

UNRAVELLING THE DRM MYSTERY

(Decoding DRM signals using Redsun RP2100)

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Background

Digital Radio Mondiale (DRM) (www.drm.org) is universal, openly standardized & non-proprietary digital radio system for the long, medium and short-wave ranges. The standard was formed by an international consortium of broadcasters, manufacturers, network operators, broadcasting unions, regulatory bodies & NGO's in co-operation with the International Telecommunication Union (ITU) in 1998. It has been endorsed by the ITU, IEC and ETSI. DRM offers clear, near FM quality audio without the interference, noise & fading normally associated with shortwave broadcasts. On Jun 16, 2003 leading shortwave broadcasters simultaneously started live, daily DRM transmissions.

DRM can be used for a range of audio content, including multi-lingual speech music as well as offering the ability to integrate data and text which can be displayed on DRM receivers to enhance the listening experience. The new system offers the radio stations and service providers access to the multimedia age with small bit rates for large target areas and long distances. DRM has better reception quality & uses less transmitter power than analog broadcasts. The bandwidth of a DRM bandpass signal is less than 20 kHz and the number of carriers used in the OFDM-modulation is relatively small (max. 460). These features motivate a real-time software implementation of a DRM-receiver on a conventional personal computer (PC) using the sound card as the input and output device. A long, medium and short wave front-end with an intermediate frequency (IF) between 5 kHz and 15 kHz is used to receive the DRM signal. Any commercial front-end with an IF of 455 kHz should be usable by adding a 455 kHz to 12 kHz adaptor (assumed the receiver bandwidth is sufficient for a DRM signal). A DRM signal with a an IF (intermediate frequency) of 12 kHz is fed into the line-in of you PC sound card & Dream converts it into audio that you can hear with speakers or headphones.

Receiver selection

It all started when AIR started its first DRM transmission from HPT, Khampur on Republic Day, 26 January 2007 and following up with a Digital Radio Transmission Workshop & Field Measurements during May 2007 alongwith setting up two new transmitters at AIR Nangli & Kingsway Camp in Delhi. For us there were two options available, either to buy a standalone DRM receiver off the shelf (oopsoff the web for us here in India !) or to go for a DIY route.

Searching the web we learnt about DRM & requirements for receiving & decoding DRM signal. We found that Redsun RP2100 (cheapest one) has a 455 kHz IF output, checked with the ebay seller regarding availability of RP2100 way back in May 2007 but the receiver was available with only Chinese labels. However after some we were informed by the ebay seller that the receiver was available with English labels. During June 2007 we went ahead & bought one receiver each for our test purpose.

Here is what you need to receive DRM broadcast on MW & SW :

- * A receiver with an output terminal for the IF frequency
- * An outdoor Antenna (or in-built whip antenna)
- * A down mixer to generate the necessary 12 kHz signal output
- * A PC with 'Dream' software
- * A soundcard with a free line or microphone input
 - soundcard input = 12 kHz IF
 - soundcard output = DRM audio

Redsun RP2100 Digital PLL Receiver

It runs with 220V/50Hz or 4 D Cells or 4 AA cells or 9V DC, 10 khz or 100khz tuning steps on FM and 1/5/9/10 khz steps on AM. External antenna connectors for FM/SW and MW broadcasting bands, it has very good signal reception sensitivity, selectivity, SNR performance, perfect signal mirror image suppression capability and excellent sound quality. RP2100 radio has been designed and manufactured by a Chinese radio manufacturer located in Guangdong, Southern China.

Frequency Coverage :

FM : 87.0 MHz to 108.0 MHz.

MW : 520 KHz to 1710 KHz

SW : 1711KHz to 29999KHz

Dual conversion PLL technology on AM band

1st IF = 55.845 MHz,
2nd IF = 455 KHz.



REDSUN RP2100 IF OUTPUT & CONNECTIONS

SNR sensitivity: FM < 5uV, MW < 0.2mV/m, SW < 20uV.
AM band signal selectivity: 40dB (100 times) on wide bandwidth mode, 60dB (1000 times) on narrow bandwidth mode. Signal mirror image suppression: 46dB (200 times) on FM band, 60dB (1000 times) on MW band, 40dB (100 times) on SW band. AM band (both MW band and SW band) bandwidth selectable: +/- 3KHz narrow and +/- 6KHz wide. Dedicated RF gain control knob designed for the better reception on AM band (both on MW and SW band). Local/DX switch designed for the different signal conditions using on AM band. Built-in PAL standard socket for the external shortwave antenna input, external FM antenna input or Cable-FM input. On the backside there is AM IF output jack, same is for external FM/SW antenna. In case of an external antenna, with the exception of a tuned antenna such as the Degen loop or an external preselector, there will be intermodulation products and you will have to reduce them by reducing RF gain or by setting the switch from "DX" to "local". RF gain has to be reduced, at maximum gain, Dream lost synchronisation every few seconds. DRM SWR had a permanent red audio LED, but perfect audio.



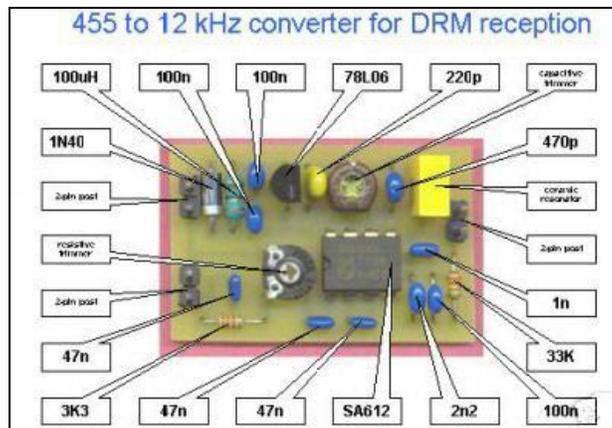
REDSUN RP2100



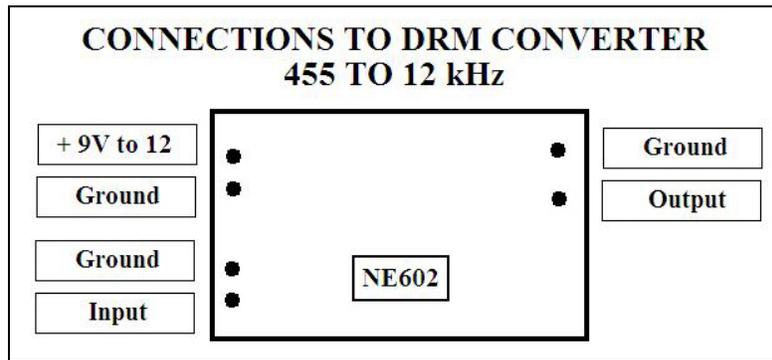
I5XWW DRM CONVERTER

DRM Converter

DRM converter kit converts 455 kHz IF to 12 kHz IF, we came across several 455 to 12 kHz converter circuits on the web & tried to build one for ourselves but later the idea was shelved & went ahead with the I5XWW converter readily available for testing purpose. Details of I5XWW converter and its components given below :



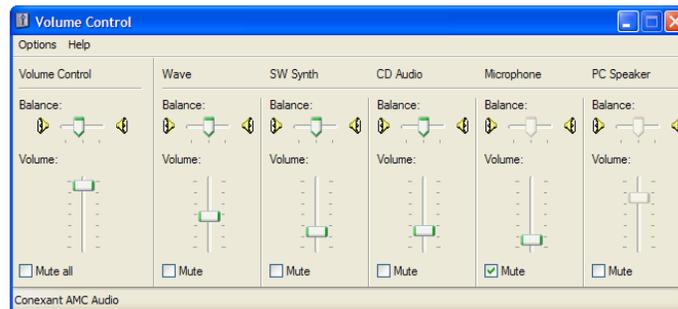
I5XWW DRM Converter 455 to 12 kHz



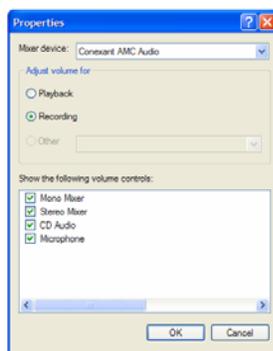
The IF signal at 455 kHz is tapped off a point in the radio circuit, where it will not load the circuit & where the passband is at least 10 kHz wide, and converted to a center frequency of 12 kHz for further application to a PC soundcard (Line-in or microphone input).

Sound card settings

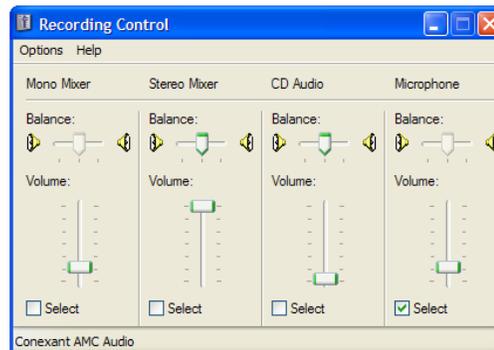
For proper DRM reception the recording mixer must use the microphone input as the only signal source. The playback mixer must not reproduce any input. Screenshots given below illustrates the settings we used.



MICROPHONE IS MUTED



RECORDING MODE SELECTED



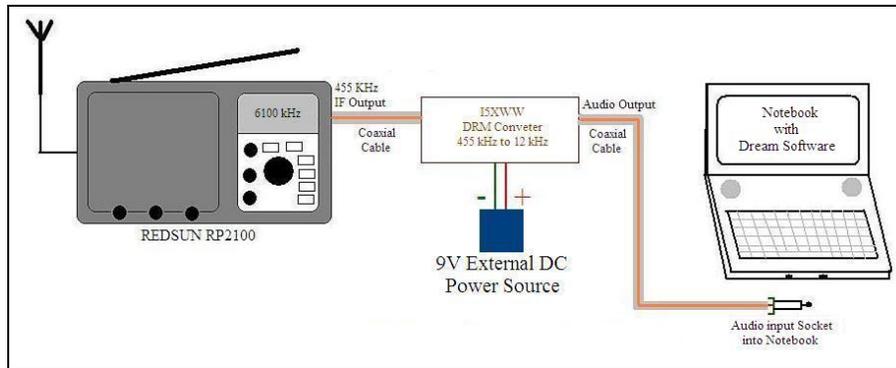
ONLY MICROPHONE IS SELECTED

Dream configuration

Dream is a software implementation of a Digital Radio Mondiale (DRM) receiver. With Dream, DRM broadcasts can be received with a modified analog receiver (SW, MW, LW) and a PC with a sound card. The computer that has Dream software installed should be fairly speedy, say at least 1.5 GHz or faster. Dream set up is very easy, once installed start the program & open "Evaluation Dialog" window. Dream has a built -in DRM broadcast schedule , by clicking view, stations dialog you can see all the DRM broadcasts available. This has also ability to update the list via internet.

Our test set up consisted of :

- * Redsun RP2100 Digital PLL AM FM SW Receiver with 455 kHz IF output
- * 30 Ft outdoor longwire antenna with 10:1 SWL-1G Balun (optional) & RG-58 50 Ohms co-axial lead-in (Tested with in-built whip antenna also which worked)
- * I5XWW DRM Converter 455 to 12 kHz with 9V battery.
- * Dream Version 1.9.4 cvs
- * Notebook Compaq Presario V2000, Windows XP Pro, 1.50 GHz CPU, 512 MB Ram, 60 GB HardDisk & On-Board Sound Card.



BLOCK DIAGRAM OF TEST SETUP

Connect the DRM converter to the receiver & notebook as shown, switch on the converter, notebook & receiver. Tune in the receiver to desired frequency. A hiss is produced through the receiver, turn down the volume. Receiver goes silent & the DRM software initiates decoding.

Failure

For several months we tested & tried with our set-up without any success. Enquiries were sent to the receiver & the DRM converter seller but they were unable to provide any technical help. We tried to decode couple of DRM transmissions directed towards South Asia but didn't succeed. Finally success came on 25th Feb 2008 when we logged (decoded) our first DRM transmission, All India Radio on 6100 kHz at around 0500 UTC. As we heard the hindi song with crystal clear audio we were just ecstatic. All India Radio was having DRM test transmissions on 23rd, 24th & 25th Feb 2008 for the DRM demo at BES Expo 2008. Average SNR was about 19 dB. There were few audio dropouts during the songs.

Required settings

We experimented with various settings, please note these settings worked for us :

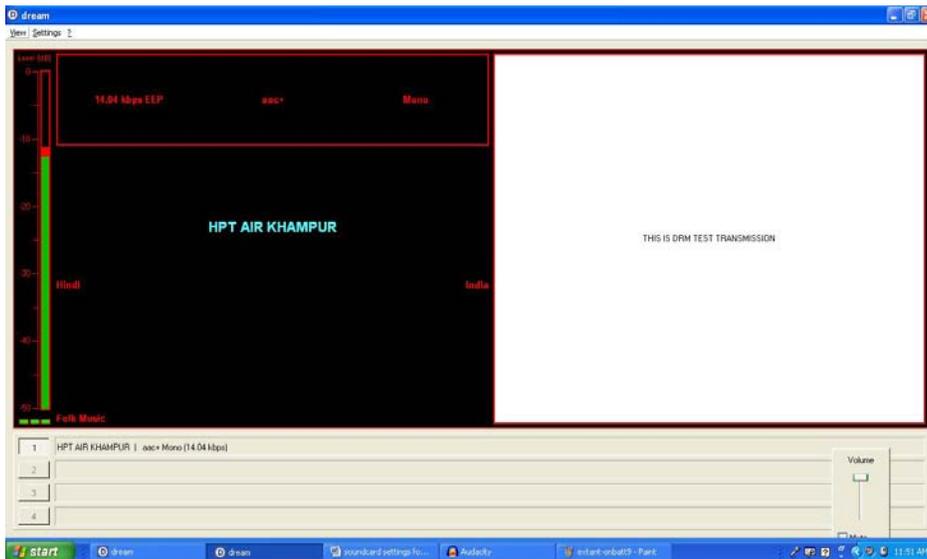
- * Receiver was running on battery (it works with receiver on power mode also)
- * RF gain was set to minimum
- * Bandwidth was selected as "wide"
- * It worked with both external & internal antenna.
- * Notebook must run on battery (It doesn't work on power mode)
- * Ensure notebook's firewall, antivirus or any other applications are disabled.
- * Distance between notebook and receiver should be maximum.
- * As per soundcard setting mentioned above mute the line-in or microphone to prevent hearing the DRM hash.

The main window shows up when the Dream software is started. The following image shows the main window once DRM transmission is successfully decoded. If not decoded only "scanning" is displayed.

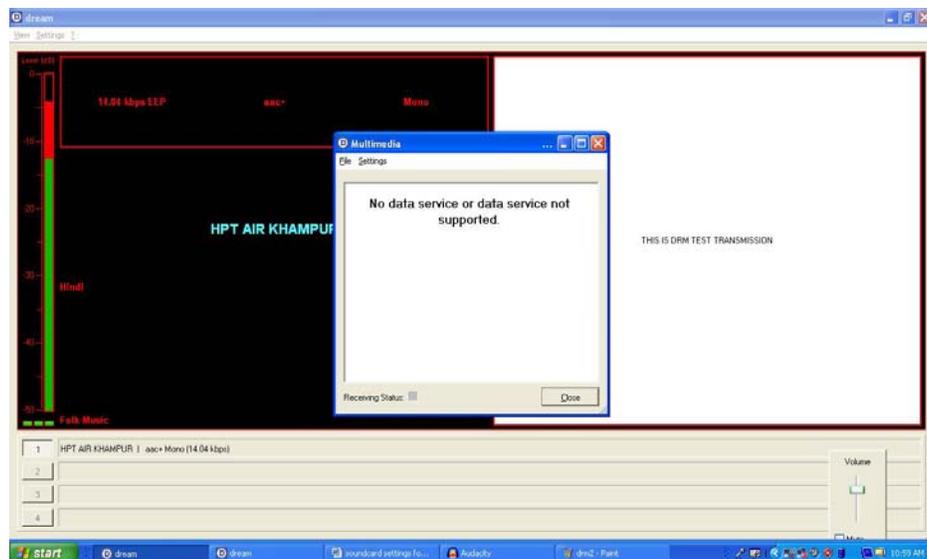


Notebook kept away from the Receiver

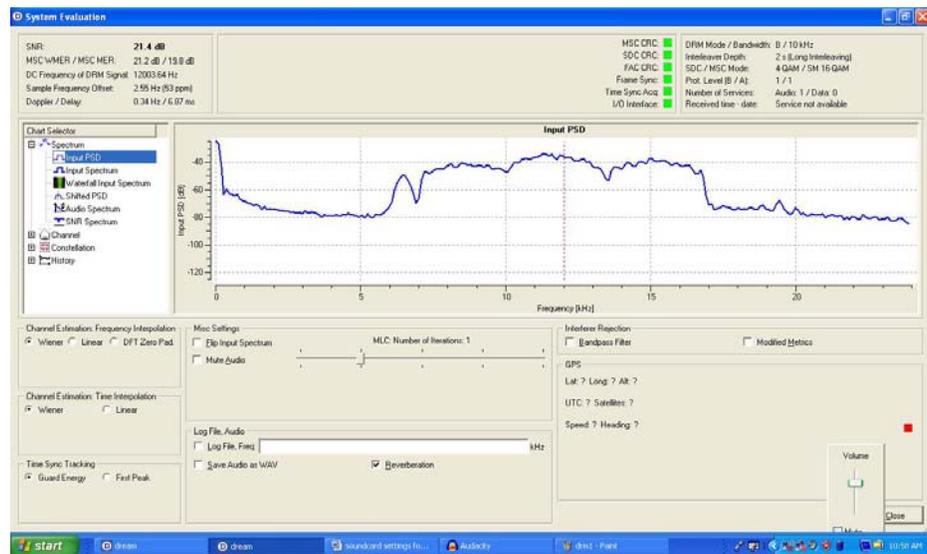
The evaluation dialog provides the user with detailed information about the current DRM reception. Some parameters like the frequency offset or SNR estimation as well as some plots can be viewed here.



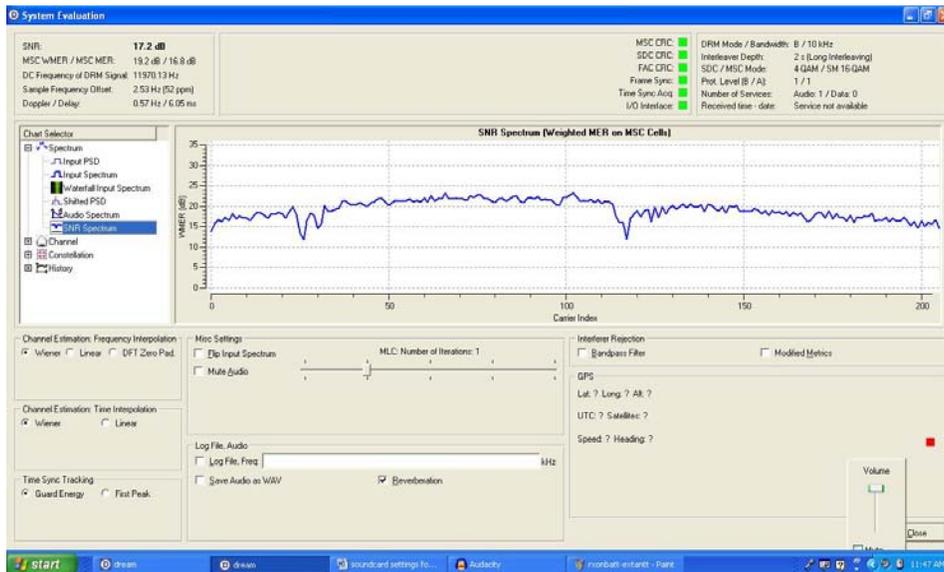
Dream main window – successfully decoded All India Radio broadcasts on 6100 kHz



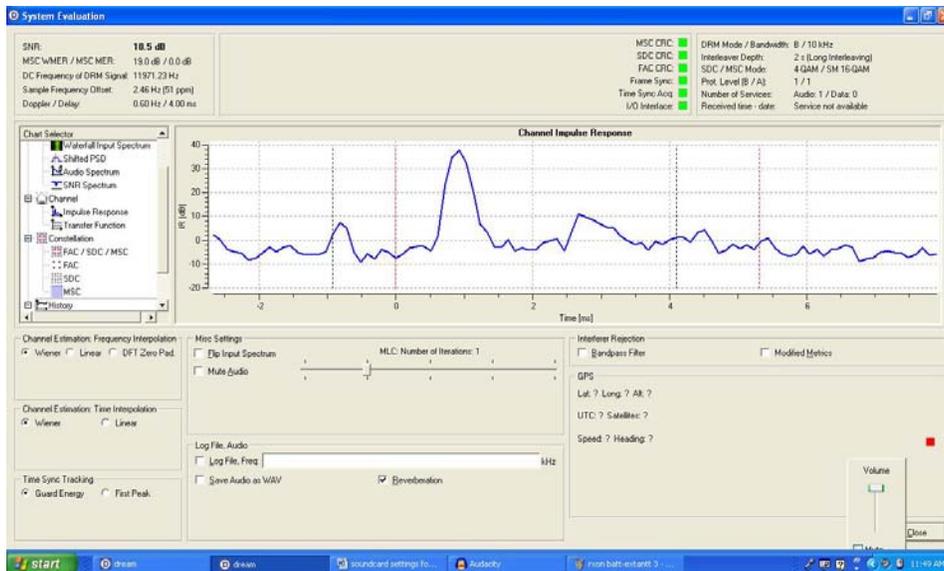
Data services were not available



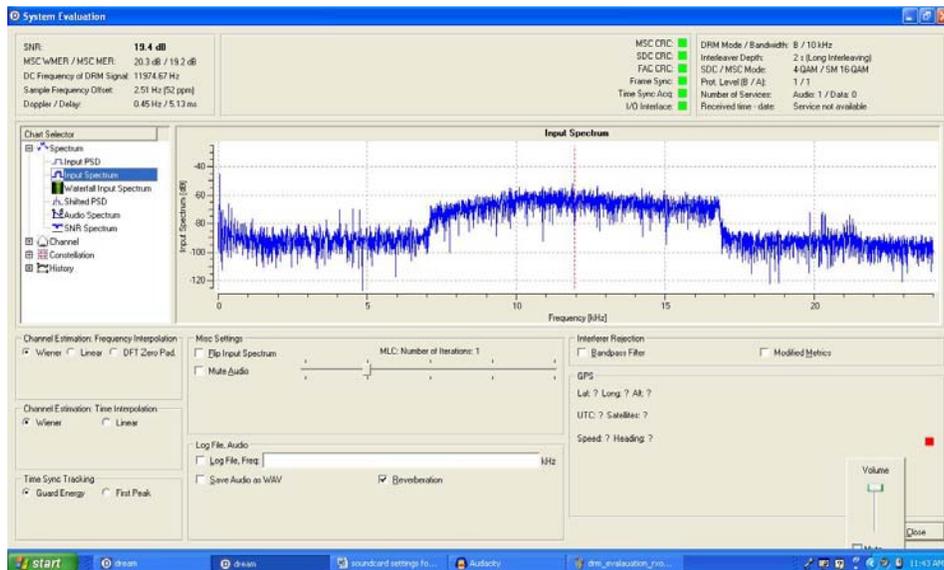
Input PSD



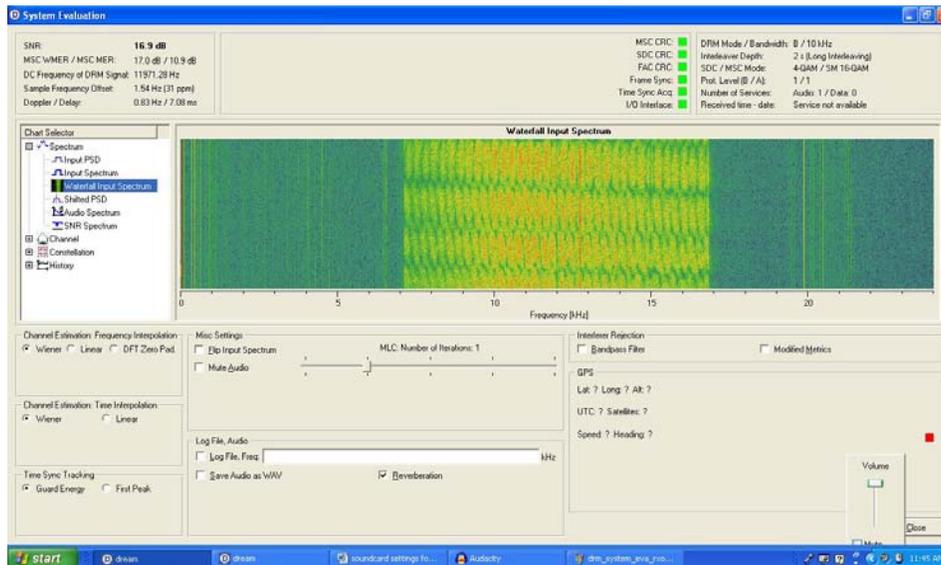
SNR Spectrum



Channel Impulse Response



Input Spectrum



Waterfall Input Spectrum

SINPO – Unlike an analog signal, a digital signal is either heard or not heard. There is nothing in between.

Total cost for the project :

RP2100 Receiver	USD 69.99 + Shipping/Insu USD 50.00	– Rs. 5002.00
DRM Converter	USD 23.00 + Shipping USD 5.00	– Rs. 1190.00
Co-axial wires, Batt & Misc stuff		- Rs. 100.00
TOTAL		- Rs. 6292.00

Hope this will encourage others also to try listening to DRM broadcasts without buying expensive DRM standalone receivers.

Future Prospects

The major hurdle in implementation of DRM is availability of cheap receivers. According to the approved annual plan 2008-09 for Ministry of Information & Broadcasting an amount of Rs. 48.4 Billion has been allocated to broadcasting sector out of which Rs. 6.4 Billion has been allocated for digitalization of transmitters & studios. Some of the plans include :

- * Replacement of old MW transmitters by new DRM MW transmitters at existing stations.
- * Upgrading & provision of MW DRM Txer with captive power plant.
- * Replacement of 6 Nos. 10 kW MW transmitters by DRM transmitters.
- * Conversion of existing DRM compatible MW Txer to DRM.
- * FM DRM+ transmitters.
- * SW DRM Transmitters for regional coverage.

According to unconfirmed reports All India Radio is developing a DRM receiver alongwith Analog Devices Inc. (ADI) . The chip for the receiver is being designed by an Indian infotech firm Jasmin Infotech.

DRM Resources on the web :

Redsun RP2100 on ebay
<http://tinyurl.com/2vj6ev>

I5XWW DRM Converter on ebay
<http://tinyurl.com/3cqaos>

DRM Softwares
<http://xoomer.alice.it/i5xww/software.htm>

I5XWW DRM Converter
<http://xoomer.alice.it/i5xww/drm.htm>

Dream download :

http://pdis.rnw.nl/norbert/inst_dream.exe
<http://home.planet.nl/~rickvdw/digitaal/drm2.html>

DRM resources by CT1ADT

<http://www.qsl.net/ct1adt/>

DRM Devices & services

<http://www.sat-schneider.de/DRM/DRM.htm>

Dream Project Homepage

<http://drm.sourceforge.net/>
<http://sourceforge.net/projects/drm/>

Build an IF mixer

<http://www.dl5mgd.de/drmischer/drmischer.htm>

Simple DRM IF circuit:

<http://www.omnirep.ch/drm/circuit.html>

DRM Receivers and Equipment

<http://www.drm.org/receiversequip/receiversequip.php>

DRM Software tools

<http://home.arcor.de/carsten.knuetter/drm.htm>

Receiver modifications for DRM :

http://www.drmrx.org/receiver_mods.html

Degen 1103 modification

<http://www.knallfunke.de/drm/mod/mod-1103.htm>

DRM Converter for ICOM RX/TRX (9 MHz IF)

IC706 (all series), IC725/726/728/729, IC735, IC-R70/71/75.
<http://spazioinwind.libero.it/ik1zyw...DRM/index.html>

Andrea Borgnino IW0HK's DRM Page

<http://www.mediasuk.org/iw0hk/drm.htm>

DRM Rx

<http://www.mydarc.de/de8msh/drm/>

Experimenting with DRM

<http://www.fineware-swl.com/drm.html>

DRM Broadcast Schedule

<http://www.drm.org/livebroadcast/livebroadcast.php>

Questions or query's please contact :

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Block Diagrams by Arun Ray.

10th March, 2008.