

Assembly instructions for STAR SSD upgrade inner power cable

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This document defines the assembly procedure for the inner power cables for the STAR SSD upgrade, part of the Heavy Flavor Tracker project.

To reduce the amount of conversion material (radiation lengths) in the inner detector, the power cable utilizes aluminum wire. Actually, copper-clad aluminum is used as a compromise between low radiation length and ease and reliability of termination. [This wire is 10% copper by volume, which results in 2.65 times better performance than copper wire in terms of radiation lengths divided by electrical resistance.]

Aluminum wire is fragile! There are two main risk areas: The wire will fracture if bent too sharply, and the copper may completely dissolve off into solder if a joint is left heated too long. In practice, the second risk is minimal, just be aware of it, you will not have any problems using normal soldering techniques. However use some care and minimize time if any rework is necessary. The fracture risk is significant... Especially with the 28 AWG wires, extreme care is needed when manipulating the individual wires to get them to the correct pins on the circular connector. On the connector board end of the cable there should be less risk of a problem.

Assembly procedure

1. Use the fixture plate, a small vise, *polished* center punch, and small hammer to swage 16 terminals to the board from the *top* side (the side where you see the silkscreen for cable clamp block).
2. Inspect for metal shavings from that operation and debur and blow off as needed.
3. Solder these terminals to the board from the bottom side. Use a liberal amount of solder, but do not intentionally apply solder into the terminal body hole (minor leakage into it is acceptable).
4. Install the Nicomatic connector on the *bottom* side of the board, paying careful attention to orientation and proper flat seating onto the board. Solder on top side, and trim pins flush with a sharp cutter after soldering. Note that the connector pins are floating in the body and it is necessary to have one soldered on each row before the connector body is really locked into place. So it needs a bit of extra care to be sure it is seated down flush.
5. Install the 3 capacitors at C2 – C4. Install an 0805 jumper at R1 and a 1206 jumper at C1. [Note: these jumpers will be removed later for WEST cables. It may be easier to use a little piece of wire for those. They are temporarily needed for the wire ID fixture.]
6. Cut a piece of cable ~290 cm. Identify the end with “standard screw thread orientation” of the visible pattern of foil wrap in the cable. This is the end that works out best to have on the connector board end of the cable.

7. Strip cable jacket to about 1.1 – 1.2 inches, using preset jacket stripper tool. It will likely bind before full circle cut, just run it most of the way and finish the job by hand. Strip foil flush to the jacket cut.
8. Mount the cable to the top side of the board using cable clamp block and four 2-56 × ¼ inch fillister head nylon screws from the bottom. When doing this, have the drain wire oriented near to terminal #16.
9. Solder the wires to the terminals according to the following table. Choose the wires according to convenient/neat position of the connections. For stripping the wires, since the silicone insulation tears so easily I find it convenient to just pinch between thumb and fingernail. Otherwise use a soft-jaw stripper so as not to scratch the aluminum wire. Use a liberal amount of solder, especially on the 28AWG wires, to ensure that they are well supported in the joint. It is ok at this point if solder wicks into the terminal body hole, it is likely to happen (but not the ideal). Trim the wires flush past the terminal; for the inner set of terminals the specially modified cutters will be required.

Terminal #	Wire
16	drain wire
15	20AWG
14	28AWG
13	28AWG
12	20AWG
11	20AWG
10	28AWG
9	28AWG
8	20AWG
7	20AWG
6	28AWG
5	28AWG
4	20AWG
3	20AWG
2	28AWG
1	28AWG

10. Trim the cable to 280 cm (measured from the far end of the connector board). Goal is to have this within +/-3 cm.
11. Slip backshell over the cable and (I suggest) tape it out of the way. *Make sure it's oriented right!*
12. Strip cable jacket to ~1.25 inches using preset jacket stripper tool. It will likely bind before full circle cut, just run it most of the way and finish the job by hand. Strip foil flush to the jacket cut. Gently bend the 28AWG wires out a bit. Trim the 20AWG wires (including drain wire) to ~1.1 inches.
13. Install the connector board end to wire ID test fixture and apply +13V. Note: The (polarized) capacitors are getting some of this voltage and so it is important to use the correct polarity! Note: The wire ID test fixture is a simple voltage divider resistor chain. If any of the wire ends short to each other, the voltages will not be correct, naturally. So, be careful to avoid this when

measuring the voltages for wire ID. (The resistors *are* large enough that there will be no damage due to any shorts.) Note/suggestion: apply slightly more than 13V so that for each of the output voltages your DMM reads slightly more than an integer number of Volts; mentally rounding down may be easier and less error-prone than mentally rounding up.

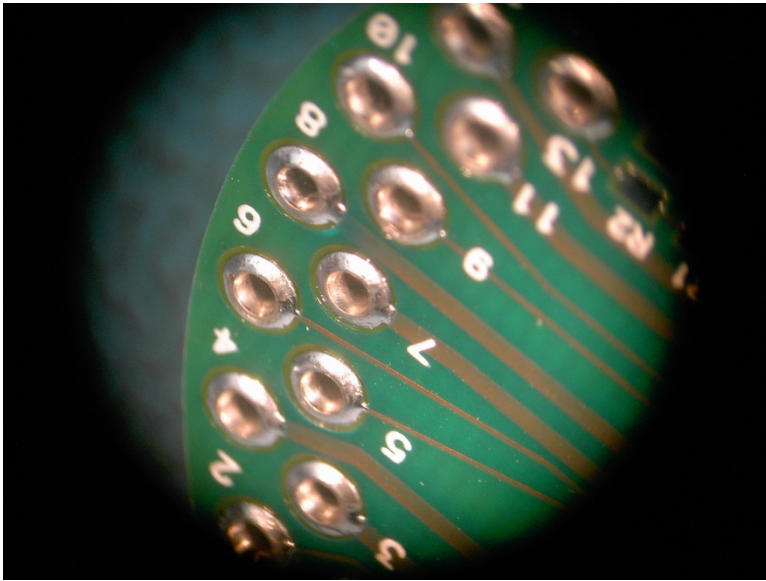
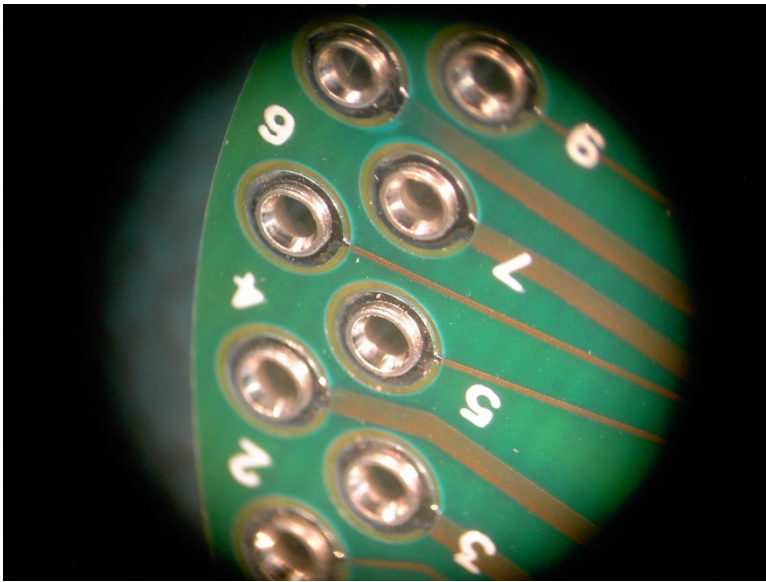
14. Prepare the ground wire: Cut 2 feet, strip one end to 1.75 inches. Solder it to pin P on the connector.
15. Pick a wire, ID it according to following table, then strip it and solder it to the appropriate connector pin. It is probably easiest to start with some of the 20AWG wires, I suggest find the ones for pins A, L, K, B, then M, then D, H, then the other 28AWG wires, and finally the ground wires. For the 28AWG wires be especially careful not to bend sharply! Trim the 28AWG wires as you go, as needed to allow for good lay without sharp bends. Solder the two ground wires (drain wire and 20AWG insulated wire) last. For these, strip the insulated wire for most of its exposed length, trim these wires back a bit, and wrap the copper external ground wire around these two aluminum wires (not the other way!) and solder together. Suggestion: Identify (and double-check!) the ground wires first, and trim them but do not solder yet. Then less stuff is in your way. Suggestion: Start wiring the connector with pins A, L, B, K, this seems to work best in my (limited) experience. Note: When crossing wires over the copper ground wire, bend **it** out the way, not the other way around.

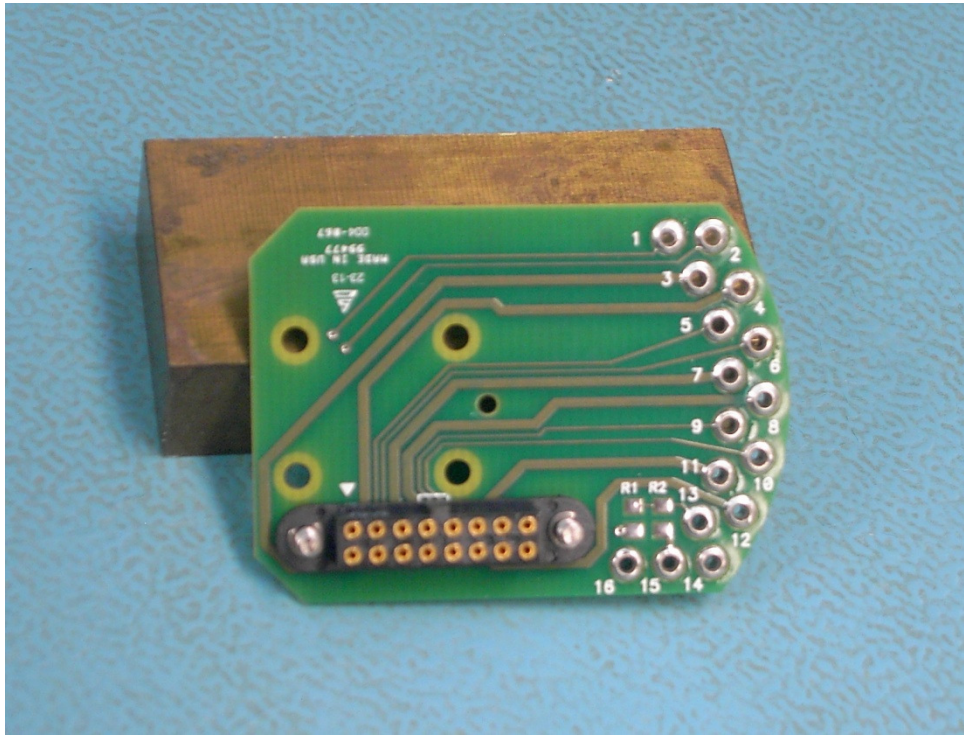
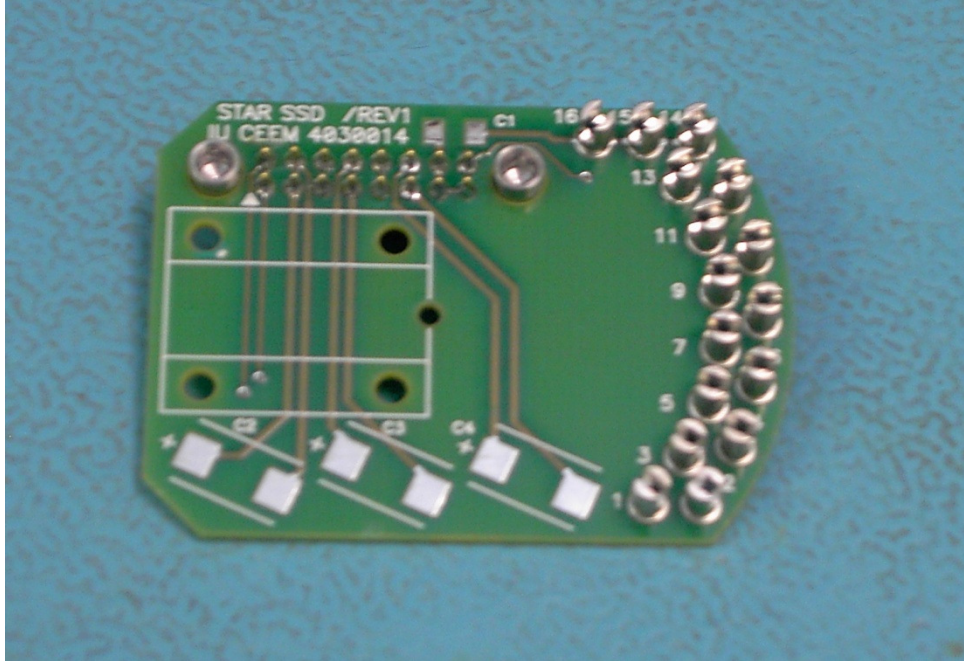
Terminal #	Wire	Identification	Connector pin	Function (ref)
16	drain wire	obvious	P (SEE ABOVE!)	GND
15	20AWG	0 V (20AWG)		
14	28AWG	0 V (28AWG)	N	BIAS_RET
13	28AWG	13 V	F	BIAS+
12	20AWG	12 V	A	L5VF+
11	20AWG	1 V	L	L5VF-
10	28AWG	2 V	R	L5VS-
9	28AWG	11 V	M	LVVS+
8	20AWG	3 V	K	P2VF-
7	20AWG	10 V	B	P2VF+
6	28AWG	4 V	J	P2VS-
5	28AWG	9 V	C	P2VS+
4	20AWG	8 V	D	M2VF+
3	20AWG	7 V	H	M2VF-
2	28AWG	5 V	E	M2VS+
1	28AWG	6 V	G	M2VS-

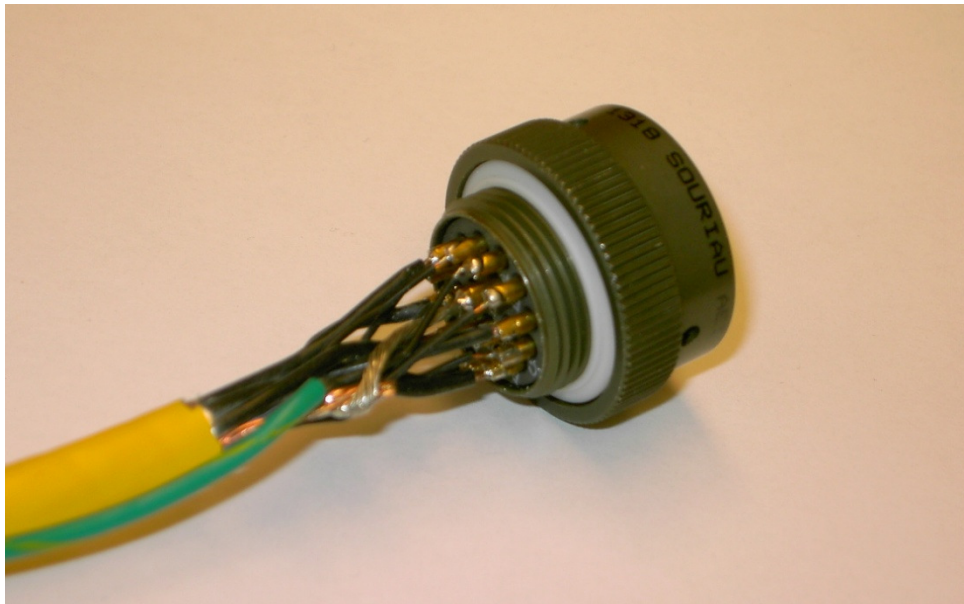
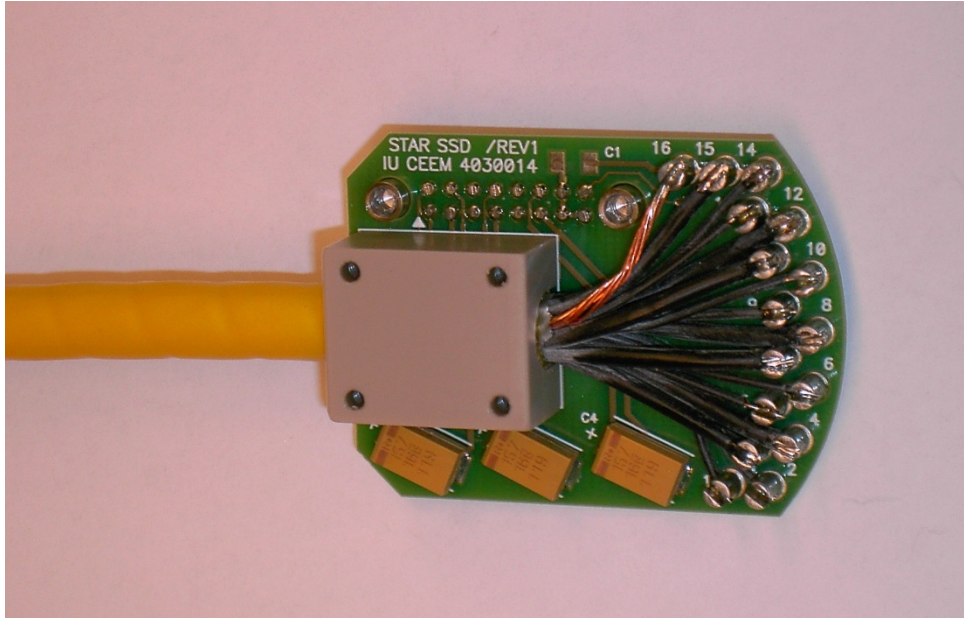
16. Double-check that the right voltages are seen on each connector pin from the front. Please be careful not to scratch the pins when probing them.
17. Cut about 9.5 inches of 3M #70 tape (leave the backer on it for cutting). Wrap/stretch over the wires and spiral back to the cover the jacket and ground wire at the point where backshell will clamp it (this uses up 2-3 inches of tape), wrap/stretch the remainder there to build up for the connector backshell/clamp to fit right.

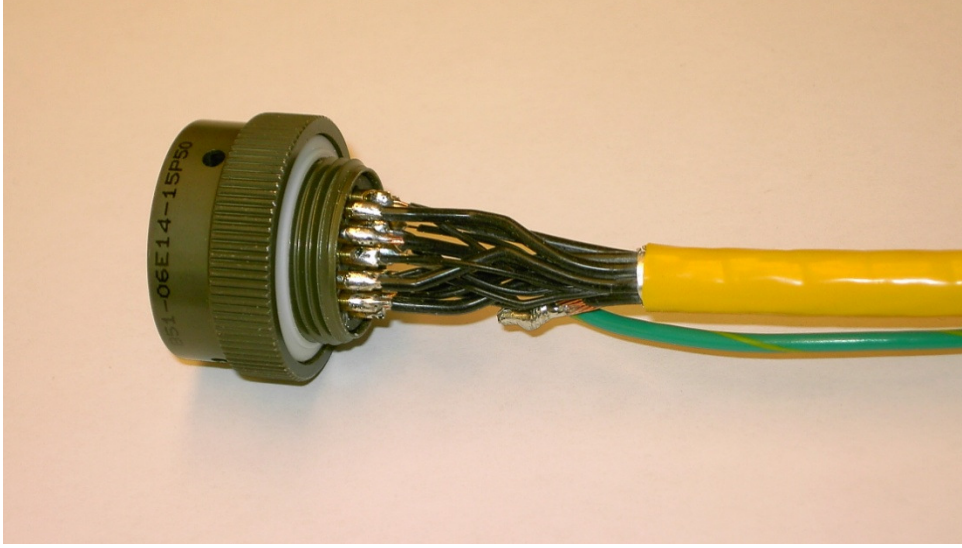
18. Screw backshell to connector body. Use dummy socket connector to grip the connector for this purpose.
19. Install cable clamp (flat one) to backshell, using McMaster # 92525A207 screws (nonmagnetic). Do not use the original screws that came with the backshell.
20. For west cables, remove jumpers at R1, C1, and install jumper at R2. For east cables, the jumpers at R1, C1 remain and R2 is open.
21. [Final test... Will be done by GV.]

Appendix – photo gallery









Appendix II – The wire ID fixture

This applies 14 different voltages (0V – 13V) to the 14 different nets on the connector board wire terminals. Note that W16, W15, and W14 are all connected together (on EAST cables). It is a resistor divider chain with 3.40k resistors (selected so that they can withstand 13V within rated power limits). There is an extra 3.40k series resistor on the 13V net, so that it is also current limited like the others in case of a short to ground.

I didn't draw a schematic, but it's evident from the pictures here. Note that it is arranged so that all three of the polarized capacitors on the connector board have the correct polarity of voltage applied to them.

