The ZQM Filter

(9/24/07)

The 'Zero Group Delay Q Multiplier' filter (ZQM) is unusual in several ways.

1) It shows a very low (near zero) group delay when using an LC feed back resonator, or a crystal resonator.

2) It does not conform to the $\mathbf{T_g = [\ 1/(4\Delta f)]}$ or $\mathbf{T_g = Q/[4IF]}$ **rule** (Where IF is the filter center freq.).

3) It could be said to confirm the "If the signal does not pass through the resonator, there is no group delay" statement.

4) It is not dependent upon the 'infection point' as in the half lattice crystal filter circuits (TRS, Shunt and Bridge).

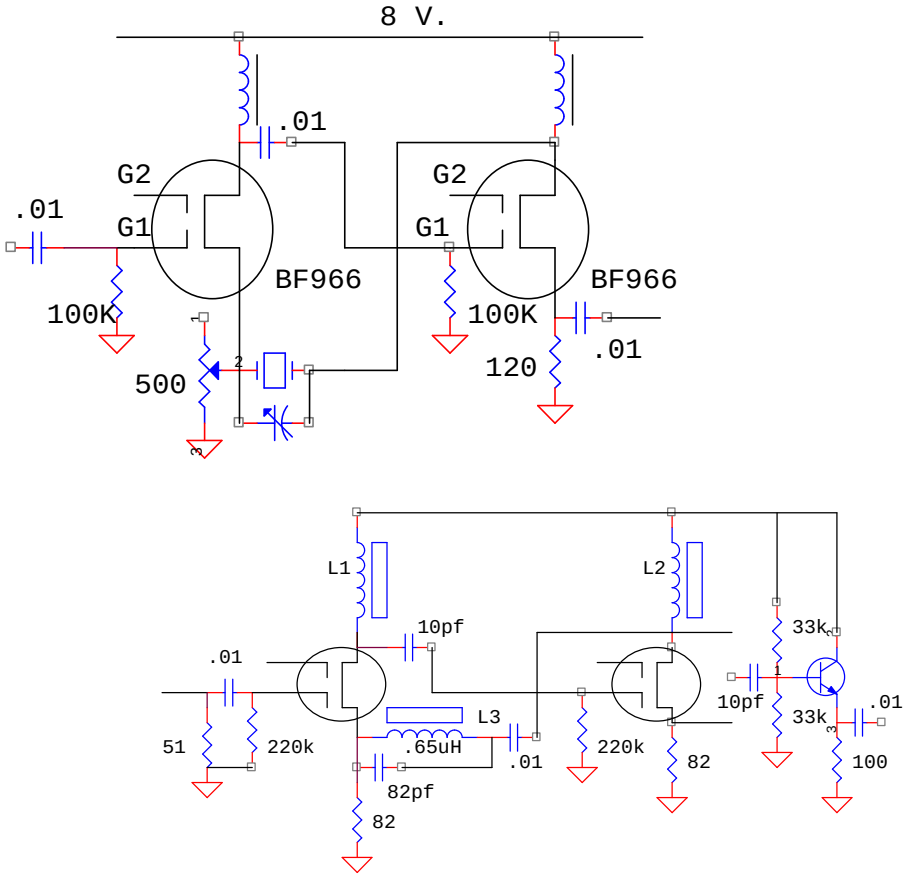

Figure 1. The ZQM Filter.

The circuit in figure 1a utilizes a crystal as the feedback resonator. A parallel LC circuit can be used as well with a broader bandpass (1b). The circuit has negative feed back except at the resonant frequency. At the resonant frequency the circuit can be made to oscillate when the gain is raised. Q can be controlled by the gain as in any oscillating circuit.

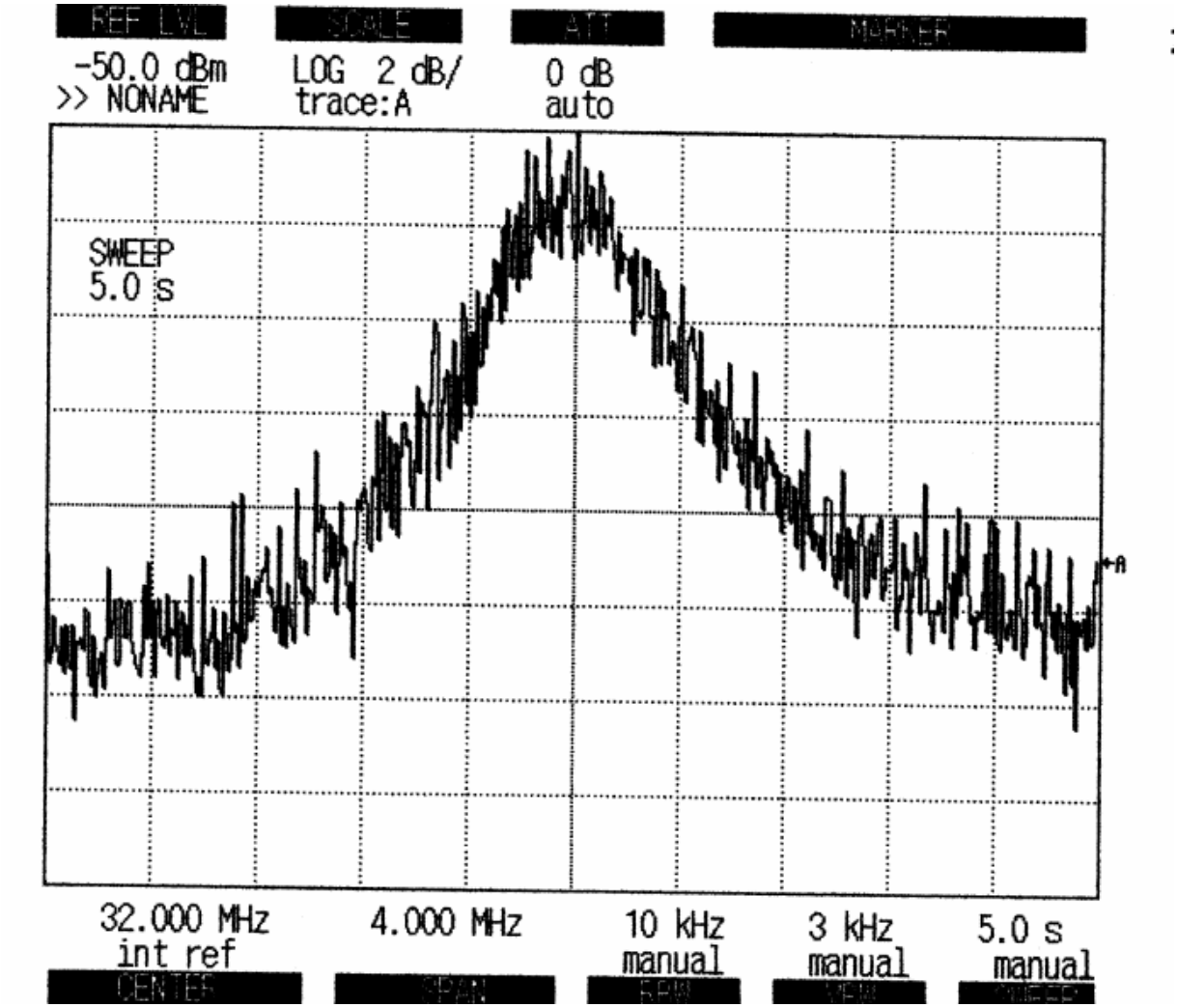

Figure 2. Bandpass of the ZQM filter as tested. The 3 dB bandwidth is approximately 600 kHz. Q =53. Normal group delay = 416 nanoseconds. This filter used an LC parallel filter L=.5 uH and C = 47pf. (Note: the amplitude scale is 2 dB per division).

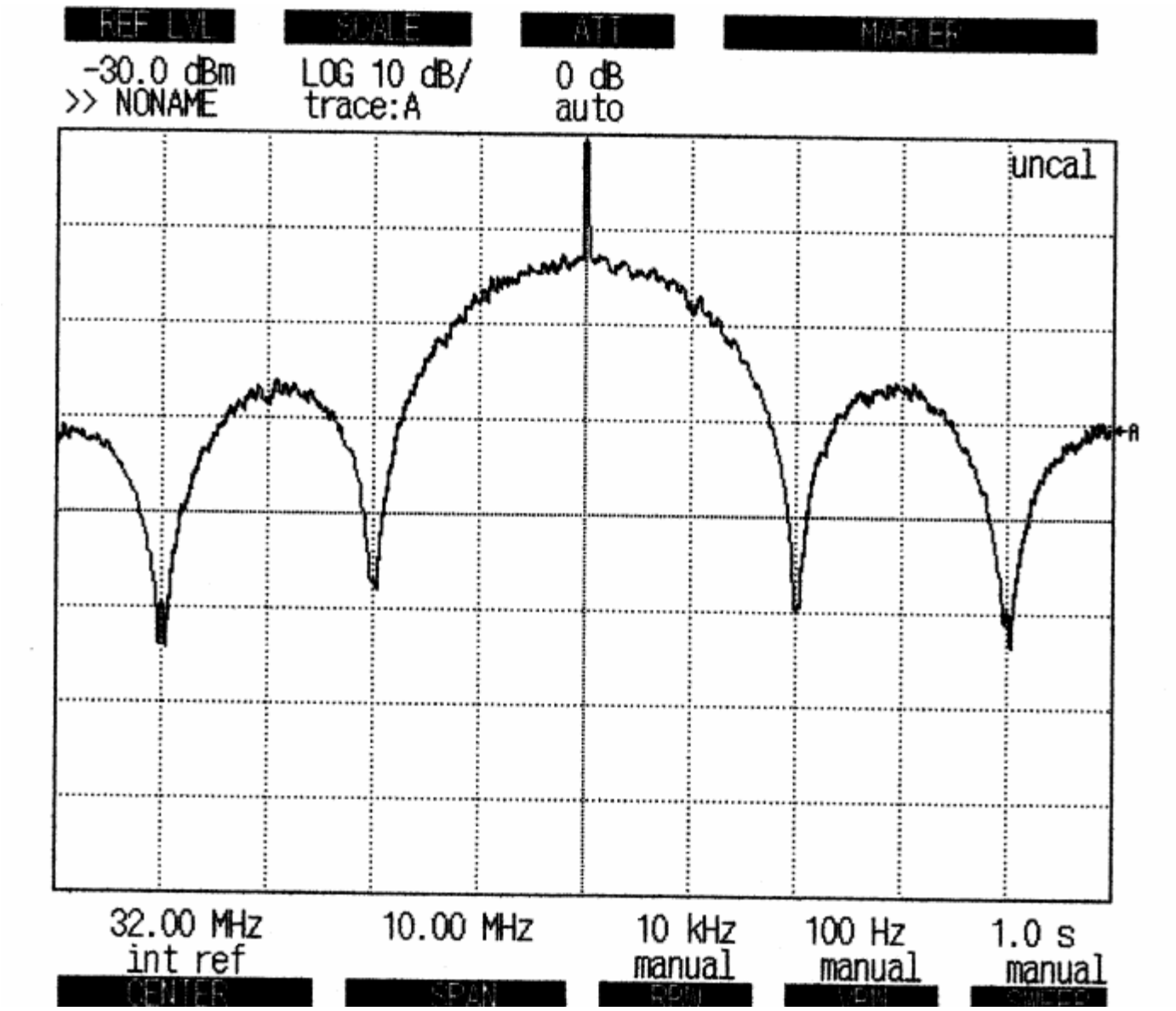

Figure 3. Random Data Input Spectrum at 2 Mb/s. Bit period = 500 nanoseconds.

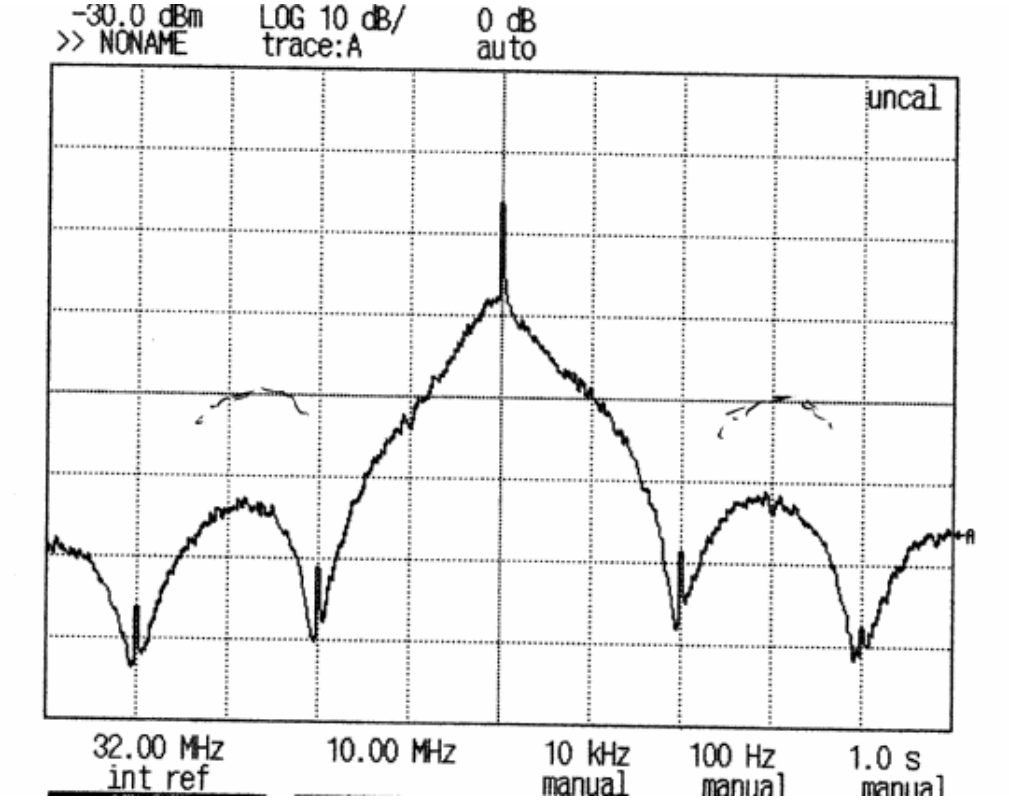

Figure 4. The Spectrum of the 2 Mb/s data after ZQM filter. The shoulders after +- 2 MHz are down 12dB.

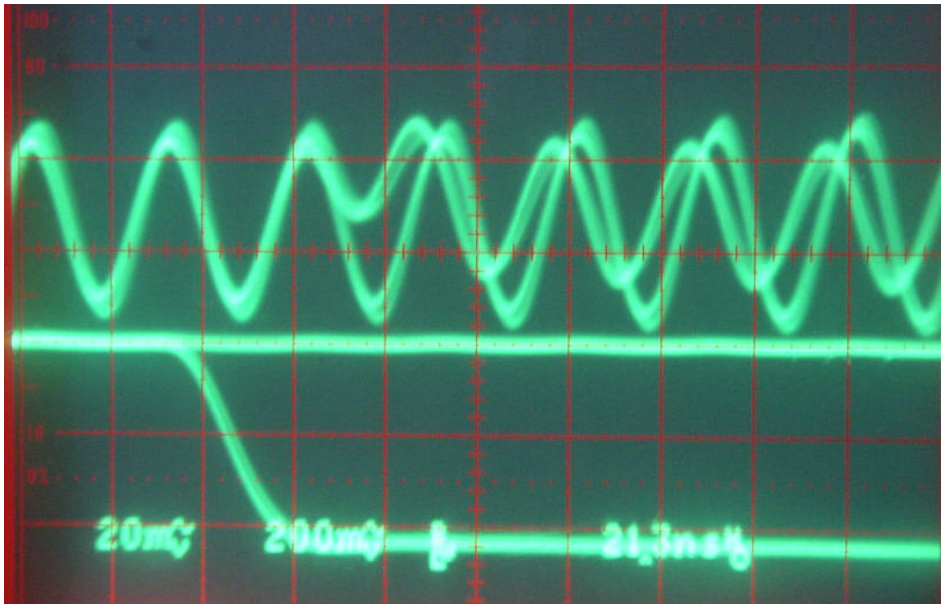

Figure 5. Modulated signal after filter at 2 Mb/s showing the phase slew rate using random data with 90 degree phase shift using NRZ-MSB modulation. The slew rate does not conform to a group delay of 400 nanoseconds.

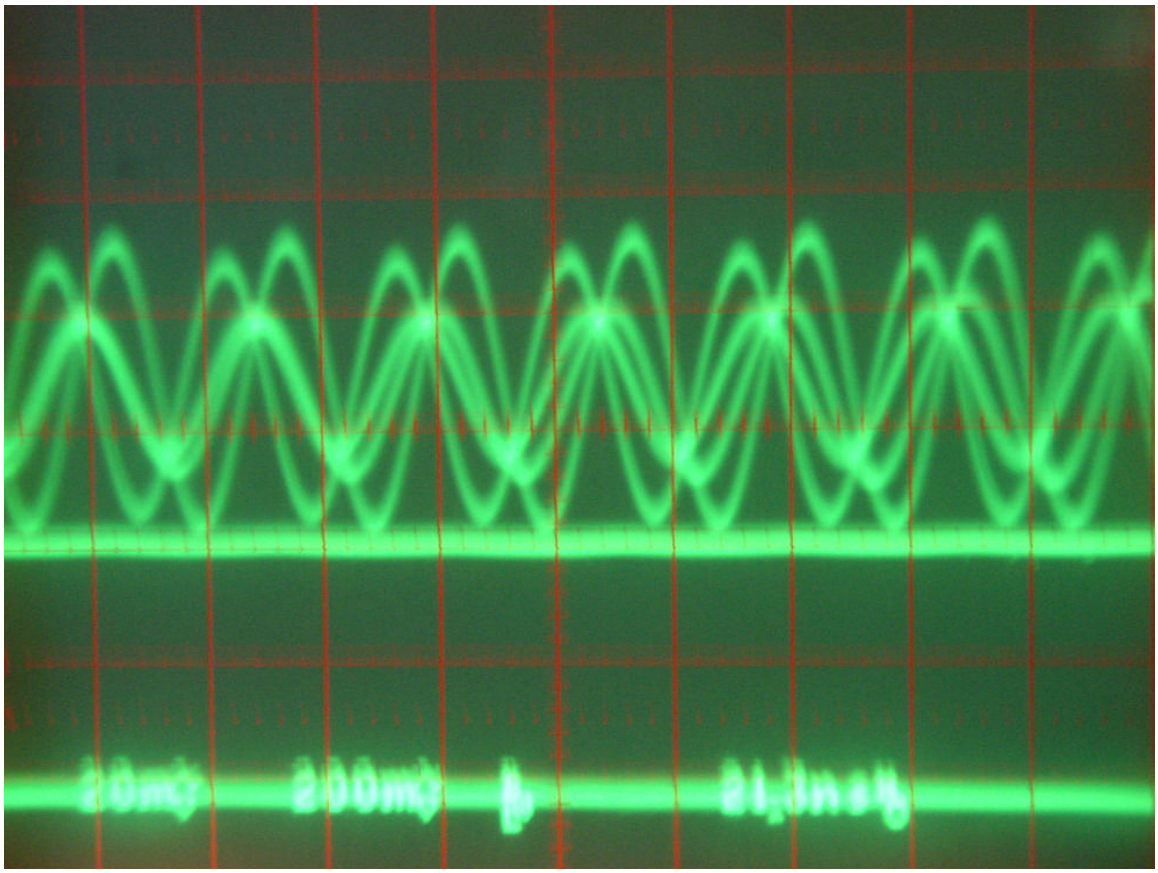

Figure 6. The Modulation Pattern for Random Data after many bit periods. Some phase slew rate slowing is seen as well as some amplitude change. The phase slew is apparently completed in 4 IF cycles. There are 16 cycles per bit period (32 MHz IF, 2 Mb/s modulation. Tuning causes this to vary. This may not be optimum tuning.

This would indicate a worst case T_g of 100-120 ns. (not 400+ nanoseconds.). Tuning and Q adjustment can cause this to vary.

Unfortunately the ZQM filter is often level sensitive.