EDGES MEMO #300

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To: EDGES Group

From: Alan E.E. Rogers

Subject: Details of EDGES-3 prototype

The concept of placing all the electronics in the antenna was proposed in memo 289. An update to the design, in which the number switches in reduced, is described in memo 293. Simulations of the EDGES-3 beam chromaticity are given in memo 294 and in memo 298 with a wire grid ground plane. Following early tests of the initial EDGES-3 prototype it was discovered that RFI generated by the Nuvo PC, DC to DC converters and other switching electronics was strong enough to require an additional layer of shielding and filtering as described in memo 299.

This memo gives details of the revised design based on separating the electronics with fast switching waveforms into a separate "inner" box. The analog "backend" electronics is also contained in the box to provide additional isolation to prevent feedback of the amplified sky signal into the antenna. A block diagram is given in Figure 1a along with a photo in Figure 1b. The VNA and its DC/DC converter is outside the inter shielded box because the spectrometer is not run when the S111 measurements are made with the VNA.

Figure 2 shows the overall circuit diagram of EDGES-3. The ethernet connections to the outside and to the VNA are made using fiber. A cable connection to the outside can be made for charging the batteries. This connection is made, which the EDGES -3 is not running, via a cable which passes through the pipes which connect the antenna boxes shown in Figure 12.

Register		
100	temperature	Frontend box
101	temperature	Ambient load
102	temperature	Hot load
103	temperature	PR59 in inner box
106	Output %	Thermal control
150	Voltage	Battery
152	Current	PR59 current

Table 1 Some key parameters monitored.

Table 1 lists the key registers which can be read out for monitoring purposes vis the RS232 link from the Nuvo PC to the PR59 thermal controller. When S11 measurements are needed the VNA can be powered up using the MEZIO control and after a delay for the VNA to reach a stable temperature the control and data retrieval is performed using the Ethernet link to the VNA.

Figure 3 shows the mechanical details of the frontend. The left box contains a 10 ft long cable with a switch which provides and "open" or a "short". The middle box contains a 50 ohm load which is heated by a 75 ohm resistor and filled with Aerogel Silia Gel Lumira LA100 for insulation. Figures 4, 5 and 6 show the circuits of the LNA, noise source, and "out of band" noise.

Figure 7 shows the circuit of the "switch board" which converts the MEZIO "pulldown" outputs to "pullup" outputs to control the R.F. switches. Figure 8 shows the circuit details of the inner box and Figure 9 shows the mechanical details.

Figure 10 shows the layout of the outer box and Figure 11 gives the dimensions of the antenna box. Figures 13 give the dimensions of the antenna base.

Items	Conditions	Volts	Amps	W
Frontend		12	0.8	10
Frontend + PC	Idle	13	1.9	25
Frontend + PC	Fastspec running	13	5.5	72
Thermal	Max	13	2.0	26
VNA	Only			14
VNA + PC + thermal	Min			39
All	Min in spectra			72
All	Max in spectra			98

Table 2. Power consumption for different items and conditions.

Table 2 gives the level of power consumption for parts of the system and different modes of operation. Theoretical models show that 98 watts, should only result in a 5 deg C temperature rise, via combination of the radiation and convection. A test was made in which a 75 W lamp and a 20 W fan were placed in an antenna box resulted in a 10 deg C temperature rise. This test was made before applying goldstone paint that increases the IR emittance. A test of placing the antenna box in the Sun resulted in a rapid rise of the 10 deg C. More tests are underway to ensure that thermal control, at least under conditions at night in Oregon. Operation during day may require circulating air through the antenna box via plastic pipe to heat exchange box in the under the antenna or a control hut as in EDGES-2. For initial operations in Oregon the wires for charging the batteries shown in the circuit of Figure 2 will only be connected via the lower box in Figure 12 during periods when the spectrometer or VNA are not running so any RFI from the charging source or cable is avoided.

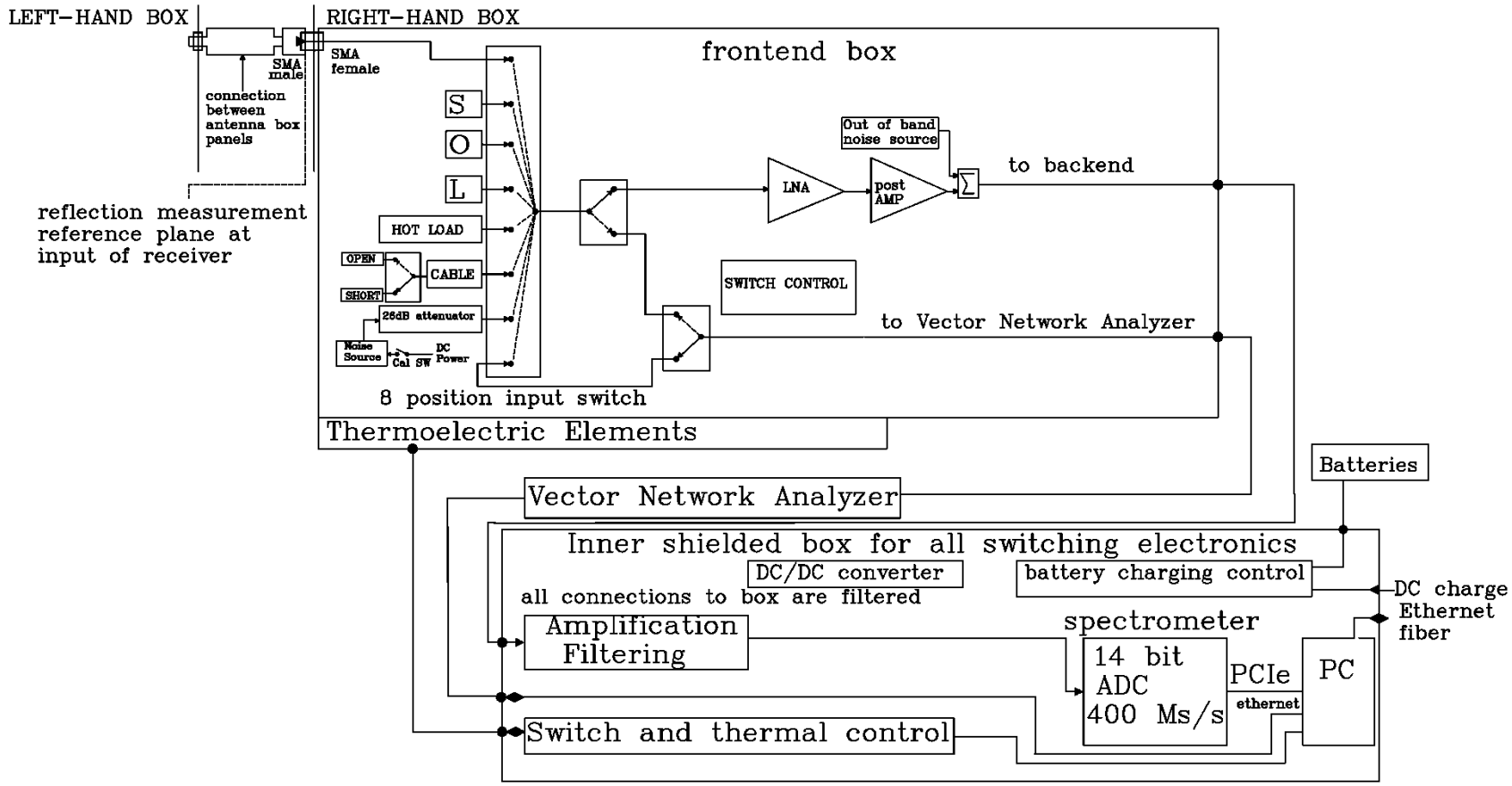


Figure 1a. Block diagram of EDGES-3.

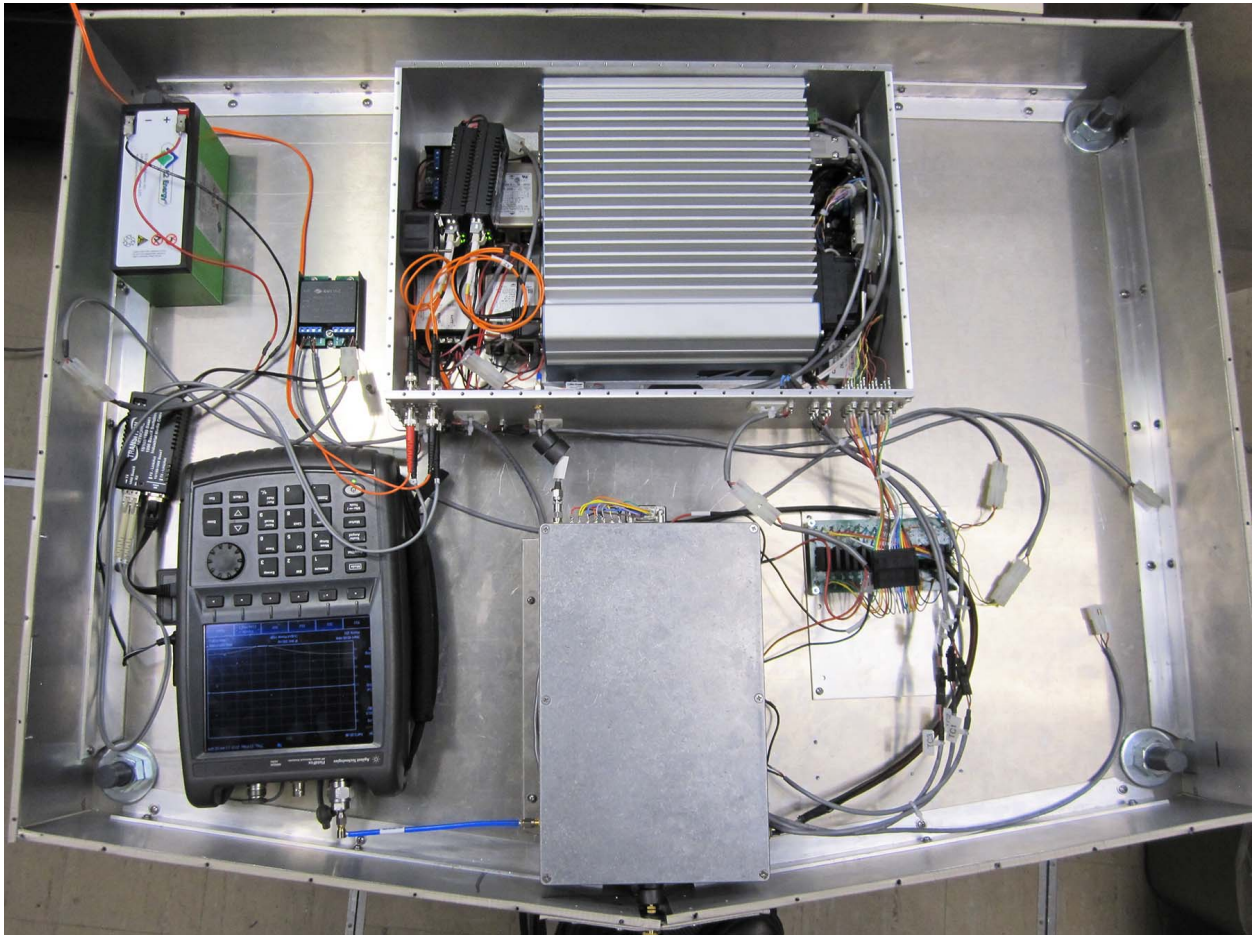


Figure 1b. Electronics with inner box cover removed.

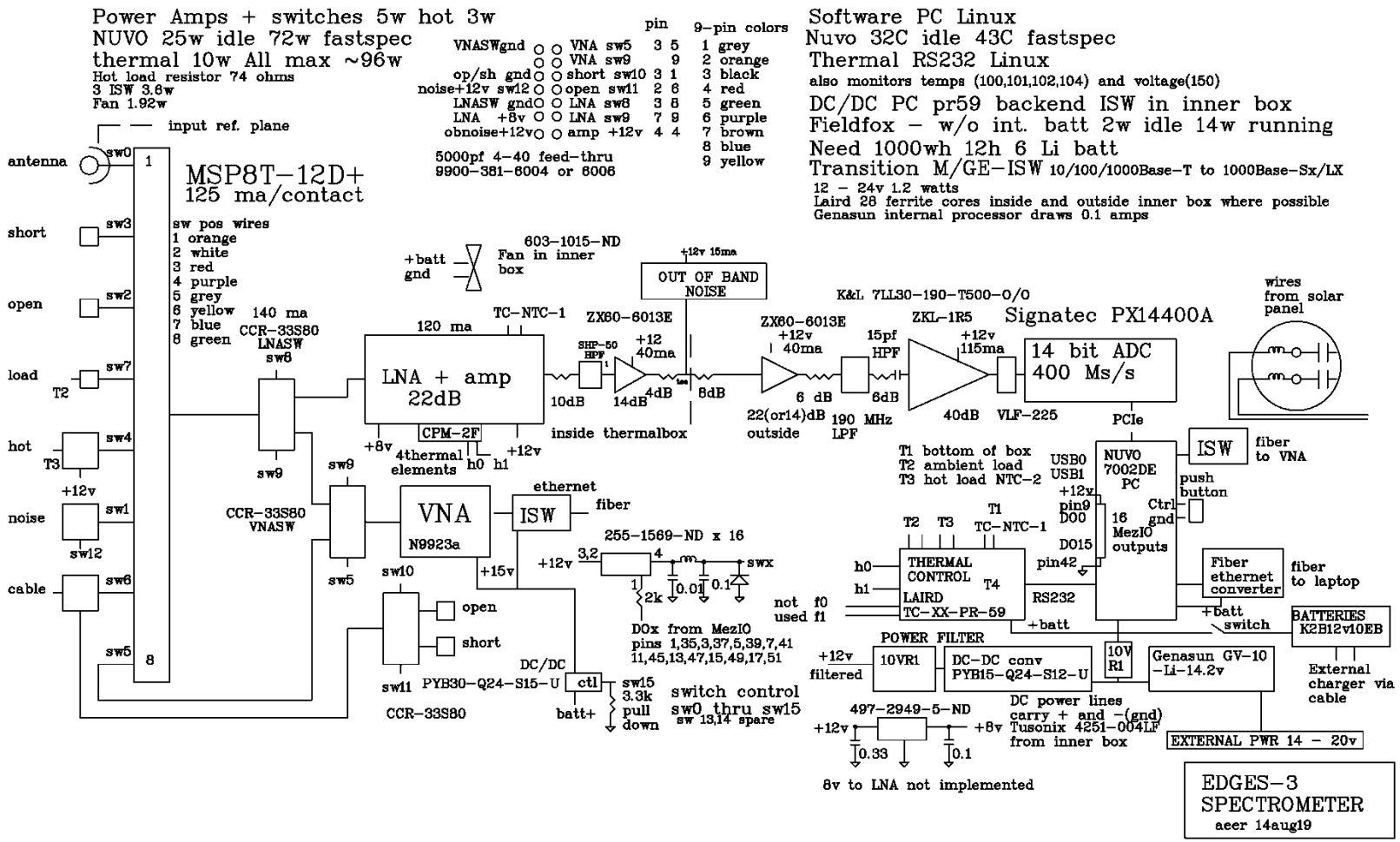


Figure 2. Overall circuit diagram

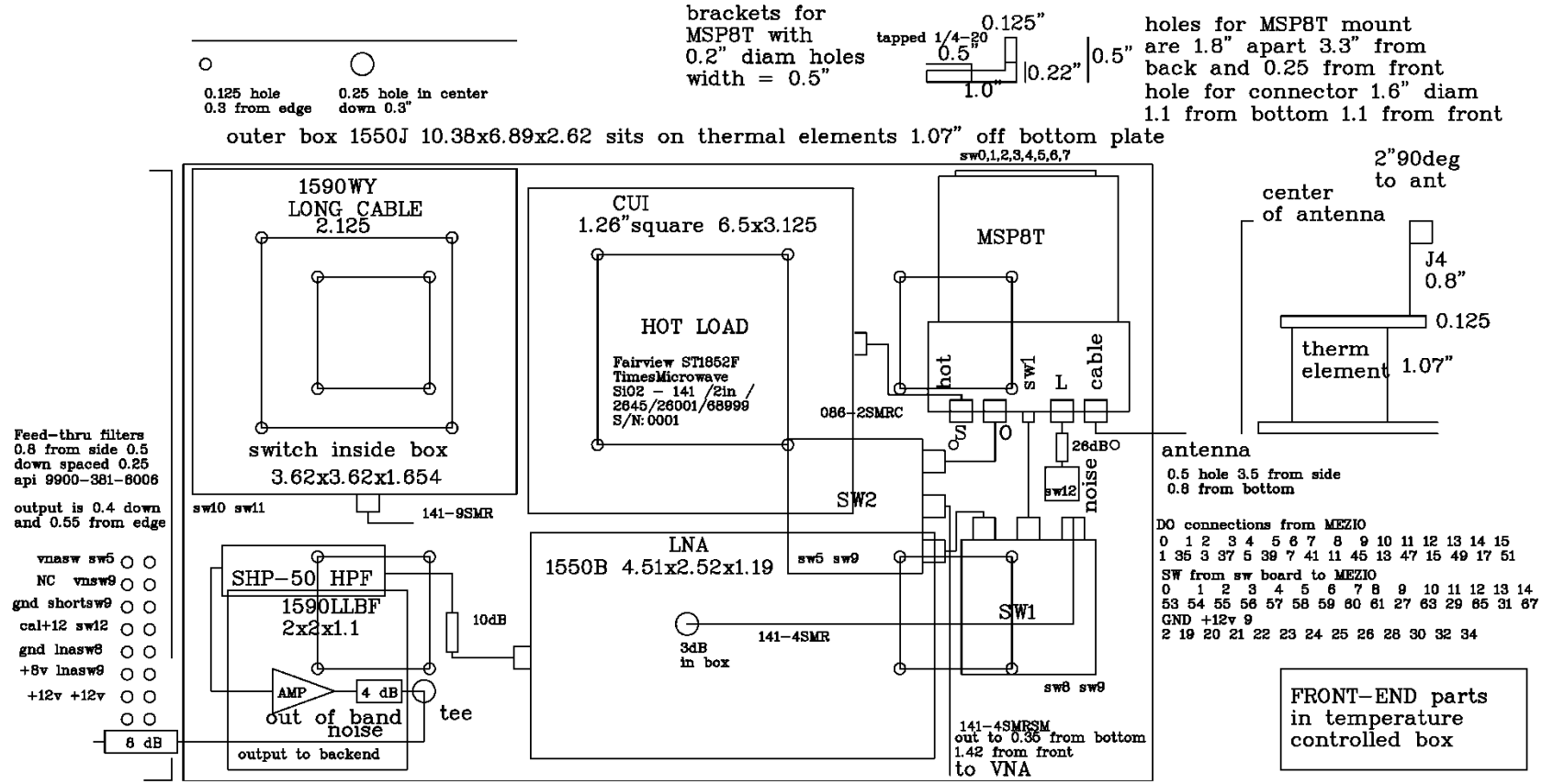


Figure 3. Frontend box layout.

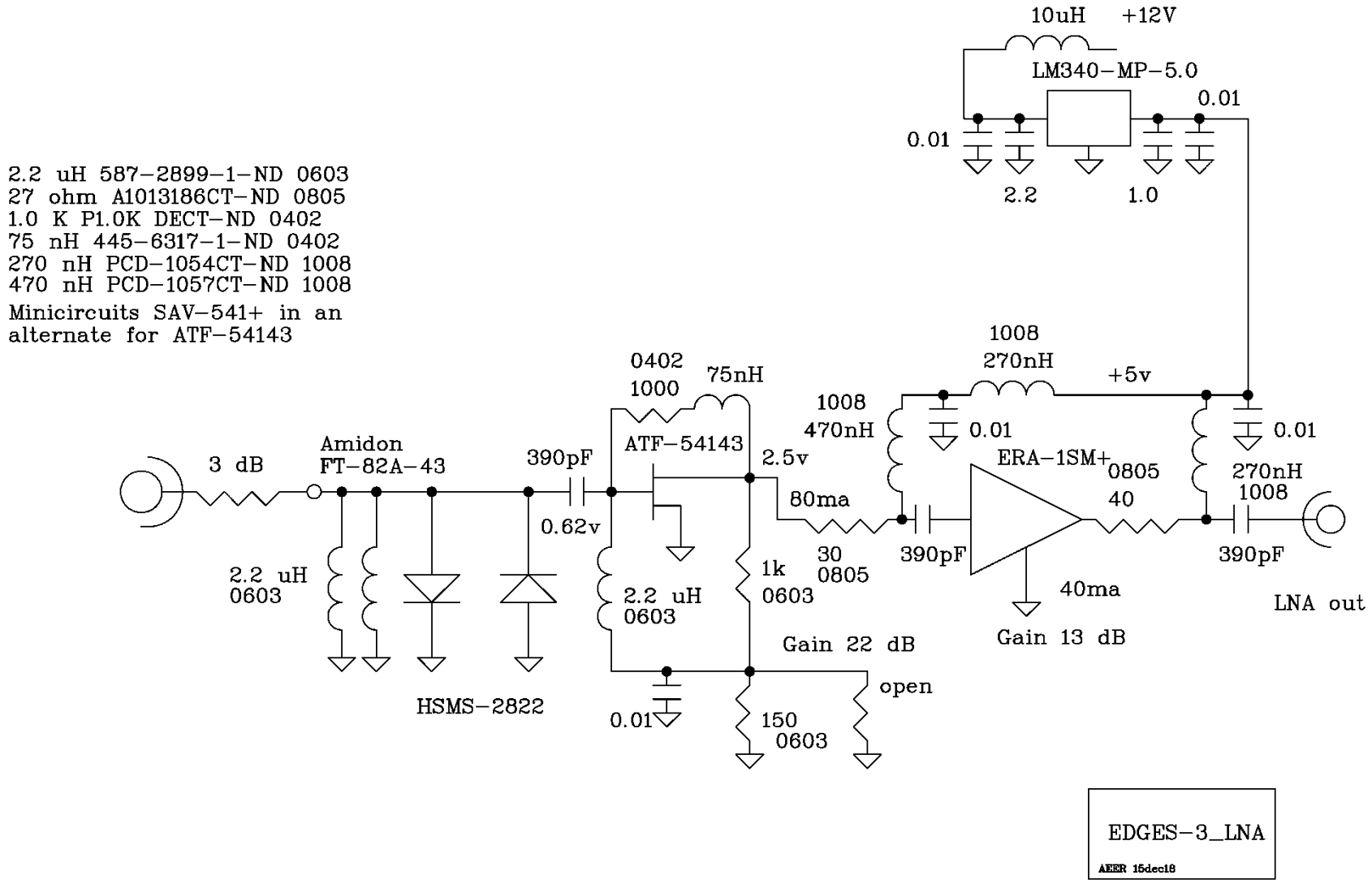


Figure 4. LNA Circuit

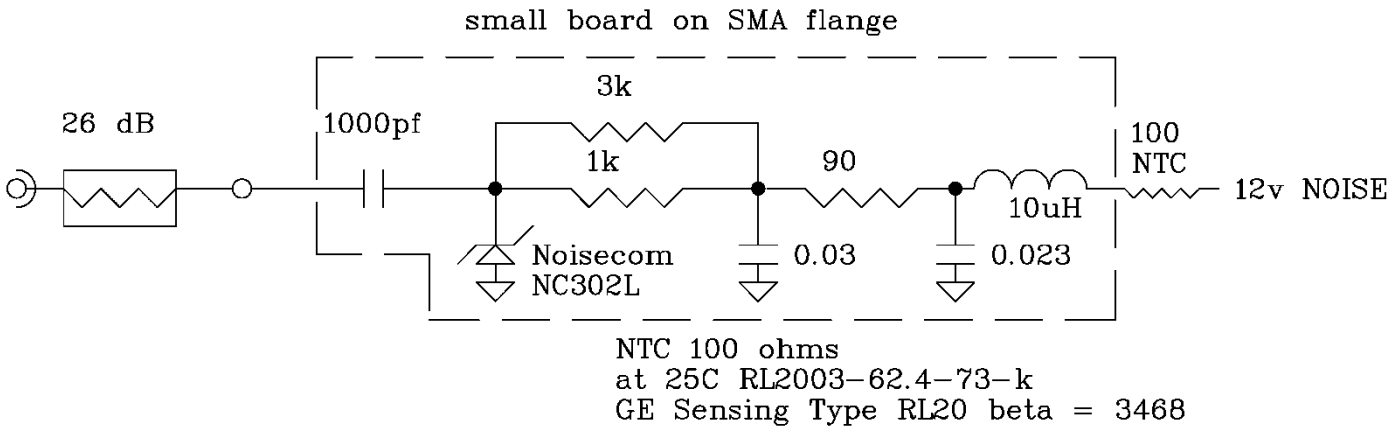


Figure 5. Noise source

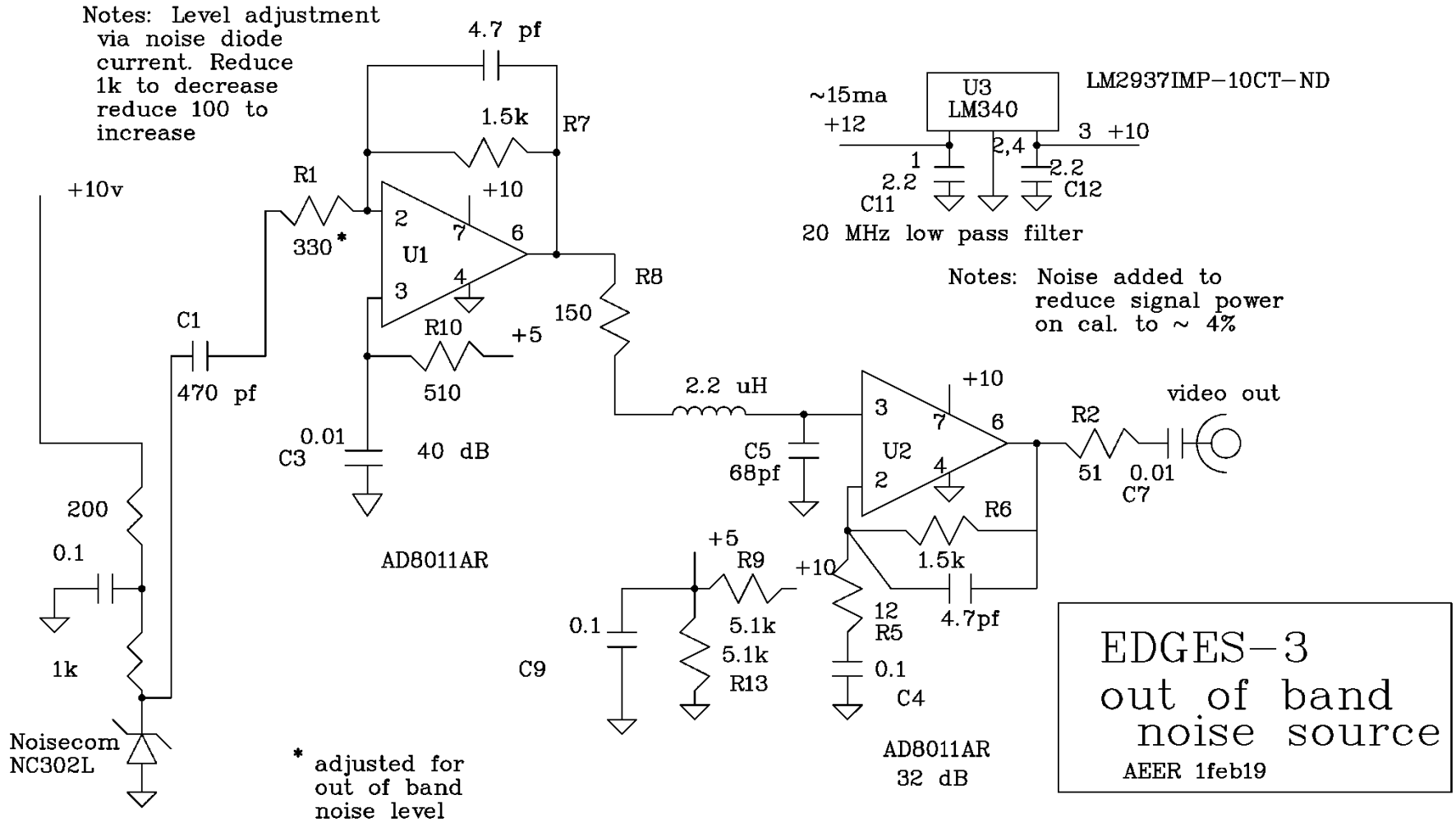


Figure 6. Out of band noise source.

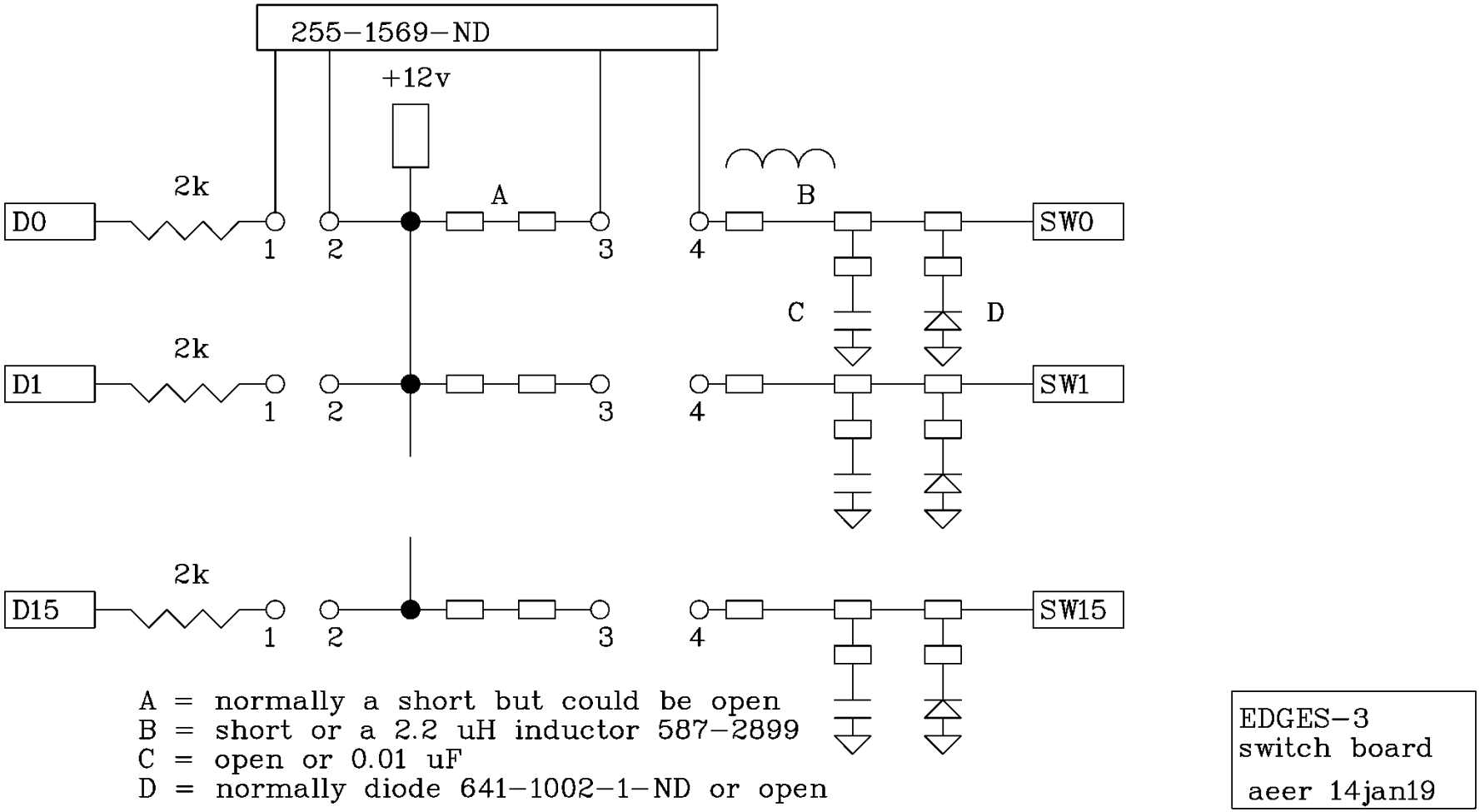


Figure 7. Switch board circuit

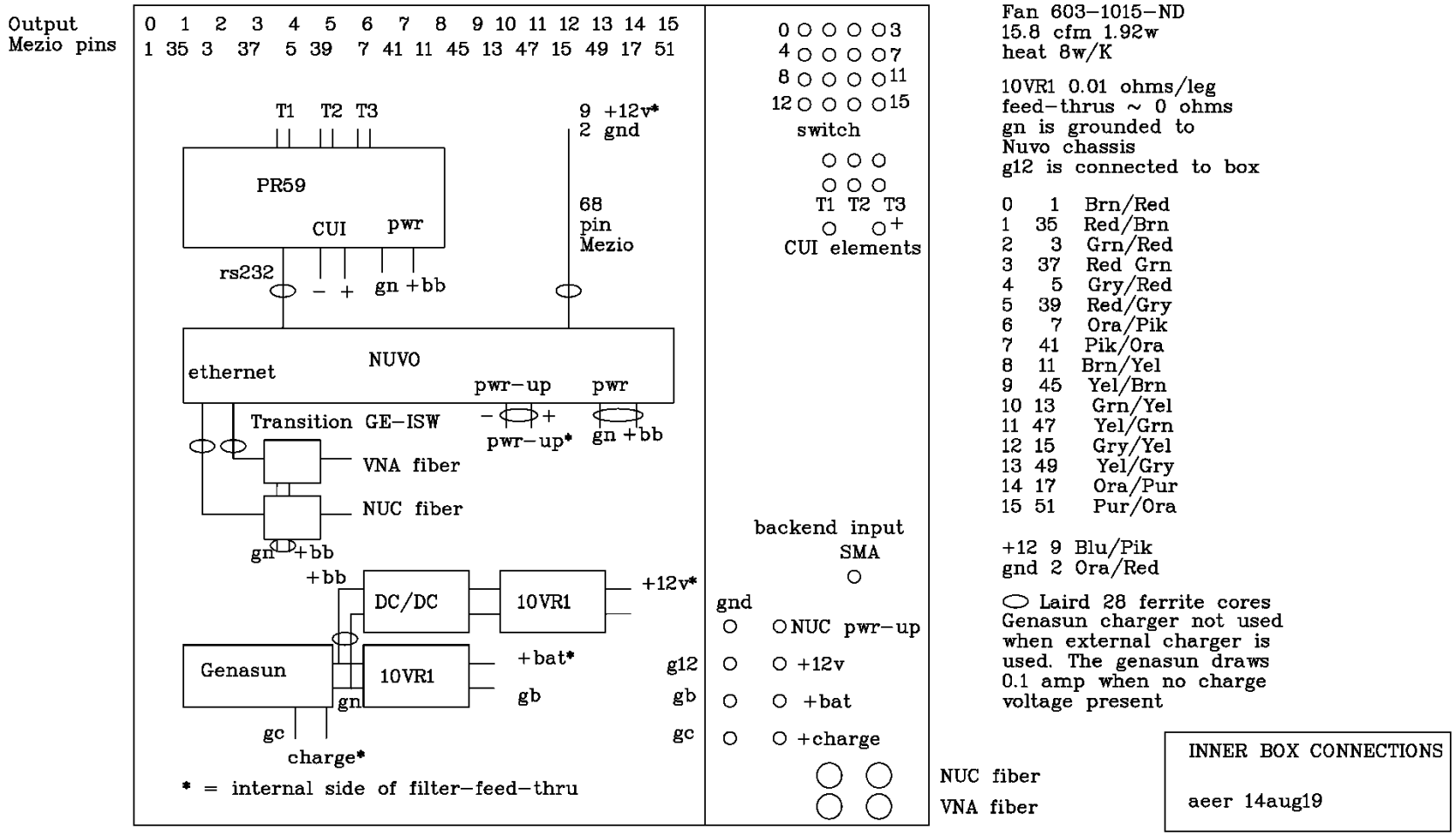


Figure 8. Circuit of electronics in inner box

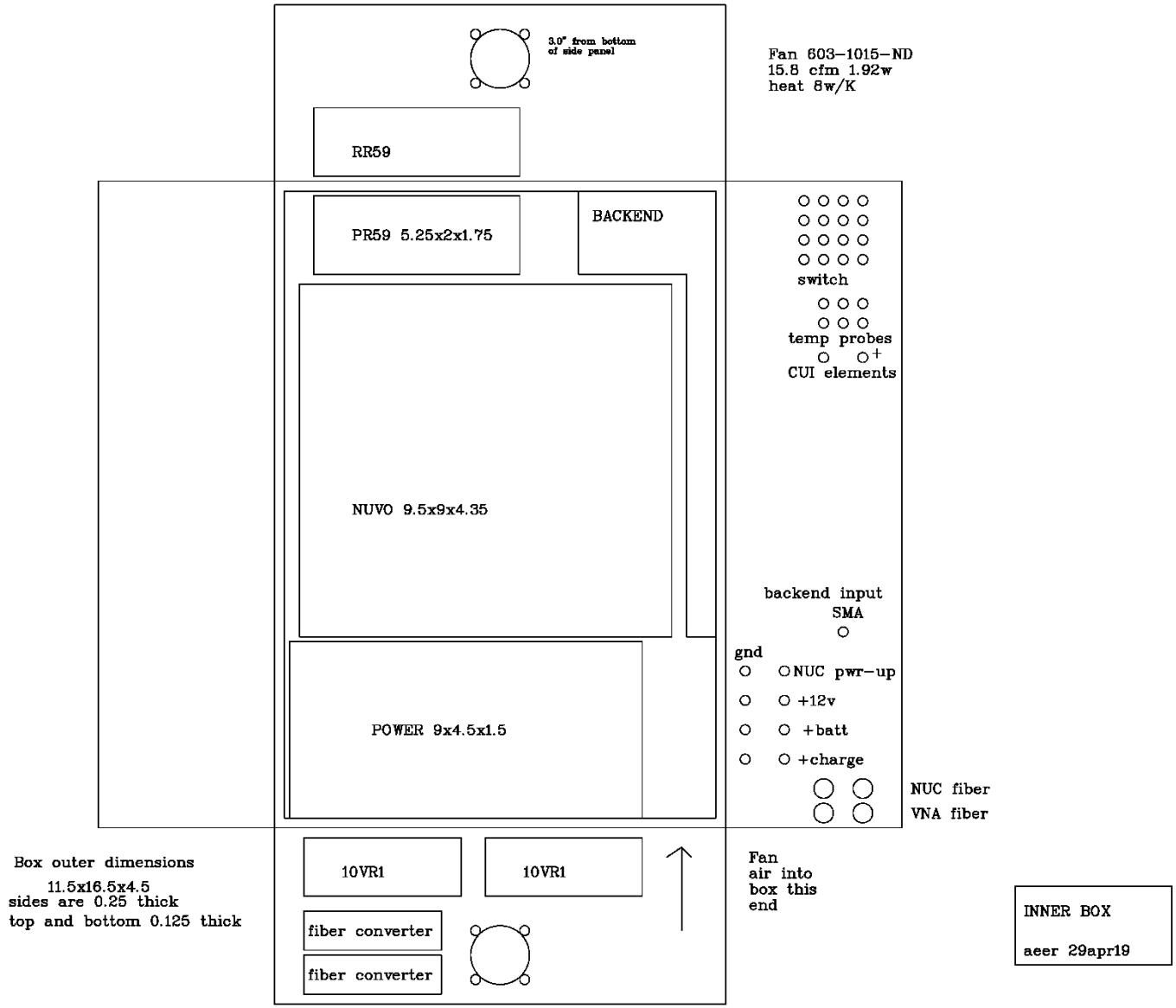


Figure 9. Inner box layout

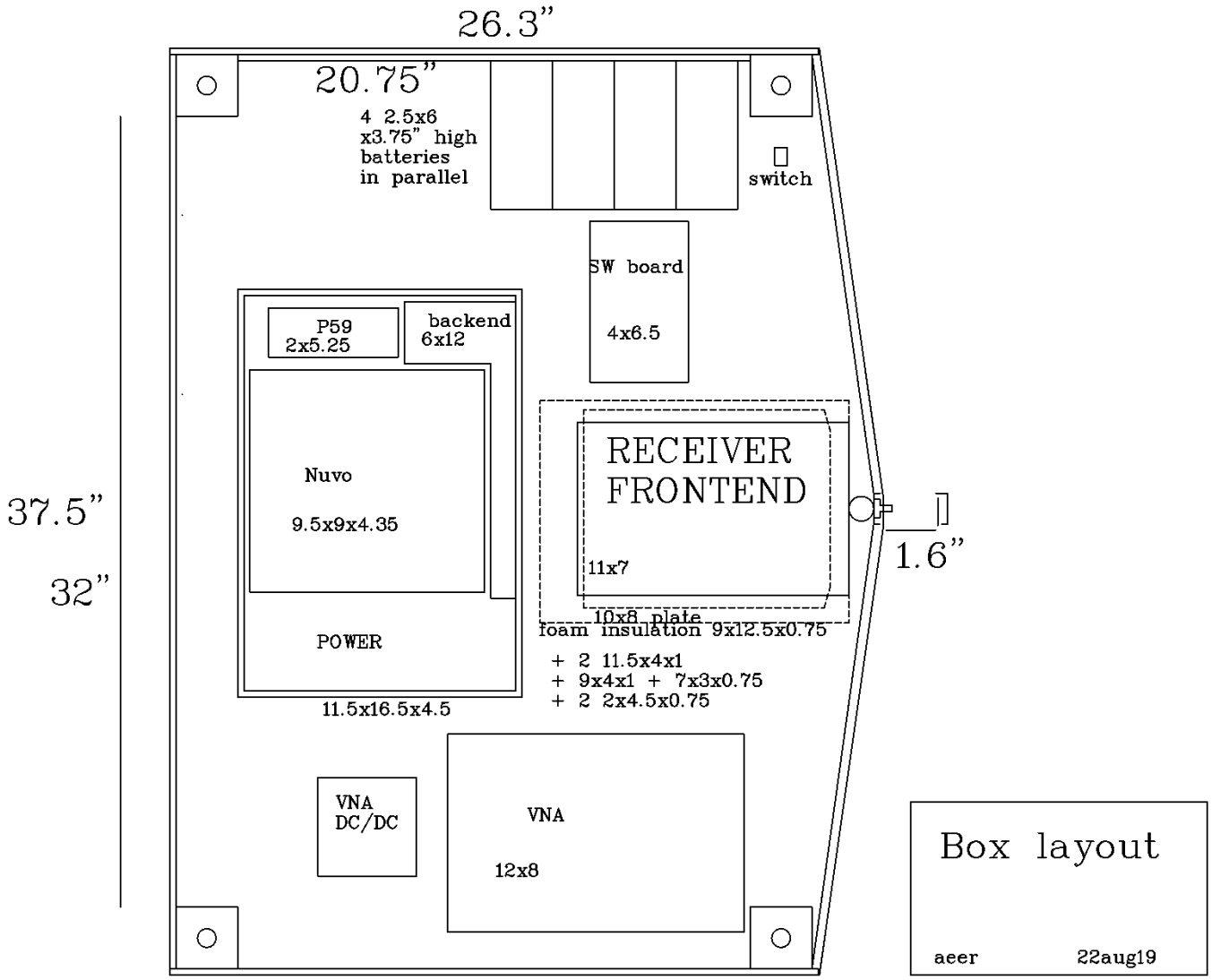


Figure 10. Outer box layout

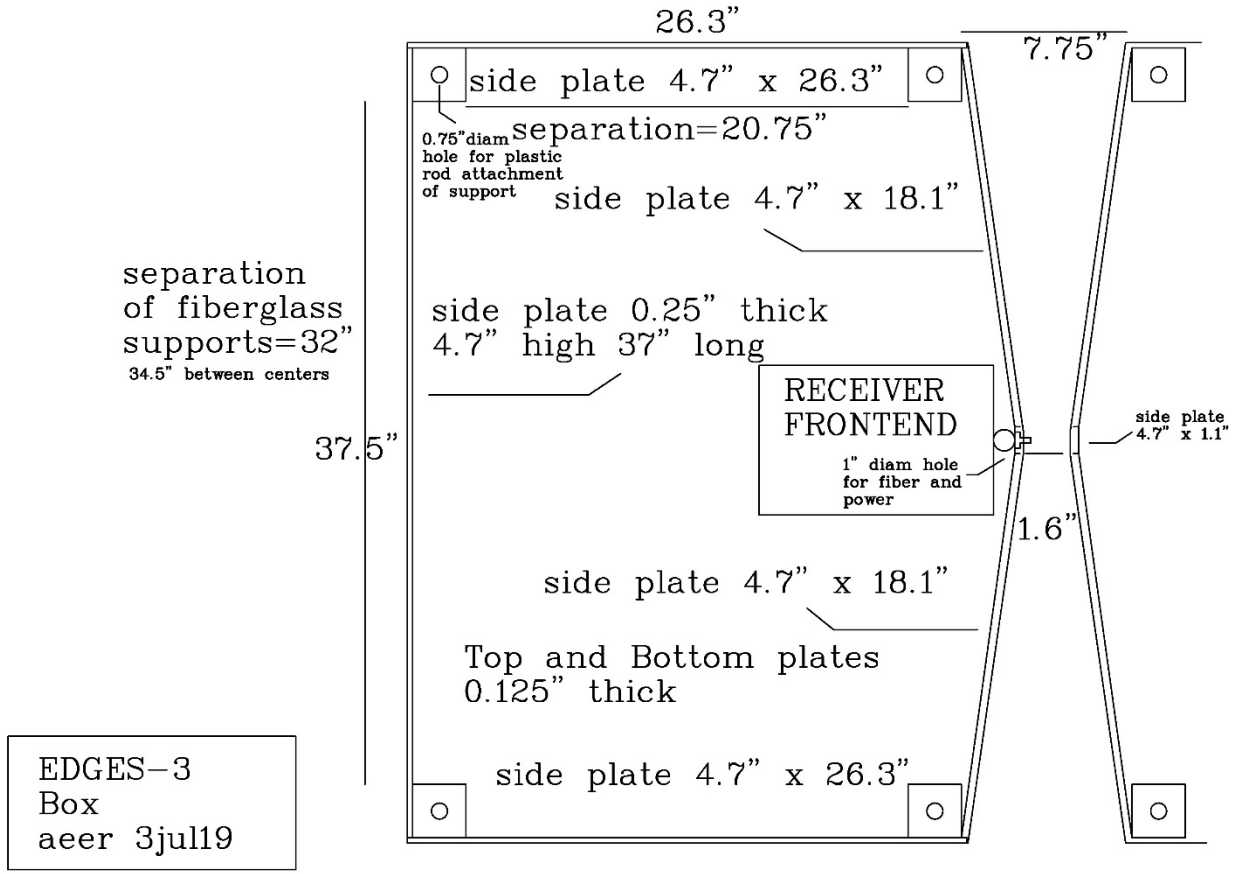


Figure 11. Outer box dimensions.

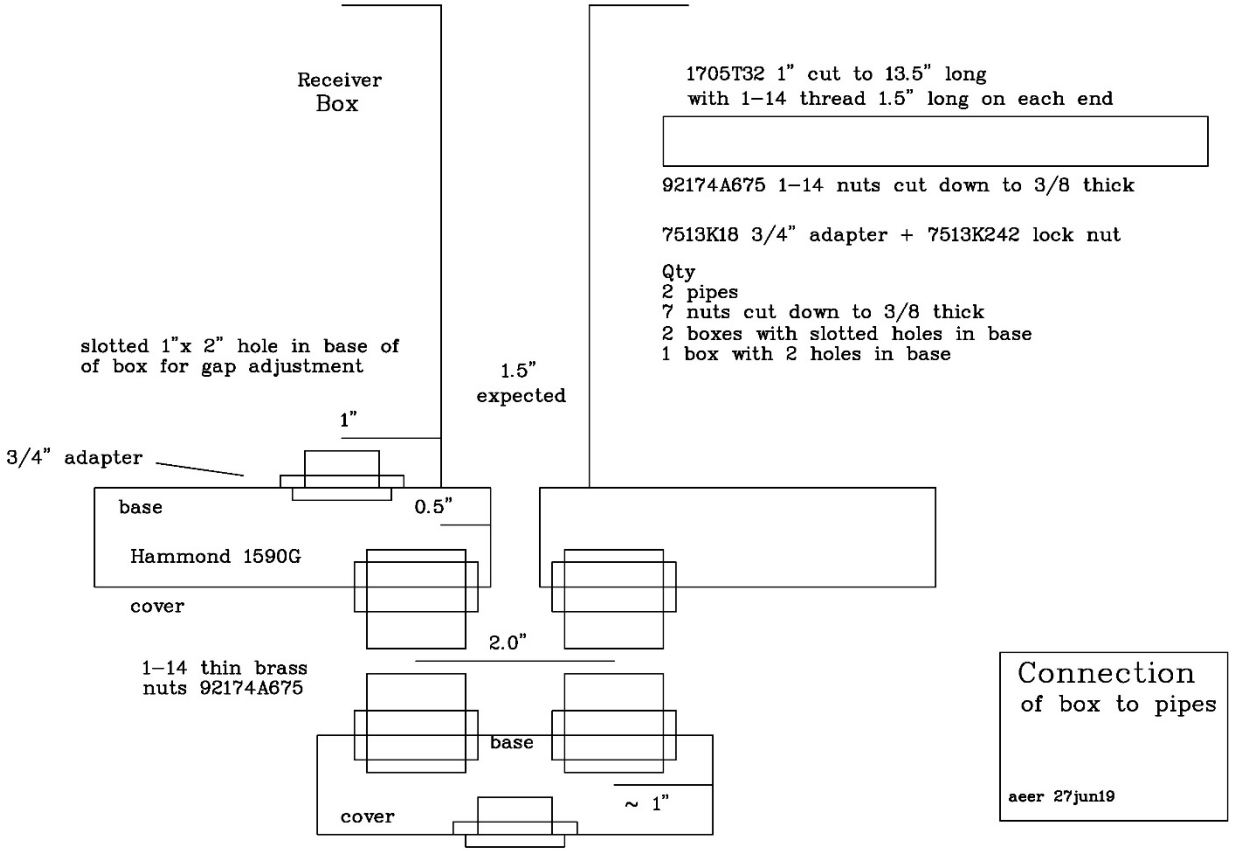


Figure 12. Connections between antenna boxes.

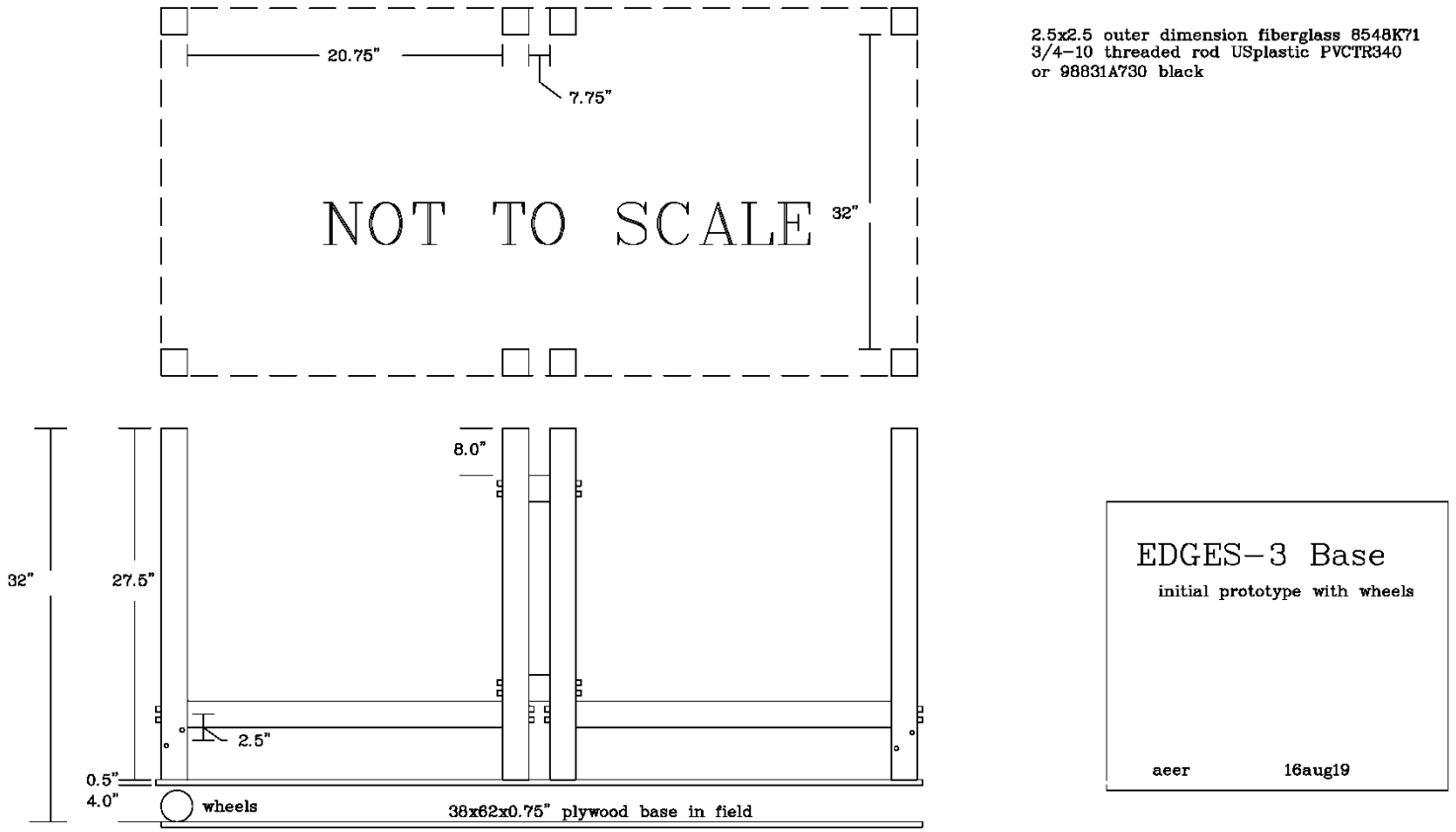


Figure 13. Antenna base.

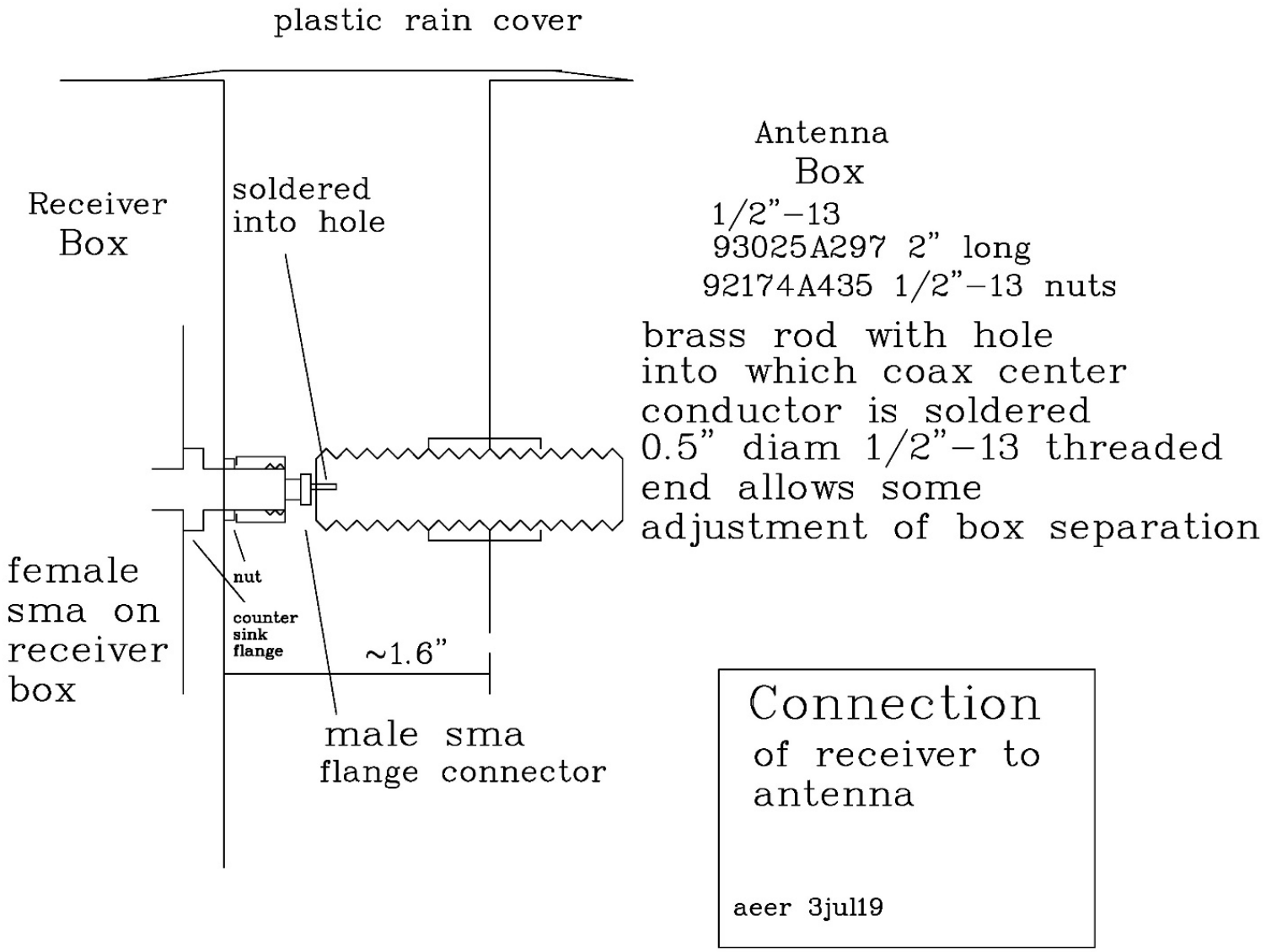

plastic rain cover
Receiver Box
soldered into hole
Antenna Box
1/2"–13
93025A297 2" long
92174A435 1/2"–13 nuts
brass rod with hole into which coax center conductor is soldered
0.5" diam 1/2"–13 threaded end allows some adjustment of box separation
female sma on receiver box
nut
counter sink flange
~1.6"
male sma flange connector
Connection of receiver to antenna
aeer 3jul19

Figure 14.

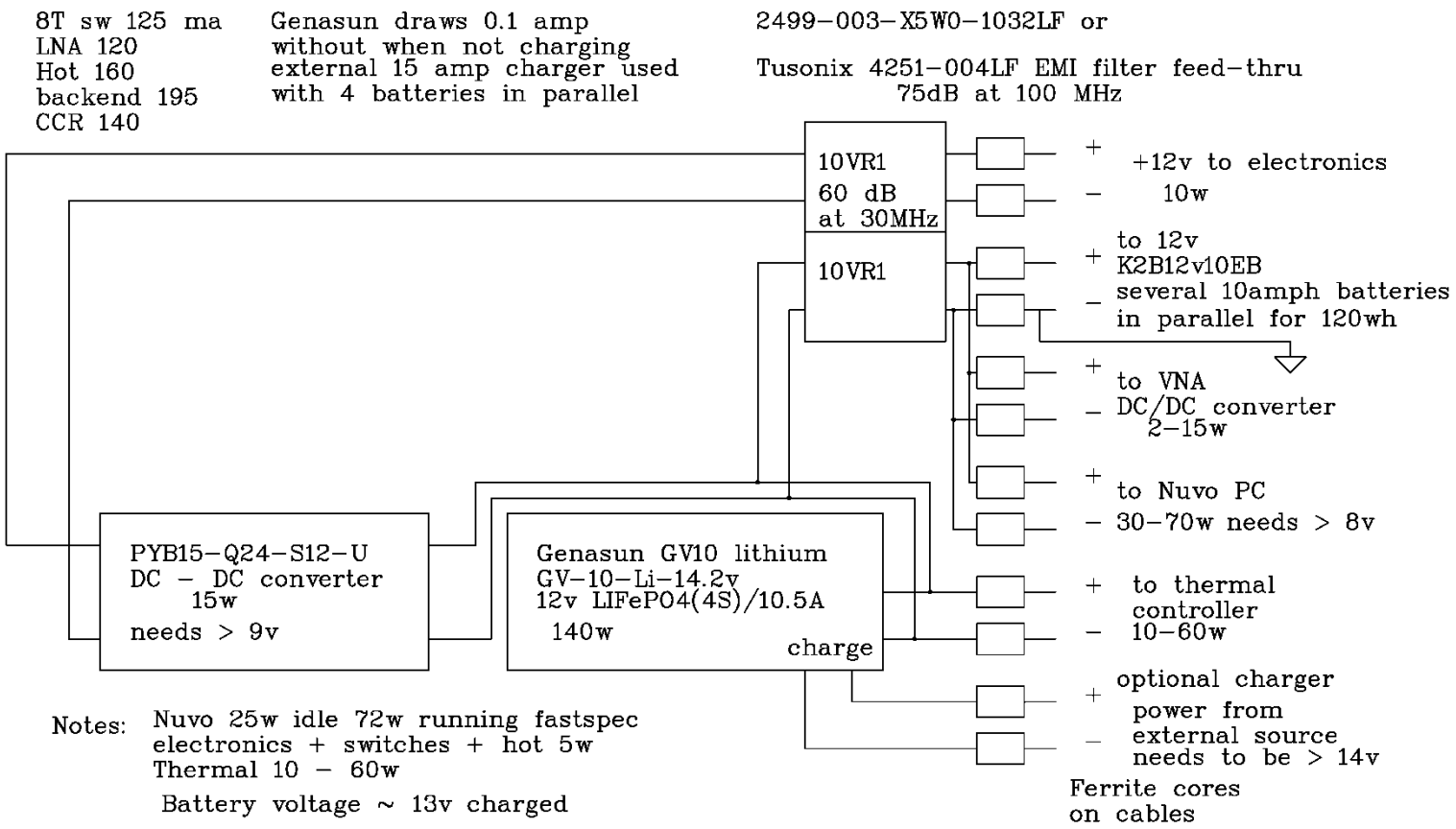
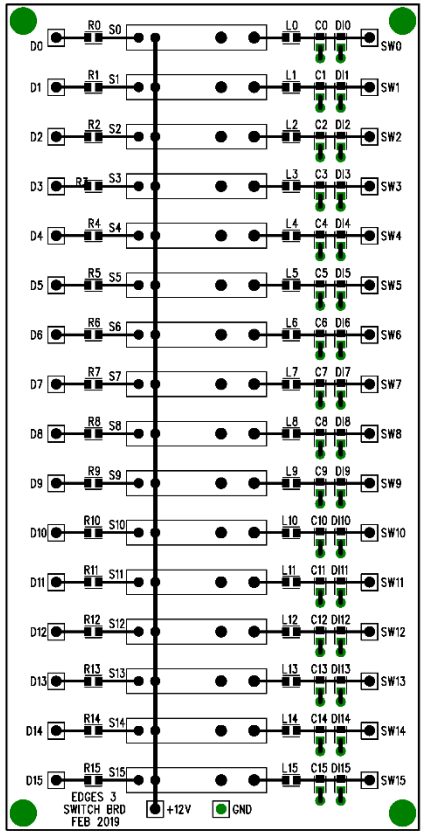

8T sw 125 ma
LNA 120
Hot 160
backend 195
CCR 140
Genasun draws 0.1 amp
without when not charging
external 15 amp charger used
with 4 batteries in parallel
2499-003-X5W0-1032LF or
Tusonix 4251-004LF EMI filter feed-thru
75dB at 100 MHz
10VR1
60 dB
at 30MHz
10VR1
+
+12v to electronics
-
10w
+
to 12v
K2B12v10EB
-
several 10amph batteries
in parallel for 120wh
+
to VNA
-
DC/DC converter
2-15w
+
to Nuvo PC
-
30-70w needs > 8v
PYB15-Q24-S12-U
DC - DC converter
15w
needs > 9v
Genasun GV10 lithium
GV-10-Li-14.2v
12v LIFePO4(4S)/10.5A
140w
charge
+
to thermal
controller
-
10-60w
+
optional charger
power from
-
external source
needs to be > 14v
Ferrite cores
on cables
Notes:
Nuvo 25w idle 72w running fastspec
electronics + switches + hot 5w
Thermal 10 - 60w
Battery voltage ~ 13v charged
EDGES-3
power system
aeer 14aug19

Figure 15. Power system connections.



EDGES 3 SWITCH BOARD

SILKSCREEN

Figure 16.

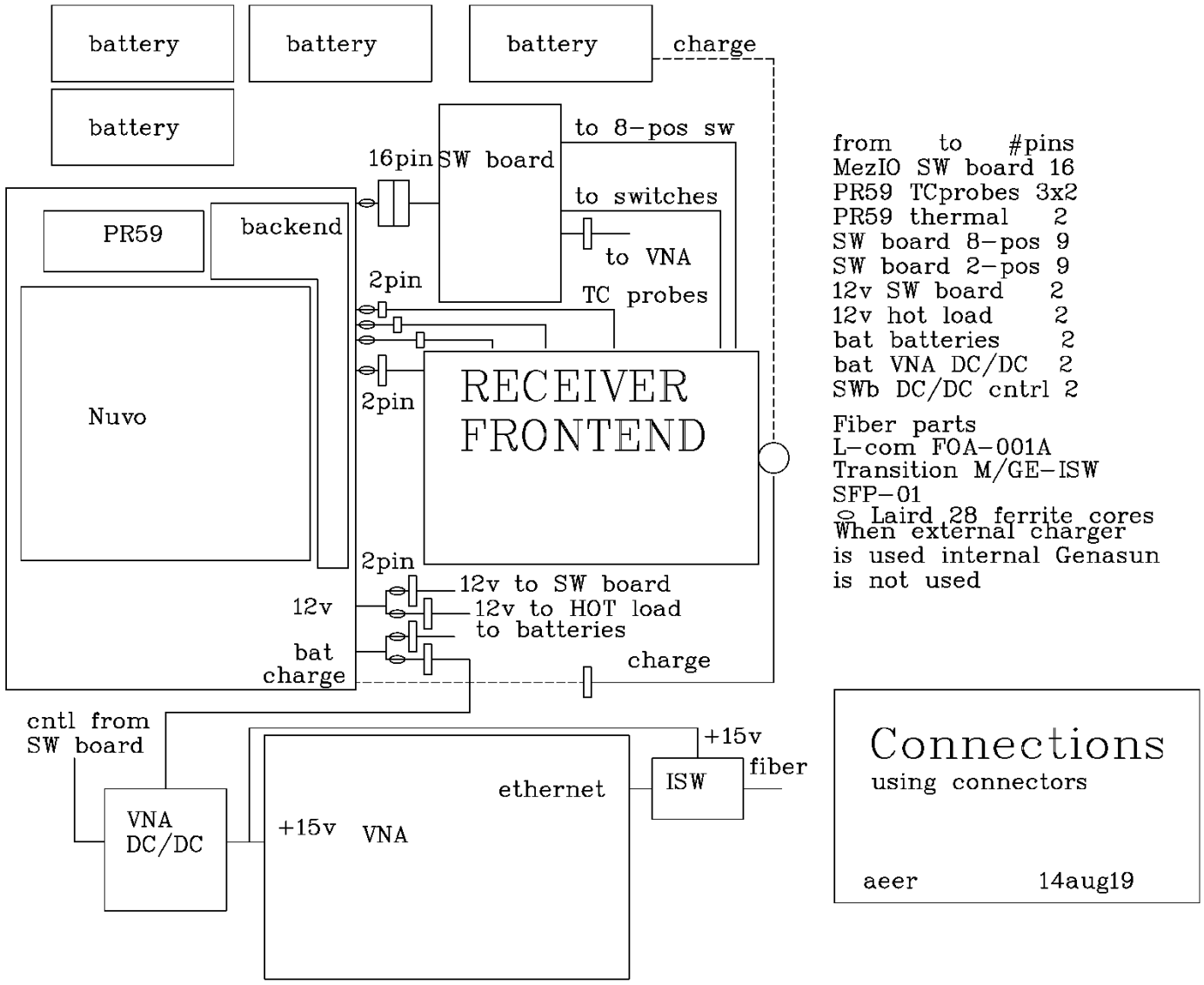

battery
battery
battery
charge
battery
to 8-pos sw
16pin
SW board
to switches
PR59
backend
to VNA
2pin
TC probes
Nuvo
RECEIVER
FRONTEND
2pin
2pin
12v to SW board
12v
12v to HOT load
to batteries
bat
charge
charge
cntl from
SW board
+15v
fiber
ethernet
ISW
VNA
DC/DC
+15v
VNA
from to #pins
MezIO SW board 16
PR59 TCprobes 3x2
PR59 thermal 2
SW board 8-pos 9
SW board 2-pos 9
12v SW board 2
12v hot load 2
bat batteries 2
bat VNA DC/DC 2
SWb DC/DC cntrl 2
Fiber parts
L-com FOA-001A
Transition M/GE-ISW
SFP-01
Laird 28 ferrite cores
When external charger
is used internal Genasun
is not used
Connections
using connectors
aeer
14aug19

Figure 17. Connections using connectors

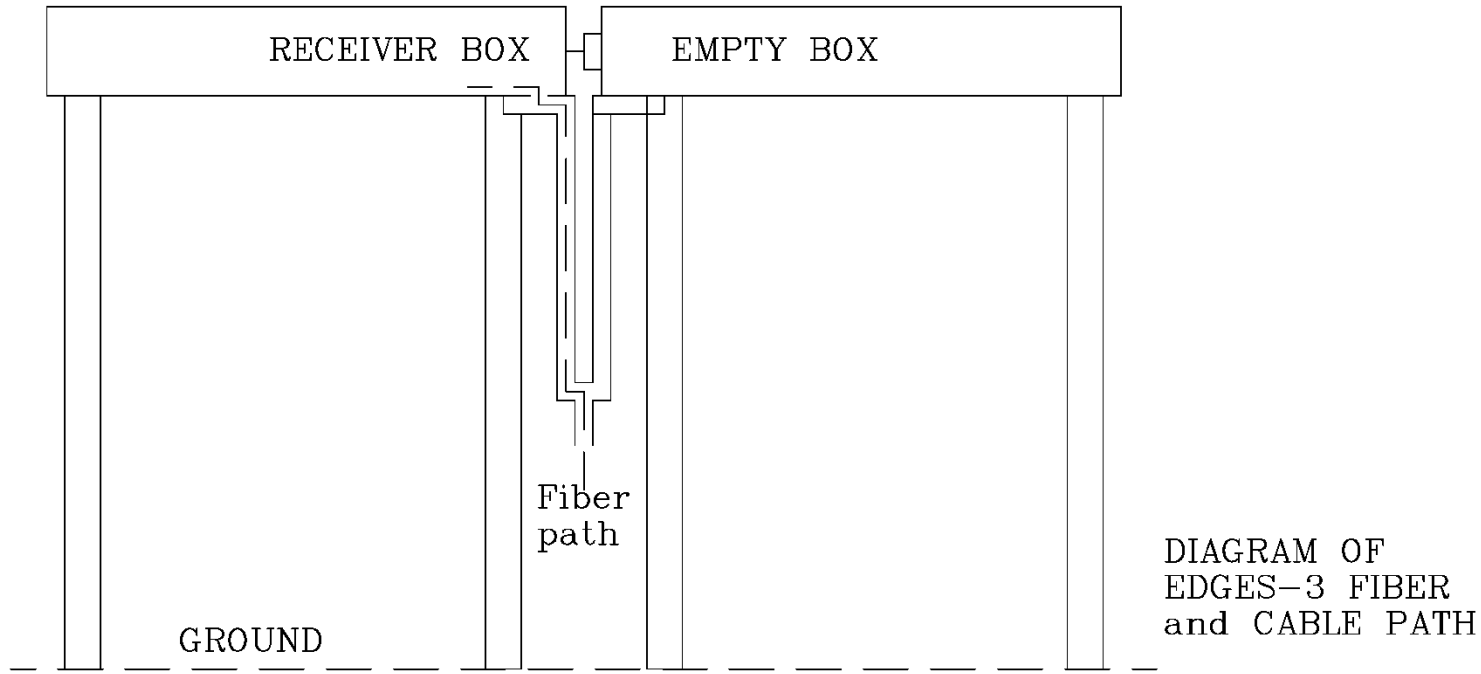


Figure 18.

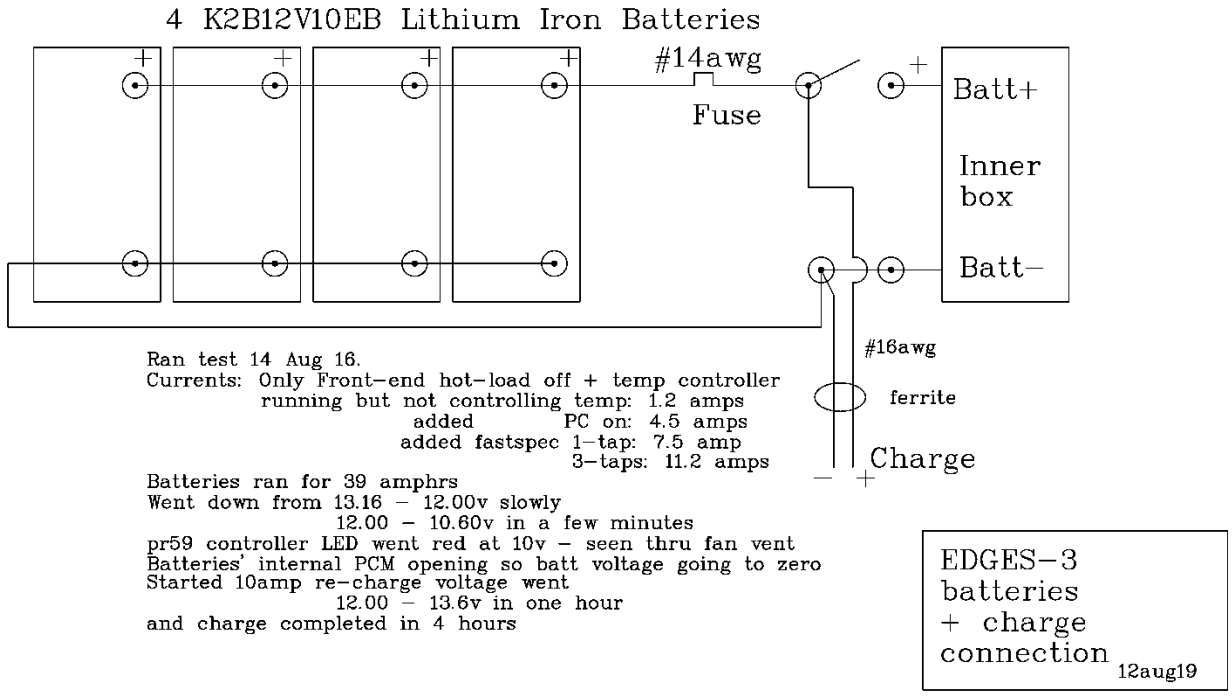


Figure 19. Battery charging.

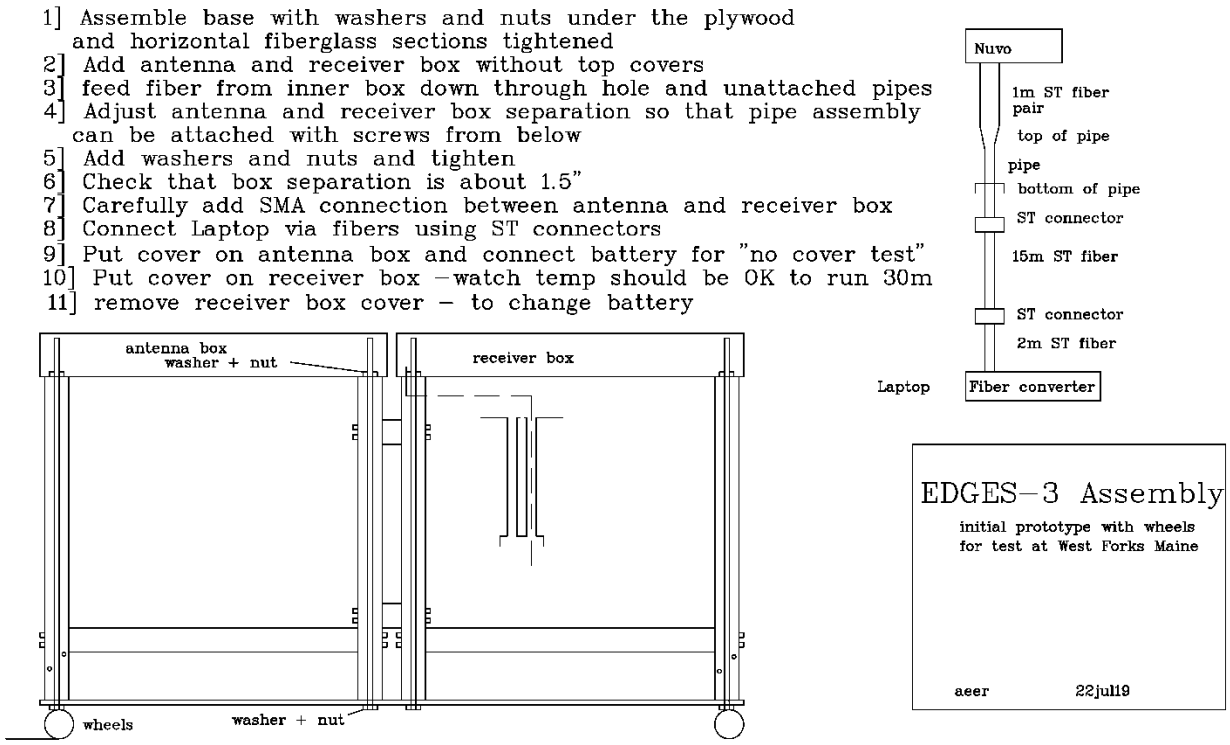


Figure 20. Assembly instructions.