



# 2014 ARRL/TAPR DCC

## SDR-based DATV-Express exciter for Digital-ATV

by

Ken Konechy W6HHC

W6HHC@ARRL.net

# DATV-Express



## The Presentation Author....



**Ken W6HHC**

# DATV-Express



**Digital-ATV technology allows Video Quality to exceed analog-ATV**



**Comparison of analog video and an DATV video using the same antennas with weak sigs**

(courtesy of G7LWT & GB3HV)

# DATV-Express



## Status of Digital-ATV Today

- DATV Video Quality can exceed analog ATV
- Very few hams transmit DATV in USA today
- European DATV is very active and growing
- Australia/New Zealand has lots of DATV activity
- Currently Digital-ATV transmitters are expensive
- US \$900 up for MPEG/DVB-S Encoder/Transmitters
- DATV Transmitter is cost barrier for most in USA



# DATV-Express

## Goals of the DATV-Express Project

- Significantly reduce price of Digital-ATV transmitters
- Provide Plug-and-Play hardware board to minimize home construction.
- Provide open platform for future DATV development
- Help educate community about new technologies
- Get more DATV stations on-air
- Encourage wider audience to get ham licensed
- Byproduct can be Software Defined Transmitter from 70 – 2450 MHz ham bands with a B/W of up to 8 MHz

# DATV-Express



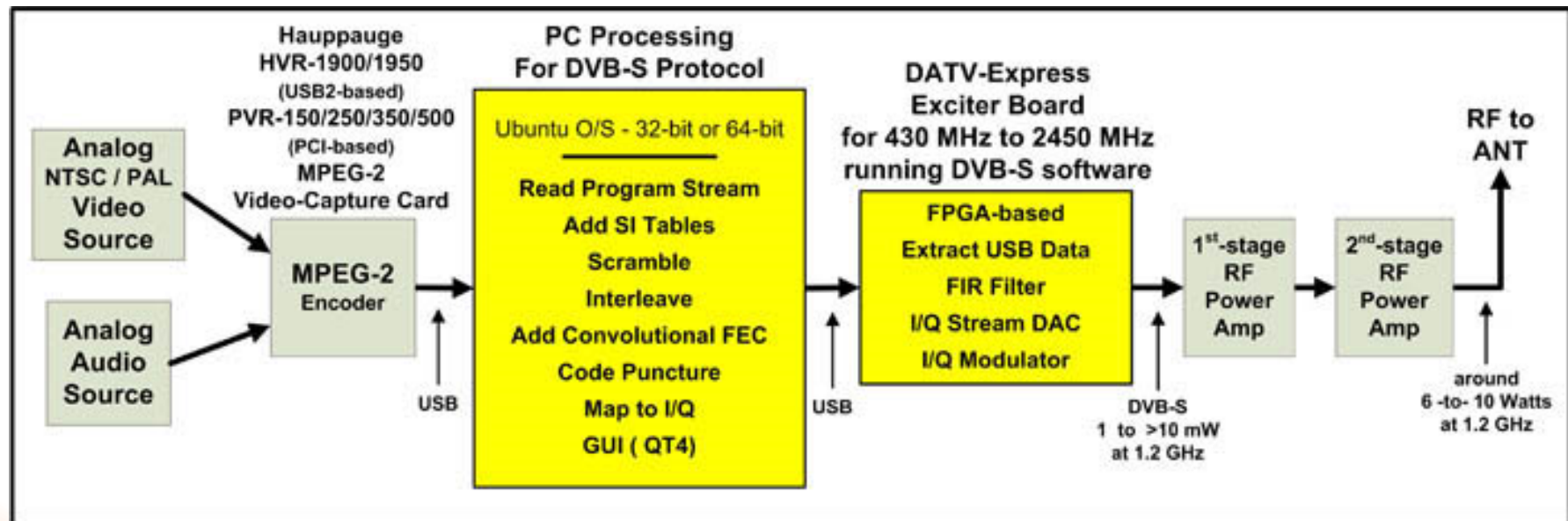
## The DATVexpress Team

- Charles Brain - G4GUO Ferring, England
- Ken Konechy - W6HHC Orange, CA, USA
- Art Towslee - WA8RMC Columbus, OH, USA
- Tom Gould - WB6P Portland, OR, USA



# DATV-Express

## Overview of DATV-Express System



Typical System Block Diagram for DATV-Express DVB-S DATV Transmitter

# DATV-Express



## DATV-Express Board features

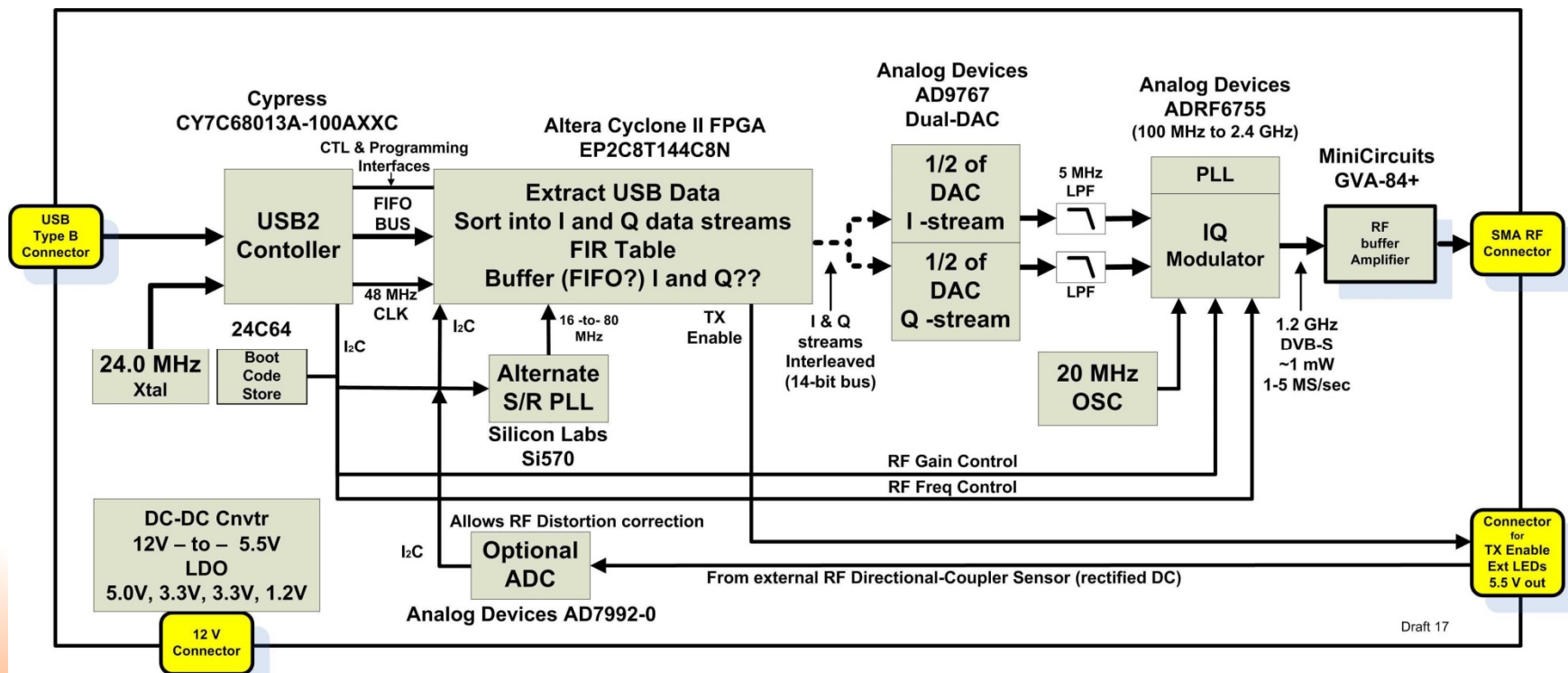
- Single custom design board preps I/Q stream and provides QPSK RF output at 432-2450 MHz
- Interfaces to PC processing through USB2 port
- Contains PLL for the 70-to-2450 MHz freq control
- Controls Symbol-Rate
- SDR-based allows many modulations and protocols
- On board buffer-RF amplifier for 1 to 10+ mW
- DC-DC power supplies allows single 12V input
- SMA connection to RF Power Amp stages and antenna



# DATV-Express



## DATV-Express board internal block diagram



Block Diagram for DATV-Express Hardware Board

# DATV-Express



## DATV-Express hardware board





# DATV-Express

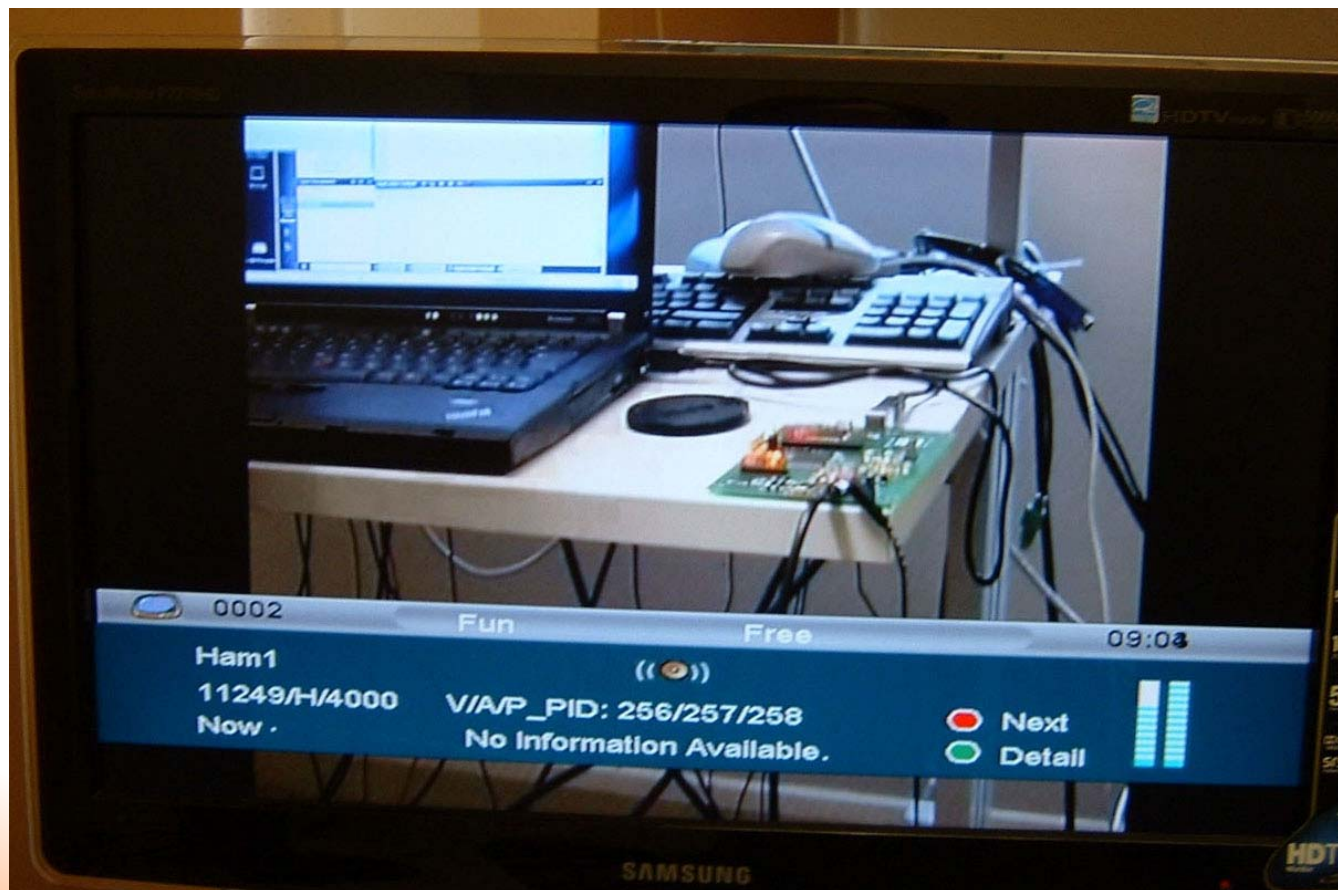
## DATV-Express System Specs

- DVB-S protocol is tested and released
- All IQ modulations (QPSK modulation was tested)
- Frequency Range:  
70–2450 MHz (Modulator chip specification)
- Symbol-Rate:
  - Adjustable: 1 to 5 MSymb/second
- Forward Error Correction is selectable
- RF output ~ 1-20 mW buffered (SMA connector)
- USB Video Capture card for NTSC or PAL
- Initially designed for one video stream
- PC Operating System – first Ubuntu-32/64-bit
  - then quadcore-ARM ODROID U3 w/ Libuntu

# DATV-Express



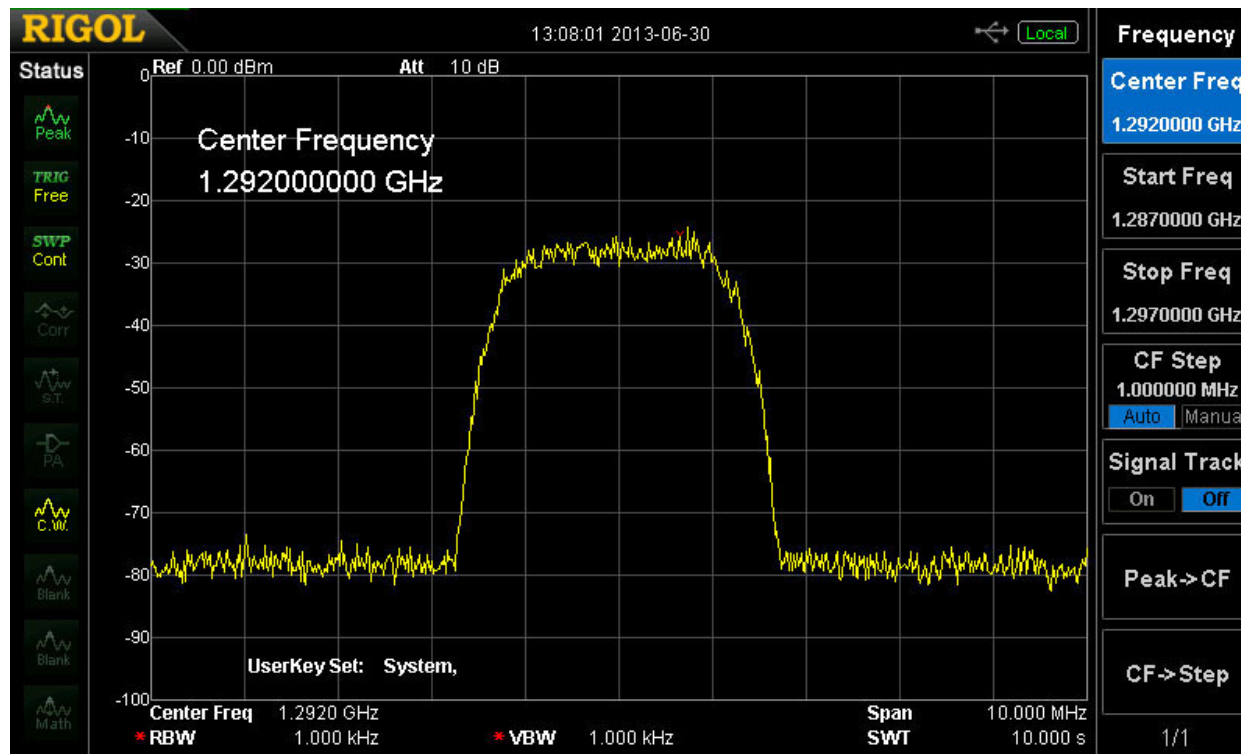
1st DVB-S Transmission on First prototype



# DATV-Express



## Clean DVB-S 1.2 GHz spectrum

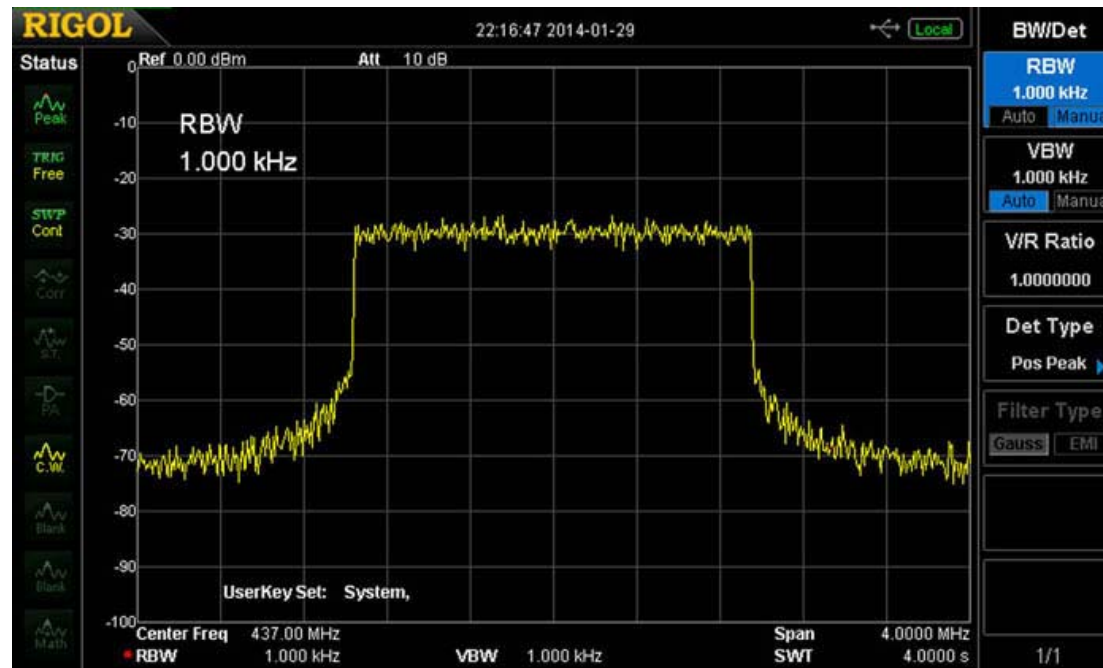


Barefoot board RF output – has 47 configurable levels of RF output



# DATV-Express

DATV-Express capable of other DATV protocols used by hams

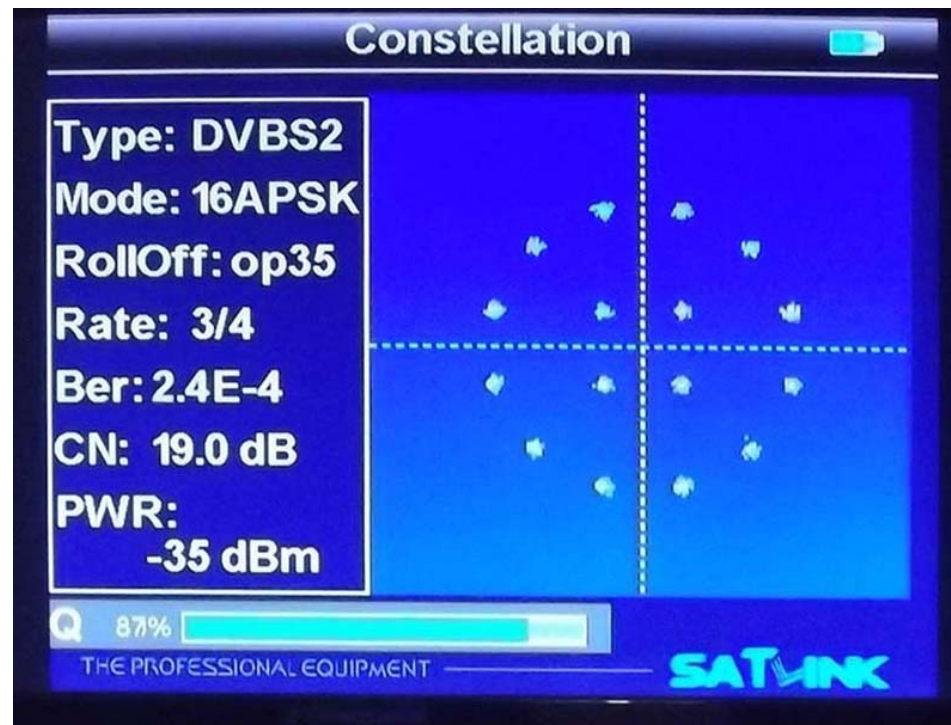


Testing DVB-T (2K mode) protocol at 2 MHz bandwidth on 437 MHz  
(using 4096-point iFFT math - with NO alias spurs)



# DATV-Express

DATV-Express capable of other DATV protocols used by hams – cont'd

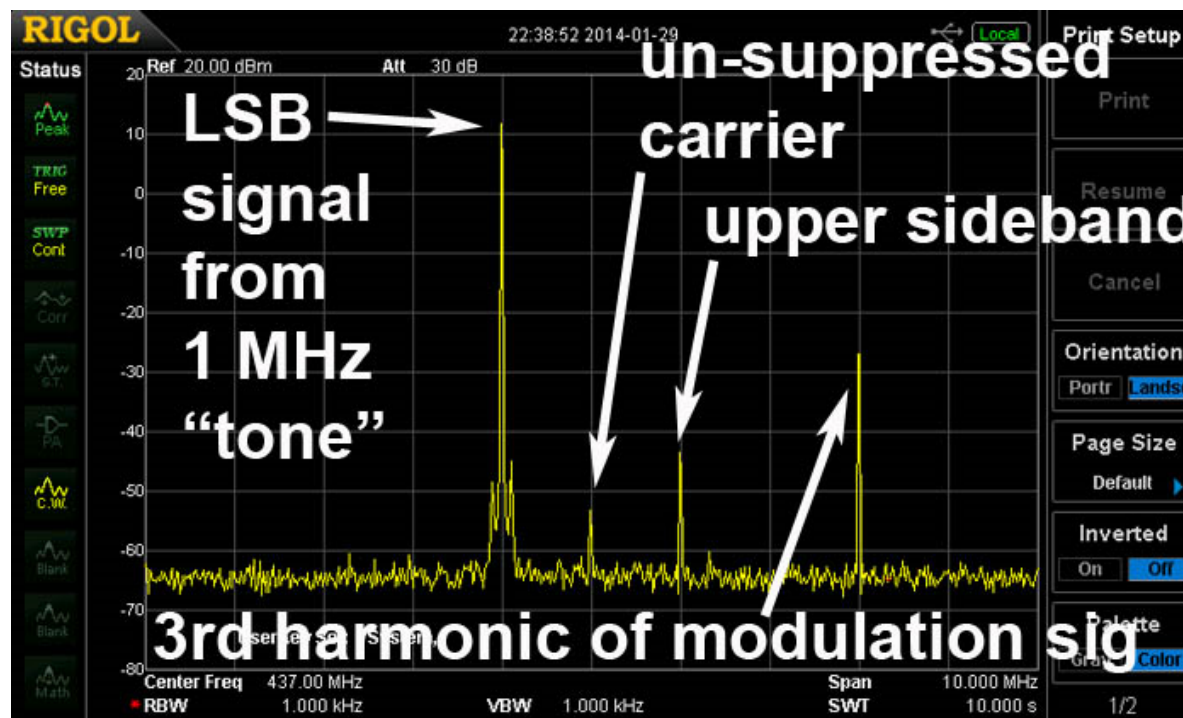


Testing constellation for 16APSK digital modulation for DVB-S2 protocol



# DATV-Express

SDR allows Lower-Side-Band for example



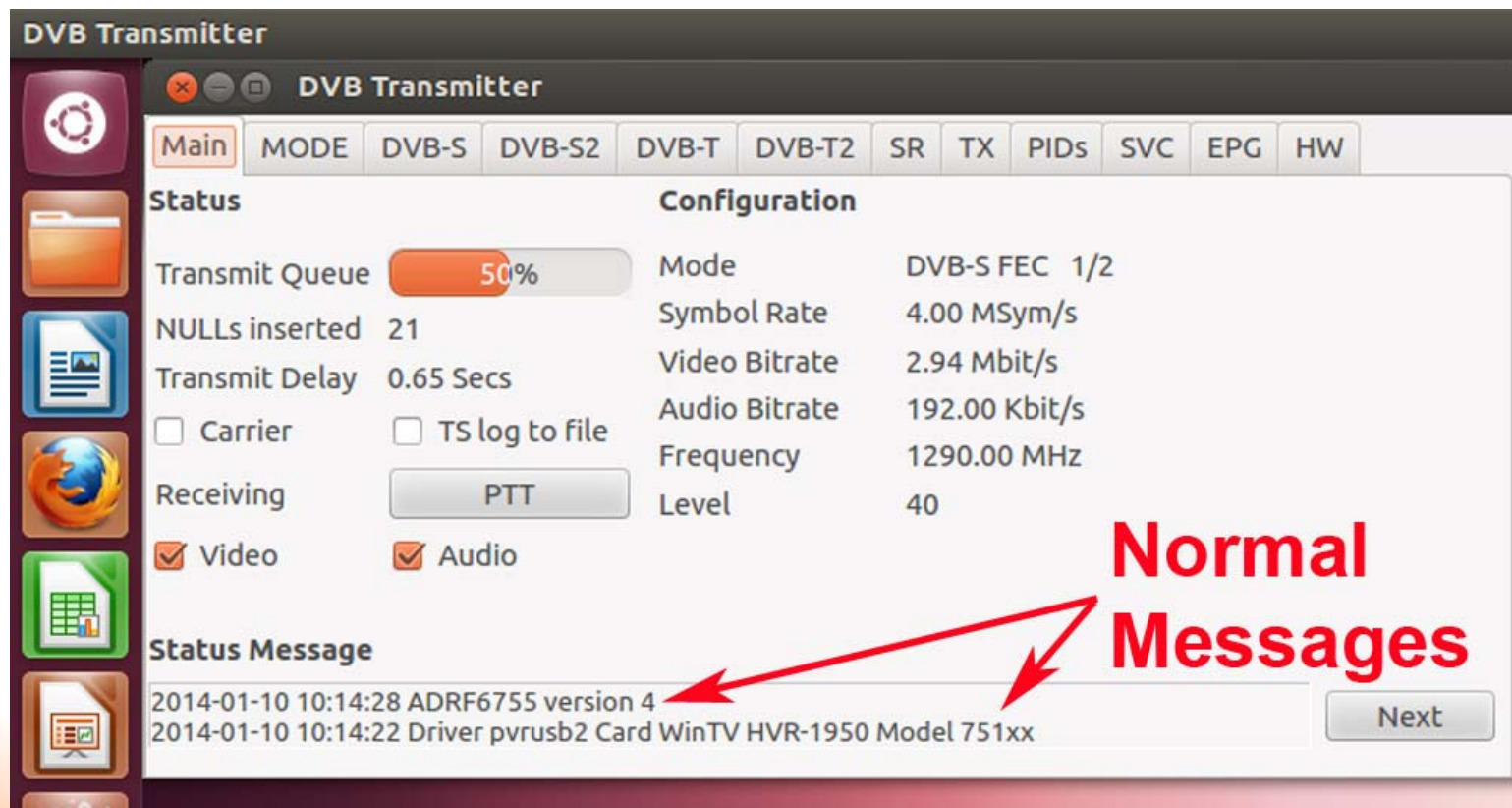
Unsuppressed carrier is down 60 dB



# DATV-Express



## Simple DATV-Express User Interface



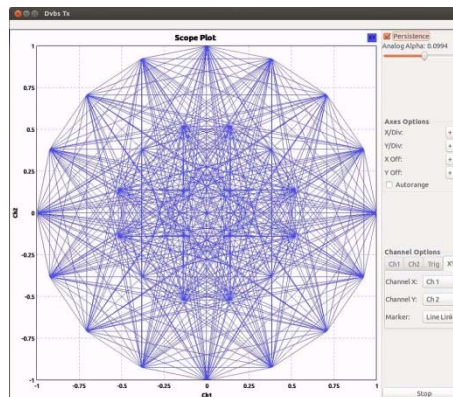
Software User Interface uses Qt4 (screen is configured for DVB-S Protocol)

# DATV-Express



## GNU Radio with DATV-Express

- Alex OZ9AEC has developed gnuradio “sink” module for DATV-Express – (see Github URL at end)
- Ron W6RZ has adapted gnuradio to run DVB-S2 32APSK
- W6RZ uses DATV-Express DVB-S2 code and tested with BladeRF & Novra S300V DVB-S2 STB at up to 10 MSym/s.



# DATV-Express



## Current Project Status on PC

- DATV-Express production board released in Feb 2014
  - Order at **[www.DATV-Express.com](http://www.DATV-Express.com)** (PayPal)
  - Order at BATC Online Shop **<https://BATC.org.uk/shop/>**
- DVB-S completed and stable
- As extra bonus, have tested board to transmit DVB-T 2K mode, however cannot guarantee performance
- DVB-S2 tested, but there are licensing issues
- Next development phase to eliminate bulky PC

# DATV-Express



## Go More Portable than bulky PC or Notebook

- Reduce Micro-PC load by using more FPGA functions
- Maybe Raspberry PI ?
- or...RikoMagic MK802iv ?
- or...Hardkernel ODROID U3 ?

# DATV-Express



## Raspberry PI

- Raspberry PI has singlecore-ARM at 700 MHz
- Raspberry PI typically uses Raspbian OS
- Originally designed for education market
- Raspberry PI is seriously under-powered for our app
- Raspbian source code repository is INCOMPLETE  
CAN NOT re-compile kernel

# DATV-Express



## RikoMagic MK802iv

- MK802iv has quadcore-ARM at 1.4 GHz
- PicUntu OS is light-weight Ubuntu
- MK802iv as option to create “smart TV’s” for internet
- PicUntu source code repository is INCOMPLETE  
CAN NOT re-compile kernel
- Kernel does not use SMP to balance load on four cores

# DATV-Express



RikoMagic MK802iv



# DATV-Express



## Hardkernel ODROID U3

- ODROID U3 has quadcore-ARM at 1.7 GHz
- Comes with Ubuntu 12.4 LTS (LDE Desktop)
- Single-board-computer designed for software developers
- Has very active software community for support
- Has complete source repository to re-compile kernel
- Charles G4GUO explains that once DATV-Express project is satisfied with release for ARM...it should work OK with almost any ARM product





# DATV-Express

Hardkernel ODROID U3 “micro-PC”

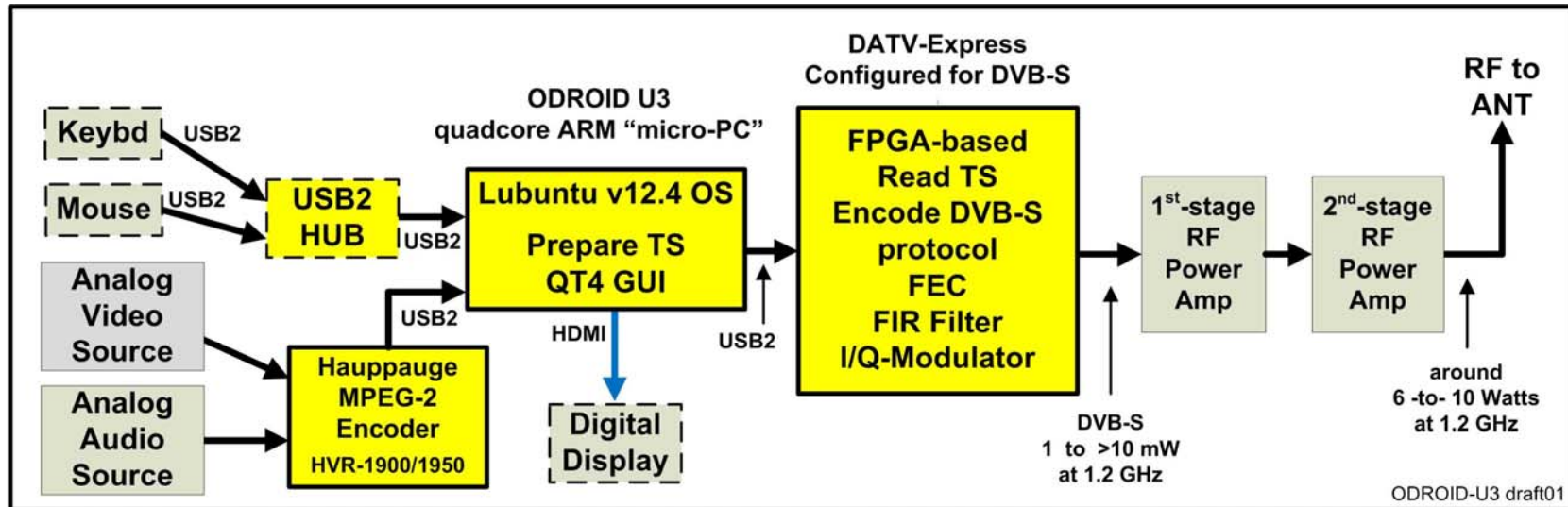


ODROID U3 is about the same size as Raspberry Pi



# DATV-Express

## Hardkernel ODROID U3



Planned System Block Diagram for DATV-Express DVB-S with ODROID U3

# DATV-Express



## Conclusion and Plans

- Ubuntu 32/64 Code for PC is finished
- We need volunteers to help with software
- G4GUO reports “have had a few genuine offers of help but the problem is that those with the time don't have the experience and those with the experience don't have time.”
- Focus now is for replacing bulky PC with “ARM Micro-PC”
- Source files will be available  
(Software, FPGA coding, gerbers, etc.)
- Beginnings of source code repository at  
[https://github.com/G4GUO/datvexpress\\_gui.git](https://github.com/G4GUO/datvexpress_gui.git)

# DATV-Express



- British ATV Club - Digital Forum  
**[www.BATC.org.UK/forum/](http://www.BATC.org.UK/forum/)**
- CQ-DATV online (free monthly) e-magazine (ePub format)  
**[www.CQ-DATV.mobi](http://www.CQ-DATV.mobi)**
- OCARC library of newsletter DATV articles  
**[www.W6ZE.org/DATV/](http://www.W6ZE.org/DATV/)**
- TAPR Digital Communications Conference proceedings (free downloads)  
**[www.TAPR.org/pub\\_dcc.html](http://www.TAPR.org/pub_dcc.html)**
- Yahoo Group for Digital ATV  
**<http://groups.yahoo.com/group/DigitalATV/>**
- DATV-Express project website  
**[www.DATV-Express.com](http://www.DATV-Express.com)**
- DigiLite Project for DATV (derivative of the “Poor Man's DATV”)  
**[www.G8AJN.tv/dlindex.html](http://www.G8AJN.tv/dlindex.html)**
- Hardkernel (Korea) for ODROID model U3 ARM-based “micro-PC”  
**[www.hardkernel.com](http://www.hardkernel.com)**
- Alex OZ9AEC GNURADIO “sink” module for DATV-Express  
**<https://github.com/csete/gr-datvexpress>**
- Ron W6RZ using GNURADIO with DATV-Express DVB-S2 code  
**<https://github.com/drmpeg/gr-dvbs2>**
- SR-Systems (Germany) D-ATV components(Boards)  
**[www.SR-systems.de](http://www.SR-systems.de) and [www.D-ATV.org](http://www.D-ATV.org)**