

Dietmar Adolf (info@asystec.de)

DRM Reception With SONY ICF-7600D/DS (ICF-2002/2003)

v1.02 2004-02-09 first released version
v1.10 2004-02-14 external antenna connector, EMI suppression, AC harmonics suppression
v2.00 2004-02-17 compact version with lowres pics

This report is intended to help others, but no absolutely no warranty is granted, if any damages result from following these steps.

This popular vintage receiver from 1983 should be modified to support DRM radio transmissions while all other operation should remain unchanged.



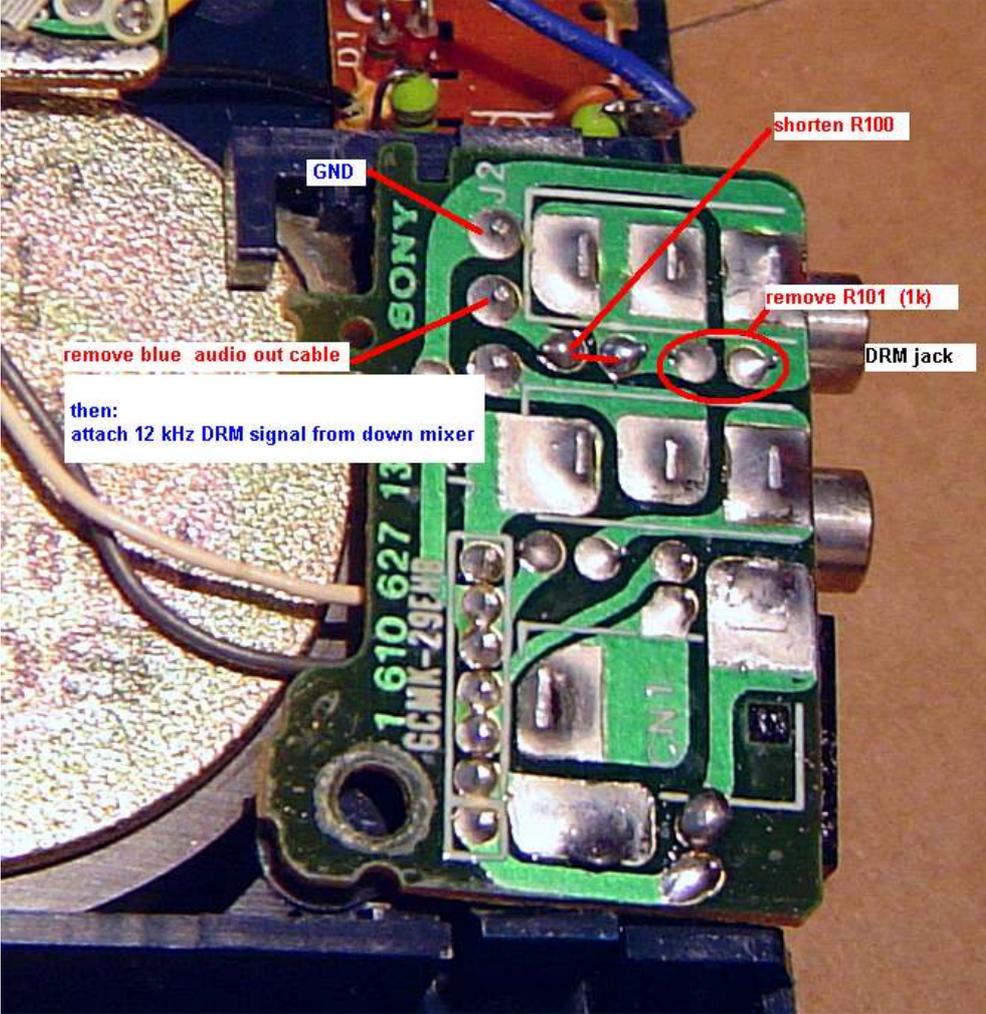
The receiver has a PLL synthesized tuning basis, but largely relies on analog circuitry for AM reception, using double conversion with $IF1 = 55.845$ MHz and $IF2 = 450$ kHz. We want to integrate the widely used DRM down mixer (manufactured and sold by Sat Schneider www.sat-schneider.de).

A first inspection of the receiver reveals the challenge: the case is packed, but it is still possible to install the DRM mixer circuit, hook up an output jack and install an external antenna connector:

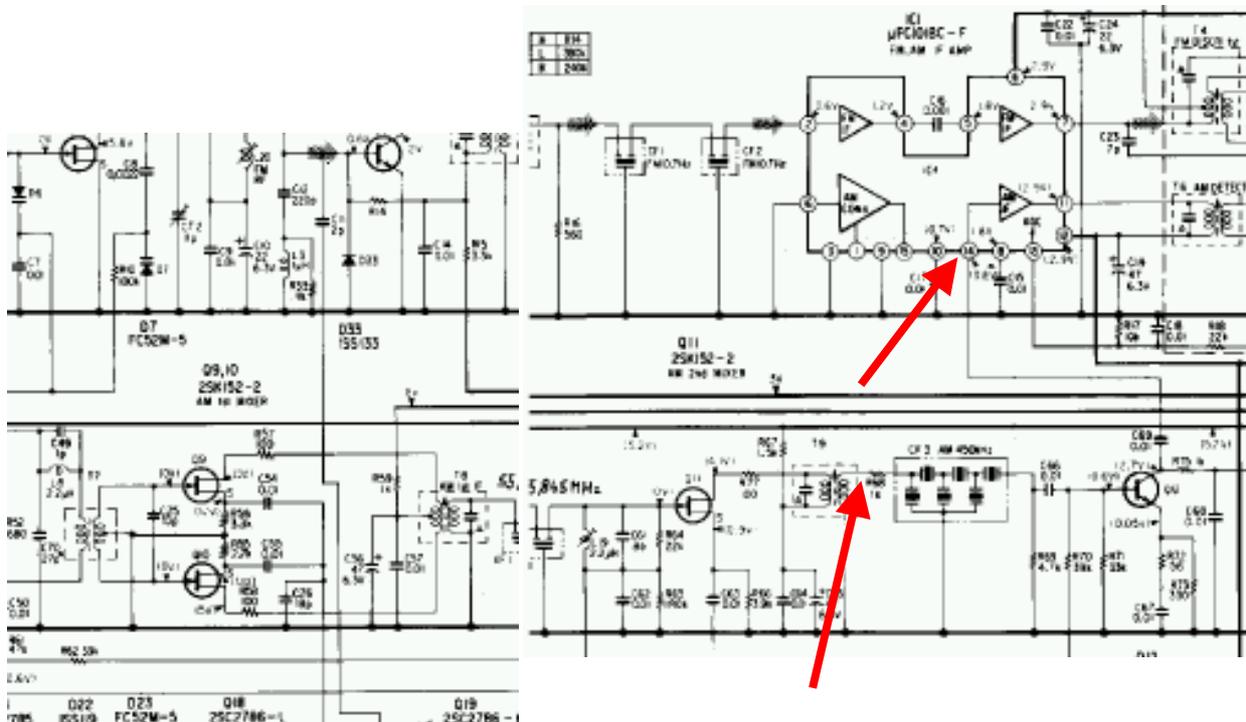


The 12 kHz DRM output signal will be hooked to the "line out" jack socket labelled with a tape symbol. The original audio output signal will be disconnected, as it is not of much use anyway. The signal is far below specs for "line out".

This is how to proceed:



IF Tapping



Looking at the circuit diagram, we identify two possible IF tap points for the DRM down mixer input:

- Pin 14 of IC1: This is the input pin of the AM IF amplifier. Here, the signal has passed the 450 kHz ceramic filter CF3, then has been amplified by transistor Q12 and DC-decoupled by C69. As the IF filter is reported to be a CFW450H, we expect an AM bandwidth of +/- 3 kHz only. If the specs are strictly met, this will not be enough for DRM reception.
- Between T9 and R68: This is just after the IF LC-oscillator and prior to the 450 kHz ceramic filter. SONY uses a very similar circuit setup to the Sangean ATS-803A, described by David M Pratt. We may expect a IF signal with bandwidth of at least 10..11 kHz

The DRM down mixer gain is adjustable: we should be able to account for the differing signal levels of both options.

Removing the front cover and the control board,



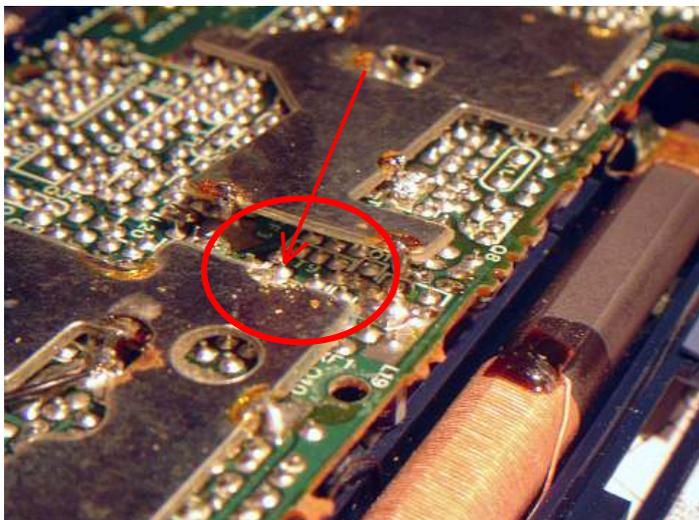
we can inspect the IF components actually installed:

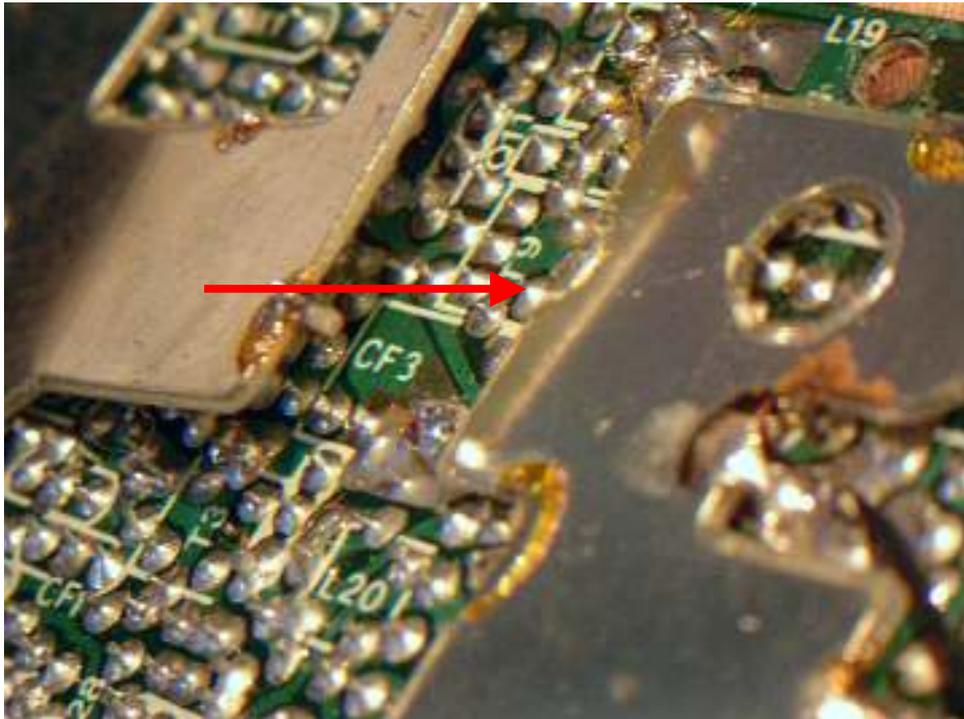


The ceramic filter SFR4501 is different than what we expected and has a distinctively small bandwidth of only ± 2 kHz and rather steep edges. While yielding an very good selectivity for AM baseband signals, this means, that option a) would fail for DRM, as we need a bandwidth 8 kHz or so. Yet, this also means that we cannot use the pre-amplified IF.

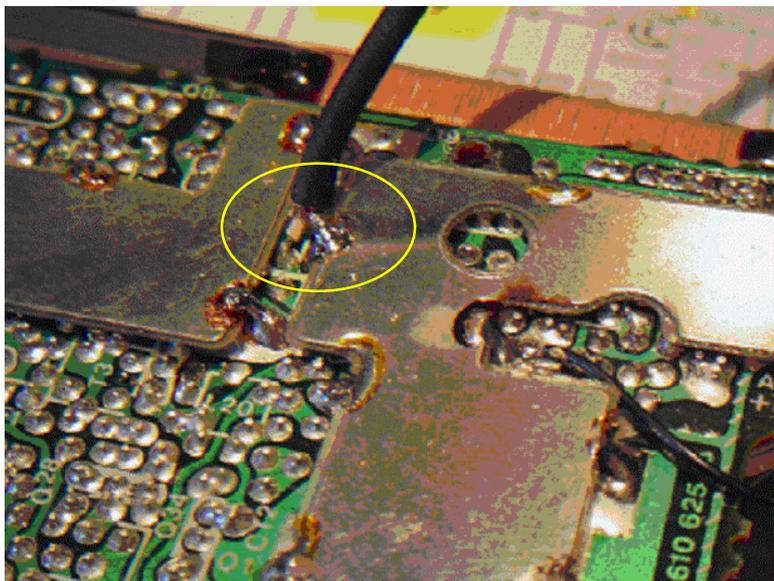
Instead, we need to identify T9 (circled red) and R68 on the soldering side and connect the down mixer IF input to them. The mixer gain needs to be set to the maximum.

After carefully removing the HF shield, the correct tap can be identified as the secondary side of T9, that is not connected to ground.





As it turns out, the correct pin is about the only pin of T9, that is accessible without removing the HF shield:

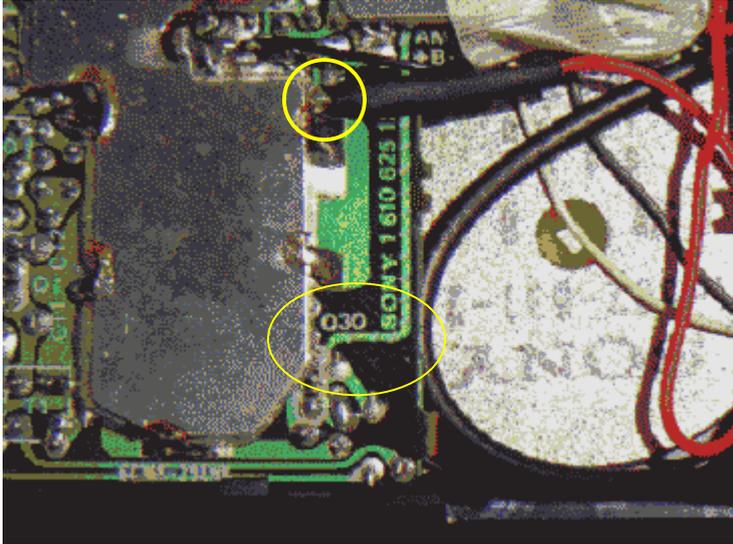


DC supply for the DRM mixer

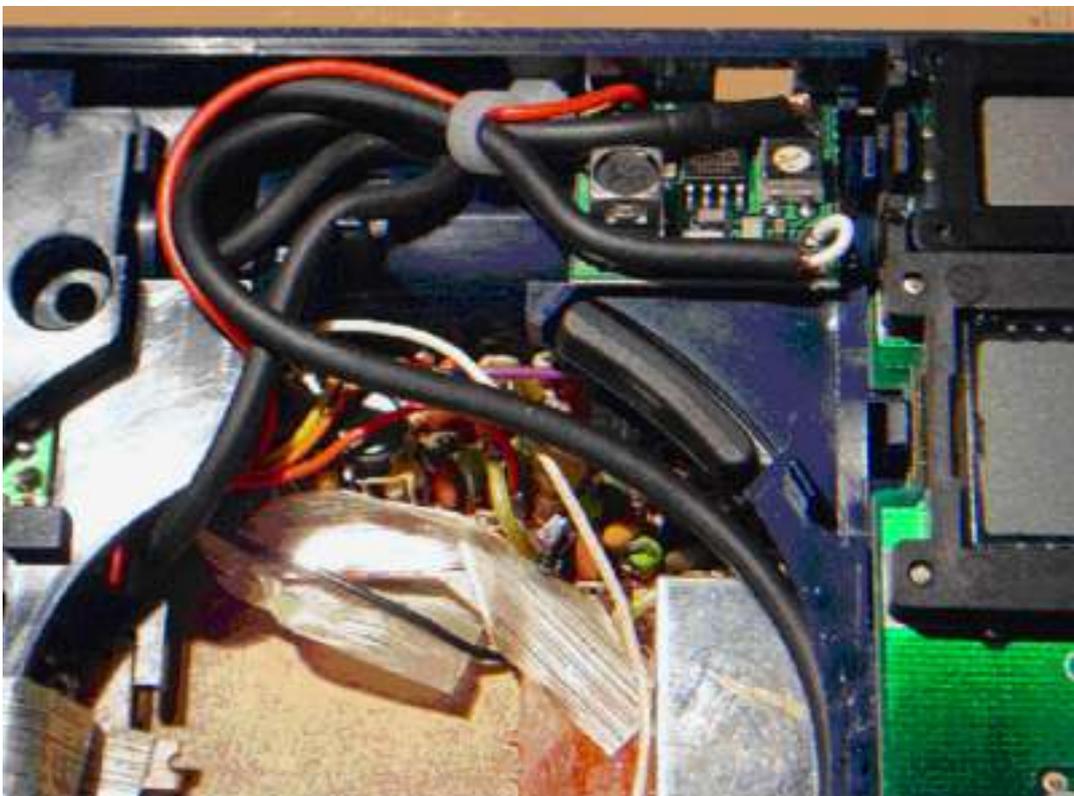
For its AC-Adaptor, SONY used a transformer with a simple half-bridge and load capacity. Ripples with 5 % of the nominal voltage (6 V) remain. Regulator transistors within the receiver further stabilize the DC supply voltage: Q30 supplies 5.2 V for the AM circuit. The DRM circuit easily draws its power from this tap. Also, we can bypass the 7805 voltage regulator on the mixer board, as the receiver ICF-7600D has a maximum voltage 6 V DC and the SA612A operates at nominal 6 V

(range 5.4 .. 8 V) and has an integrated voltage regulator. We found that the mixer SA612A still operates at around 4 V.

To achieve DRM reception with low batteries, we **need to tap the mixer supply voltage from the emitter of Q30**. The tap is readily accessible:



The **DRM mixer** board can be placed near the load speaker. To shield interferences with the ferrite antenna, it was wrapped with paper and **aluminum foil**.



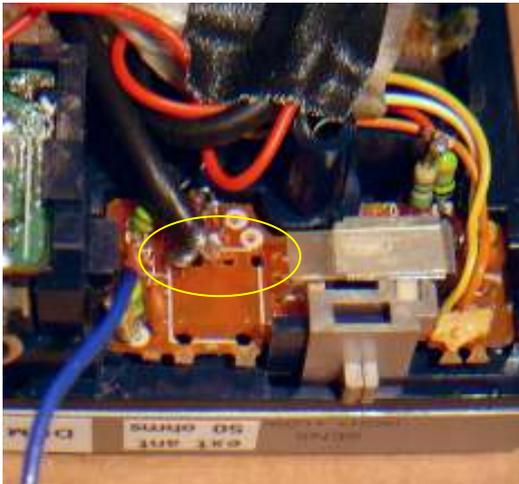
HF Noise Suppression / External Antenna

HF noise picked up by the cable linking the DRM IF out jack and the sound card impaired the overall reception of regular SW signals while the DRM output was connected.

With the DRM down mixer, the 12 kHz DRM output signal passes a simple band filter favoring the range 1..20 kHz and suppressing HF noise. The impedances of the DRM output (around 2 kOhms) and the sound card "line in" (around 5 kOhms) are matched fair enough not to expect further signal degradation.

By some experimenting, it was found that the built-in telescope antenna was the culprit for unwanted EMI/RFI pickup, as it placed very near the DRM down-mixer and is using an unshielded cable.

Installing an **SMA connector for a 50 Ohm coax connection to an external antenna really made the difference**. Disconnecting the internal telescope antenna and using the newly installed shielded link to the antenna dramatically reduced the EMI/RFI interference. The antenna leads were soldered directly into the provided socket space on the antenna board:



prepared „pins“
1 (left) : shield
3: core

The SMA connector fits perfectly into the gap, when the receiver case. After these steps, plugging or unplugging the DRM output did no longer affect the normal short-wave reception.

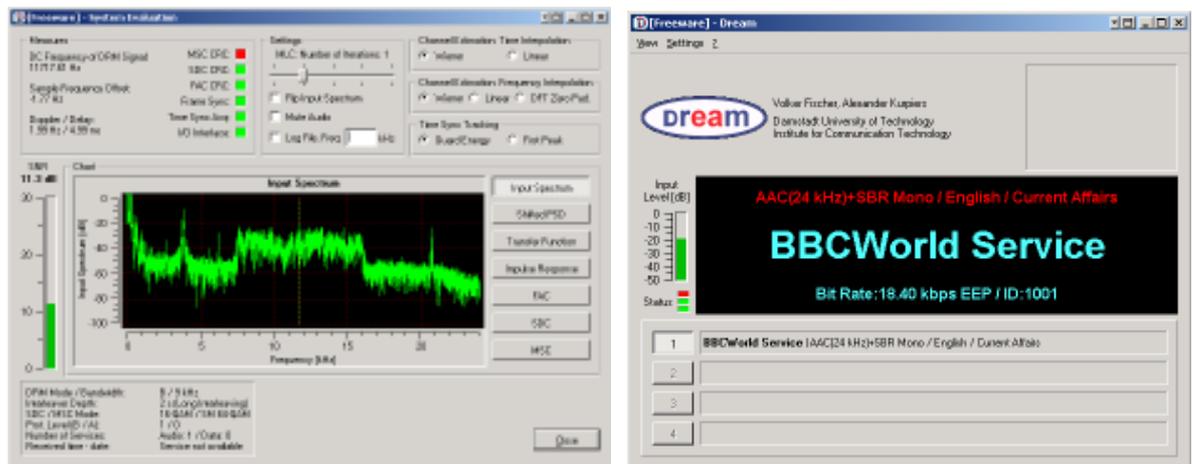
Possible Further Improvement

Add a ceramic filter CFW450F (+/- 6 kHz) [or CFW450E (+/- 7.5 kHz)] prior to the DRM mixer input for better selectivity.

Results

- The behavior of the AM IF handling is only slightly degraded. The AM 2nd mixer is only offset about a few kHz with the new device installed. This may be corrected by fine tuning.
- Adjusting the the LC oscillator of the DRM down mixer is critical and needs some very careful adjustments.
- The total power consumption of the receiver is increased by 5 mA to a maximum of 55 mA in AM mode (The DRM mixer is powerless in FM mode using 45 mA).
- Typically the DRM signal was only a few dB above noise level with faint signals. The resulting SNR of around or below 10 dB could not be decoded while the external power supplies of the receiver and the notebook used were connected.

2004-02-07 22:34 UTC 1296 kHz (Orfordness, UK. 70 kW beam to NL (96°)). Receiver in Berlin, DE. Built-in ferrite antenna and telescope antenna.



The spectrum shows a neighboring AM station (we have no 450 kHz IF filter!) below the DRM center frequency. Also, we suffer from a lot of noise below 1 kHz due to bad, noisy SONY DC power supply.

- **Cheap power supplies without HF suppression** insert transient distortions into the IF signal, that **severely impair the signal decoding**, mostly rendering it impossible. The SNR indicator will never be stable in this case.
- On battery power, even a very faint signal from NRNW at 21.780 MHz transmitted with 10 kW from Bonaire on the Antilles could be decoded in Berlin, Germany.