Initiation Date:
31 July 2016

Participant(s):
WB4GCS

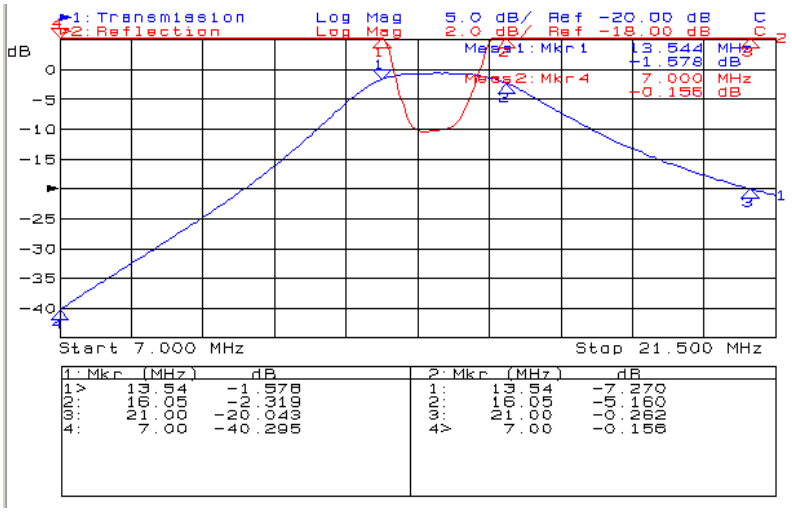
Initial Symptoms:
Failed 40m and 20m bandpass filters as measured on 30 July.

Actions:
Ordered capacitors to fix failed 40m filter.

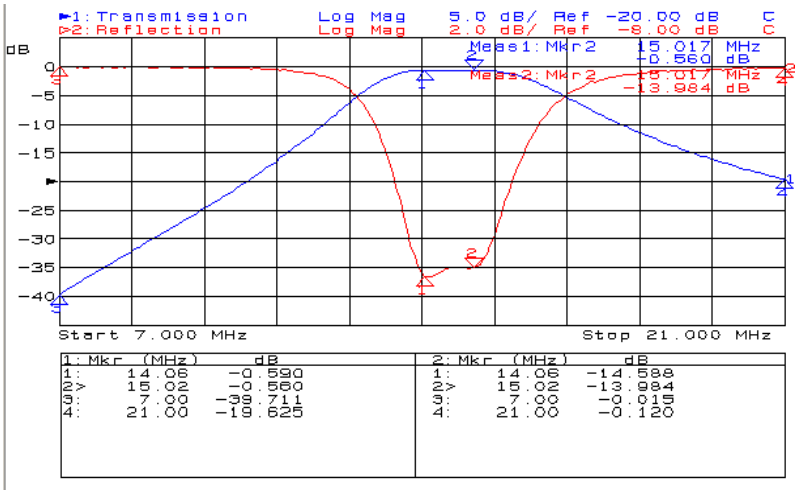
Found caps in junque box to replace overheated 82pf cap in W3WH 20m filter. Had to parallel two to get measured value of 81 pF in place of 82pF +/- 20% cap, which measured at 80pF.

Repeat measurements.

Observations:
Original measurement of failed filter



Measurement of repaired filter



Analysis:
The repair obviously made a difference in return loss; nothing much in transmission.
Original return loss of 5-7 db equates to SWR of 2.5 – 3.5 – UNSAT.
Repaired return loss of 15 db equates to SWR of 1.4; better but not great.

Markers are at return loss of 10db, which corresponds to SWR = 2+. Not great for passband. Future passband measurements will look for return loss of 20db, SWR = 1.2.

Hypothesis:
The 82 pF capacitor was damaged due to overheating.

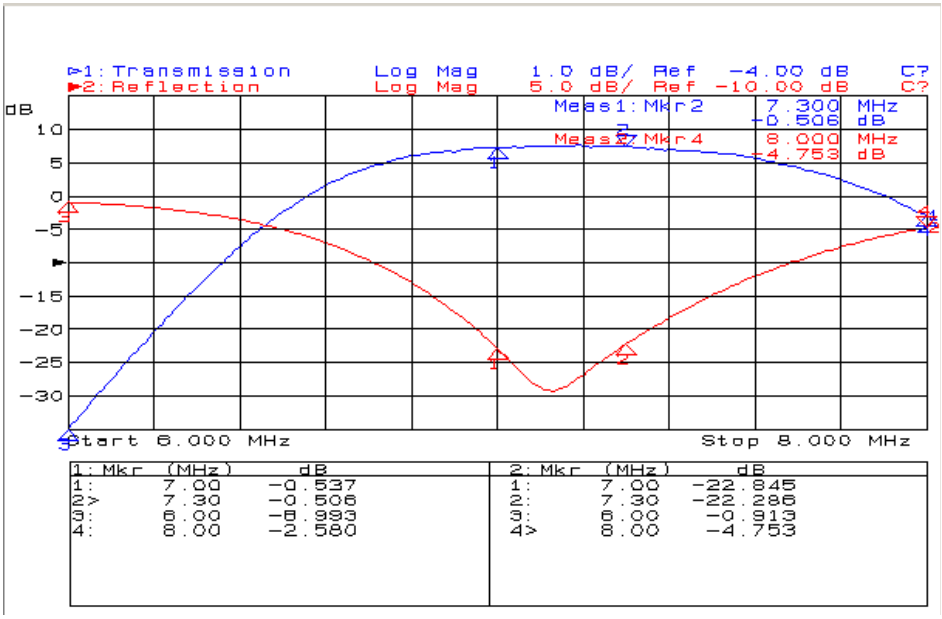
Plan:
Repair the 40m filter when ordered caps arrive.

Results:
1. The 20m filter is repaired and usable, if not great.

Conclusion:
Make future passband measurements based on 20db return loss, rather than 10db. Since return loss has turned out to be a much more sensitive indicator than S21 (transmission), tune future filters for symmetry and performance based on return loss.

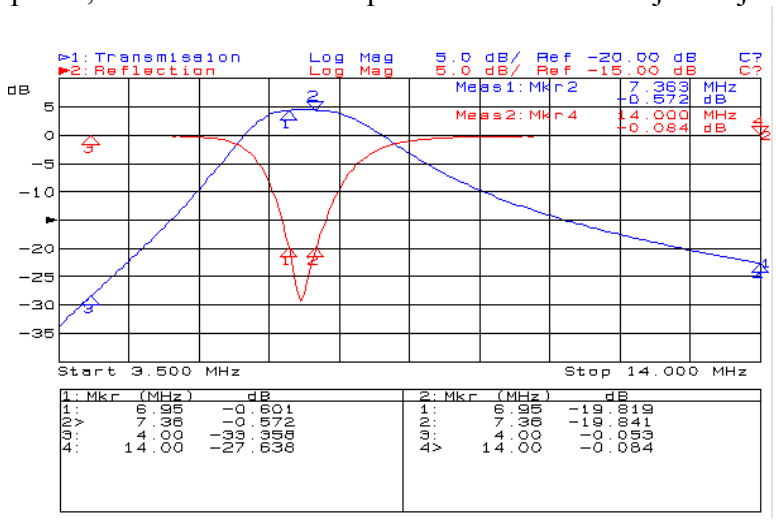
Continuation 5 Aug:
Installed replacement 2200pF 1600VDC capacitors in N3SH40-1. Response much better, but did not like almost 1db insertion loss and asymmetric return loss. Didn't save plot, because I wanted to see if I could tune it.

Improved return loss symmetry and magnitude by slightly squeezing one of the coils. Made further improvements by *spreading* slightly the discolored coil. Narrow response:



MUCH better return loss, corresponds to SWR of 1.06 to 1.2. Insertion loss is also improved, but would still like to see less than 0.5 db. Would like to replace the series cap, but its voltage rating is not marked.

Now let's see wide response; how well does the repaired/retuned filter reject adjacent bands.



This is much better and tolerable. Time to test in use.

0.5db Insertion loss is more than spec, 0.25 db. Perhaps the 470pF series cap is also damaged. Unfortunately, its voltage rating is not marked.

Plan:
Use the filter for a while.
Order a series cap.

What voltage rating?
Filter rating is 250W ICAS.

$P = I^2Z$

$I = SQRT(P/Z) = SQRT(250/50) = SQRT(5) = 2.23 Amps\ RF$

$Z_c = 1/(\omega C) = 1/(2\pi(7.3E6)(470E\text{-}12)) = 46.38\ \Omega$ reactive

SO, conservatively assuming that all current flows through the series capacitor and none in the shunt L-C circuits,

$$V_{series\ capacitor} = I\ Z_c = 2.23\ A \cdot 46.38\ \Omega = 103.4\ V_{ac}$$

Therefore, order 470 pF capacitor rated to at least 200 Volts.

Question:
Is it worth the effort?

$$Insertion\ Loss = 10 \log_{10}(P_{out}/P_{in})$$

$$10^{\ Insertion\ Loss/10} = P_{out}/P_{in}$$

$$P_{out} = P_{in} \cdot 10^{\text{Insertion Loss}/10}$$

With 0.5 db Insertion Loss and 100 Watts in,

$$P_{out} = 100 \cdot 10^{-0.5/10} = 100 \cdot 10^{-0.05} = 89.13 \text{ Watts}$$

Seems like a big drop, but again, half a db – not detectable by most ears.

Conclusion:
Leave well enough alone unless performance problems are seen in the field.

Final note:
A filter such as this will not perform or survive, unless it sees the input and output impedances for which it was designed. This filter shows signs of serious abuse – exploded capacitors, probably caused by excessive voltage, and overheated inductors, probably caused by excessive current, caused by the same excessive voltage.

Hypothesis:
This filter was subjected to high power and high SWR at the same time.

Recommendation:
Filters such as this should be installed between the transmitter and the antenna tuning device, so it sees 50 Ω at input and output.