A DATV transponder for ARISS

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06/04/2004



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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



UK Police Helicopters - DTV equipment

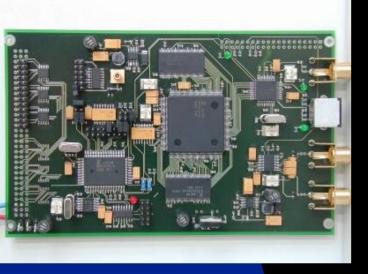
Digital video transmitted on 3Ghz band 10 watt output to a simple 2 turn helix Ground stations use 6 fixed x 4 patches Range limited by earth curvature Use 28 volt supplies Use DO-160 environment/EMC tests Two producers – both well populated by amateurs



A UK developed 2.4GHz patch for satellite use

(L band version also available)





26/10/2004

Existing DATV transmitters

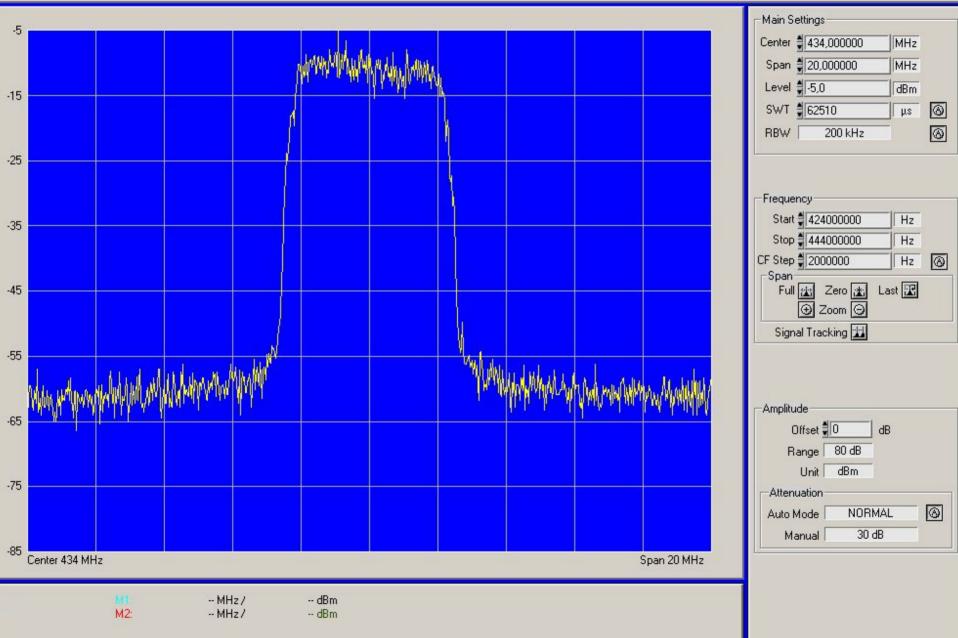
Mit Unterstützung des Deutschen Amateur Radio Club e.V., der Arbeitsgemeinschaft Amateurfunk-Fernsehen e.V. und von Einzelpersonen wurden von der DATV-Entwicklergruppe um Prof. Uwe Kraus, DJ8DW, an der Bergischen Universität Wuppertal mehrere DATV-Sender und -Empfänger für den 434 MHz-Amateurfunkbereich 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



8

Trigger Measure



Existing DATV transmitters





Dutch Digital Amateur Television Site welcome to D-ATV.com



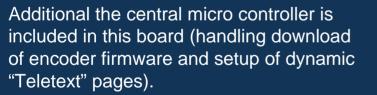
entity interleaver is generic(DEPTH : integer := 12: RAM_SIZE : integer := 204 RAM_DITS : integer := 11; SYMBOL_DELAY : integer := port() Reset : IN std_logic; Clk : IN std_logic;

Clk : IN std_logic; ClkEna : IN std_logic; SyncIn : IN std_logic; DataIn : IN unsigned(7

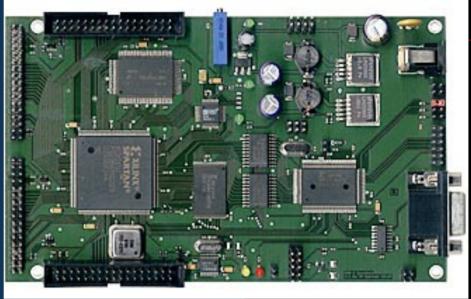
Existing DATV transmitters

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).

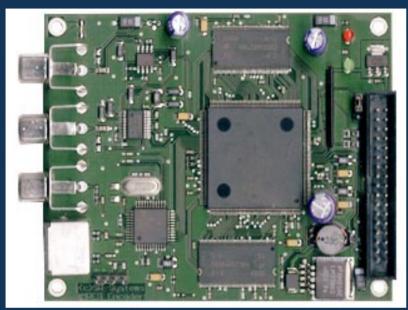


Two separate power supplies are used to produce 2,5 V and 5 V.



Stefan Reimann *SR*-Systems

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.

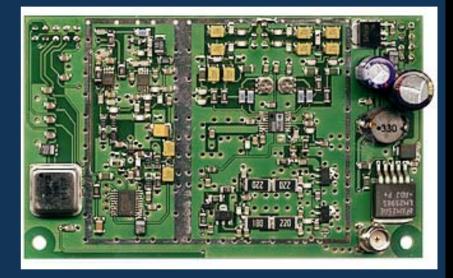
Stefan Reimann *SR*-Systems

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



Digital Amateur TV

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





Fachwerband für Amateur-Datenfunk

Existing 2.4 GHz DATV receive equipment

Existing "Free to Air" decoders

€150.00

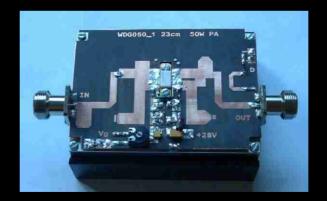
2.4 ->1.3GHz downconvertor

€25.00



Ground Segment DATV transmit equipment

23cms DATV exciter€300.0050 watt amplifier & 24V PSU€200.004 foot antenna and L/S feeds€185.00

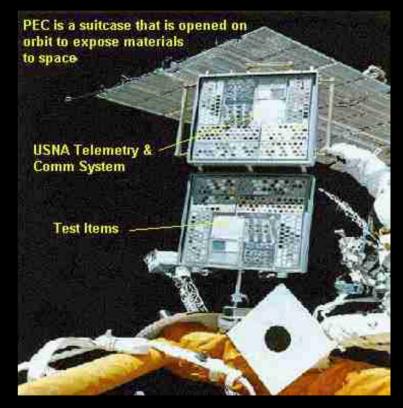


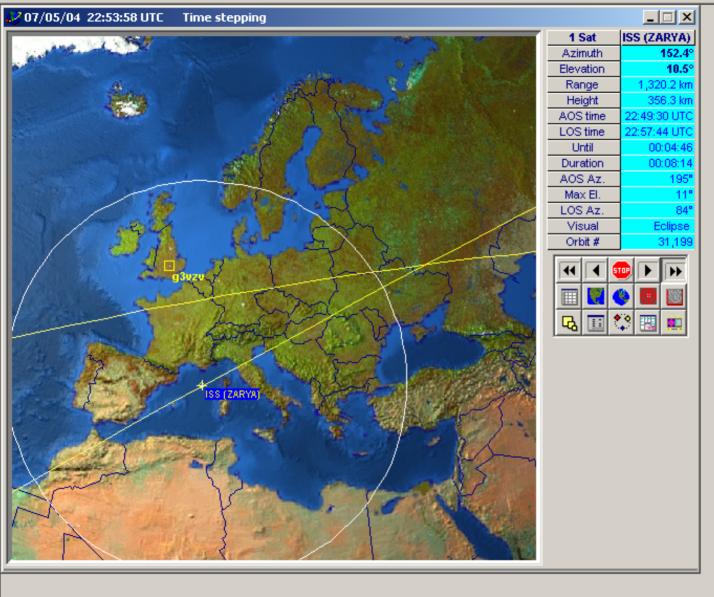


PCSAT2

External ISS Experiment in the Amateur

<u>Satellite Service</u> <u>US Naval Academy Satellite Lab</u> <u>Bob Bruninga, WB4APR, Principle Investigator</u> <u>Midshipmen Otero, Silver, Jones, Kolwicz, Evans, and</u> <u>Henry (Class of 03)</u>





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

Element Reference Epoch: 2003, 87.50000 Black = Computed Values (No Data Entry) Blue = Critical User Data Entry Values Orbit Properties Start Range to Spacecraft vs. Elevation Angle Orbit Velocity Spacecraft Parameter: Value: Unit: Start Range to Spacecraft vs. Elevation Angle Parameter: Value: Unit: Earth Radius: 6.378.17 km Km Second Rame Second Rame Not mathematication Spacecraft Semi-Major Axis (a): 6.738.17 km Second Rame Second Rame Second Rame Not mathematication Not mathematication Second Rame Not mathematication Second Rame Not mathematication Re = 6378.136 km Mean Orbit Altitude: 360.00 km Mean Orbit Altitude: Not Implemented deg./day Mean Orbit Altitude: 6.738.17 Km Mean Orbit Altitude: 6.738.17 Km Km Earth Station Re = 6378.136 km Re = 6378.136 km	Orbit Performance:			Jan A. Kin	26th Aug	26th August 2004 Version: 1.0			
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	Uplink:		MHz	¥		dB		0 log (S/h)	
	Downlink:	2420	MHz	0.124 meters	164.7		5 = 22.0 + 2		

DATV on ARISS

Jan A. King (Change

Date Data Last Modified: 26th August 2004

27

Uplink Command Budget:

Version: 1.0

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	e Isotropic	Radiated	Power (EIRF	P) [EIRP=Pt x
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 Pe				
Ionospheric Losses:	-1.0						
Rain Losses:	0.0						
Isotropic Signal Level at Ground Station:	-133.1	dBW					
Spacecraft:							
Eb/No Method							
Spacecraft Antenna Pointing Loss:	0.0						
Spacecraft Antenna Gain:		dBiC					
Spacecraft Transmission Line Losses:	-1.0						
Spacecraft LNA Noise Temperature:	150						
Spacecraft Transmission Line Temp.:	270						
Spacecraft Sky Temperature:	290						
S/C Transmission Line Coefficient:	0.7943						
Spacecraft Effective Noise Temperature:	436						
Spacecraft Figure of Merrit (G/T):		dB/K					
S/C Signal-to-Noise Power Density (S/No):		dBHz	Boltzman's Constant:		-228.6	dBW/K/Hz	
System Desired Data Rate:	2000000						
In dBHz:		dBHz					
Telemetry System Eb/No:	13.1		Assumes Spectral Effi	ciency of 1	.0 b.p.s./⊢	Iz of Bandwi	dth
Telemetry System Required Bit Error Rate:	9.00E-04						
Telemetry System Required Eb/No:	13.0		This Eb/No Required to meet B.E.R.				
System Link Margin:	0.1	dB					
26/10/2004							

DATV on ARISS Downlink Telemetry Budget:

Jan A. King (Chang

Date Data Last Modified:

Version: 1.0

26th August 2004 Parameter: Units: Value: 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 0.0 dB S/C Connector, Filter or In-Line Switch Losses: 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 Use Value Appropriate for Elevation Angle Selected in Orbit Perfor Atmospheric Loss: -1 dB Ionospheric Loss: -0.2 dB Rain Loss: 0.0 dB Isotropic Signal Level at Ground Station: -151.4 dBW Ground Station: ----- Eb/No Method ----2.0 dB Ground Station Antenna Pointing Loss: Ground Station Antenna Gain: dBiC 28 -1 dB Ground Station Transmission Line Losses: 50 K Ground Station LNA Noise Temperature: 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 3.0 dB/K Ground Station Figure of Merrit (G/T): dBW/K/Hz G.S. Signal-to-Noise Power Density (S/No): 78.2 dBHz Boltzman's Constant: -228.6 System Desired Data Rate: bps 2000000 63.0 dBHz In dBHz: 15.2 dB Telemetry System Eb/No: 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: This Eb/No Required to meet B.E.R. 13 dB System Link Margin: dB 2.2

- 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