

TRANSCEIVER INTERMOD SHOOTOUT on 40M in EUROPE

The purpose of this test was to determine how Ten-Tec's brand new OMNI VII fairs "on receive" against other popular transceivers, especially in the discipline of intermodulation, on 40m.

Despite the latest buzz around close-in dynamic range, here in Europe we still face significant intermodulation problems with ALL transceivers, especially when using a good antenna on 40m and especially when we are beaming the pacific. This is only a problem in the evening and during the night, but it is a significant problem.

Testing close-in dynamic range is beyond the scope of most amateurs, and is done professionally by the ARRL and by Sherwood Engineering who will receive a new OMNI VII soon for testing.

In the meantime we have conducted a "practical test" of intermodulation on 40m, comparing several popular transceivers:

- OMNI VII S/N 00000 (pre-production unit)
- ORION Main RX (V.2.059d)
- ORION Sub RX
- FT-1000 MK5 Field w. INRAD CW Roofing Filter
- FT-2000
- TS-480 SAT
- K2 (w. latest firmware and updates)

And, just for interest (since it is brand new), we tuned across the band with the OMNI VII under various settings of preamp, attenuation, and while using an external preselector.

Each step was captured on a short video lasting 30 to 60 seconds. We experienced two anomalies which I will point out.

Thomas, DL7AV, also measured the phase noise of the OMNI VII.

After the test, DJ6ZM spent several hours a night for several nights working 40m DX and comparing the OMNI VII to his ORION and FT-1000.

We discovered an interesting "feature" of the S-Meter during normal operations, and conducted an additional test 2 days later, entitled "S-Meter Test".

TEST ENVIRONMENT:

Test Site: DL1A, a BCC contest station located on the west side of Munich (inside the city)
Antenna: 3-element monoband Yagi up 35m (100 ft.), pointing northeast
Date: Friday, March 2nd, 2007
Time: 1900 to 2100 GMT
Test Ops: Rick (NJ0IP), Toffy (DJ6ZM)
Measurements: Thomas (DL7AV) – March 3rd, 2007

TEST CONDITIONS:

All radios were tested with their preamplifier switched OFF, except for a couple exceptions which are highlighted.

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Even under these circumstances, average radios will exhibit a blanket of noise across the entire 40m band that can typically be S9 or higher.

Good radios will show an S2 to S4 blanket of noise across the band until you switch in 6 to 12 dB of attenuation.

Excellent radios will not have a blanket of noise, but tuning across the band, you will find several carriers which at first seem to be just that – “carriers”, but after careful investigation, turn out to be “ghosts” caused by receiver intermodulation. You can distinguish ghosts from actual carriers by inserting attenuation and watching the S-meter:

- If the reduction in signal strength coincides with the attenuation, it is a carrier.
- If the signal strength decreases significantly more than the amount of attenuation used, it is a ghost.

For the purpose of our test, we chose a “Ghost Carrier” on 7005.0 kHz.

All of the radios tested in our test were considered by the testers to be at least “good radios”. Indeed, rotating the antenna 50 to 60 degrees in either direction typically reduced the signal strength of the intermod significantly. With our 3-el. Yagi pointing northeast, we really tested “Worst Case”.

TEST METHODOLOGY:

- Each radio was tuned to a “ghost” on 7005.0 kHz with its preamplifier switched off
- The signal strength of the intermod carrier was noted
- The attenuator was asserted, step by step and the signal strength was again noted
- If the radio had an IPO/AIP, it was switched in and signal strength was noted
- If the radio had a built-in preselector, it was also switched in and signal strength noted
- The OMNI VII was also tested using an external home-brew preselector (bandpass filter, but not tunable). This preselector has an insertion loss of 6dB. It also has a preamplifier with 6dB to compensate for insertion loss.

ANOMOLIES:

- The K2 was accidentally filmed with the preamplifier initially switched on and its S-meter showing full-scale, with a blanket of noise. Ignore this and compare it to the others after we have switched its preamplifier off.
- The FT-1000 has a built in preselector (VAR) but we found it to have a 4 S-Unit insertion loss. All radios sound much quieter if you add 24dB of attenuation, so we did not record the radio’s performance in this position. It was of course very quiet, but weak signals are also lost in this position. In contrast, the FT-2000’s built-in preselector has no noticeable insertion loss.
- During the first part of the video of the TS-480 you will notice that the sound of the carrier disappears entirely. This was caused by a near by carrier outside of the audio-DSP, but inside the regulation range of the AGC. Once the carrier went away, you hear the ghost.
- Without realizing it, I accidentally switched to speaking German while testing the TS480. (sri) I did a quick summary in English at the very end of its video. See the chart for clarity.

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EXPLANATION OF NEGATIVE COMMENT:

While testing the FT-2000, I made a negative comment (in the film) about running the radio in a contest. Indeed a couple of operators at DL1A have tried the FT-2000 in contests and quickly thrown in the towel – (switched to the FT-1000 or another radio). This has been documented by them and I have confirmed it myself. When the band overcrowds with strong signals, the FT-2000 begins to pump so badly that copy becomes very difficult. Hopefully Yaesu will address this soon. We found it to be a show stopper during contests.

CLEAR WINNER: The ORION (main RX)

Without the aid of attenuation or preselector, the other radios did not even come close. But please do not over-rate this. We only tested one aspect: intermodulation performance on 40m. And, other radios have attenuators and may be used with external preselectors.

It is our (humble) opinion that all of the radios tested would give excellent performance in contests except for the problems pointed out above (FT-2000 pumping and TS-480 blocking) under certain conditions.

RESULTS:

This is not an apples to apples comparison because the radios have different features, different steps in attenuation, etc. In addition, the signal strength of the specific carrier we were listening to on 7.005 kHz was QSBing slightly.

| TRANSCEIVER (with clickable link to video) | Pre-Amp ON | Pre-Amp OFF | IPO-ON | Attn - 6dB | Attn - 12dB | Attn - 18dB | IPO + VAR |
|---|---------------|----------------|-----------|---------------|----------------|----------------|--------------|
| OMNI VII | S5-B | S7 | N/A | S6 | S5 | S3 | N/A |
| OMNI VII / Preselector | N/T | S0 | N/A | N/N | N/N | N/N | N/A |
| ORION Main RX | N/T | S1 | N/A | S0 | N/N | N/N | N/A |
| ORION Sub RX | N/T | S6 | N/A | S5 | S2 | S0 | N/A |
| FT-1000 5-Field / INRAD | N/T | S9 | S0 | S6 | S2 | S0 | NR |
| FT-2000 | N/T | S9+20 | S1 | N/T | N/T | N/T | S0 |
| K2 | S9+40-B | S6 | N/A | N/A | N/A | S0 | N/A |
| TS-480 | S9+20-B | S3 | N/A | N/A | S0 | N/A | N/A |
| - B = Blanketing entire band | | | | | | | |
| N/A = Not Applicable; N/N = Not Necessary; N/T = Not Tested; N/R = Not Reasonable | | | | | | | |
| Note: Both OMNI VII links link to same video | | | | | | | |

- [2nd OMNI VII video](#)
- [3rd OMNI VII video](#)
- The “Blanketing entire band” is when you have a hash-like noise level over the entire band. As you tune, the strong desired signals pop out above the noise, but it is very tiring to listen like this.
- We did not measure pre-amp on for most radios. The values shown in this column pertain to the blanket of noise, not to the specific intermod carrier (7005 kHz) shown in all other columns.
- The VAR (preselector) on the FT-1000 had too much insertion loss to be reasonable. Switched in, we had a very quiet band, but the weak signals were also gone.

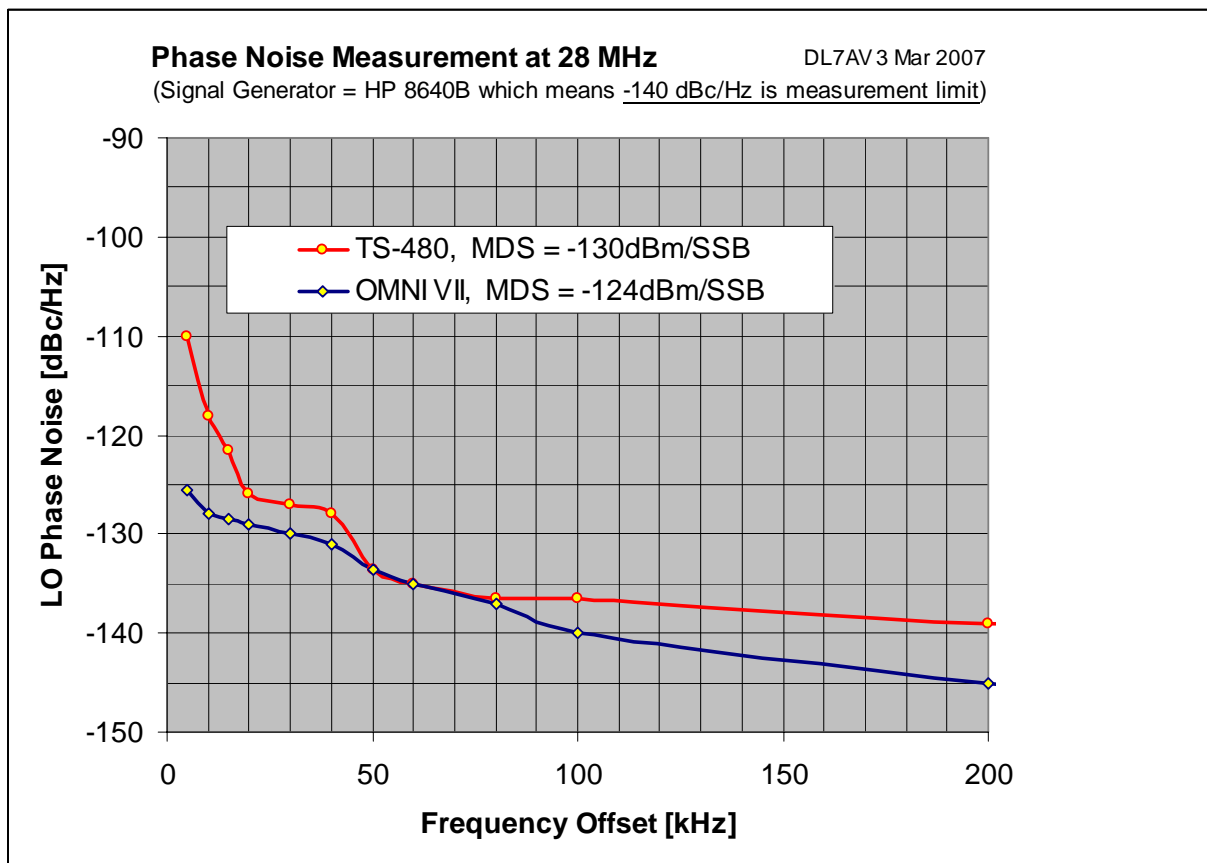
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REALITIES:

- It took about an hour to run the tests and like any other signal on the band, the intermod also has QSB. So a 1 or 2 S-unit difference between any two radios might also have been due to QSB of the signals causing intermod.
- We did not measure the sensitivity of each radio at the point in which it achieved S0 on the ghost signal. This would have improved the value of the test significantly.
- No matter when we switched to the ORION (main RX), it just did not have any significant intermodulation – just a barely audible carrier.

MEASUREMENTS:

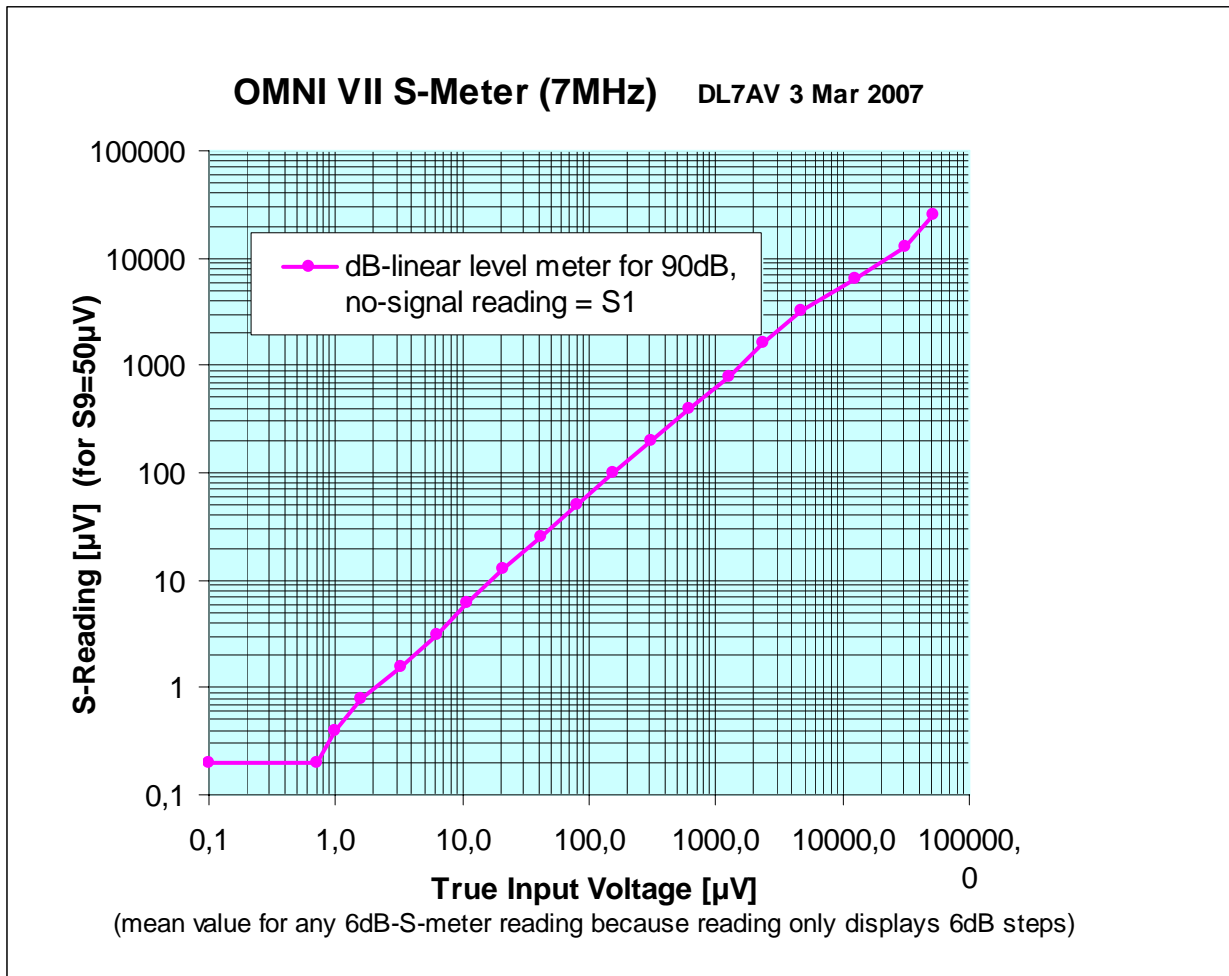
Thomas is especially interested in 6 meters and has been using the TS-480 recently. It is a good radio and an outstanding radio for its price, but not really in the same class as the other radios in this test. Thomas wanted to see how the OMNI VII compares to his TS-480. He measured the phase noise of the OMNI VII and compared it to the TS-480. Here are his results:



Note: "MDS" = minimum discernable signal (values shown are just for info, & not associated with this graph. The OMNI VII was measured with preamp OFF)

The second, and only other measurement made by Thomas was S-meter accuracy. Here are his results

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As can be seen, the S-meter is accurate enough to be used for field strength measurements, if you can accept that the increments are in full S-units. This is possibly the only rig currently on the market that can read accurately all the way down to S-2.

The S-meter has two readouts – a bar graph which (IMO) is more of just a level indicator, and a digital display of signal strength (e.g. “S7”).

S-METER TEST:

Toffy discovered that the S-meter always shows true signal strength, regardless of the setting of preamp or attenuation. We checked with Ten-Tec and they confirmed:

“We have corrected the reading for pre-amp gain, and attenuator. If the signal is S9 it will read S9 no matter what you do with the pre-amp or attenuator.”

So we ran another test:

Using an elecraft K1 running about 100 mw into a simple antenna, we set an S9 carrier (preamp and attenuation off). We then switched through the various front end options and recorded the reading. Then we repeated these same steps for our favorite “Ghost” on 7005 kHz. Here are our results:

| OMNI VII | K1 100mw | 7005 kHz |
|-----------|----------|----------|
| PreAmp ON | S9 | S9+10 |

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| | | |
|-------------------|----|----|
| PreAmp OFF | S9 | S8 |
| 6 dB Attenuation | S9 | S7 |
| 12 dB Attenuation | S9 | S6 |
| 18 dB Attenuation | S9 | S4 |

5-Mar-07

Whereas the signal strength of our inserted carrier remained steady, the signal strength of the Intermod signal actually reduced because the OMNI VII's receiver characteristics improved as we raised the attenuation. The S-meter reflected this change.

WHAT WE LIKED:

- The OMNI VII has beautiful ergonomics. This radio is easy to use. You won't get lost in layered sub menus and with just 5 knobs it certainly is less intimidating than an ORION or FT-2000. The OMNI VII is very easy to operate.
- The QSK is superb. The 3 testers with their combined 140+ years of CW experience have never experienced better QSK on any other rig.
- S-meter accuracy
- The DSP filter seems to work as well as the ORION, except that it does not go down to 100 Hz and the increments are in 50 Hz steps (ORION = 10 Hz). I always ran my ORION's DSP filter in 50 Hz increments anyway, to increase the speed of adjustment.
- The NR worked somewhat better than that on the ORION
- The color screen, but only when viewed at the right angle

WHAT WE DID NOT LIKE:

- The sound with NR switched on. Even at its lowest setting it seemed to distort slightly. On the other hand, it seemed to reduce the background noise even better than the ORION.
- I personally do not like the bar graph S-meter. But the digital read-out is accurate and its handling of preamplifier and attenuation is a cool feature.
- We also had a few occasions where the operator stood up (sliding across the chair) and touched the radio and got zapped – resulting in the radio needing to be turned off and on again. Unlike the ORION, this routine takes only a couple of seconds. Ten-Tec's response: *"The static discharge is real. The fix is already implemented in production. It is just a case of adding a ground from the encoder frame to the chassis."*
- The viewing angle of the screen is quite small, making it difficult for more than one or two people to view at the same time.

CONCLUSIONS AND (humble) OPINIONS ON THE OMNI VII:

To be honest, we did not expect the OMNI VII to fair as well as it did. Although we were skeptical about the "distributed roofing filters", the "on the air" performance of this radio seems to be much closer to that of the ORION than to that of the Jupiter.

To put a rumor to bed, this is definitely not just a Jupiter 2 !

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Using 12 to 18 dB of attenuation or an external preselector, the OMNI VII could hear just as well as any of the other radios. Indeed, at times we “perceived” we were copying weak signals even better with it than on the ORION or FT-1000. All other radios also needed attenuation (except for the ORION).

I have used an external preselector on all radios I have owned since 1979 when I built my first preselector, designed by DL7AV. The only exception was with the ORION – it simply did not need one. If I had Toffy’s antenna farm, I probably would use the preselector with the ORION as well.

Most hams do not have a 3-element 40m beam at 100 ft., so they will probably never experience the signal strengths and levels of intermod we encountered during our test. In that case, and as I confirmed on my own 40m vertical at home, from what we have seen so far, the OMNI VII is an outstanding performer.

More to come: unfortunately we did not have a contest or a crowded CW band during the days we played with the OMNI VII in preparation for this report. As Carl, N4PY, wrote *“What I am waiting for is a big CW contest on 40 meters.”* All indications are that this is going to be a great radio, but a “BIG” contest is where the rubber meets the road! It’s simply not possible to comment on close-in dynamic range at this time.

After the test, Toffy spent several hours a night for several nights running DX on 40m CW. He enjoyed using the radio and claimed that for all practical purposes it was about as good as his ORION. Of course for weak signal DX the ORION will ultimately be better.

DL1A will add an OMNI VII to its arsenal.

We anxiously await the OMNI VII lab test results from ARRL and Sherwood Engineering.
