Filter Tests, Aug.18/08

The filter response to the 3PRK signal was adjusted to give a 120 degree phase shift between phase 1 and phase 2. The phases were observed on the oscilloscope.

Adjusting to get cancellation of one phase with 3 PRK leaves nothing for the second stage to work on. Any further tuning will seek to cancel the remaining stage. Adjusting to get 120 degrees out of the first stage then allows the following stages to have a non canceling phase to work with. There will be additional phase losses. It helps if the modulator has a balance level adjustment to correct for this amplitude loss on one phase.

3PSK can be adjusted to start with 120 degrees eliminating the 3PRK first stage effect—thus it is a better starting choice..

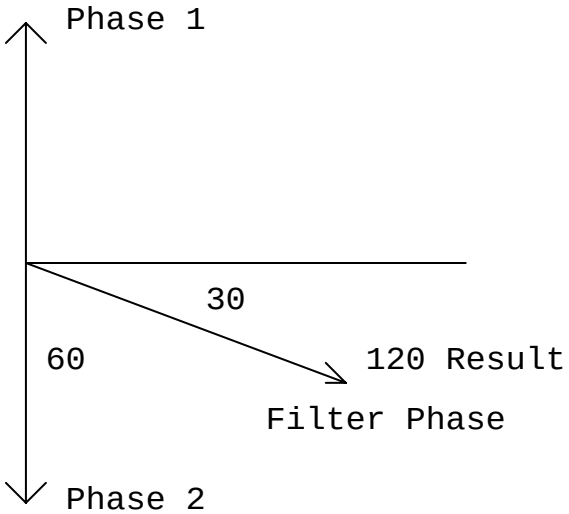

Figure 1. Possible phase tuning for 1st stage.

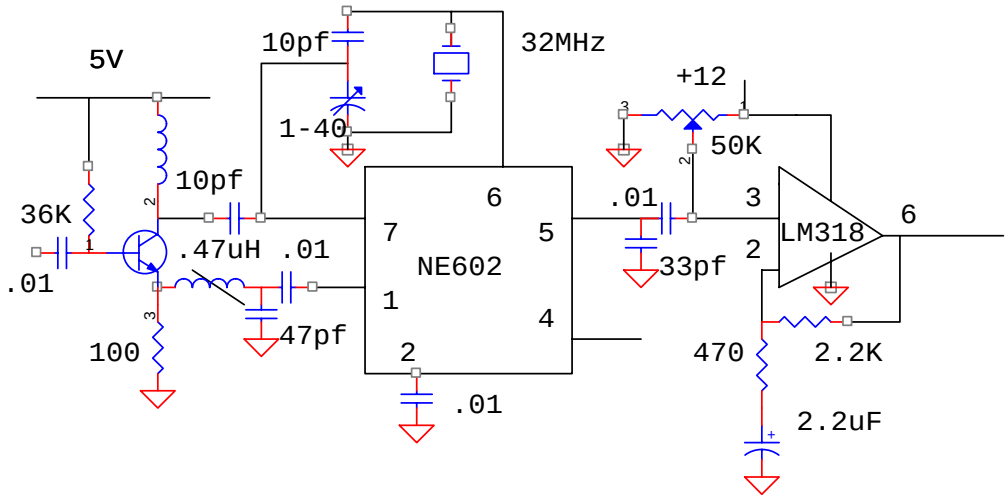

Figure 2. The output is proportional to the phase remaining after phase loss in the filters.

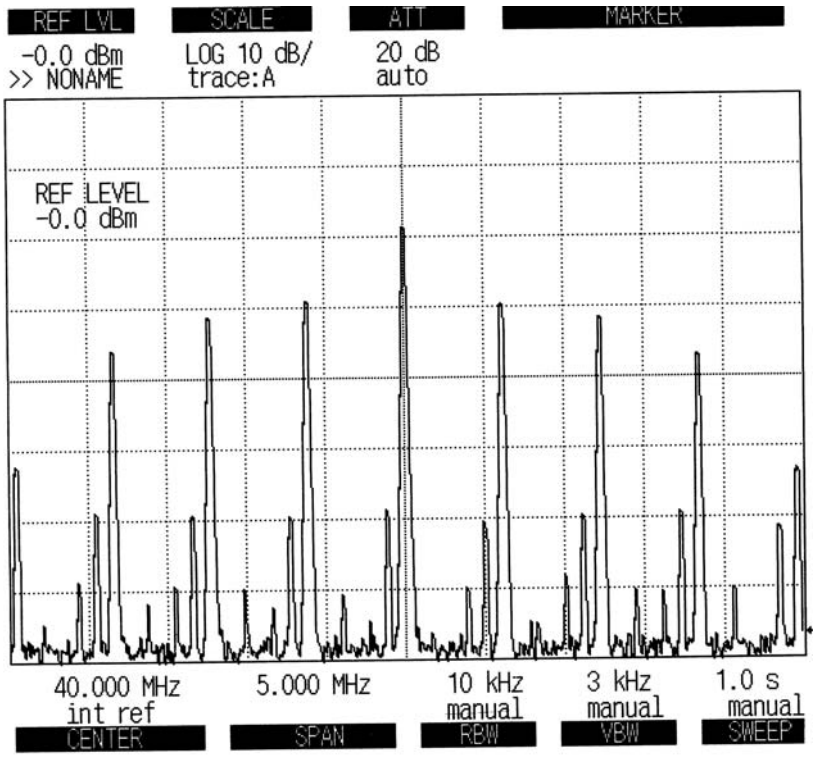

Figure 3. Spectrum before 2 stage TRS filter. Using 3PSK modulation.

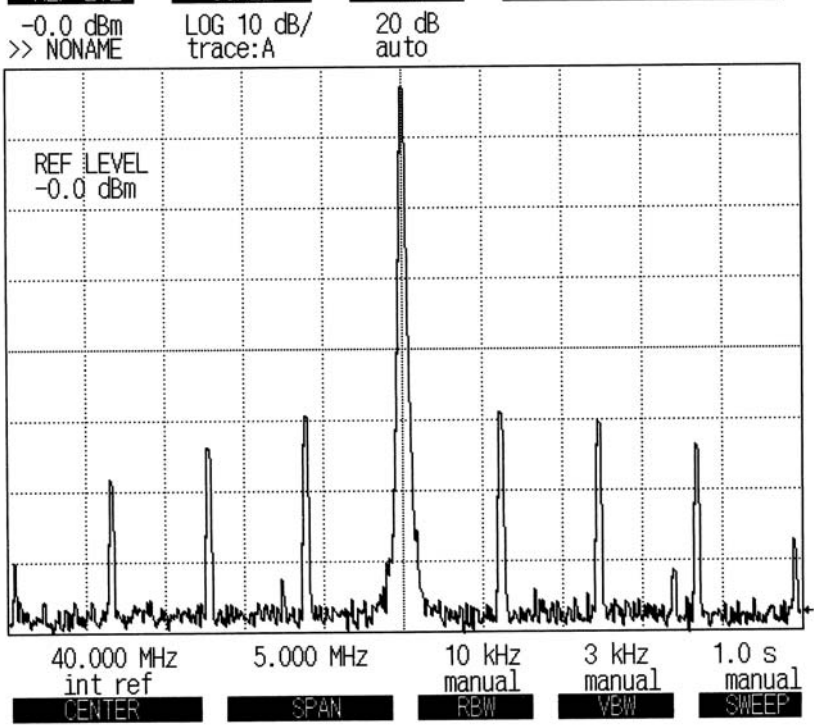

Figure 4. Spectrum after 2 Stages of TRS filter. The shoulders are reduced approximately 36-40 dB. See Fig. 10. The phase loss ---- 120 degrees before, 40 degrees - --after as determined from the output levels of the detector in Figure 2. This varied slightly with impedance matching between boards 1) and 2).

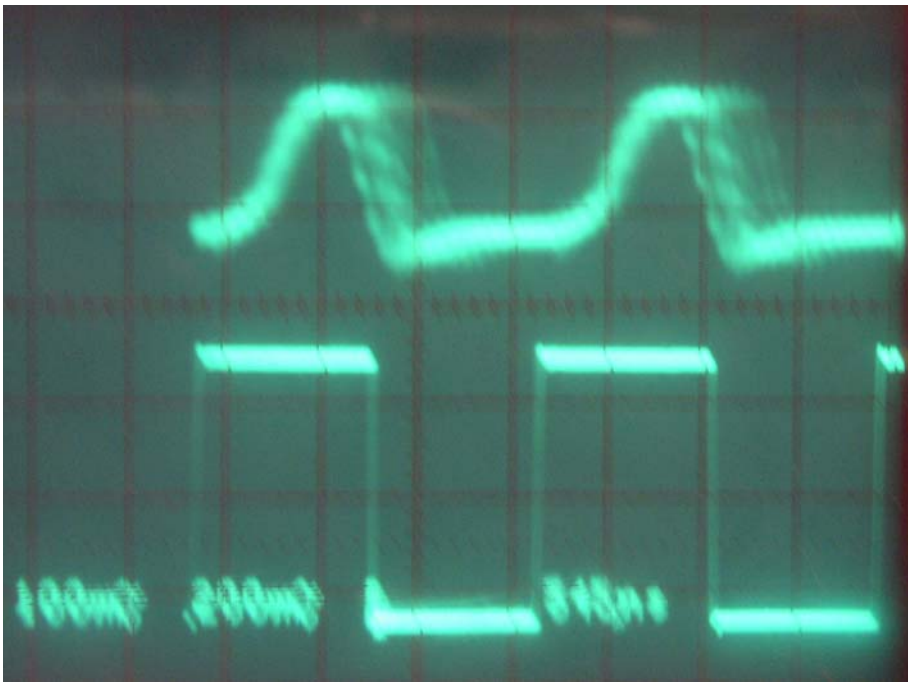

Figure 5. Detected output of 2 stages of TRS filter. The phase loss is from 120 to 40 degrees. Detector circuit RC rise time using Fig. 2 limits the minimum number of altered cycles that can be used. This is not an optimum detector, but it allows measurement of the phase loss in the filters from the amplitude of the detected signal from before and after the filter.

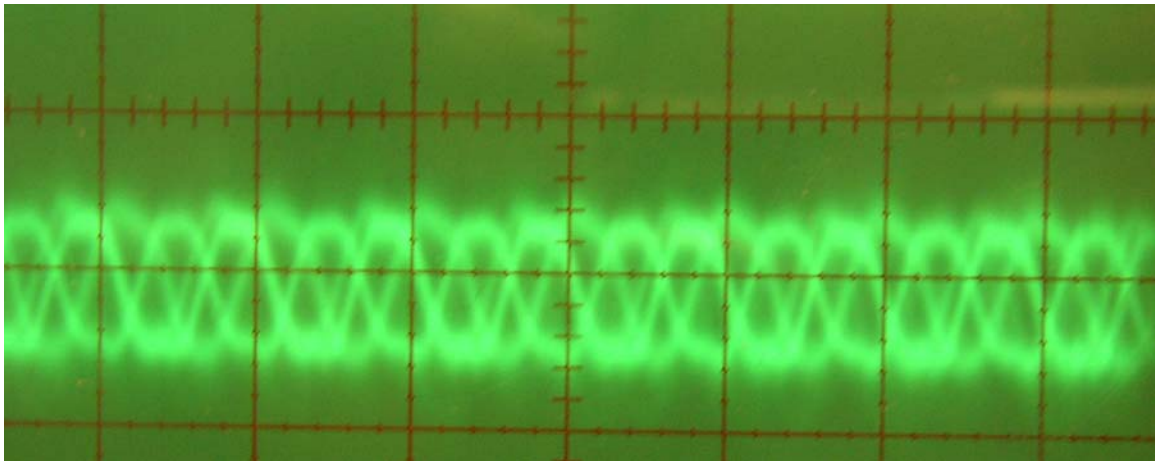

Figure 6. Stage 1 of the TRS filter tuned to convert 3PRK to 3PSK (180 degrees to 120 degrees).

The filters cannot be used with 180 degree phase shift if tuned to get cancellation on one phase.

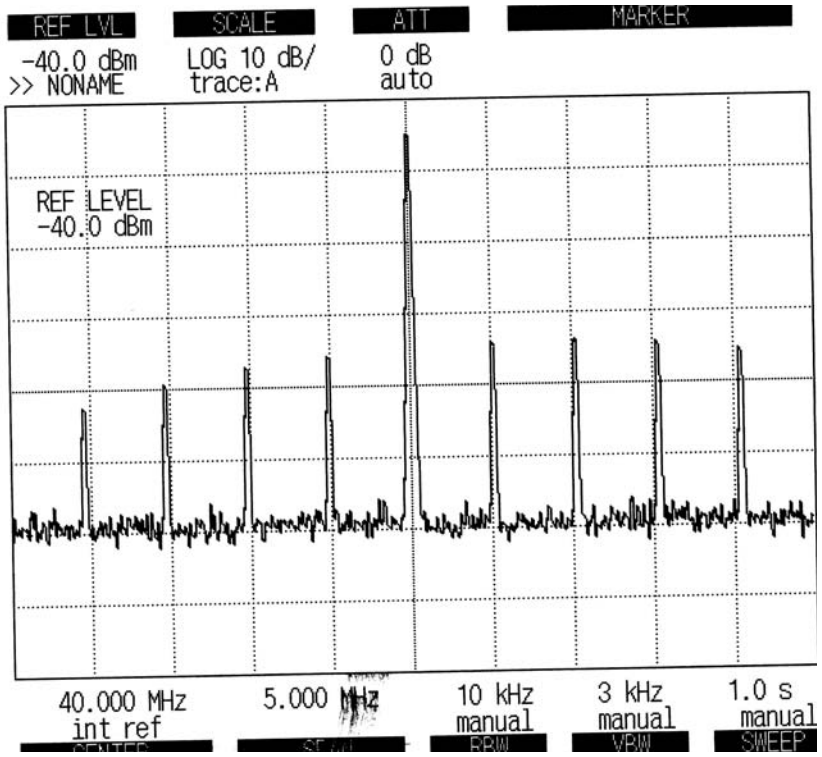

Figure7. Spectrum after tuning TRS filter with 3PRK (180 deg.) input to have 120 phase shift instead of cancellation of one phase. 1st Stage only of 3 stage filter.

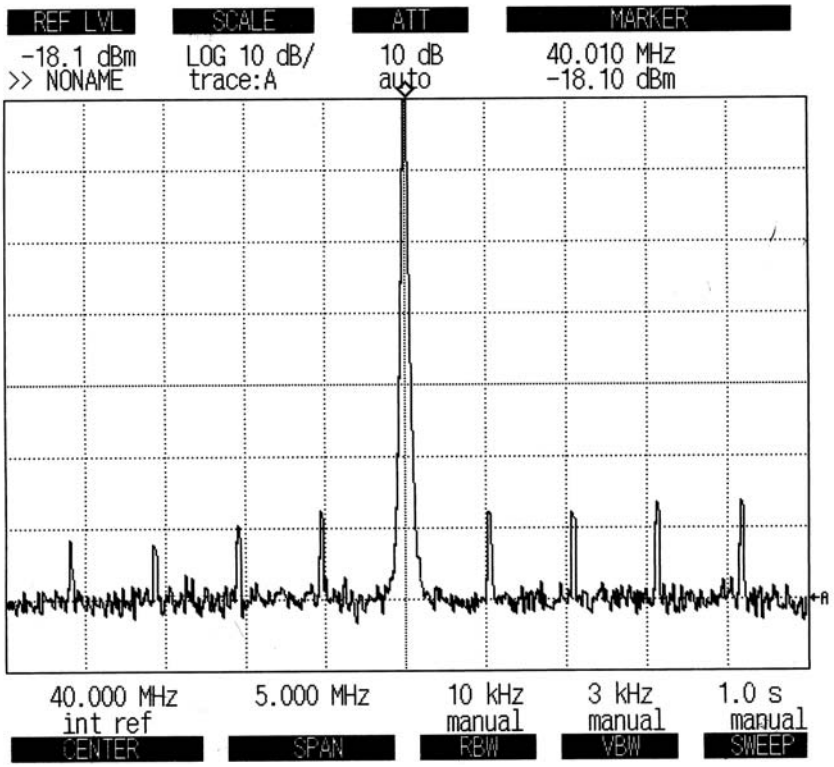

Fig. 8. Spectrum after 3 stages of TRS filter using 3PRK input.

The spectrum analyzer plots above are average volyage levels. To obtain RMS power, mutiply by 2. Thus if the plot shows -50 dB, the average power is -100 dB.

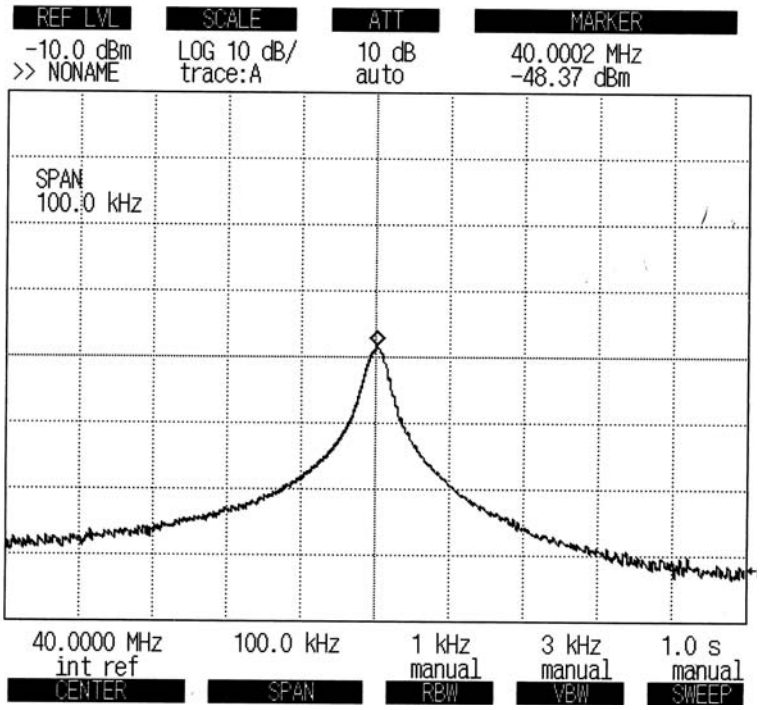

Figure 9. Swept response of stage one of the 3 pole filter used with 3PRK modulation. This setting gives the maximum detected phase with a 3PRK input. Balance tuning is indicated. There is excellent shoulder reduction.

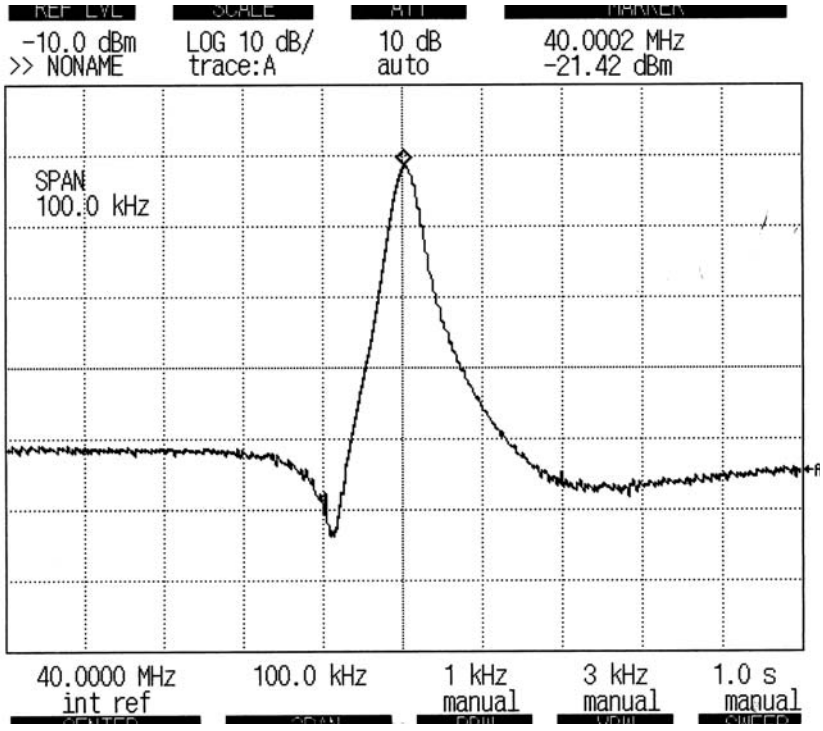

Figure 10. Swept response of last two stages of 3 section TRS filter using 3PRK input.

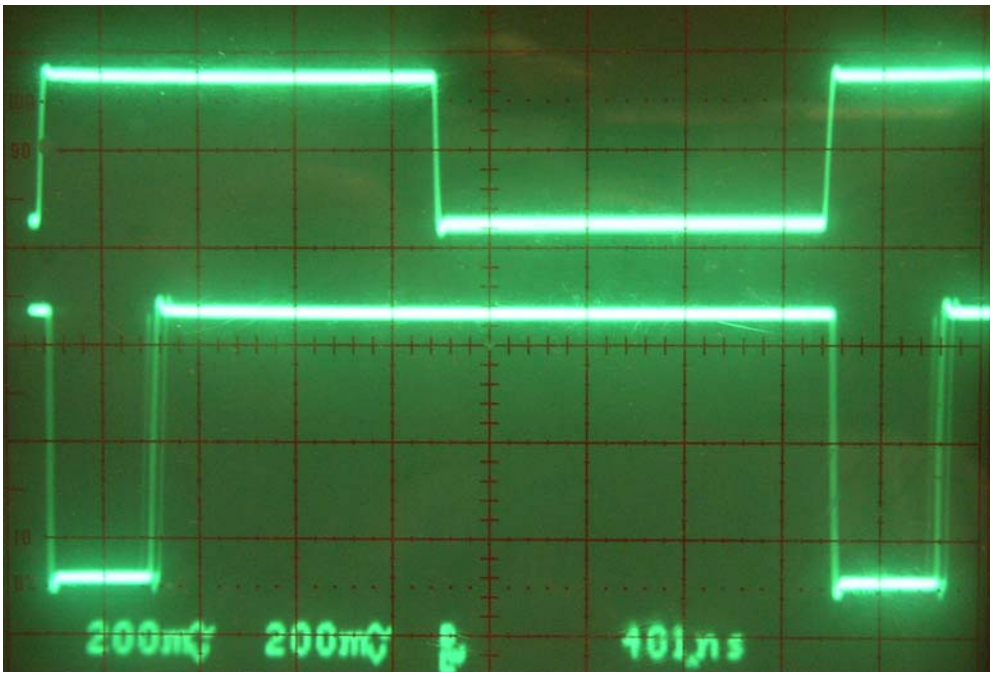

Figure 11. Detector output from a D flip flop detector (Figures 10.5 and 10.6 in UNB Textbook). The upper trace is the clock for a 1's only signal, or the data for a 10101010 pattern The lower trace is the phase detected output.

If there is no group delay in the filter chain, there is no phase slewing as in Fig. 3.4 of the textbook. The phase shift is as seen in Figures 8.5 and 8.6. The detected pulse output will be the same for before and after the filter chain. Any slewing due to group delay will cause the pulse to be narrower, or the edges to be less , after the filter.

Apparatus used for testing:

1) Analog Audio MSB board with approximately 1 Mb/s square wave modulator input from 74HC4046 oscillator. Variable duty cycle for the 2 phases. The equivalent data pattern is 1010101010101---
2) 40 MHz TRS filter built by Mike Zierdt at Bell Labs.
3) 40 MHz CATV receiver modified to bypass the filters and go direct to detector of Fig. 2 above. Built for CTI using NRZ-MSB.
4) Various single pole filters used to obtain a good start from 3PRK by off tuning for comparison.
5) Filter #2 has 3 stages. First stage can be used to off tune for 3 PRK and remaining 2 can be used as bandpass filtering for the remaining 120 degree 3PSK.

The CATV receiver 3) has the detector circuit of Fig. 2. The RC rise time of the circuit limits the minimum number of cycles that can be used in testing. The number of cycles in a relative period was kept constant to allow maximum rise time to allow measurement of the phase loss. (Fig. 5). Using a D flip flop phase detector it was seen there is no rise time in the TRS filter bank so that a minimum number of altered cycles could be used.

There is some mismatch in impedances between boards 1) and 2) which have adversely affected the phase loss measurement.

There is some question as to whether Fig. 6 still applies after latest adjustments.

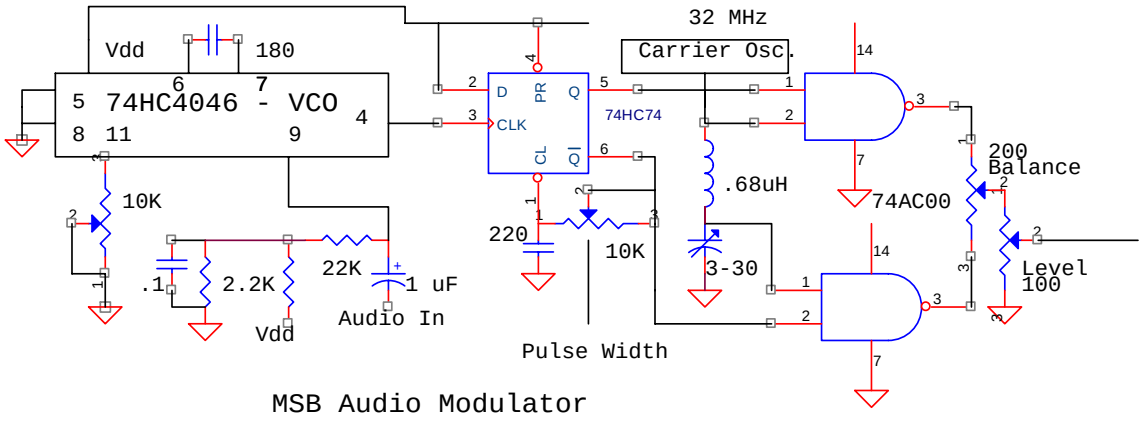

Figure5.

In Figure 5, the 74HC4046 VCO generates a square wave with the frequency varied by the audio input level. Approximately 1 Volt peak to peak is used. The square wave rising leading edge causes a one shot pulse to be generated which has a variable width. The time on each phase varies, having as little as 2 percent of the modulation cycle period on the shortest phase switched time to about 50% of the period. The positive and negative outputs switch the carrier phase by 120 degrees. The amount of the phase shift is variable with the .68 microHenry and trimmer capacitor. The gates transmit only one phase or the other. A data pattern equivalent to 10101010101--- is created.

For 180 degree modulation, a center tapped transformer was used to provide 180 degree phase differences to the 74AC00 in place of the phase shift LC.