A DATV transponder for ARISS

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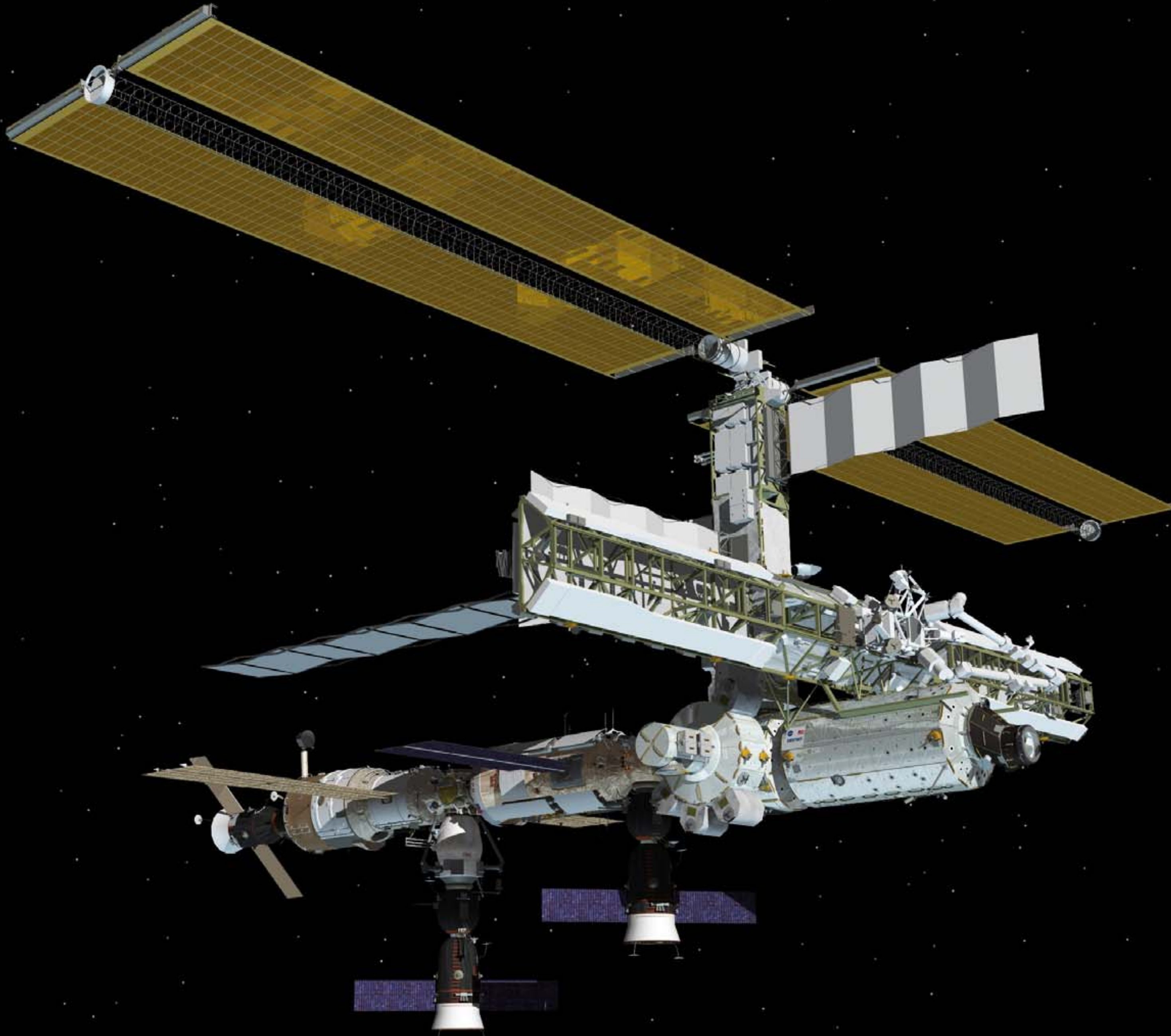
008E06697



Introduction

- External payloads are where the ARISS team will be concentrating their developments
- The ISS is a stable platform
- Robust supplies of 28V dc power are available
- We should avoid the 145 & 435MHz bands due to existing usage on board the ISS

A Digital ATV transponder & beacon device

- One or more on-board cameras with a graphic overlay acting as a test card.

  These would drive a
- 2.4GHz ATV transmitter using digital encoding to one of the existing DTV formats
- With a 1.2GHz DATV receiver.

The benefits of an ARISS based DATV transponder & beacon

- Attractive for existing ATV amateurs – a cadre of technically competent amateurs in all three IARU Regions
- Existing ATV operation already uses microwave repeaters both FM and Digital
- Will enlarge the user base for ARISS operations
- Autonomous operation without astronaut intervention
- Will add to the attraction of existing ARISS school contacts
- Good PR value
- Could be used to maintain safety watch of external structure
- Could be used to maintain light pollution watch
- Doppler shift is not relevant
- Full duplex “look thru” would be possible for users


G-PASS
SUSSEX
POLICE

UK Police Helicopters - DTV equipment

Digital video transmitted on 3Ghz band

10 watt output to a simple 2 turn helix

Ground stations use 6 fixed x 4 patches

Range limited by earth curvature

Use 28 volt supplies

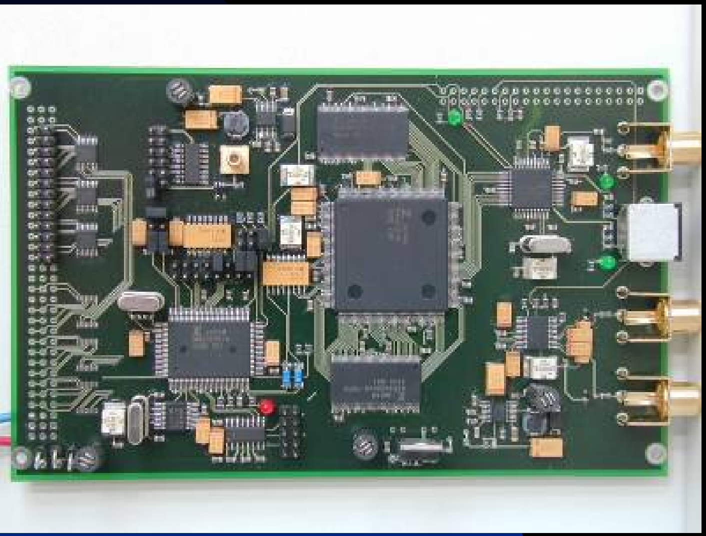
Use DO-160 environment/EMC tests

Two producers – both well populated by amateurs

A UK developed 2.4GHz patch for satellite use

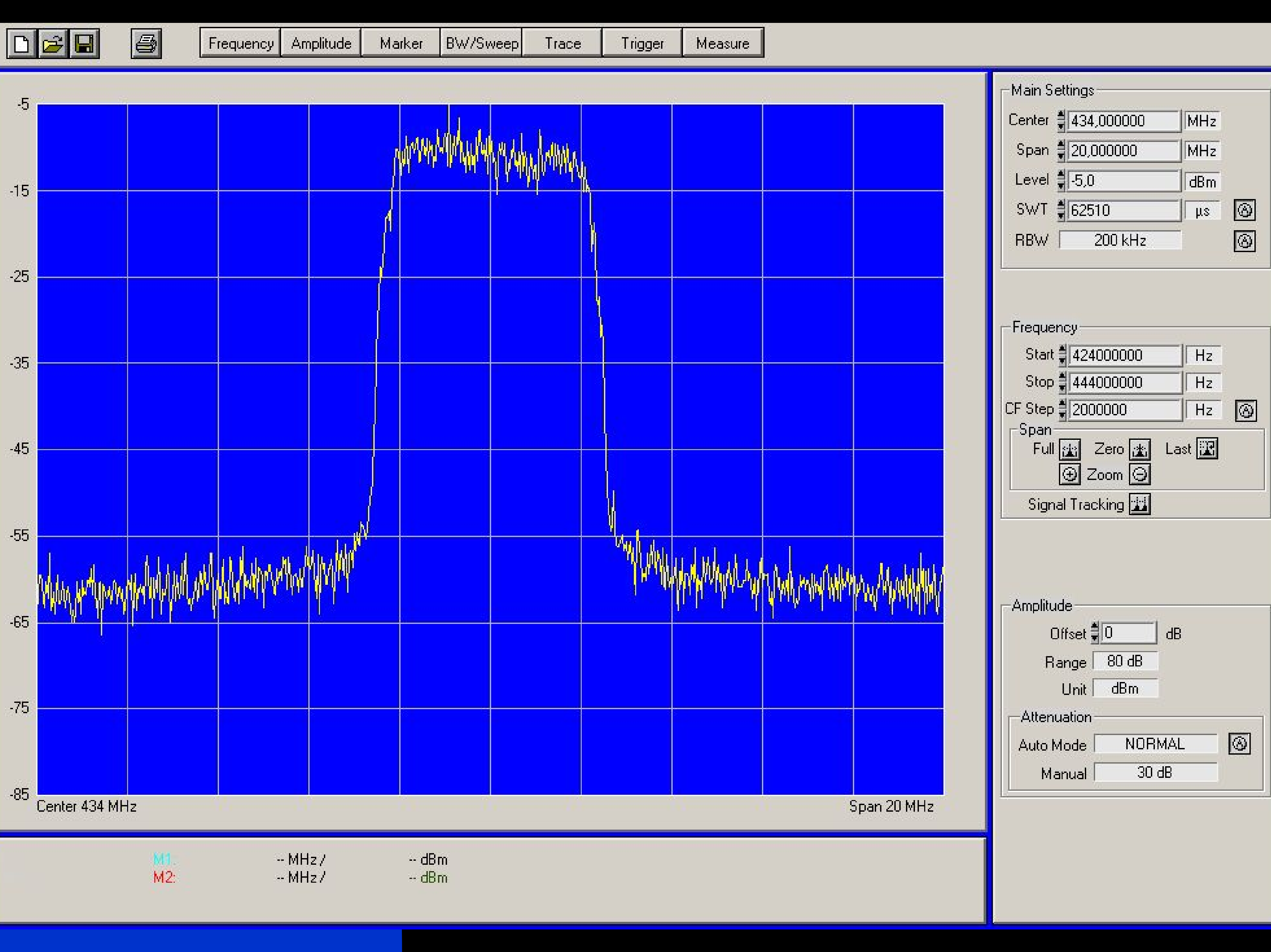
(L band version also available)

Existing DATV transmitters



Mit Unterstützung des Deutschen Amateur Radio Club e.V., der Arbeitsgemeinschaft Amateurfunk-Fernsehen e.V. und von Einzelpersonen wurden von der DATV-Entwicklergruppe um Prof. Uwe Kraus, DJ8DW, an der Bergischen Universität Wuppertal mehrere DATV-Sender und -Empfänger für den 434 MHz-Amateurfunkbereich gebaut und in Feldversuchen durch engagierte Funkamateure erprobt. Bei diesen Geräten der 1. Generation wird die im Mobilfunk bewährte GMSK-Modulation verwendet, während in einer weiterentwickelten Variante (3. Generation) zusätzlich die beim digitalen Satelliten-TV bewährte QPSK-Modulation mit höherer Bildqualität aktivierbar ist. Außerdem ermöglichen neue hochintegrierte MPEG2-Coder und -Decoder-Bausteine jetzt auch Funkamateuren, digital Live-TV zu senden und zu empfangen.

DATV-Coder-Spezifikation: Input analog PAL/NTSC, Y/C, 2-Kanal-Audio. Output 2 x MPEG-2 bitparallel 2 - 10 Mb/s einstellbar



Frequency
Amplitude
Marker
BW/Sweep
Trace
Trigger
Measure
-5
-15
-25
-35
-45
-55
-65
-75
-85
Center 434 MHz
Span 20 MHz
M1: -- MHz / -- dBm
M2: -- MHz / -- dBm
Main Settings
Center 434,000000 MHz
Span 20,000000 MHz
Level -5,0 dBm
SWT 62510 µs
RBW 200 kHz
Frequency
Start 424000000 Hz
Stop 444000000 Hz
CF Step 2000000 Hz
Span
Full
Zero
Last
Zoom
Signal Tracking
Amplitude
Offset 0 dB
Range 80 dB
Unit dBm
Attenuation
Auto Mode NORMAL
Manual 30 dB

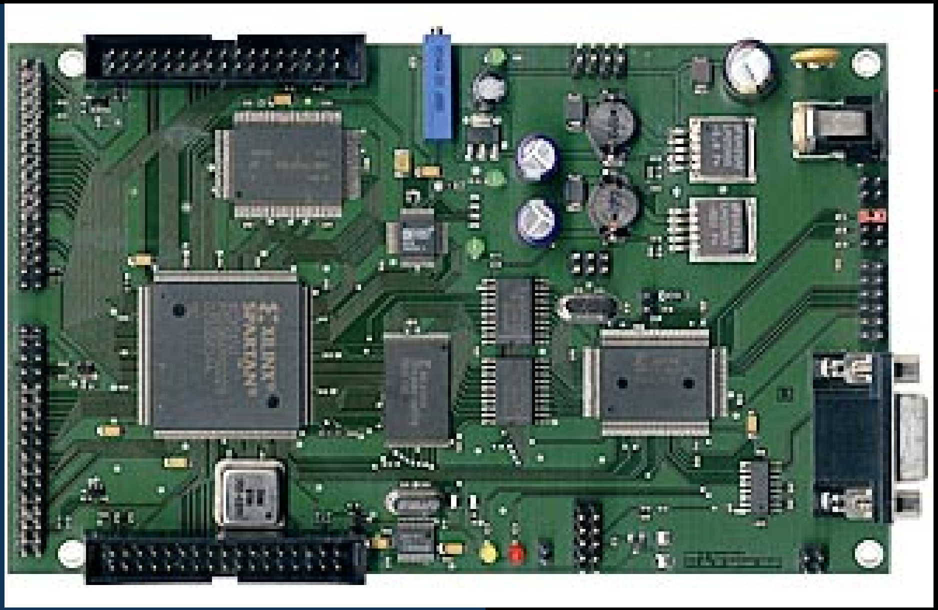
Existing DATV transmitters

Dutch Digital Amateur Television Site

welcome to D-ATV.com

Existing DATV transmitters

Base band preparation

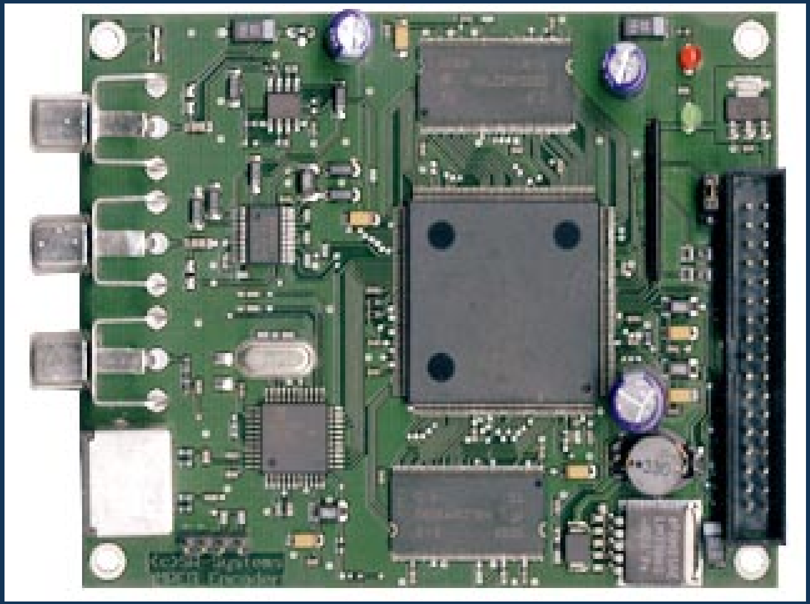


Up to 4 MPEG-Encoder can be connected to the base band preparation board which includes the transport stream multiplexer and an QPSK-Modulator (DVB-S) which is capable of 64QAM (DVB-C) or GMSK (by firmware update).

Additional the central micro controller is included in this board (handling download of encoder firmware and setup of dynamic “Teletext” pages).

Two separate power supplies are used to produce 2,5 V and 5 V.

Encoder



The encoder is based on the Fujitsu MPEG-2 System LSI MB86391. This is a special developed DSP for real time video compression.
Bases on this SR-Systems has developed an encoder board for D-ATV application which incorporates the necessary peripheral components like SDRAMs, audio- and video-Codecs as well as all required power supply demands (3,3 and 1,8 V).

The encoder supports the formats SIF (352x288 Pixel), HD1 (352x576 Pixel) and D1 (720x576 Pixel) at data rates from 1,5 Mbit/s to 6 Mbit/s. This data rate includes already a 16-bit-Stereo audio channel.
The encoder firmware can individually be adjusted and is launched during system start.

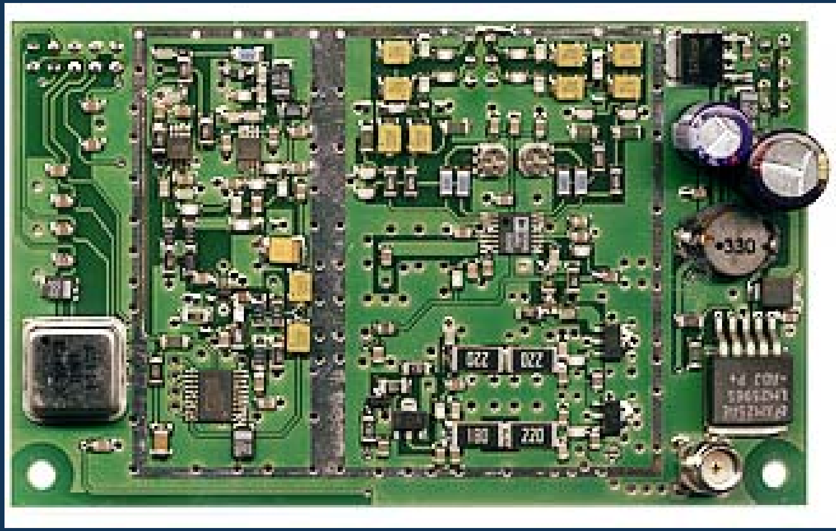
Data out supplies a transport Stream according to ISO/IEC 13818 to an 8-bit TS-Interface with clock and Frame sync signal.

IQ-Transmitter

The dual band IQ-TX (1200-1300 MHz and 2300-2500 MHz) supplies an average Pout of 10 mW. The board includes the power supply (5 and 8 V).

As modulator an Analog-Device chip is used. The PLL is by National Semiconductor, both VCO's by Maxim.

The IQ transmitter has been developed by Jens Geisler and Henning Rech (FH Pforzheim).



Stefan Reimann
***SR*-Systems**

D-ATV

Digital Amateur TV

Thomas Sailer, HB9JNX/AE4WA
Henning Rech, DF9IC/N1EOW
Stefan Reimann, DG8FAC
Jens Geisler, DL8SDL

ADACOM e. V.
Fachverband für Amateur-Datenfunk

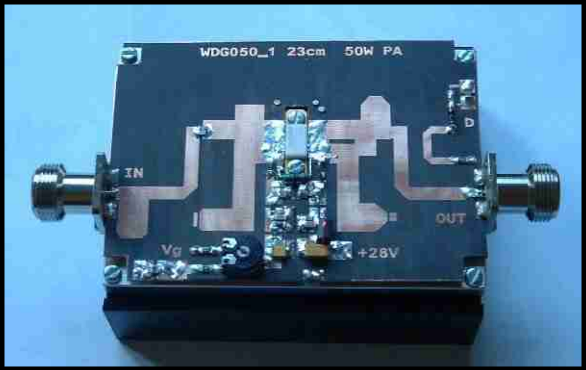
Existing 2.4 GHz DATV receive equipment

Existing “Free to Air” decoders €150.00

2.4 ->1.3GHz downconvertor €25.00

Ground Segment DATV transmit equipment

23cms DATV exciter	€300.00
50 watt amplifier & 24V PSU	€200.00
4 foot antenna and L/S feeds	€185.00



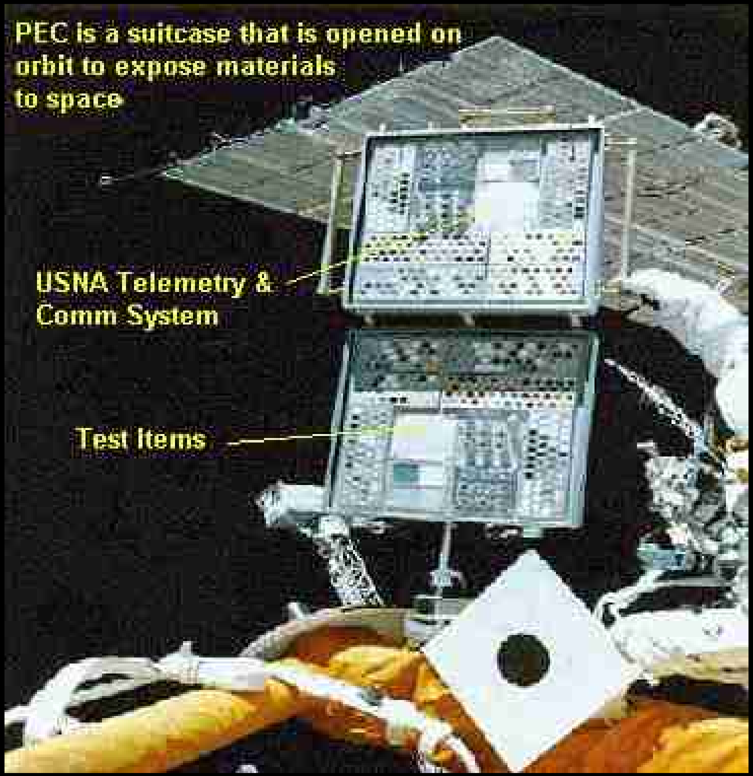
PCSAT2

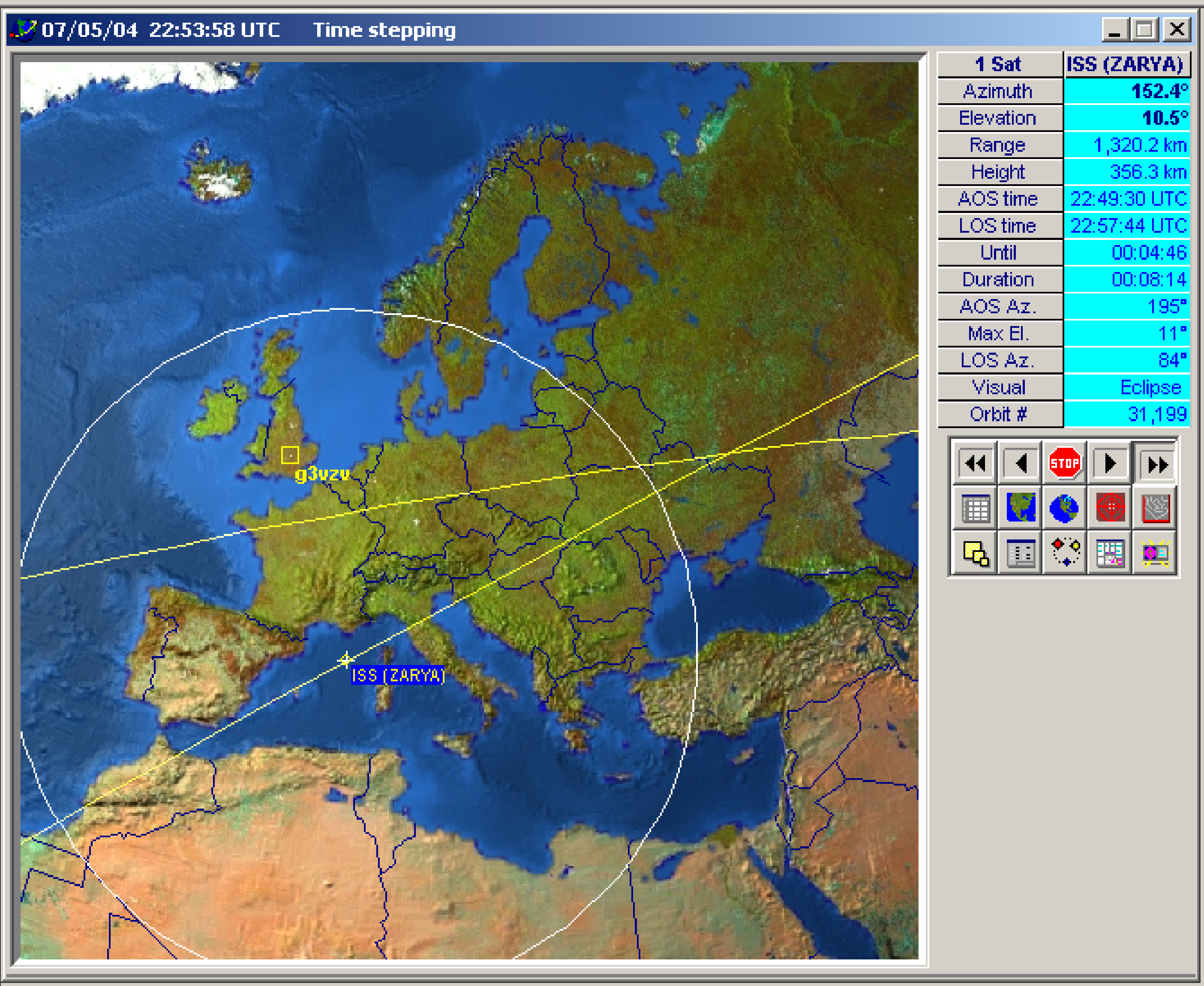
External ISS Experiment in the Amateur Satellite Service

US Naval Academy Satellite Lab

Bob Bruninga, WB4APR, Principle Investigator

Midshipmen Otero, Silver, Jones, Kolwicz, Evans, and Henry (Class of 03)




07/05/04 22:53:58 UTC Time stepping
1 Sat
ISS (ZARYA)
Azimuth 152.4°
Elevation 10.5°
Range 1,320.2 km
Height 356.3 km
AOS time 22:49:30 UTC
LOS time 22:57:44 UTC
Until 00:04:46
Duration 00:08:14
AOS Az. 195°
Max El. 11°
LOS Az. 84°
Visual Eclipse
Orbit # 31,199
STOP
g3vzv
ISS (ZARYA)

Conclusions

- The concept is based upon existing but new technologies
- The “market” for a DATV transponder is already significant.
- Technical support from a new (to satellites) group of technically competent amateurs should be available.
- It would support existing ARISS activities - especially school contacts
- Pictures are worth a thousand words.
- Live pictures from space are probably worth even more!
- The concept has received initial outline approval

THE NEXT STEPS

- Market the project to potential users
- Produce a link budget analysis
- Agree on a technical specification
- Develop an international group of “builders”
- Produce a “proof of concept” prototype
- Attend the ARISS meeting in Washington in October to present the proposal to the Hardware Selection Committee

DATV on ARISS

Blue	= User Data Entry Values
Black	= Computed Values (**No Data Entry**)
Red	= Key Results
Blue	=Critical User Data Entry Values

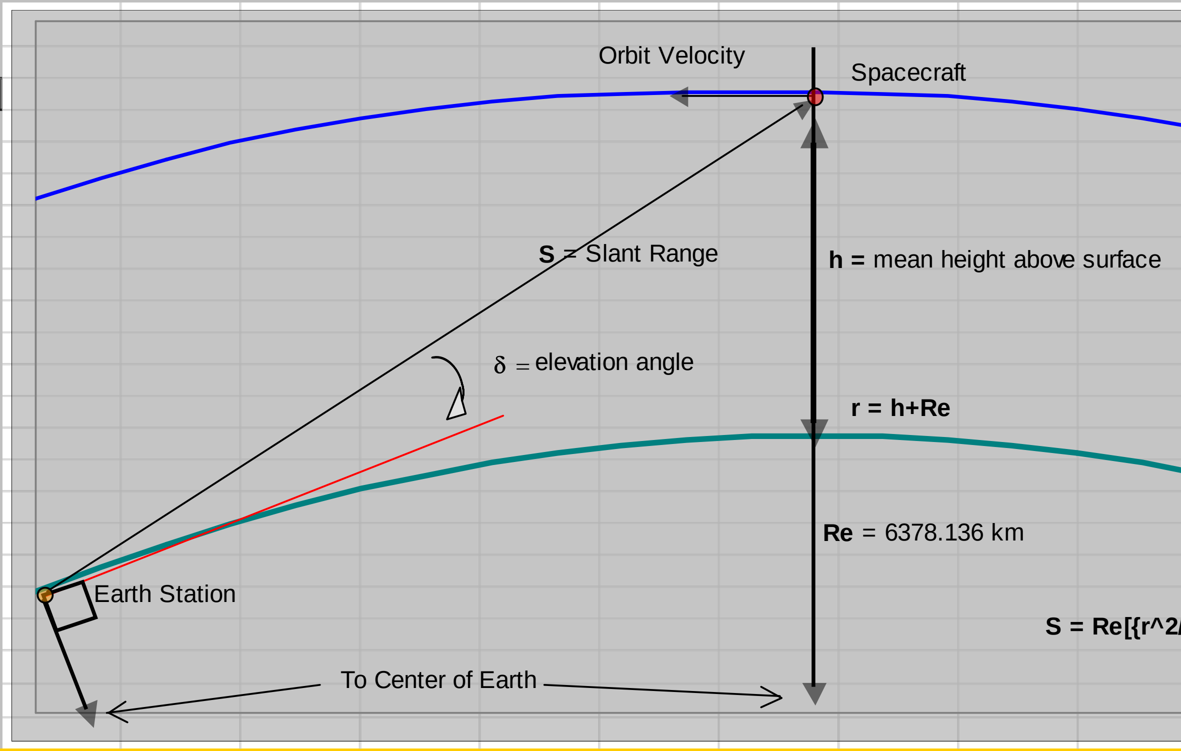
NOTE: Cells Not Yet

Element Reference Epoch: 2003, 87.50000

Orbit Properties

Slant Range to Spacecraft vs. Elevation Angle

Parameter:	*Value:*	*Unit:*
Earth Radius:	6,378.17	km
Height of Apogee (ha):	360	km
Height of Perigee (hp):	360	km
Semi-Major Axis (a):	6,738.17	km
Eccentricity (e):	0.000000	
Inclination (I):	98.61	degrees
Argument of Perigee (ω):	180.0	degrees
R.A.A.N. (Ω):	7.00000	degrees
Mean Anomaly (M):	0.00	degrees
Period:	91.742	minutes
$d\omega/dt$:	-3.6487	deg./day
$d\Omega/dt$:	1.2304	deg./day
dM/dt:	Not Implemented	deg./day
Mean Orbit Altitude:	360.00	km
Mean Orbit Radius:	6,738.17	km
Sun Synchronous Inclination:	96.89	degrees
Elevation Angle (δ):	**5.0**	degrees
Slant Range:	**1,687.07**	km.



	Frequency:		Wavelength:		Path Loss:	
Uplink:	1265	MHz	0.237	meters	159.0	dB
Downlink:	2420	MHz	0.124	meters	164.7	dB

Path Loss = 22.0 + 20 log (S/λ)

DATV on ARISS

Uplink Command Budget:

Jan A. King (Chang

Version: 1.0

Date Data Last Modified:

26th August 2004

Parameter:	Value:	Units:	Comments:
Ground Station:			
Transmitter Power Output:	50.0	watts	
In dBW:	17.0	dBW	
In dBm:	47.0	dBm	
Transmission Line Losses:	-3.0	dB	
Connector, Filter or In-Line Switch Losses:	-1.0	dB	
Antenna Gain:	20.0	dBiC	
Ground Station EIRP:	33.0	dBW	Ground Station Effective Isotropic Radiated Power (EIRP) [EIRP=Pt x I
Uplink Path:			
Ground Station Antenna Pointing Loss:	-1.0	dB	
Antenna Polarization Losses:	-4.0	dB	
Path Loss:	-159.0	dB	
Atmospheric Losses:	-1.0	dB	Use Value Appropriate for Elevation Angle Selected in Orbit Performan
Ionospheric Losses:	-1.0	dB	
Rain Losses:	0.0	dB	
Isotropic Signal Level at Ground Station:	-133.1	dBW	
Spacecraft:			
------- Eb/No Method -------			
Spacecraft Antenna Pointing Loss:	0.0	dB	
Spacecraft Antenna Gain:	8.0	dBiC	
Spacecraft Transmission Line Losses:	-1.0	dB	
Spacecraft LNA Noise Temperature:	150	K	
Spacecraft Transmission Line Temp.:	270	K	
Spacecraft Sky Temperature:	290	K	
S/C Transmission Line Coefficient:	0.7943		
Spacecraft Effective Noise Temperature:	436	K	
Spacecraft Figure of Merrit (G/T):	-19.4	dB/K	
S/C Signal-to-Noise Power Density (S/No):	76.1	dBHz	Boltzman's Constant: -228.6 dBW/K/Hz
System Desired Data Rate:	2000000	bps	
In dBHz:	63.0	dBHz	
Telemetry System Eb/No:	13.1	dB	Assumes Spectral Efficiency of 1.0 b.p.s./Hz of Bandwidth
Telemetry System Required Bit Error Rate:	9.00E-04		
Telemetry System Required Eb/No:	13.0	dB	This Eb/No Required to meet B.E.R.
System Link Margin:	**0.1**	dB	

DATV on ARISS

Downlink Telemetry Budget:

Jan A. King (Chang

Version: 1.0

Date Data Last Modified:

26th August 2004

Parameter:	Value:	Units:	Comments:
Spacecraft:			
Spacecraft Transmitter Power Output:	10.0	watts	
In dBW:	10.0	dBW	
In dBm:	40.0	dBm	
Spacecraft Transmission Line Losses:	-1.0	dB	
S/C Connector, Filter or In-Line Switch Losses:	0.0	dB	
Spacecraft Antenna Gain:	8.0	dBiC	
Spacecraft EIRP:	17.0	dBW	Spacecraft Effective Isotropic Radiated Power (EIRP) [EIRP=Pt x I
Downlink Path:			
Spacecraft Antenna Pointing Loss:	-1.0	dB	
Antenna Polarization Loss:	-1.5	dB	
Path Loss:	-164.7	dB	
Atmospheric Loss:	-1	dB	Use Value Appropriate for Elevation Angle Selected in Orbit Perfor
Ionospheric Loss:	-0.2	dB	
Rain Loss:	0.0	dB	
Isotropic Signal Level at Ground Station:	-151.4	dBW	
Ground Station:			
------- Eb/No Method -------			
Ground Station Antenna Pointing Loss:	-2.0	dB	
Ground Station Antenna Gain:	28	dBiC	
Ground Station Transmission Line Losses:	-1	dB	
Ground Station LNA Noise Temperature:	50	K	
Ground Station Transmission Line Temp.:	290	K	
Ground Station Sky Temperature:	180	K	
G.S. Transmission Line Coefficient:	0.7943		
Ground Station Effective Noise Temperature:	253	K	
Ground Station Figure of Merrit (G/T):	3.0	dB/K	
G.S. Signal-to-Noise Power Density (S/No):	78.2	dBHz	Boltzman's Constant: -228.6 dBW/K/Hz
System Desired Data Rate:	2000000	bps	
In dBHz:	63.0	dBHz	
Telemetry System Eb/No:	15.2	dB	Assumes Spectral Efficiency of 1.0 b.p.s./Hz of Bandwidth
Telemetry System Required Bit Error Rate:	9.00E-04		
Telemetry System Required Eb/No:	13	dB	This Eb/No Required to meet B.E.R.
System Link Margin:	**2.2**	dB	

Name of organization with a brief description of organizations activities:

Detailed description of Project including length of time needed to develop:

Estimate of funding including the expected source of funding:

Proposed certification procedure for the project:

Preliminary block diagram and sketches of the project:

What involvement will the crew have in the project (development, deployment, set-up and operation)

How will the Amateur Radio Community benefit from this project?

What Amateur Radio frequencies will the project utilize?

Any other comments that will help assist the Hardware Selection Committee evaluate this project