01 DEC 2011:

Following the recent shocking revelation that the AC line filters built in to the CorComm IEC power entry modules may be even worse than our scariest nightmares at high frequencies, I did a bit more of a test.

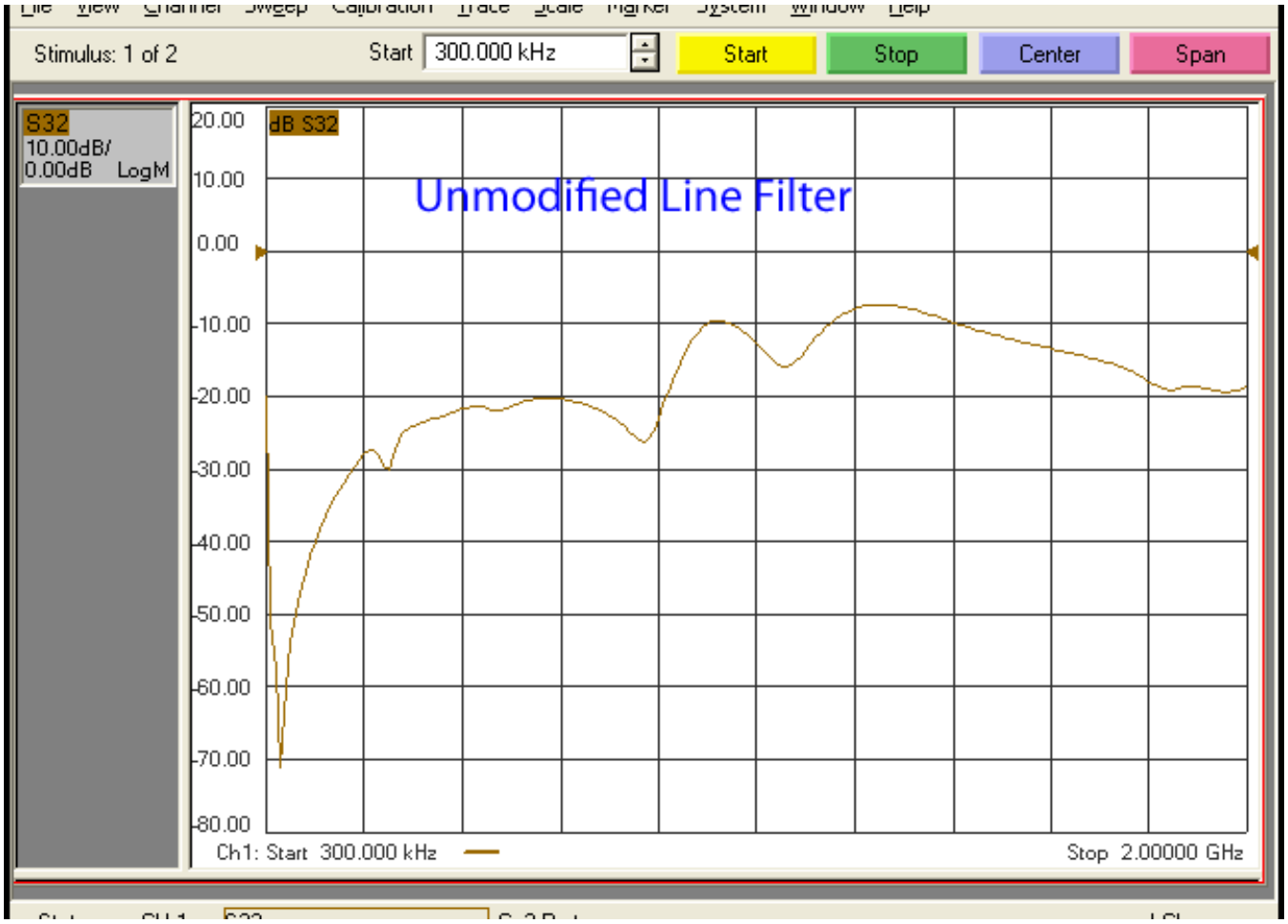
First I configured the test article, a CorComm model 6EF1F, as shown in page 2. While this is not really the "right" way to do it, this approach could be tried quickly and seems not to be too awfully bad. Support for this claim comes from the observation that the test data was barely affected at all by grasping of the cables at various locations during the test, indicating that there was not a significant amount of RF flowing where it should not be, such as on the outside of the cables, etc, that might corrupt the test results.

The test article was then tested with a fully-calibrated VNA sweeping from 300 kHz to 2 GHz. The transmission through the test article is shown in the VNA plot on page 3.

Note that the performance is fairly decent in the VHF through part of the UHF region, but is severely lacking in the L-band regime. Much improvement is needed in this area.


RF Test Connection: Equipment Side


RF Test Connection: AC Line Side
LINE


Stimulus: 1 of 2
Start 300.000 kHz
Start
Stop
Center
Span
S32
10.00dB/
0.00dB LogM
dB S32
Unmodified Line Filter
20.00
10.00
0.00
-10.00
-20.00
-30.00
-40.00
-50.00
-60.00
-70.00
-80.00
Ch1: Start 300.000 kHz
Stop 2.00000 GHz

In an attempt to improve the performance in the low/mid L-band regime, a 1000pF capacitor with minimal lead lengths was added as shown on page 5. The VNA test results are shown on page 6.

The improvement in the critical L-band region is not striking, and was in fact a significant disappointment.

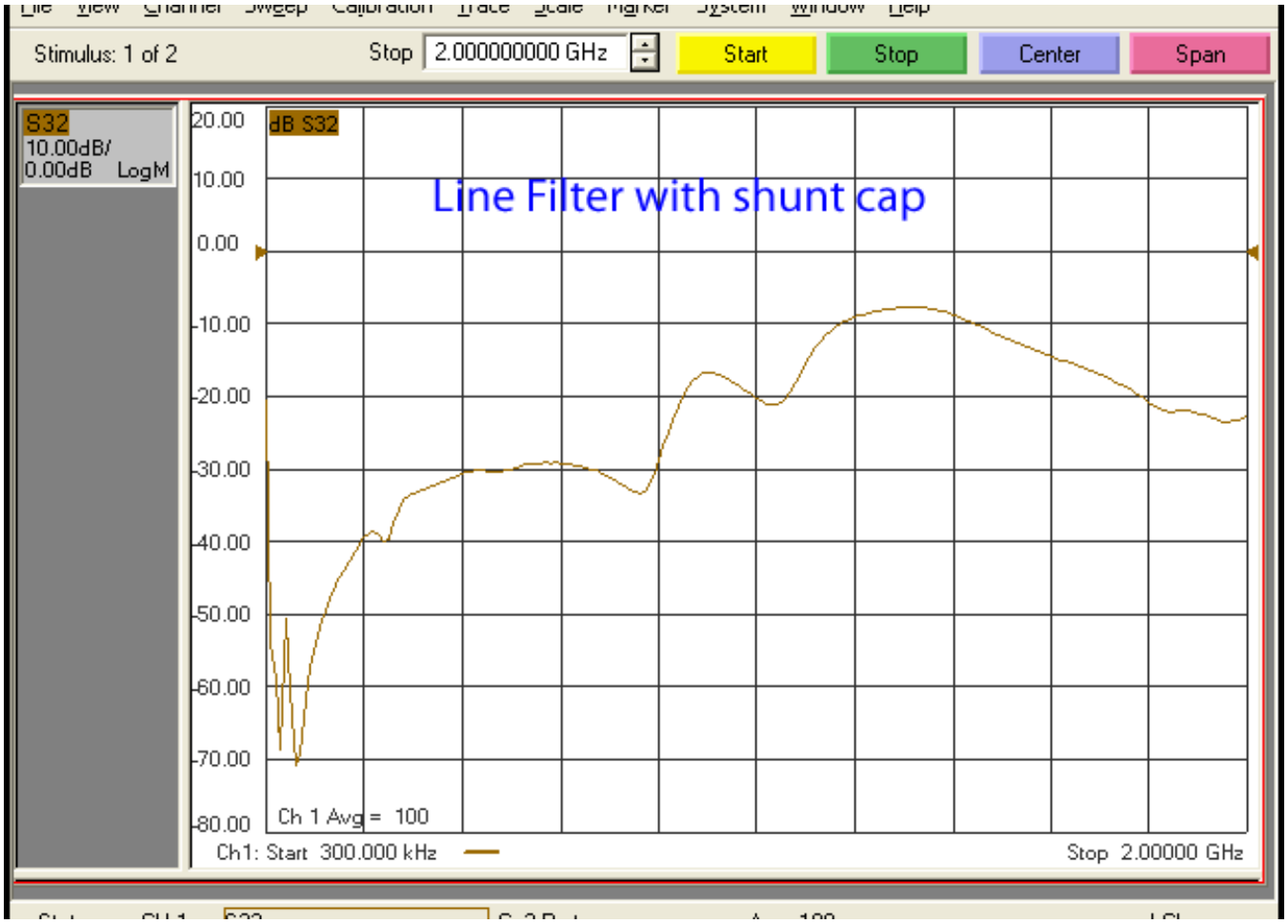
I suspect that significantly more improvement might be attained with the addition of ferrite beads and additional caps on the terminals, but this could not be tried at the time due to lack of the appropriate ferrite beads on hand.

First Conclusions:

> Clearly much better performance is desirable.

> We cannot blindly trust the filtered IEC power entry modules (as-is) to do much good at the frequencies of interest to us.


Added capacitor across signal line in unsuccesssful bid to
reduce HF transmission through filter


Stimulus: 1 of 2
Stop 2.000000000 GHz
Start
Stop
Center
Span
S32
10.00dB/
0.00dB LogM
dB S32
Line Filter with shunt cap
20.00
10.00
0.00
-10.00
-20.00
-30.00
-40.00
-50.00
-60.00
-70.00
-80.00
Ch 1 Avg = 100
Ch1: Start 300.000 kHz
Stop 2.00000 GHz

13 JAN 2012:

I modified the line filter by Adding another layer of filtering, as shown on page 8, aimed at achieving some significant L-band improvement. The ferrite bead is a nondescript unit of unknown properties culled from Dana's junkbox; the feedthru capacitor is 500 pF rated at 500 Vdc. 10-mil brass shimstock was used in the construction. Soldering to the body of the Corcomm filter was a bit of a challenge using ordinary rosin-core electronics solder, but this would probably become much easier with use of a better flux.

The top graph on page 9 shows the VNA test results with the filter exactly as shown on page 8. Note substantial improvement in the result compared to earlier experiments.

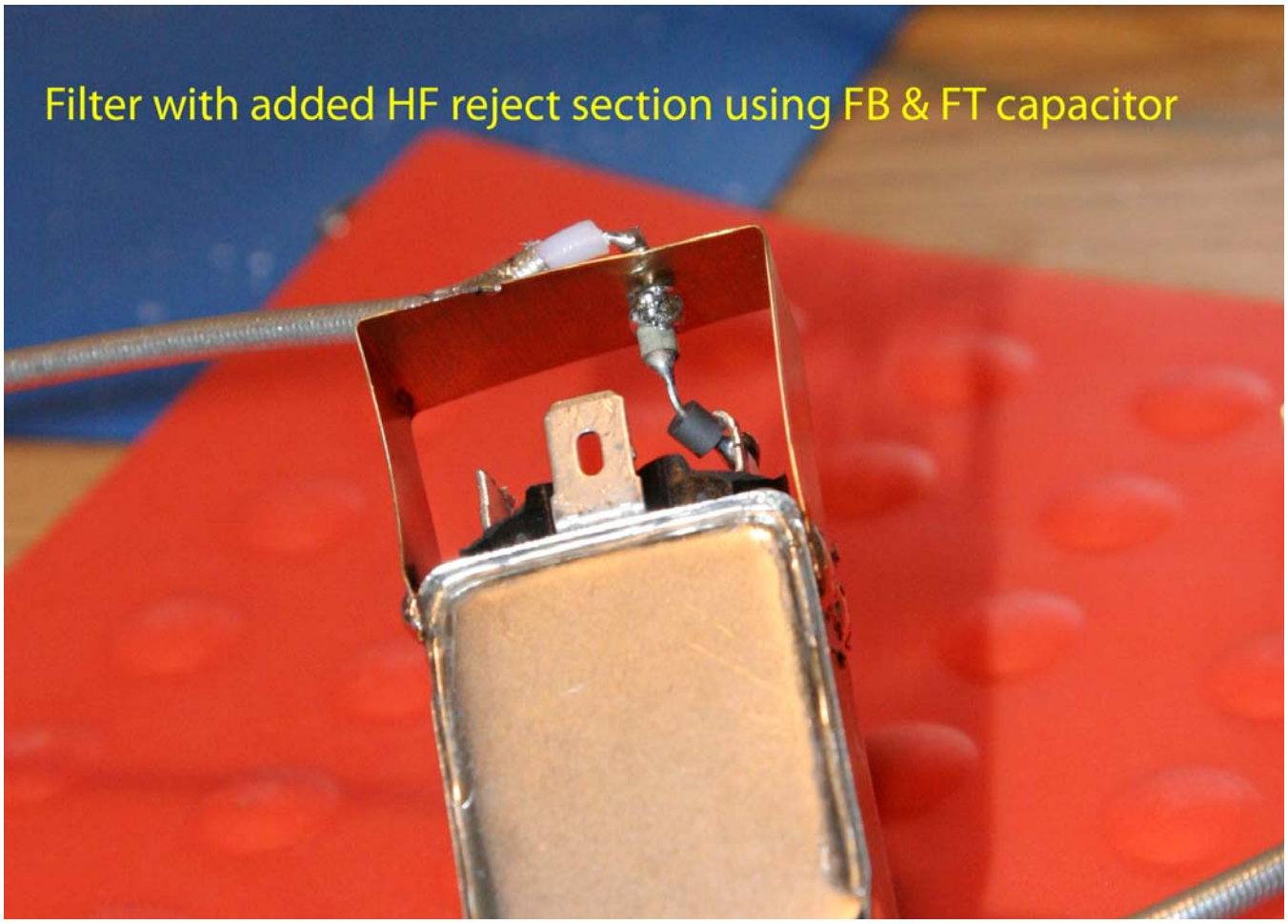
Finally I added side plates of shim stock to completely close off the cavity, with results as shown in the bottom graph of page 9. Somewhat surprisingly, adding the side shields made negligible difference.

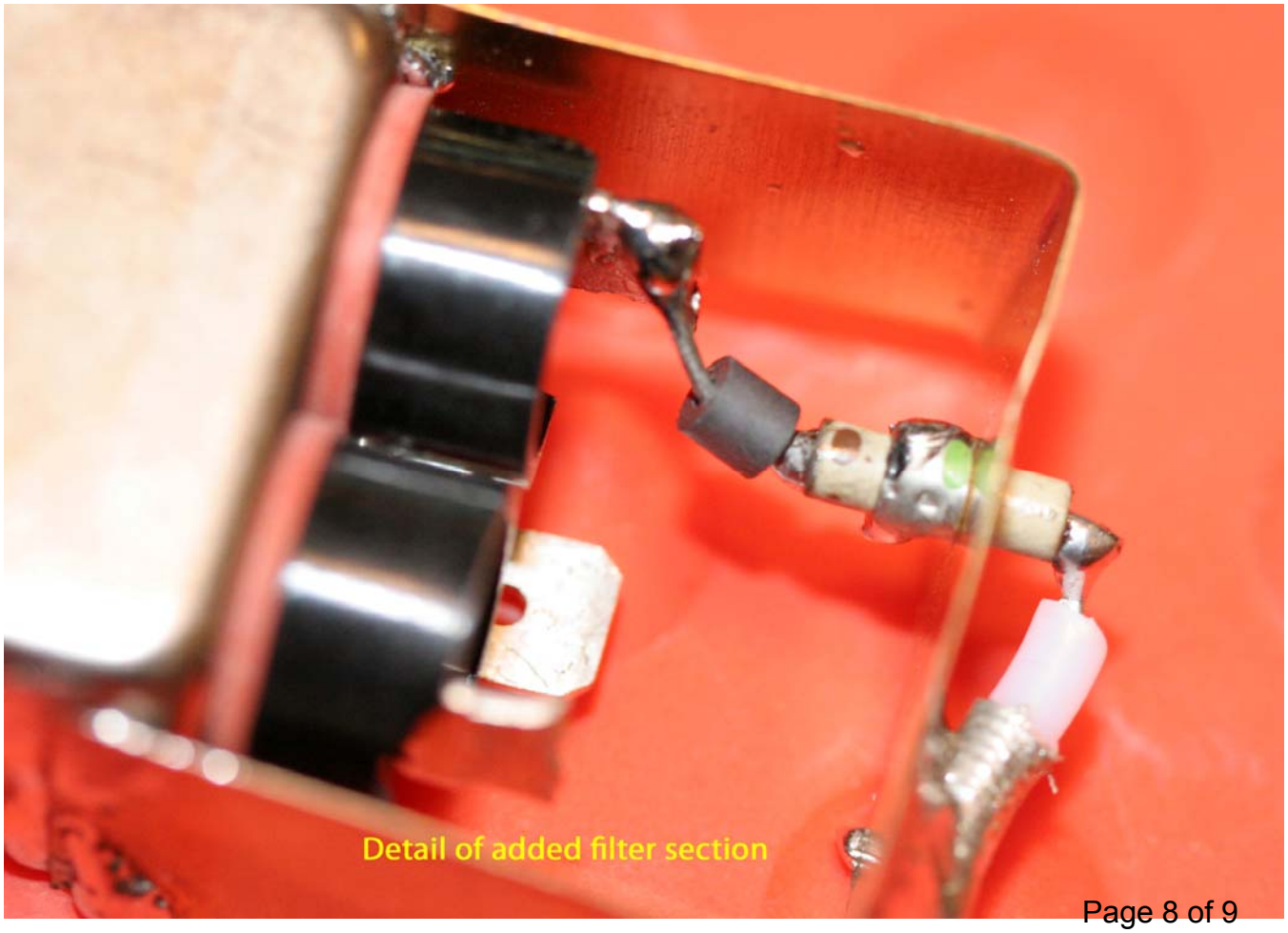
The important thing is that both these tests reveal a quite marked improvement over the original filter (or even the original with the added short-lead capacitor).

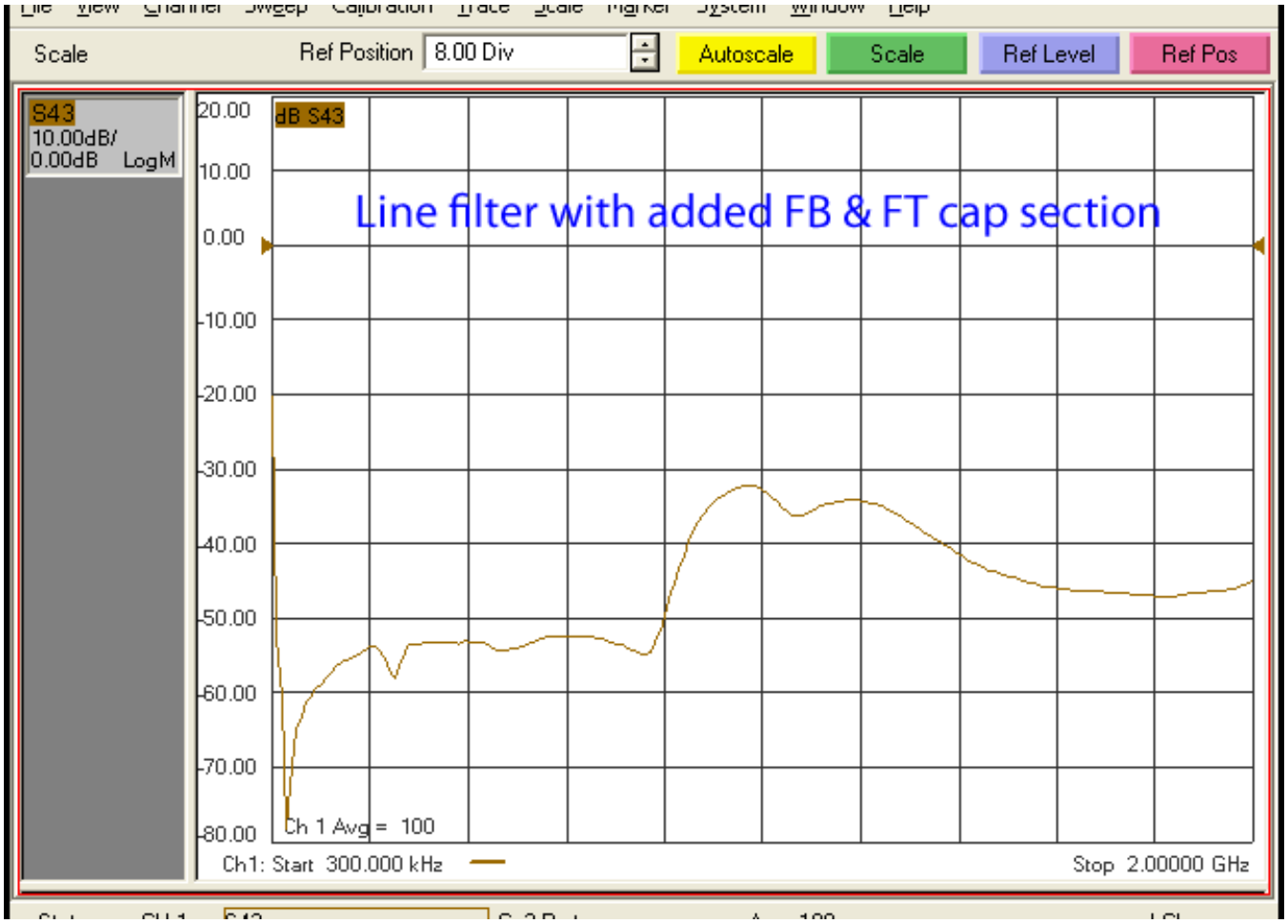
However, even more improvement is likely to be needed in more critical situations. I suspect that a 2-stage version of the added HF filter section could still be implemented fairly easily given a little more thought about construction.

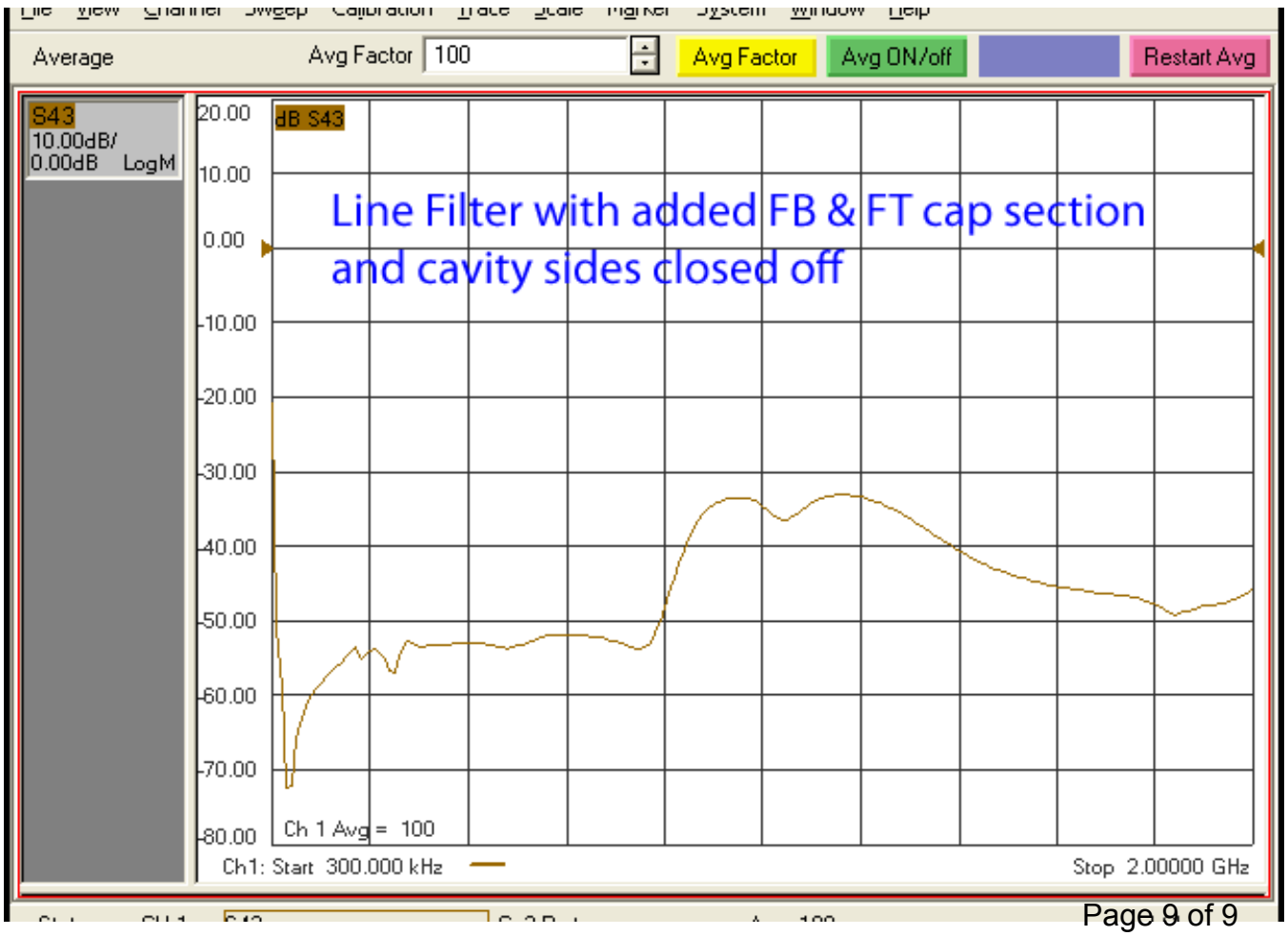
NOTE: For practical use, these modifications to the Corcomm filter should use higher voltage rated feedthrough capacitors, probably 1 kV or higher, to really safely accommodate voltage transients on the power line.

Dana Whitlow
01 Dec 2011
Revised 13 Jan & 19 Jan, 2012
line_filt_tests.pdf


Filter with added HF reject section using FB & FT capacitor


Detail of added filter section


Scale
Ref Position
8.00 Div
Autoscale
Scale
Ref Level
Ref Pos
S43
10.00dB/
0.00dB LogM
dB S43
Line filter with added FB & FT cap section
20.00
10.00
0.00
-10.00
-20.00
-30.00
-40.00
-50.00
-60.00
-70.00
-80.00
Ch 1 Avg = 100
Ch1: Start 300.000 kHz
Stop 2.00000 GHz


Average
Avg Factor
100
Avg Factor
Avg ON/off
Restart Avg
S43
10.00dB/
0.00dB LogM
dB S43
Line Filter with added FB & FT cap section
and cavity sides closed off
20.00
10.00
0.00
-10.00
-20.00
-30.00
-40.00
-50.00
-60.00
-70.00
-80.00
Ch 1 Avg = 100
Ch1: Start 300.000 kHz
Stop 2.00000 GHz