^{19}F / ^{1}H Decoupling on Varian Inova spectrometers with a single high-band AMT transmitter amplifier.

Supplement to Application note by Steve Cheatham, Bruce Adams, and Eriks Kupce

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When performing $^{19}F\{^{1}H\}$, or $^{1}H\{^{19}F\}$ experiments on spectrometers with a single high-band amplifiers, it is necessary to turn of the transmitter blanking (i.e. put the amplifier into "cw" mode), as described in the Varian application note. The cost in Signal:Noise (as noted in the application note) is substantial. Quoting from the application note, page 2: "Note that in either case, the noise from the AMT amplifier (which must be on during data acquisition, to provide the decoupler signal) will unavoidably pass through the observe bandpass filters and so lower the S/N of the spectrum, as compared to a spectrum taken without decoupling. It is again necessary to force the amplifier into the CW (unblanked) mode, using the ampmode parameter; with a single highband AMT the correct value of ampmode is 'cd' (for 2-channel systems) or 'cddd' (for 3- or 4-channel systems)."

With the addition of a simple set of crossed-diodes between the observe filter (^{19}F in the following examples), this S:N loss can almost completely be eliminated. For years, crossed diodes (in combination with appropriate ¼ λ cables) have been used to provide passive, fast gating at the transmitter and at the receiver. By modifying the circuit in the Application Note (see Figure 1) with three sets of crossed-diodes in series (1N4148 diodes were used, but 1N914s or 4448s would also work), a dramatic improvement in S:N can be achieved when the transmitter is operated in "cw" mode (ampmode='cd').

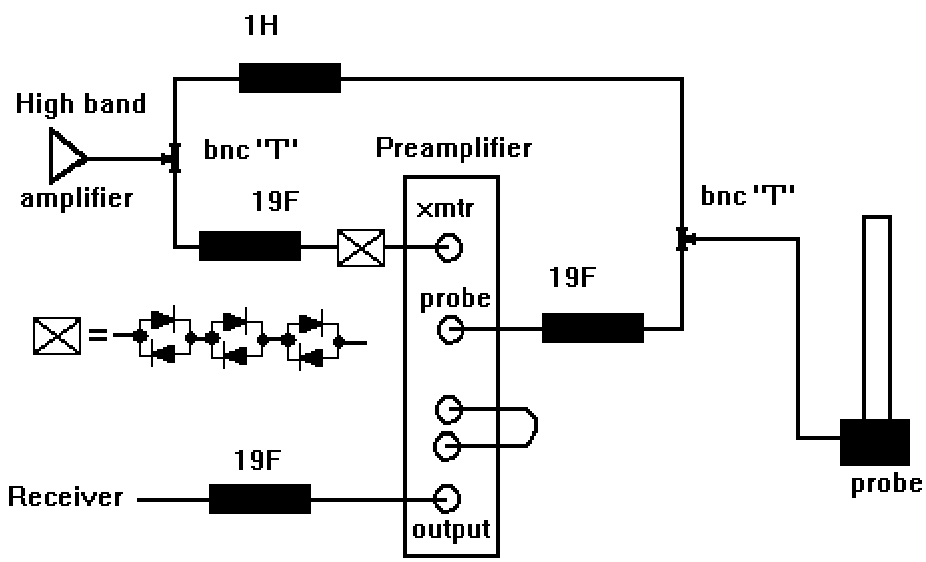


Figure 1.

The isolation could be further improved by adding a tuned coil (inductor) in parallel to the diodes, matched to the capacitance of the diodes in the "off" state (below the turn-on potential of the diodes). This would create a parallel LC filter at the specific frequency, and would theoretically improve the noise rejection at the observe frequency. Even without the tuned inductor, the isolation improvement is dramatic.

Figure 2 shows $^{19}F\{^1H\}$ (proton decoupled, ^{19}F observe) data acquired on a fluorinated saccharide. The top spectrum was acquired without the addition of the crossed-diodes, and the bottom spectrum was acquired with the cross-diodes at the Xmtr input of the receiver pre-amplifier, as shown in Figure 1.

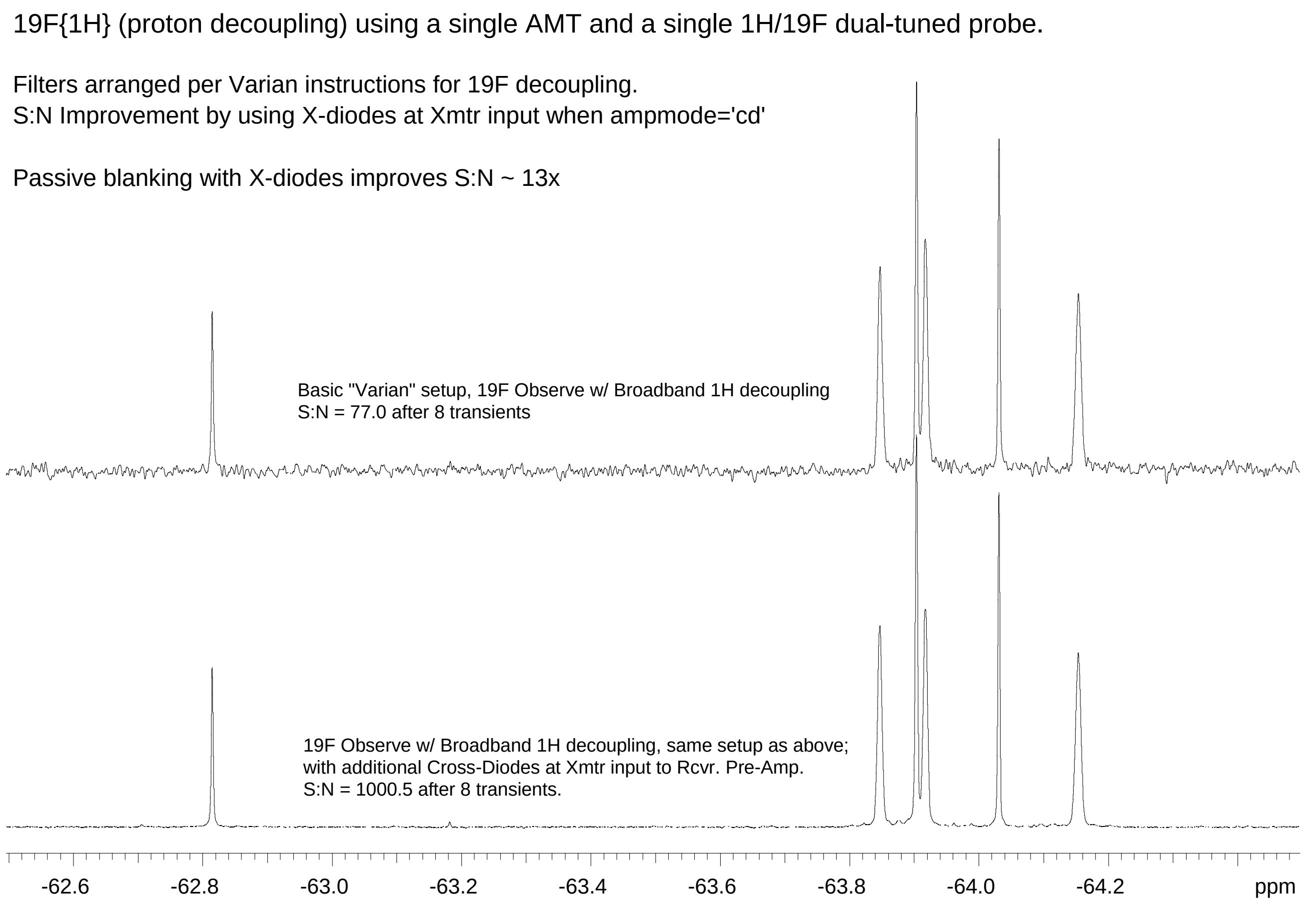
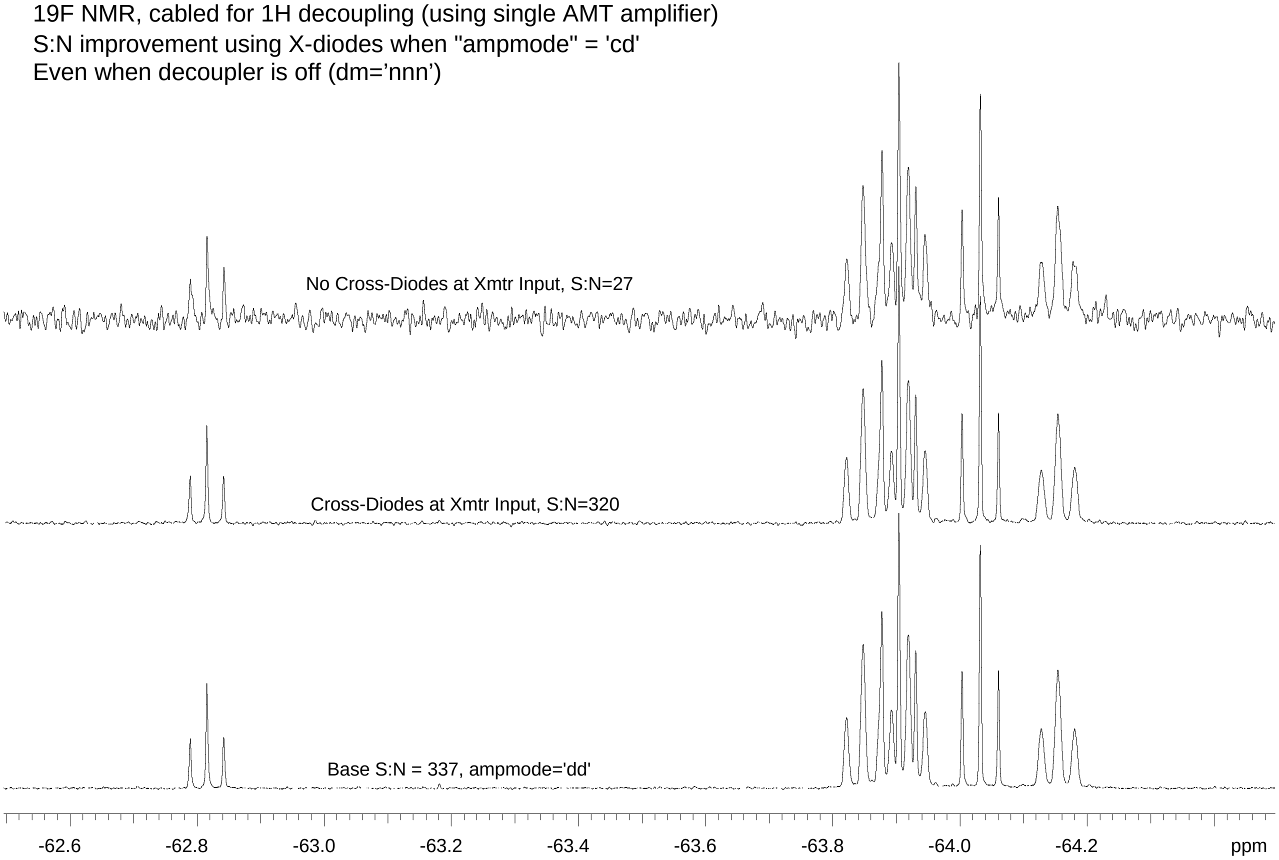


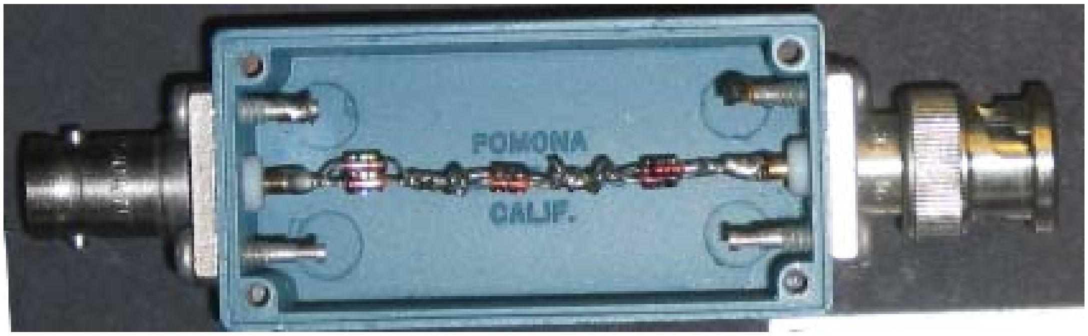
Figure 2.

Even without decoupling, simply putting the AMT amplifier into “cw” mode (ampmode=’cd’) will seriously degrade the Signal:Noise (as shown in Figure 3).

Figure 3:



The component is easy to assemble in a "Pomona Box", with less than $0.10 worth of diodes. The assembly is shown below, and took about 10 minutes to fabricate.

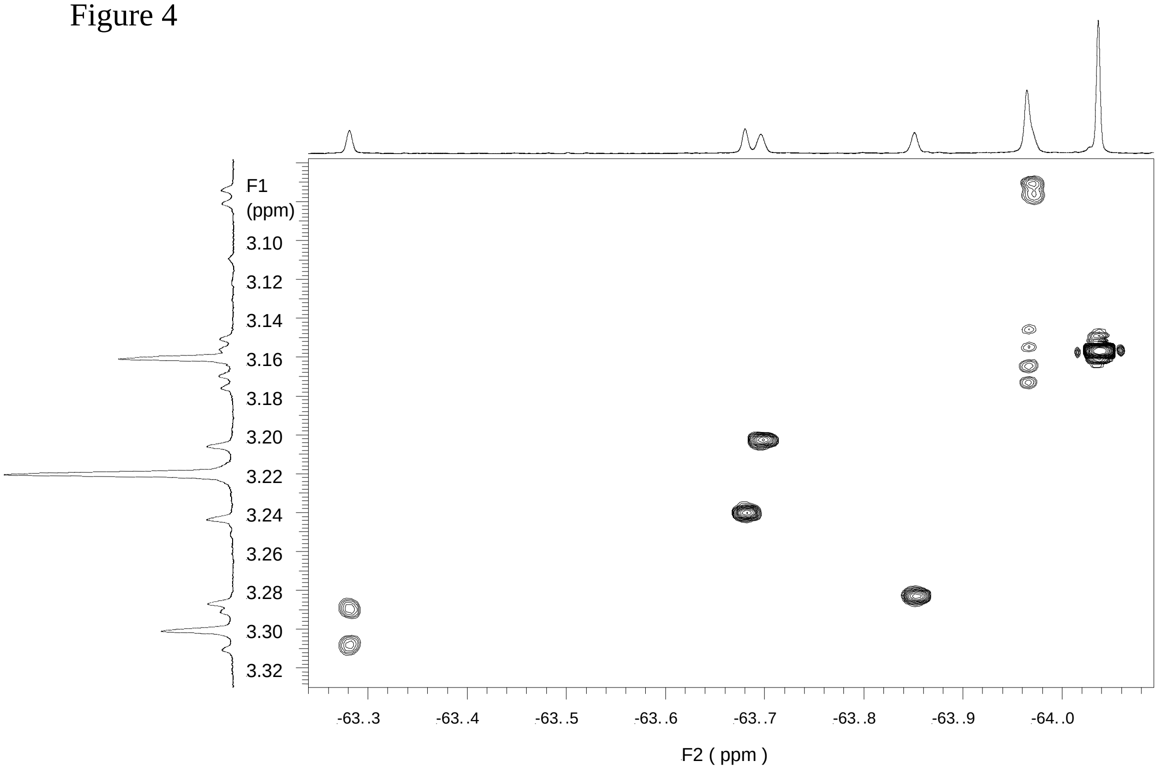


This setup has also been used to collect ^{19}F-^{1}H 2D correlation spectra. One example is shown in Figure 4, which is a 2D-HF correlation spectrum of a partially fluorinated sugar. The spectrum was acquired in less than 15 minutes. Before the addition of the Crossed-Diodes, no signal was visible (above the noise) after an hour of signal averaging.

Trifluoro Propionyl Ester of a disaccharide

^{19}F-^{1}H 2D Correlation

Figure 4



<u>Important Note</u>: One important side effect of using crossed-diodes to gate the transmitter noise is that frequency-shifted, shaped pulses (so-called "SLP" pulses) do not work. Selective pulses that use a phase-ramp to generate frequency offsets require pure, sinusoidal Rf pulses. The diodes introduce a momentary discontinuity in the pulse waveform, which disrupts the phase continuity of SLP pulses. Simply stated, selective pulses generated in *pbox* won't work using the crossed-diodes.