ParkinsonSat

NAVAL OSCAR-84

... APRS plus a new PSK31 Approach

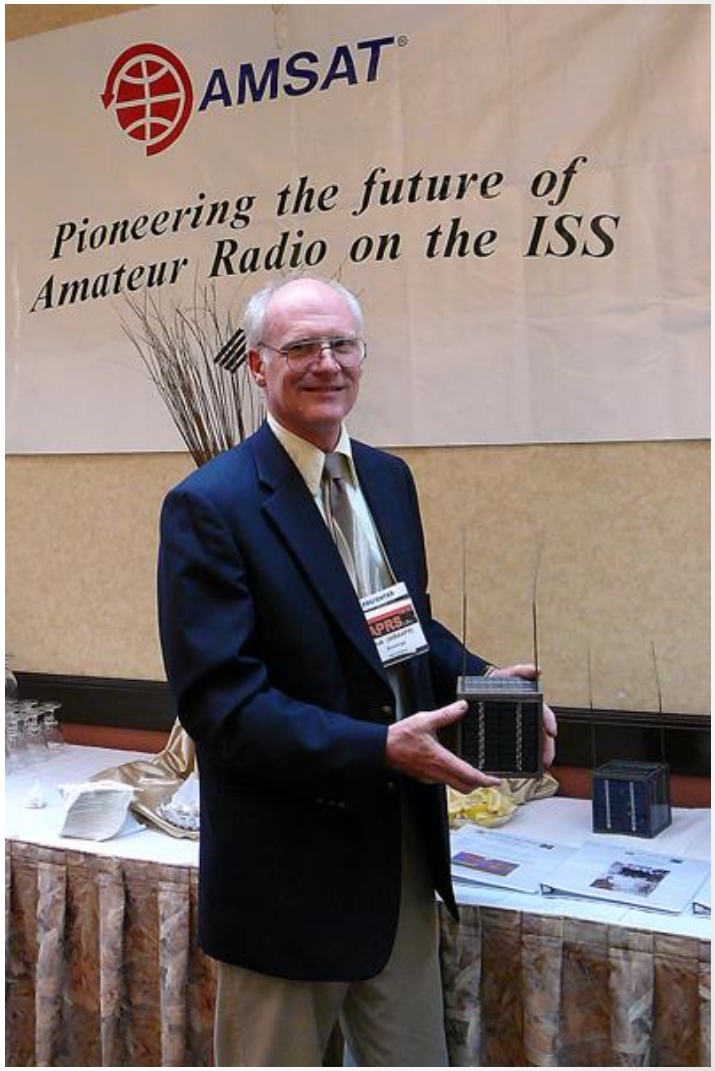
AMSAT-UK Colloquium 2015

Mike Rupprecht, DK3WN
Bob Bruninga, WB4APR

Bob Bruninga

WB4APR

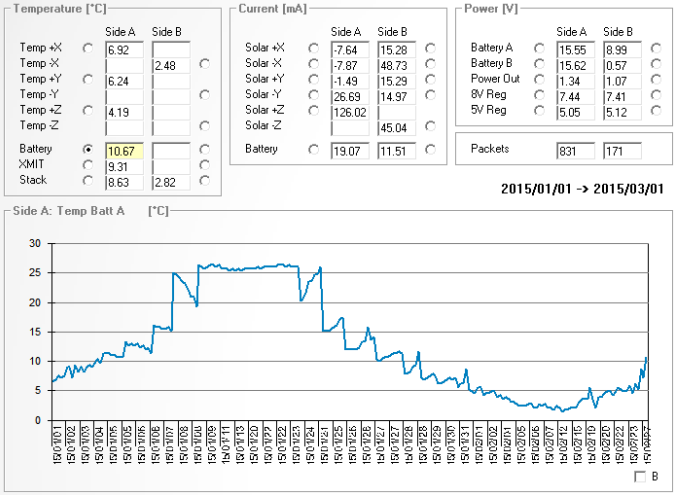
- Senior Research engineer at the US Naval Academy
- 1970 - 1990 USNA
- 1984 developed CETS (Connectionless Emergency Traffic System) on C-64 for digital packet comms
- 1992 changed name of CETS to APRS
- 2001 developed PCSAT-1
- 2006 developed PCSAT-2 APRS satellite to fly on outside of ISS
- 2007 developed ANDE, RAFT and MARScom APRS amateur satellites for deployment by Space Shuttle
- 2015 completed PSAT, QIKCom-1, QIKCom-2

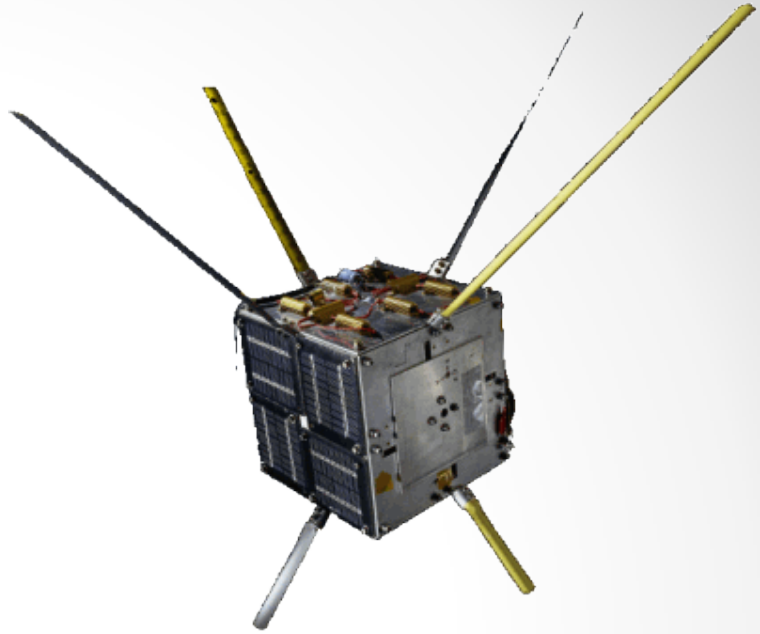


PSAT is one of five APRS-networked Amateur Radio satellites that will be in orbit during 2015.
The others include PCsat-1, QIKcom-1 (set to launch in September), QIKcom-2 (set to launch in December) and the ARISS packet radio system on board the International Space Station since 2007.

USNA's APRS satellites

PCSAT-1 (NO-44)





AX.25 packet system for use as a UI digipeater, telemetry, command, control
W3ADO-1 1k2 and 9k6, PCSAT-1, PCSAT-2

launched September 30, 2001 from the Kodiak Launch Complex on Kodiak Island, Alaska
NO44 operates in a negative power budget
most passes only one lucky packet
hard to command

```
20150302075949,W3ADO-1>BEACON,SGATE,qAS,EA6XQ:T#002,077,092,088,067,215,11111111,0001,1
20150302080149,W3ADO-1>BEACON,SGATE,qAS,EA6XQ:T#004,159,159,036,209,215,11111111,0011,1
20150303091358,PCSAT-11>BEACON,SGATE,qAR,CU2ZG-1:T#001,141,067,063,071,218,11111111,0000,1
20131127014203,PCSAT-12>BEACON,SGATE,qAS,JA0CAW-6:T#007,096,081,119,123,217,11111111,0010,1
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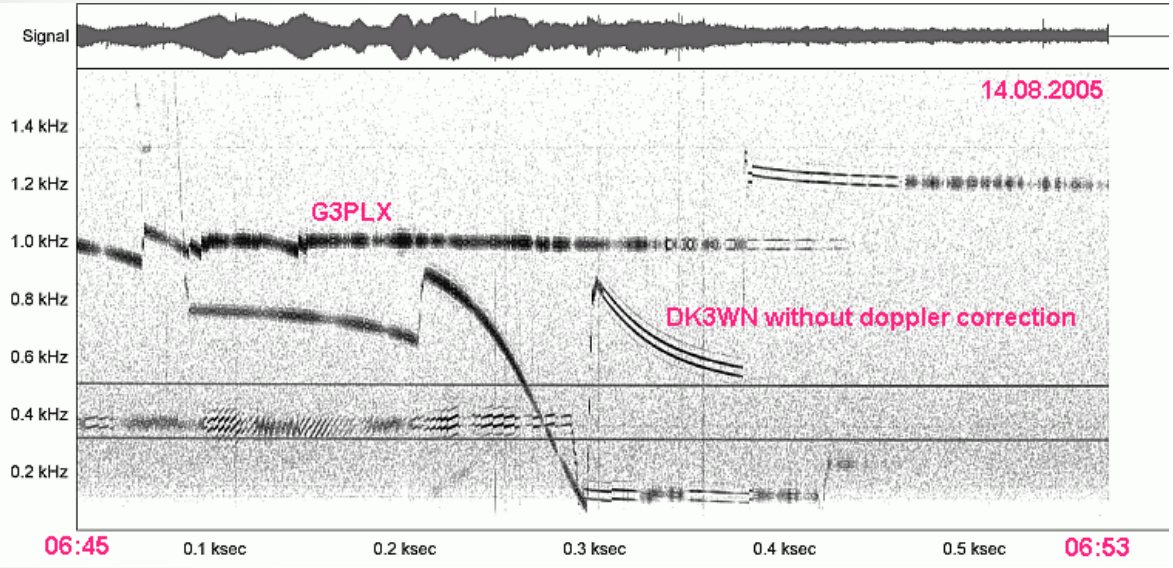
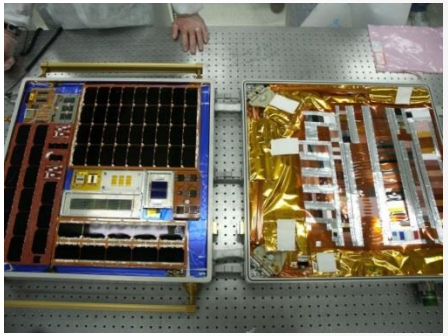
USNA's APRS satellites

PCSAT2





- July 2005 – Space Shuttle Discovery -> exterior of ISS -> September 2006 – Space Shuttle Atlantis
- suitcase-like Passive Experiment Container
- 10-meter PSK31 multi-user transponder
- FM voice repeater
- AX.25 packet system for use as a UI digipeater, telemetry, command, control

```
fm PCSAT2 to BEACON via SGATE WIDE ctl UI pid F0 T#143,164,139,155,143,146,11111111,0010,1
fm PCSAT2 to BEACON via SGATE WIDE ctl UI pid F0 >312242z OPS Normal. Enjoy! [de WB4APR]
fm PCSAT2 to BEACON via SGATE WIDE ctl UI pid F0 T#144,154,106,019,113,008,11111111,0011,1
fm DK3WN to CQ via PCSAT2* ctl UI^ pid F0 =4943.52N/00857.19E-Mike, JN49LR >>> www.dk3wn.info {UIV23}
fm PCSAT2 to BEACON via SGATE WIDE ctl UI pid F0 T#170,138,140,001,000,075,11111111,0001,1
```

USNA's APRS satellites

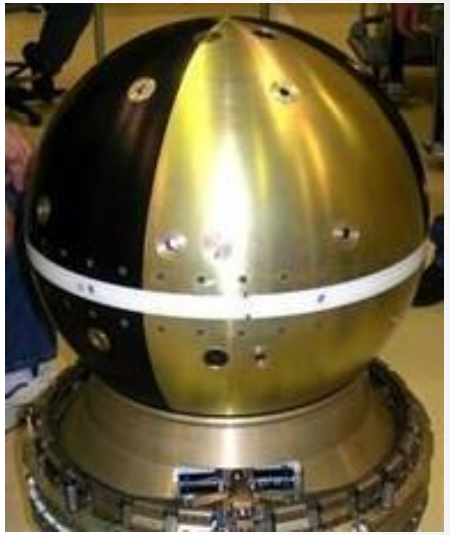
ANDE-MAA (NO-61)

Atmospheric Neutral Density Experiment (ANDE) consists of two microsatellites launched from the Shuttle payload bay will measure the density and composition of the low Earth orbit (LEO) atmosphere while being tracked from the ground.

Mock ANDE Active (NO-61), 48cm, 52 kg
Fence Calibration (NO-62)

- December 2006 (Discovery) – December 2007
- laser experiment
- voice synthesizer
- AX.25 packet system for use as a UI digipeater, telemetry, command and control

ANDE Deorbit Award
AMSAT P3E donation (3 pixel: MAA)



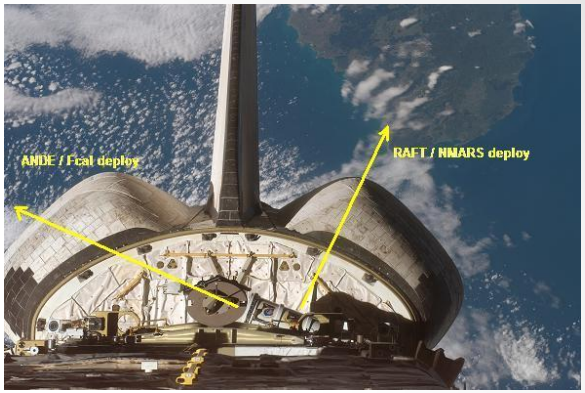
```
20061222161746 : SP7THR-6]APRS,ANDE-1*,qAo,SP7THR:=5034.00N/02204.44E`73' Via Satellite {UISS50}
20061222161700 : DK3WN-1]APU25N,ANDE-1*,qAo,SP7THR:=4943.90N/00857.30E-Mike 10w
20061222161652 : ANDE-1]BEACON,qAo,DK3WN-1:T#002,004,008,008,005,005,01000000,000
20070211000018 : DK3WN]APRS,ANDE-1*,qAr,DK3WN-2::TALK :test ande 1234567890 ANDE speaks
20070210235813 : ANDE-1]BEACON,qAr,DK3WN-2:T#007,135,049,052,049,214,11100001,999
```

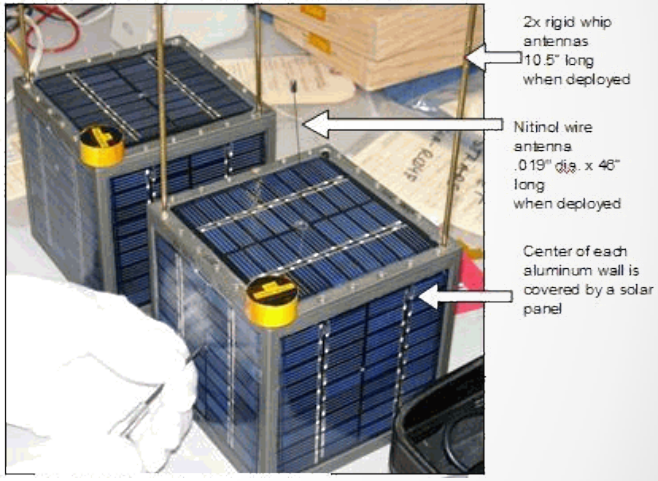
USNA's APRS satellites

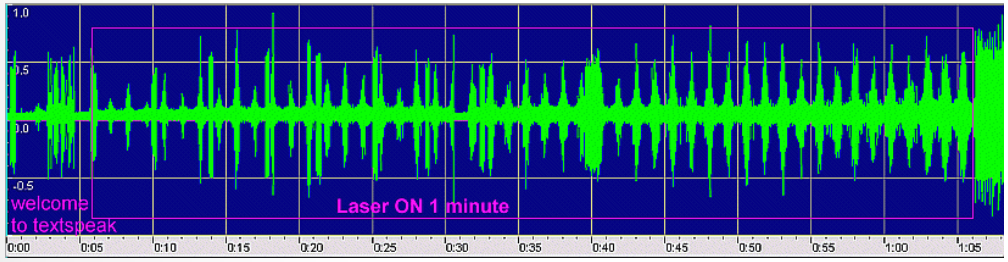
RAFT

Atmospheric Neutral Drag Experiment

- December 2006 (Discovery) – May 2007
- radar experiment (NSSS frequency 216.98MHz)
- laser experiment (Graz)
- PSK31 transponder
- voice synthesizer
- AX.25 packet system for use as a UI digipeater, telemetry and command, control








```
RAFT>BEACON,SGATE: T#026,086,102,037,065,070,00000000,000
RAFT>BEACON,SGATE: RAFT is on 145.825  US Naval Academy
RAFT>BEACON,SGATE: T#027,080,002,036,034,070,10000000,000
RAFT>BEACON,SGATE: T#030,078,002,035,034,069,10000000,000
RAFT>BEACON,SGATE: T#031,078,002,034,034,070,10000000,000
```

ParkinsonSat

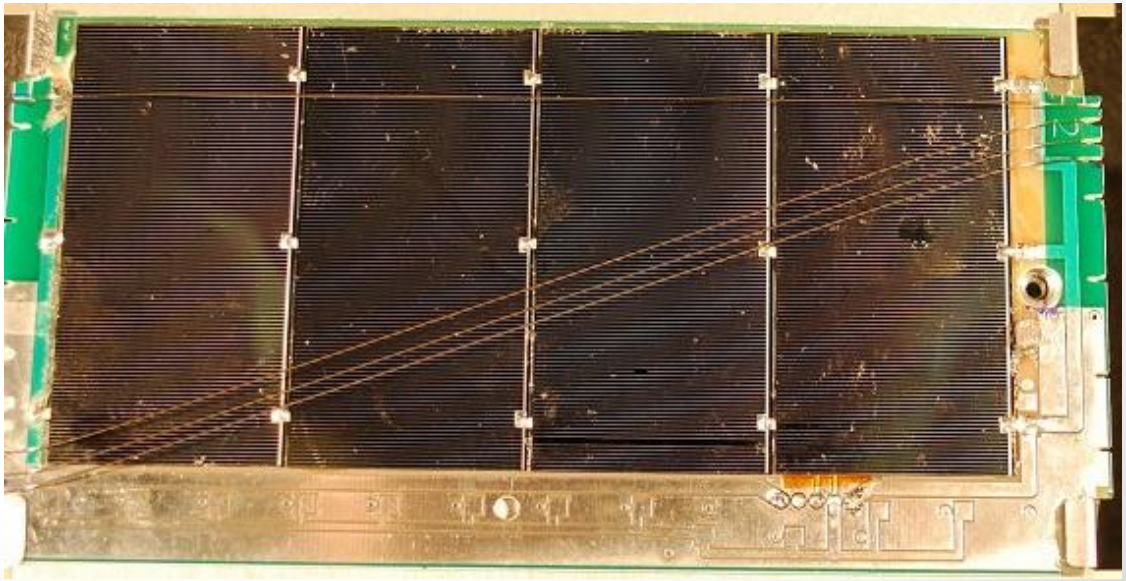
- Initiated in 2006 with seed funding from The Aerospace Corporation and ONR (Office of Naval Research) in honor of the retirement of Dr. Bradford Parkinson, the original model evolved into a cubesat in 2008.
- Parkinson is an American engineer and inventor and United States Air Force colonel and best known as the father of the Global Positioning System.

- During the long wait for an launch opportunity, the design was changed and simplified in 2014.

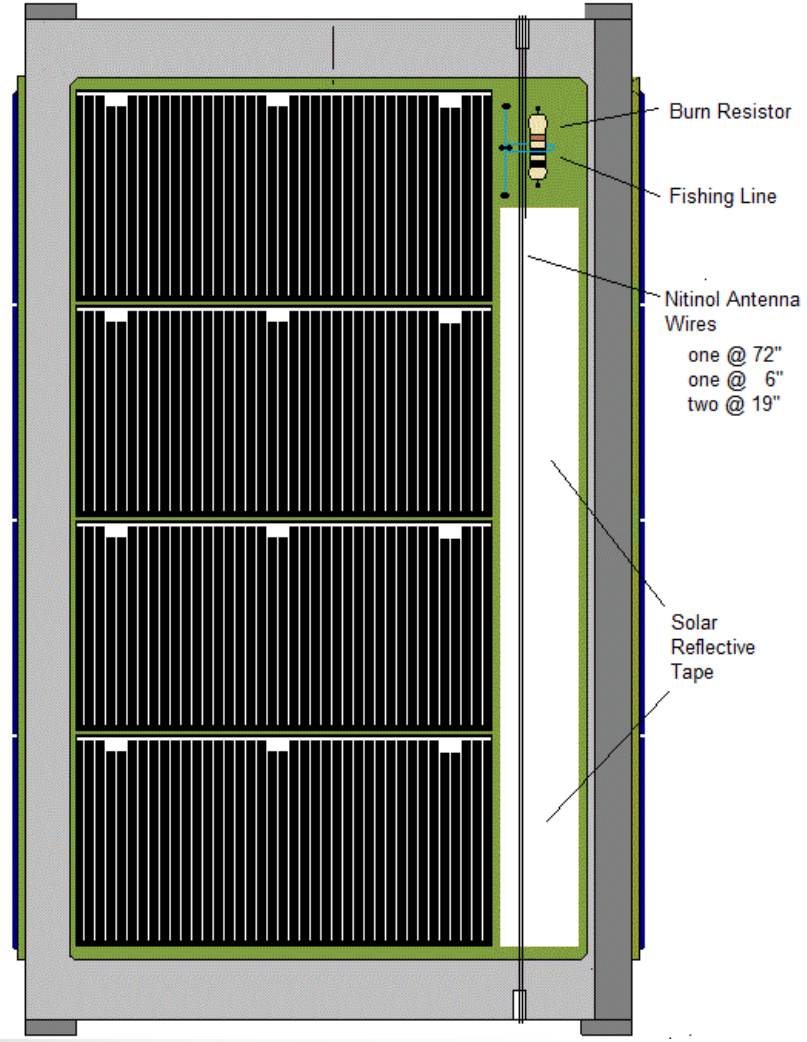
• The four deployable fixed solar arrays were removed as higher efficiency solar cells became available.

• 1U cubesat but in a 1.5U package

• 4 large and efficient solar cells per side

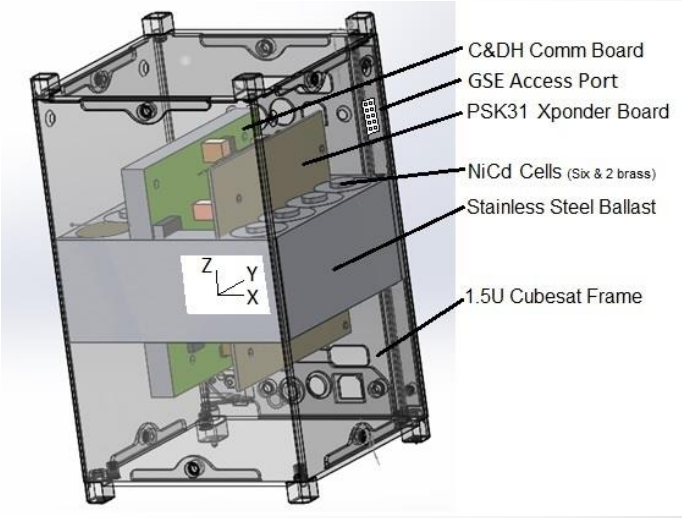


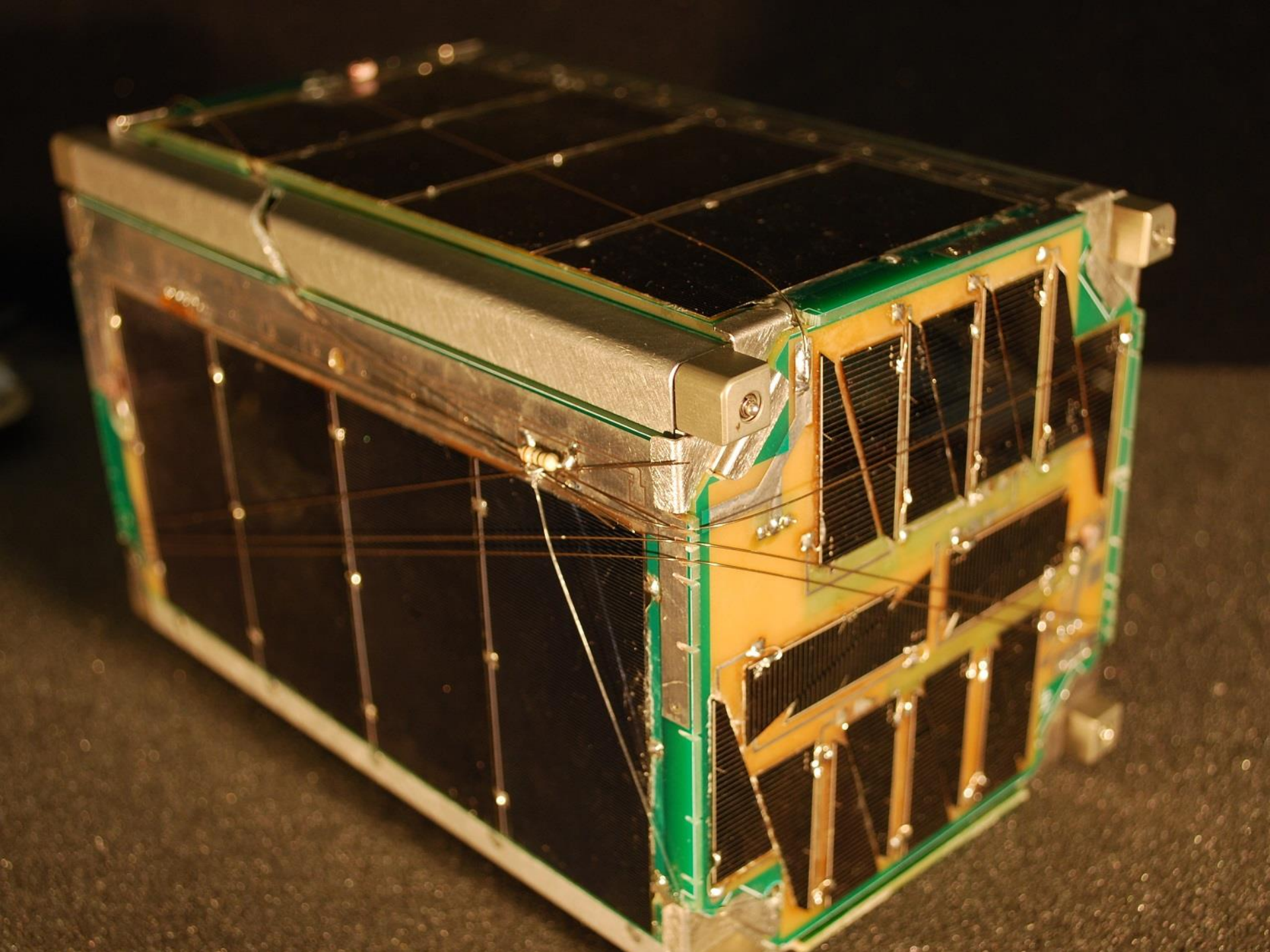
ParkinsonSat



on command to deploy the antennas which are stowed for launch, the burn resistor heats, melting the nylon fishing line holding the wire antennas

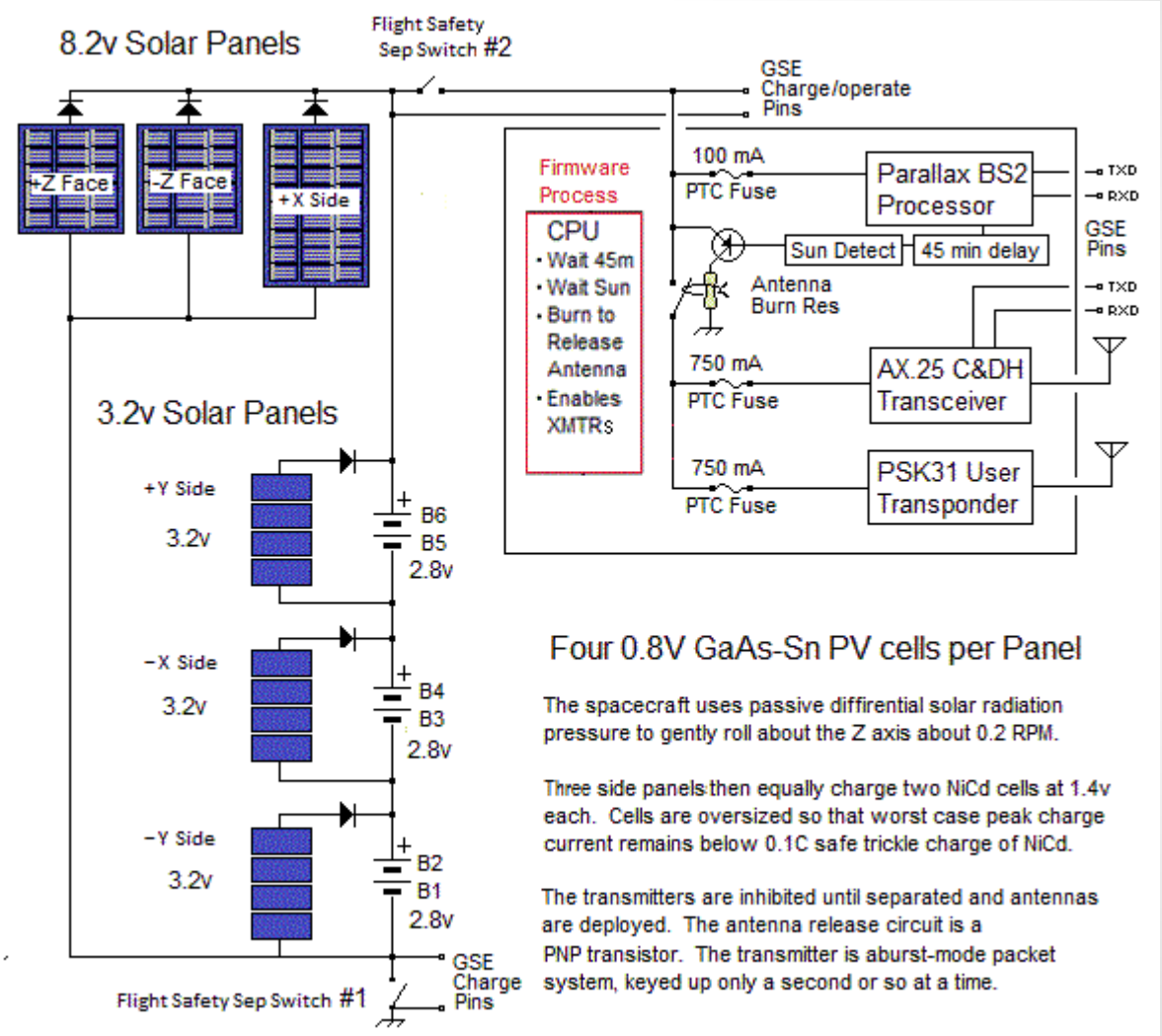
the offset solar reflective stripe compared to the black solar panels imparts a slight spin about the Z axis for good thermal balance. It also assures equal charge on the batteries which are charged one NiCd pair solar side panel





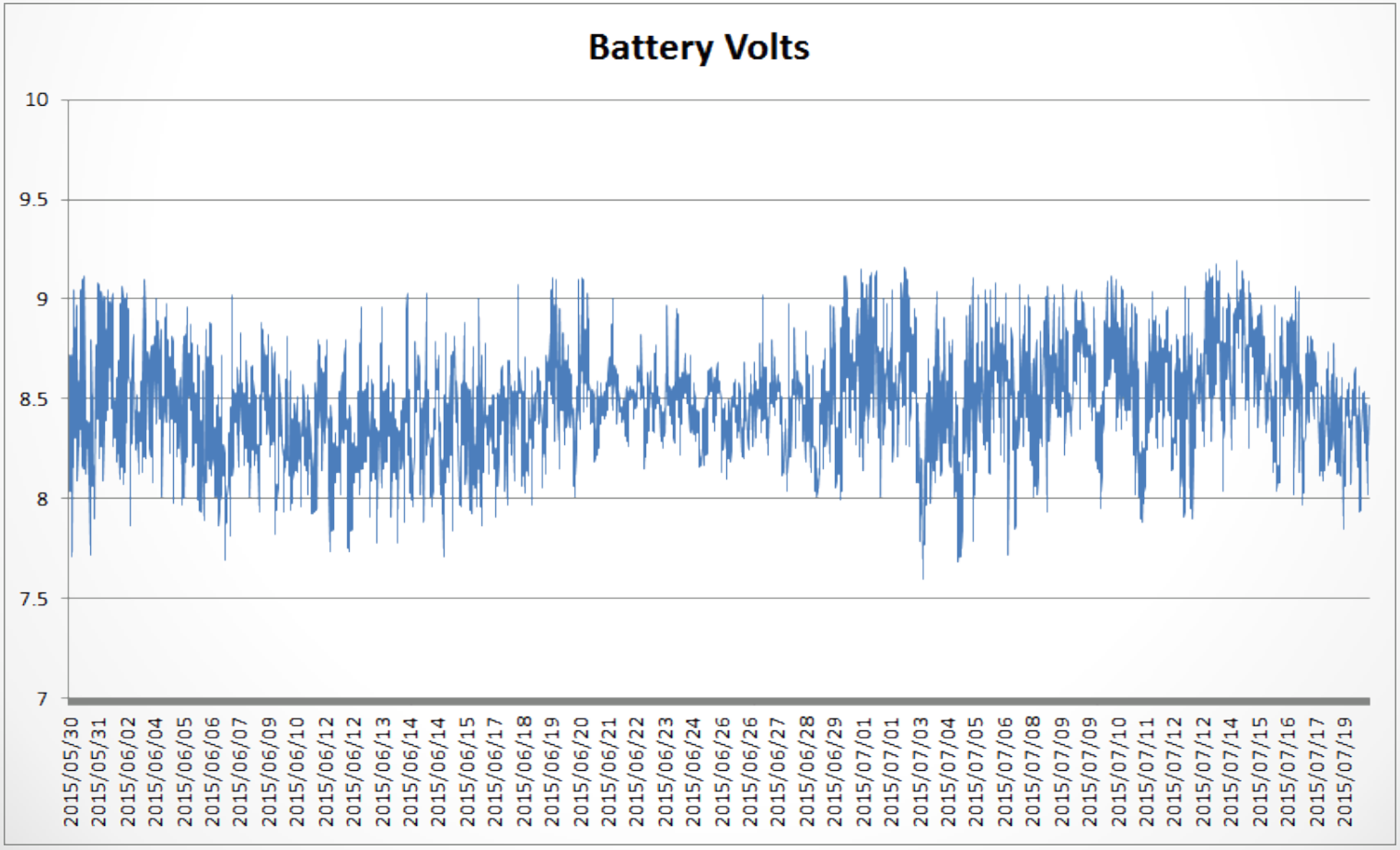
PSAT power system

- power system consist of six 1800 mAh NiCd cells
- everything runs on this bus with their own internal 5v regulators
- charging is provided by full string (8.4v) charging on the +Z, -Z and +X side
- the other 3 side panels charge at 700mA into one pair of NiCd cells each
- to save power, the CPU is put to sleep for 2.3 sec out of every 2.5 sec MA cycle



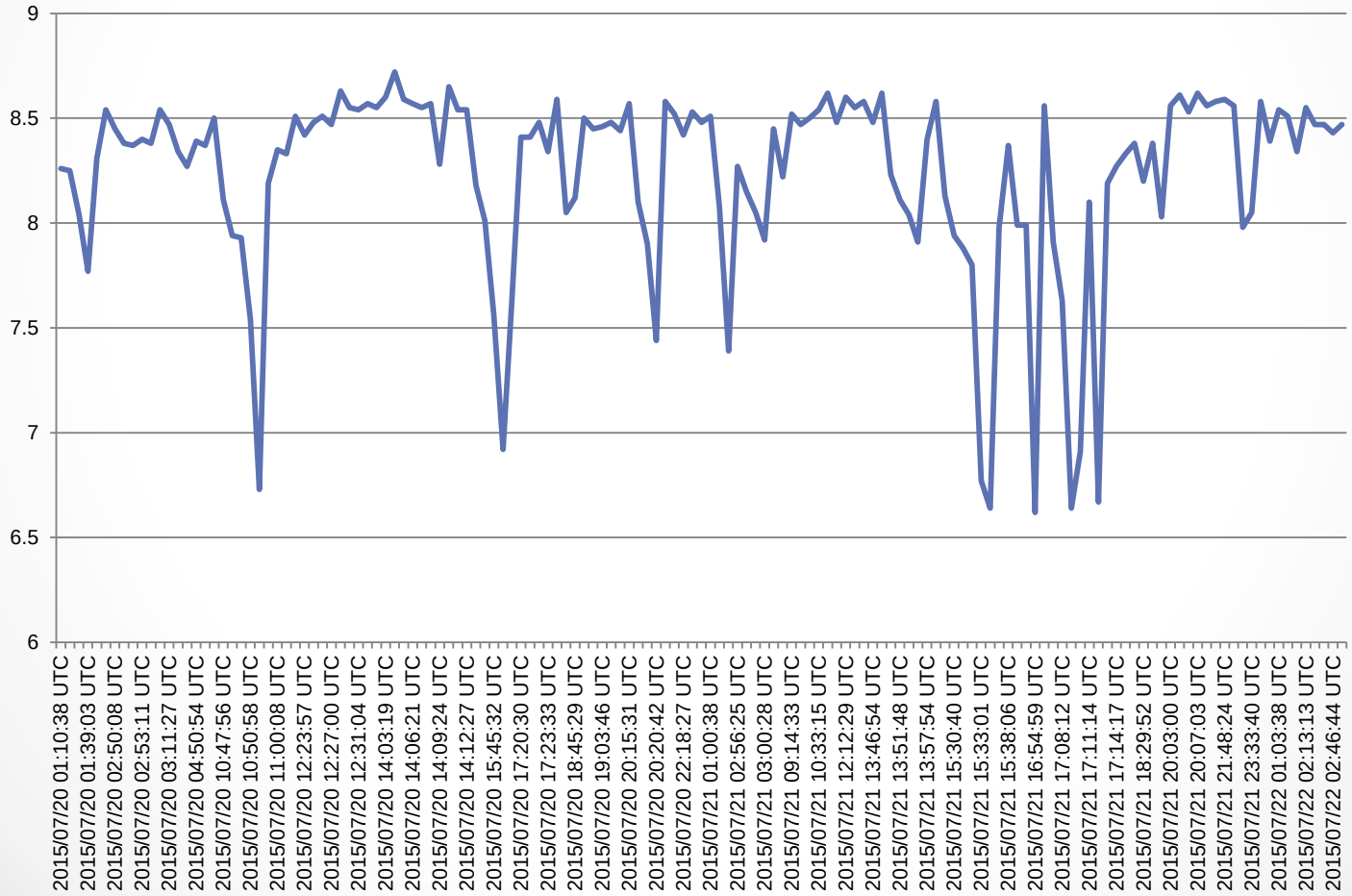
PSAT power system

- power budget positive (normal APRS and PSK31 operations during eclipse season)
- PSK31 AUTO mode



PSAT power system

- battery voltage since July 20
- SAFE mode

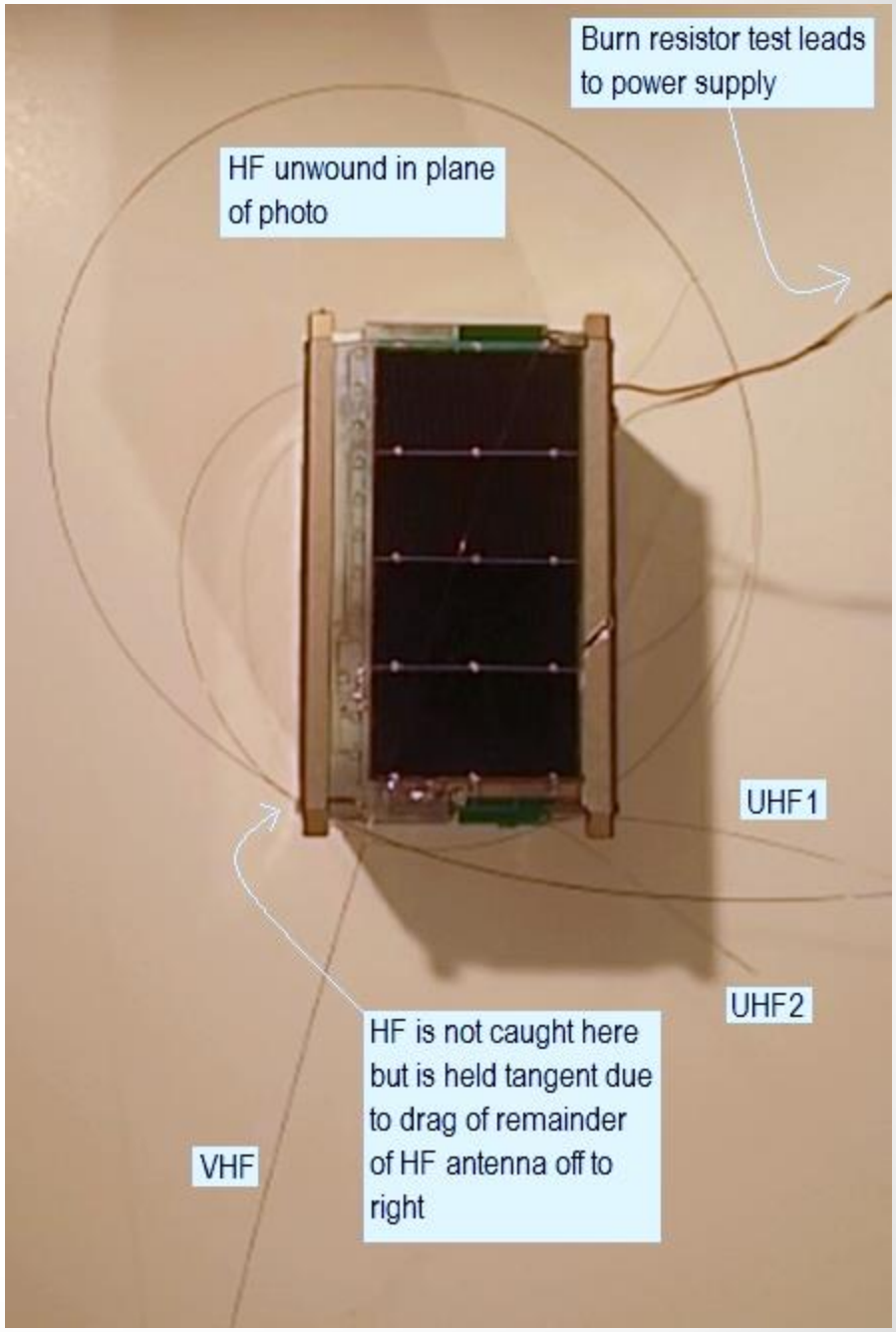


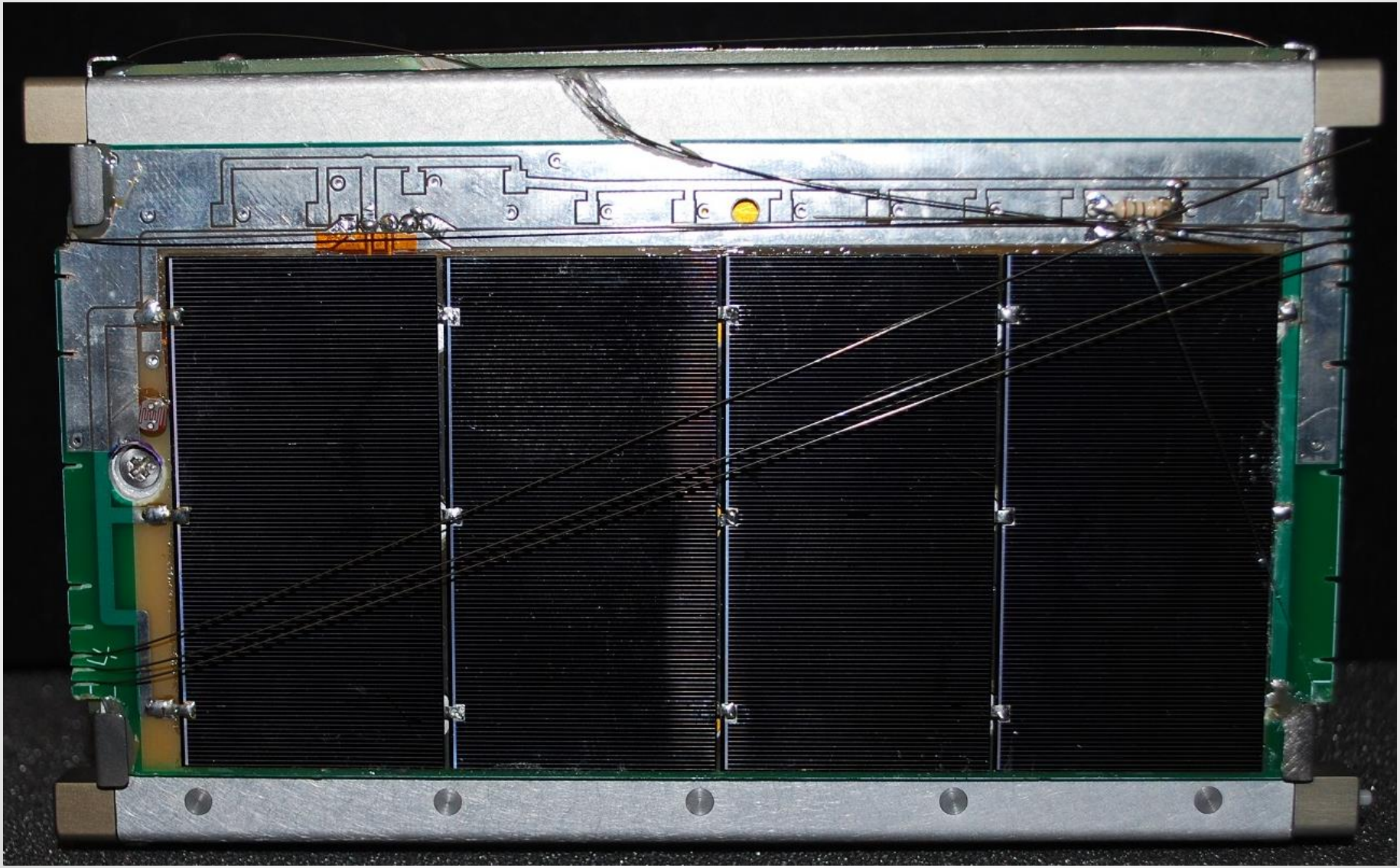
PSAT antennas

VHF:
21" nitinol wire whip (53.3cm)

UHF:
two 6.25” nitinol wire (15.9cm)
fed with a 90 degree hybrid

HF:
72" nitinol wire (1.83m)

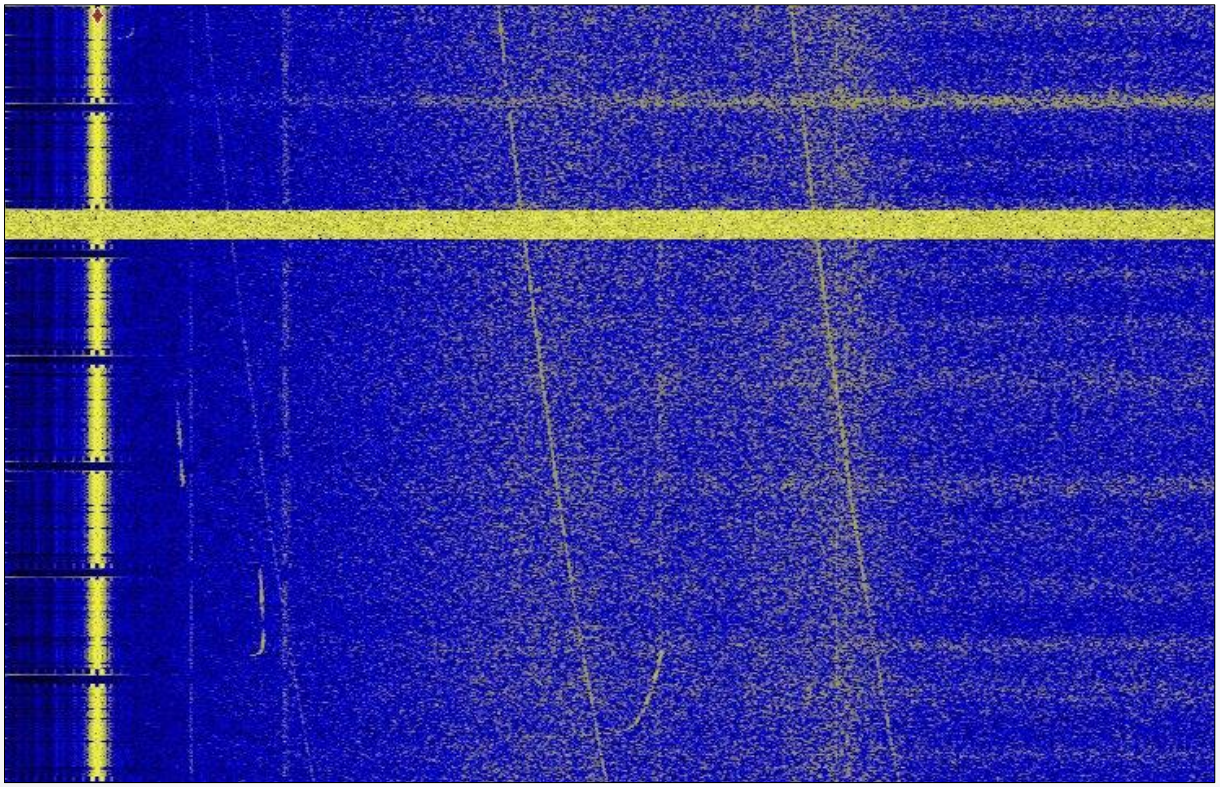




primary mission – PSK1 transponder

Uplink: 28.120 MHz, USB, BPSK31
Downlink: 435.350 MHz, FM, BPSK31

Brno University of Technology



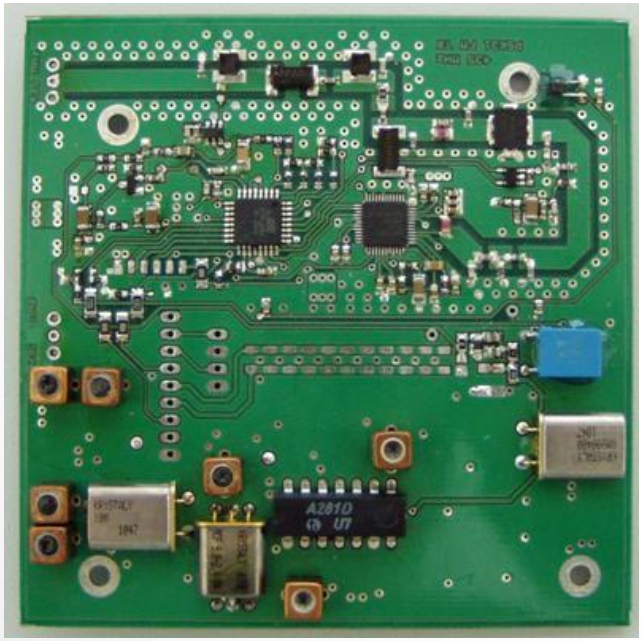
PSK31 transponder

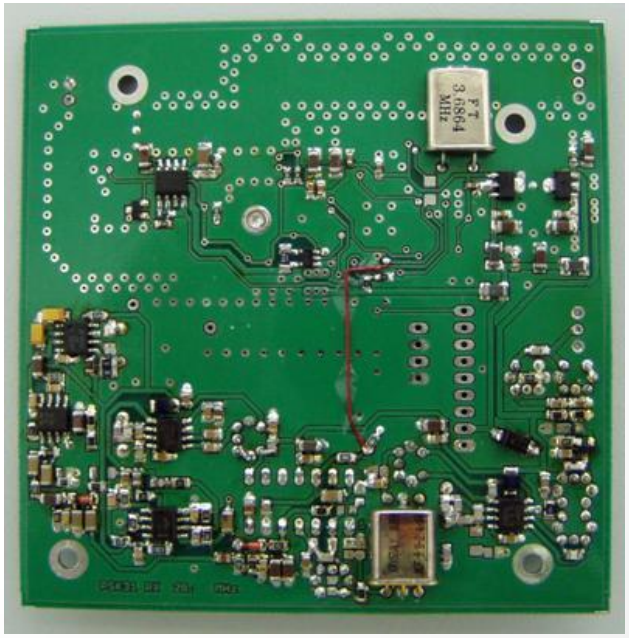
- it permits dozens of simultaneous PSK31 users to operate full duplex (up to 30)
- operating full duplex on PSK-31 is new and it will take a while for users to figure out how to do this

PSK31 Transponder is ON for users
The Brno University PSK31 transponder has been authorized for user uplinks and is working well

operating passband range: 28.120160 MHz - 28.122560 MHz
Output center frequency: 435.350 MHz with FM modulation

The *telemetry* channel at 315 Hz (PSAT) or 365 Hz (BRICsat) is *fixed* with no Doppler, since it is generated onboard into the FM downlink.

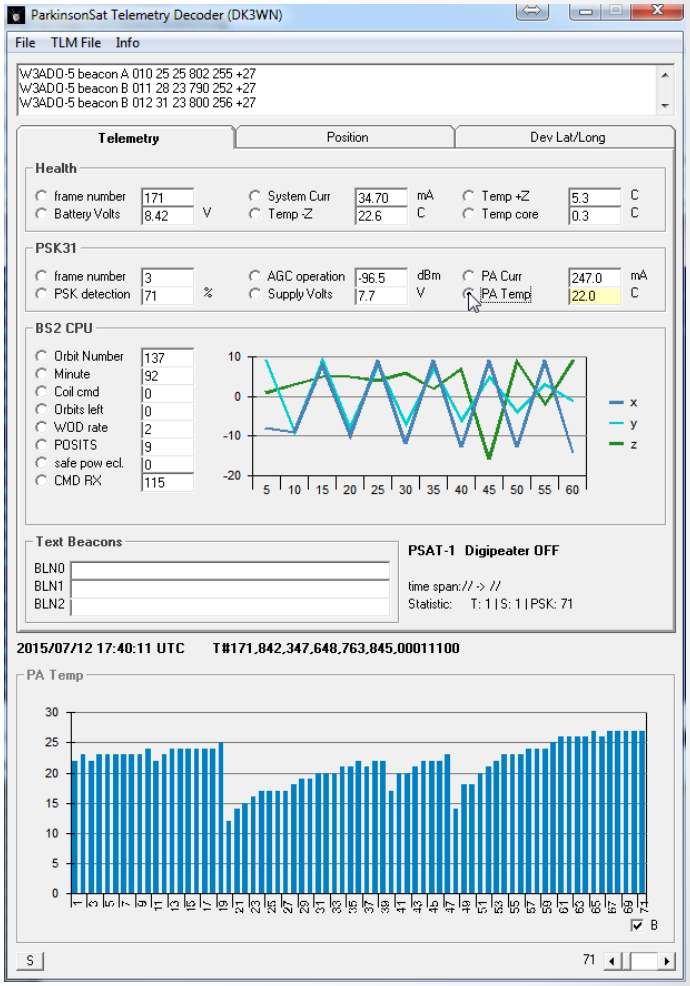




PSAT PSK31 telemetry

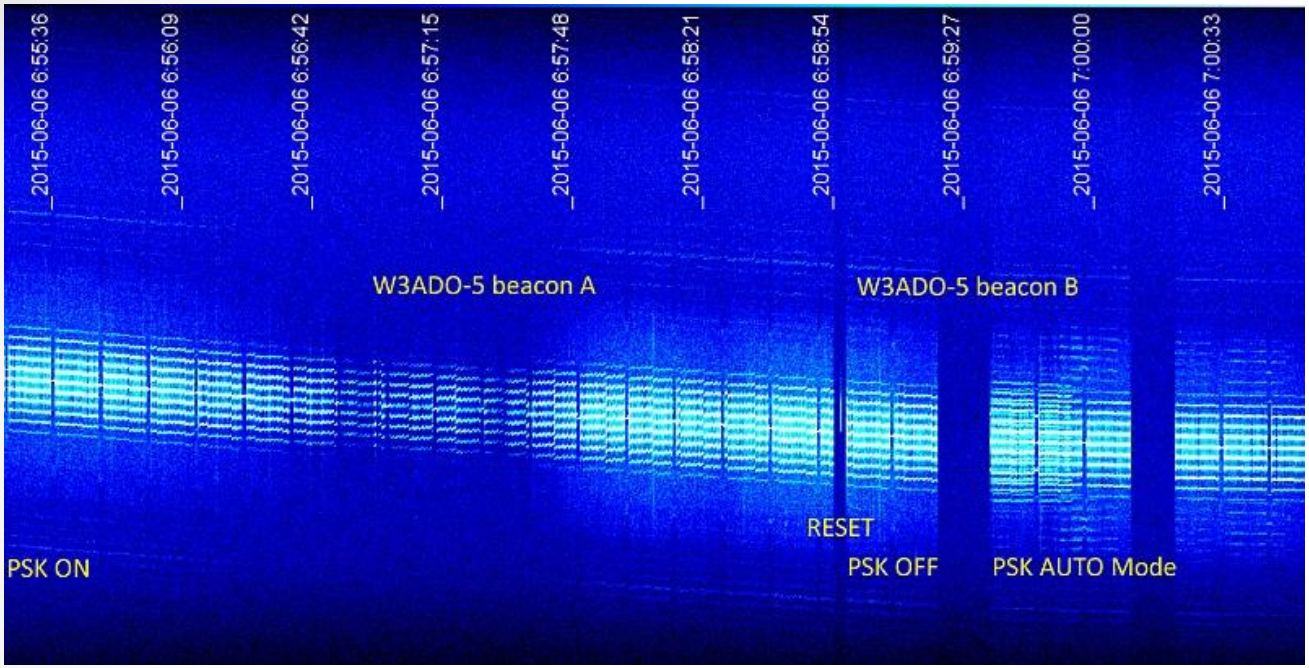
W3ADO beacon MODE NOF DET AGC VC IC TMP

MODE	A or B A - transmitter always on, B - transmitter turns on if BPSK31 signal is present
NOF	number of frame (0 ... 999)
DET	percentage of BPSK31 detection (0 ... 99%)
AGC	percentage of AGC operation (0 ... 99%)
VC	supply voltage (10 mVolts)
IC	power amplifier current (mA)
TMP	temperature of PA transistor (C)




```
W3ADO-5 beacon B 002 34 36 794 248 +24
W3ADO-5 beacon B 003 84 28 795 249 +25
W3ADO-5 beacon B 004 90 44 794 249 +26
W3ADO-5 beacon B 005 65 36 791 248 +26
W3ADO-5 beacon B 006 21 25 788 248 +26
```

PSAT PSK31 telemetry – PSK on




```
[PSK ON]
W3ADO-5 beacon A 023 00 22 807 251 +6
W3ADO-5 beacon A 024 00 22 806 251 +8
W3ADO-5 beacon A 030 03 23 795 252 +13
W3ADO-5 beacon A 031 00 22 794 252 +13
...
W3ADO-5 beacon A 040 00 23 790 249 +16
W3ADO-5 beacon A 041 15 23 788 249 +17
W3ADO-5 . [reset]
W3ADO-5 beacon A 000 12 23 797 247 +16
W3ADO-5 beacon A 001 00 23 790 249 +17
[PSK AUTO mode ON]
W3ADO-5 beacon B 002 34 34 803 245 +12
W3ADO-5 beacon B 003 99 33 791 249 +15
```

249 +32 n
coe
W3ADO-5 beacon B 011 93 44 807 248 +32 eEl
W3ADO-5 beacon B 012 99 30 805 248 +32 neree
W3ADO-5 beacon B 01 r soo W3ADO-5 beacon B
000 40 44 817 246 +29 eoi e
W3ADO-5 beacon B 001 87 47 804 247 +31 3
W3ADO-5 beIO-5 beacon B 001 62 24 818 249 +30
eg.
W3ADO-5 beacon B 002 93 50 809 249 +30
ÛeW3ADO-5 beacon B 003 84 28 811 250 +30 oo
W3ADO-5 beacon B 004 93 44 813 248 +31 aid
W3ADO-5 beacon B 005 99 34 808 249 +31 t =
W3ADO-5 beacon B 006 99 46 810 251 +31 to5e
W3ADO-5 beacon B 007 71 48 809 250 +32 o ao
W3ADO-5 beacon B 008 96 34 806 248 +32 oP a
W3ADO-5 beacon B 009 75 45 807 250 +32 a

45 807 250 +32
QTH :
UP pse DL6TY DL6TY pse k n -la dt
t AMel Col quium July 24-26th at Guildford * 73 de DK3WN * Enjoy the AMSAT-UK .oi oquium
aG5 l
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eUP e oe at
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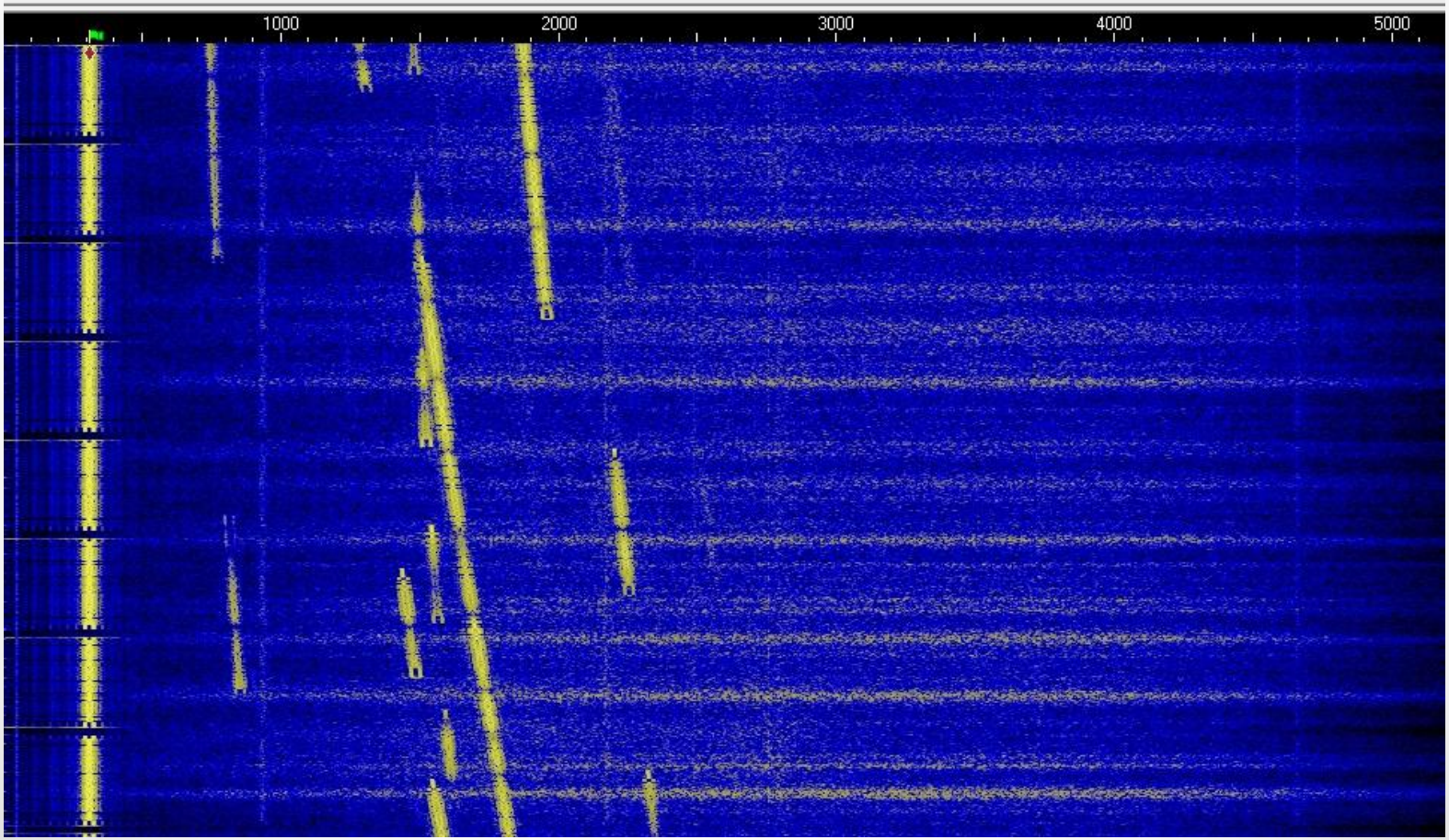


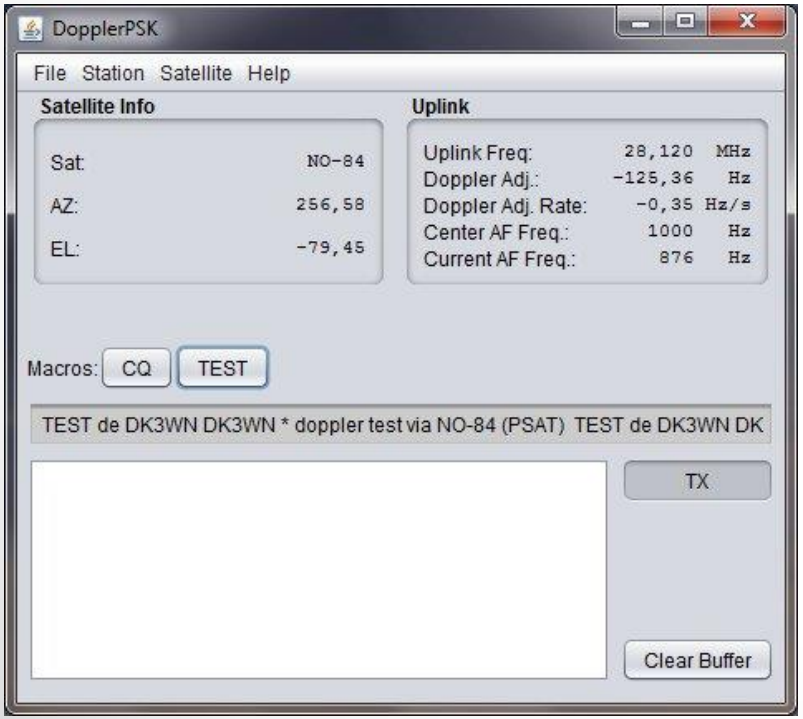
PSK DopplerPSK

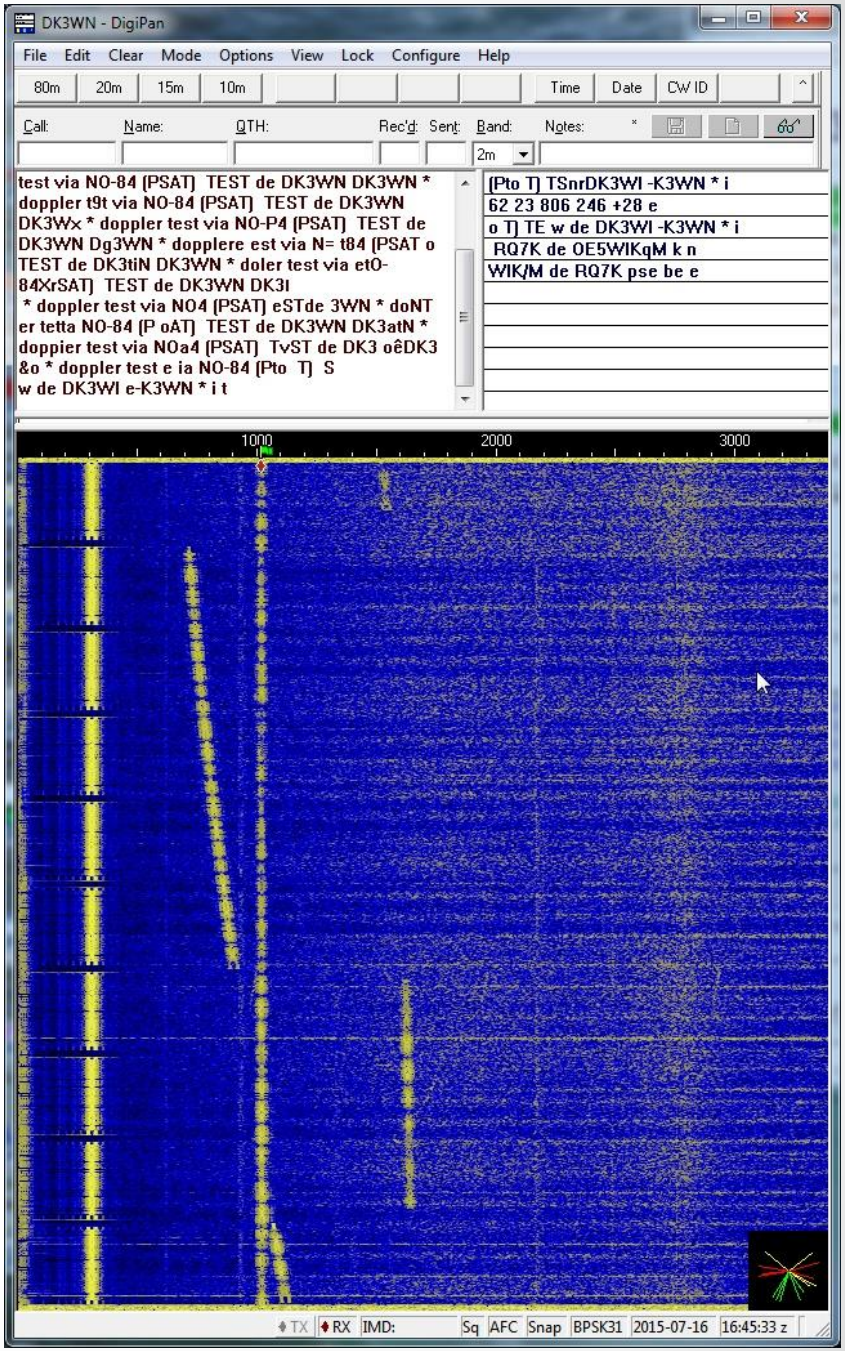
by Andrew Flowers K0SM

• experimental program to compensate the doppler shift on PSK31 uplinks

• its a PSK31 transmitter that is merged with an orbital propagator to cause your the transmitted signal to drift exactly opposite to uplink doppler effect

http://www.frontiernet.net/~aflowers/dopplerpsk/dopplerpsk.html

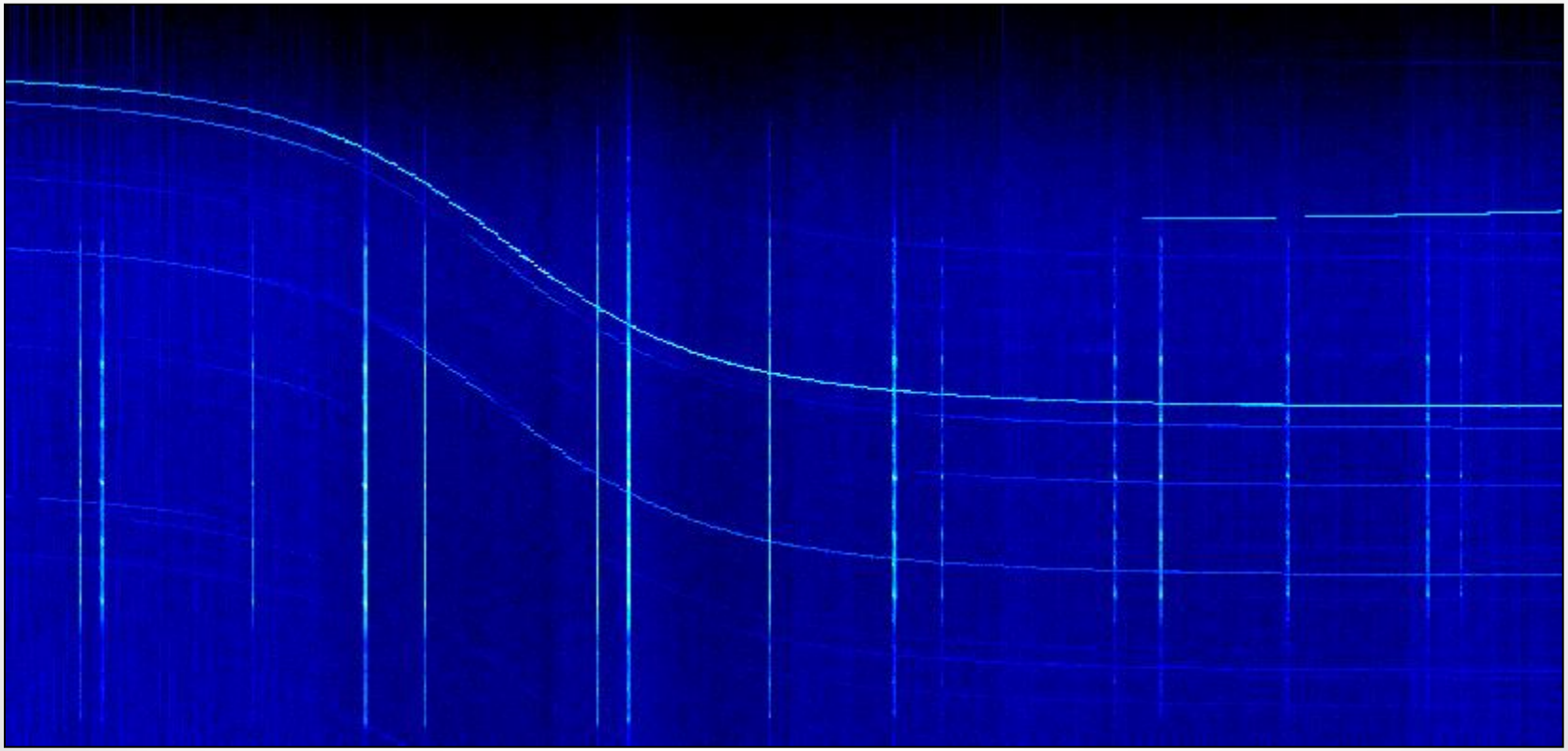




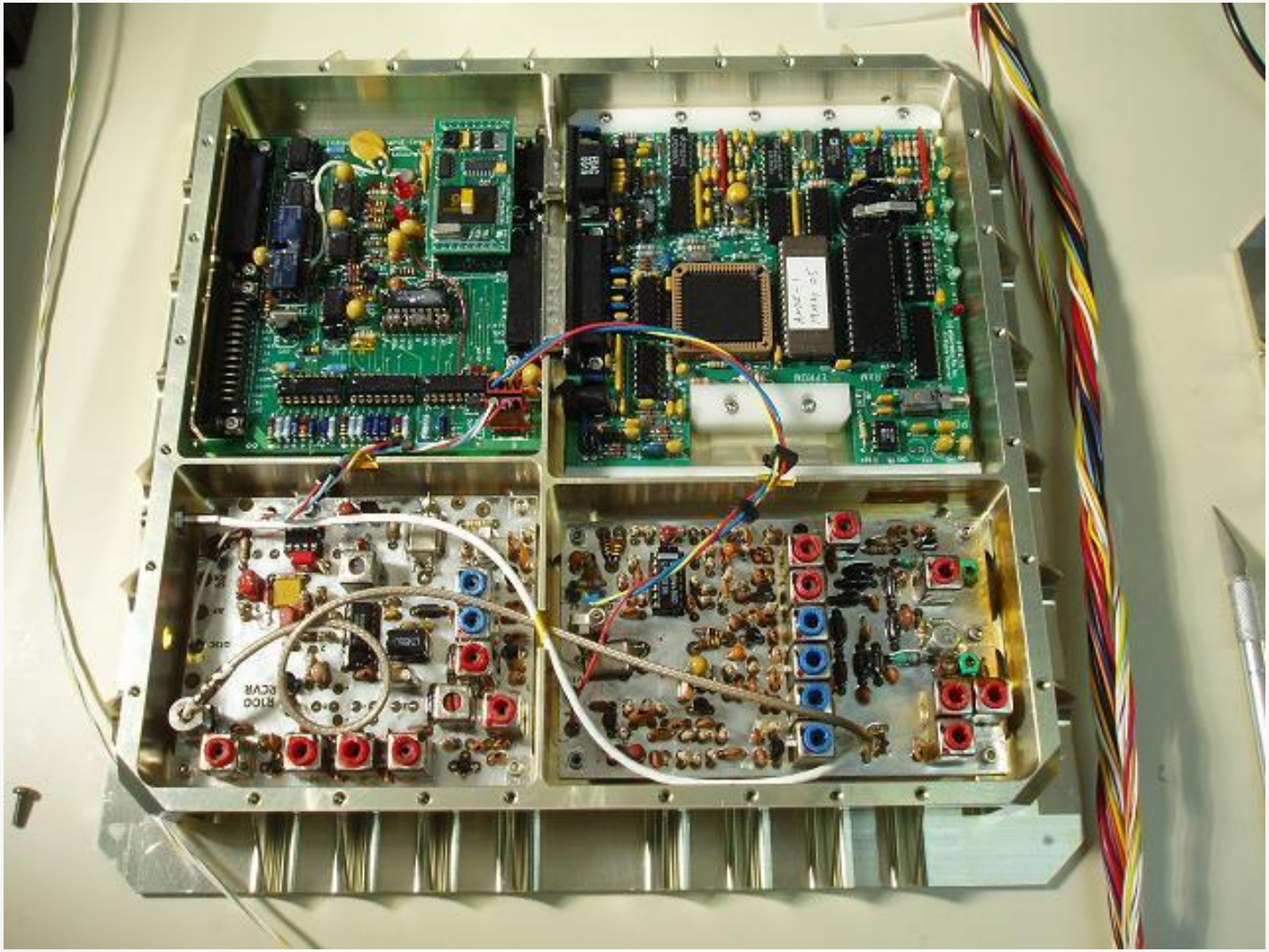
secondary mission – APRS digipeater

Uplink: 145.825 MHz, FM, 1k2 AFSK AX.25
Downlink: 145.825 MHz, FM, 1k2 AFSK AX.25

Byonics Micro-Trak TinyTrak4



previous APRS transponder



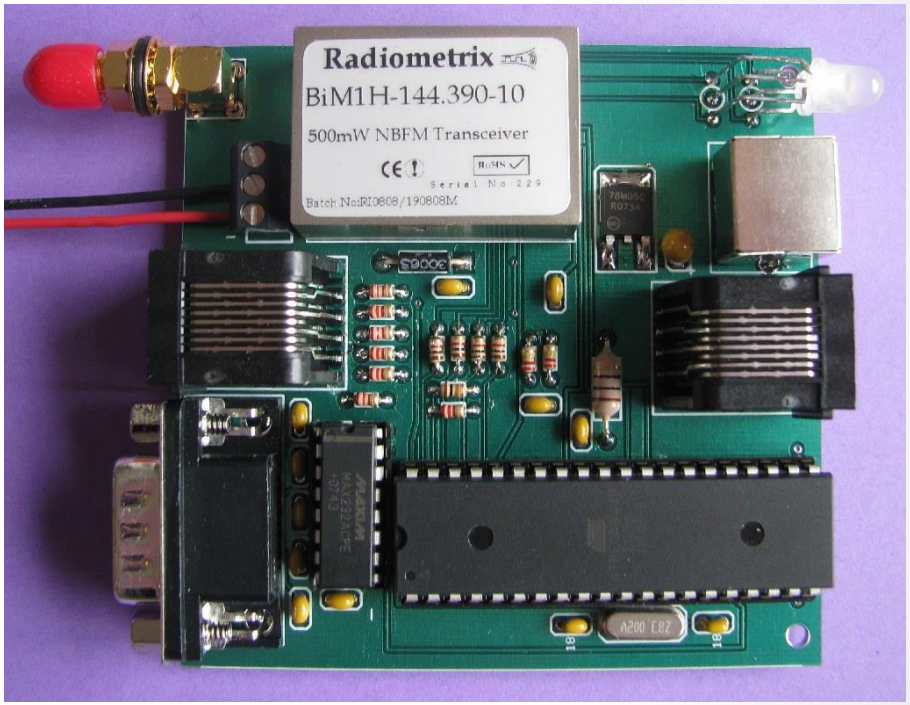
huge reduction from previous APRS transponders on PCSAT's 1,2, ANDE and RAFT missions – now reduced 18:1 in volume/mass

PSAT transceiver

- The Micro-Trak TinyTrak4 (MT-TT4) is a Byonics TinyTrak4 controller combined with a single channel, crystal controlled 500mW radio
- 5 telemetry channels

Transmitter
RF Power output <+ 28 dBm
Spurious Emissions -36 dBm
Adjacent channel Transmission power -37 dBm
FM Frequency Deviation (peak) +/- 3.5 kHz
Enable timing 8 ms
Current 280 mA @ 5 VDC

Receiver
RF sensitivity @ 2dB SINAD -120 dBm
RF sensitivity @ 1ppm BER -115 dBm
RSSI Threshold -127 dBm
RSSI Range 60 dB
Blocking 88 dB
Image and Spurious emission -70 dBm
Adjacent channel rejection -70 dBm
LO Leakage, re-radiated -60 dBm
Current 8 mA @ 5 VDC
Operating temperature -10 to + 60 C



- When the DIGI is on, the satellite callsign is PSAT
- When it is off (SAFE mode), the callsign is PSAT-1
- The ALIASes are the usual, ARISS, APRSAT and WIDE
- 4 packet types (BS2 telemetry, MT-TT4 telemetry, position, bulletins)

PSAT BS2 CPU telemetry

S#033814,0z290

S#OOOOMM,CzWPS

S	upper case means the command receiver is awake and "s" means it is napping
#OOOO	is the orbit number (up to 9999)
MM	minute in that orbit (00-95)
C	coil command mode (0,1,2)
z	orbits left in the 4 day reset counter (base 62) –> broken! Is ALWAYS z
W	WOD telemetry RATE (1,2,3,4, etc. Every W MA counts) 0=off
P	POSITS enabled over 1 USA, 2 Europe, 3 Japan, 4 AuNz, 5 SA, 6 AF, 7 HI
S	SavePower in dark if 1. Normal if 0.

```
20150621160200,PSAT>APRSON,ARISS,qAR,UA0SNV-1:s#033331,0z200,qhDqhEqhFqhHqhIqhIpiJpiKpiLphLphMphM
20150621160359,PSAT>APRSON,ARISS,qAR,UA0SNV-1:s#033333,0z200,cDPaFP0HPAIPBJOCJOEKOGLOHLOHLOGMNGMN
20150621204944,PSAT>APRSON,ARISS,qAR,HG8GL-5 :Hi!
20150621205117,PSAT>APRSON,ARISS,qAR,DK3WN-1: S#033813,0z290,pLJpMJoMInMInNGnNGnMFnNCnNbnNdnNfnNg
20150621205224,PSAT>APRSON,ARISS,qAR,DK3WN-1: S#033814,0z290,oMgoMhpMipMipLipLiqKiqJiqHiqFiq0hqeg
```

PSAT BS2 CPU telemetry – spin analysis

S#033814,0z290,qhDqhEqhFqhHqhIqhIpiJpiKpiLphLphMphM

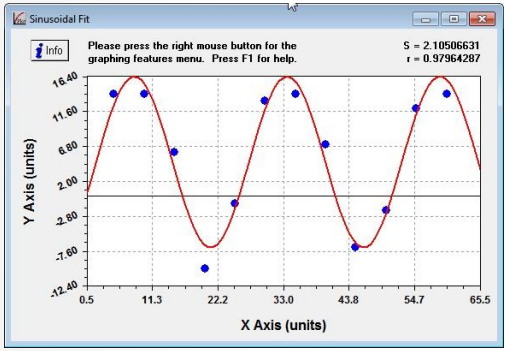
0z200 -> WOD=2 -> 12 samples every 5 sec

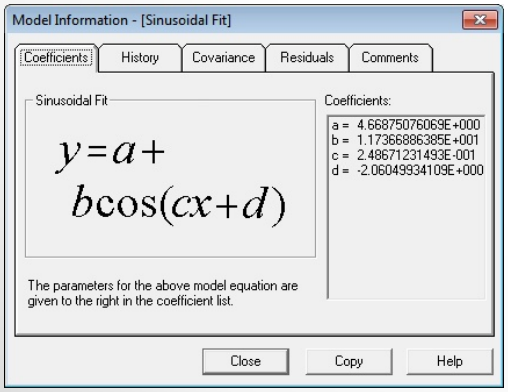
sun vector triplets

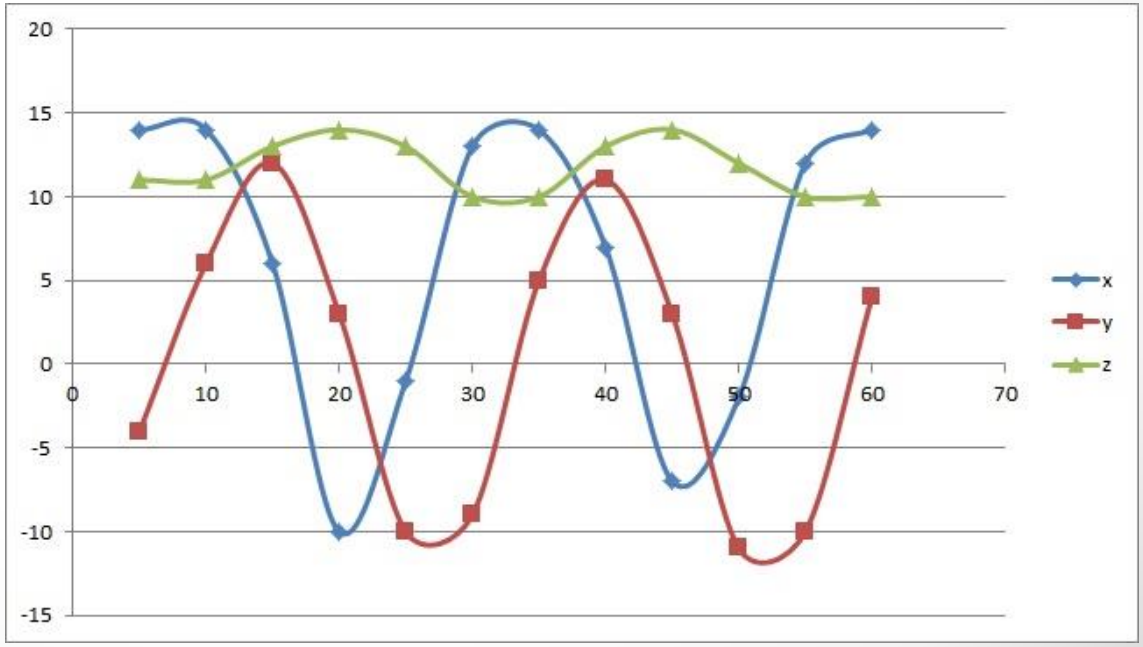
```
xyz xyz xyz xyz xyz xyz xyz xyz xyz xyz xyz xyz
-----------------------------------------------
NdK NFK FLM jCN ajM MiJ NEJ GKM gCN bkL LjJ NDJ
```

values A-Z = +1 to + 26, a-z = -1 to -26

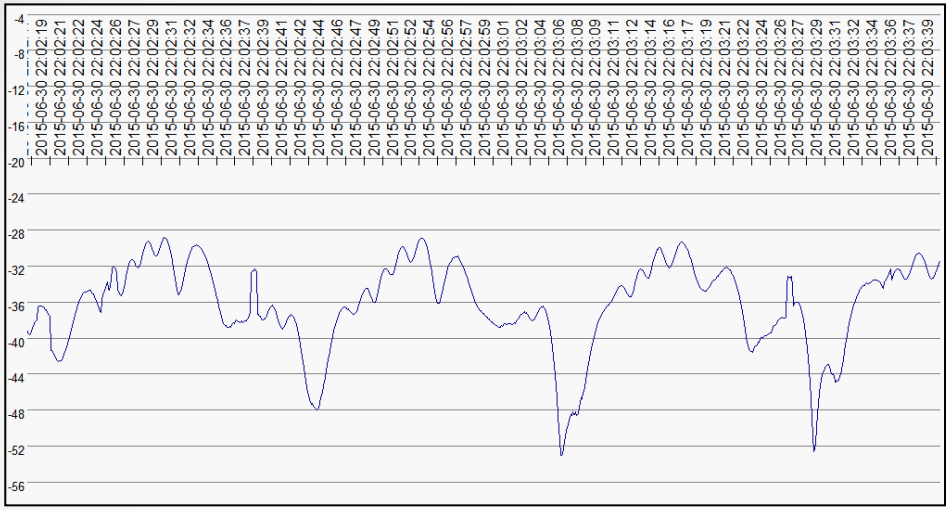
sec	x	y	z
5	14	-4	11
10	14	6	11
15	6	12	13
20	-10	3	14
25	-1	-10	13
30	13	-9	10
35	14	5	10
40	7	11	13
45	-7	3	14
50	-2	-11	12
55	12	-10	10
60	14	4	10



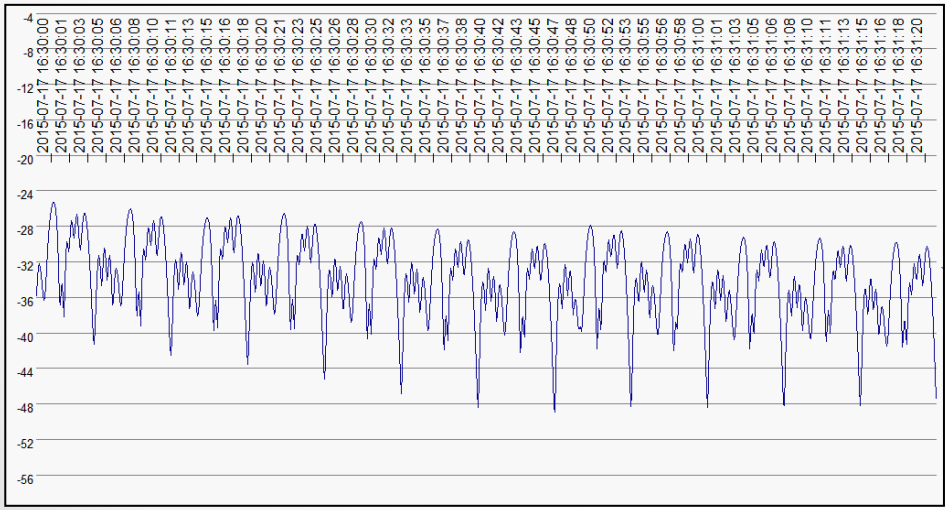




PSAT spin analysis

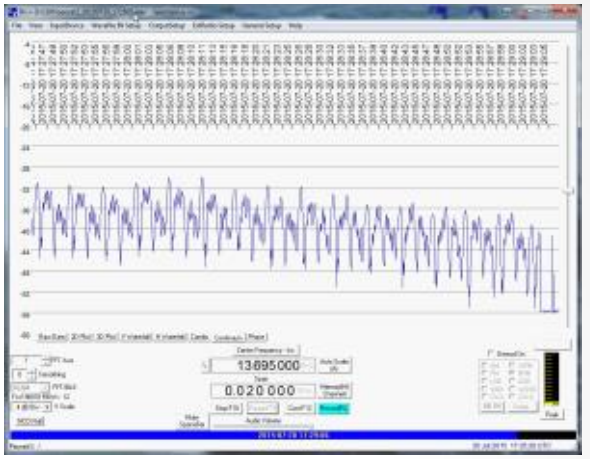


30 June -> 23 sec interval -> 2.6 rpm

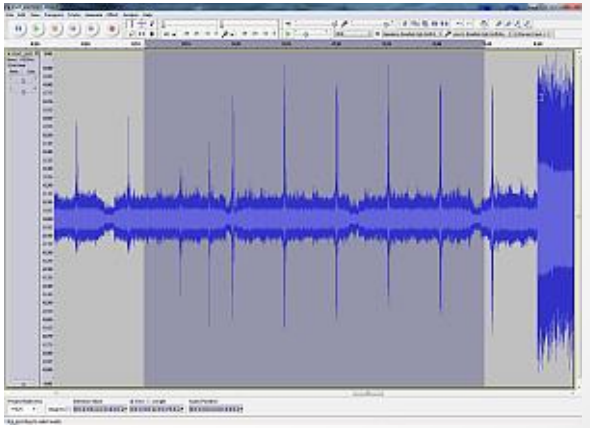


17 July -> 7 sec interval -> 8.6 rpm

RF field strength analysis
PSK31 transponder



SpectraVue => contiunuum plot



Audacity -> envelope curve

PSAT MT-TT4 CPU telemetry

T#815,802,361,867,491,371,00011000

T#SSS, VVV, III, XXX, YYY, ZZZ, 00011X00

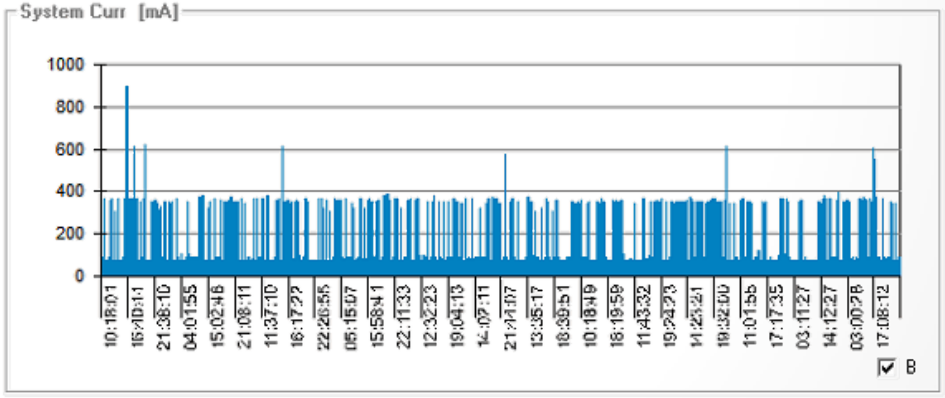
VVV	Bus Volts in mV
III	Bus Current in mA
XXX	Temp +Z
YYY	Temp - Z
ZZZ	Temp Bat

where T = -1.26E-6*X^3 +0.0028*X^2 -2.215*X + 625

where T = -1.26E-6*X^3 +0.0028*X^2 -2.215*X + 625

where T = -2.57E-6*X^3 +0.0061*X^2 -5.149*X +1475

X has meaning: 0 = digi on
1 = digi off

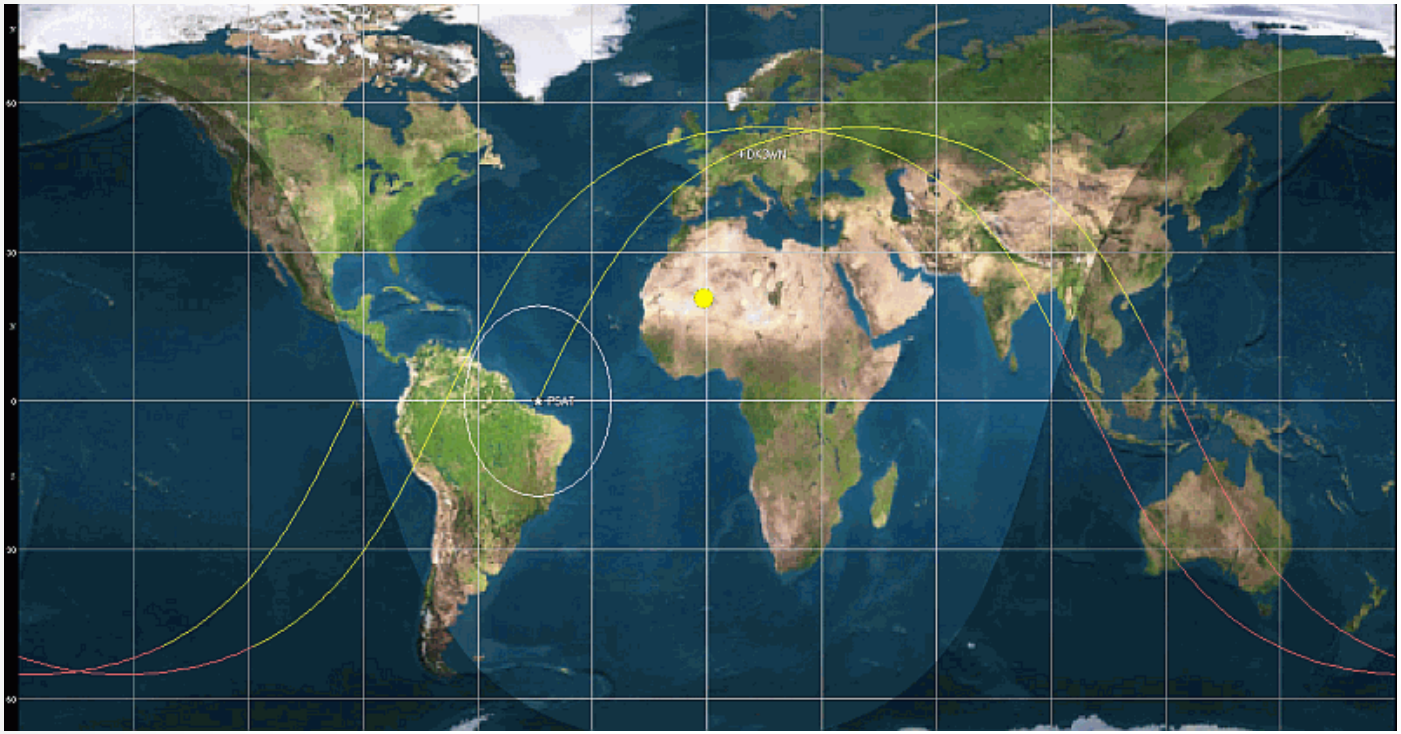



```
20150629190509,PSAT>APRSON,ARISS,qAR,DK3WN-8:T#815,802,361,867,491,371,00011000
20150629190610,PSAT>APRSON,ARISS,qAR,DK3WN-8:T#816,816,085,869,494,371,00011000
20150629191115,PSAT>APRSON,ARISS,qAR,UA0SNV-1:T#821,820,086,882,488,372,00011000
20150629191216,PSAT>APRSON,ARISS,qAR,UA0SNV-1:T#822,823,086,885,489,372,00011000
20150629191317,PSAT>APRSON,ARISS,qAR,UA0SNV-1:T#823,826,083,887,493,372,00011000
```

PSAT position packets

!48 . N\027 . ES120/999/W3ADO s#000133,0z090

PSAT can generate its own APRS position report from a simple Lat/Long orbit table



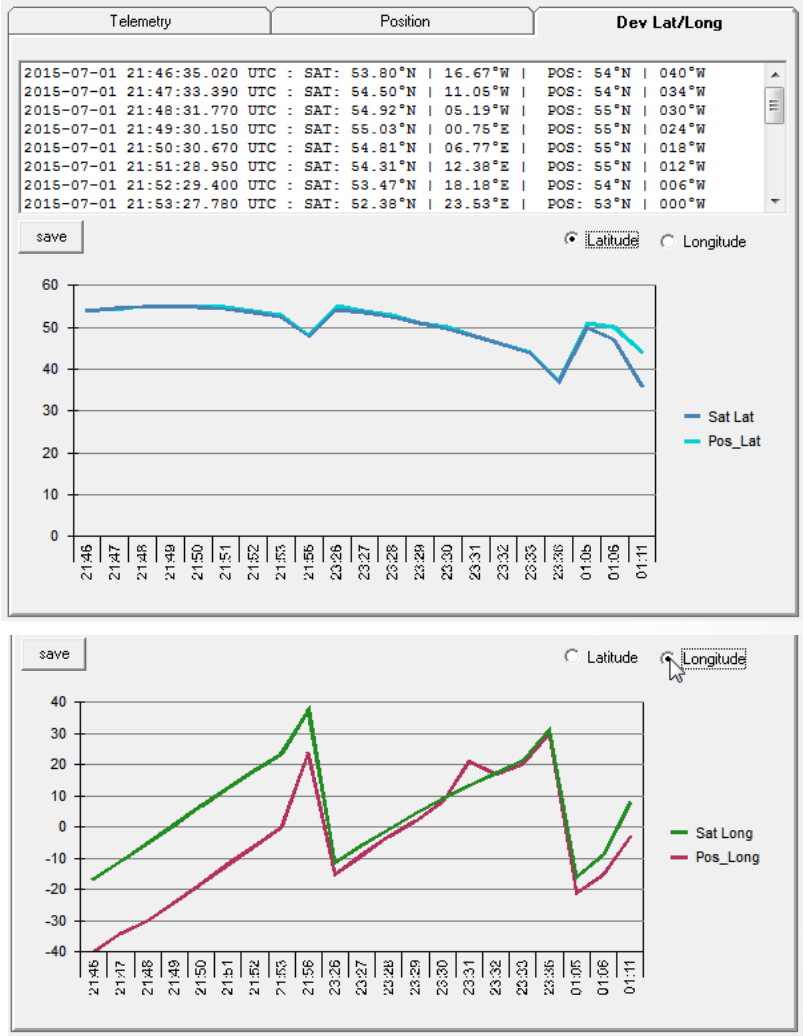

```
20150629001541,PSAT>APRSON,ARISS,qAR,DK3WN-8: !48 . N\027 . ES120/999/W3ADO s#000133,0z090
20150629001641,PSAT>APRSON,ARISS,qAR,DK3WN-8: !41 . N\023 . ES120/999/W3ADO s#000134,0z090
20150629012351,PSAT>APRSON,ARISS,qAS,K8YSE-4: !15 . N\118 . WS040/999/W3ADO s#000206,0z090
20150629012551,PSAT>APRSON,ARISS,qAS,K8YSE-4: !21 . N\114 . WS040/999/W3ADO s#000208,0z090
```

PSAT position packets

Maintenance Operations

- fix orbit period
- fix MA counter
- fix longitude

Once the position is predictable, then we can use that data to only enable position reports and bulletins over countries with an Amateur Radio population.



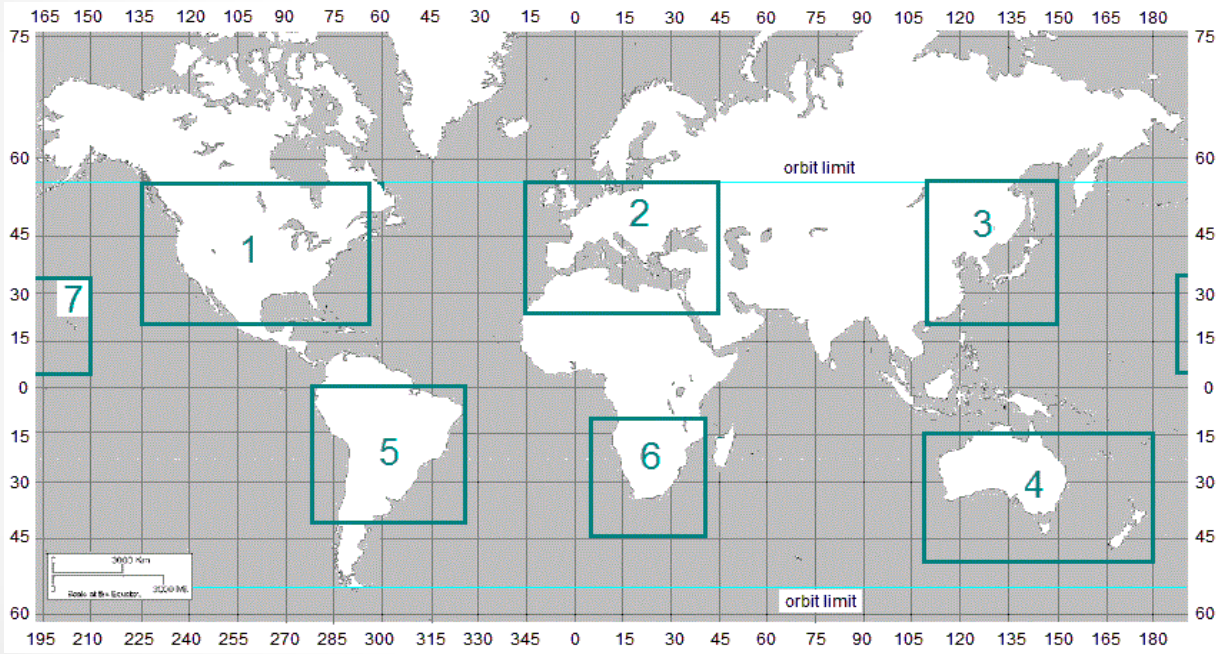
extended timestamp:
AGW-OnlineKISS, OnlineKISS

```
[61 Bytes TIME Frame]
   1 > C0 09 32 30 31 35 2D 30 37 2D 31 39 20 31 39 3A 31 39 3A 32
  21 > 35 2E 35 37 30 20 55 54 43 3B 32 30 31 2E 35 3B 31 33 2E 36
  41 > 3B 39 34 2E 39 3B 32 2E 32 32 B0 45 3B 33 35 2E 32 38 B0 4E
  61 > C0
2015-07-19 19:19:25.570 UTC;201.5;13.6;94.9;2.22°E;35.28°N
```

PSAT bulletin packets

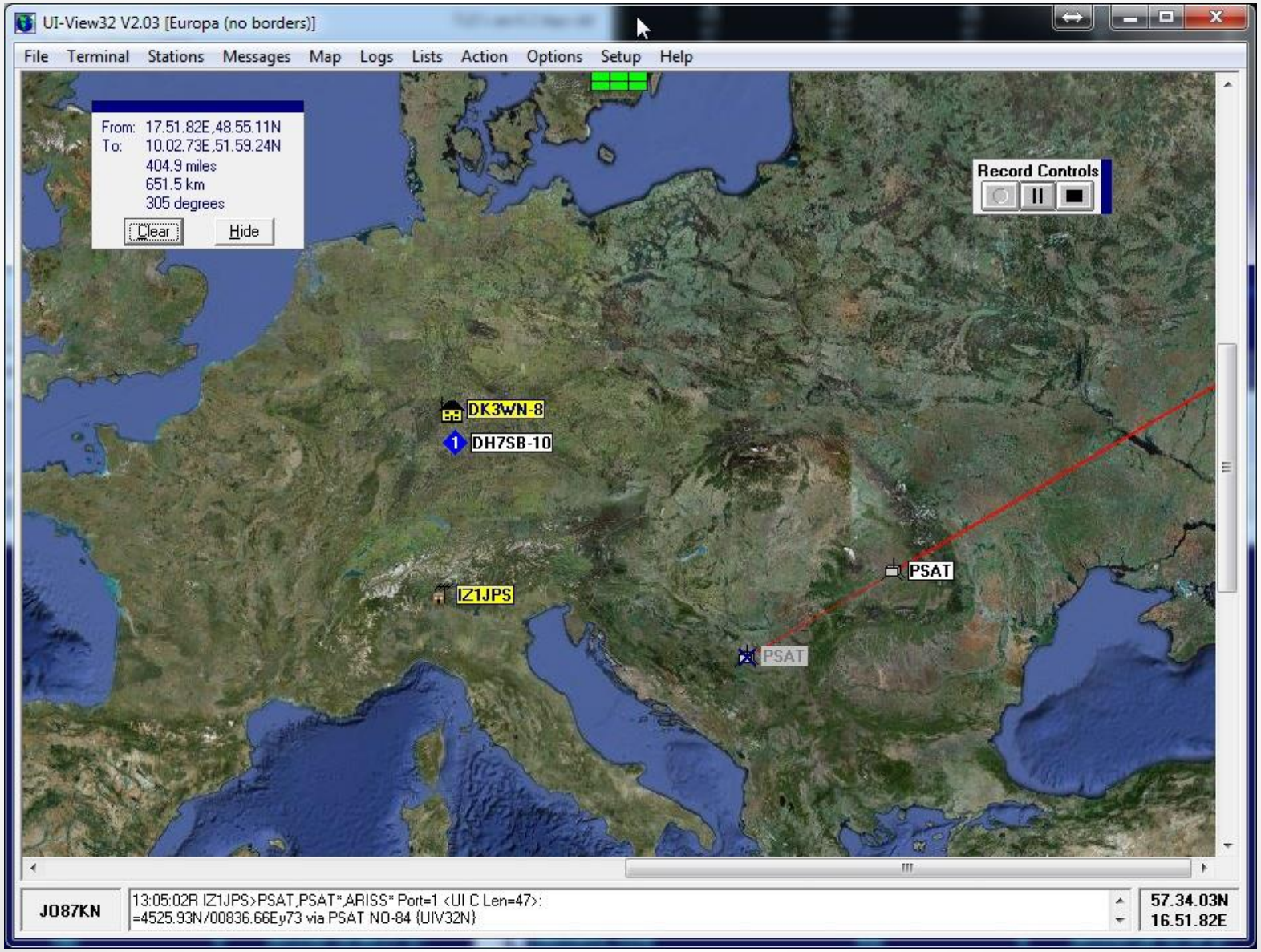
PSAT contains 3 bulletins for every country area, BLN0USA, BLN1USA,BLN2USA for example over the USA. The same geographical areas are used for sending Bulletins.

the higher priority BLN0 is sent every 2 minutes and the other two are sent every 4 minutes on the alternating 2 which results in one bulletin per minute if enabled.

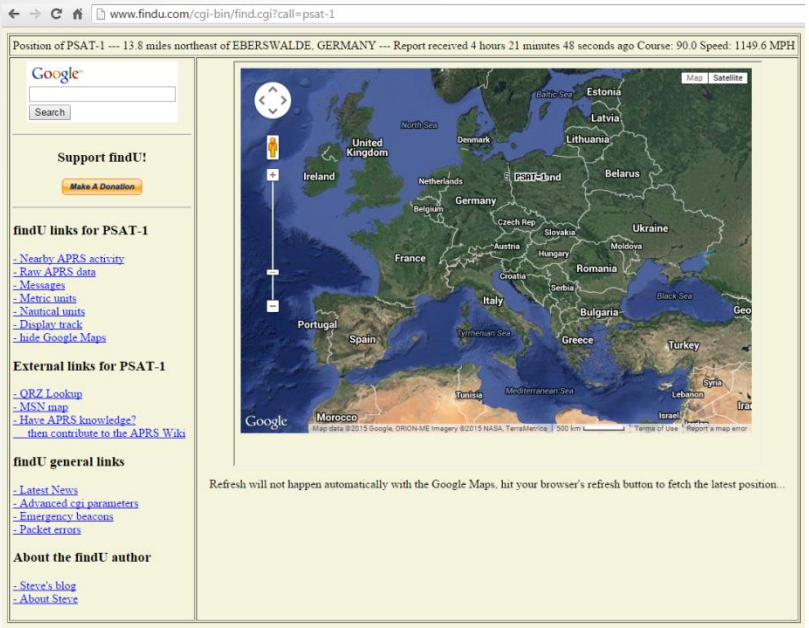


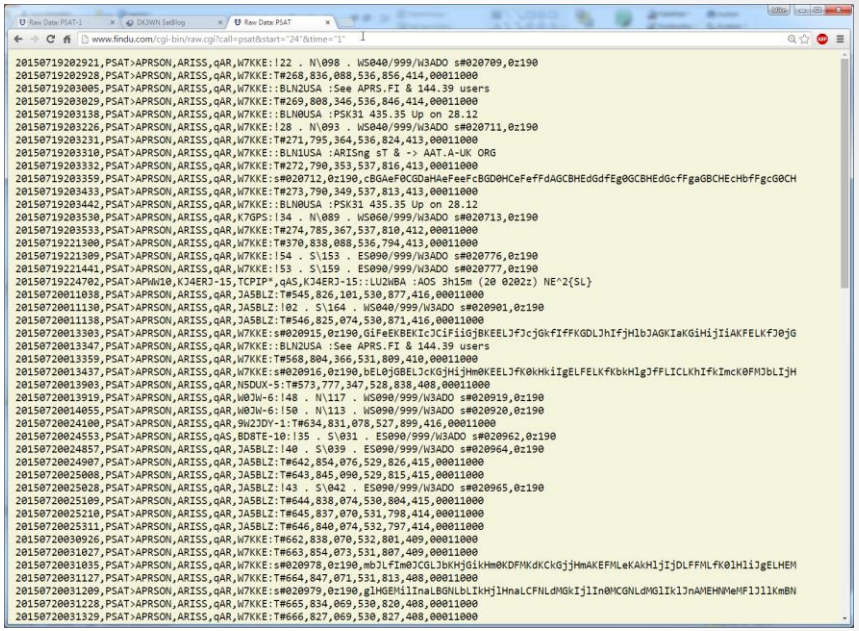

```
20150524130133,PSAT-1>APOFF,ARISS,qAR,ON7EQ-10::BLN0USA :PSK31 435.35 Up on 28.12
20150524080458,PSAT-1>APOFF,ARISS,qAR,HG8GL-5::BLN1USA :ARISS.NET & PCSAT.APRS.ORG
20150522100551,PSAT-1>APOFF,ARISS,qAR,ON7EQ-10::BLN2USA :See APRS.FI & 144.39 users
20150629222129,PSAT>APRSON,ARISS,qAR,DK3WN-8::BLN0EUR :PSK31 435.35 Up on 28.12
20150629222129,PSAT>APRSON,ARISS,qAR,DK3WN-8::BLN1EUR :Coming soon -> AMSAT-UK Colloquium July 24-26th at Guildford
20150629222130,PSAT>APRSON,ARISS,qAR,DK3WN-8::BLN2EUR :See APRS.FI & 144.80 users
```

UI-View


UI-View32 V2.03 [Europa (no borders)]
File Terminal Stations Messages Map Logs Lists Action Options Setup Help
From: 17.51.82E,48.55.11N
To: 10.02.73E,51.59.24N
404.9 miles
651.5 km
305 degrees
Clear
Hide
Record Controls
DK3WN-8
DH7SB-10
IZ1JPS
PSAT
PSAT
JO87KN
13:05:02R IZ1JPS>PSAT,PSAT*,ARISS* Port=1 <UI C Len=47>:
=4525.93N/00836.66Ey73 via PSAT NO-84 {UIV32N}
57.34.03N
16.51.82E

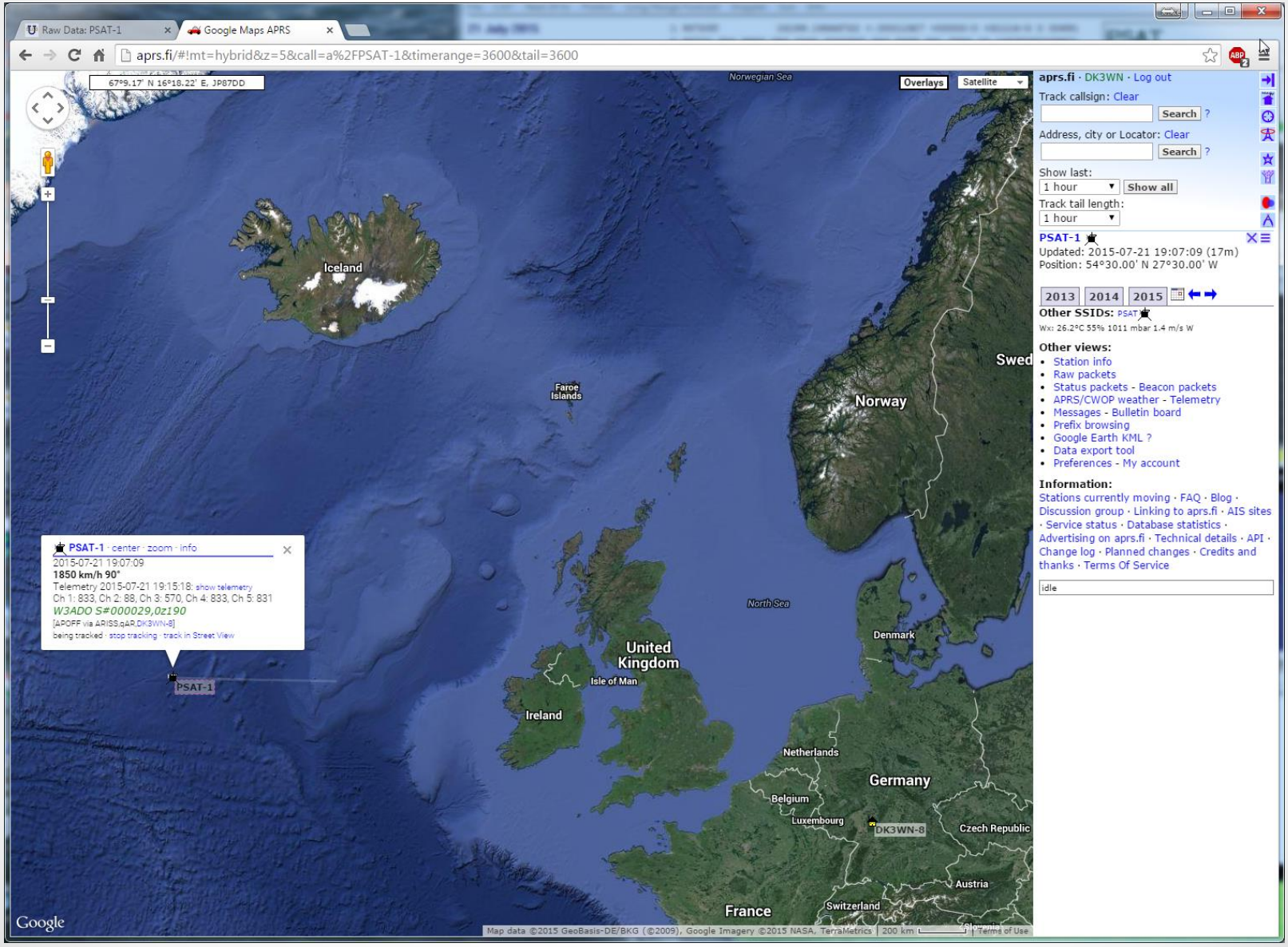
findu.com



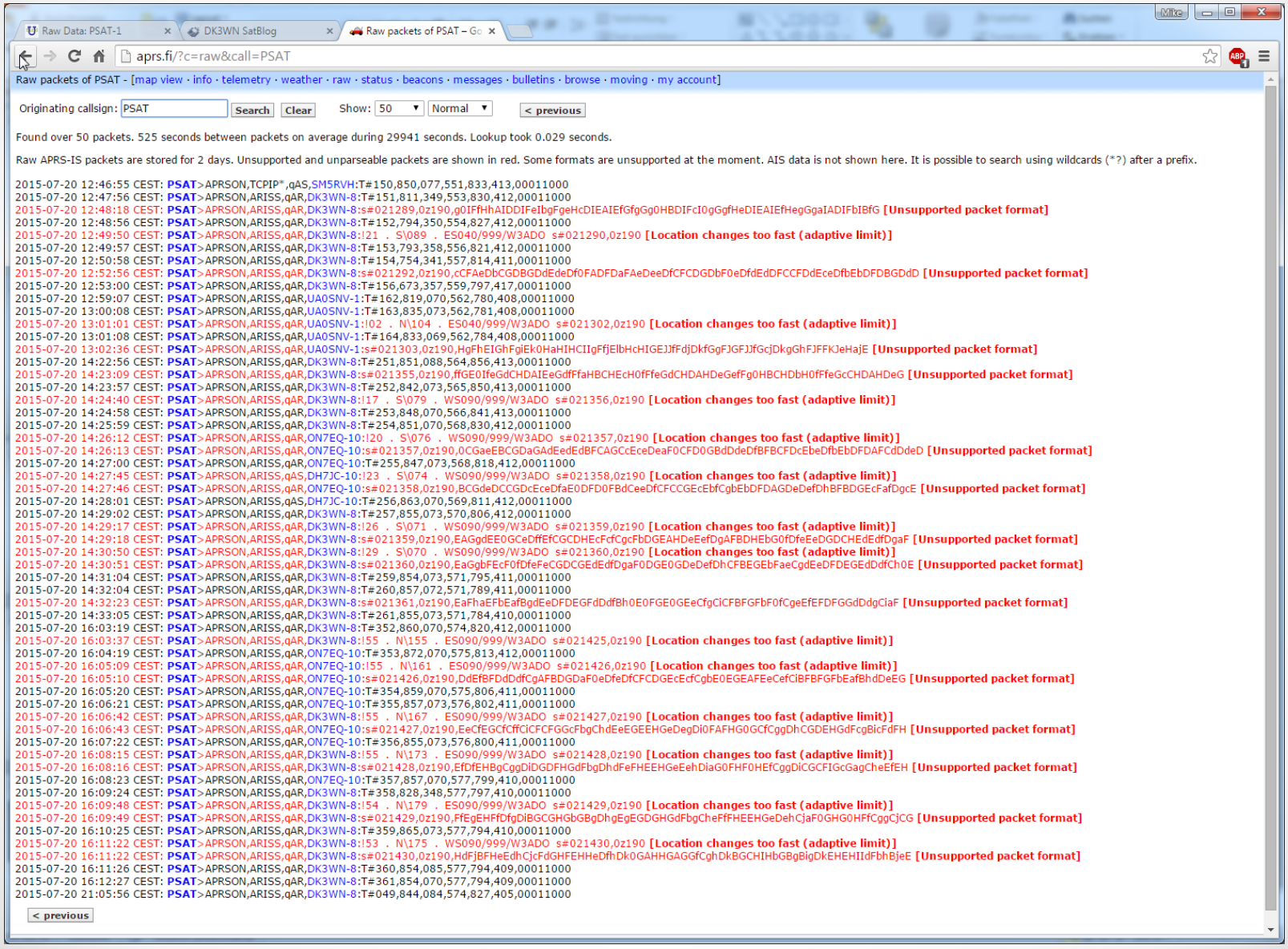


http://www.findu.com/cgi-bin/raw.cgi?call=psat&start=24&time=1
http://www.findu.com/cgi-bin/raw.cgi?call=psat-1&start=320

aprs.fi


Raw Data: PSAT-1
Google Maps APRS
aprs.fi/#!mt=hybrid&z=5&call=a%2FPSAT-1&timerange=3600&tail=3600
67°09.17' N 16°18.22' E, JP87DD
Overlays
Satellite
Norwegian Sea
Iceland
Faroe Islands
Norway
Swed
North Sea
United Kingdom
Isle of Man
Ireland
Denmark
Netherlands
Germany
Belgium
Luxembourg
DK3WN-8
Czech Republic
Austria
Switzerland
France
PSAT-1 · center · zoom · info
2015-07-21 19:07:09
1850 km/h 90°
Telemetry 2015-07-21 19:15:18: show telemetry
Ch 1: 833, Ch 2: 88, Ch 3: 570, Ch 4: 833, Ch 5: 831
W3ADO S#000029,0z190
[APOFF via ARISS,qAR,DK3WN-8]
being tracked · stop tracking · track in Street View
PSAT-1
aprs.fi · DK3WN · Log out
Track callsign: Clear
Search ?
Address, city or Locator: Clear
Search ?
Show last:
1 hour
Show all
Track tail length:
1 hour
PSAT-1
Updated: 2015-07-21 19:07:09 (17m)
Position: 54°30.00' N 27°30.00' W
2013
2014
2015
Other SSIDs: PSAT-1
Wx: 26.2°C 55% 1011 mbar 1.4 m/s W
Other views:
Station info
Raw packets
Status packets - Beacon packets
APRS/CWOP weather - Telemetry
Messages - Bulletin board
Prefix browsing
Google Earth KML ?
Data export tool
Preferences - My account
Information:
Stations currently moving · FAQ · Blog · Discussion group · Linking to aprs.fi · AIS sites · Service status · Database statistics · Advertising on aprs.fi · Technical details · API · Change log · Planned changes · Credits and thanks · Terms Of Service
idle
Google
Map data ©2015 GeoBasis-DE/BKG (©2009), Google Imagery ©2015 NASA, TerraMetrics
200 km
Terms of Use

aprs.fi


Raw Data: PSAT-1
DK3WN SatBlog
Raw packets of PSAT – Go
aprs.fi/?c=raw&call=PSAT
Raw packets of PSAT - [map view · info · telemetry · weather · raw · status · beacons · messages · bulletins · browse · moving · my account]
Originating callsign: PSAT
Search
Clear
Show: 50
Normal
< previous
Found over 50 packets. 525 seconds between packets on average during 29941 seconds. Lookup took 0.029 seconds.
Raw APRS-IS packets are stored for 2 days. Unsupported and unparseable packets are shown in red. Some formats are unsupported at the moment. AIS data is not shown here. It is possible to search using wildcards (*?) after a prefix.
2015-07-20 12:46:55 CEST: PSAT>APRSON,TCPIP*,qAS,SM5RVH:T#150,850,077,551,833,413,00011000
2015-07-20 12:47:56 CEST: PSAT>APRSON,ARISS,qAR,DK3WN-8:T#151,811,349,553,830,412,00011000
2015-07-20 12:48:18 CEST: PSAT>APRSON,ARISS,qAR,DK3WN-8:s#021289,0z190,g0IFfHhAIDDIFeIbgFgeHcDIEAIEfGfgGg0HBDIFcI0gGgfHeDIEAIEfHegGgaIADIFbIBfG [Unsupported packet format]
2015-07-20 12:48:56 CEST: PSAT>APRSON,ARISS,qAR,DK3WN-8:T#152,794,350,554,827,412,00011000
2015-07-20 12:49:50 CEST: PSAT>APRSON,ARISS,qAR,DK3WN-8:!21 . S\089 . ES040/999/W3ADO s#021290,0z190 [Location changes too fast (adaptive limit)]
2015-07-20 12:49:57 CEST: PSAT>APRSON,ARISS,qAR,DK3WN-8:T#153,793,358,556,821,412,00011000
2015-07-20 12:50:58 CEST: PSAT>APRSON,ARISS,qAR,DK3WN-8:T#154,754,341,557,814,411,00011000
2015-07-20 12:52:56 CEST: PSAT>APRSON,ARISS,qAR,DK3WN-8:s#021292,0z190,cCFAeDbCGDBGDdEdeDf0FADFDaFAeDeeDfCFCDGDbF0eDfdEdDFCCFDdEceDfbEbDFDBGDdD [Unsupported packet format]
2015-07-20 12:53:00 CEST: PSAT>APRSON,ARISS,qAR,DK3WN-8:T#156,673,357,559,797,417,00011000
2015-07-20 12:59:07 CEST: PSAT>APRSON,ARISS,qAR,UA0SNV-1:T#162,819,070,562,780,408,00011000
2015-07-20 13:00:08 CEST: PSAT>APRSON,ARISS,qAR,UA0SNV-1:T#163,835,073,562,781,408,00011000
2015-07-20 13:01:01 CEST: PSAT>APRSON,ARISS,qAR,UA0SNV-1:!02 . N\104 . ES040/999/W3ADO s#021302,0z190 [Location changes too fast (adaptive limit)]
2015-07-20 13:01:08 CEST: PSAT>APRSON,ARISS,qAR,UA0SNV-1:T#164,833,069,562,784,408,00011000
2015-07-20 13:02:36 CEST: PSAT>APRSON,ARISS,qAR,UA0SNV-1:s#021303,0z190,HgFhEIGhFgiEk0HaHIHCIIgFfjElbHcHIGEJJfFdjDkfGgFJGFJJfGcjDkgGhFJFFKJeHajE [Unsupported packet format]
2015-07-20 14:22:56 CEST: PSAT>APRSON,ARISS,qAR,DK3WN-8:T#251,851,088,564,856,413,00011000
2015-07-20 14:23:09 CEST: PSAT>APRSON,ARISS,qAR,DK3WN-8:s#021355,0z190,ffGE0IfeGdCHDAIEeGdfFfaHBCHEcH0fFfeGdCHDAHDeGefFg0HBCHDbH0fFfeGcCHDAHDeG [Unsupported packet format]
2015-07-20 14:23:57 CEST: PSAT>APRSON,ARISS,qAR,DK3WN-8:T#252,842,073,565,850,413,00011000
2015-07-20 14:24:40 CEST: PSAT>APRSON,ARISS,qAR,DK3WN-8:!17 . S\079 . WS090/999/W3ADO s#021356,0z190 [Location changes too fast (adaptive limit)]
2015-07-20 14:24:58 CEST: PSAT>APRSON,ARISS,qAR,DK3WN-8:T#253,848,070,566,841,413,00011000
2015-07-20 14:25:59 CEST: PSAT>APRSON,ARISS,qAR,DK3WN-8:T#254,851,070,568,830,412,00011000
2015-07-20 14:26:12 CEST: PSAT>APRSON,ARISS,qAR,ON7EQ-10:!20 . S\076 . WS090/999/W3ADO s#021357,0z190 [Location changes too fast (adaptive limit)]
2015-07-20 14:26:13 CEST: PSAT>APRSON,ARISS,qAR,ON7EQ-10:s#021357,0z190,0CGaeEBCGDaGAdEedEdBFCAGCcEceDeaF0CFD0GBdDdeDfBFBCFDcEbeDfbEbDFDAFCdDdeD [Unsupported packet format]
2015-07-20 14:27:00 CEST: PSAT>APRSON,ARISS,qAR,ON7EQ-10:T#255,847,073,568,818,412,00011000
2015-07-20 14:27:45 CEST: PSAT>APRSON,ARISS,qAS,DH7JC-10:!23 . S\074 . WS090/999/W3ADO s#021358,0z190 [Location changes too fast (adaptive limit)]
2015-07-20 14:27:46 CEST: PSAT>APRSON,ARISS,qAR,ON7EQ-10:s#021358,0z190,BCGdeDCCGDcEceDfaE0DFD0FBdCeeDfCFCCGEcEbfCgbEbDFDAGDeDefDhBFBDGEcFafDgcE [Unsupported packet format]
2015-07-20 14:28:01 CEST: PSAT>APRSON,ARISS,qAS,DH7JC-10:T#256,863,070,569,811,412,00011000
2015-07-20 14:29:02 CEST: PSAT>APRSON,ARISS,qAR,DK3WN-8:T#257,855,073,570,806,412,00011000
2015-07-20 14:29:17 CEST: PSAT>APRSON,ARISS,qAR,DK3WN-8:!26 . S\071 . WS090/999/W3ADO s#021359,0z190 [Location changes too fast (adaptive limit)]
2015-07-20 14:29:18 CEST: PSAT>APRSON,ARISS,qAR,DK3WN-8:s#021359,0z190,EAGgdEE0GCeDffEfCGCDHEcFcfCgcFbDGEAHDeEefDgAFBDHEbG0fDfeEeDGDCHEdEdfDgaF [Unsupported packet format]
2015-07-20 14:30:50 CEST: PSAT>APRSON,ARISS,qAR,DK3WN-8:!29 . S\070 . WS090/999/W3ADO s#021360,0z190 [Location changes too fast (adaptive limit)]
2015-07-20 14:30:51 CEST: PSAT>APRSON,ARISS,qAR,DK3WN-8:s#021360,0z190,EaGgbFEcF0fDfeFeCGDCGEdEdfDgaF0DGE0GDeDefDhCFBEGEbFaeCgdEeDFDEGEdDdfCh0E [Unsupported packet format]
2015-07-20 14:31:04 CEST: PSAT>APRSON,ARISS,qAR,DK3WN-8:T#259,854,073,571,795,411,00011000
2015-07-20 14:32:04 CEST: PSAT>APRSON,ARISS,qAR,DK3WN-8:T#260,857,072,571,789,411,00011000
2015-07-20 14:32:23 CEST: PSAT>APRSON,ARISS,qAR,DK3WN-8:s#021361,0z190,EaFhaEFbEafBgdEeDFDEGFdDdfBh0E0FGE0GEeCfgCiCFBFGFbF0fCgeEfEFDFGGdDdgCiaF [Unsupported packet format]
2015-07-20 14:33:05 CEST: PSAT>APRSON,ARISS,qAR,DK3WN-8:T#261,855,073,571,784,410,00011000
2015-07-20 16:03:19 CEST: PSAT>APRSON,ARISS,qAR,DK3WN-8:T#352,860,070,574,820,412,00011000
2015-07-20 16:03:37 CEST: PSAT>APRSON,ARISS,qAR,DK3WN-8:!55 . N\155 . ES090/999/W3ADO s#021425,0z190 [Location changes too fast (adaptive limit)]
2015-07-20 16:04:19 CEST: PSAT>APRSON,ARISS,qAR,ON7EQ-10:T#353,872,070,575,813,412,00011000
2015-07-20 16:05:09 CEST: PSAT>APRSON,ARISS,qAR,ON7EQ-10:!55 . N\161 . ES090/999/W3ADO s#021426,0z190 [Location changes too fast (adaptive limit)]
2015-07-20 16:05:10 CEST: PSAT>APRSON,ARISS,qAR,ON7EQ-10:s#021426,0z190,DdEfBFDdDdfCgAFBDGDaF0eDfeDfCFCDGEcEcfCgbE0EGEAFEeCefCiBFBFGFbEafBhdDeEG [Unsupported packet format]
2015-07-20 16:05:20 CEST: PSAT>APRSON,ARISS,qAR,ON7EQ-10:T#354,859,070,575,806,411,00011000
2015-07-20 16:06:21 CEST: PSAT>APRSON,ARISS,qAR,ON7EQ-10:T#355,857,073,576,802,411,00011000
2015-07-20 16:06:42 CEST: PSAT>APRSON,ARISS,qAR,DK3WN-8:!55 . N\167 . ES090/999/W3ADO s#021427,0z190 [Location changes too fast (adaptive limit)]
2015-07-20 16:06:43 CEST: PSAT>APRSON,ARISS,qAR,ON7EQ-10:s#021427,0z190,EeCfEGCfCffCiCFCFGGcFbgChdEeEGEEHGeDegDi0FAFHG0GCfCggDhCGDEHGdFcgBicFdFH [Unsupported packet format]
2015-07-20 16:07:22 CEST: PSAT>APRSON,ARISS,qAR,ON7EQ-10:T#356,855,073,576,800,411,00011000
2015-07-20 16:08:15 CEST: PSAT>APRSON,ARISS,qAR,DK3WN-8:!55 . N\173 . ES090/999/W3ADO s#021428,0z190 [Location changes too fast (adaptive limit)]
2015-07-20 16:08:16 CEST: PSAT>APRSON,ARISS,qAR,DK3WN-8:s#021428,0z190,EfDfEHBgCggDiDGDFHGdFbgDhdFeFHEEHGeEehDiaG0FHF0HEfCggDiCGCFIGcGagCheEfEH [Unsupported packet format]
2015-07-20 16:08:23 CEST: PSAT>APRSON,ARISS,qAR,ON7EQ-10:T#357,857,070,577,799,410,00011000
2015-07-20 16:09:24 CEST: PSAT>APRSON,ARISS,qAR,DK3WN-8:T#358,828,348,577,797,410,00011000
2015-07-20 16:09:48 CEST: PSAT>APRSON,ARISS,qAR,DK3WN-8:!54 . N\179 . ES090/999/W3ADO s#021429,0z190 [Location changes too fast (adaptive limit)]
2015-07-20 16:09:49 CEST: PSAT>APRSON,ARISS,qAR,DK3WN-8:s#021429,0z190,FfEgEHFfDfgDiBGCGHGbGBgDhgEgEGDGHGdFbgCheFfFHEEHGeDehCjaF0GHG0HFfCggCjCG [Unsupported packet format]
2015-07-20 16:10:25 CEST: PSAT>APRSON,ARISS,qAR,DK3WN-8:T#359,865,073,577,794,410,00011000
2015-07-20 16:11:22 CEST: PSAT>APRSON,ARISS,qAR,DK3WN-8:!53 . N\175 . WS090/999/W3ADO s#021430,0z190 [Location changes too fast (adaptive limit)]
2015-07-20 16:11:22 CEST: PSAT>APRSON,ARISS,qAR,DK3WN-8:s#021430,0z190,HdFjBFHeEdhCjcFdGHFEHHeDfhDk0GAHHGAGGfCghDkBGCHIHbGBgBigDkEHEHIIdFbhBjeE [Unsupported packet format]
2015-07-20 16:11:26 CEST: PSAT>APRSON,ARISS,qAR,DK3WN-8:T#360,854,085,577,794,409,00011000
2015-07-20 16:12:27 CEST: PSAT>APRSON,ARISS,qAR,DK3WN-8:T#361,854,070,577,794,409,00011000
2015-07-20 21:05:56 CEST: PSAT>APRSON,ARISS,qAR,DK3WN-8:T#049,844,084,574,827,405,00011000
< previous

aprs.fi


Raw Data: PSAT-1
DK3WN SatBlog
Telemetry from PSAT – Go
aprs.fi/telemetry/a/PSAT
Telemetry - [map view · info · telemetry · weather · raw · status · beacons · messages · bulletins · browse · moving · my account]
Callsign: PSAT
Search
Clear
Completed generating statistics (took 0.012 s).
Real-time page updates enabled.
Start date (YYYY-MM-DD HH:MM): 2015-07-18 19:48:50
End date (YYYY-MM-DD HH:MM): 2015-07-20 19:48:50
It is possible to search using wildcards (*?) after a prefix. Example: VK*
Telemetry from PSAT - info
Comment: W3ADO s#018700,0z290
Location: 5°30.00' S 13°30.00' W - locator II34GM00AA - show map - static map
Last position: 2015-07-17 20:09:36 CEST (3d 1h39m ago)
Last telemetry: 2015-07-20 21:05:56 CEST (43m ago)
Values: Channel 1: 844 (TLM: 844 EQN: 0,1,0)
Channel 2: 84 (TLM: 84 EQN: 0,1,0)
Channel 3: 574 (TLM: 574 EQN: 0,1,0)
Channel 4: 827 (TLM: 827 EQN: 0,1,0)
Channel 5: 405 (TLM: 405 EQN: 0,1,0)
Bit sense: 1 2 3 4 5 6 7 8 (TLM: BITS: 11111111)
Telemetry history graphs for PSAT
[24 hours · 48 hours · week · month · year]
PSAT Channel 1 2015-07-18 22:43:05 -> 2015-07-20 21:05:56 CEST
900
850
800
750
700
650
Jul 19 0:00
Jul 19 8:00
Jul 19 16:00
Jul 20 0:00
Jul 20 8:00
Jul 20 16:00
PSAT Channel 2 2015-07-18 22:43:05 -> 2015-07-20 21:05:56 CEST
700
600
500
400
300
200
100
0
Jul 19 0:00
Jul 19 8:00
Jul 19 16:00
Jul 20 0:00
Jul 20 8:00
Jul 20 16:00
PSAT Channel 3 2015-07-18 22:43:05 -> 2015-07-20 21:05:56 CEST

APRS services

It is easy to send an email from your ham radio using APRS.
You may only send one line messages (67 total characters maximum).

```
:EMAIL    :dk3wn@amsat.org This is a test via PSAT. 73

1:Fm DK3WN-1 To APRS Via PSAT*,ARISS* <UI C Pid=F0 Len=55> [UTC:18:35:28R]
:EMAIL    :dk3wn@amsat.org this is a test via PSAT. 73
```

APRS Message from DK3WN-1

OpenAPRS - APRS Message to Email Gateway [daemon@openaprs.net]

Gesendet: Wed 2015-07-01 20:35
An: dk3wn@amsat.org

```
this is a test via PSAT. 73

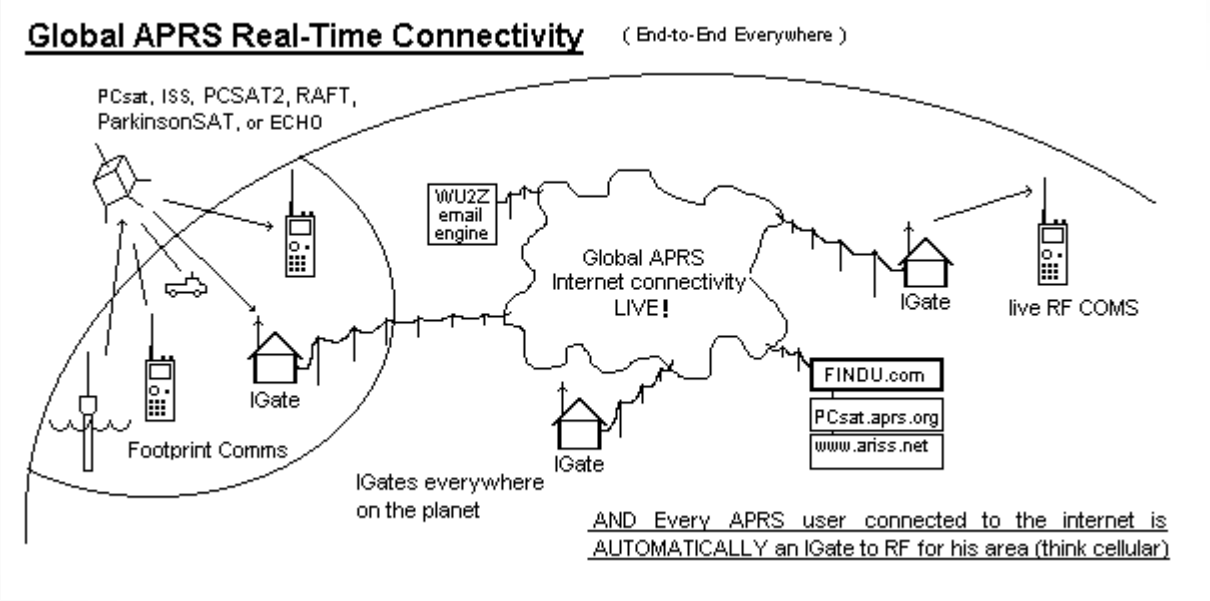
----------------------------------------
  Date      : 2015-07-01 18:35:29 UTC
  From      : DK3WN-1
  To        : dk3wn@amsat.org
  IGATE     : DK3WN-8
----------------------------------------


---
OpenAPRS.Net Message to Email Gateway
```

… works also other satellites e.g. NO-44, BugSat-1 or ISS

APRS iGate

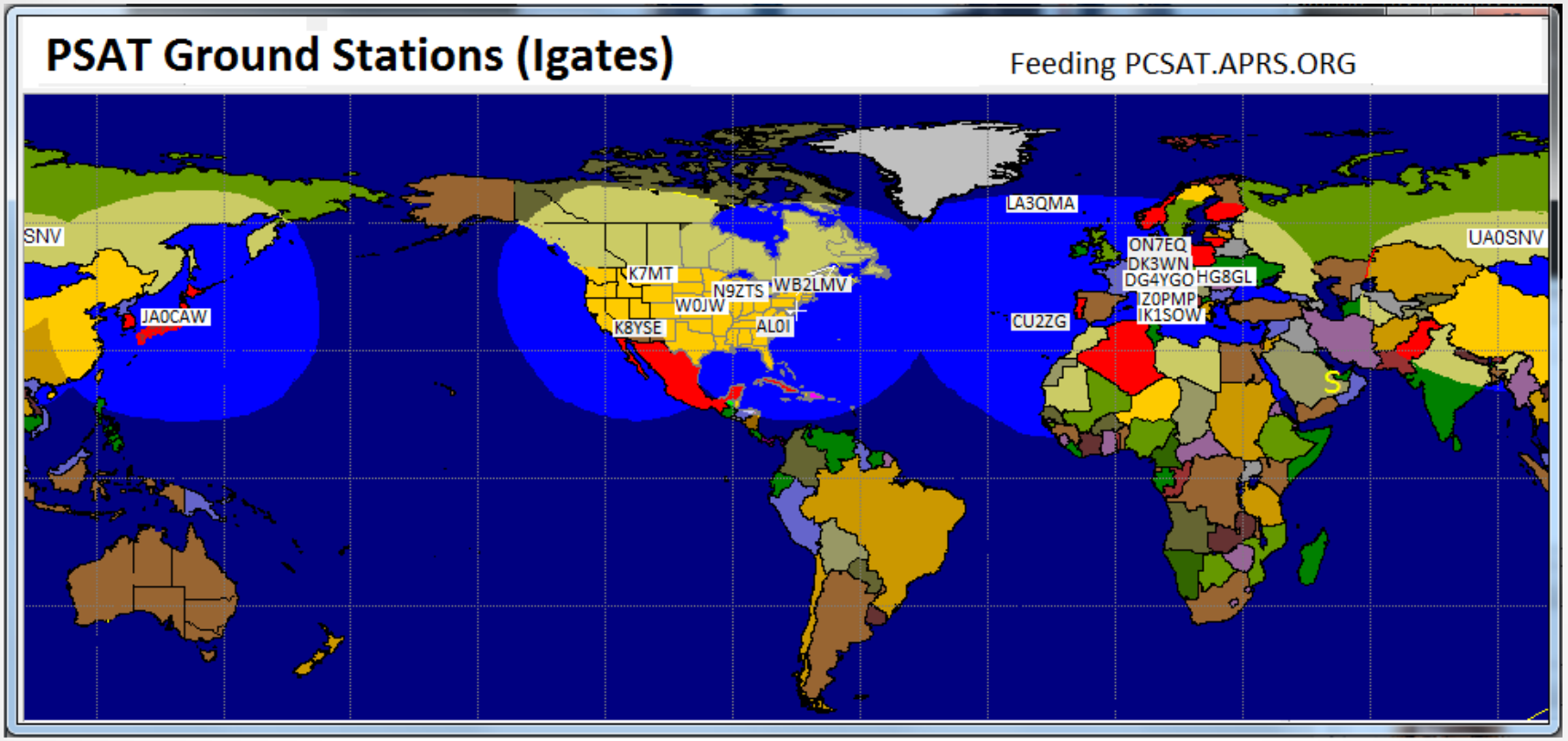
pass all packets heard on RF to APRS-IS



We need PSAT IGates in Hawaii, India, China and anywhere in the Southern Hempsiphere …

So if you have ever thought about being a satellite IGate, now is the time. And the ideal OMNI antenna for PSAT is a simple 19.5” vertical whip over a large metal ground plane.
An even better one (+2 dB) is a 3/4 wave vertical whip (58”) over a large metal ground plane.

PSAT iGates

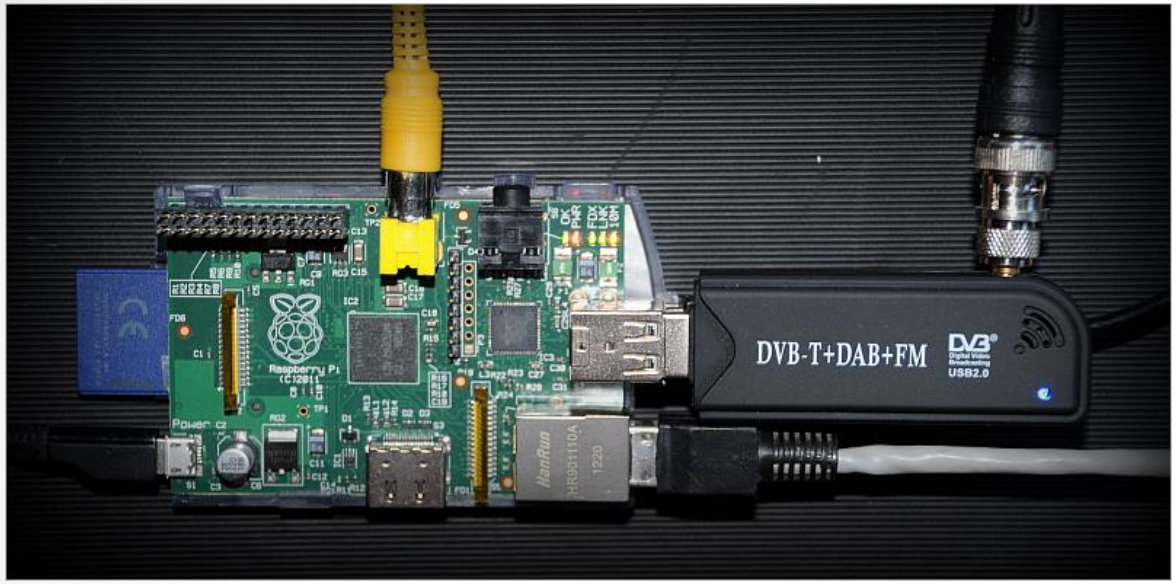


9W2CEH, 9W2DIE, 9W2JDY, AI9IN, AL0I, BD8TE, CU2ZG, DG4YGO, DH7JC, DK3WN, DL5MAM, EA1JM, EA6XQ, F4GUK, F8COD, FR1GZ, HG8GL, HR1PAQ, HS0BBD, IK1SOW, IS0AML, IZ0PMP, JA0CAW, JA2PIT, JA5BLZ, JE9PEL, JH1LWU, JH4XSY, JJ1WTK, K0KOC, K4AG, K7GPS, K7MT, K8YSE, KB1CHU, KB1PVH, KB3KBR, KB9ZWL, KC2WBX, KC4AAC, KC9DOA, KD0KZE, KD0PGM, KD8TH, KG6HSQ, LA3QMA, LU1DZL, LU1WFU, LU2HAM, LW2DTZ, M0NRT, N0AGI, N5DUX, N5KAR, N9ZTS, NK7N, ON7EQ, PA3EKM, PA3GUO, PA6HAP, PP5CAM, PT2AP, R4UAB, RA2FG, SM5RVH, SQ5RTW, SV3RNJ, UA0SNV, UW7HR, VK2JNG, VK4CBW, VK8MA, VO1BIL, W0JW, W7HR, W7KKE, WA8LMF, WB2LMV, YD0NXX, ZL1KM, ZL2CIA, ZS5YE, ZS6AAG

[Jul 22]

APRS iGate

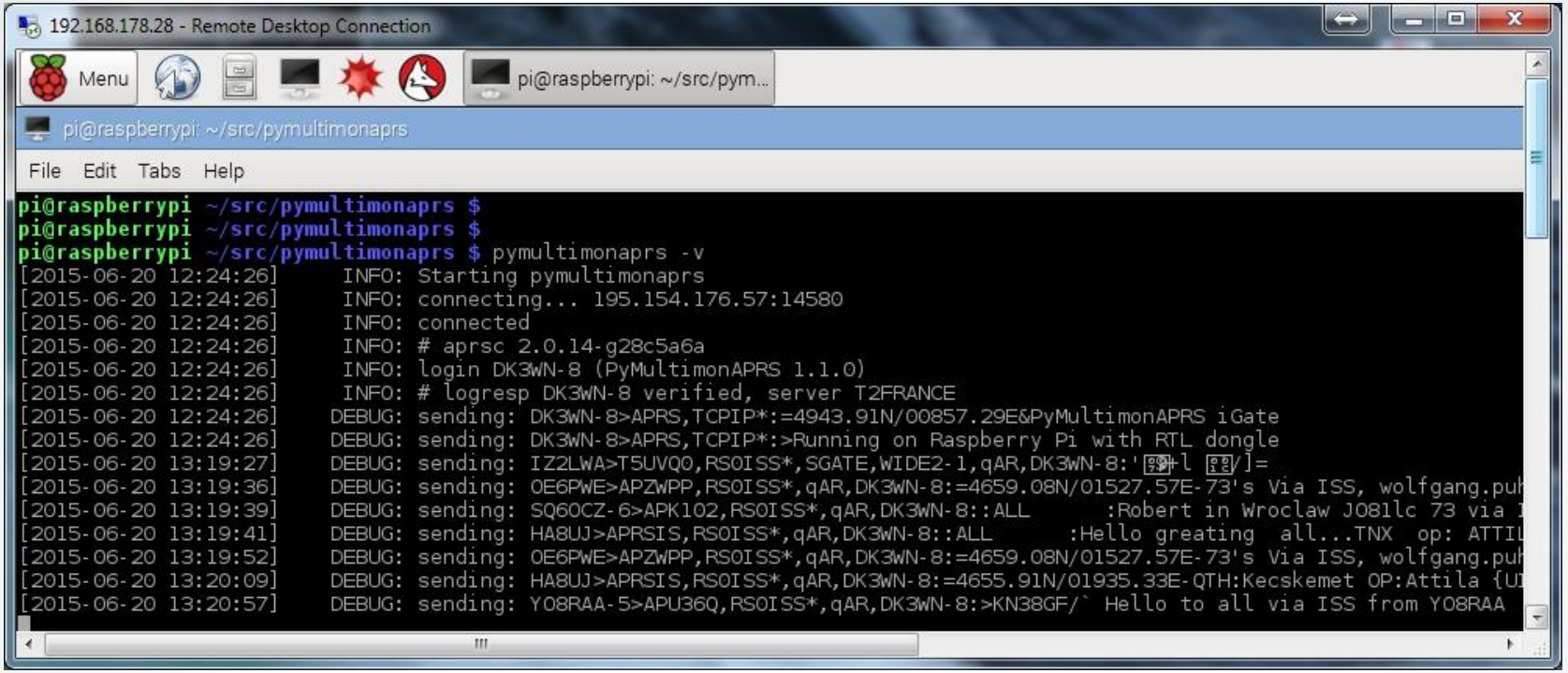
APRS IGate with Raspberry Pi and DVB-T stick



http://www.kubonweb.de/?p=130
http://www.mstewart.net/super8/aprs/RASP/index.htm
http://n5dux.com/ham/raspberrypi/igate.php
http://www.radio.cc/post/aprs-igate-with-raspberr-pi-setup

Raspberry PI iGate APRX with soundmodem
https://www.youtube.com/watch?v=MtUnuJn_70o

APRS iGate



- multimon-NG decoder

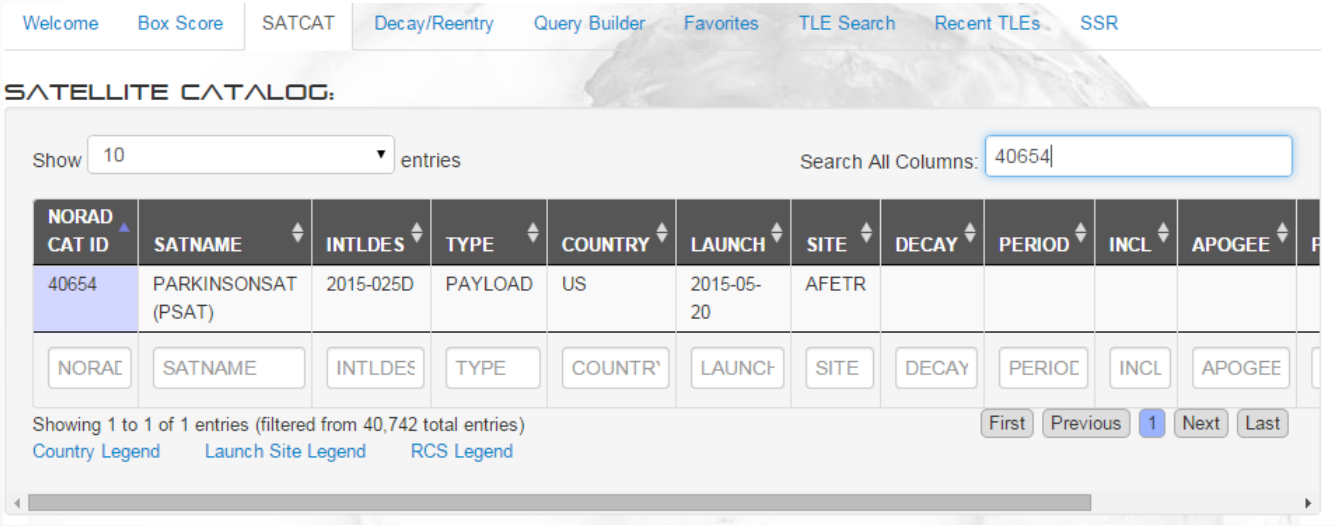
MultimonNG a fork of multimon, it decodes the following digital transmission modes:
POCSAG512 POCSAG1200 POCSAG2400 EAS UFSK1200 CLIPFSK AFSK1200 AFSK2400 AFSK2400_2 AFSK2400_3 HAPN4800 FSK9600 DTMF ZVEI

PSAT - TLE

- PSAT was launched on a military rocket flight (DoD)
- we cannot get the TLEs directly from SpaceTrack
- we can get them from the satellite owner/operators

- CalPoly: http://mstl.atl.calpoly.edu/~ops/keps/kepler.txt

- NORAD #40654 = ULTRASat1




```
PSAT
1 90720U          15202.10031234 +.00007994 +00000-0 +21237-3 0 00732
2 90720 054.9937 073.3874 0242881 333.9704 024.9228 15.14608693009316
```

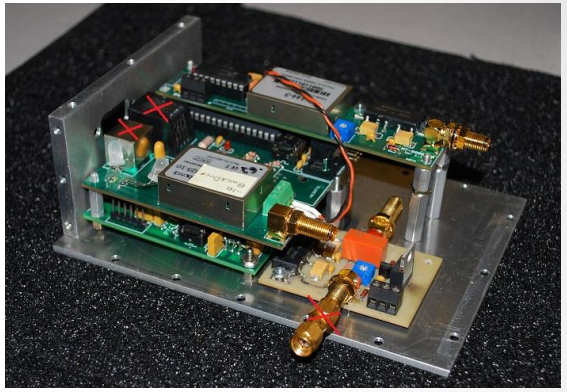
USNA's APRS satellites

What's next?

QIKcom-1

- Release from ISS in October 2015
- 1st APRS Terrestrial-User-Alerting Beacon Satellite

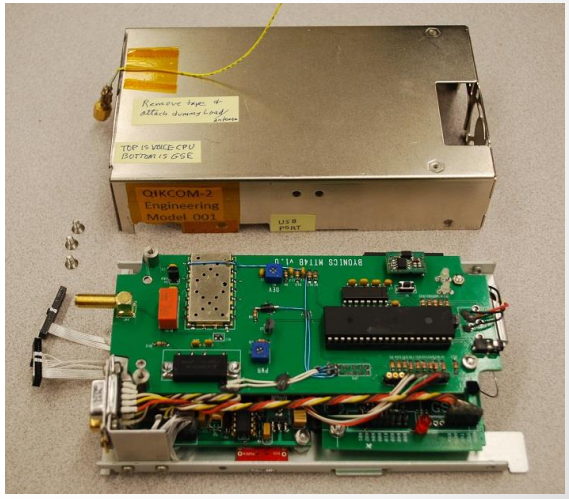
- flies on a host spacecraft (28V, no solar panels and ADCS)
- APRS transceiver (Byonics MT-TT4)
- MicroAmp-3
- 4 watts beacon transmitter (transmit on 144.39MHz and 144.80MHz APRS frequencies



QIKcom-2

- launch December 2015
- 1st APRS TouchTone Satellite

- The full APRStt system is a complete two way system that enters APRS data using DTMF and lets the user receive APRS information by synthesized voice response.



ParkinsonSat

NAVAL OSCAR-84

... APRS plus a new PSK31 Approach

Thank you!

Mike Rupprecht, DK3WN
Bob Bruninga, WB4APR