

The 4th Swedish EME
meeting
Örebro 2015



ONoEME MOONBEACON:

3 Years of "non stop"
operation

The 4th Swedish EME
meeting
Örebro 2015



<http://www.onoeme.org>

ON4BCB

Walter Crauwels



ON7UN

Eddy Jaspers



INTRODUCTION:

- What or who is ONoEME 1296mhz EME beacon
- What “went OK”
- What “went wrong”

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INTRODUCTION:

The idea:

- After a meeting in Sweden April 2011



INTRODUCTION:

The idea:

- After a meeting in Sweden April 2011
- A possible way to improve activity
- Challenge to build an automatic station
- A standard in frequency, amplitude and timing

DESIGN CRITERIA:

- Using VK3UM simulation software we came to the conclusion that we need :
 - a 3,7m diameter solid dish
 - a good constructed feedhorn
 - a transmit power of 400 watt or more
- Should give an audible loudspeaker copy on a 2,4m dish with reasonable LNA

DESIGN CRITERIA:

- We want to be accurate in frequency so need to ref. Lock the LO to a GPSDO
- The beacon must start transmitting at the start of each minute.
- The beacon should have a very stable output power, so the beacon can be used to check moon reflection conditions
- The antenna must track the moon accurately
- We need to have a monitoring and control system



LOCATION:

- We need to find a location with good moon window at both low and high declinations
- The location need to be safe
- The air cooling will make some noise
- An industrial area is preferred where we have less zoning issues and where some noise would be no problem.

LICENSE:

- We applied the Belgian authorities for a license for a high power unmanned station
- The frequency needs to be “in band”, preferred 1296.000 Mhz (reference frequency)
- After 3 months we received our license

LICENSE:



KONINKRIJK BELGIE

BIPT

Het BIPT verleent volgens de voorwaarden van de wet van 30 juli 1979, het Koninklijk Besluit van 15 oktober 1979 en het Ministerieel Besluit van 9 januari 2001, alsook volgens de hierna vermeldde voorwaarden, de toestemming om volgend automatisch station te installeren en te laten werken zonder personeel.

Club: UBA

Rue de la Presse, 4
1000 Brusselles

Station: ONOEME

VerGUNNINGnummer: 60002353

Coördinaten: 4 ° 48 ' 45 " E
51 ° 15 ' 4 " N

Opstellingsplaats: Achterstenhoek, 32
2275 Lille

Hoogte boven zeeniveau (m): 16

F: Toegestane zendfrequentie (MHz)
P: Maximaal toegestaan vermogen aan de uitgang van de versterker (W)
G: Antennewinat (dB)
H: Antennehoogte boven de grond (centraal punt, m)

F:	Type:	P:	G:	H:	Verbinding met...:
1296.000	EME BEACOM	200	30	4	

Technisch verantwoordelijke:

ONTUN
JESPERS Eddy
Zanddijk 67
2480 Dessel
014737.22.97

Vervangend verantwoordelijke:

ON4BCB
CRAUWELS Walter
Waversesteenweg 210
2500 Lier
03/488.34.81 047728 11 71



Opmerking:

- Toelating Internet. - De zender mag enkel werken bij antenne-elevatie dan 14 graden. - Maximale breedte (-3dB) is 500 Hz.

Opgemaakt te Brussel, 3/11/2011

In naam van de Voorzitter van de Raad van het BIPT,
de bevoegde ambtenaar,

Philippe Appeldoorn
Eerste Ingenieur-Adviseur

Elipse Building Gebouw C

Belgisch Instituut voor postdiensten en telecommunicatie

Koning Albert II-steen 35 1030 Brussel Tel.: 02-226 88 88 Fax: 02-226 88 77
<http://www.bipt.be>

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ANTENNA:

- a German made antenna from RFS with a very heavy fixed AZ-EL mount was available



ANTENNA:

- A conical bearing was made on the top part



ANTENNA:

- All parts get together



ANTENNA:

- A very heavy duty gearbox on top of the mount to turn the upper part against the fixed mount



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EME BEACON

ANTENNA:

- To guide the heavy top, a construction with 6 wheels where added



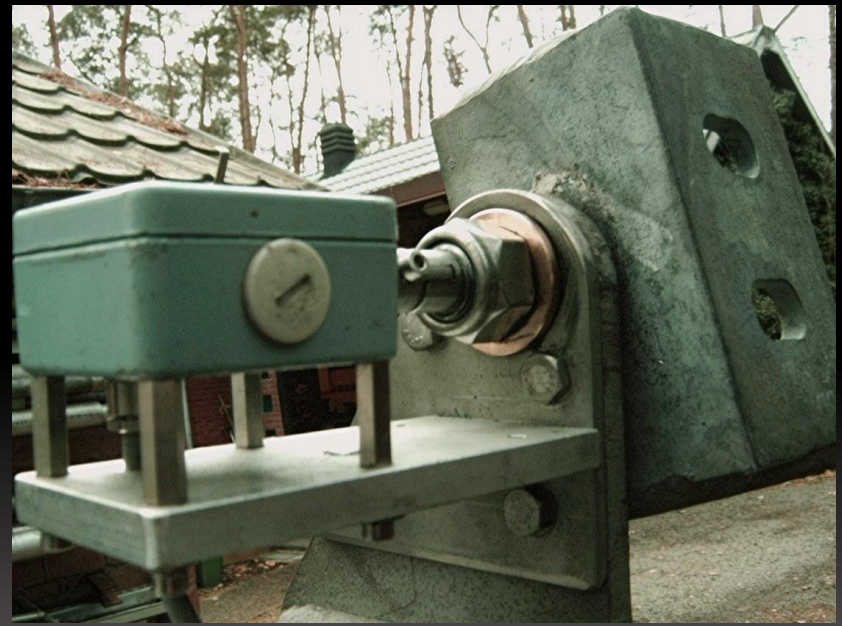
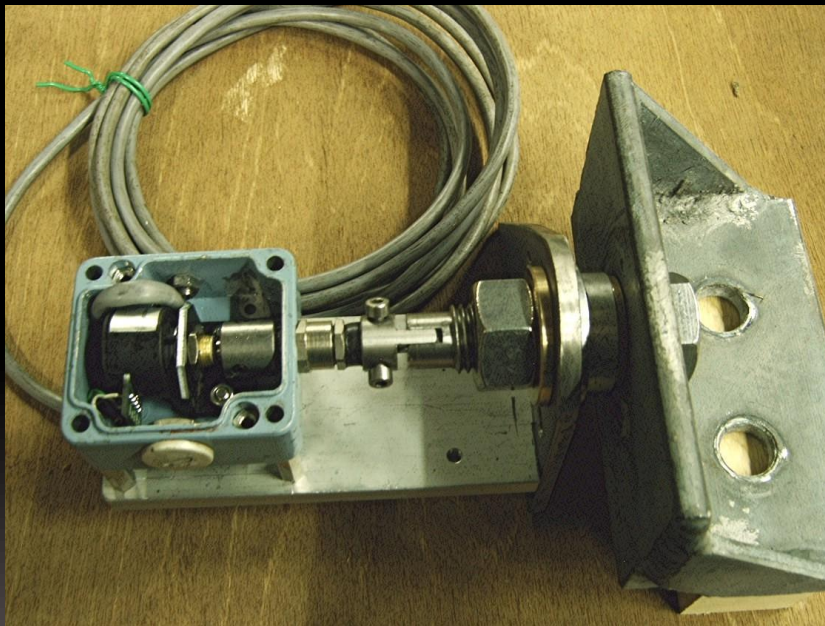
ANTENNA:

- A very heavy duty ball screw stainless steel 50" actuator was used for elevation



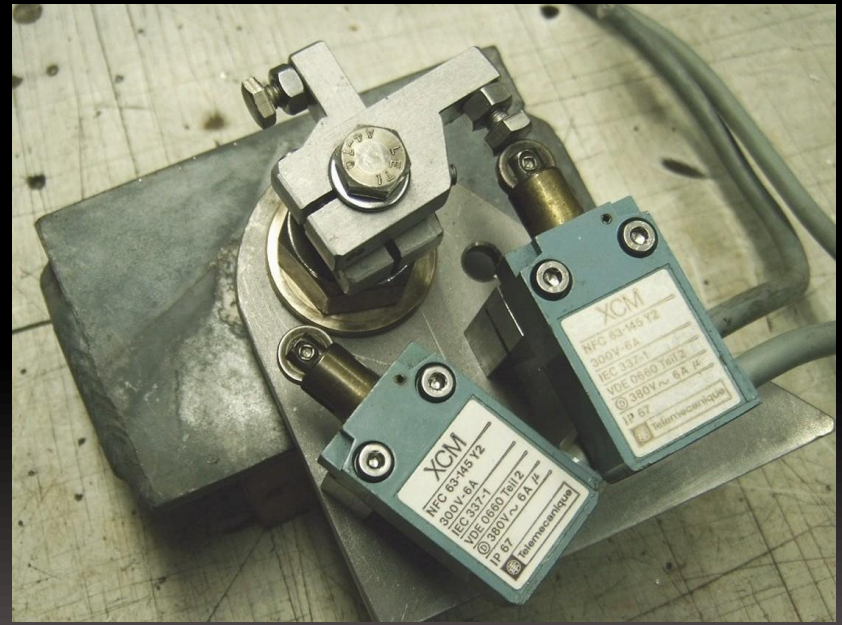
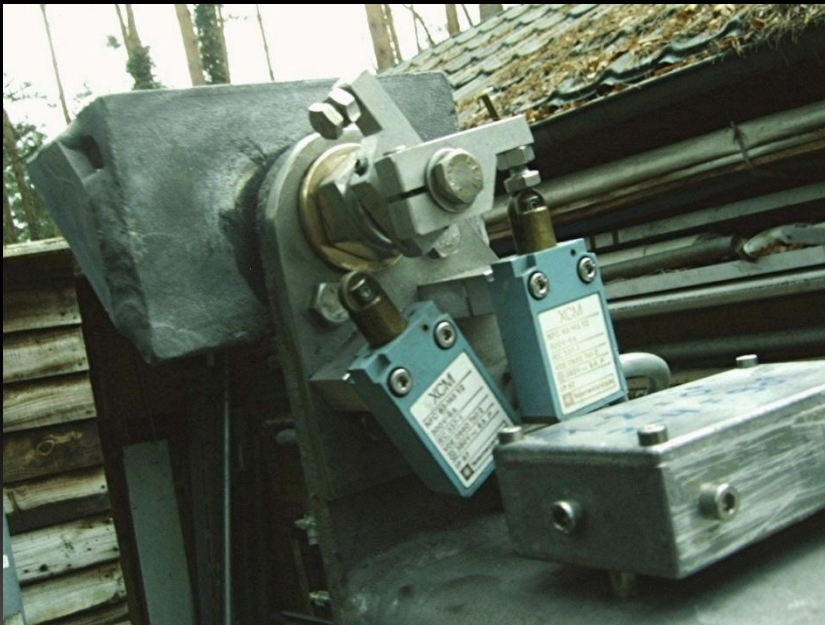
ANTENNA:

- Fixing of the elevation encoder



ANTENNA:

- The elevation limit switches



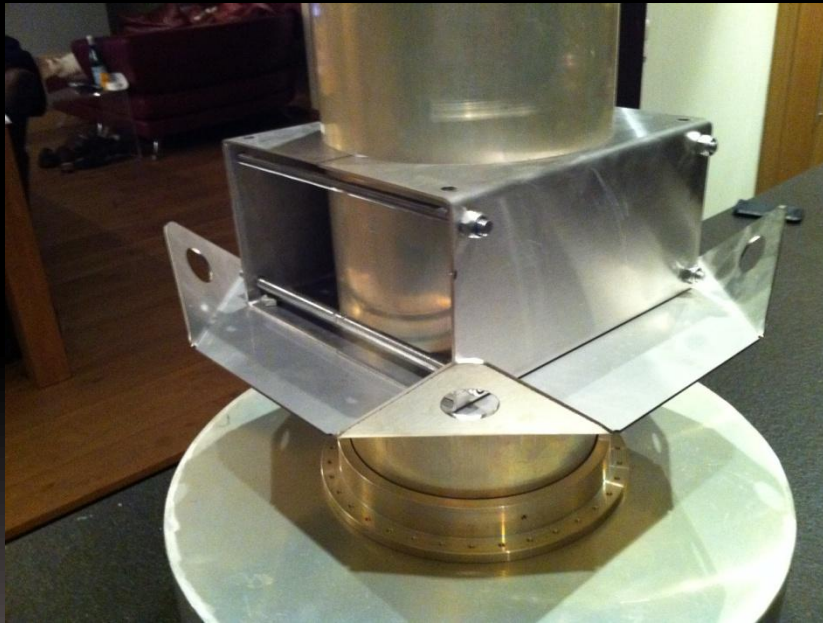
ANTENNA:

- The elevation actuator pushes the antenna up at the lowest connection point of the antenna



FEEDHORN:

- An OM6AA designed round septum polarizer with a super VE₄MA choke ring for F/D 0.375



FEEDHORN:

- First sunnoise test



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THE FOUNDATION:

- We made a concrete slab and made a construction of H beams



THE FOUNDATION:

- We decided to mount the antenna on a 10' sea container



THE FOUNDATION:

- Moving the antenna to the 10" container



THE FOUNDATION:

- The container was mounted on two H beams



THE EXCITER:

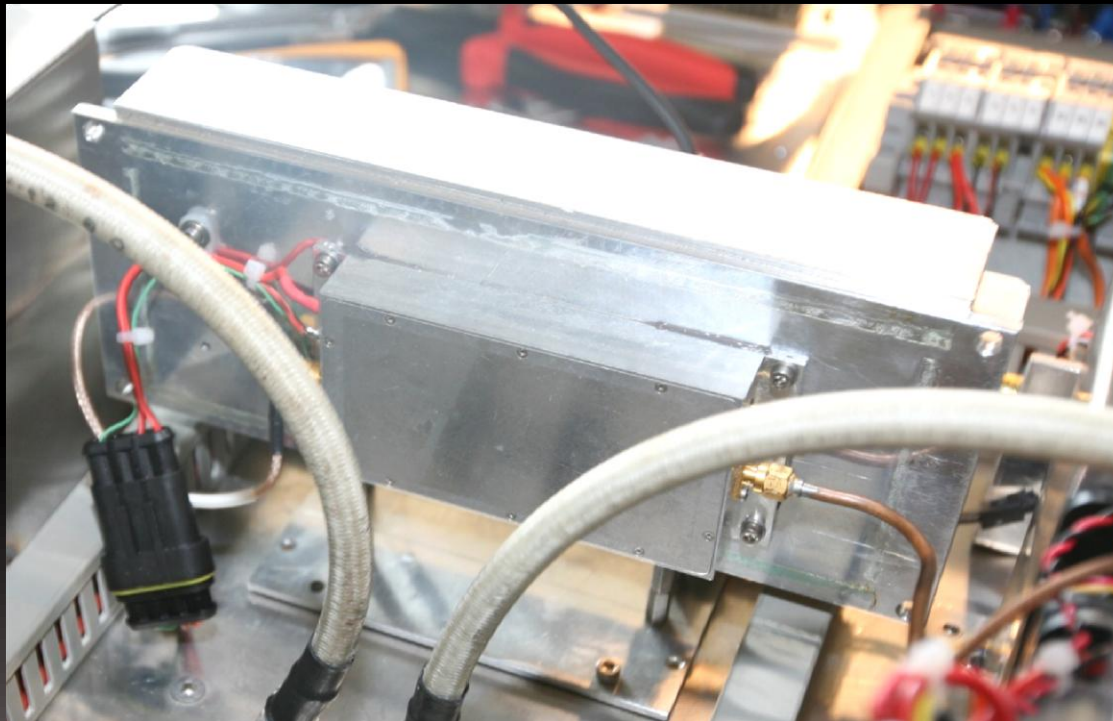
- A ref locked DB6NT V3 exciter was used



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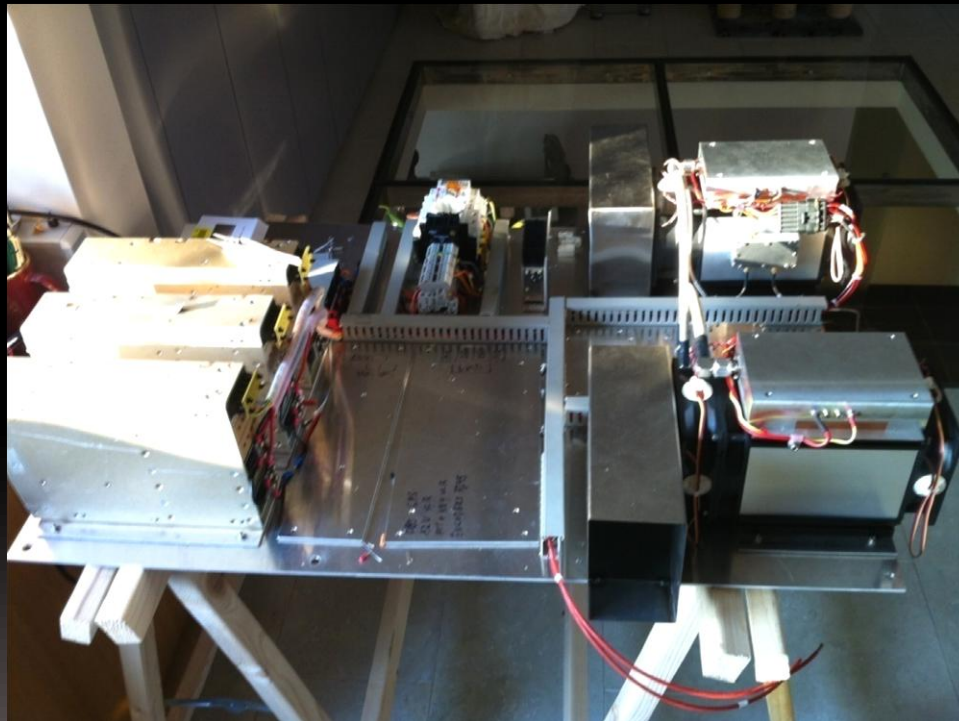
THE DRIVER:

- The M57762 as driver amplifier



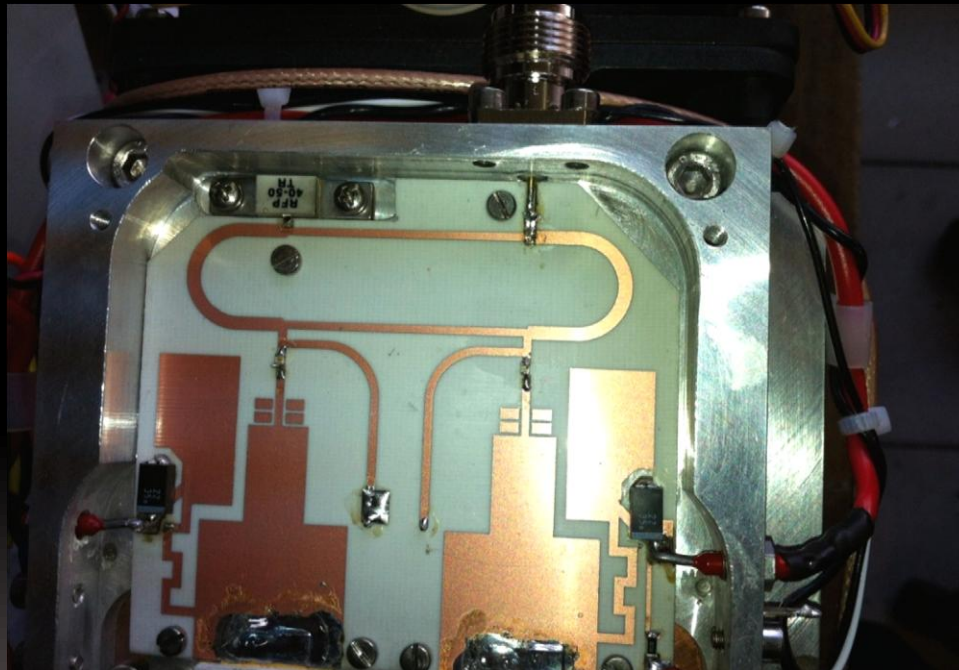
THE FINAL AMPLIFIERS:

- 2 x PE1RKI SSPA 250W



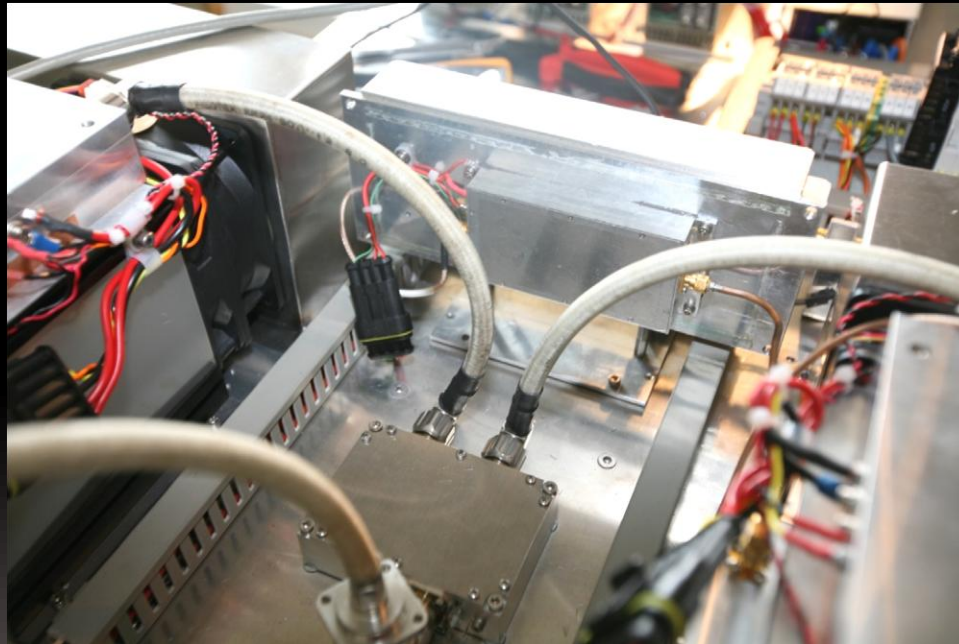
THE FINAL AMPLIFIERS:

- 2 x PE1RKI SSPA 250W



THE FINAL AMPLIFIERS:

- 90° Hybrid combiner



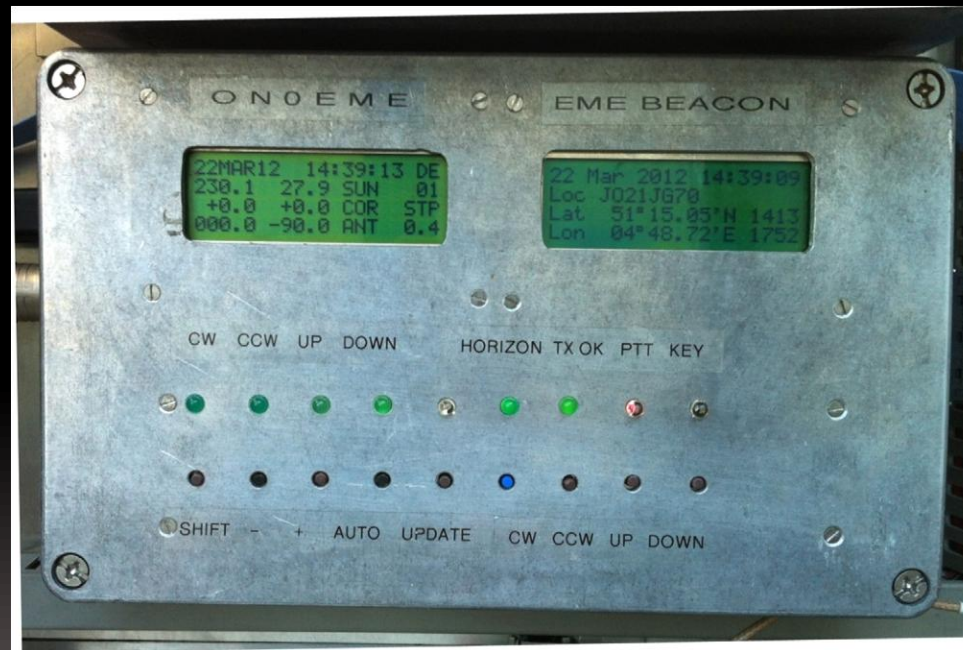
THE POWER SUPPLIES:

- Astec switched psu 2 X 28V each @ 15A each



THE ANTENNA CONTROLLER:

- 89C51ED2 OE5JFL based tracker



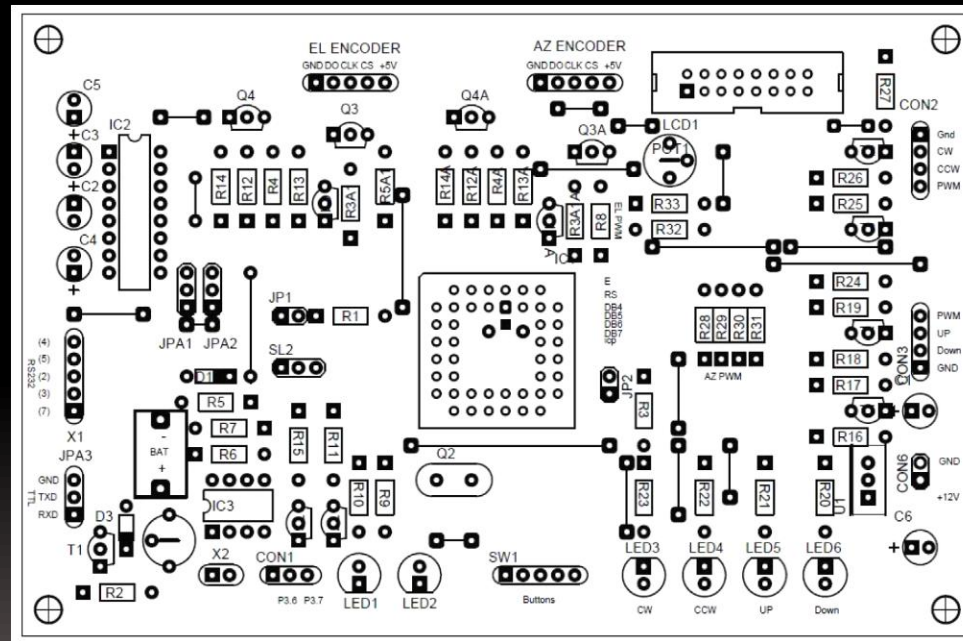
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THE ANTENNA CONTROLLER:

- Moon or sun tracking, stow or maintenance
- Time, date, position updated by GPS time
- Beacon keyer GPS timed
- Indication when moon above horizon
- Indication when moon above 10° elevation
- Motors controlled by PWM

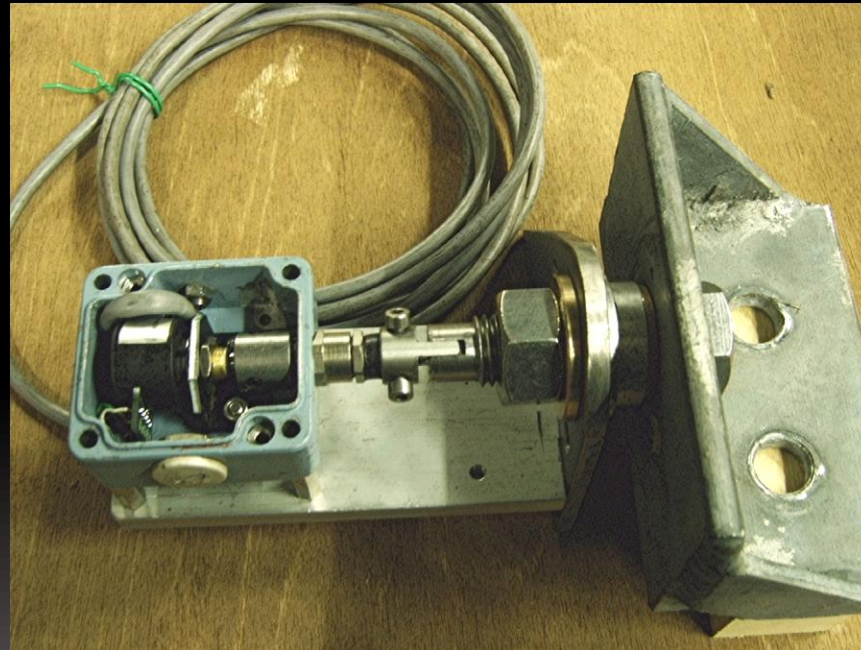
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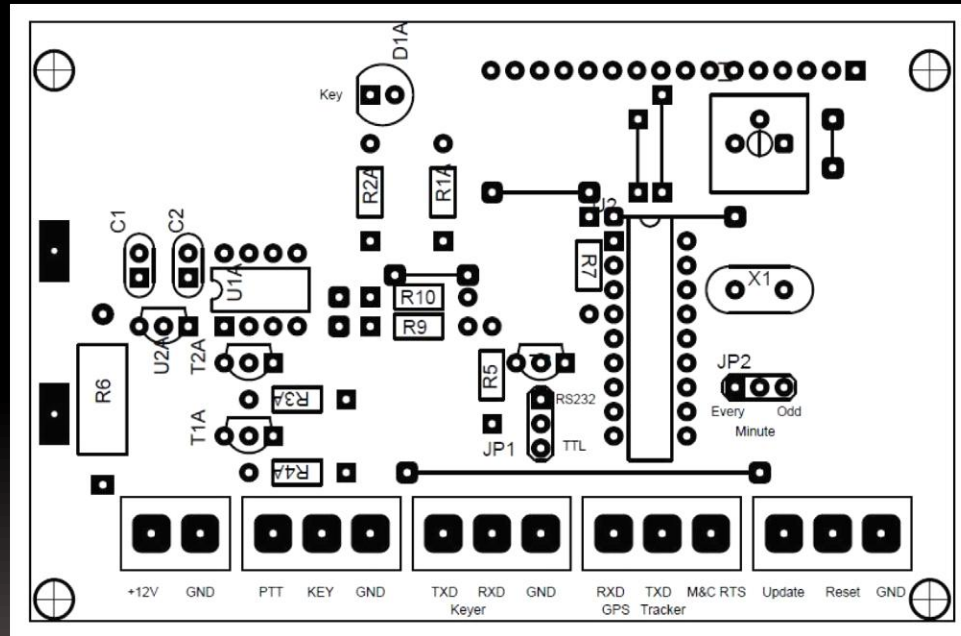
THE ANTENNA CONTROLLER:

- Using 12bit absolute encoders



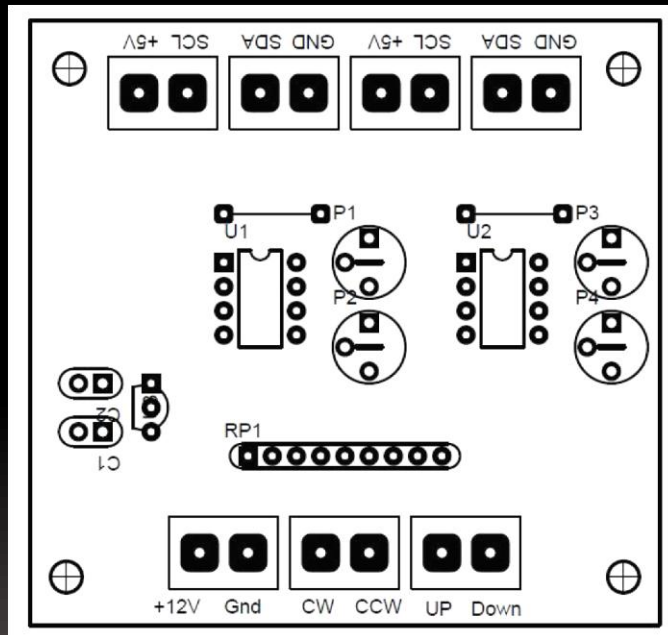
THE ANTENNA CONTROLLER:

- Beacon Keyer G4JNT



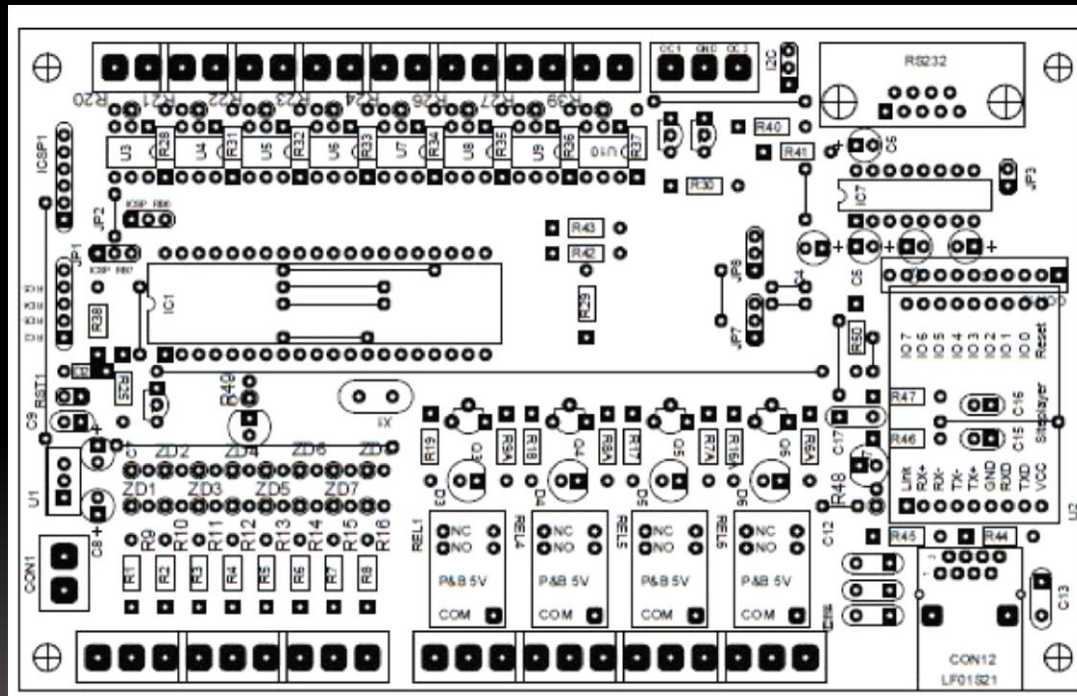
THE ANTENNA CONTROLLER:

- DC Motor controller & H-bridges



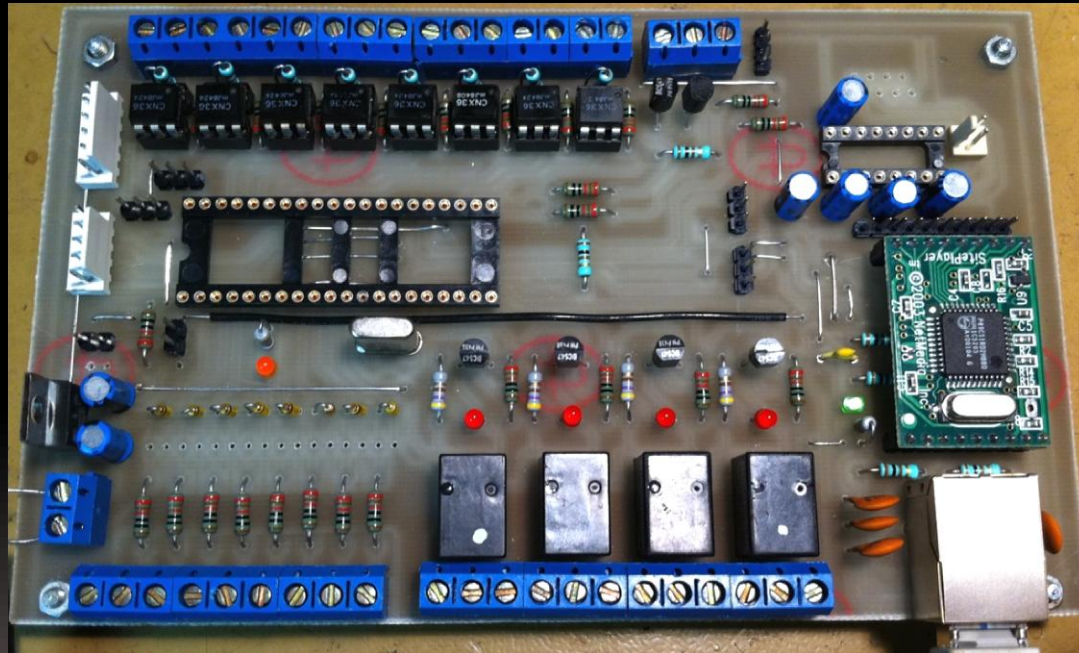
MONITOR AND CONTROL:

- Universal M&C board based on 18F45K22



MONITOR AND CONTROL:

- Universal M&C board based on 18F45K22



MONITOR AND CONTROL:





- Universal M&C board based on 18F45K22
- 8 opto isolated inputs
- 4 relais
- 12 x 10bit analog to digital converters
- 4 x TTL outputs
- 2 UART's (Rs232 ports)
- Embedded webserver
- I2C bus for expansion

MONITOR AND CONTROL:

ON 0 EME

EME BEACON 1296.000 MHz

Status Control











Main parameters	
Beacon operational	
Moon above horizon	
Allowed TX (10deg)	
PTT (TX)	
Azimuth Antenna	256.3 °
Elevation Antenna	22.2 °
Azimuth Moon	256.6 °
Elevation Moon	22.0 °

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MONITOR AND CONTROL:

EME Beacon Admin

Click [HERE](#) for WW User window

Moon parameters		Beacon parameters	
Az Moon	256.8	Beacon Status	
El Moon	21.7	GPS 3D fix	
Az Antenna	256.8	PTT status	
El Antenna	22.1	PTT beacon enabled	
Offset Az	0	PTT (bias) enable	
Offset El	0	Key (cw) enabled	
Doppler	-190	Key (cw) enable	
Above Horizon		Every/Odd Minute key	
Above 10 degrees		Every/Odd Minute key switch	

MONITOR AND CONTROL:

Tx & PA parameters		Tracking parameters	
PA1 Temp alarm		Offset Az	0
PA1 Temp	291.67	Offset EL	0
PA2 Temp alarm		Step	0004
PA2 Temp	295.10	Az 1	1400
PA1a VCC	27.77	El 1	0400
PA1b VCC	27.72	Az 2	1400
PA2a VCC	27.50	El 2	0400
PA2b VCC	27.77	Track Moon (0)	
Forward power	508.12	Track Sun (1)	
Reflected power	38.47	Goto maintenance position (2)	
VCC 12V	11.94	Enable/disable tracking	0001
PTT		Enable/disable Tracking (Toggle)	

EQUIPMENT ENCLOSURE:

All equipment is outdoor mounted at the backstructure of the antenna





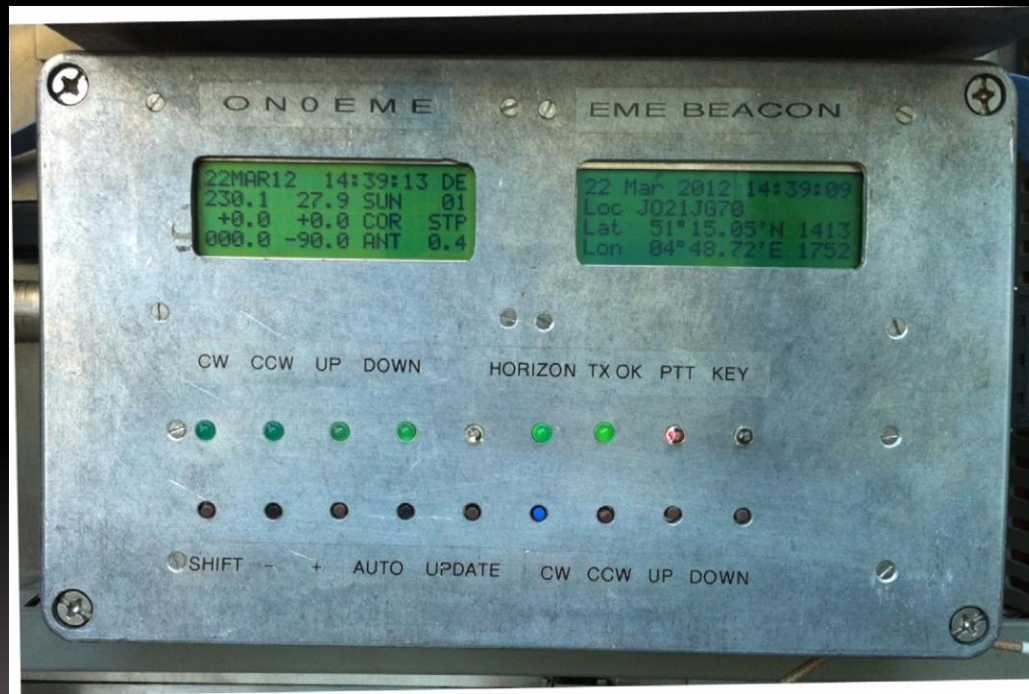
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WHAT WENT OK:

- No problems to the AZ and EL systems.
- Modified OE5JFL worked perfect



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WHAT WENT OK:

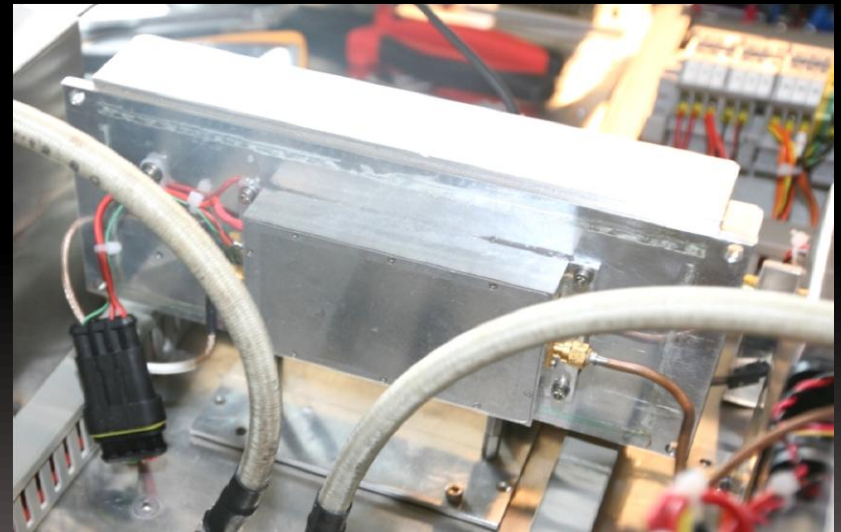
- The beacon was operational during high wind storms, snow, ice , we never had to stow the antenna due to mechanical problems or reverse conditions from the elements.



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WHAT WENT OK:

- Exciter and driver amplifier , no problems worked perfectly over the years



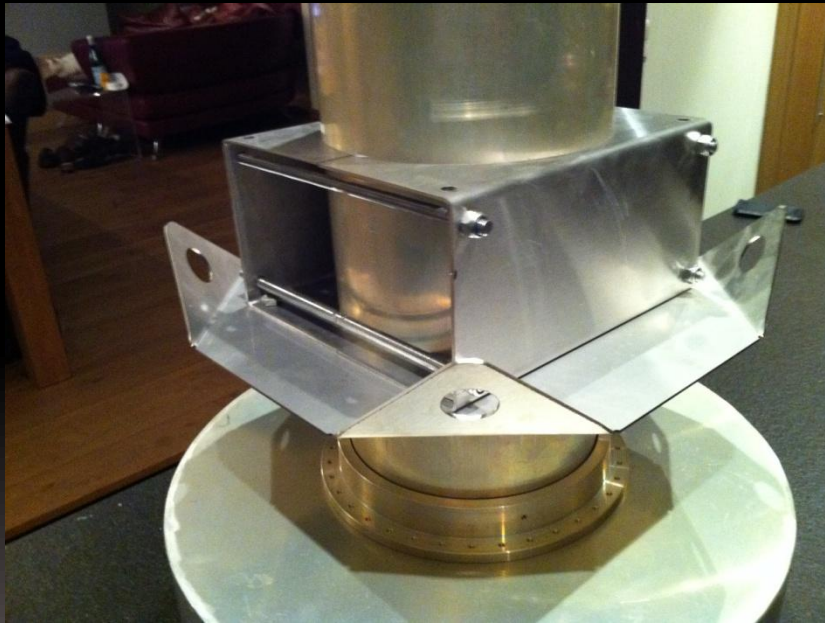
WHAT WENT OK:

- Power supplies , no failure on any of the 28 or 12 VDC power supplies



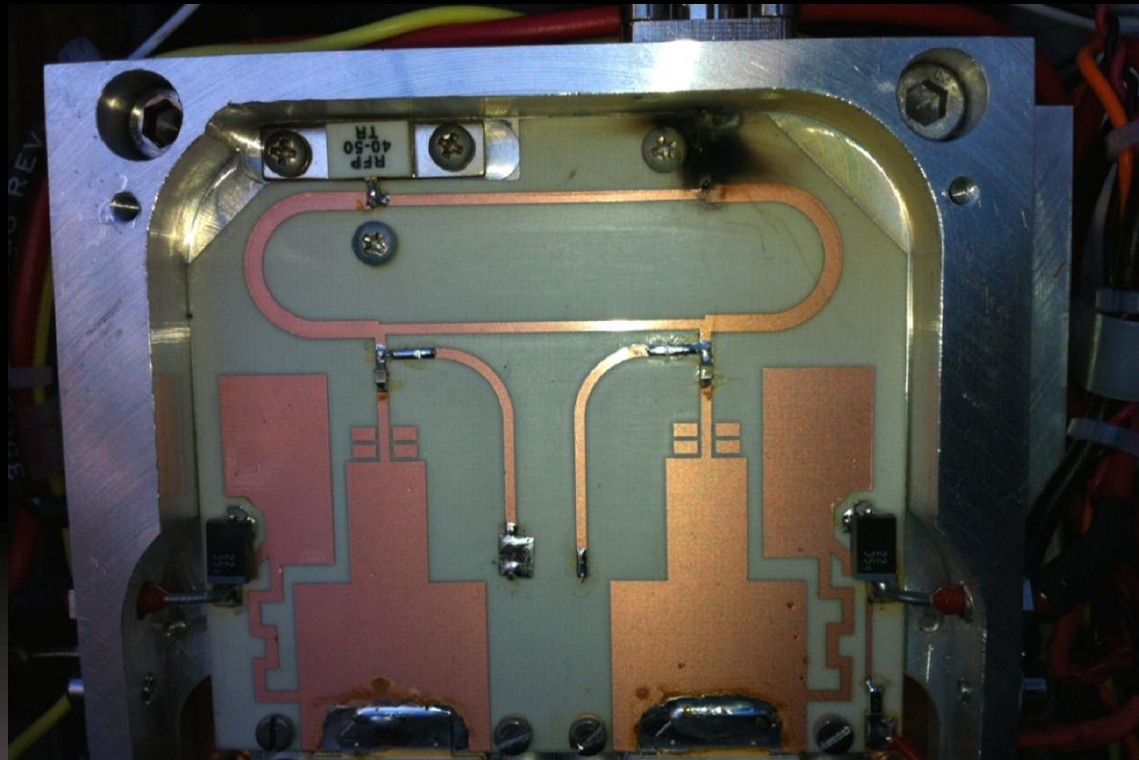
WHAT WENT OK:

- no problems to the feedhorn etc...



WHAT WENT WRONG:

- Ham radio use is not equal to heavy duty cycle



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WHAT WENT WRONG:

- Ham radio use is not equal to heavy duty cycle



WHAT WENT WRONG:

- output couplers burning out
- output connectors burning off the PCB
- output FET's Drain coming loose off the pcb

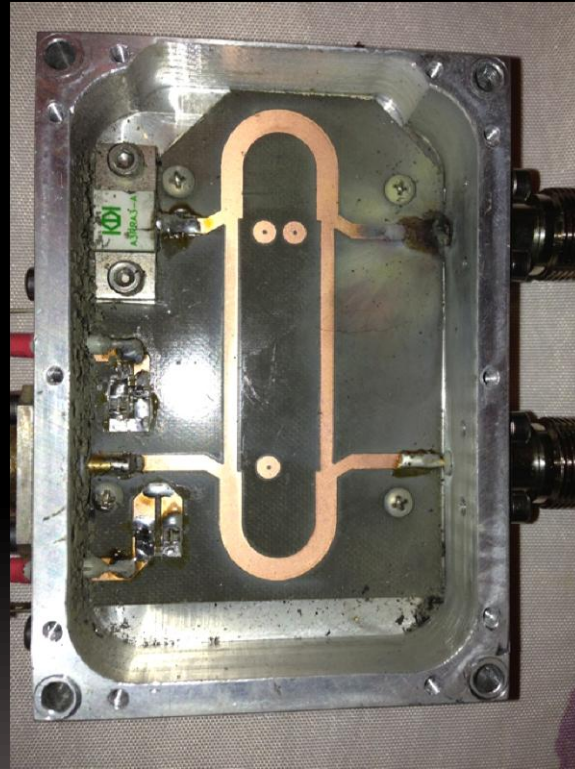
WHAT WENT WRONG:

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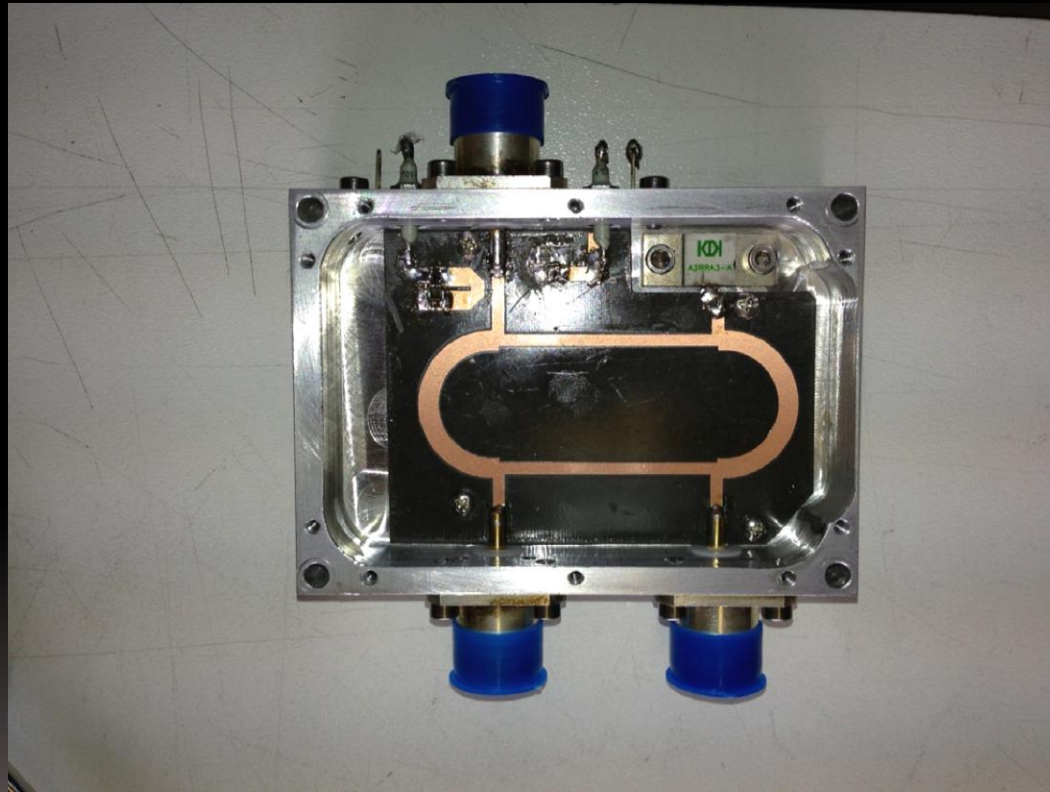
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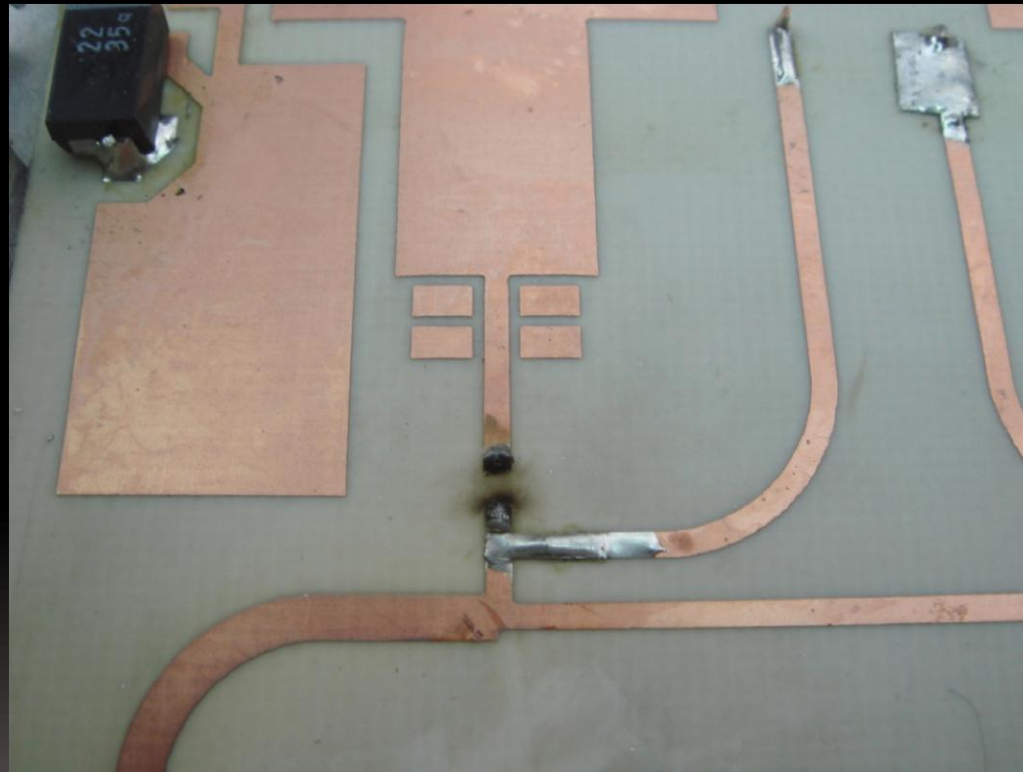
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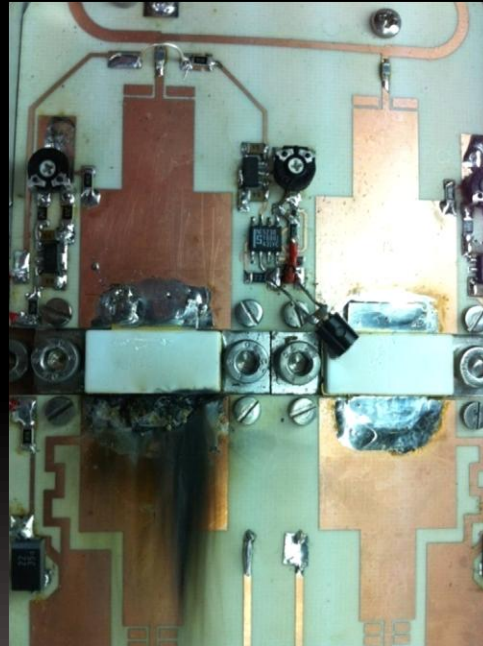
WHAT WENT WRONG:

- ATC100A burned out



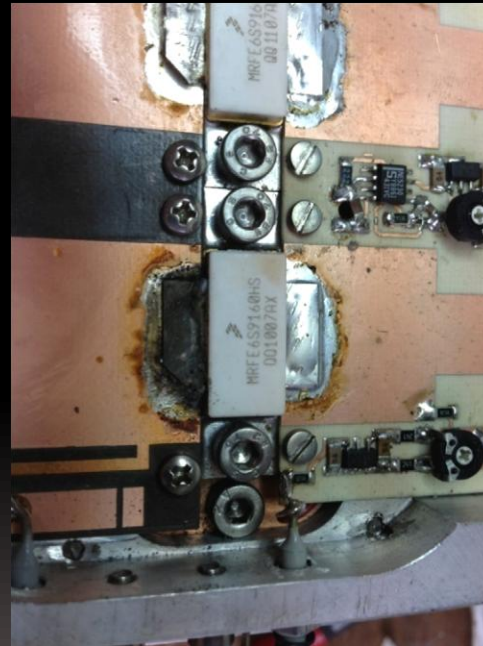
WHAT WENT WRONG:

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WHAT WENT WRONG:

- Fet burned out
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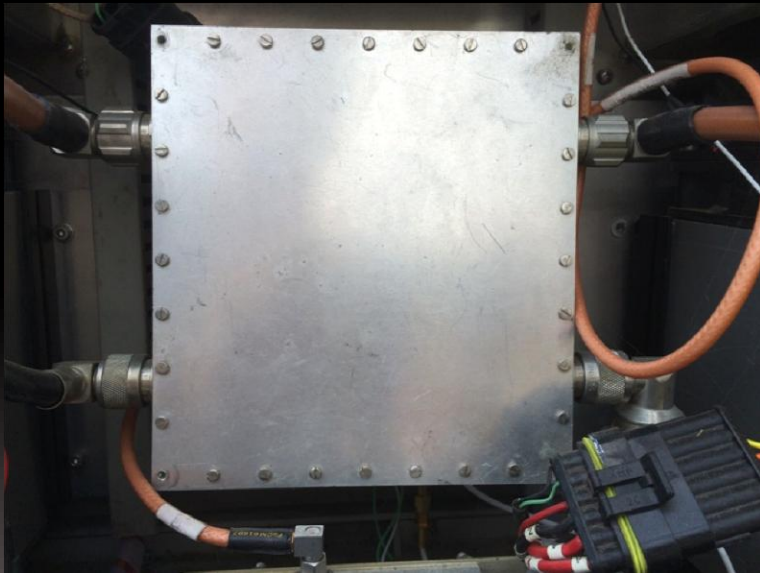


WHAT WENT WRONG:

- Cure :
- First rogers 4003 in the output couplers being replaced by 5880 in 2 OZ copper.
- Total output board being replace by Rogers 5880 2 OZ copper
- Different solder has been applied to solder the different components in the output circuits
- Lowered the power to 400 watt of output power and limited the current draw to max 10 amps per device.

WHAT WENT WRONG:

- We replaced the output coupler by an air 90° hybrid coupler
- We installed an external directional coupler



WHAT WENT WRONG:

- Found some humidity under the PCB's of the PA's after failures.
- decided to leave bias on during winter time so each device draws around 2 amps during idle time and when no moon present.

WHAT WENT WRONG:

- Decided to install a heating in the beacon box to keep the minimum temperature to $+15^{\circ}\text{C}$, a 50 watt temperature controlled heater is installed.



WHAT WENT WRONG:

- The FAN circulation air through the beacon box has been temperature controlled and stops circulation cold and humid air when temperature is below 20°C
- The FAN's cooling the heatsink get temperature control so the FAN's keep circulating air when the heatsink temperature is above 30°

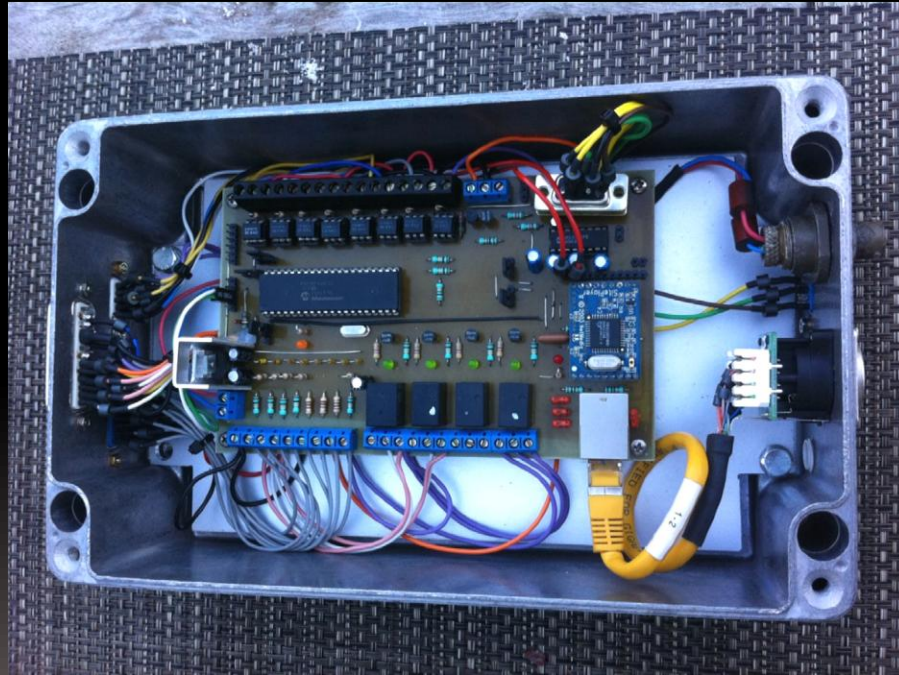


WHAT WENT WRONG:

- Beacon Website failure
- The embedded webserver “hangs”
- Due to RF ? From our self or GSM ?
- or Denial-of-service attack Ddos on port 80 ?
- Bugs in the firmware/software ?

WHAT WENT WRONG:

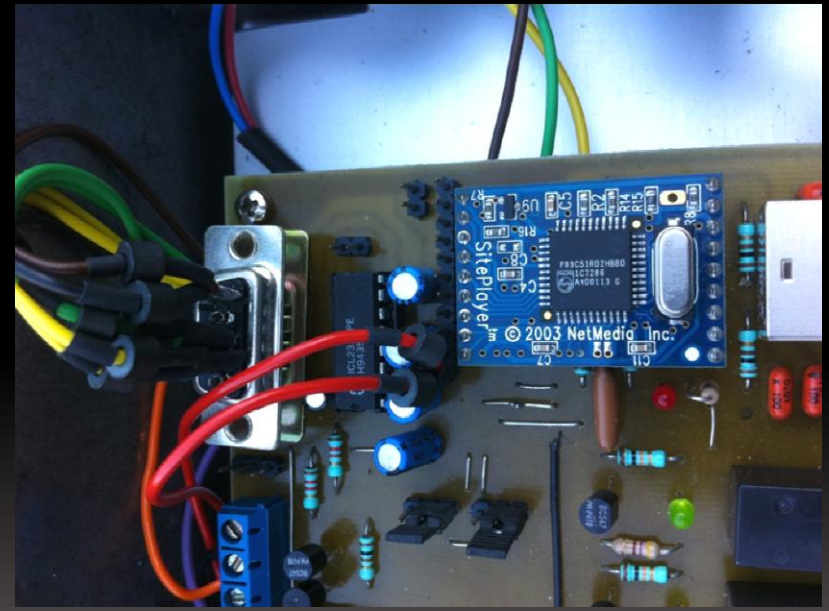
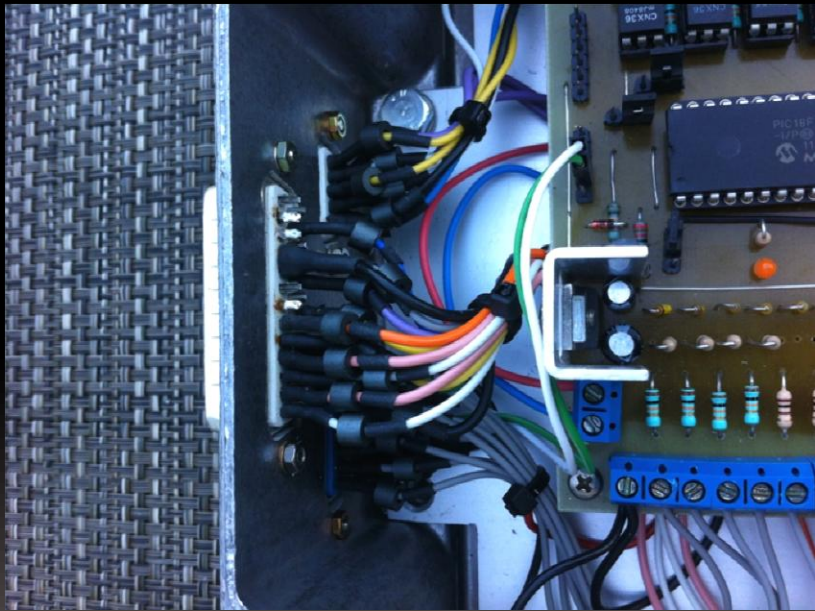
- Build a complete new beacon controller with serious decoupling:



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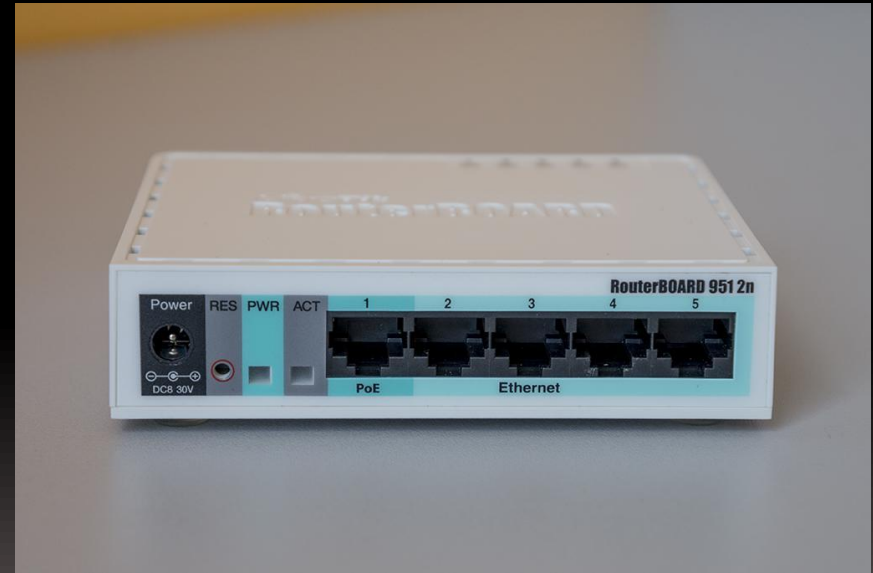
WHAT WENT WRONG:

- Build a complete new beacon controller with serious decoupling:



WHAT WENT WRONG:

- We installed a “firewall” in front of the VDSL modem, to prevent attacks on port 21,22,23 & 80





CONCLUSION:

- ONoEME has been on air since March 31st 2012
- It has been in daily operation since, and is now stable after some difficulties in the start-up period
- Reception reports have been received from stations with dishes as small as 135 cm.

SOME FIGURES:

- ONoEME tracked: 1060 Moon passes
- ONoEME transmitted: 380.000 min of CW
- ONoEME transmitted: 250.000 min of pure carrier
- ONoEME consumed: 10.400 kW/h electric power

QUESTIONS ?:

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SPECIAL THANKS:

- *Hannes* **OE₅JFL** for his support, his tracking hardware, which is still the 'stand alone reference' in tracking hardware
- *Marc* **ON₅OT**, for all help in the mechanical construction, for the ideas on the drives and motors. Marc was responsible for the complete mechanics of this beacon
- *Luc* **ON₃LNL** for the software development and debugging of the M&C
- Our sponsor (who would like to stay anonymous) for the use of his site and electrical power.

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