Notch filters (wrt to Atlas Transceivers)

Kevin Murphy ZL1UJG

I recently stumbled across an interesting error in the Atlas 210X, and probably 215X and possibly other versions of this transceiver.

After an interesting incident with a 1.44 uH toroid, 820 pF, and 2200 pF capacitors (wrt carrier oscillator), I looked at one of the notch filters in the Atlas 210X. <u>This note will apply to all the Notch filters and also reworking the Carrier oscillator (using my mod).</u>

There is the 5.52 MHz Notch filter (parallel tuned circuit) after the TX mixer. This is to reject the 5.52 MHz component. I had removed the components off the PC200B PCB as I had it fitted them to a small PCB underneath, together with a small MMIC and Attenuator.

The incident, mentioned earlier led me to believe that there may be problems in the notches.

First, the notch consisted of a large 2000 pF ceramic and 0.6 uH variable inductor. I measured the inductor as 0.6 uH.
Note:- The schematic (online @ ON6AB) indicated 2200 pF

What is the resonance of a 2000pf and 0.6 uH.
F= 1/(2 * PI *√(L*C)) = 4.59. MHz

What capacitor resonates with 0.6 uH at 5.52 MHz
$C = 1/(4* PI^2 * F^2 * L)$ = 1386 pF or 1.385 nF

What?
I breadboarded the components as a parallel tuned circuit and fed them one end from a signal generator and level indicator at the opposite end. The level indicator was a spectrum analyser.

I tuned to 5.52 MHz and found the notch. It was a measly 10 dB…
I measured the 3 dB bandwidth and calculated the Q as 10…!

After locating a 100 pF NPO (or COG type capacitor) from the parts box I reran the notch test . The test was at 21 MHz this time. Do the maths if you want.

The notch was -35 dB deep and measuring the 3 dB bandwidth gave a Q of 100.
I reran the the test again with the 1.44 uH toroid and this gave a notch of 45 dB and a Q of 183 (at a frequency of 12.86 MHz).

I looked at the original capacitor. It was not NPO, COG or silver mica. It was a Z5F dielectric, which I believe is molded mud…

I think the capacitor is so ineffective that at 5.52 MHz the capacitance degrades markedly.
I think there is a number of notches in both the TX and RX filter paths using unsatisfactory capacitors. They have had to increase the number of them, due to the use of inferior capacitors. (Most of the notches use 2200 pF or 470 pF capacitors)

If one replaces the inferior capacitor, with either NPO/COG or silver mica types, then the performance of the notches will increase dramatically.

There is enough adjustment in the inductor to use a 1000pF and 330 pF in parallel.

Note for the modification in the carrier oscillator that I suggested, it is important to use NPO/ COG or silver mica types as well.

One may have to use several capacitors to achieve the correct values
Perhaps 330 pF in parallel with 470 pF (to replace the 820 pF) and 2200 pF.
If the 2200 pF isnt available then 2 paralleled 1000 pF may need to be used. A small variable could be used to fine tune, if required, since the the 1.4 uH is a fixed axial inductor.

I would welcome any feedback on this find, either through the reflector or directly.

PS. I havent done the rework on these notches yet, as I don't have the correct value NPO, COG or Silver mica capacitors. I await my next component order to Farnell.

I also note that some of the filter data mentioned that mylar capacitors are used. A small search on the web indicates that use at RF is not recommended…?

I think that the High power Low pass filters use Silver mica?

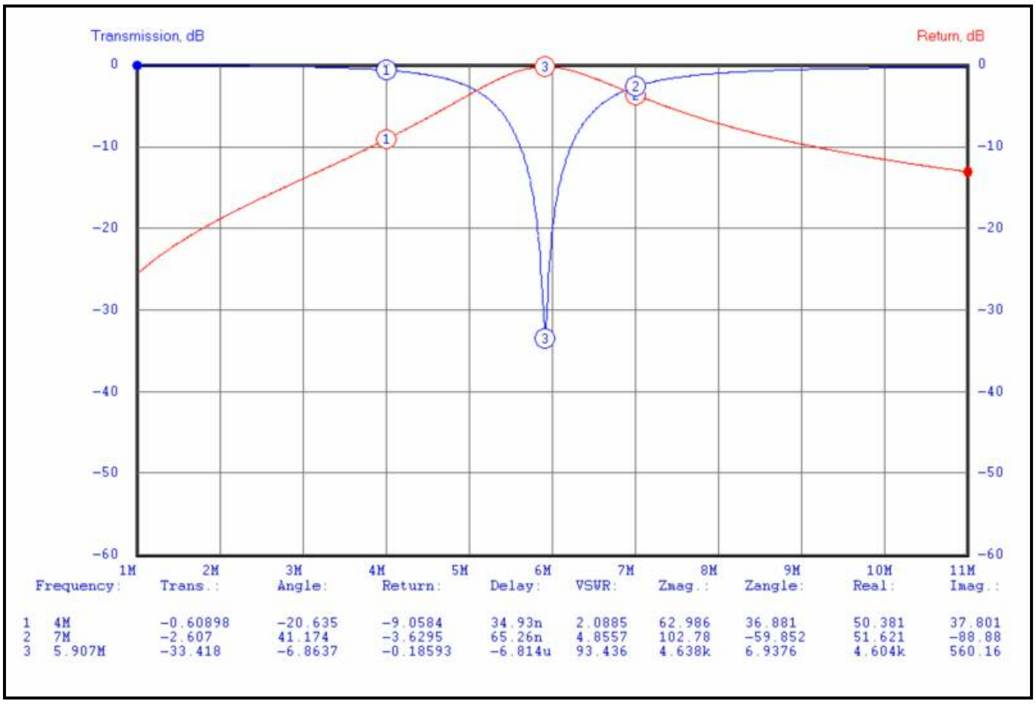
Friday, April 21, 2006
Further investigation.
I tested a mylar "greencap" of 2200 pF. This resonated at 4.38 MHz with the 0.6 uH inductor. The dip was only 13 dB, which showed low Q of the material. However the resonant frequency was about right. Not recommended for RF.

I resonated the 0.6uH inductor (white with a ferrite tuning core) with three parallel capacitors totalling 890 pF (2 silver mica and 1 NPO ceramic). The resonant frequency was was 6.714 MHz with a dip of 23.5 dB and a 3 dB bandwidth of 120 kHz. The Q (of L and C) was therefore 56.

I unravelled a few turns of the toroid inductor (T37-2 now with about 12 or 13 turns). This resonated at 5.894 MHz with a notch of 33 dB and a 3 dB bandwidth of 39 kHz. The Q (of L and C) therefore was 151

With just changing the inductor from a ferrite core axial inductor to an iron dust toroid, increases the Q significantly, and also the notch depth. A way of fine-tuning the resonant frequency could be to use a small trim capacitor 5-60 pF. This is not yet tested.

The toroid was an Amidon/ CWS bytemark T37-2 core (0.37" and type 2 material)



The graph above shows notch depth for the toroid and 890 pF capacitors and was made using an analysis program called Elsie. The notch depth matches closely with measured values.
A free student version is available from http://www.tonnesoftware.com/

<u>Reworking the TX Notch filter</u> Sunday, June 10, 2007

In an earlier note I mentioned that the rejection of the notches used for rejecting the IF signal (both on TX and RX) were about 10dB, which was not satisfactory. The notches were made up of a 2200 pF (+/-) capacitor and 0.6 uH adjustable inductor in parallel. This was primarily due to the use of incorrect type of capacitor.

I reworked the notch so that it was on a small prototype PCB underneath the chassis of the Atlas 210x. (This also had a low gain MMIC (MAR-4 or MSA-0485 or 86) and a 3 dB attenuator. The MMIC was used to provide a wideband termination for the mixer, while the 3 dB attenuator provided termination of the Bandpass filter, while the notch remained in the middle of the overall circuit. (This was done in my unit to improve the performance). I don't have a PA board, but will build a 10 watt version instead

For the notch I used silver mica capacitors, with a little 50 pf Murata ceramic trimmer for fine tuning. The silver mica capacitors were 1000 pF and 330 pF, while the toroid was wound on a T37-2 iron dust toroid, with 11 turns.

The unit showed ~ 29 dB notch on 5520 MHz, and the notch deteriorated by 3 dB in a 42.5 kHz bandwidth, which equated to a loaded Q of 130. Amidon charts show a Q of ~ 145 for this core, with 12 turns at 5.5 MHz. For the Q to degrade from 145 to 130 the Q of the capacitor combination is ~ 1300. The Q of silver mica capacitors are ~ 1300, according to some research on the net. The small trimmer capacitor is rated at a Q of 300 minimum at 1 MHz however since it is only a small portion of the total value its effect is negligible.

The board has about 4 dB gain, in my application but the attenuator could be changed in value so that there is 0 dB (or x1) gain through the unit.