — **OSH Park PCB** — **tx80m** — [1]–[3]
- **prsc-253** — **Dual banana binding posts** — **For antenna connection.** — [1]–[3]
Put the hole centers 2.5 cm from the closest bevel above and the right hole center 1 cm from the closest bevel to right. The hole centers are 3/4” apart. A 13/64” drill works well to drill the case. Use 8 mm wrench on nuts.
- **prsc-?** — **electrical tape** — **to cover screw heads** — [-]–[-]
Cut small pieces and put over screw heads to ensure batteries don’t get shorted. White tape works well on holder’s black plastic.

Batteries, battery holder (BH), etc.

- **prsc-240** — **battery holder (BH)** — - — [2]–[6]
prsc-240 is the Adafruit one but we may include alternatives in that definition in the future.
- **prsc-304** — **Wire with barrel connector at end.** — **To connect battery holder to PCB.** — [1]–[3]
Right-angle barrel connector at end of wire.
- **prsc-?** — **AA NiMH batteries** — **high capacity** — [8x2=16]–[16x3=48]

Screws, washers, nuts, and stand-offs.

- **prsc 314** — **screws, 4-40, L=3/8”** — **For BH to case, low profile.** — [8]–[24]
Torx T-8. Drill size for 4-40 screws?
- **prsc 281** — **screws, 6-32, L=3/8”** — **For standoffs to PCB and to case bottom.** — [10]–[30]
Need 5 for bottom and 5 for top. Torx T-15, ss 18-8, pan head. We may need to use thread locking fluid. Drill size for 6-32 screws?
- **prsc 347** — **locknuts, 4-40 nylon insert** — **For BH screws in case top.** — [8]–[24]
Use 1/4” wrench. Not low profile. If we change this, we may need shorter screws.
- **prsc 313** — **washers, #4, metal-bonded sealing** — **For #4 screws, case top.** — [8]–[24]
We’re using these for v4. But I think they require too much screw pressure to seal. The plastic top may not take the needed pressure. So we should try for flat metal washers + blue sealing washers in next version. But we need #4 and the smallest size blue sealing washers are #6. Hum... Problem, there are no sealing washers below size #6 except for the high-pressure metal bonded sealing washers.
- **prsc 295 (to change in v5)** — **female-female standoffs** — **6-32, L=5/8”** — [5]–[15]
Hex width=3/8” (3/8”=9.52mm, for wrench). These are the wider standoffs of the two types I tried. The extra width makes them better for using the blue sealing washers. These are a bit too short. Go to a slightly longer version in tx80m v5. See section on changes for next version.

Miscellaneous.

- **prsc-?** — **Thread locking liquid.** — **For screws going into standoffs.** — [-]-[-]
For now, don't use it. But may be use it in future if some screws start coming loose. Use temporary? For use on top (PCB end) and bottom (case end) of standoffs. Will it damage the sealing washers? At time of completion, not used in tx80m-v4.
- **xxx** — **acrylic template for drilling bottom** — - — [1]-[1]

Order of parts moving vertically from top to bottom.

Case top - part order from top to bottom.

prsc	part
347	lock nuts
313	metal bonded sealing washers
.	case top
240	battery holder main part (add cover later)
314	screws for BH
.	pieces of electrical tap to cover screws
?	batteries (add later)
304	wire with barrel connector at end

Case bottom - part order from top to bottom.

prsc	part
253	dual banana binding posts, on side
281	screws that go into PCB
?	OSH Park PCB
295	standoffs
298	sealing washers
?	case bottom
281	screws that go into case bottom and standoffs

3 “Multi” (found in several modules).

These are specifically for parts found in several of the PCB modules. This means that some parts will have two cdem bags, one in the multi here and one in the enclosure building bag.

Misc.

- **prsc-298** — **washer, blue sealing, #6.** — **For toroids and standoffs.** — [11]–[33]
Use three per toroid in center hole to protect wire from the metal screw. Also need 5 per tx to use them between case bottom and standoff. 6+5=11 For the case... Blue instead of metal bonded. I tried metal bonded rubber pressure sealing washers but they needed too much screw pressure to seal against screw. I was afraid that the plastic would crack.
- **prsc-251, 256** — **Switch, SPST, toggle** — **S101 : S201 S202** — [3]–[9]
prs-spst-toggle-v2. Use prsc-251 (salvage) until finished. Then prsc-256 (digikey). For prsc-256 (use an 8mm wrench).
- **prsc-035** — **Heat sink for TO-220.** — **For LM371 and IRF610.** — [2]–[6]
Put on before soldering. Use prsc-355 screws (6-32).
- **prsc-355** — **Screws for heatsinks.** — **For LM371 and IRF610.** — [2]–[6]
- **prsc-?** — **test points** — **TP101 TP102 TP103 TP104 TP105 : TP401 TP402 TP403 TP404 : TP501 : TP601 : TP701, mostly leave off for now** — [12]–[36]
prs-test_point_1pin_pad, PRS-2PIN_TEST_POINT. No need to solder these on unless we get a need. Be careful of heatsinks being in the way.
- **prsc-305** — **pin arrays, 6x2 and 4x2** — **S205 S206 S207 : P302** — [3 [6-by-2] and 1 [4-by-2]]–[9 [6-by-2] and 3 [4-by-2]]
Rectangular header. On switches submodule (S205 S206 S207): 3 [6-by-2] for analog input headers. On controller submodule (P302): 1 [4-by-2] for unused ATMega pins. In earlier versions, used prsc-126 (jameco), but all on tx80m-v4 were longer version from digikey. The prsc-305 are 2x(?) and need to be cut to the proper length.

Capacitors.

- **prsc-203** — **C 10uF** — **C101 C104 : C402 C403 : C701** — [5]–[15]
prs-SMT_i2413_pol.C. Bar on component marks (+) end.
- **prsc-206** — **C 100nF, X7R, SM1206.** — **C102 C103 C105 : C301 C302 C303 C304 C307 : C401 : C501 C502 C503 : C601** — [13]–[36]
Size SM1206. These are all bypass caps and therefor can be non-NP0. Prsc choices: {89 90 206 227}. Using 206 because we have many of these. We also have plenty of 089 if need be.
- **prsc-090** — **C 100nF, NP0, SM1206** — **C703** — [1]–[3]
I checked: Not bypass, use NP0. Prsc choices for 100nF SMT-i1206 {89 90* 206 227*}. Only the * ones are NP0. I have more of the 090, so let's use these.

Resistors.

- **prsc-48** — **R 100k, SM1206.** — **R101 : R507** — **[2]–[6]**
R101 is the current limiter on the v-reg ‘sub-module’ green LED. On 2016-01-24, we decided to go with 100 k-ohm (changes “10k?” to “100k”). But we may want to go to 82k. R507 is on the pre-driver and is good at 100k. The prsc-48 packages were marked “1003” (100E3 = 100k).
- **prsc-13** — **R 10k, SM1206** — **R304 R305 R306 R307 : R401 R402 R403 R408 : R501 R503** — **[10]–[30]**
Prsc choices were {013 1%, 060 0.1%}. Chose 013. R306 and R307 are pull-downs on unused ADCs; using 10k should be ok. R304 is the red LED304 resistor and may change in future. The package is marked “1002” (100E2 = 10E3 = 10k)
- **prsc-82** — **R 1k, SM1206.** — **R201 R206 R211 : R303 : R502 R504 R506 : R601** — **[8]–[24]**
R303 is the orange LED303 resistor and may change in future. The package is marked “1001” (100E1 = 1E3 = 1k).

4 SM-100 – V-regulator.

Misc.

- **prsc-278** — **barrel jack** — **P101** — [1]–[3]
For power to board. Use 10 mm wrench. During tx80m-v4 build, didn't use a lock washer.
- **prsc-141** — **HRP5 5V V-reg** — **U101** — [1]–[3]
- **prsc-260** — **LM317, variable V-reg, TO-220** — **U102** — [1]–[3]
Through hole. We started with prsc-142 (LM317 from?). But now using prsc-260 (digikey).
- **prsc-72** — **Green LED, SM1206** — **LED101** — [1]–[3]
On/off power indicator. Bottom view:  .
- **prsc-149** — **Diode, SM2512.** — **D101 D102 D103** — [3]–[9]
Prsc choices {149 150 208}. Decided on 149 on 2016-01-23 (see cnotes). Ordered 100 on 2016-01-24. For prsc-149, cathode (marked k on PCB) is marked by a bar on the package. ¹

Capacitors and resistors.

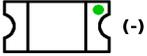
- **prsc-195** — **C 1uF, SMT-i2413** — **C106** — [1]–[3]
- **prsc-197** — **R 240 ohm, SM1206** — **R102** — [1]–[3]
Prsc-197. 5%. Maybe next time go for more precise?
- **prsc-261** — **R 0-ohm, SM1206** — **R104** — [1]–[3]
Max R103+R104 < 5k-ohm. Se we need R104=0 if R103_max = 5k. If we don't need the full range, we could use a R103 = 2k and R104 = 2k. Then range is 2k–4k instead of 0–5k.
- **prsc-191** — **R-trimmer 5k** — **R103** — [1]–[3]

¹For conduction, we use (+ [A—►|—K] -), A = anode, K = cathode. I'll have to check what D101 D102 D103 are for. But I think they are placed to allow a return path passed v-reg for safety.

5 SM-200 – Switches (aka user input).

- **prsc-257** — **exkey-jack** — **J201** — [1]–[3]
3.5mm stereo jack (trs). Used to be prsc-215 in tx80m v1 and v2.
- **prsc-279** — **Resistor array, 4 x 1k** — **R202 R207 R212** — [3]–[9]
- **prsc-39** — **switch, SMT, 2x spst** — schematic designation? — [1]–[3]
For DI (digital input) cw speed and timing.
- **prsc-321** — **2-pin rect header jumper.** — To place on S205 S206 S207. — [3]–[9]
Sparkfun.

6 SM-300 – Controller.

- prsc-65** — Osc 16MHz, SMT 5032 — X301 — [1]–[3]
 Sparkfun. The chamfered pad is on pin 1. This is not the crystal for which the chamfered pad may appear on a different pin. But note that the writing on the top may be right-side-up or inverted relative to pin 1. I check the bottom for pin 1 and then mark that corner with a sharpie on the top.
- prsc-67** — ATmega328-P, 32-pin TQFP — U301 — [1]–[3]
- prsc-164** — ISP header, 3x2 — P301 — [1]–[3]
 Sparkfun
- prsc-096** — C 18pF, SM1206 — C305 C306 — [2]–[6]
 Prsc-096 is NP0, 5%.
- prsc-70** — LED, white, SM1206. — LED301 — [1]–[3]
 Uses R301. Bottom view:  . Top view:  .
- prsc-74/prsc-265** — LED, yellow, SM1206. — LED302 — [1]–[3]
 Uses R302. Started with prsc-074 (tx80m n10). Went to prsc-265 (tx80m n11 n12) when prsc-074 ran out.
- prsc-264** — LED, orange/amber, SM1206. — LED303 — [1]–[3]
 Used to use prsc-073, but they're all gone.
- prsc-71** — LED, red, SM1206 — LED304 — [1]–[3]
 Uses R304. Same pattern as prsc-070... Bottom view:  . Top view:  .
- prsc-262** — R, 4.7 k, SM1206 — R301 R302 — [2]–[6]
 Resistors for LEDs. R301->white, R302->yellow. These may change.

7 SM-400 – Oscillator.

- **prsc-10** — **RT9193**, **sot-23-5** — **U402** — **[10]–[30]**

- **prsc-9** — **BSS138**, **sot-23** — **Q401 Q402** — **[2]–[6]**

- **prsc-7** — **XTAL, 25MHz, AMB8G** — **X401** — **[1]–[3]**

This is the crystal for which the chamfered pad is not always on the same pin. Looking at the top and reading the writing going from left to right, pin one is always the bottom left pin. Top view (pin 1 position

marked in image but not on package):  .²

- **prsc-8** — **Si5351**, **MSOP10** — **U401** — **[1]–[3]**

- **prsc-14** — **C 470nF, SM1206** — **C404 C405** — **[2]–[6]**

Prsc-014 is X7R, by-pass caps for power on Si5351, so don't need to be NP0.

²All the ones I used in tx80m v4 had this bottom view:



. But the datasheet notes that the chamfered pin may not

always be associated with the same pin number.

8 SM-[500 600 700] – RF power chain.

500s – Pre-driver.

- **prsc-29** — **2N2222, TO-18** — **Q501 Q502** — [2]–[6]
Prsc: 023 from mouser, 029 from dk. I used the 2N2222 on tx80m-v4 n10 and an SMT version on n11 and n2. It is an MMBT2222 soldered on to a tiny breakout board. Tests showed that the MMBT2222 worked fine. So we're going to that for the tx80m-v5.
- **prsc-200** — **R, 100 ohm, SM1206** — **R505** — [1]–[3]
- **prsc-236** — **C, 50 pF, SM1206** — **C504** — [1]–[3]
Prsc-236 is 47pF NP0 5%. Wanted 50pF, but using 47pF instead.

600s – Driver.

- **prsc-076** — **4001, SOIC-14** — **U601** — [1]–[3]

700s – Power amplifier.

- **prsc-64** — **IRF610** — **Q701** — [1]–[3]
- **prsc-62** — **Inductor, 5uH** — **L701** — [1]–[3]
- **prsc-205** — **C, 10 nF, SM1206** — **C702** — [1]–[3]
Prsc-205 is 5%, C0G, want better? C0G = NP0?

9 SM-800 – Filter.

- **prsc-058** — C, 120pF, SM1206 — C803 — [1]–[3]
NP0
- **prsc-59** — C, 1.5 nF, SM1206 — C802 — [1]–[3]
Prsc-059 is NP0, ?
- **prsc-204** — C, 1 nF, SM1206 — C804 — [1]–[3]
Prsc-204 is NP0, ?
- **prsc-57** — C, 330 pF, SM1206 — C801 — [1]–[3]
Prsc-57 is NP0, ?
- - — **wire or braid** — P801 — [-]–[-]
Solder these on before screwing the PCB into the enclosure. Just get wire or braid at the soldering station.

Toroid building.

- **prsc-45** — **Toroid T50-6** — - — [2]–[6]
Toroids for L801 and L802. Amidon T50-6.
- **prsc-106** — **magnet wire, AWG-24** — **Wire for L801 and L802.** — [-]–[-]
Use AWG-24, red on 2015 ipro 1130v16a (see as07).
- **prsc-106, 42cm pre-cut** — **Cut for 26 turn on T50 toroid, L801** — - — [2]–[6]
- **prsc-106, 40cm pre-cut** — **Cut for 24 turn on T50 toroid, L802** — - — [2]–[6]
- - — **wound toroid using prsc-45** — **L801** — [2]–[6]
2.7 uH.
- **wound toroid using prsc-45** — **L802** — - — [2]–[6]
2.3 uH.

Toroid fastening.

- **prsc-116-6a** — **washer, nylon, #6.** — - — [4]–[12]
Use two per toroid, one above the blue washers and one under.
- **prsc-270** — **screws, 6-32, L = 1/2”.** — - — [2]–[6]
ss, torx T-15. Need 1 per toroid.
- **prsc-271 incorrect?, prsc-309 correct?** — **locknut, 6-32, nylon insert** — - — [2]–[6]
ss. Use 8mm wrench. Need 1 per toroid. I had it as prsc-271 when I started building. But looking at bags with prsc-271 and prsc-309, it looks like 271 our normal thickness and 309 are low-profile. I have definitely been using low-profile and like them better for this.

Materials to use.

- - — **Sand paper.** — **150 grit** — [-]–[-]
For stripping enamel from magnet wire ends.

10 Build notes.

Preparation

The ideal order of events is as follows. When one version is built, the documentation is altered to note the changes needed for the next version. The KiCad project is updated to implement changes. At the same time, components that will be needed can be ordered. The PCBs are then ordered from OSH Park. While we wait for the PCBs, several things can be done.

- Build the cases.
- Put on heatsinks (prsc-035) on LM-317 and IRF-610. ³ Screws to use: prsc-355. 6-32, L=1/4", torx T-15. Nuts to use: nylon insert 6-32, prsc-309(uses 5/16" 7.94mm wrench) or prsc-?. Use two small pieces of PCB on edge of component to stop heatsink from rotating during screw tightening. Don't forget the heatsink compound (prsc-002). Place nut on outside of heatsink and screw head on inside. Place component on inside of heatsink.
- Build toroids, take picture, and check number of turns on picture.

Building the case.

Building the case involves the following.

- Mark each case with a transmitter number.
- Prepare that battery holders.
 - Mark each battery holder cover (see **Fig. 1**) and inside with a transmitter number and an "L" or an "R" for "Left" or "Right" side holder. ^{4 5}
 - Cut battery case walls to allow drilling of screw holes.
 - Remove wire cover from battery case. See **Fig. 2**. And unsolder wires from battery holder tabs.
 - Drill screw holes in battery holder. Also drill holes in side where wires will come out.
 - Drill screw holes in case top to match battery holder holes.
 - Drill screw holes in case bottom using template to ensure proper hole position.
 - Cut and strip new wires for battery holder. One will be super short and will just connect the two battery holders. The other will have the barrel plug at the end and will need to be long enough to include stress relief knots in both ends.
 - Solder the short wire to two battery holders at latch end.
 - Solder wire with barrel plug to battery holders at hinge end. The tip (stripped) wire goes to (+) tab.
- Drill and smooth the top for battery holder screws.
- Drill and smooth the bottom for PCB standoff screws.
- Drill the side for antenna binding posts / banana plugs.
- Install antenna binding posts, PCB standoffs, and battery holders.
- Cover battery holder screw heads with electrical tape.

³See LB.2016 N.01 p.57 and N.02 p.77.

⁴The reason for marking the battery holder **insides** is that the screw holes will not be in exactly the same place on different transmitters and on the left versus right side.

⁵The reason for making the battery holder **covers** is that we found that different battery holders are slightly different from each other. So the top of one may look like it fits on another but doesn't fit well. With building three transmitters, that 6 covers to keep associated with 6 holder insides.



Figure 1: Marking of battery holder cover with transmitter number and “L” or “R”.



Figure 2: Cutting off small plastic knobs holding on wire cover inside battery holder.

Notes regarding several submodules.

- **Test point (TP) loop construction and soldering.** Bend some wire (AWG?, smaller than 22?) into a triangle loop with a doubled base. Clamp at tip with hemostats and test best hand position to be steady. Put some flux on wire base and pad. Solder a large bead onto the pad. Attached the loop while remelting the solder bead.
- **Test point loops to solder.** We don't need to populate all TP pads with TP loops. Put loops on the following: The ground next to the power switch, the antenna (-) pad which will also get a longer wire,⁶ the output of the oscillator submodule, the output of the pre-driver, the output of the power amplifier (IRF610).
- **Prsc-256 SPST toggle switches (SM-100 and SM-200).** In tx80m-v4 build, we used only prsc-256 (digikey) in SM-100 and SM-200 SPST toggle switches. Used an 8 mm wrench to tighten. The alternate (prsc-251) are salvage switches. We didn't put any lock washers as we did other times. We may have to add them later.
- **Wire to switch and jack pins.**
 - Cut wire and bend end to make an “L”.
 - Put flux on pad and on bottom of “L”.
 - Solder a bead onto the pad.
 - Solder the bottom of the “L” onto the pad while re-melting the bead.
 - Loop the top of the “L” around the pin or thread it through the hole in the pin.
 - Crimp with pliers.
 - Add flux to pin and “L” top and solder.

⁶We don't want to do both as one piece. We want the loop soldered early so that it is available for testing during the build process. But we don't want the wire to the antenna until the end so that it doesn't get in the way. Once we have a wire there, we could remove the loop. So we could solder on just a short bent wire instead of a true loop.

In the last solder step, make sure to do it quick enough that the bead on the pad doesn't melt. Having a large bead helps. A heatsink on the "L" mid-section can be used but was found not to be necessary if good heat transfer was ensured.

SM-100. Voltage regulator.

Nothing here yet.

SM-200. User input (switches).

Nothing here yet.

SM-300. Controller.

Nothing here yet.

SM-400. Oscillator.

Nothing here yet.

SM-[500 600 700]. RF power chain.

I usually don't solder and then test each SM of the RF power chain. Instead, I solder on all the "multi" components for the entire power chain. I then solder SM-500 and test it's output. I then solder all the SM-600 and SM-700 and test the SM-700 output.

Note that the SM-500 is two separate circuits. Circuit 1 (c1) gets input from the controller for when RF out is to be turned on. Circuit 2 (c2) gets input from the oscillator SM. The outputs of c1 and c2 combine in SM-600 to either run it or not. The c1 output is a stepped up constant voltage of it's input from the microcontroller. The c2 output is RF and is on whenever the oscillator SM is on.

- Test point loops are not needed on any pads in the RF power chain. ⁷

SM-800. Filter.

Nothing here yet.

Finish - mounting of PCB.

The last part is the mounting of the PCB into the case, the connection of wires from the PCB to the antenna binding posts, and the final testing of the transmitter. We want to connect the wires to the binding posts before testing so we can connect the 50 ohm load.

- After the PCBs are completely soldered, screw them into the standoffs in the case.
- Completely unscrew the outer nut (8 mm wrench) on each antenna binding post (prsc-253) on the inside of the case and also remove the washer.
- There is a wire soldered to each 'antenna out' pad on the PCB. Wrap each one around the corresponding binding post. Just using fingers is ok.
- Put washer and nut back on and tighten.

⁷On tx80m-v4 n10 and n11, I placed TP loops on TP601 and TP701 so that I could have my hands free to save waveform images during the measurements (for documentation). On n12, I didn't bother putting any loops on these two pads. In the future, we should have pictures of these waveforms available at test time. If measurements look like the document pictures, we can move on. So in the future, leave TP601 and TP701 pads unpopulated.

11 Changes wanted for tx80m-v5.

- Wider test pads. Just a tiny bit wider.
- Larger pads on LM317 and IRF610 to get better heat transfer from iron.
- In v-reg SM (D101 D102 D103, prsc-149), the pads need to extend a bit more into the center space between the pads.
- In the pre-driver SM (SM-500), we're changing Q501 and Q502 from 2N2222 (prsc-029, TO-18 package) to MMBT2222 (prsc-?, sot-23). This was tested in tx80m-v4 when 2N2222 were used in n10 and MMBT2222 on mini breakout boards were used in n11 and n12.
- The standoffs we're currently using are not quite tall enough. Even with the blue sealing washers at the bottom, the SPST switches are also touching the bottom of the case. We're currently using prsc-295 (mmc 91780A286, L=5/8"=15.88mm). Go to the next size up in length (mmc mmc 91790A290, L=3/4"=19.05mm).
- Try to use low profile nuts on case top and see if we need to use shorter screws.

12 Abbreviations.

cdem Components separated out from stock and reserved for use in this project. I have a single box where there should be enough reserved components to build three tx80m before the PCBs arrive from OSH Park.

prsc A number I use to identify components uniquely.

SM submodule. These are parts of the PCB that used to be separate PCBs in an early development version of the transmitter. They each represent a separate functional unit and all the components in a particular SM have schematic numbers in the same “hundreds”. Eg the voltage regulator SM components have numbers in the 100’s, the user input SM components have numbers in the 200’s. As a shorthand, I’ll sometimes use SM-100 for the voltage regulator SM, SM-200 for the user input SM, etc.

SM1206 A surface mount component size. Usually, I’ll use SM for “submodule”. But in a couple places, I’ve used SM as a shorthand for “surface mount”.

tx80m Shorthand for this 80 m transmitter project and the transmitters themselves.

13 Component sources.

Case

- **prsc-240** — **battery holder (BH), 8x AA** — **Adafruit 875** — [2/6]-[]
1–9: 5.95 USD each, 10–99: 5.36 USD each. For two sets of tx80m (6), we need 12 BH. $12 \times 5.95 = 71.40$ USD. $12 \times 5.36 = 64.32$ USD. If we're building 3 more sets, that's 18 BH. $18 \times 5.95 = 107.10$ USD. $18 \times 5.36 = 96.48$ USD. But we can still buy them in sets of 12 or 10 even if we only buy 12 for the next set (v5). This is because we will use the extras for the tx2m we'll be building next. So the plan is to buy just 12 in the next order (this was written 2016-10-28).