DRM Receive Conversion for Yaesu FT920 HF Transceiver by Don M0DKS

1. Introduction

This conversion describes the addition of the DRM receive function for a Yaesu FT920 HF Transceiver that is equipped with the FM-1 optional FM transceive board. The FT920 is a double hetrodyne receiver that for AM and SSB has a first IF of 68.985 MHz with a roofing filter bandwidth of 20 kHz (-6dB) and a second IF of 8.215 MHz. With the installation of the FM-1 option board a third IF of 455 kHz is added for FM demodulation. For DRM the third IF is mixed down to 12 kHz and fed into a PC sound card for demodulation.

2. Opening the FT920

Lay the radio on the work bench with the front panel facing you. Turn the radio upside down. To remove the lower panel, remove 3 screws near the front and 3 screws from the rear of the chassis. Lift the lower panel up from the rear and pull out backwards. The FM-1 unit is now accessible.

3. FM-1 option board

The FM demodulator on the FM-1 is built around the Motorola MC3361C IC. The block diagram from the data sheet shows that pin 3 is the mixer output and pin 5 is the input for the demodulator with a band pass filter connected between pins 3, 4 and 5.

The band pass filter is a Murata CFWM455F which has a bandwidth of 12 kHz (-6dB) and 25 kHz (-60dB).
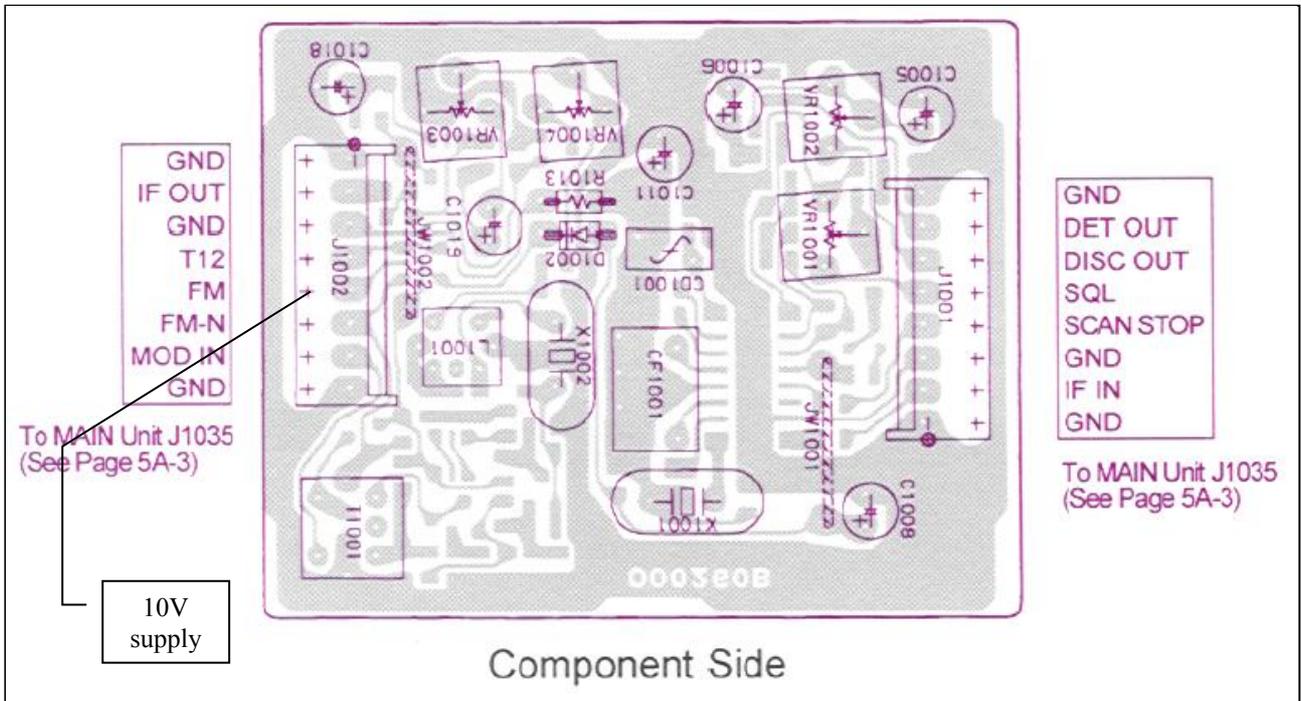
The 455 kHz third IF signal is tapped at the output of the Murata filter just before pin 5 of Q1001 in the diagram below.
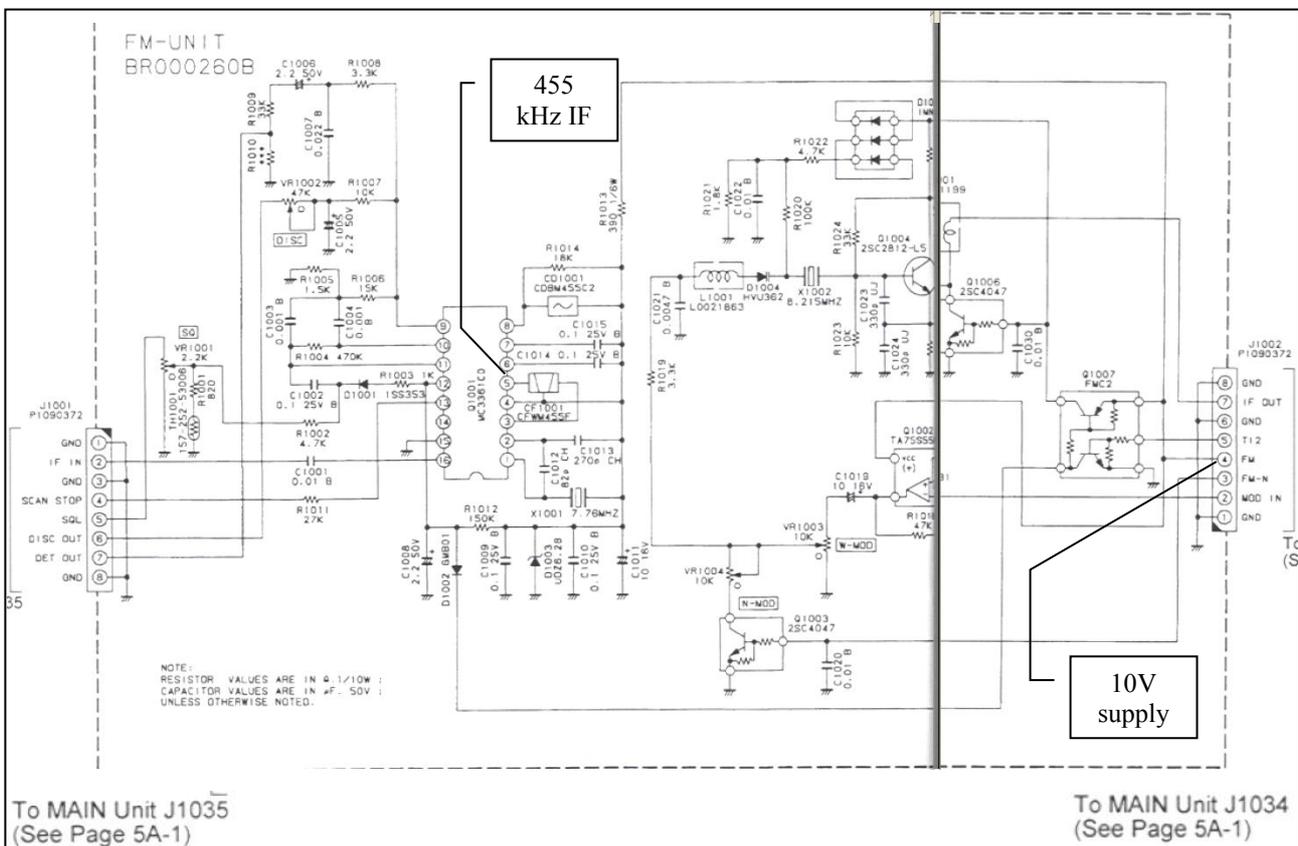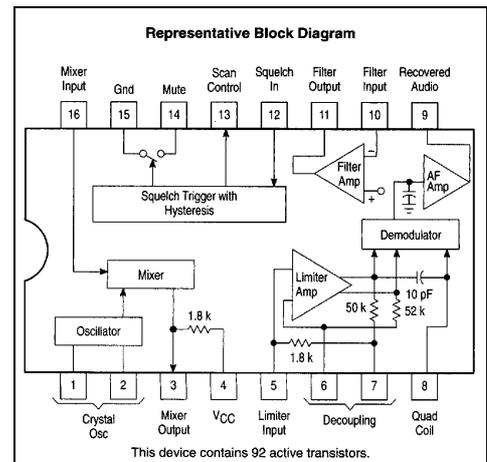
A stabilised 10V power supply is tapped from pin 4 of connector J1002, this is labelled FM in the diagram above since it only switches on if FM mode is selected on the front panel of the radio.

4. Power supply wire

A short wire (150 mm) is soldered on pin 4 at the component side of connector J1002. The connector has pins that are accessible.


Component Side

5. Tapping the 455 kHz IF

Use 200 mm of miniature 50 ohm coax such as RG316. Remove 50 mm of the jacket and then 45 mm of the shield so 45 mm of isolated centre conductor is exposed. Remove 5 mm of the centre isolation so the centre wire is exposed. On the chip side of FM-1 solder the shield to the ground point of capacitor C1011 (1). Next solder the centre conductor to the output of the Murata filter. This corresponds to pin 5 of Q1001 (2). If

Chip Side

necessary also fit a plastic sheet below the FM-1 board to prevent short circuits from the miniature coax.

6. Mixing the 455 kHz IF down to 12 kHz
This is performed by the Sat Schneider Crystal Mixer (fo = 467 kHz, use for IF exact 455 kHz). Prepare the mini coax and insert the wires from the component side into the ZF 455 kHz holes and solder from the crystal side (shield of coax to the ground plane and centre conductor to the input). Insert the power supply wire into the 7 – 20V Ub hole and solder on the crystal side. Use 3 metres of thin microphone cable and prepare the ends. Insert the wires from the component side into the NF 12 kHz holes and solder from the crystal side (shield of cable to the ground plane and centre conductor to the output). Connect the other end of the microphone cable to a 3.5 mm jack plug. The centre of the coax is connected the forward pin of the jack plug and the shield is connected to the rear contact.

7. Installing the mixer into the Radio
The mixer (3) is installed to the left of the FM-1 board (4) with double sided Velcro tape. One side is stuck to the motherboard and the other side to the crystal of the mixer. Output cable (5) is routed along the wire loom to the rear of the chassis and exits via an existing hole (6) and is plugged into the sound card of the PC. Also shown are coax (7) with the 455 kHz input signal and 10V power supply wire (8). The potentiometer is set for maximum signal on the sound card.
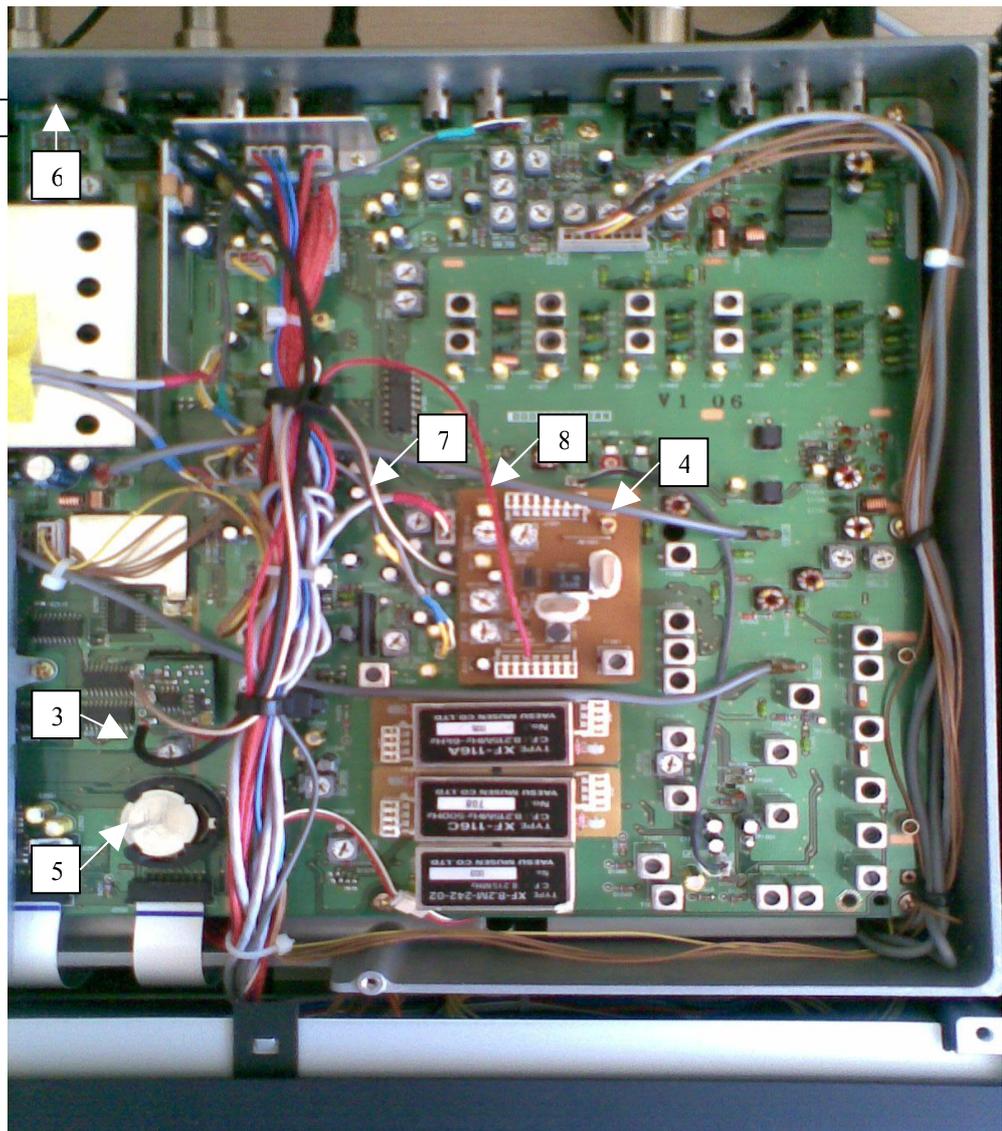
8. Software installation
Details about installing the Open- Source DRM decoder DREAM can be found here:
http://sourceforge.net/apps/mediawiki/drm/index.php?title=Main_Page#Installation

9. Windows mixer settings (Master Volume Control Panel)

Master volume and Wave should be set to maximum and all other inputs including line and microphone should be set to mute to ensure the 12 kHz baseband input signal (undecoded COFDM signal) does not interfere with the decoded audio signal.

10. Signal to Noise Ratio

Since the COFDM signal consists of hundreds of closely spaced carriers (Mode A has 228 carriers in 10 kHz), strong antenna signals cause intermodulation products in the pre-amplifiers and mixer stages of the receiver and make the recovered signal impossible to decode. The transmissions of BBC-Deutsche Welle from Skelton (3.995 MHz) and Sines (9.545 MHz) for example achieve the best signal to noise ratio when the pre-amplifiers are switched off (IPO function on) and the signal is attenuated to S9 (The radio is switched to FM reception with the radio volume turned to zero). In this case Skelton achieved 35 dB and Sines 38 dB signal to noise ratio (see screen shots). Both were received with a tuned doublet antenna. Also important are pre-amplifiers in active short wave antennas. In many cases strong Medium and Long Wave signals cause intermodulation and degrade the DRM signal so decoding is no longer possible. In this case it is better to use a passive long wire antenna with attenuator since high signal to noise ratio of the antenna signal is more important than signal strength (S-meter level). If the noise floor is very high such as in the evening, signal to noise ratio can also be improved by using a magnetic aerial (tuned loop antenna).

11. Materials

DRM crystal mixer: SAT-Service Schneider, Dipl.- Ing. Ulf Schneider, Landsberger Str.62a, D - 04736 Waldheim, Germany, Phone: +49(0)34327 92809, http://www.sat-schneider.de/

RG316 coax: Waters & Stanton Plc, Spa House, 22 Main Road, Hockley, Essex, SS5 4QS, United Kingdom, Phone +44 (0)1702 206835, +44 (0)1702 204965, http://www.wsplc.com/index.php
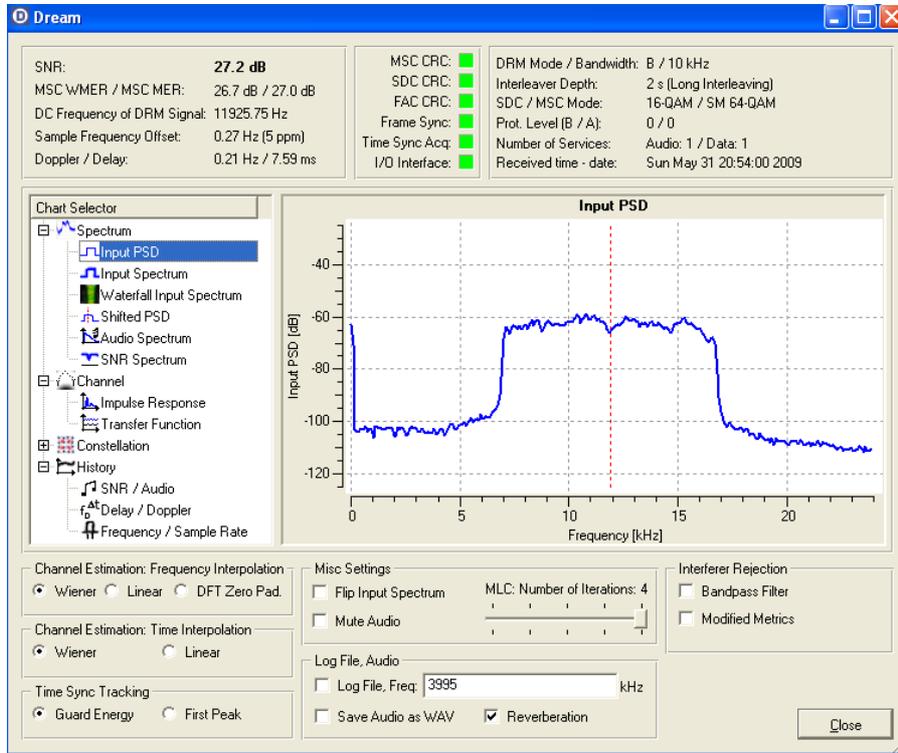
12. Disclaimer

Attention! The modification will be done at your own risk! You may loose vendor warranty and liability!

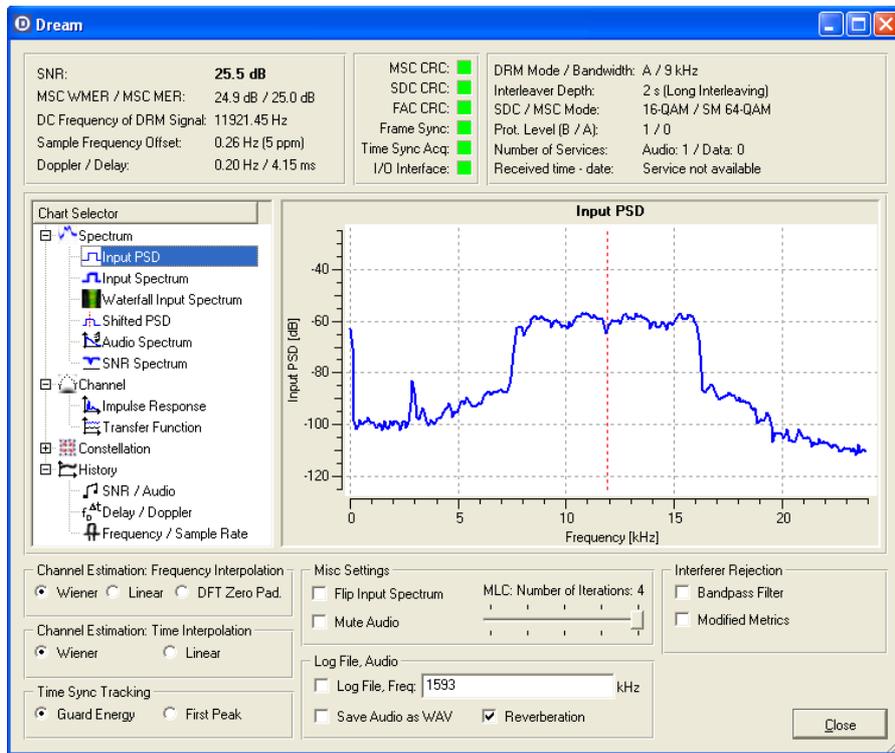13. Contact: radio.experimenter (at) talktalk.net (no spam)

13. Screen shots

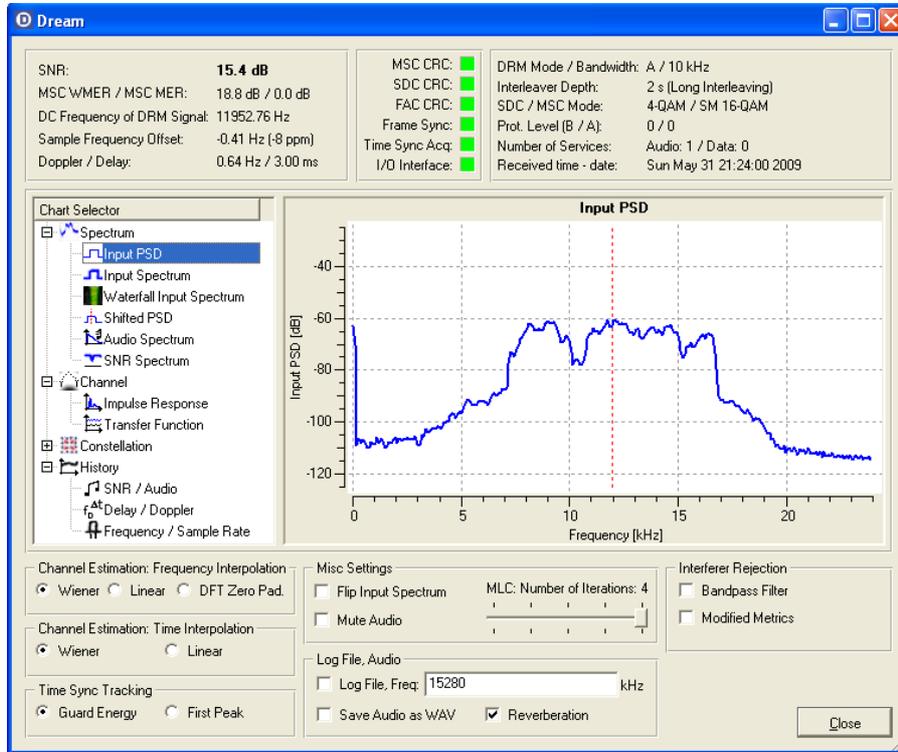Below are screen shots from DREAM.

BBC-Deutsche Welle Skelton UK 100 kW 27dB

WDR2 Klassik Langenberg Germany 10 kW 25dB

HCJB Voz Global Quito Equador 4 kW 15dB

BBC-Deutsche Welle Sines Portugal 90 kW 38dB