GNURadio x HackRF
开源软件无线电

HACKRF.NET

A BLOG ABOUT OPENSOURCE SDR

GNURadio

THE FREE & OPEN SOFTWARE RADIO ECOSYSTEM

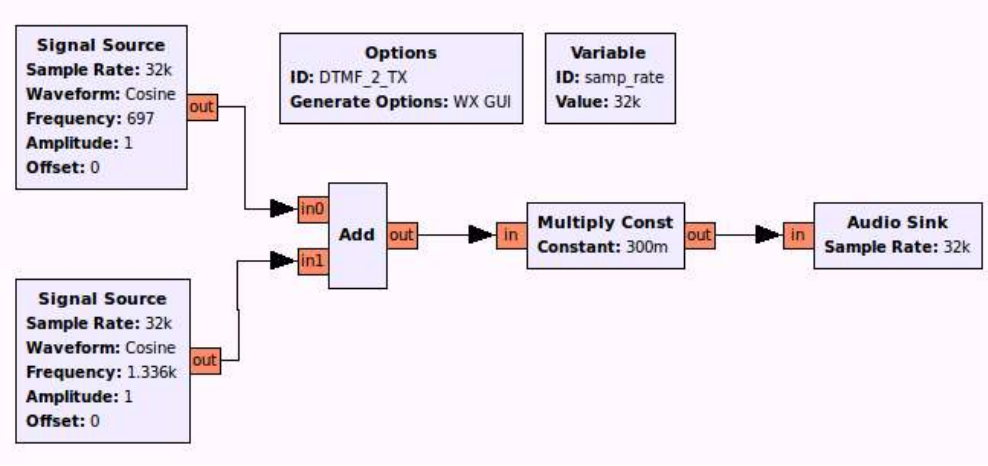
星天科技

STARTEST TEC.

<热身>

电话拨号盘 - DTMF 双音多频

- aoss multimon -a dtmf

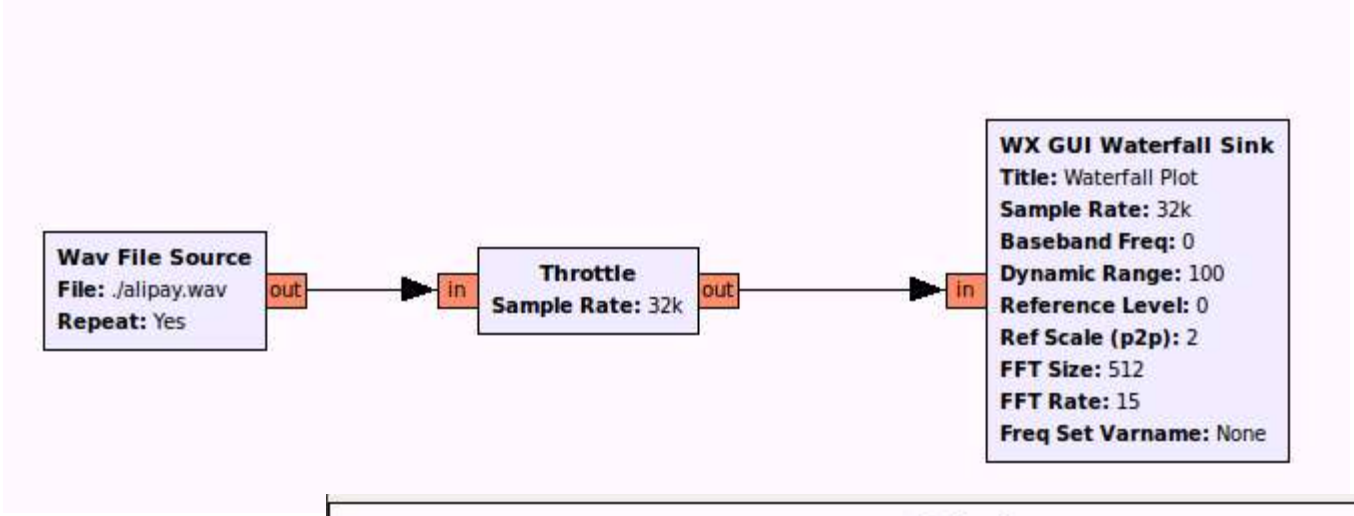


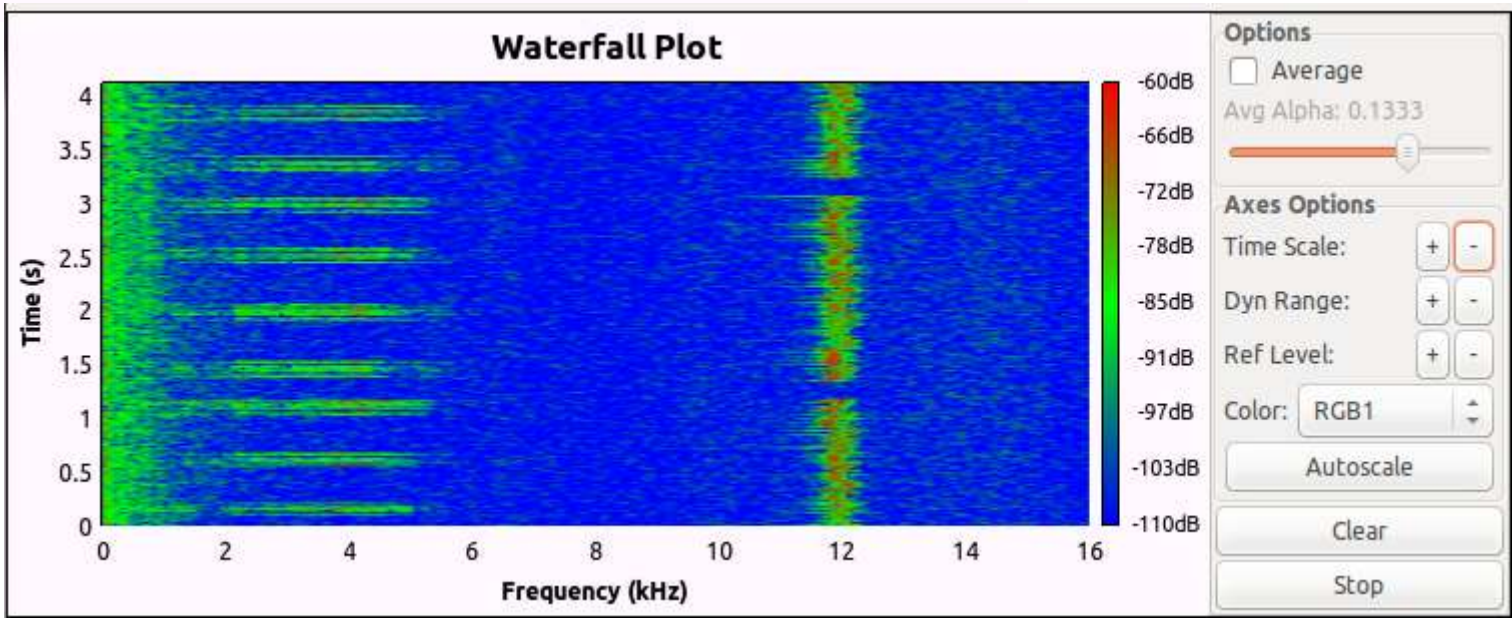
- 柯南 杜普蕾
- 我们现场用口哨吹?
  - 口哨音域不够...

双音多频键盘

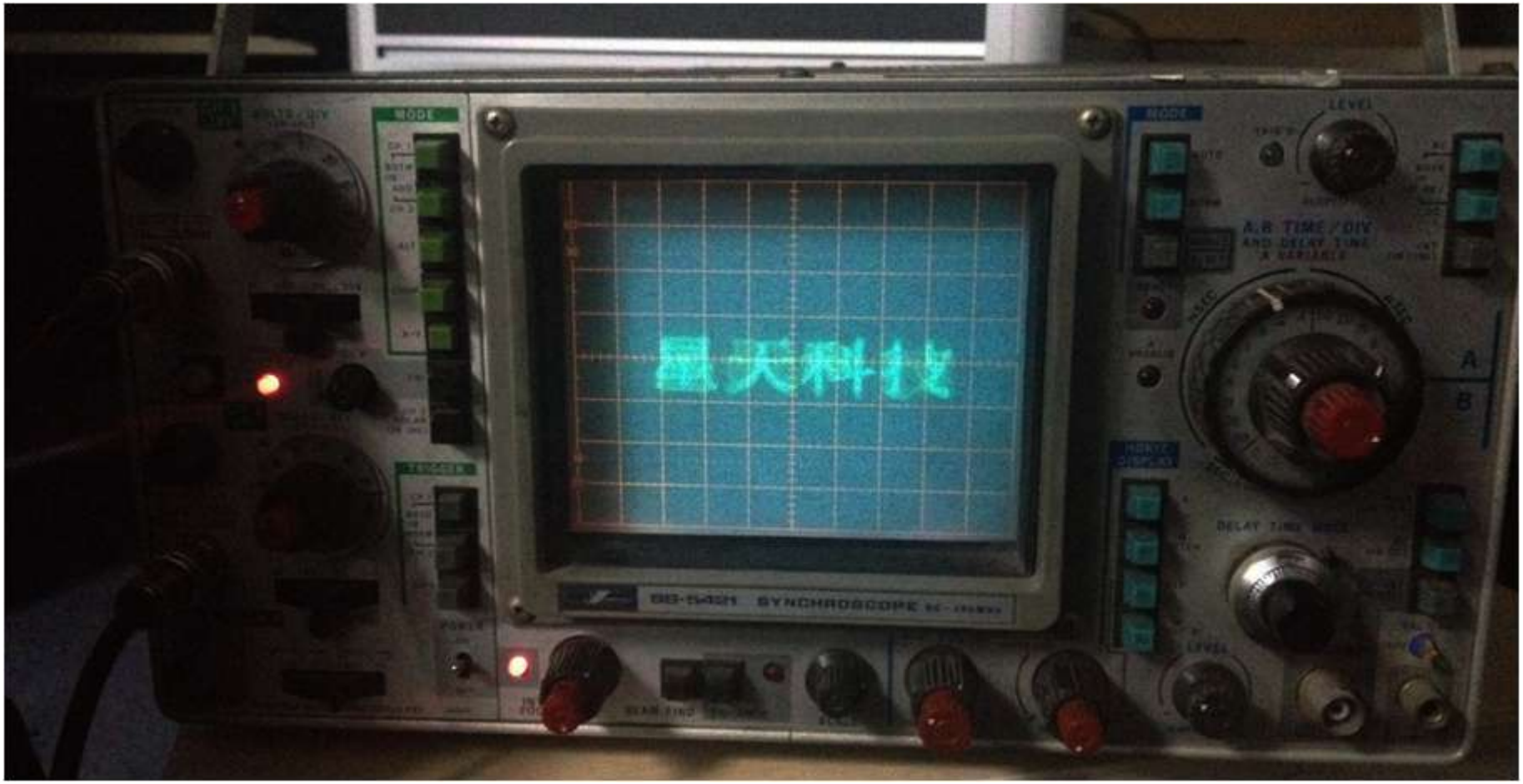
	1209 Hz	1336 Hz	1477 Hz	1633 Hz
697 Hz	1	2	3	A
770 Hz	4	5	6	B
852 Hz	7	8	9	C
941 Hz	*	0	#	D

支付宝 当面付 咻咻咻


Wav File Source
File: ./alipay.wav
Repeat: Yes
out
in
Throttle
Sample Rate: 32k
out
in
WX GUI Waterfall Sink
Title: Waterfall Plot
Sample Rate: 32k
Baseband Freq: 0
Dynamic Range: 100
Reference Level: 0
Ref Scale (p2p): 2
FFT Size: 512
FFT Rate: 15
Freq Set Varname: None


Waterfall Plot
Time (s)
Frequency (kHz)
0
0.5
1
1.5
2
2.5
3
3.5
4
0
2
4
6
8
10
12
14
16
-60dB
-66dB
-72dB
-78dB
-85dB
-91dB
-97dB
-103dB
-110dB
Options
Average
Avg Alpha: 0.1333
Axes Options
Time Scale:
Dyn Range:
Ref Level:
Color:
RGB1
Autoscale
Clear
Stop

声卡 x 示波器



遥控大铁门重放 -熊孩子中的战斗熊

- 人大附中校门遥控器 链接

软件源里其它有趣的东西

- Xcwcp
- minimodem -t 100
- gMFSK：哔哔哔
- ultrasonic networking
  - 使用了GNURadio提供的TUNTAP PDU

</热身>

GNURadio与SDR介绍

- 开源的信号处理编程框架
  - C++ / SWIG / Boost / Python
  - Scheduler
  - 大量采样数据流处理

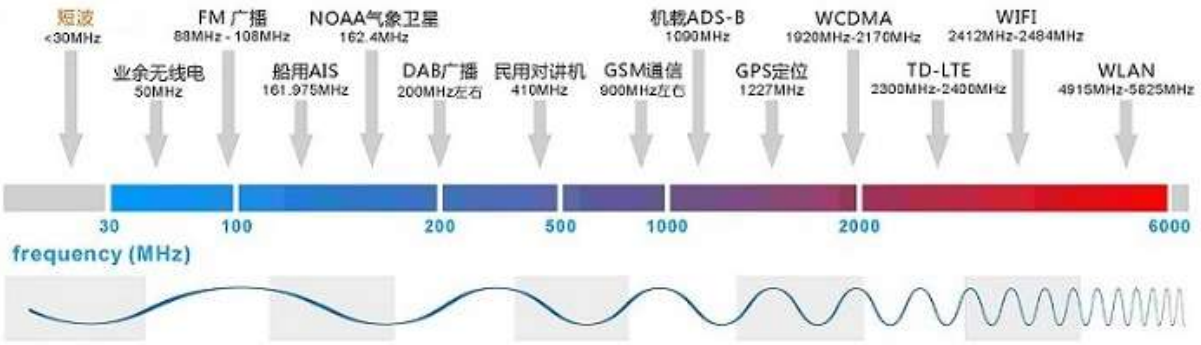
为什么需要开源软件无线电

- 开发快
- 有了软件，再也不用“无限垫”
- 课本上的信息可以直接在空中进行传播验证
- 外设贵
  - USRP 母板 人民币18000 + 不同频段子板每个~2000元
  - Agilent和RS公司的仪表 几十万起步
- 全世界的射频工程师和硬件工程师

- 现在，你只需要一个HackRF，一台PC，就能扣开无线电世界的大门。

HackRF项目

- Kickstarter上融资成功
  - $602,960　　1,991 backers
  - 先期从DARPA申请项目造500块测试版本免费送人测
- 覆盖频段30MHz – 6GHz
  - “一块顶过去五块”
- 带宽 20MHz
- 由于深圳过年的缘故 5月才到货



HackRF, an open source SDR platform

by Michael Ossmann

Funded! This project was successfully funded on Sep 4.

1,991
backers

$602,960
pledged of $80,000 goal

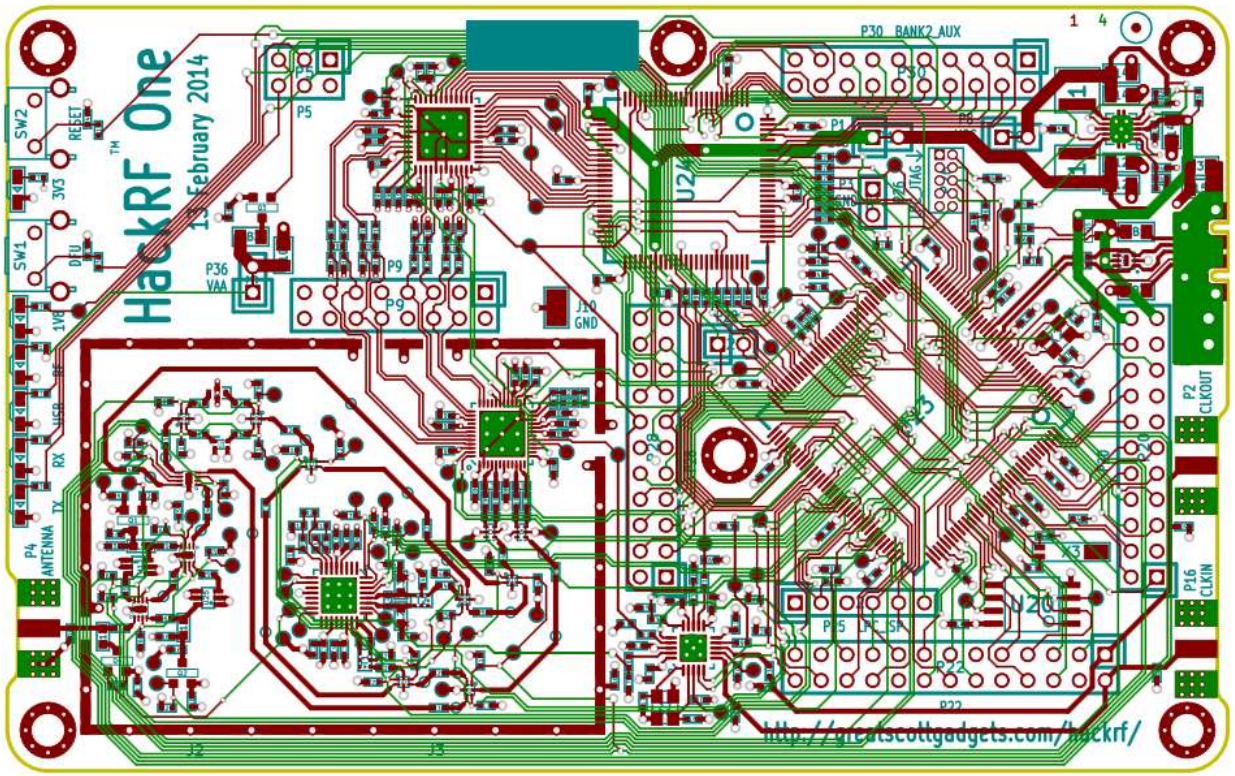
0
seconds to go

Project by
Michael Ossmann
Evergreen, CO
Contact me

3 created · 11 backed

Has not connected Facebook

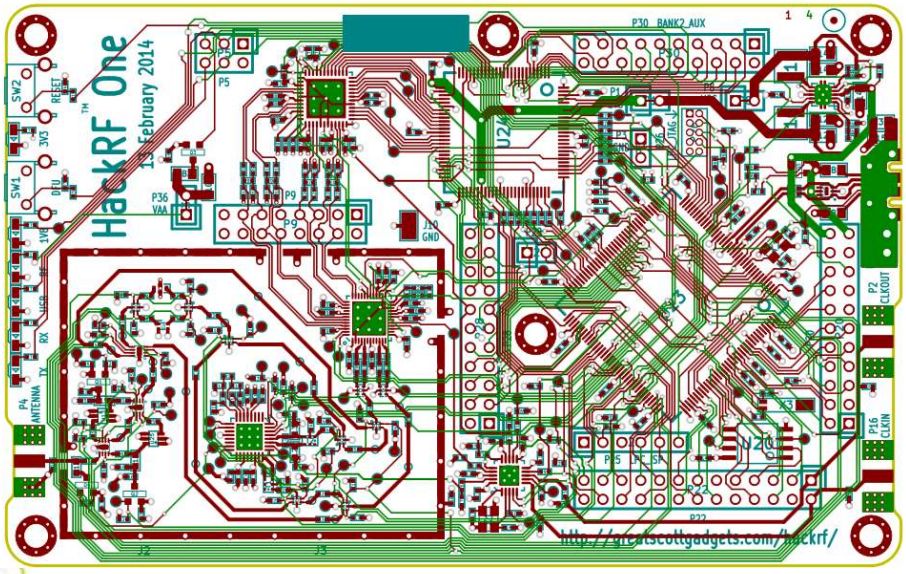
星天科技
STARTEST TEC.

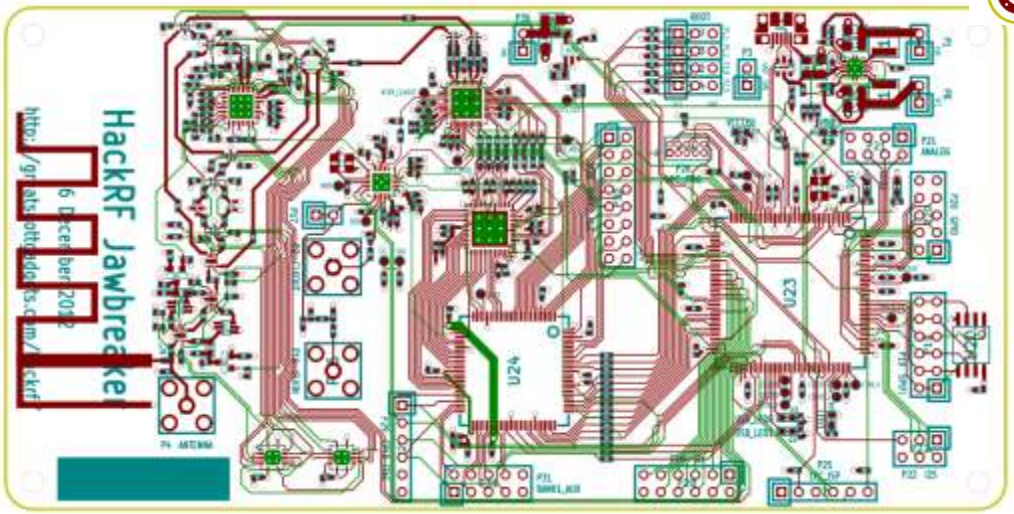


- RFFC5072 - 混频器提供80MHz到4200MHz的本振
- MAX2837 - 2.3GHz to 2.7GHz 无线宽带射频收发器
- MAX5864 - ADC/DAC, 22MHz采样率 8bit
- LPC4320/4330 - ARM Cortex M4处理器, 主频204MHz
- Si5351B - I2C可编程任意CMOS时钟生成器，由800MHz分频提供40MHz 50MHz 及采样时钟
- MGA-81563 - 0.1–6GHz 3V, 14 dBm 放大器
- SKY13317 - 20 MHz-6.0 GHz 射频单刀三掷(SP3T)开关
- SKY13350 - 0.01-6.0 GHz 射频单刀双掷(SPDT)开关

HackRF One针对测试版本Jawbreaker做了哪些改进

- 废柴微带天线
- 将RFFC5072和MAX2837放入屏蔽罩
- 更紧凑
- DFU 和Reset按钮





- Jawbreaker中小的信号干扰
- 测试版本Jawbreaker已经不被最新版的固件所支持

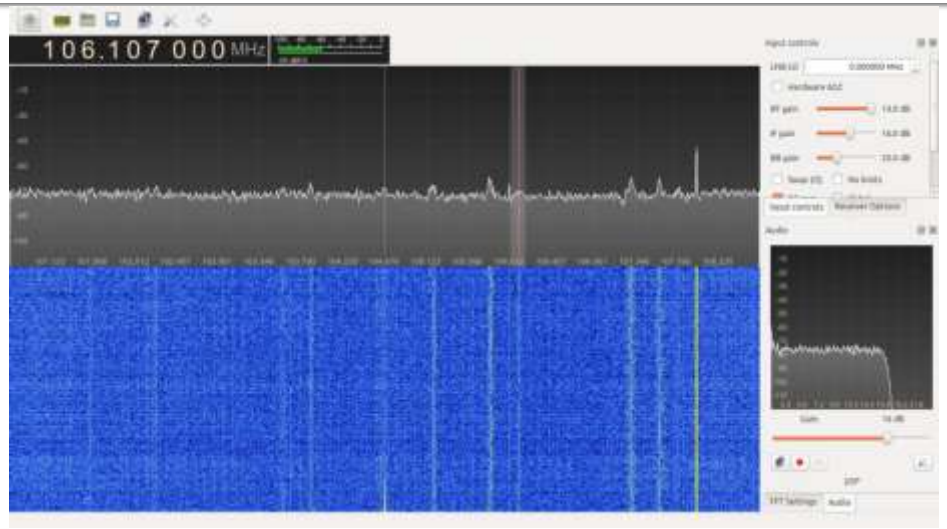
HackRF 硬件原理

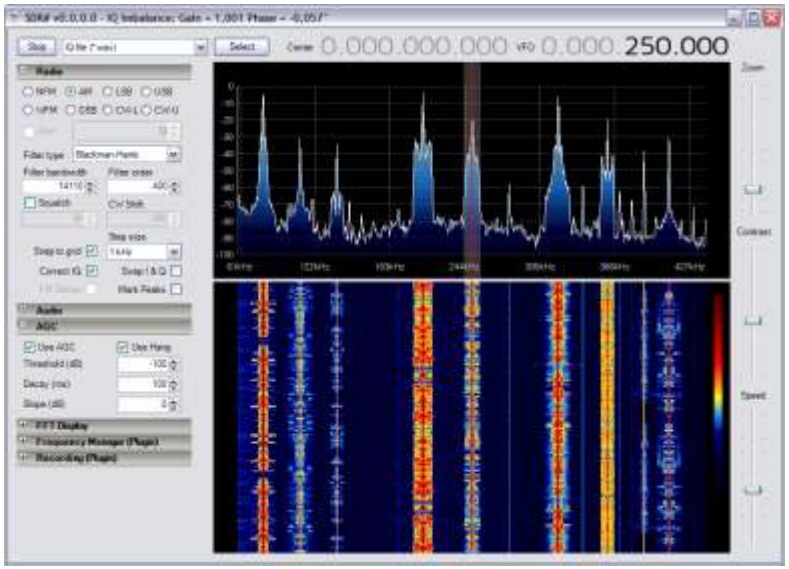
- 由射频开关决定是否经由14dB的放大器进行放大
- 经过镜像抑制滤波器对信号进行高通或低通滤波
- 信号进行RFFC5072芯片混频到2.6GHz固定中频
- 信号送入MAX2837芯片混频到基带，输出差分的IQ信号
  - 其间MAX2837芯片可以对信号进行带宽限制
- MAX5864芯片对基带信号进行数字化后送入CPLD和单片机
- LPC4320/4330处理器将采样数据通过USB送至计算机

Showtime

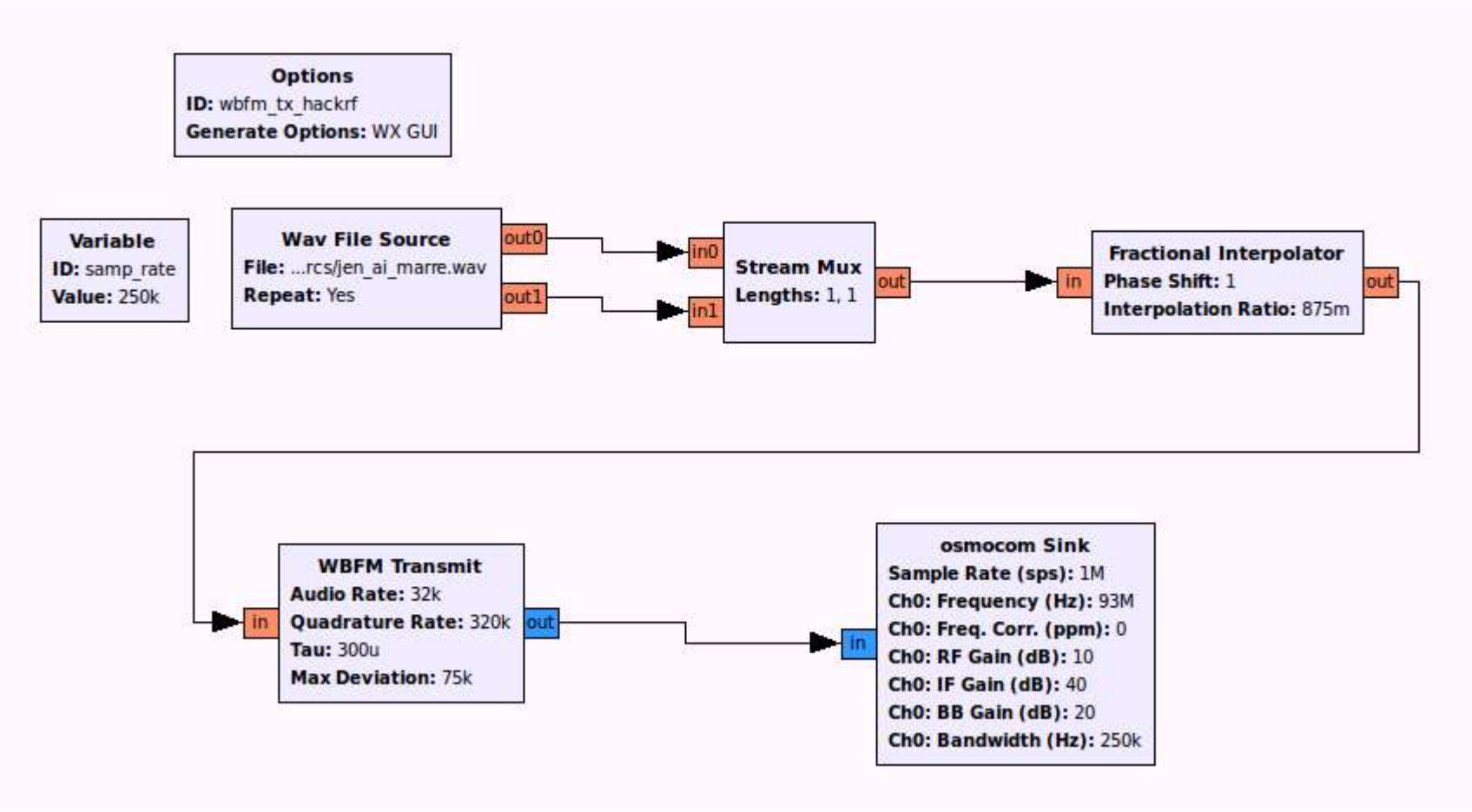
FM接收

- gqrx项目
  - http://gqrx.dk
  - 作者也是资深业余无线电爱好者 呼号OZ9AEC
  - 基于Qt
- SDR# (SDRSharp)
  - Windows平台
  - 可以自定义插件
- NBFM / WBFM 接收

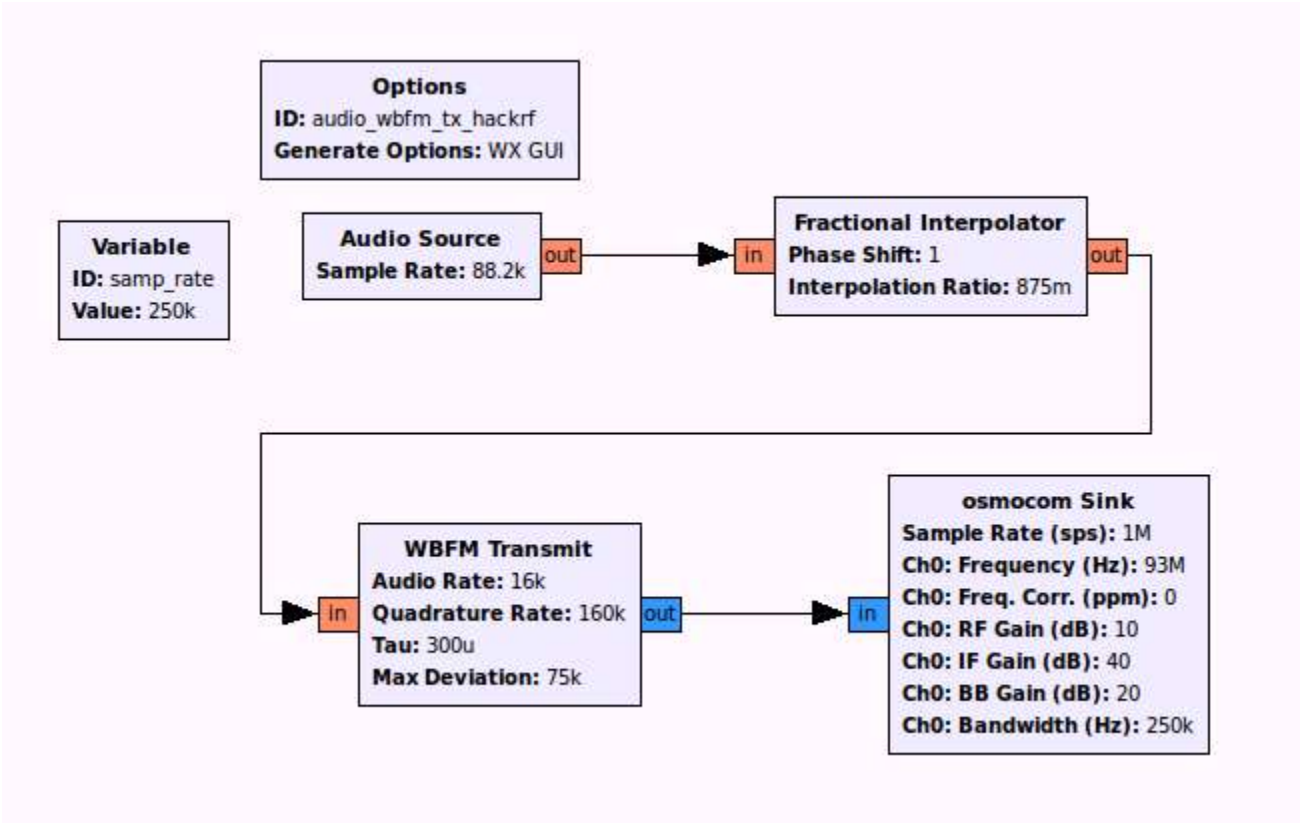




FM发射 – WAV源 (1/2)


Options
ID: wbfm_tx_hackrf
Generate Options: WX GUI
Variable
ID: samp_rate
Value: 250k
Wav File Source
File: ...rcs/jen_ai_marre.wav
Repeat: Yes
out0
out1
in0
in1
Stream Mux
Lengths: 1, 1
out
in
Fractional Interpolator
Phase Shift: 1
Interpolation Ratio: 875m
out
in
WBFM Transmit
Audio Rate: 32k
Quadrature Rate: 320k
Tau: 300u
Max Deviation: 75k
out
in
osmocom Sink
Sample Rate (sps): 1M
Ch0: Frequency (Hz): 93M
Ch0: Freq. Corr. (ppm): 0
Ch0: RF Gain (dB): 10
Ch0: IF Gain (dB): 40
Ch0: BB Gain (dB): 20
Ch0: Bandwidth (Hz): 250k

FM发射 – 麦克风源 (2/2)

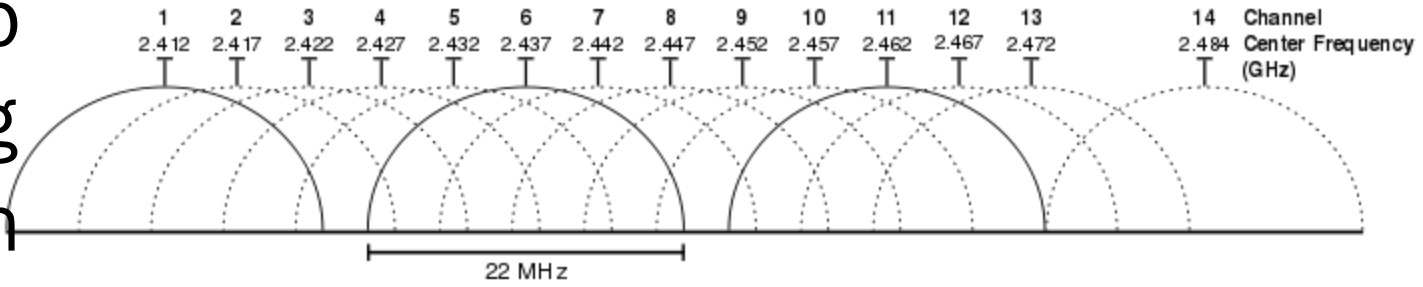

Options
ID: audio_wbfm_tx_hackrf
Generate Options: WX GUI
Variable
ID: samp_rate
Value: 250k
Audio Source
Sample Rate: 88.2k
out
in
Fractional Interpolator
Phase Shift: 1
Interpolation Ratio: 875m
out
in
WBFM Transmit
Audio Rate: 16k
Quadrature Rate: 160k
Tau: 300u
Max Deviation: 75k
out
in
osmocom Sink
Sample Rate (sps): 1M
Ch0: Frequency (Hz): 93M
Ch0: Freq. Corr. (ppm): 0
Ch0: RF Gain (dB): 10
Ch0: IF Gain (dB): 40
Ch0: BB Gain (dB): 20
Ch0: Bandwidth (Hz): 250k

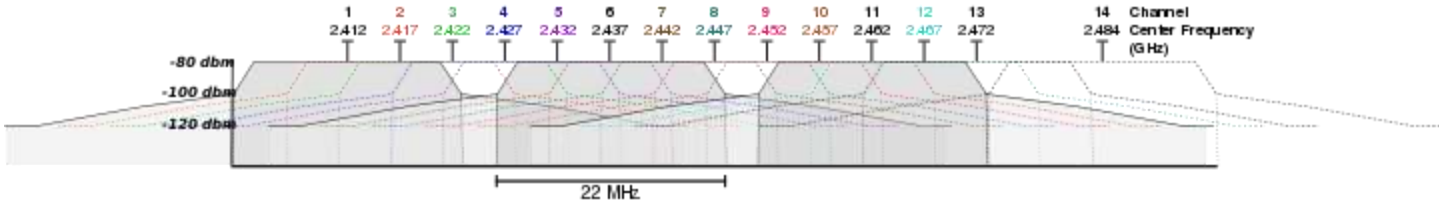
DAB 数字广播发射

- Digital Audio Broadcasting
- 音质达到接近 CD 的水平
  - AAC编码/ Reed Solomon 前向纠错编码
- 北京目前已经有17个以上的DAB频道
- 我们自己搭一个DAB电台?

看WiFi

- 802.11b
- 802.11g
- 802.11n
- 802.11a





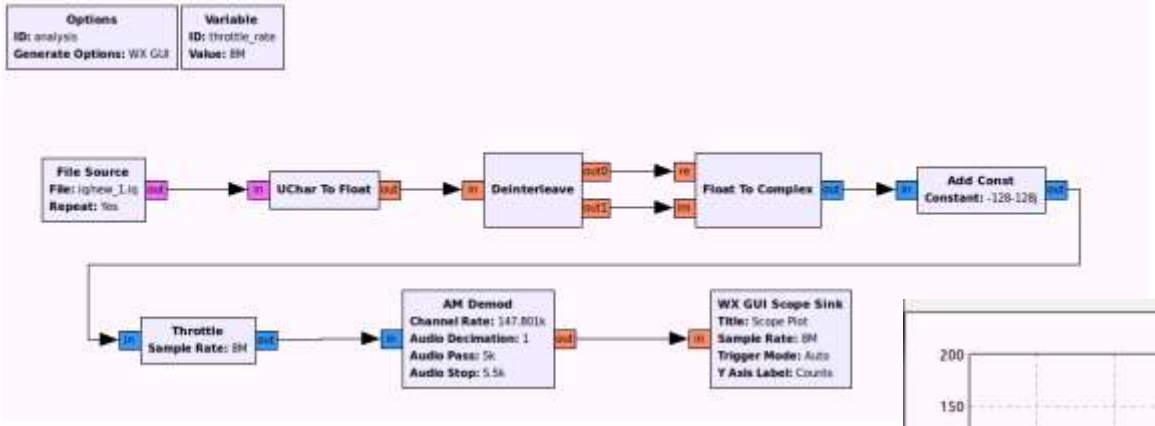
- 2.4GHz
- 5.8GHz

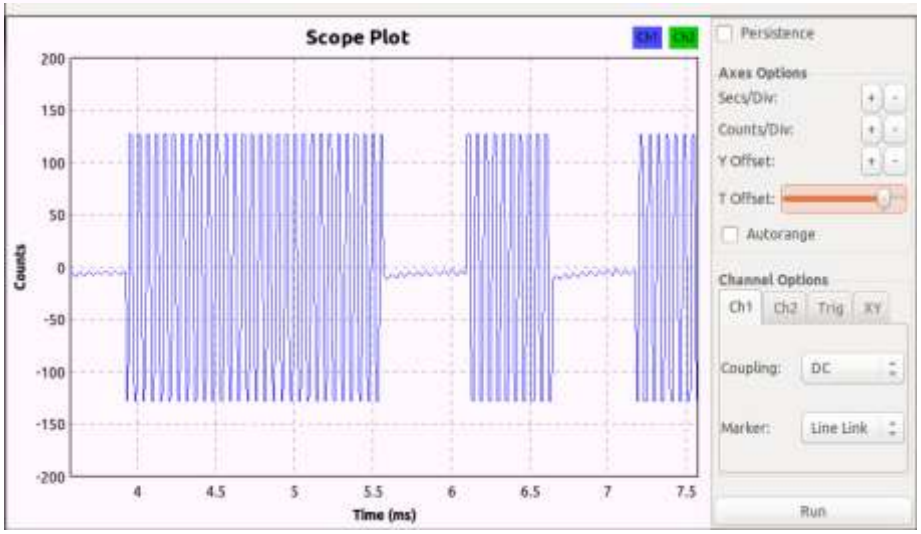
遥控小车重放与分析 1/3

- hackrf_transfer -r car.iq -f 40000000 -s 8000000 -i 60
- hackrf_transfer -t car.iq -f 40000000 -s 8000000 -a 1 -l 30 -x 40
- 咱有20MHz带宽
  - 因此可以同时采回27MHz和40MHz遥控

遥控小车重放与分析 2/3

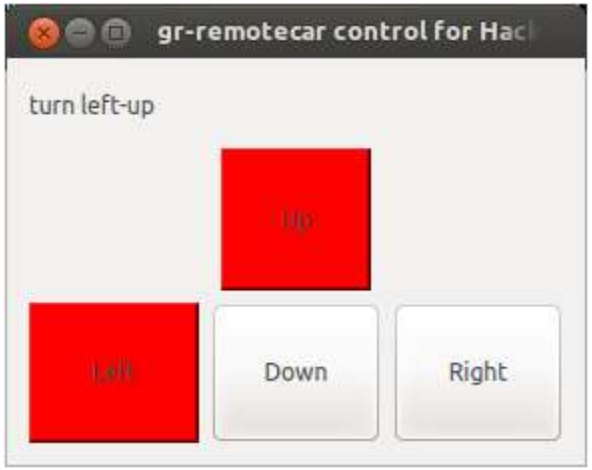
- 见https://github.com/scateu/gr-remotecar

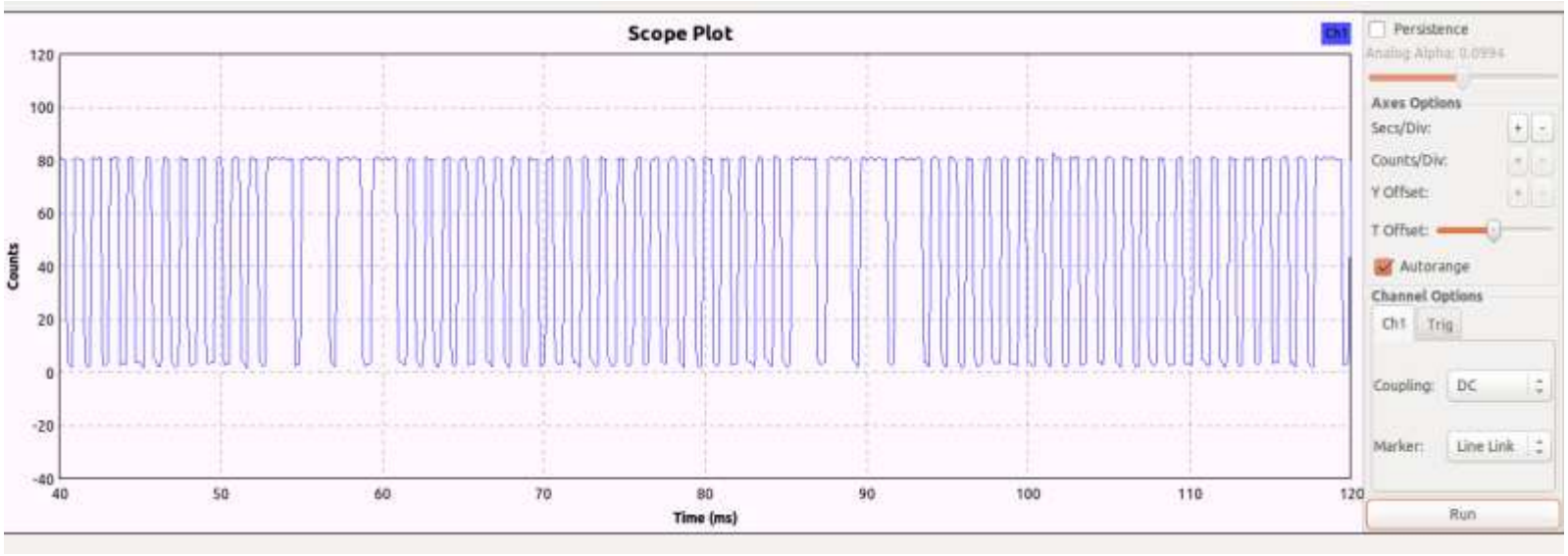




遥控小车重放与分析 3/3

- 分析好之后 我们可以用gr-modtool 着手写DSP模块
- 模块完成后，加一个简易的PyQt的外壳

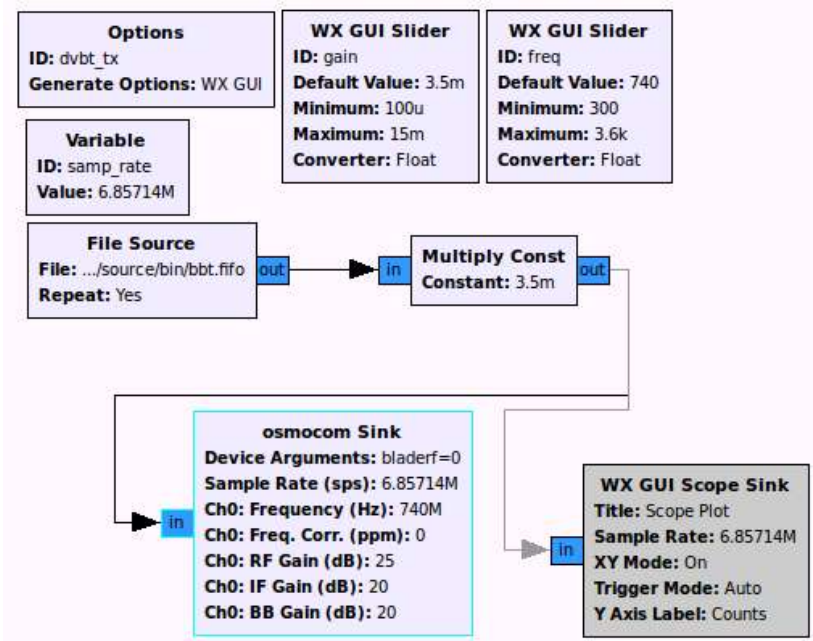




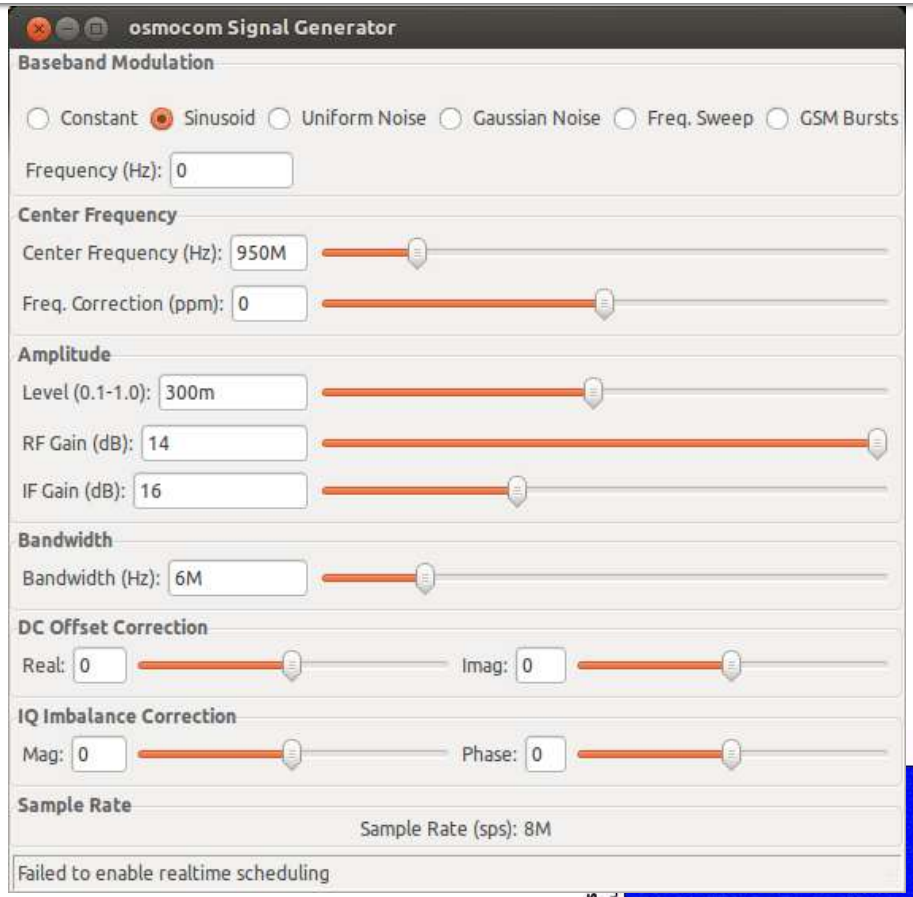
DVB-T 广播

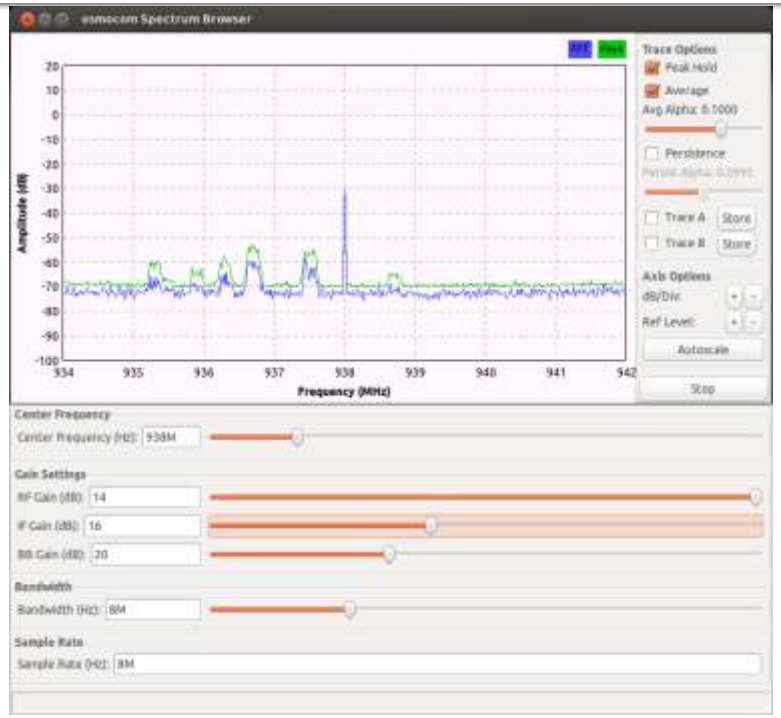
```
argilo@argilo-thinkpad: ~
argilo@argilo-thinkpad:~$ avconv -f alsa -i pulse -f video4linux2 -s 640x480 -i /dev/video0 -vf draw
text=fontfile=/usr/share/fonts/truetype/freefont/FreeSerif.ttf:text="VE3IRR":x=440:y=420:fontsize=48
:fontcolor=white@0.6:box=1:boxcolor=black@0.2 -vcodec mpeg2video -s 640x480 -r 60 -b 4000000 -acodec
 mp2 -ar 48000 -ab 192000 -ac 2 -muxrate 4524064 -mpegts_transport_stream_id 1025 -mpegts_service_id
 1 -mpegts_pmt_start_pid 0x1020 -mpegts_start_pid 0x0121 -f mpegts -y ~/git/in.fifo
avconv version 0.8.10-4:0.8.10-0ubuntu0.12.04.1, Copyright (c) 2000-2013 the Libav developers
  built on Feb  6 2014 20:56:59 with gcc 4.6.3
[alsa @ 0x1b96a20] capture with some ALSA plugins, especially dsnoop, may hang.
[alsa @ 0x1b96a20] Estimating duration from bitrate, this may be inaccurate
Input #0, alsa, from 'pulse':
  Duration: N/A, start: 1393735453.892946, bitrate: N/A
    Stream #0.0: Audio: pcm_s16le, 48000 Hz, 2 channels, s16, 1536 kb/s
[video4linux2 @ 0x1b97240] Estimating duration from bitrate, this may be inaccurate
Input #1, video4linux2, from '/dev/video0':
  Duration: N/A, start: 10634.325125, bitrate: 147456 kb/s
    Stream #1.0: Video: rawvideo, yuyv422, 640x480, 147456 kb/s, 30 tbr, 1000k tbn, 30 tbc
Incompatible pixel format 'yuyv422' for codec 'mpeg2video', auto-selecting format 'yuv420p'
[buffer @ 0x1b98160] w:640 h:480 pixfmt:yuyv422
[drawtext @ 0x1bb7340] auto-inserting filter 'auto-inserted scaler 0' between the filter 'src' and t
he filter 'Parsed filter 0 drawtext'
[scale @ 0x1be2ba0] w:640 h:480 fmt:yuyv422 -> w:640 h:480 fmt:yuv420p flags:0x4
[mpegts @ 0x1bbccc0] muxrate 4524064, pcr every 60 pkts, sdt every 1504, pat/pmt every 300 pkts
Output #0, mpegts, to '/home/argilo/git/in.fifo':
  Metadata:
    encoder         : Lavf53.21.1
    Stream #0.0: Video: mpeg2video, yuv420p, 640x480, q=2-31, 4000 kb/s, 90k tbn, 60 tbc
    Stream #0.1: Audio: mp2, 48000 Hz, 2 channels, s16, 192 kb/s
Stream mapping:
  Stream #1:0 -> #0:0 (rawvideo -> mpeg2video)
  Stream #0:0 -> #0:1 (pcm_s16le -> mp2)
Press ctrl-c to stop encoding
frame= 1287 fps= 60 q=2.6 size=       0kB time=21.38 bitrate=   0.0kbits/s dup=915 drop=0
```

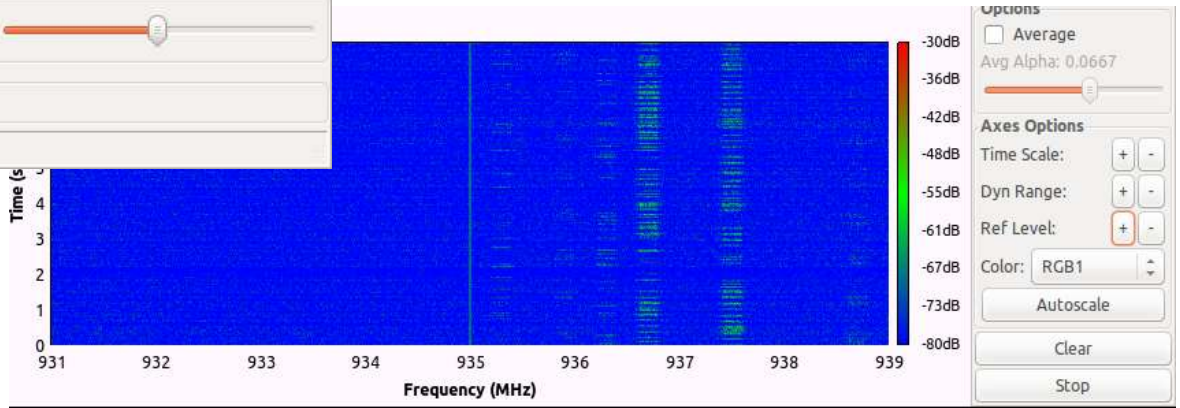
- 顺便: fabrice bellard用VGA头做成了DVB-T发射机



用作频谱仪和矢量信号源

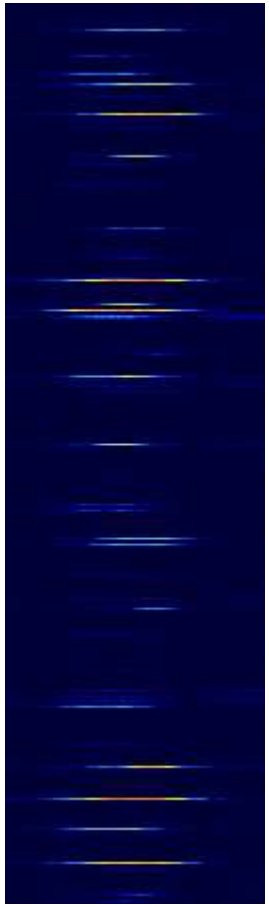






飞航雷达ADS-B 1/1
广播式自动相关监视

- Dump1090



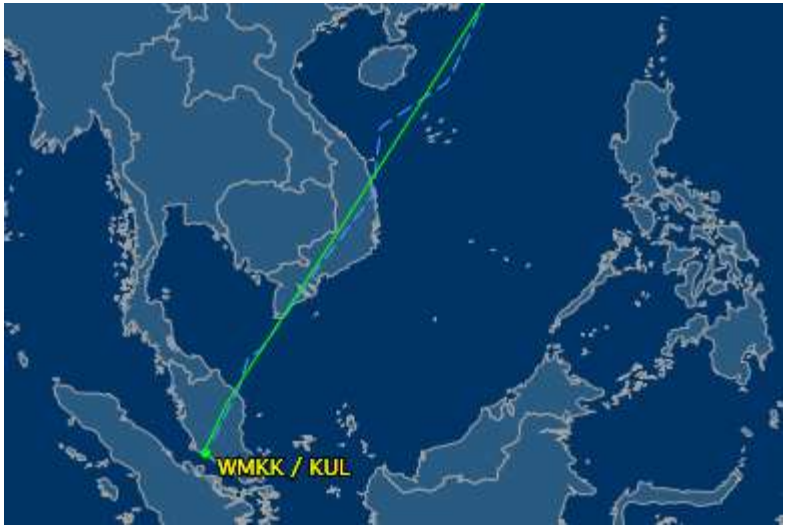
Hex	Flight	Altitude	Speed	Lat	Lon	Track	Messages	Seen .
ad57bb		11800	0	0.000	0.000	0	34	1 sec
ada521		9825	283	0.000	0.000	265	6	9 sec
a77a4f	HAL15	36000	379	34.199	-119.240	275	81	14 sec
a9bb70		28625	0	0.000	0.000	0	37	3 sec
a8bcf0		0	0	0.000	0.000	0	43	2 sec
a8c45e		0	0	0.000	0.000	0	3	24 sec
a70b4d		6825	0	0.000	0.000	0	22	27 sec
a8b939		0	0	0.000	0.000	0	295	1 sec
aa4199		19525	0	0.000	0.000	0	14	23 sec
a4ce21	456	7300	254	34.012	-118.444	83	923	0 sec
71bc18	AAR202	9825	273	34.030	-118.647	95	395	0 sec
a8da40		0	0	0.000	0.000	0	71	34 sec
a3dbe7		5425	0	0.000	0.000	0	41	1 sec
a379af		0	0	0.000	0.000	0	61	0 sec
a89216		36000	0	0.000	0.000	0	64	3 sec

ADS-B 2/2

共发现 1 架飞机

ICAO: 7800a1
航班号: CCA8209
纬度: 21700 英尺
速度: 325 节
坐标: 39.970729, 115.913939

FlightAware.com
FlightRadar24.com



OpenMHz.com 监控华盛顿

使用HackRF+Node.js监控Motorola SmartNet II

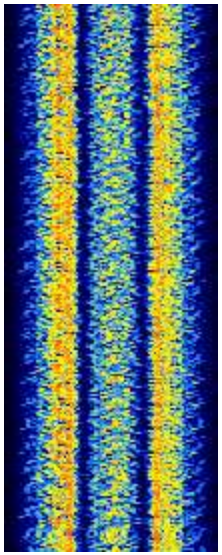
DC Scanner About Statistics

Filter Groups Tags Talkgroups Archive Live ★ 00:00/ 00:00

All -

← Older Newer →

	Alpha		Chan	Num	Talkgroup	Group
▶ 26s	DCFD 01 Disp	5:13:03 - 2014年3月10日 星期一	856.987	1616	01 Dispatch	Fire/EMS
▶ 28s	DCFD 011 EM1	5:13:03 - 2014年3月10日 星期一	857.588	1904	011 EMS 1	Fire/EMS
▶ 38s	DCFD 01 Disp	5:12:03 - 2014年3月10日 星期一	855.213	1616	01 Dispatch	Fire/EMS
▶ 30s	DCFD 013 EM3	5:11:23 - 2014年3月10日 星期一	857.588	1936	013 EMS 3	Fire/EMS
▶ 2s	DCFD 013 EM3	5:11:08 - 2014年3月10日 星期一	857.588	1936	013 EMS 3	Fire/EMS
▶ 23s	DCFD 01 Disp	5:10:49 - 2014年3月10日 星期一	859.987	1616	01 Dispatch	Fire/EMS



GPS重放

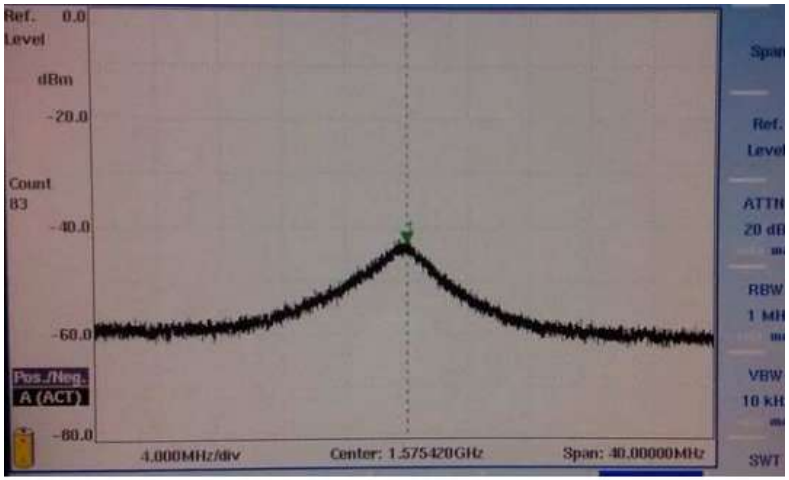


Figure 3: GPS Spectrum for Recording

Figure 7: GPS receiver status when replaying

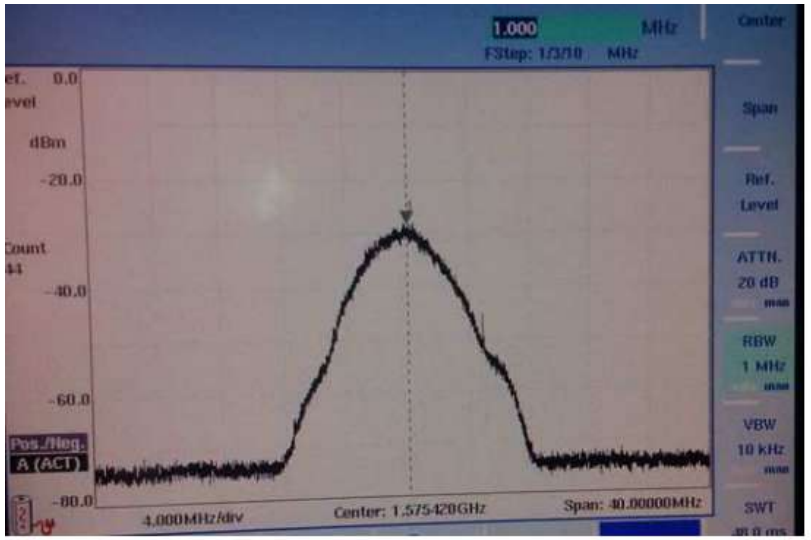


Figure 6: GPS Spectrum after Replaying

L1: 1575.42MHz

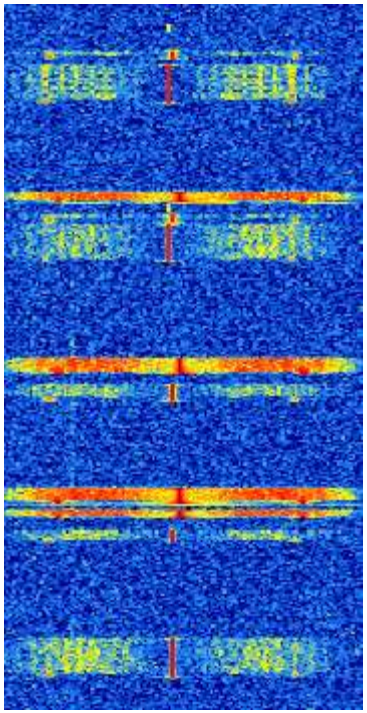
船舶自动识别系统
AIS (Automatic Identification System)

- Marine Channel 87 – 161.975 MHz
  Marine Channel 88 – 162.025 MHz
- 调制方式
  - NBFM
- 带宽
  - 12.5kHz 或 25kHz

http://www.marinetraffic.com/ais/home

ACARS 飞机通信寻址与报告系统

- Aircraft Communications Addressing and Reporting System
- gr-acars
- 131.550MHz
- AM调制
- 带宽 5kHz – 8kHz
  - 高度，速度，油量，航向等
    - ACARS主要通过VHF（甚高频）向地面基站发送信息，在进行解码后，传回航空公司的控制中心

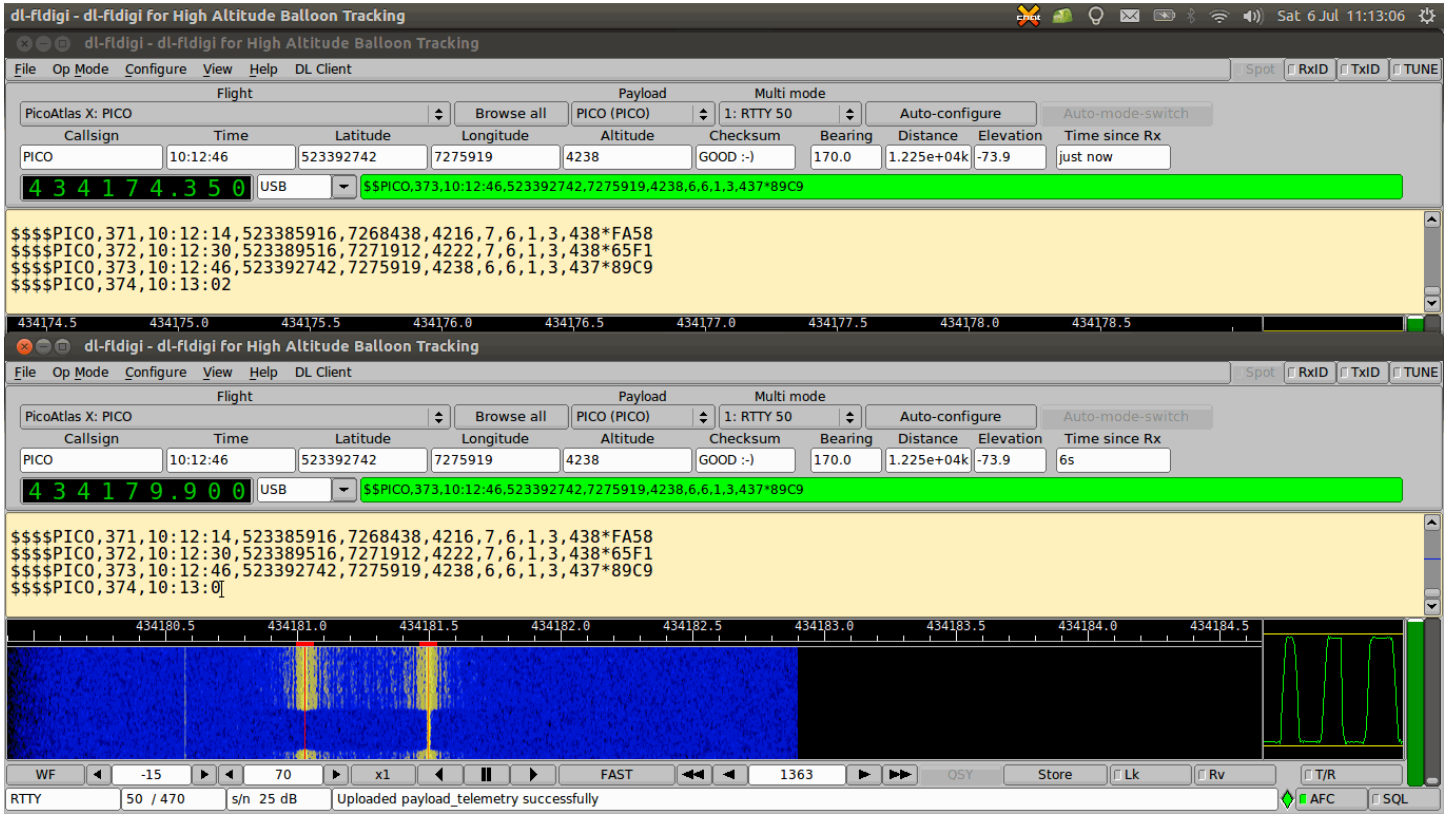


APRS

- 144.640MHz
- 国内的APRS站[aprs.fi](aprs.fi)

探空气球

PICO High Altitude Balloons (HAB)

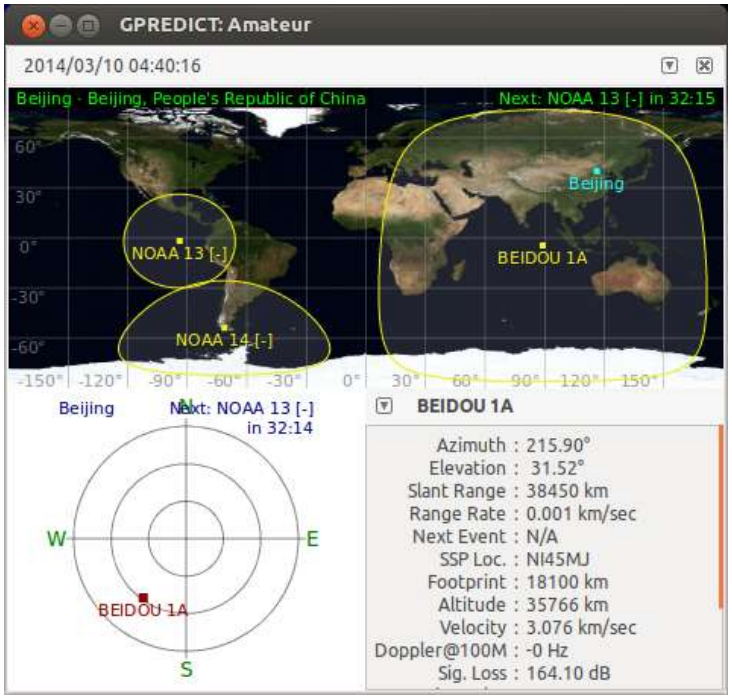


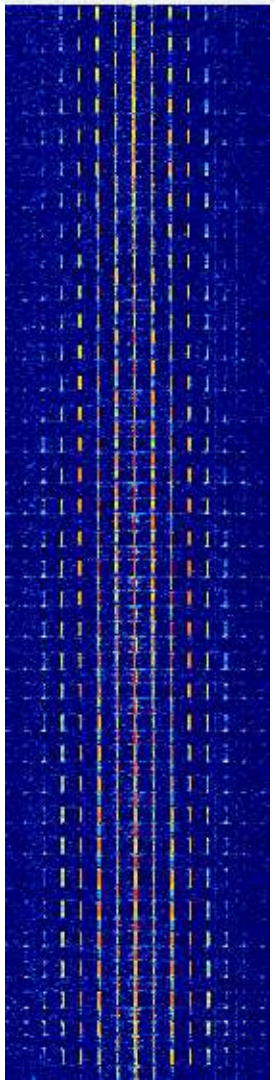
RTTY

The HackRF seems to be better than the USRP B100 for narrow bandwidth modes as it doesn't suffer from the discrete stepping TCXO that the USRP B100 manifests.

NOAA / APT(Automatic Picture Transmission)

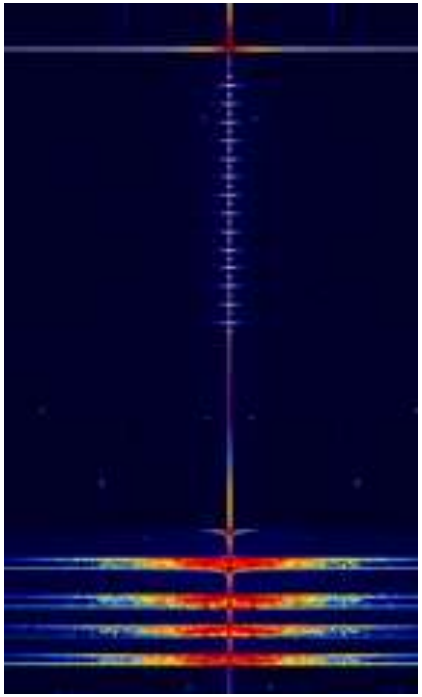
- 卫星轨道预报软件: gPredict
- NOAA-18 : 137.9125MHz
- 解码程序:
  - WXtoImg 或 apt-get



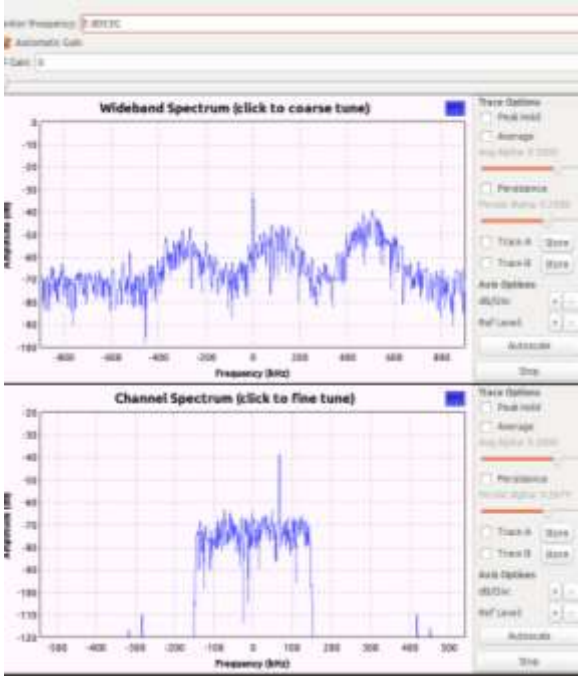


移动交通信号灯

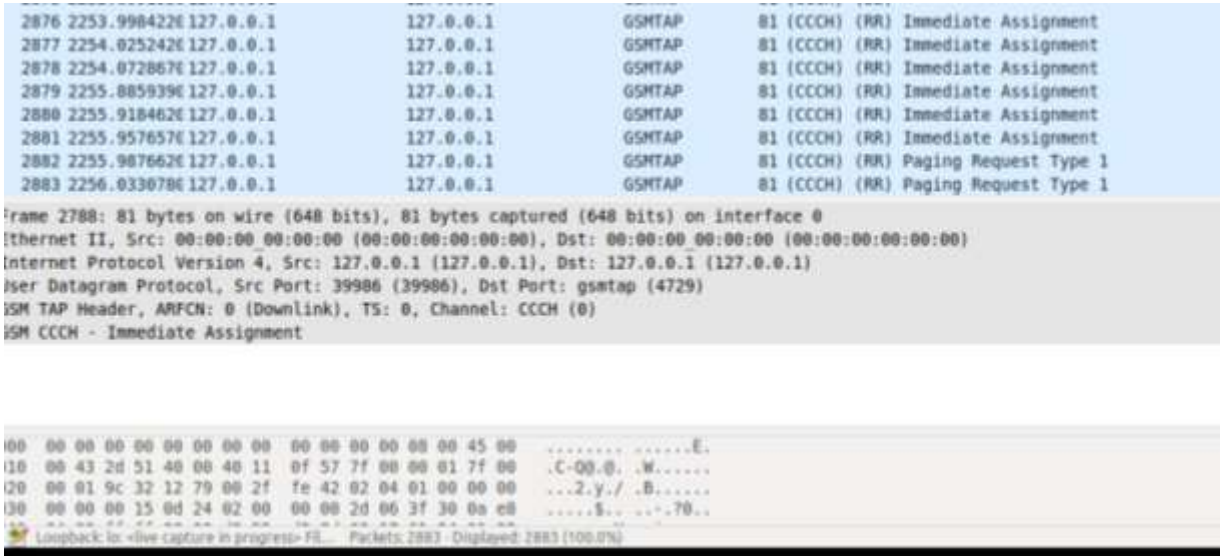
- 154.463 MHz



GSM 分析

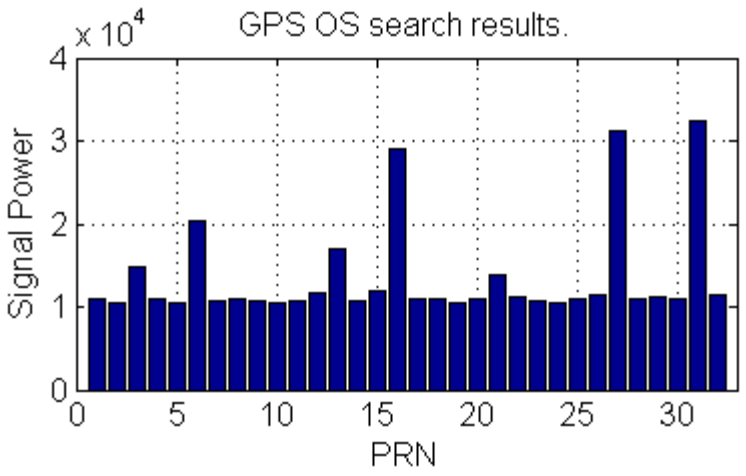


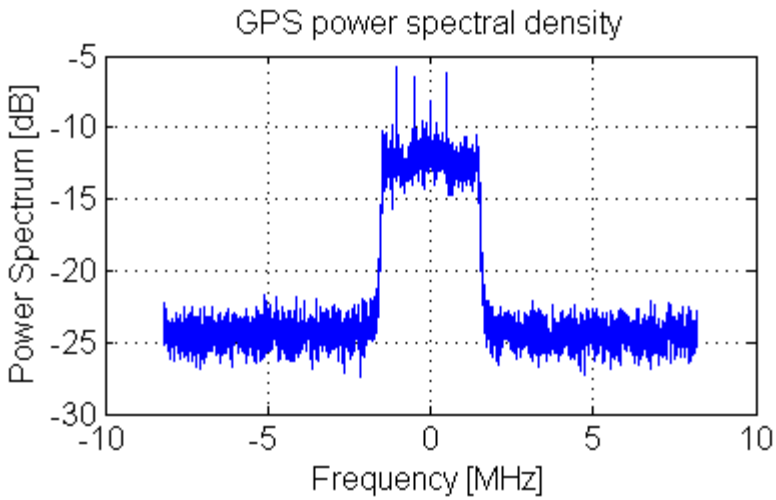
下行: 935MHz – 960MHz　1805MHz – 1850M
上行:890MHz – 915MHz　1710MHz – 1755M



GNSS-SDR

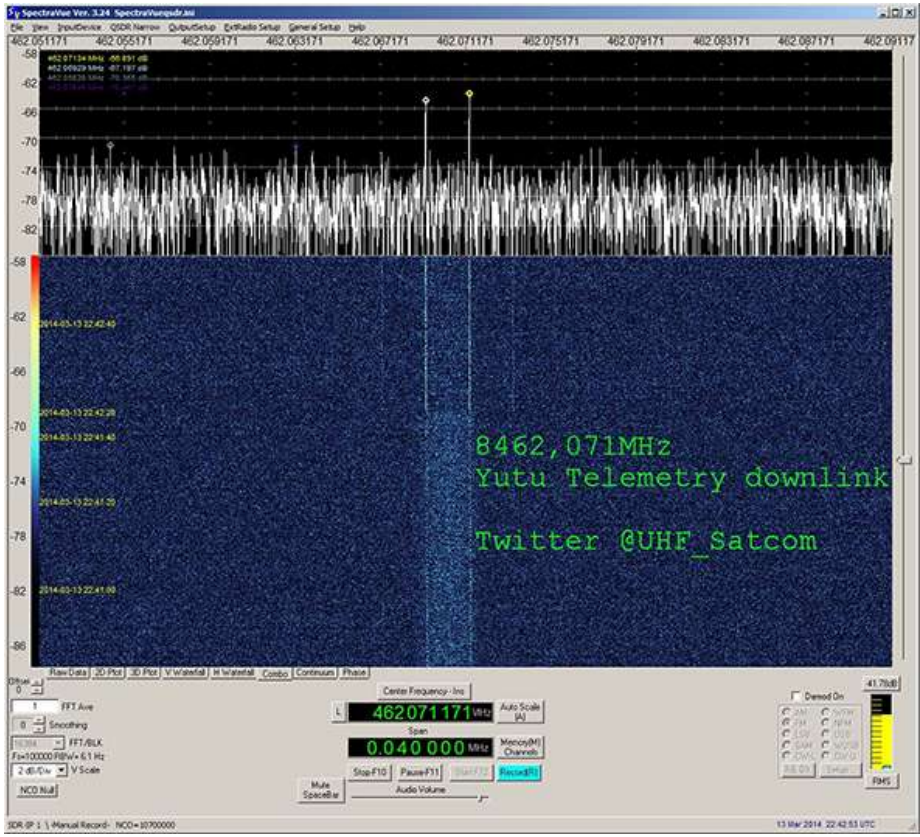
- Global Navigation Satellite System
  - www.taroz.net/gnsssdrlib_e.html
  - www.rtklib.com
  - Github.com/gps-sdr/gps-sdr





玉兔

OS/2
UHF Satcom
@uhf_satcom
Monitoring VHF to EHF satellites since Y2K. CNC / Electronic / Computer hacking & IT Security - basically anything technical and interesting! Ham Call M0EYT.
England · uhf-satcom.com


8462,071MHz
Yutu Telemetry downlink
Twitter @UHF_Satcom
462071171 MHz
0.040 000 MHz

LTE Cell Scanner TDD Support

JiaoXianjun / **LTE-Cell-Scanner**
forked from Evrytania/LTE-Cell-Scanner

Watch 1

Adding TDD and LNB feature! LTE SDR cell scanner optimized to work with very low performance RF front ends (8bit A/D, 20dB noise figure)

Detected Cells information list

	Duplex mode	Cell ID	Antenna ports	Frequency offset	Received power	CP type	Num. RB	PHICH duration	PHICH resource
1860MHz	FDD	142	2	-41.8006kHz	-0.90925	Normal	100	Normal	1
1860MHz	FDD	86	2	-41.7744kHz	-1.1267	Normal	100	Normal	1
1890MHz	TDD	253	2	-41.116kHz	11.1699	Normal	100	Normal	1/2
2565MHz	TDD	29	2	-36.1428kHz	34.8551	Normal	100	Normal	1
2565MHz	TDD	28	2	-86.9578kHz	33.9531	Normal	100	Normal	1
2565MHz	TDD	27	2	-86.9563kHz	31.5544	Normal	100	Normal	1
2585MHz	TDD	68	2	-87.975kHz	35.9489	Normal	100	Normal	1/6
2585MHz	TDD	66	2	-88.2294kHz	28.9758	Normal	100	Normal	1/6
2585MHz	TDD	67	2	-94.2675kHz	31.1485	Normal	100	Normal	1/6
2604.9MHz	TDD	355	2	4.905kHz	34.416	Normal	100	Normal	1
2645MHz	TDD	22	2	-89.3233kHz	29.8605	Normal	100	Normal	1
2645MHz	TDD	21	2	-89.3376kHz	27.2821	Normal	100	Normal	1

Note: Frequency offset is dongle specific.
Note: Received Power only has relative meaning.

其它

- ADS-B 重放
  - http://dangerousprototypes.com/2013/02/28/defcon-20-renderman-on-ads-b-aero-radio/
- Internet Relay / 频谱服务器
- Tvsharp: 模拟电视
- 分析汽车无线钥匙
  - BlackHat链接
  - http://andrewmohawk.com/2012/09/06/hacking-fixed-key-remotes/

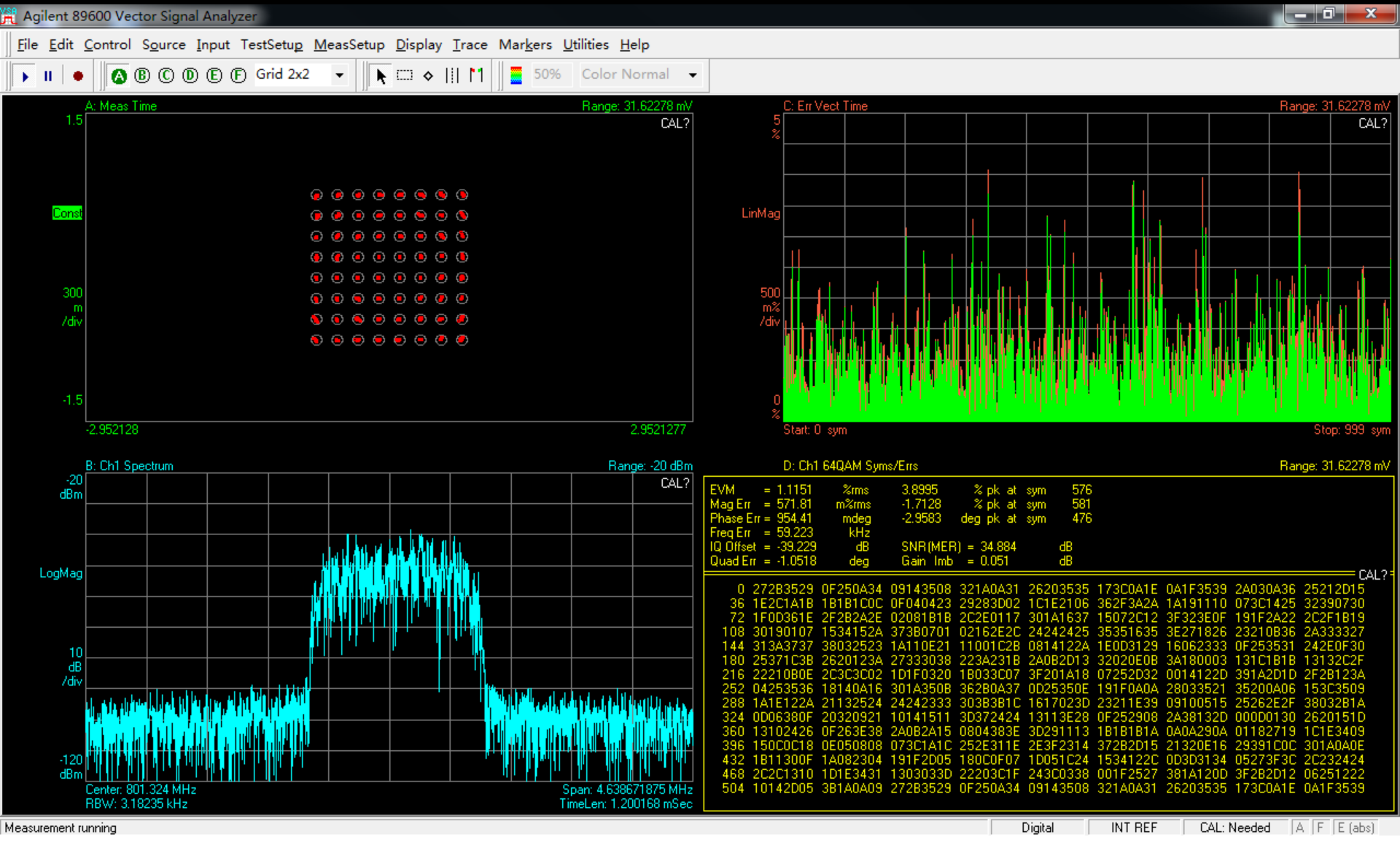
</演示>

射频性能 (1/2)

- 最大发射功率
  - 10dBm
  - 不同频段有所差异
- 64QAM发射
  - EVM ~ 1.5%

星天科技 HackRF One 测试报告			
测试日期	2014/2/21 15:32		
主检签字			
序列号			
PPM校准	测试设备型号	Rohde&Schwarz FSIQ26 矢量信号分析仪	
	测试条件	频率:3.015GHz SPAN:100kHz	
	PPM	-48	
发射功率测试	测试设备型号	Rohde&Schwarz FSIQ26 矢量信号分析仪	
	测试条件	SPAN=10MHz，Ref=15dBm	
		测试结果	功率/dBm
	RF_Gain = 14dB	94MHz	9.61
		915MHz	7.88
		2509MHz	13.37
		3015MHz	-0.39
		5703MHz	-11.78
	RF_Gain = 0dB	94MHz	-3.47
		915MHz	-2.15
		2509MHz	5.39
		3015MHz	-10.21
		5703MHz	-23.04
64QAM发射测试	测试设备型号	Agilent E8491B + 89600	
	测试条件	频率/MHz	801.324
		Sample Rate/MHz	6
		RF Gain/dB	14
		IF Gain/dB	20
		BB Gain/dB	20
		衰减常数	0.4
		Samples per Symbol	6
	测试结果		
	EVM	1.53%	
接收功率测试	测试设备型号	Agilent E4438C 矢量信号源	
	接收测试程序	osmocom_fft	
	测试条件	IF_Gain=16dB	
		测试项目	功率/dBm
	RF_Gain = 14dB 信源发射功率=-50dBm 单载波	93MHz	-15
		952.3MHz	-18
		2.513GHz	-13
		3.013GHz	-30
		5.823GHz	-42
	RF_Gain = 0dB 信源发射功率=-50dBm 单载波	93MHz	-29
		952.3MHz	-28
		2.513GHz	-25
		3.013GHz	-41
		5.823GHz	-50
FM发射功能验证	通过		
DAB发射功能验证	通过		

射频性能 (2/2)


Agilent 89600 Vector Signal Analyzer
File Edit Control Source Input TestSetup MeasSetup Display Trace Markers Utilities Help
Grid 2x2
50%
Color Normal
A: Meas Time
Range: 31.62278 mV
CAL?
1.5
Const
300
m
/div
-1.5
-2.952128
2.9521277
C: Err Vect Time
Range: 31.62278 mV
CAL?
5
%
LinMag
500
m%
/div
0
%
Start: 0 sym
Stop: 999 sym
B: Ch1 Spectrum
Range: -20 dBm
CAL?
-20
dBm
LogMag
10
dB
/div
-120
dBm
Center: 801.324 MHz
RBW: 3.18235 kHz
Span: 4.638671875 MHz
TimeLen: 1.200168 mSec
D: Ch1 64QAM Syms/Errs
Range: 31.62278 mV
EVM = 1.1151 %rms 3.8995 % pk at sym 576
Mag Err = 571.81 m%rms -1.7128 % pk at sym 581
Phase Err = 954.41 mdeg -2.9583 deg pk at sym 476
Freq Err = 59.223 kHz
IQ Offset = -39.229 dB SNR(MER) = 34.884 dB
Quad Err = -1.0518 deg Gain Imb = 0.051 dB
CAL?
0 272B3529 0F250A34 09143508 321A0A31 26203535 173C0A1E 0A1F3539 2A030A36 25212D15
36 1E2C1A1B 1B1B1C0C 0F040423 29283D02 1C1E2106 362F3A2A 1A191110 073C1425 32390730
72 1F0D361E 2F2B2A2E 02081B1B 2C2E0117 301A1637 15072C12 3F323E0F 191F2A22 2C2F1B19
108 30190107 1534152A 373B0701 02162E2C 24242425 35351635 3E271826 23210B36 2A333327
144 313A3737 38032523 1A110E21 11001C2B 0814122A 1E0D3129 16062333 0F253531 242E0F30
180 25371C3B 2620123A 27333038 223A231B 2A0B2D13 32020E0B 3A180003 131C1B1B 13132C2F
216 22210B0E 2C3C3C02 1D1F0320 1B033C07 3F201A18 07252D32 0014122D 391A2D1D 2F2B123A
252 04253536 18140A16 301A350B 362B0A37 0D25350E 191F0A0A 28033521 35200A06 153C3509
288 1A1E122A 21132524 24242333 303B3B1C 1617023D 23211E39 09100515 25262E2F 38032B1A
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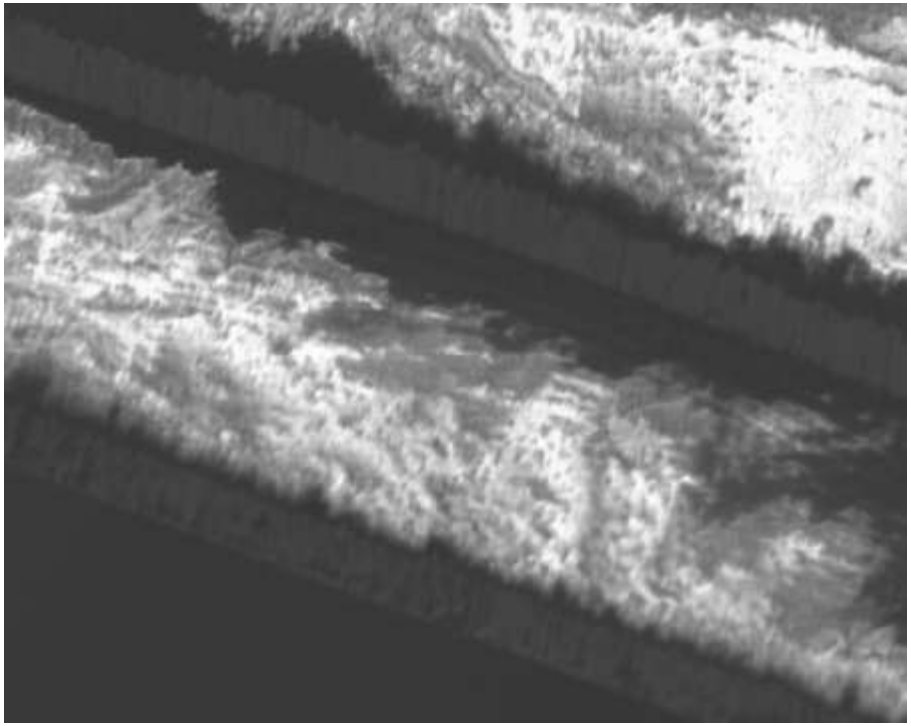
396 150C0C18 0E050808 073C1A1C 252E311E 2E3F2314 372B2D15 21320E16 29391C0C 301A0A0E
432 1B11300F 1A082304 191F2D05 180C0F07 1D051C24 1534122C 0D3D3134 05273F3C 2C232424
468 2C2C1310 1D1E3431 1303033D 22203C1F 243C0338 001F2527 381A120D 3F2B2D12 06251222
504 10142D05 3B1A0A09 272B3529 0F250A34 09143508 321A0A31 26203535 173C0A1E 0A1F3539
Measurement running
Digital
INT REF
CAL: Needed
A F E (abs)

制造

- 元件
- 工艺
- 扫描电镜
- 自动测试系统 (ATE)



工艺控制:自动测试

- 使用仪表
  - SCPI指令

星天科技 HackRF One 测试报告			
测试日期	2014/2/21 15:32		
主检签字			
序列号			
PPM校准	测试设备型号	Rohde&Schwarz FSIQ26 矢量信号分析仪	
	测试条件	频率:3.015GHz SPAN:100kHz	
	PPM	-48	
发射功率测试	测试设备型号	Rohde&Schwarz FSIQ26 矢量信号分析仪	
	测试条件	SPAN=10MHz，Ref=15dBm	
		测试结果	功率/dBm
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		915MHz	7.88
		2509MHz	13.37
		3015MHz	-0.39
		5703MHz	-11.78
	RF_Gain = 0dB	94MHz	-3.47
		915MHz	-2.15
		2509MHz	5.39
		3015MHz	-10.21
		5703MHz	-23.04
64QAM发射测试	测试设备型号	Agilent E84918 + 89600	
	测试条件	频率/MHz	801.324
		Sample Rate/MHz	6
		RF Gain/dB	14
		IF Gain/dB	20
		BB Gain/dB	20
		衰减常数	0.4
		Samples per Symbol	6
	测试结果		
	EVM	1.53%	
接收功率测试	测试设备型号	Agilent E4438C 矢量信号源	
	接收测试程序	osmocom_fft	
	测试条件	IF_Gain=16dB	
		测试项目	功率/dBm
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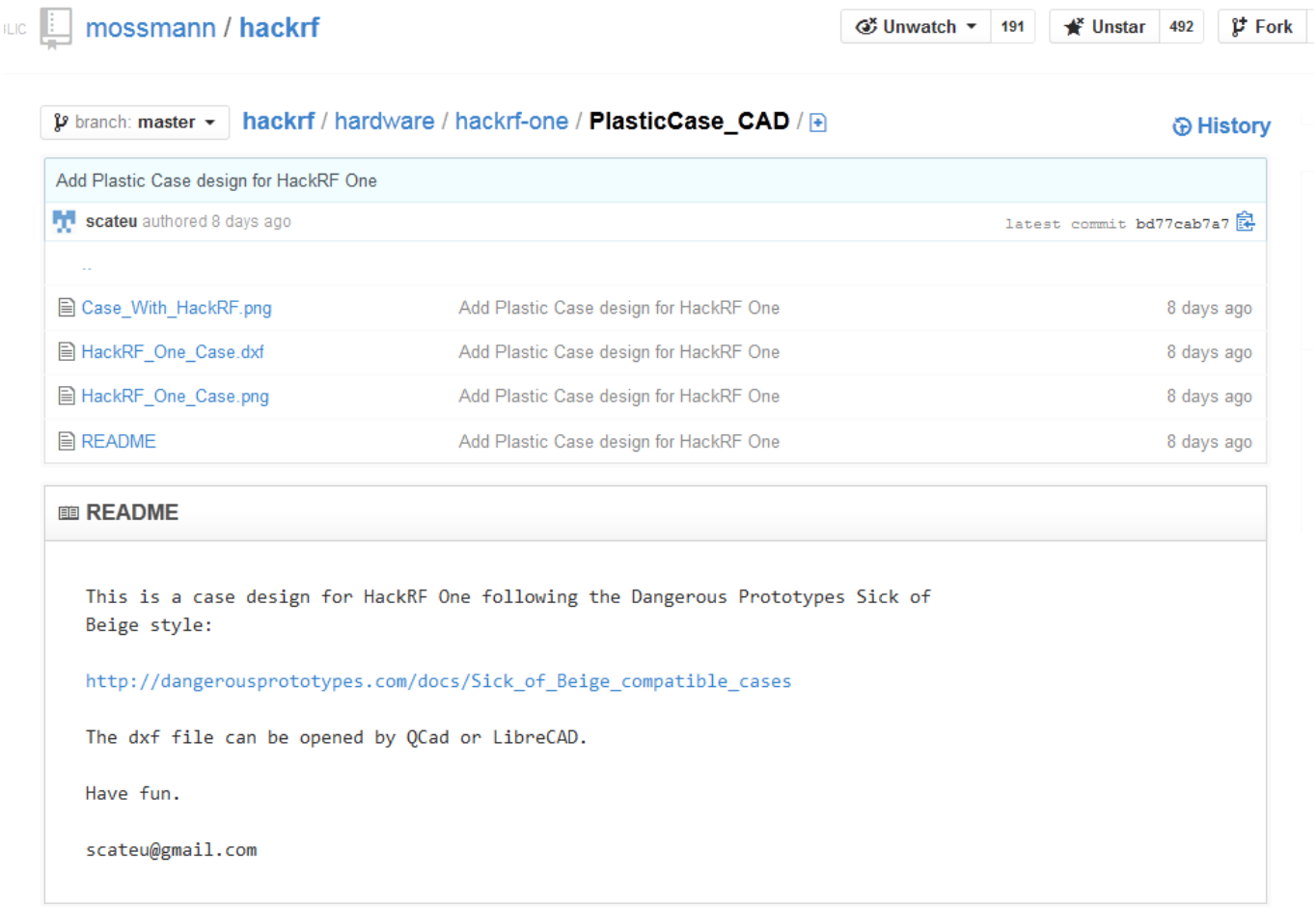
		952.3MHz	-18
		2.513GHz	-13
		3.013GHz	-30
		5.823GHz	-42
	RF_Gain = 0dB 信源发射功率=-50dBm 单载波	93MHz	-29
		952.3MHz	-28
		2.513GHz	-25
		3.013GHz	-41
		5.823GHz	-50
FM发射功能验证	通过		
DAB发射功能验证	通过		

给HackRF项目贡献

- 打包: Debian / Ubuntu
- 文档中文化/中文社区
  - HackRF.net
- 射频算法:
  - 可变中频
- mirror: build-gnuradio
- LiveCD
- VMWare Image
  - HackRF.net提供了一个 via citypw
- 邮件列表: hackrf-cn@googlegroups.com
- GSoC

Merged



mossmann / hackrf

Unwatch 191 | Unstar 492 | Fork

branch: master — hackrf / hardware / hackrf-one / PlasticCase_CAD / — History

Add Plastic Case design for HackRF One

scateu authored 8 days ago — latest commit bd77cab7a7

..		
Case_With_HackRF.png	Add Plastic Case design for HackRF One	8 days ago
HackRF_One_Case.dxf	Add Plastic Case design for HackRF One	8 days ago
HackRF_One_Case.png	Add Plastic Case design for HackRF One	8 days ago
README	Add Plastic Case design for HackRF One	8 days ago

README

This is a case design for HackRF One following the Dangerous Prototypes Sick of Beige style:

http://dangerousprototypes.com/docs/Sick_of_Beige_compatible_cases

The dxf file can be opened by QCad or LibreCAD.

Have fun.

scateu@gmail.com

人们不禁要问

- 这么好的板卡，在哪里可以买到？
- 肯定要上万块钱吧
- Kickstarter 5月份才能拿到
- 我们什么时候拿到

- 是的，你没有看错！
  - Steve Ballmer →

- 我公司已经造好了
  - 淘宝地址见HackRF.net

特别介绍 & Thanks

- LTE-Cell-Scanner for TDD-LTE
  - Author: jiaoxianjun
- Blue-Lotus
- Shawn C
  - HackRF.net中文社区
  - Suse
- TUNA
- 业余无线电协会/ BY1QH
  - synsun

业余无线电操作执照/申请呼号

- BH1RLW : Repair Linux Wireless
- http://qrz.com/db/bh1rlw
- 报名: 阳光无线 BY1CW

联系方式 & 现场提问

- 王康
  - scateu@gmail.com
  - 138-1037-8201
  - Blog: http://scateu.me
  - http://HackRF.net

需要用仪表的可以联系我

北京星天无限科技有限公司

星天科技 STARTEST TEC.

tuna 清华大学网管会

正式全称:
清华大学TUNA协会