

IC-7410 Transmitter Re-test Report

By Adam Farson VA7OJ/AB4OJ, February 19-20, 2015

Introduction

I re-tested the transmitter section of IC-7410 S/N 02001066 to address customer complaints regarding transmitted audio distortion and excessive transmitter IMD in radios which had been retrofitted with the new MAIN UNIT board to correct the ALC overshoot issue observed on original IC-7410's. The re-test data is presented in this report.

Transmitter Tests

1: CW Power Output. In this test, the RF power output into a 50Ω load is measured at 3.6, 14.1 and 50.1 MHz in CW or RTTY mode, at a primary DC supply voltage of +13.8V.

Table 1: CW Power Output.

RF PWR %	P _o Meter %	Power Output W		
	Freq. MHz	3.6	14.1	50.1
100	100	100	95	97

Note: Power output was low at initial power-up, increasing by approx. 10% when keyed up after a few minutes in receive/standby. All tests were thus conducted after a 10-minute warm-up time.

2: SSB Peak Envelope Power (PEP). Here, an oscilloscope is terminated in 50Ω and connected to the IC-7410 RF output via a 50 dB high-power attenuator. At 100W CW, the scope vertical gain is adjusted for a peak-to-peak vertical deflection of 6 divisions.

Test Conditions: USB mode, HM-36 mic connected, RF PWR 100%, Mic Gain 45%, COMP OFF/ON, TBW=WIDE (default), COMP ≈ 30% (6 dB compression on voice peaks), SSB TX Bass/Treble 0 dB (default), supply voltage +13.8V.

Speak loudly into the microphone for full-scale ALC reading. **Figures 1 and 2** show the envelope for 100W PEP, without and with compression respectively. **Figures 3 and 4** show the corresponding results from my 2011-2012 test report¹ for the same IC-7410 with the original MAIN UNIT board.

Notes:

1. Comparing Figures 1 and 3, it will be seen that compression is somewhat more aggressive with the original MAIN UNIT than with the new one.
2. Figures 1 and 2 also show some overshoot (130W PEP max.) on voice peaks.
3. If compression is increased > 40%, some distortion will be heard in the transmitted audio on voice peaks.

¹ <http://www.ab4oj.com/icom/ic7410/7410notes.pdf>

Figure 1. 100W PEP speech envelope, no compression (new).

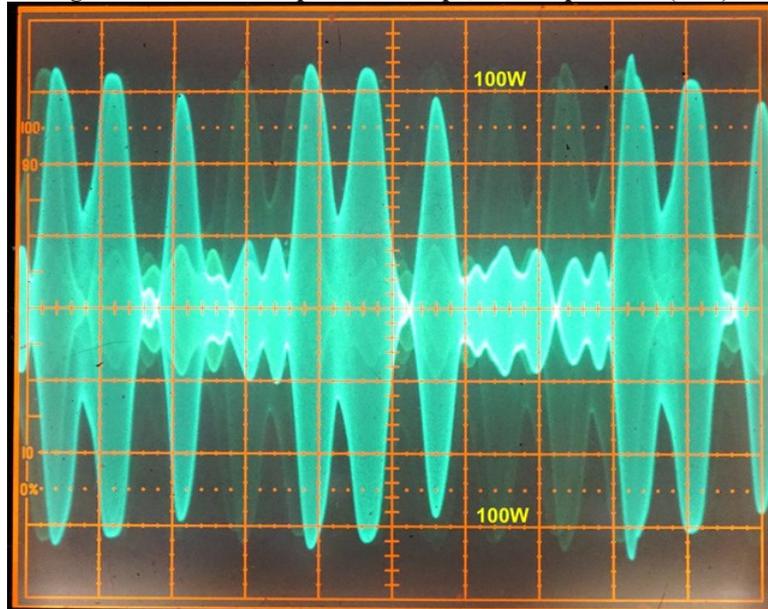


Figure 2. 100W PEP speech envelope, 6 dB compression (new).

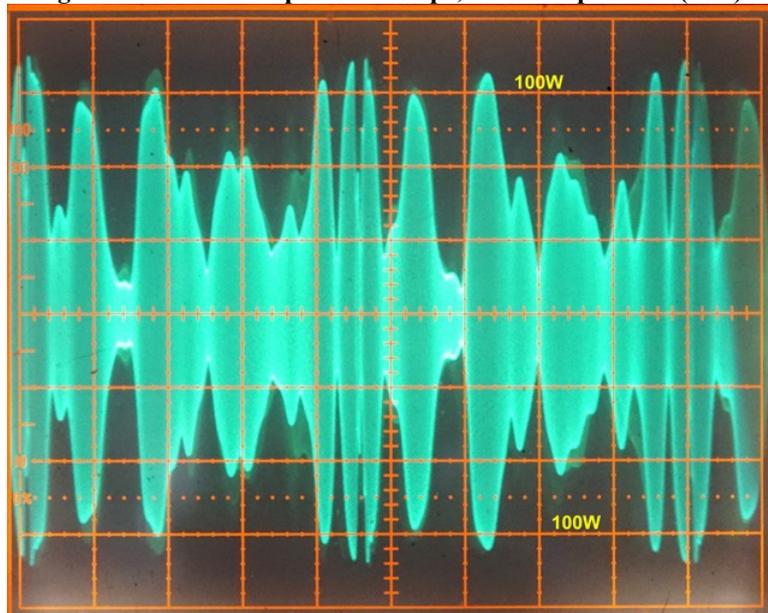
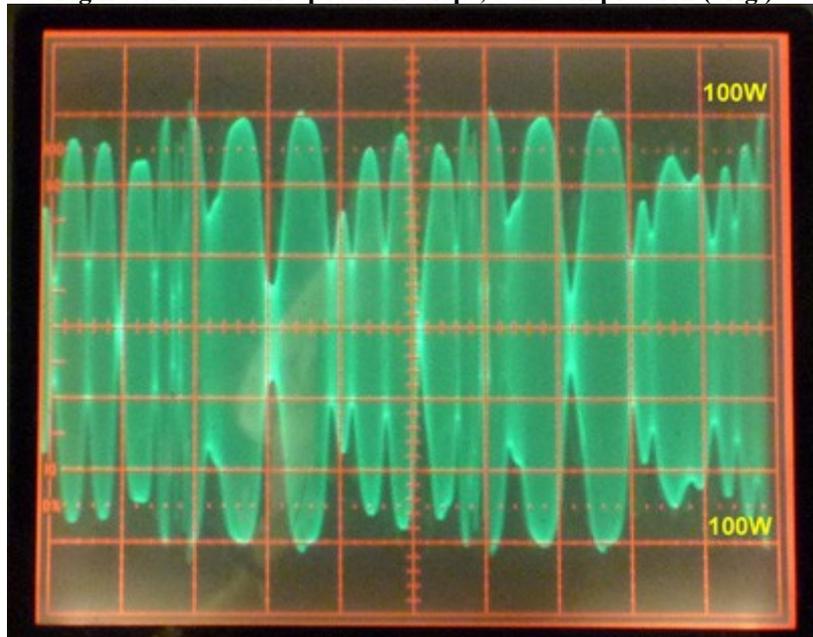


Figure 3: 100W PEP speech envelope, no compression (orig.)



Figure 4: 100W PEP speech envelope, 6 dB compression (orig.)



3: SSB ALC overshoot: A re-test was performed in which white noise was applied from a tone/noise generator program in the computer via the USB port, and the RF envelope observed on an oscilloscope terminated in 50Ω and connected to the IC-7410 RF output via a 50 dB high-power attenuator.

Test Conditions: 14100 kHz USB, COMP off, TBW=WIDE (default), SSB TX Bass/Treble 0 dB (default), DATA OFF MOD = USB, USB MOD Level = 50% (default). Test signal: white noise.. Supply voltage +13.8V.

Set $P_o = 50W$ in RTTY mode. Select USB, then adjust USB Audio Codec device volume on computer and SET MODE Menu 39 (USB MOD LEVEL) for 50% ALC reading.

At 50W PEP output (**Figure 5**), *no ALC overshoot* was observed.

Figure 6 shows a typical overshoot spike with baseband level set for 50W PEP output, as observed in the IC-7410 with the original MAIN UNIT.

Figure 5: ALC overshoot (new).

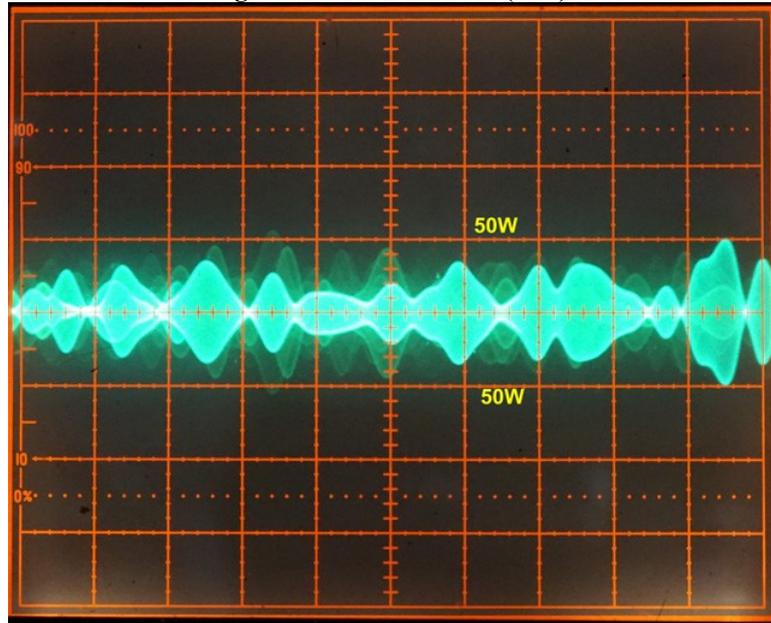
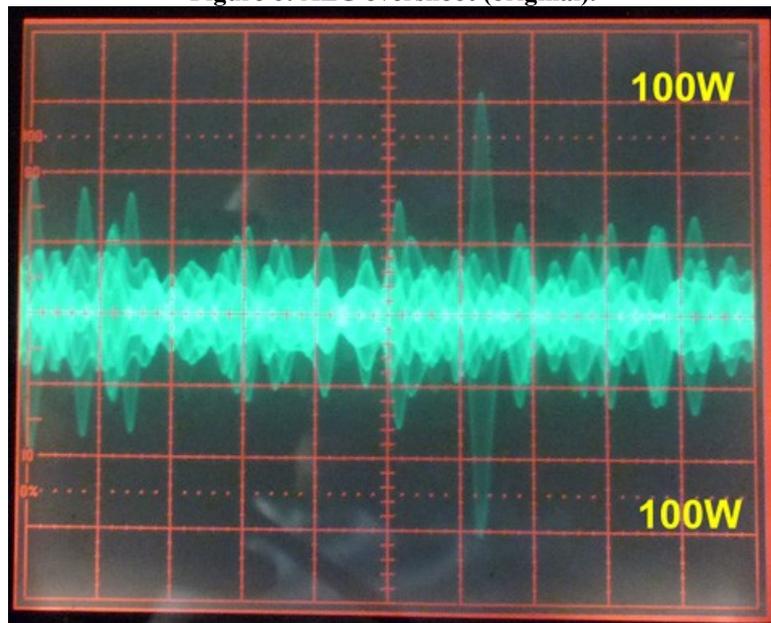


Figure 6: ALC overshoot (original).



4: Transmitter 2-tone IMD test. In this test, a 2-tone test signal is applied to the USB port from a tone-generator program running on a laptop computer. A spectrum analyzer is connected to the IC-7410 RF output via a 60 dB high-power attenuator. The -10 dBm reference level equates to 100W.

Test Conditions: DC supply 13.8V, measured at DC power socket. 14100 kHz USB, DATA OFF MOD = USB. COMP OFF. Test tones: 700 and 1700 Hz, at equal amplitudes.

Adjust USB Audio Codec device volume on computer and SET MODE Menu 39 (USB MOD LEVEL) for 100W PEP (each tone at -6 dBc). **Figures 7, 8 and 9** show the two test tones and the associated IMD products. **Figures 10, 11 and 12** show the corresponding results from my original test report (2011-2012) for the same IC-7410 with the original MAIN UNIT board. New and original IMD data are summarized in **Tables 2 and 3** respectively.

Figure 7: Spectral display of 2-tone IMD at 3.6 MHz, 100W PEP (new).

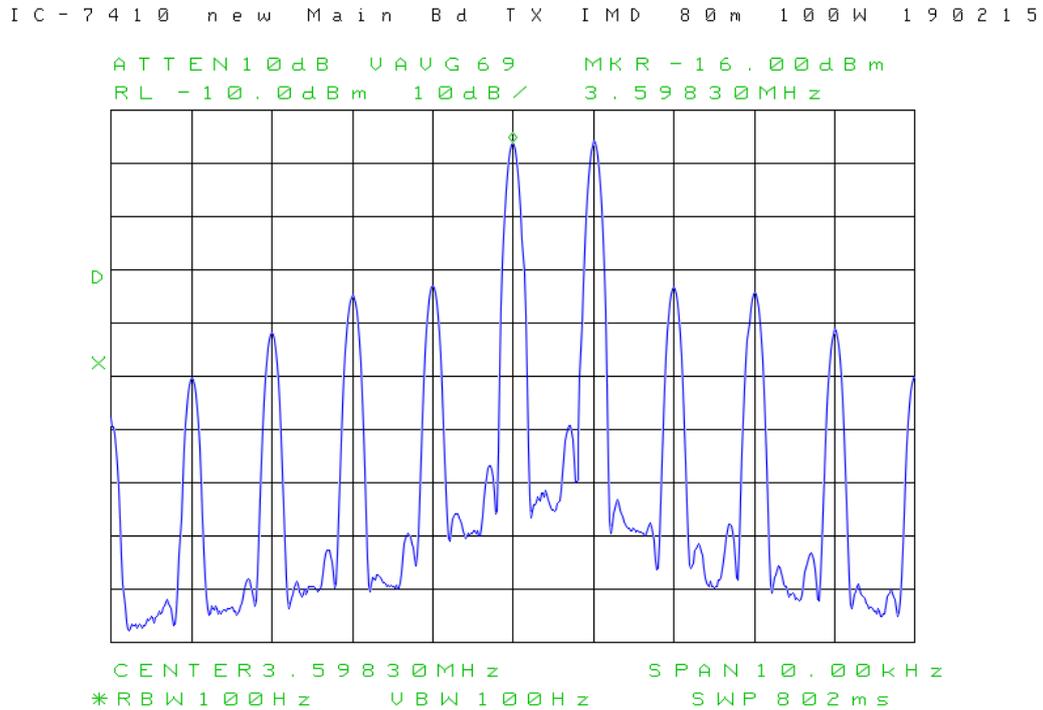


Figure 8: Spectral display of 2-tone IMD at 14.1 MHz, 100W PEP (new).

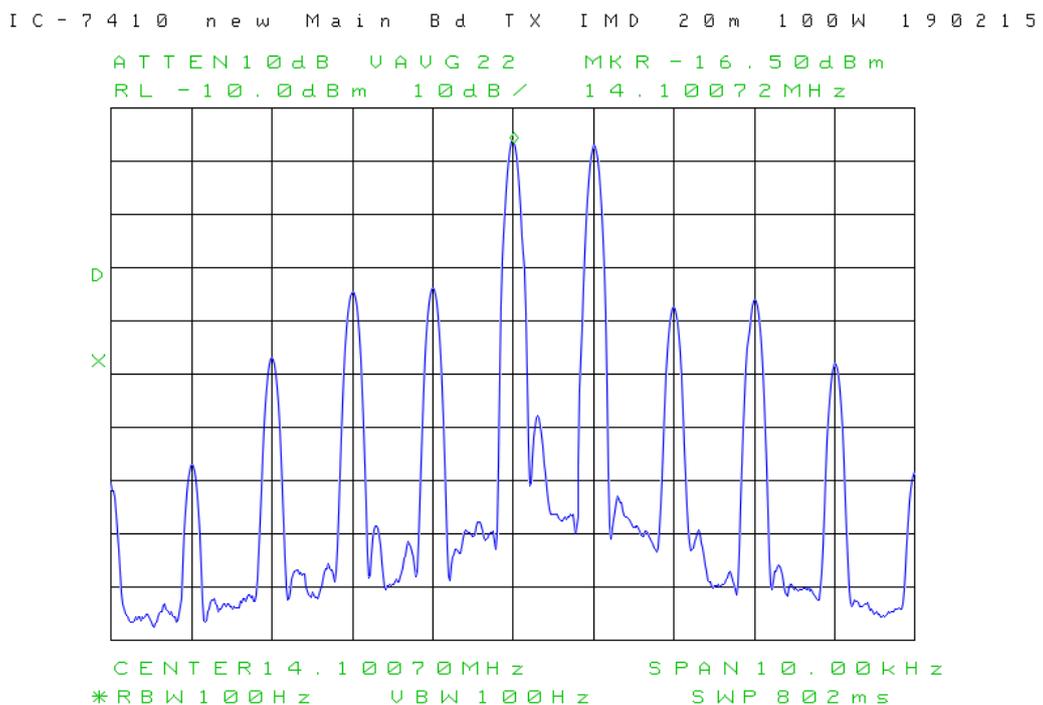


Figure 9: Spectral display of 2-tone IMD at 50.1 MHz, 100W PEP (new).

IC-7410 new Main Bd TX IMD 6m 100W 190215

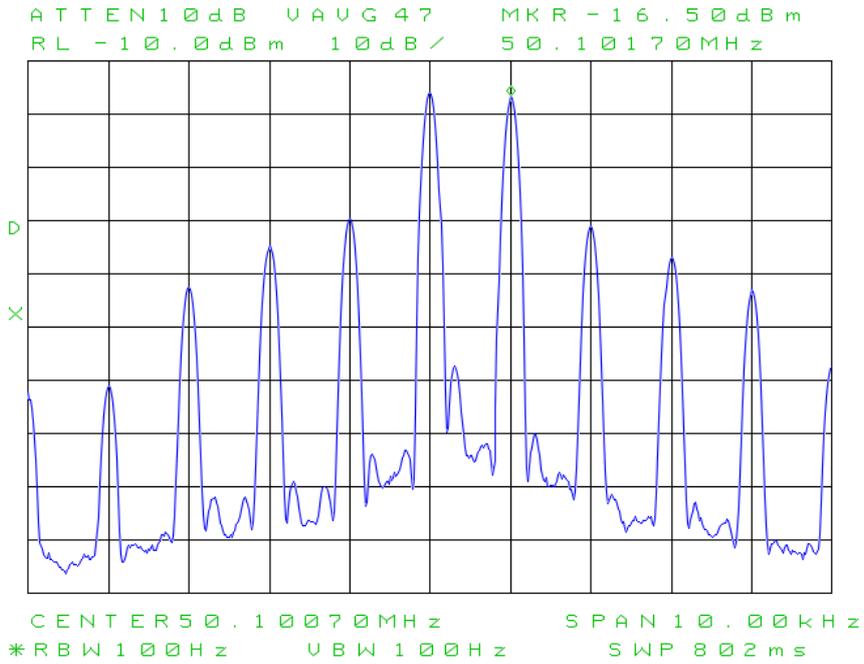


Table 2. 2-tone IMD (new).

2-tone TX IMD Products at 100W PEP			
IMD Products	Rel. Level dBc (0 dBc = PEP)		
	3.6 MHz	14.1 MHz	50.1 MHz
IMD3 (3 rd -order)	-34	-36	-30
IMD5 (5 th -order)	-35	-35	-37
IMD7 (7 th -order)	-49	-54	-44
IMD9 (9 th -order)	-66	-75	-60

Figure 10: Spectral display of 2-tone IMD at 3.6 MHz, 100W PEP (orig.)

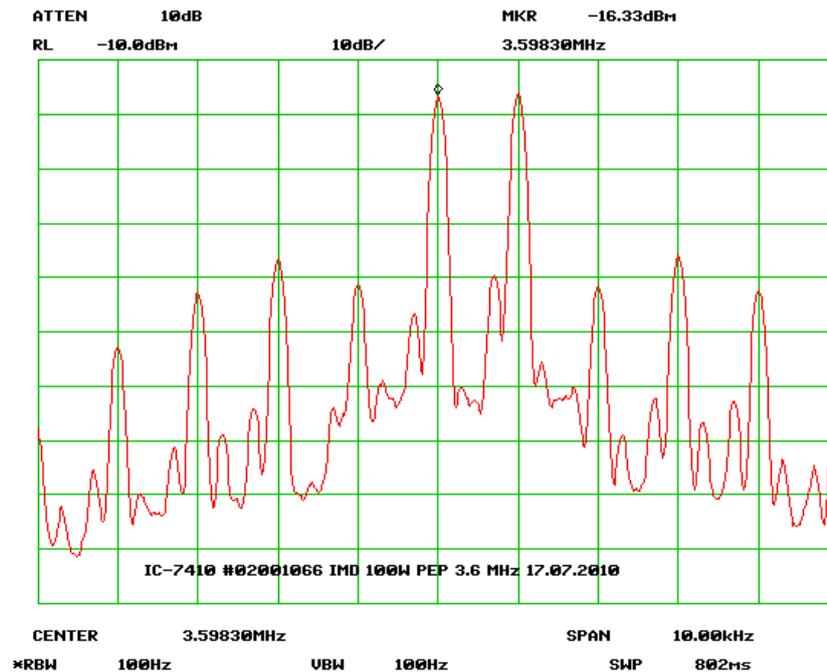


Figure 11: Spectral display of 2-tone IMD at 14.1 MHz, 100W PEP (orig.)

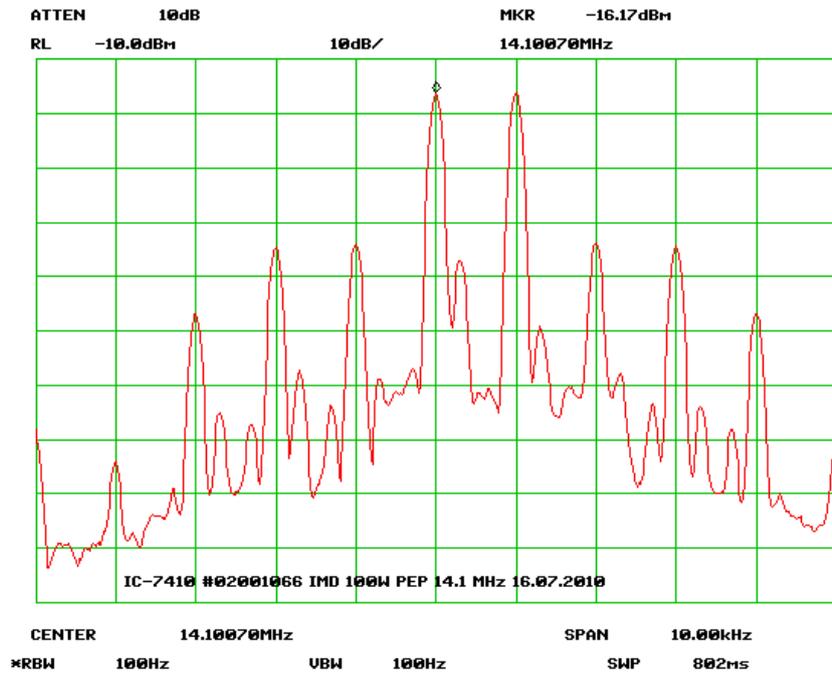


Figure 12: Spectral display of 2-tone IMD at 50.1 MHz, 100W PEP (orig.)

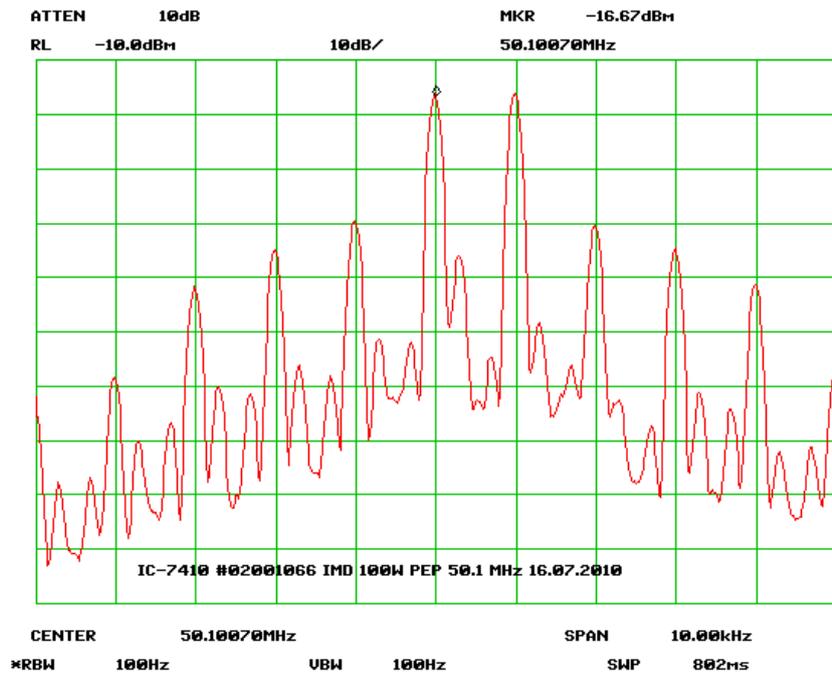


Table 3. 2-tone IMD (orig.)

2-tone TX IMD Products at 100W PEP			
IMD Products	Rel. Level dBc (0 dBc = PEP)		
	3.6 MHz	14.1 MHz	50.1 MHz
IMD3 (3 rd -order)	-42	-34	-30
IMD5 (5 th -order)	-37	-34	-35
IMD7 (7 th -order)	-43	-47	-42
IMD9 (9 th -order)	-53	-70	-56

5: Transmitted composite noise. A spectrum analyzer is connected to the IC-7410 RF output via a 60 dB high-power attenuator. The spectrum analyzer's phase-noise utility is started. **Figures 13 and 14** are the resulting composite-noise plots.

Test Conditions: 3.6, 14.1 and 50.1 MHz RTTY, 100W output to 50Ω load. Utility minimum/maximum offset (10 Hz/1 MHz) and spot frequencies configured as shown in **Figures 13 and 14**. (**Note:** The limitation of this measurement method is that the measured noise power is close to the spectrum analyzer's own noise floor.)

Figure 13: Composite noise at 3.6 & 14.1 MHz, 100W (new).



Figure 14: Composite noise at 14.1 & 50.1 MHz, 100W (new).



Figures 15 and 16 show the corresponding results from my original test report (2011-2012) for the same IC-7410 with the original MAIN UNIT board. Note the 100 Hz minimum offset.

Figure 15: Composite noise at 3.6 MHz, 100W (orig.)

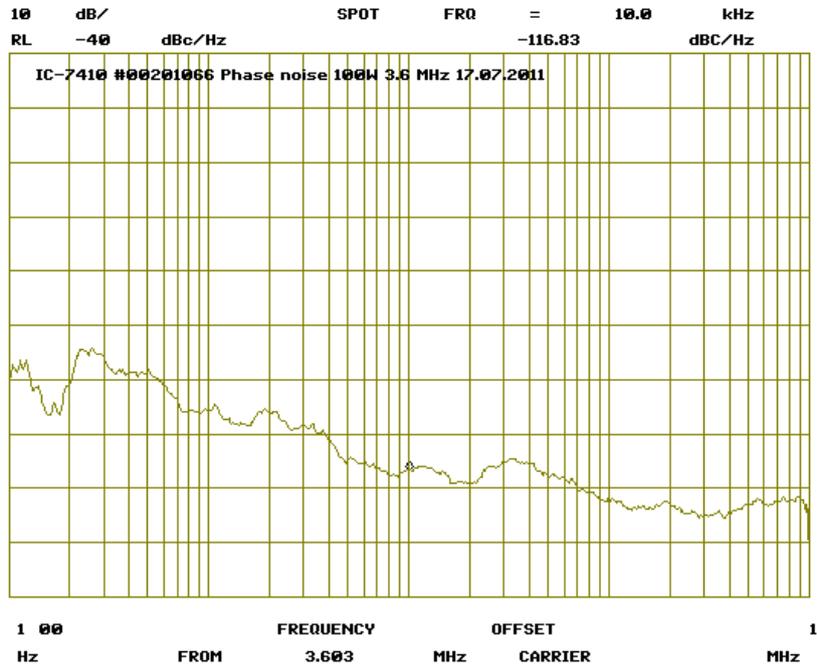


Figure 16: Composite noise at 14.1 MHz, 100W (orig.)

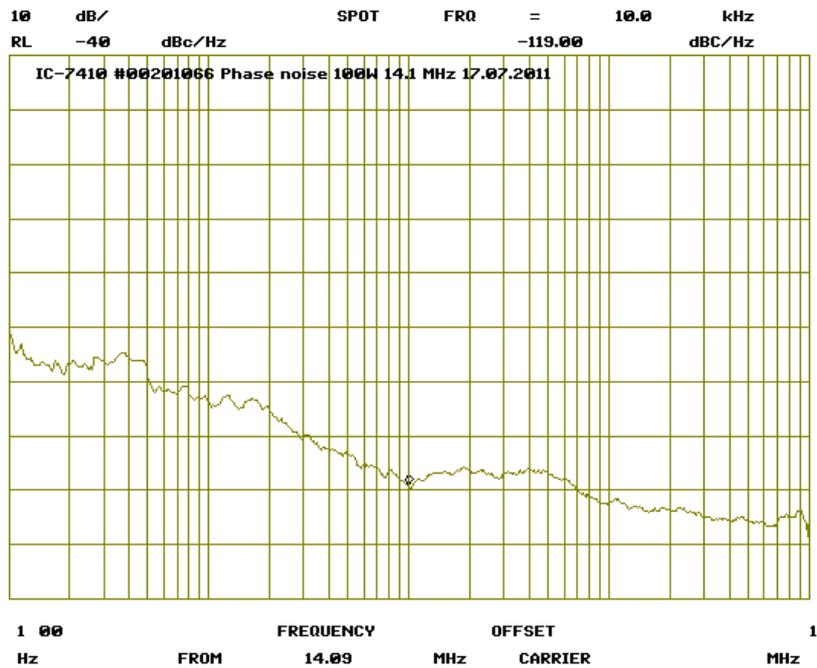
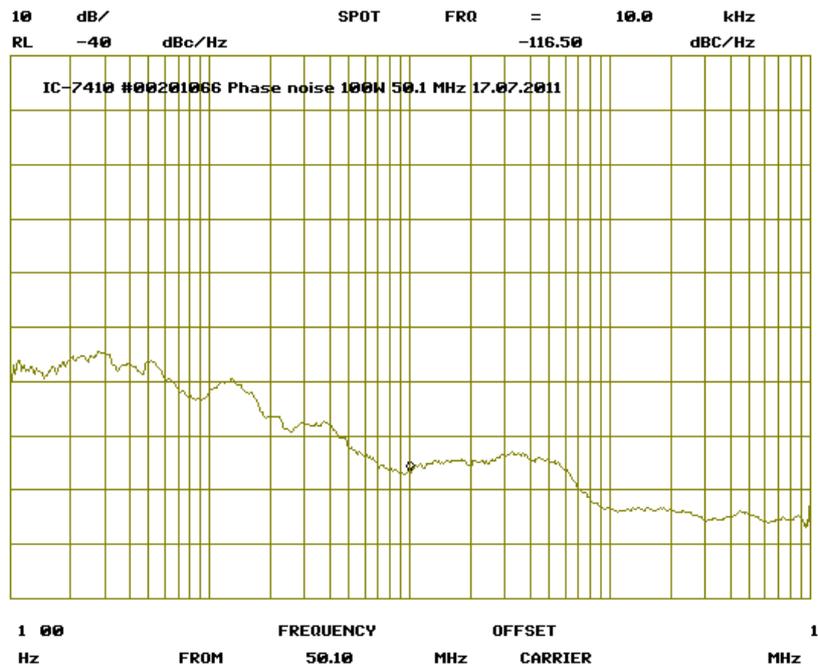


Figure 17: Composite noise at 50.1 MHz, 100W (orig.)



On-air operation

Upon completing the lab tests, I operated the IC-7410 on 20m and 40m SSB for several hours. Using a Heil PR-781 microphone with COMP \approx 30% (6 dB compression on voice peaks), Bass -1 to +1 and Treble +3, distant stations reported that transmitted audio sounded "smooth and pleasant". On 40m in the evening, distant stations reported lack of "talk power" with compression OFF; COMP at 30% remedied this. With COMP > 40%, distant operators heard some harshness on voice peaks.

Conclusions

1. It will be seen from the above tests that the objective of the MAIN UNIT board redesign, namely the elimination of the severe ALC overshoot problem, has been achieved.
2. Compression is slightly less aggressive at the 30% setting than in the 2011-2012 test suite. Although slight ALC overshoot (130W PEP max.) was observed on SSB voice peaks at RF PWR = 100%, this is not seen as a major issue.
3. Transmitter IMD is comparable to the 2011-2012 data. Higher-order IMD (7th and 9th) is improved, at the expense of a slight degradation in 3rd-order IMD.
4. Phase noise performance is comparable to that measured in 2011-2012. This is as expected.
5. From the foregoing, I am unable to confirm the user complaints of excess IMD and degraded transmit audio associated with the new MAIN UNIT.

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