

# **IC-7410 User Evaluation & Test Report**

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**Introduction:** This report describes the evaluation of IC-7410 S/N 02001066 from a user perspective. *Appendix I* presents results of an RF lab test suite performed on the radio. I was able to spend a number of days with the IC-7410 in my ham-shack, and thus had the opportunity to exercise the radio's principal features and evaluate its on-air behavior.

**1. Physical “feel” of the IC-7410:** Owners of current Icom IF-DSP transceivers should find the IC-7410 very familiar, and will immediately feel comfortable with it. The front-panel layout is quite similar to that of the IC-746Pro and IC-7400, except that the larger LCD display is immediately noticeable. The learning curve will be minimal for IC-7600, IC-7700 or IC-7800 owners.

The main tuning knob has a knurled Neoprene ring similar to that of the IC-7600; it turns very smoothly without side-play. As in the IC-7600, the major rotary controls are arranged in two vertical rows on either side of the screen and keypad. The concentric MIC GAIN/RF POWER controls are in the left-hand row. The large monochrome LCD screen displays a very clear, crisp image, with excellent contrast and a paper-white backlight.

The IC-7410 is solidly constructed and superbly finished. It conveys a tight, smooth, and precise overall feel (as did its predecessors). The sheet-steel case is finished in an attractive black crinkle coating and fitted with a handle on the left side. The case retaining screws are located in recesses in the case covers. The front panel is sculpted (somewhat like the IC-7700 front panel) and has a smooth, matte surface.

The IC-7410 is quite heavy (10 kg/22 lb). It uses the same die-cast, compartmented chassis as the IC-9100, except that the rear-panel holes for the 2m, 70 cm and 23 cm antenna sockets are covered by blanking plates. The radio is fitted with the new 4-pin DC power socket. A USB “B” socket is provided on the rear panel, allowing direct CI-V and baseband connectivity to a PC via a standard USB cable. Both the case and the rear panel are well-ventilated. The front case feet are solid and extensible, allowing the front of the IC-7410 to be angled upwards.

**2. Control knob/key functions and menus:** Apart from some differences in placement, the IC-7410's control knobs will be very familiar to users of the IC-7600 and IC-746Pro. The menus are somewhat akin to those in the IC-7600, as the IC-7410's feature set is very similar to that of the 7600 but minus Dual Watch. The menu presentation resembles that of the IC-746Pro, but the larger number of configurable settings is accommodated by item numbers selected via up/down softkeys e.g. the RTTY, KEYER (in CW mode) and TCON (tone controls) menus. I found the set-up process fairly intuitive after consulting the relevant user-manual sections in cases of doubt.

Menus are selected by pressing the MENU key on the bottom left of the screen; this key also serves as an EXIT key. Menu selections with default values can be returned to default by pressing and holding their respective softkeys. For several menu items, the F-3 key serves this purpose even though it is not marked DEF.

The filter selection and adjustment procedure is similar to that on other Icom DSP radios. Press and hold the FILTER key for 1 sec. to adjust the filter bandwidth, select CW/SSB Sharp/Soft shape factors and match the desired roofing filter to each IF filter and mode. All IF filters are continuously adjustable.

Being a current IC-7700 owner and former 756Pro-series owner, I found that the IC-7410's controls and menus fell readily to hand. A user familiar with a radio such as the IC-756Pro3 or IC-746Pro should find the IC-7410's learning curve minimal. The IC-7410's default settings are very usable, allowing the radio to be placed in service with minimal initial set-up.

**3. LCD display screen:** The 13 cm (5 inch) diagonal monochrome LCD screen is 10 cm wide, 1 cm wider than the IC-746Pro screen. The display is very bright and crisp, and presents all radio parameters. The display layout is very similar to that of the IC-746Pro. The IC-7410 offers a limited, non-real-time spectrum scope very similar to that of the 746Pro. The spectrum scope is initiated via menu and displays an approximate, qualitative histogram of band occupancy in the lower field of the screen. It mutes the receiver during its acquisition cycle. Scope span is configurable in the range 0.5 to 25 kHz.

The Notch (MN) and FILTER keys, and the Twin PBT controls, open pop-ups in the lower field of the screen. These can be used to select notch width and filter/PBT bandwidth respectively.

The CFL display backlight in the test unit was slow-starting ( $\approx 15$  sec. delay) when powering up the radio cold after it had been off for a few days at  $< 15^{\circ}\text{C}$  ambient.

**5. USB interfaces:** The IC-7410 is equipped with a rear-panel USB "B" port. The radio can be directly connected via the "B" port to a laptop or other PC via a standard USB "A-B" cable. This is without doubt one of the IC-7410's strongest features. The USB port transports not only CI-V data, *but also TX and RX PCM baseband* between the IC-7410 and the computer. As a result, the USB cable is the only radio/PC connection required. Gone forever is the mess of cables, level converters and interface boxes! I believe that this feature will be standard on all future Icom HF radios. An Icom driver is required in the PC; this is downloadable from the Icom Japan World website. **Note:** The IC-7410 is *firmware-upgradeable* via the USB "B" port.

**6. Filter selections and Twin PBT:** As do the other Icom DSP transceivers, the IC-7410 offers fully-configurable RX IF selectivity filters for all modes. Three default filter selections are available for each mode, with continuously variable bandwidth via the FILTER menu. In addition, there are selectable Sharp and Soft shape factors for SSB and CW. The IC-7410 comes fitted with a 15 kHz MCF roofing filter at the 64.455 MHz 1<sup>st</sup> IF. Easily-installable plug-in 6 and 3 kHz roofing-filter modules are available as optional accessories. The filter menu allows association of any one of the 3 roofing filters with each of the 3 IF filter selections.

The Twin PBT controls and PBT CLR key operate in exactly the same manner as on the IC-756Pro series, as does the BPF filter configuration feature (for filter bandwidths of 500 Hz or less.)

The TPF menu item in the RTTY menu selects the Twin Peak Filter (TPF) in RTTY mode. No CW APF (Audio Peak Filter) is provided. However, the CW RX LPF and HPF are a reasonable alternative to the "missing" APF; their ranges are 100 - 2000 and 500 - 2400 Hz respectively. The HPF and LPF can be set to "bracket" the received CW tone in a tight 100 Hz audio bandwidth. The F-3 softkey restores these filters to default (off).

**7. BPF vs. non-BPF filters:** As in other Icom IF-DSP radios, the IC-7410 allows the user to select two additional shapes for 500 Hz or narrower filters, in addition to SHARP and SOFT. These are BPF (steeper skirts) and non-BPF (softer skirts).

To configure a BPF filter, select a 500 Hz or narrower CW, RTTY or SSB-D filter with Twin PBT neutral. To set up a non-BPF filter, select a filter with BW > 500 Hz, and narrow the filter to 500 Hz or less by rotating the Twin PBT controls. Numerical and diagrammatic bandwidth displays and a "BPF Indicator" icon facilitate use of this feature. Examples of BPF and non-BPF filter passbands are illustrated in **Figs. 3 & 4** (Pages 11 – 12).

**8. Notch Filters:** The tunable manual notch filter (MN) is inside the AGC loop, and is extremely effective. The MN has 3 width settings (WIDE, MID and NAR); its stopband attenuation is at least 70 dB. The manual notch suppresses an interfering carrier before it can stimulate AGC action; it thus prevents swamping. The auto notch filter (AN) is post-AGC. It suppresses single and multiple tones, but strong undesired signals can still cause AGC action and swamp the receiver. MN and AN are mutually exclusive, and ANF is inoperative in CW mode. The NOTCH key toggles OFF – AN – MN. When MN is selected, a pop-up field is displayed at the bottom of the screen, allowing selection of WIDE, MID or NAR (narrow) notch by pressing and holding the key. Operation of the NOTCH key is identical to that in the IC-7700 or IC-7600.

**10. NR (noise reduction):** The DSP NR functionality is comparable to that of the IC-7700, and works very well. In SSB mode, the maximum noise reduction occurs at an NR control setting of 60%. As NR level is increased, there is a slight loss of "highs" in the received audio; this is as expected. The measured SINAD increase in SSB mode was about 10 dB.

**11. NB (noise blanker):** The IF-level DSP-based noise blanker is arguably one of the IC-7410's strongest features. I found it to be extremely effective in suppressing fast-rising impulsive RF events before they can stimulate AGC action within the DSP algorithm. The NB completely blanks noise impulses which would otherwise cause AGC clamping. I found its performance comparable to that of the IC-7700's NB. The NB menu (threshold, depth and width) is accessed by pressing and holding the **NB** key. The NB works very effectively in conjunction with NR.

**12. AGC system:** The IC-7410 has dual AGC loops. The primary loop samples the digitized 36 kHz IF at the ADC output. This loop limits the IF signal power applied to the ADC input, thereby preventing ADC over-ranging even in the presence of extremely strong signals. The digital AGC detector for the secondary loop is within the DSP algorithm. Level indications from both detectors are processed in the DSP for AGC management. This architecture prevents strong adjacent signals from swamping the AGC, and allows full exploitation of the ADC's dynamic range.

The AGC menu is similar to that of the IC-7600. The Slow, Mid and Fast AGC settings are customizable via menu for each mode, and AGC can be turned OFF via menu.

**13. Receive and transmit audio menus:** The IC-7410 TCON (Tone Control) menu offers the same generous selection of audio configuration parameters as that of the IC-7600 and IC-7700: TBW (low and high cutoff frequencies), RX and TX Bass/Treble EQ, RX HPF and LPF, transmit compression, etc. All audio settings are grouped under the M2/TCON softkey (F-4 in menu M2).

**14. Metering:** As in the IC-746Pro, on-screen bar-graphs replace the traditional moving-coil meter. Pressing and holding the ANT/METER key toggles between ALC and COMP. The S-meter, P<sub>o</sub> and ALC scales are displayed at all times.

**15. VFO/Memory management:** The IC-7410 offers the same VFO and memory management features as other current Icom HF+ transceivers: VFO/memory toggle and transfer, memory write/clear, memo-pad, Split, VFO A/B swap and equalize, etc.

**16. Brief “on-air” report:** Prior to starting the test suite, I installed the IC-7410 in my shack and connected it to my solid-state 1 kW amplifier and multi-band vertical antenna. The interface was straightforward – RF drive, PTT, ALC and carrier request (for amplifier auto-tuning). Once I had set up the ALC for 1 kW output, I was 100% QRV.

**a) SSB:** I made several 20m and 17m SSB QSO's with friends who are familiar with my voice and the sound of my signal. Distant stations reported that the audio quality of my transmissions was "excellent, clean and natural" when using the Heil PR-781 desk mic plugged into the radio's MIC socket. Two stations I worked on 20m SSB assisted me in optimizing transmit audio settings for the PR-781 and HM-36. It was observed that higher COMP settings caused slight distortion on voice peaks when using the HM-36. The radio showed no signs of excessive heating even after a few hours' "rag-chew" SSB operation at 65 – 70W PEP output.)

The following are the settings I used in the SSB trials:

**Table 1: Transmit Audio Settings.**

Mic	Band	Conditions	Mic Gain	TBW	COMP	Bass	Treble
PR-781	20m	S9+	60%	WIDE	OFF	-1	+3
HM-36	20m	S9+	60%	WIDE	≈ 6 dB	-2	+4
PR-781	17m	S5, QSB	60%	MID	6 dB	-1	+3

The DSP-based noise blanker is superb. It does not distort the signal at all, and can be left on at all times; it is every bit as good as the IC-7700 or IC-7600 blanker. It suppressed fast-rising noise spikes and almost completely eliminated locally-generated electrical noise.

As discussed in Section 10 above, I found the NR very effective on SSB. Even at 60%, NR did not attenuate “highs” excessively. NR is very effective in conjunction with NB.

Preamps 1 and 2 (10 and 16 dB gain, respectively) brought weak stations up to very comfortable copy without S/N degradation. The SSB filters and Twin PBT were excellent, as we have come to expect from other Icom DSP radios. MN and AN were extremely helpful. I was able to notch out single tones with MN; also, AN reduced the levels of multiple tones, suppressing the higher-pitched tone and reducing the level of the lower-pitched tone by about 20 dB.

Overall, the IC-7410 receiver seemed a little noisier than my IC-7700 in the sense that band noise was more obtrusive. NR seemed slightly more effective on the 7700 than on the 7410. Still, SSB operation on the 40, 20 and 17m bands with a mix of strong and weak signals was very comfortable and pleasant.

**b) CW:** I also held a 30-minute QSO with a station on 20m CW, using a straight key, QSK and semi-break-in. There was no evidence of “dit-clipping”. With 500 and 250 Hz CW filters (Sharp, BPF) and NR/NB on, ringing was minimal with Preamp off.

At  $\approx$  15 wpm, I found full-break-in operation very smooth and pleasant, with virtually instantaneous receiver recovery. No keying artifacts were audible in the headphones. (*Note:* See 19.2, below.)

I then set up a 250 Hz filter (Soft, non-BPF) with NR on and Preamp off. Again, there was virtually no audible ringing, and the received CW note was very smooth.

Activating Preamp 1 or 2 raised the noise level, causing slight ringing which was more noticeable in the absence of signals.

**c) AM:** In a quick check of AM reception, I listened to various MF and HF broadcast stations. A local station on 690 kHz and a music broadcast on 6910 kHz sounded good on the IC-7410’s internal speaker, but much clearer (as one would expect) on my external speaker or on the headset.

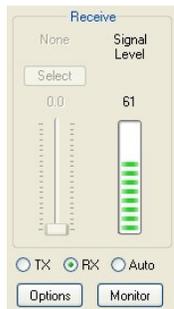
The 9 kHz AM filter offered the best frequency response, but the 6 kHz setting sounded somewhat “smoother” and 3 kHz cut the “highs” excessively. The IC-7410’s Twin PBT is fully functional in this mode. Mid AGC was best for average to good signal conditions, but Fast AGC handled rapid selective fading more effectively.

NR was quite effective in improving the S/N ratio of weak AM signals. (*Note:* See 19.3, below.)

The NR did not distort the recovered audio even at its maximum setting (60%). Above 60%, the NR control had no further effect. (Note that the AM bass and treble EQ settings were both 0 dB, with HPF off.)

AN was effective in suppressing interfering tones and heterodynes, but MN caused some distortion when tuned across the signal. The reason for this is that MN suppresses the carrier in a manner similar to selective fading.

**d) RTTY:** I did not operate RTTY during the on-air test period, but monitored some 20m RTTY signals. I found that I was able to tune accurately using the center tuning indicator; the RTTY decoder in the lower field of the screen displayed the received text accurately. The squelch can be set to mute the audio in the absence of a received signal; this is convenient when using the Twin Peak Filter (TPF).



**17. Test for EMC and Baseband Levels:** No EMC issues of any sort were observed when using a headset plugged into the IC-7410's PHONES jack or an external speaker connected to the radio's EXT-SP jack. Tests were conducted at 1 kW on 40, 20, 17, 15, 12 and 10m and at 500W on 6m.

I measured the **RX baseband output** levels at the USB port using DM780\*, and at ACC Pin 12 (AF) with a true RMS DVM. With a 10.000 MHz S9 + 10 dB test signal offset 1 kHz to yield a 1 kHz test tone, DM780 read 61% of full scale and the level at ACC Pin 12 was 219 mV RMS (well within the 100 – 300 mV spec.)

**18. Interfacing with Ham Radio Deluxe (HRD):** I installed the Ver. 1.1 Icom USB drivers (downloadable from the Icom Japan world-wide support site) and HRD Ver. 5 Beta on my laptop, and connected the computer to the IC-7410 with a standard USB cable. The IC-7410 showed up in the computer as "USB Audio Codec". Once I had set the levels correctly, HRD started working, and was displaying PSK31 and RTTY traffic and waterfalls. *\*DM780 is a component of HRD.*

**19. Concerns:** The following issues were observed in the course of lab testing:

1. An **ALC overshoot** of up to 6 dB occurs on SSB (but not on any other mode) when a white noise baseband is applied to the USB port, with USB MOD level at 50%. This overshoot can be reduced to 1.5 dB by careful adjustment of baseband level and Compression. This adjustment requires observation of the RF envelope with an oscilloscope, and is quite critical. The overshoot can damage amplifiers driven by the IC-7410. *Note: This phenomenon was not observed at all on my IC-7700.* This issue has been reported on the IC-7410 Yahoo! Group. (See **Test 17a**, ALC Overshoot, in Appendix 1B, Transmitter Tests.)
2. **CW QSK** (full break-in) does not work well when using the internal keyer at speeds > 12 wpm. If a string of dits is transmitted at speeds > 12 wpm, the receiver does not recover between dits. This issue has been reported on the IC-7410 Yahoo! Group. (See **Test 22b**, QSK Recovery, in Appendix 1B, Transmitter Tests.)
3. A disturbing **high-frequency hiss** is heard on **AM** when receiving a weak signal. (< -100 dBm). The hiss is especially noticeable at less than 30% modulation. NR and/or a narrower IF filter reduces or eliminates the hiss. If the modulation percentage is increased to 80%, and/or if signal power is -85 dBm or higher, the receiver quiets fully. (See **Test 1a**, AM Sensitivity, in Receiver Test section.)

4. Close-in **reciprocal mixing noise** is a few dB worse than on the IC-7600. This will affect the reception of weak SSB/CW signals in the presence of strong adjacent out-of-band signals. (See **Test 2**, Reciprocal Mixing, in Receiver Test section.)

**20. Conclusion:** After several days' worth of "cockpit time" on the IC-7410, I am very favorably impressed by its solid, refined construction, clear and informative display, easy familiarization experience, smooth operating "feel", impressive array of features and excellent on-air performance (taking into account the concerns listed above). This radio offers much of the functionality and performance of the IC-7600 in a 746Pro-sized package, and in a price class between the IC-7200 and the IC-7600. Icom are once again right on the mark with the straightforward USB computer interface.

**21. Acknowledgements:** I would like to thank Ray Novak N9JA at Icom America, and Paul Veel VE7PVL and Jim Backeland VE7JMB at Icom Canada for making an IC-7410 and an IC-9100 available to me for testing and evaluation.

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# Appendix 1: Performance Tests on IC-7410 S/N 02001066

As performed in my home RF lab, July 11 - 21, 2011.

## A. Receiver Tests

**1: MDS (Minimum Discernible Signal)** is a measure of ultimate receiver sensitivity. In this test, MDS is defined as the RF input power which yields a 3 dB increase in the receiver noise floor, as measured at the audio output.

**Test Conditions:** ATT off, NR off, NB off, Notch off. AGC-M. SHARP, 15 kHz roofing filter. Levels in dBm.

Table 2: MDS.

Preamp	3.6 MHz		14.1 MHz		50.1 MHz	
	SSB 2.4 kHz	CW 500 Hz	SSB 2.4 kHz	CW 500 Hz	SSB 2.4 kHz	CW 500 Hz
Off	-128	-137	-127	-134	-126	-131
1	-136	-142	-135	-142	-134	-139
2	-139	-146	-137	-143	-136	-143

**1a: AM Sensitivity.** Here, an AM test signal with 30% modulation at 1 kHz is applied to the RF input. The RF input power which yields 10 dB (S+N)/N is recorded (Table 3).

**Test Conditions:** ATT off, NR off, NB off, Notch off. AGC-M. Wide (9 kHz) AM filter. 15 kHz roofing filter. Levels in dBm.

Table 3: AM Sensitivity..

Preamp	0.9 MHz	3.9 MHz	14.1 MHz
off	-108	-109	-107
1	-115	-117	-115
2	-116	-118	-116

*Note: No degradation in 0.5 – 1.6 MHz range.*

### Notes:

1. Sensitivity is not degraded in the 0.5 – 1.6 MHz range.
2. The high-frequency hiss observed when receiving a weak AM signal (< -100 dBm) with the 9 kHz IF filter selected. The hiss is especially noticeable at less than 30% modulation, or when the received carrier is unmodulated. NR and/or the 6 or 3 kHz IF filter reduces or eliminates the hiss. If the modulation percentage is increased to 80%, and/or if signal power is -85 dBm or higher, the receiver quiets fully.

**1b. 12 dB SINAD FM sensitivity:** In this test, a distortion meter is connected to the external speaker jack, and an FM signal modulated by a 1 kHz tone with 3 kHz peak deviation is applied to the RF input. The input signal power for 12 dB SINAD is recorded (Table 4).

Table 4: FM SINAD Sensitivity.

Preamp	29.5 MHz	52.525 MHz	52.525 MHz Squelch Sens.
off	-118	-109	-116
1	-120	-118	-126
2	-122	-120	-129

**2: Reciprocal Mixing Noise** occurs in a superheterodyne receiver when the noise sidebands of the local oscillator (LO) mix with strong signals close in frequency to the wanted signal, producing unwanted noise products at the IF and degrading the receiver sensitivity. Reciprocal mixing noise is a measure of LO spectral purity.

In this test, a strong "undesired" signal is injected into the receiver's RF input at a fixed offset from the operating frequency. The RF input power is increased until the receiver noise floor increases by 3 dB, as measured at the audio output. Reciprocal mixing noise, expressed as a figure of merit, is the difference between this RF input power and measured MDS. The test is run with preamp off. The higher the value, the better.

**Test Conditions:** SSB mode, 2.4 kHz filter, preamp off, ATT off, NR off, NB off, negative offset. Reciprocal mixing *in dB* = input power – MDS (both in dBm).

**Table 5: Reciprocal Mixing Noise.**

Offset kHz	3.6 MHz LSB			14.1 MHz USB			50.1 MHz USB		
Roof Fitr	15	6	3	15	6	3	15	6	3
2	76	76	78	74	75	76	74	76	77
3	80	80	82	81	80	81	78	80	80
5	84	86	89	87	86	87	85	86	86
7	86	90	92	89	89	90	87	89	89
10	92	93	94	92	92	93	90	90	92
20	96	97	98	97	96	96	95	96	96
50	99	99	100	100	99	100	98	100	100

**3: IF filter shape factor (-6/-60 dB).** This is the ratio of the -60 dB bandwidth to the -6 dB bandwidth, which is a figure of merit for the filter's adjacent-channel's rejection. The lower the shape factor, the "tighter" the filter.

In this test, an approximate method is used. An RF test signal is applied at a power level approx. 60 dB above the level where the S-meter just drops from S1 to S0. The bandwidths at -6 and -60 dB relative to the input power are determined by tuning the signal generator across the passband and observing the S-meter. Reciprocal mixing noise limits the level range to 60 dB or less.

**Test Conditions:** 10.000 MHz, SSB/CW modes, preamp off, AGC MID, ATT off, NR off, NB off.

**Table 6: IF Filter Shape Factors.**

Filter	Sharp	Soft
2.4 kHz SSB	1.42	1.57
500 Hz CW	1.40	1.59
250 Hz CW	1.46	2.25

**4: AGC threshold & SSB filter roll-off.** An RF test signal is applied at a level 6 dB below AGC threshold, with AGC off. The signal is offset 1 kHz from the receive frequency to produce a test tone. While tuning the signal generator across the IF passband, the frequency and audio level are noted at several points on the filter flank.

**Test Conditions:** 10.000 MHz LSB, 2.4 kHz filter, 15 kHz roofing filter, preamp off, AGC M, then off, ATT off, NR off, NB off. Input signal level -104 dBm (6 dB below measured -98 dBm AGC threshold.)

**4a. AGC threshold:** With AGC-M, increase RF input power until baseband level increases < 1 dB for a 1 dB increase in input level. Measured value = -98 dBm.

**4b. Roll-off:** With AGC off, reduce RF input power to 6 dB below AGC threshold = -104 dBm. Test data in Table 7 (roll-off in dB).

**Table 7: IF Filter Roll-off.**

Offset Hz	Sharp	Soft
250	-4	-7
300	-0.3	-5.5
400	-0.3	-4
500	0	-3
750	-0.1	-1
1000	0	0
2000	-2	-1.5
2500	-2.5	-5
2700	-3	-7
2800	-13	-14

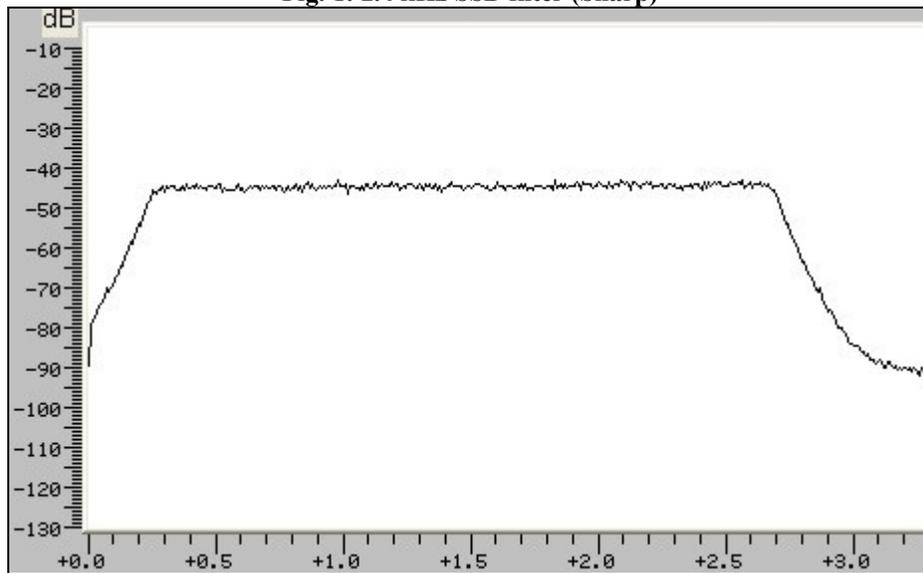
**4c. Typical IF filter passband curves:** The examples illustrated below depict typical filter passbands. Due to the limited dynamic range of the measurement method, the accuracy of the amplitude scale is limited.

In this test, a flat noise spectrum (band-limited to 30 MHz) from an RF noise source is applied to the antenna input, and the filter passband curve is captured by a baseband spectrum-analysis program running in a PC connected to the IC-9100 via the USB port.

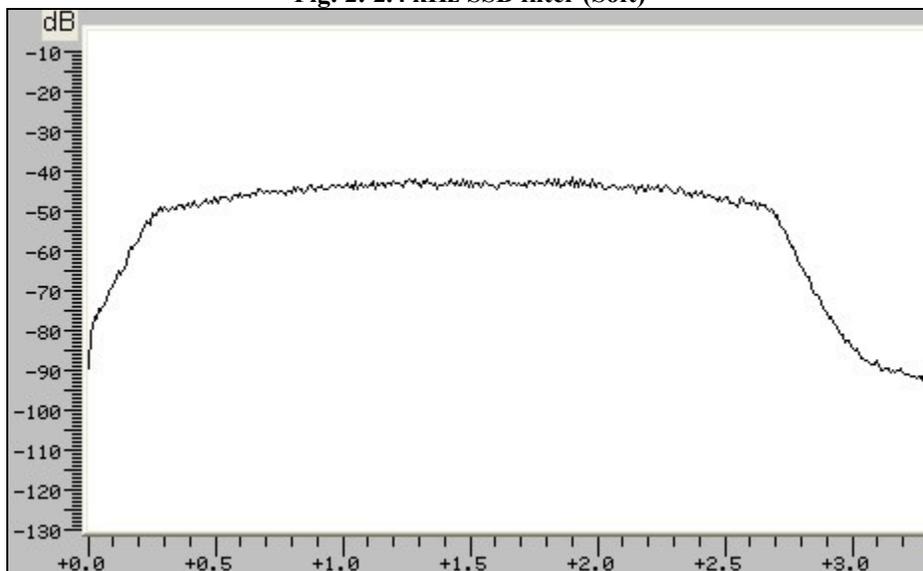
**Test Conditions:** Noise loading (PSD) = -142 dBm/Hz. IC-9100 tuned to 14.100 MHz. AGC slow, NR/NB/preamp/ATT off, Twin PBT neutral.

**Figs. 1 – 6** are the measured passband curves for various filter configurations.

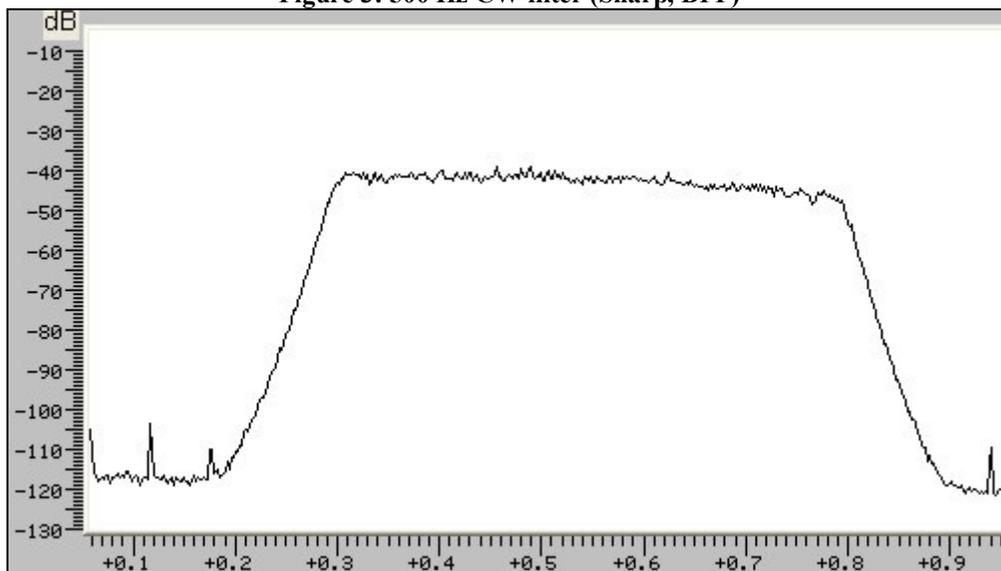
**Fig. 1: 2.4 kHz SSB filter (Sharp)**



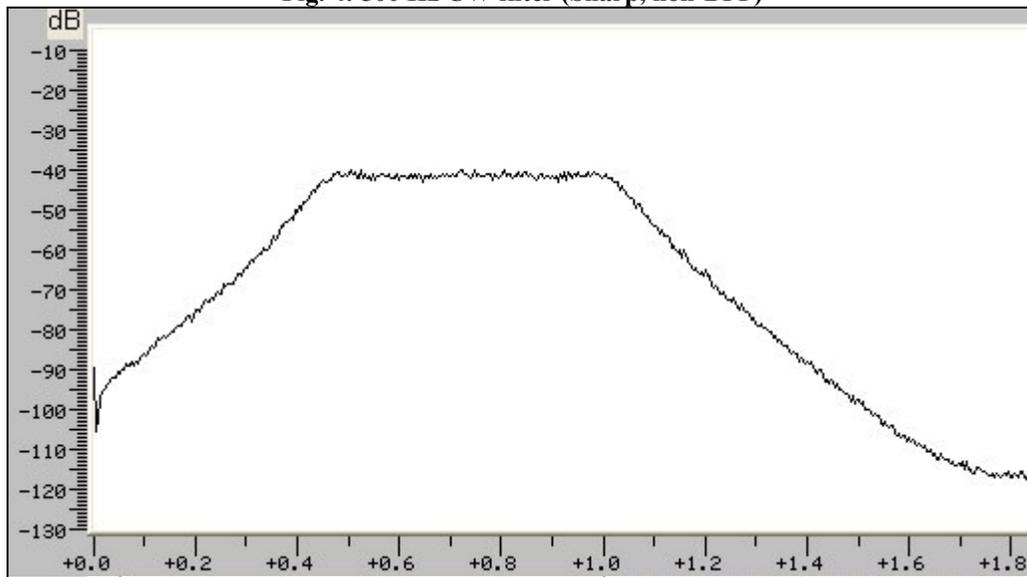
**Fig. 2: 2.4 kHz SSB filter (Soft)**



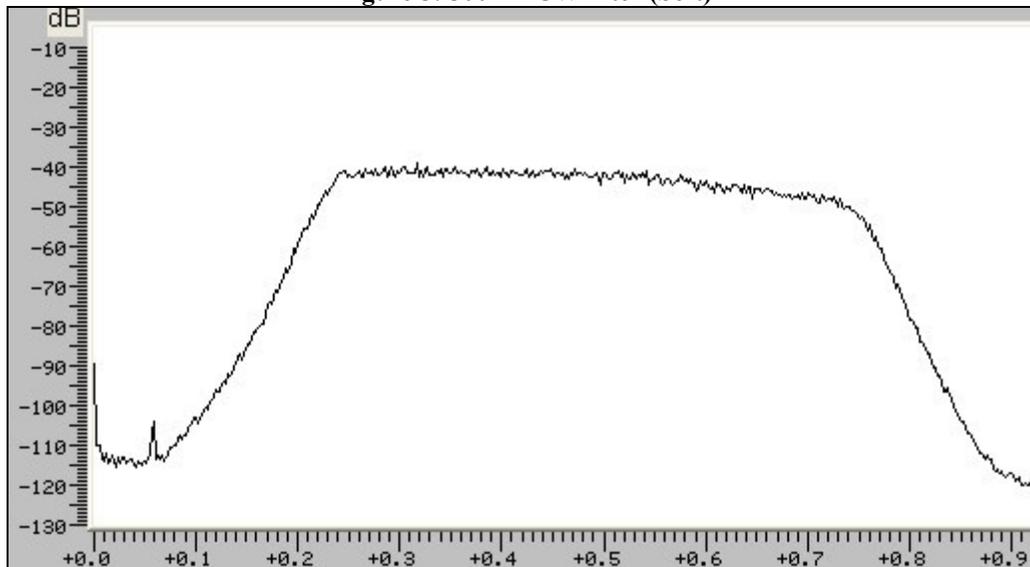
**Figure 3: 500 Hz CW filter (Sharp, BPF)**



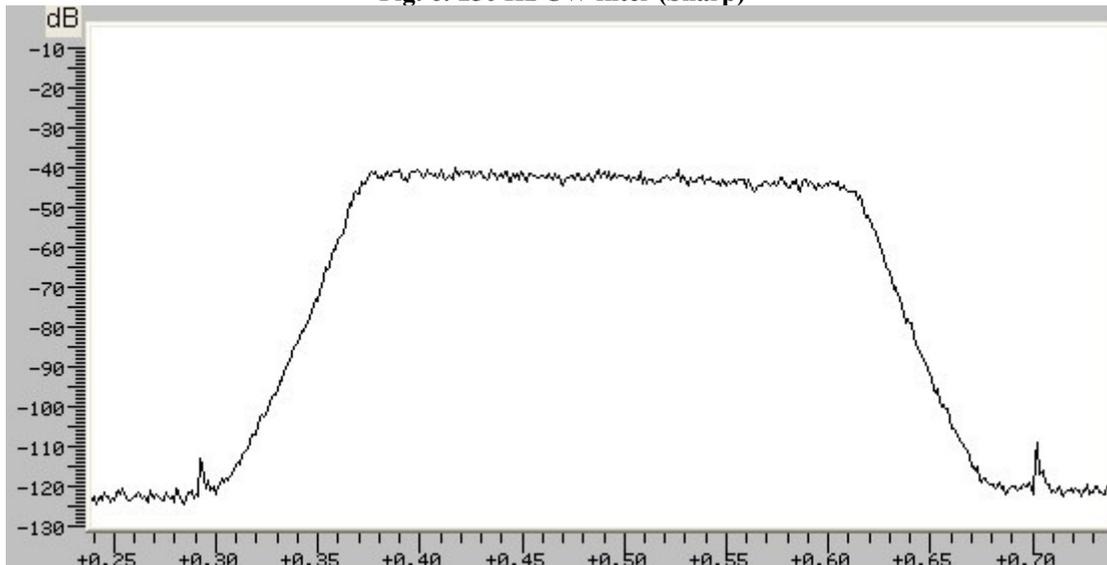
**Fig. 4: 500 Hz CW filter (Sharp, non-BPF)**



**Figure 5: 500 Hz CW filter (Soft)**



**Fig. 6: 250 Hz CW filter (Sharp)**



**5: NR noise reduction, measured as SINAD.** This test is intended to measure noise reduction on SSB signals close to the noise level.

The test signal is offset 1 kHz from the receive frequency to produce a test tone, and RF input power is adjusted for a 6 dB SINAD reading (-120 dBm). NR is then turned on, and SINAD read at 30%, 50% and 60% (max.) NR settings.

**Test Conditions:** 10.000 MHz LSB, 2.4 kHz Sharp, AGC MID, preamp off, ATT off, NR off, NB off, Twin PBT neutral.

Table 9: NR SINAD.

NR %	SINAD dB
0	6
25	8
40	11
50	13
55	16(max.)
60	15

This shows an S/N improvement of 10 dB with NR at maximum for an SSB signal roughly 5 dB above noise level. This is an approximate measurement, as the amount of noise reduction is dependent on the original signal-to-noise ratio.

Figures 7 and 8 are spectrograms of a single-tone RF signal at -120 dBm with NR off and at maximum, respectively.

Figure 7: SSB 2.4 kHz. -120 dBm RF signal, NR off.

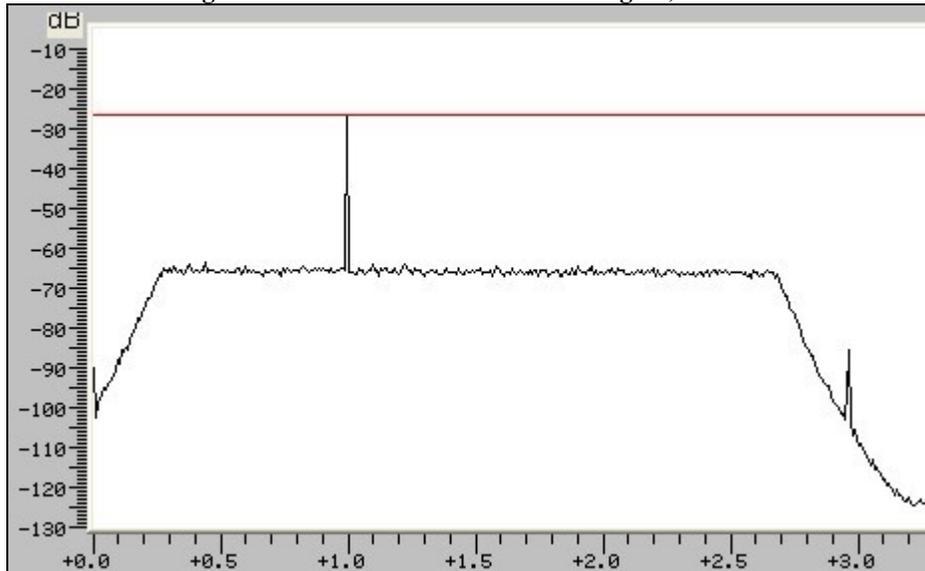
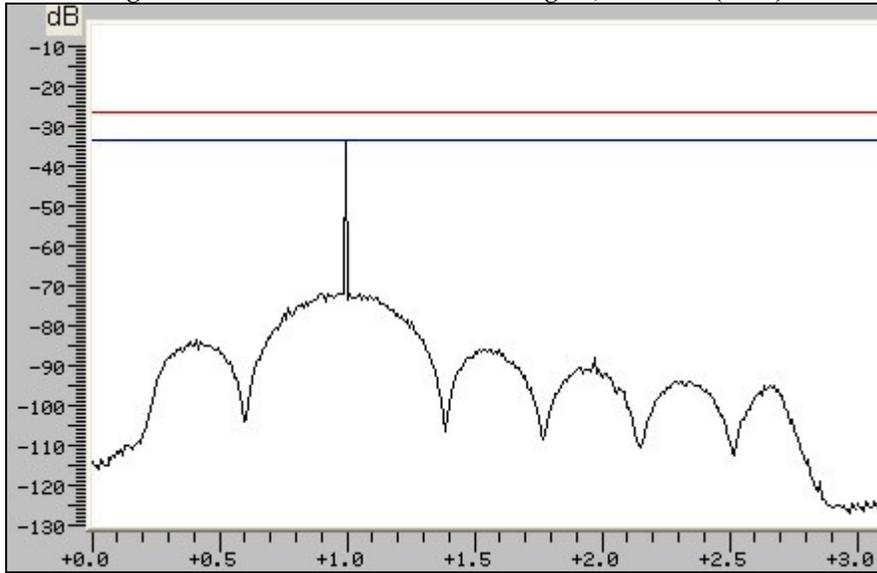


Figure 8: SSB 2.4 kHz. -120 dBm RF signal, max. NR (55%).



**6: Manual Notch Filter (MNF) stopband attenuation and bandwidth.** In this test, an RF signal is applied at a level slightly more than 70 dB above MDS. The test signal is offset 1 kHz from the receive frequency to produce a test tone. The MNF is carefully tuned to null out the tone completely at the receiver audio output. The stopband attenuation is equal to the difference between the test signal power and MDS.

**Test Conditions:** 14.100 MHz USB at -72 dBm (S9), 2.4 kHz Sharp, AGC MID, preamp off, ATT = 0 dB, NR off, NB off, MNF on, Twin PBT neutral.

Increase input level sufficiently to raise baseband level 3 dB above noise floor

**Results:** MNF nulls out signal completely. Measured MDS was -127 dBm per Test 1. A -57 dBm test signal was applied.

Thus, **stopband attenuation**  $\approx 70\text{dB}$  ( $= -127 - \{-57\}$ )

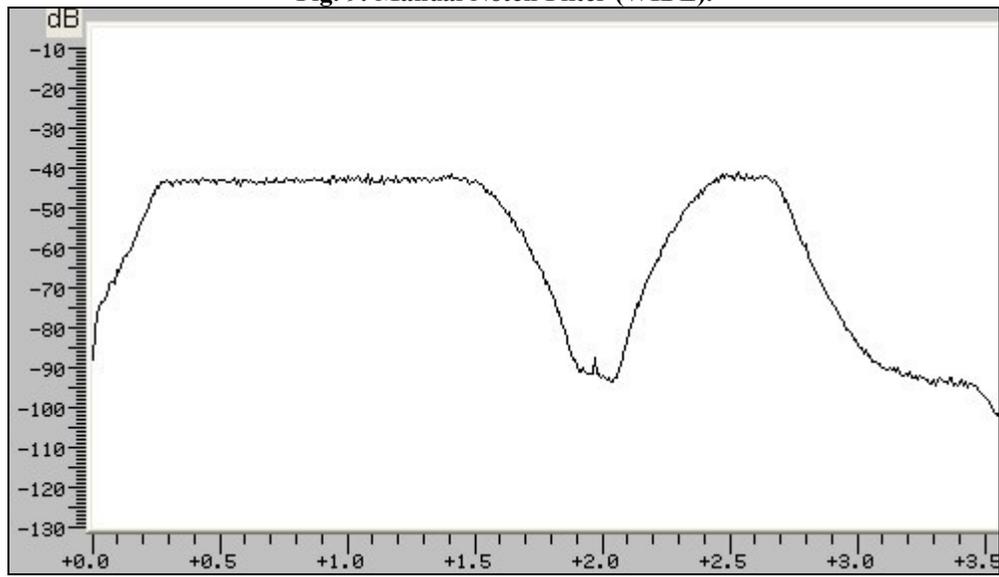
The receive frequency is now offset on either side of the null. The frequencies at which the audio output rises by 6 dB are noted. The **-6 dB bandwidth** is the difference between these two frequencies.

Table 10: MNF BW.

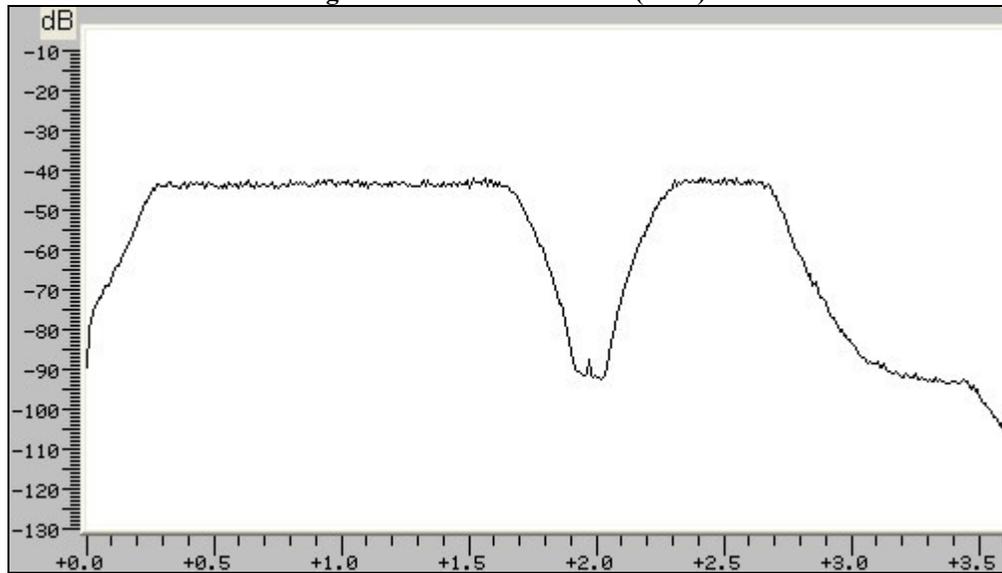
MNF -6 dB BW	
Wide	130 Hz
Mid	94 Hz
Narrow	67 Hz

The figures below depict the Manual Notch Filter stopband for **Wide**, **Mid** and **Narrow** settings. Due to the limited dynamic range of the measurement method, the accuracy of the amplitude scale is limited.

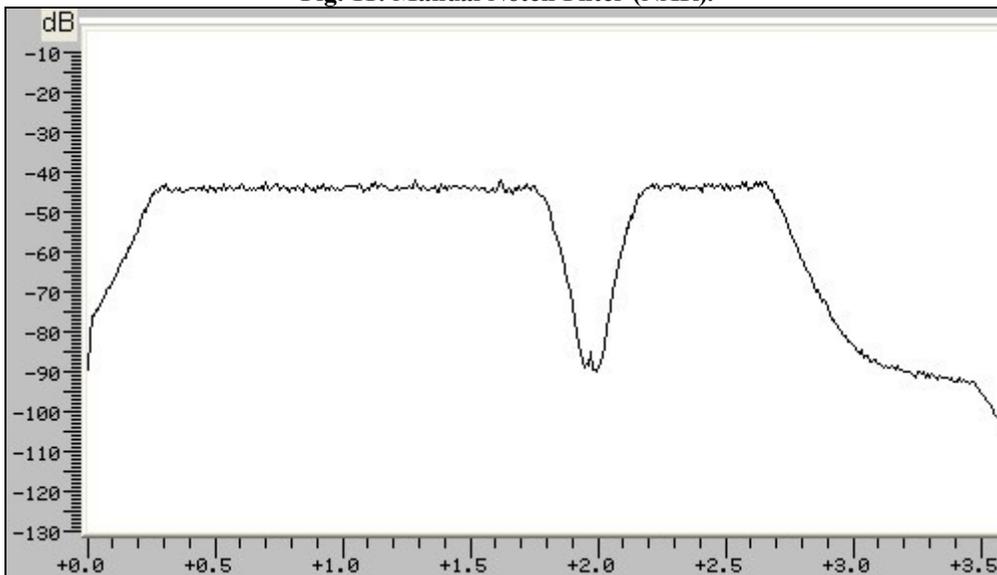
**Fig. 9: Manual Notch Filter (WIDE).**



**Fig. 10: Manual Notch Filter (MID).**



**Fig. 11: Manual Notch Filter (NAR).**



**7: AGC impulse response.** The purpose of this test is to determine the IC-7410's AGC response in the presence of fast-rising impulsive RF events. Pulse trains with short rise times are applied to the receiver input.

**Test Conditions:** 10.000 MHz LSB, 2.4 kHz SSB filter (Sharp), NR off, NB off/on, Preamp off/2, AGC Fast, with decay time set to 0.1 sec.

**Test with pulse trains.** Here, the pulse generator is coupled to the IC-7410 RF input via the pick-off port of a line sampler. The sampler's main port is terminated in 50Ω. The IC-7410 is tuned to 10 MHz, as the RF spectral distribution of the test pulse train has a strong peak in that band. AGC Fast (0.1 sec) and Preamp 2 are selected.

The pulse rise time (to 70% of peak amplitude) is 10 nS. Three pulse durations are used: 30, 50 and 100 nS. In all cases, pulse period is 600 mS. Pulse amplitude is 16V<sub>pk</sub> (e.m.f.)

The AGC recovers completely; there is no evidence of clamping.

**Table 11: AGC impulse response.**

Pulse duration ns	AGC recovery ms	S: Pre off	S: Pre 2
30	≈ 100 (no clamping)	S2	S7
50	≈ 100 (no clamping)	S2.5	S8
100	≈ 100 (no clamping)	S1	S8

**8: Noise blanker (NB) impulse response.** As the IC-7410's noise blanker is a DSP process "upstream" of the AGC derivation point, the NB should be very effective in suppressing impulsive RF events before they can stimulate the AGC. To verify this, the NB is turned on during Test 7b (above). NB Level is adjusted for best suppression of the test pulses.

At 30 nS pulse duration, the S-meter deflection is *completely suppressed* (with Preamp off, 1 and 2) showing that the impulsive events never reach the AGC derivation point. At NB Level = 25%, Depth 8\*, Width 85, occasional faint ticks are heard. At Width 100, the pulse ticks are almost inaudible with Preamp off; with Preamp 2, a very faint "chuff" sound is heard for each pulse. Signals and/or band noise would mask these artifacts completely.

Next, NR is activated. With NR at 60% and NB on, the ticks are *completely inaudible*. As in other Icom IF-DSP radios, the NB mitigates AGC response to fast-rising RF events.

*\*default value*

**9: S-meter tracking & AGC threshold.** This is a quick check of S-meter signal level tracking.

**Test Conditions:** 2.4 kHz USB, Preamp off, ATT off, AGC MID.

A 14.100 MHz test signal at MDS is applied to the RF input. The signal power is increased, and the level corresponding to each S-meter reading is noted. (S9 readings are taken with Preamp off, Preamp 1 and Preamp 2 in turn.)

**Table 12: S-Meter Tracking.**

S	S0	S1	S2	S3	S4	S5	S6	S7	S8	S9	S9+10	S9+20	S9+30	S9+40	S9+50	S9+60
<b>dBm</b>	-96	-94	-91	-88	-86	-83	-80	-77	-75	-72	-62	-52	-43	-34	-23	-14
Preamp 1 on: S9 = -79 dBm. Preamp 2 on: S9 = -88 dBm.																
Measured AGC threshold (preamp OFF): -98 dBm (from Test 4)																

**9a: Attenuator tracking.** This is a quick verification of attenuator accuracy.

**Table 13: ATT Value.**

ATT	Value dB
OFF	0
ON	18

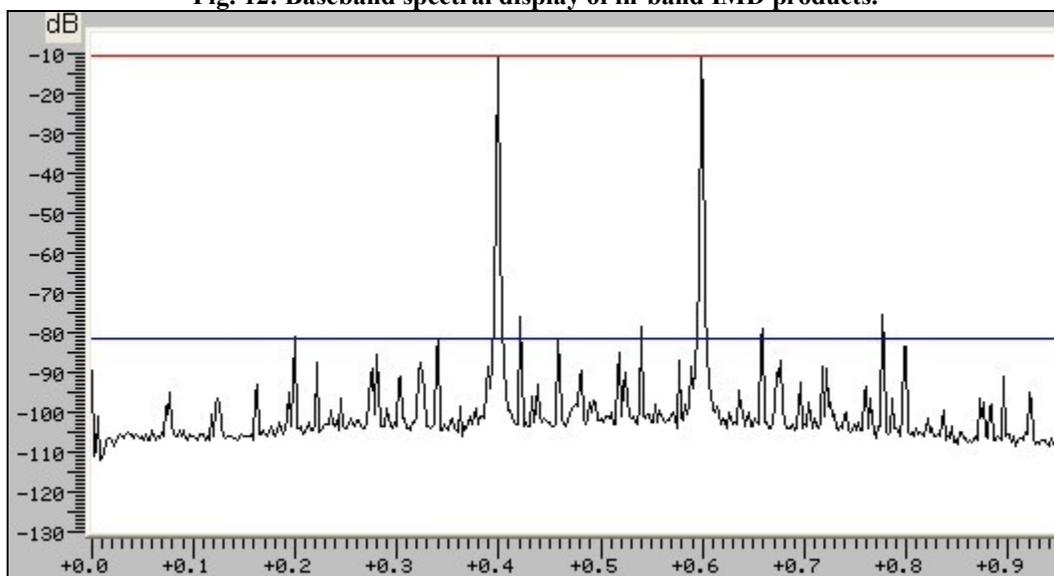
**10. In-Band IMD test.** The purpose of the In-Band IMD Test is to measure the intermodulation (IMD) products present in the audio output of the receiver when two closely-spaced signals (both falling within the IF passband) are applied to the RF input.

In this test, two signals  $f_1$  and  $f_2$  of equal amplitude and separated by 200 Hz offset are injected into the receiver input.  $f_1 = 10000.0$  and  $f_2 = 10000.2$  kHz. The 3<sup>rd</sup>-order IMD products are at 9999.8 and 10000.4 kHz respectively.

The two test signals are combined in a passive hybrid combiner and applied to the receiver input via a step attenuator. A baseband spectrum analyzer (here a PC running a FFT spectral-analysis program) is connected to the IC-7410's rear-panel USB port.

**Test Conditions:** IC-7410 tuned to 9999.6 kHz, 3.6 kHz USB, NR off, NB off, Preamp off, ATT off, AGC-F. RF input power -57 dBm composite (each test signal -63 dBm). Baseband spectrum analyzer reference level adjusted to place test signals at -10 dB line. **Fig. 12** illustrates the test signals and 3<sup>rd</sup>-order IMD products.

**Fig. 12: Baseband spectral display of in-band IMD products.**



On the X-axis, +0.0 kHz  $\hat{=}$  9999.6 kHz (virtual carrier).  $f_1$  is at +0.4 kHz,  $f_2$  at +0.6 kHz. The 3<sup>rd</sup>-order IMD products are at +0.2 and +0.8 kHz respectively.

**Test Result:** In-band IMD =  $-10 - (-82) = -72$  dB.

**11. Two-Tone 3<sup>rd</sup>-Order Dynamic Range (DR<sub>3</sub>) & Third-Order Intercept (IP<sub>3</sub>).** The purpose of this test is to determine the range of signals which the receiver can tolerate while essentially generating no spurious responses.

In this test, two signals of equal amplitude P<sub>i</sub> and separated by a known offset Δf are injected into the receiver input. If the test signal frequencies are f<sub>1</sub> and f<sub>2</sub>, the offset Δf = f<sub>2</sub> - f<sub>1</sub> and the 3<sup>rd</sup>-order intermodulation products appear at (2f<sub>2</sub> - f<sub>1</sub>) and (2f<sub>1</sub> - f<sub>2</sub>).

The two test signals are combined in a passive hybrid combiner and applied to the receiver input via a step attenuator. The receiver is tuned to the upper and lower 3<sup>rd</sup>-order IMD products (2f<sub>2</sub> - f<sub>1</sub> and 2f<sub>1</sub> - f<sub>2</sub> respectively) which appear as a 600 Hz tone in the speaker. The per-signal input power level P<sub>i</sub> is adjusted to raise the noise floor by 3 dB, i.e. IMD products at MDS. The P<sub>i</sub> values for the upper and lower products are recorded and averaged.

**Note:** If the audio output drops by less than 3 dB when one of the test signals is removed, the measurement is noise-limited (indicated by NL in the table.)

$$DR_3 = P_i - \text{MDS}. \quad \text{Calculated } IP_3 = (1.5 * DR_3) + \text{MDS}.$$

**Test Conditions:** 14.1 MHz, CW mode, 500 Hz filter, AGC off, ATT off, NR off, NB off, CW Pitch = 12 o'clock. DR<sub>3</sub> in dB; IP<sub>3</sub> in dBm. NL = noise limited.

Table 14: DR<sub>3</sub> and IP<sub>3</sub> at 14.1 MHz. Δf in kHz, DR<sub>3</sub> in dB, IP<sub>3</sub> in dBm.

Roof	Preamp off						Preamp 1						Preamp 2					
	15		6		3		15		6		3		15		6		3	
Δf	DR3	IP3	DR3	IP3	DR3	IP3	DR3	IP3	DR3	IP3	DR3	IP3	DR3	IP3	DR3	IP3	DR3	IP3
3	79NL		80NL		80NL		80NL		80NL		81NL		78	-26	79	-25	80NL	
5	85	-2	88	-2	89	-1	84	-16	87	-12	89	-9	79	-25	85	-16	88	-11
7	89	-1	91	3	95	8	87	-12	92	-4	94	-1	82	-20	90	-8	92	-5
10	95	8	97	11	98	13	93	-3	96	2	97	9	87	-13	94	-2	94	-2
20	99	14	99	14	100	16	98	5	99	6	100	8	91*	-7	98	4	99	5
30	98	13	99	14	102	19	99	6	100	8	99	6	97	2	98	4	98	4
50	100	16	100	16	101	17	100	8	100	8	101	9	99	5	99	5	99	5

\* Reading depressed by low-level spur at 14.140 MHz.

**11. Two-Tone 2<sup>nd</sup>-Order Dynamic Range (DR<sub>2</sub>) & Second-Order Intercept (IP<sub>2</sub>).** The purpose of this test is to determine the range of signals far removed from an amateur band which the receiver can tolerate while essentially generating no spurious responses within the amateur band.

In this test, two widely-separated signals of equal amplitude P<sub>i</sub> are injected into the receiver input. If the signal frequencies are f<sub>1</sub> and f<sub>2</sub>, the 2<sup>nd</sup>-order intermodulation product appears at (f<sub>1</sub> + f<sub>2</sub>). The test signals are chosen such that (f<sub>1</sub> + f<sub>2</sub>) falls within an amateur band.

The two test signals are combined in a passive hybrid combiner and applied to the receiver input via a step attenuator. The receiver is tuned to the IMD product ( $f_1 + f_2$ ) which appears as a 600 Hz tone in the speaker. The per-signal input power level  $P_1$  is adjusted to raise the noise floor by 3 dB, i.e. IMD product at MDS. The  $P_1$  value is then recorded.

$$DR_2 = P_1 - \text{MDS}. \text{ Calculated } IP_2 = (2 * DR_2) + \text{MDS}.$$

**Test Conditions:**  $f_1 = 6.1$  MHz,  $f_2 = 8.1$  MHz, CW mode, 500 Hz filter, AGC off, ATT off, NR off, NB off, CW Pitch = 12 o'clock.  $DR_2$  in dB;  $IP_2$  in dBm.

**Table 14: MDS in dBm,  $DR_2$  in dB,  $IP_2$  in dBm.**

Preamp	MDS, 14.2 MHz	$DR_2$	$IP_2$
off	-137	102	67
1	-142	103	64

**12. Roofing-filter bandwidth (approximate):** This is a non-invasive test, in which the widest available DSP-IF filter (10 kHz AM) is selected. A CW test signal is applied at the S9 level (-72 dBm). The receiver is then de-tuned above and below the center frequency for a 1 S-unit ( $\approx 3$  dB) drop in S-meter reading, and the frequency offsets  $\Delta f$  and  $-\Delta f$  recorded. The 3 dB bandwidth  $B_{3dB} = 2\Delta f$ .

This procedure is useful for checking the 6 and 3 kHz roofing filters, but not the 15 kHz filter. This restriction is imposed by the 10 kHz maximum DSP-IF filter bandwidth.

**Test Conditions:** 10 MHz, AM mode, 10 kHz IF filter, AGC-M, ATT off, NR off, NB off, Preamp off.

**Table 15: Roofing Filter BW in kHz**

Nominal BW	Meas. 3 dB BW
6	$\approx 10^*$
3	$\approx 7.2$

*\* 10 kHz is the limiting case due to the DSP IF filter bandwidth of 10 kHz. It is possible that the actual bandwidth of the 6 kHz roofing filter exceeds 10 kHz.*

**13. AGC action** due to signal within roofing-filter passband but outside the DSP IF channel: The purpose of this test is to determine the input power level at which an unwanted signal falling within the roofing-filter window, but outside the DSP IF passband, starts stimulating the AGC.

**Test Conditions:** 10 MHz, CW, 250 Hz IF filter, 3 kHz roofing filter, AGC-M, ATT off, NR off, NB off, Preamp off. Offset tuning by +500 Hz.

AGC action (S-meter indication) starts at **-25 dBm** test signal power, due to effect of reciprocal mixing noise. When offset is increased to +1 kHz, S-meter indication starts at **-24 dBm**.

**14. 1<sup>st</sup>-IF image rejection:** In this test, the IC-7410 is tuned to a mid-band frequency  $f_0$ , and a test signal is applied at  $f_0 +$  twice the 1<sup>st</sup> IF. The test signal power is increased sufficiently to raise the noise floor by 3 dB.

**Test Conditions:**  $f_0 = 15$  MHz, CW, 500 Hz IF filter, 15 kHz roofing filter, AGC-M, ATT off, NR off, NB off, Preamp off. Set main tuning to 15.000 MHz. Test signal freq. =  $(2 * 64.455) + 15 = 143.91$  MHz.

Measured MDS = -135 dBm. Test signal power for 3 dB noise floor increase = -20 dBm. Thus, image rejection =  $-20 - (-135) = 115$  dB.

**14a. 1<sup>st</sup>-IF rejection:** In this test, the IC-7410 is tuned to a mid-band frequency  $f_0$ , and a test signal is applied to the antenna port at the 64.455 MHz 1<sup>st</sup> IF. The test signal power is increased sufficiently to raise the noise floor by 3 dB.

**Test Conditions:**  $f_0 = 15$  MHz, CW, 500 Hz IF filter, 15 kHz roofing filter, AGC-M, ATT off, NR off, NB off, Preamp off. Set main tuning to 15.000 MHz. Test signal freq. = 64.455 MHz.

Measured MDS = -135 dBm. Test signal power for 3 dB noise floor increase = -26 dBm. Thus, 1<sup>st</sup>-IF rejection =  $-26 - (-135) = 102$  dB.

**15. Audio THD:** In this test, an audio distortion analyzer is connected to the external speaker output. An 8 $\Omega$  resistive load is connected across the analyzer input. An S7 to S9 RF test signal is applied to the antenna input, and the main tuning is offset by 1 kHz to produce a test tone. The audio voltage corresponding to 10% THD is then measured, and the audio output power calculated.

**Test Conditions:** 10 MHz, USB, 3 kHz IF filter, 15 kHz roofing filter, AGC-F, ATT off, NR off, NB off, Preamp off. Offset tuning by -1 kHz.

Measured audio output voltage = 3.9V rms. Thus, audio power output =  $\sqrt{[(3.9)^2 / 8]} = 1.9\text{W in } 8\Omega$ . (Spec. is 2W).

## B. Transmitter Tests

**16: 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 16: CW Power Output.

RF Power %	P <sub>o</sub> Meter %	Power Output W		
	Freq. MHz	3.6	14.1	50.1
70	70	81	79	77
100	100	115	112	105

**16a: Autotuner (ATU) insertion loss.** In this test, the transmitter is set for 100W (+50 dBm) output (P<sub>1</sub>) on various bands. On each band, the ATU is activated and tuned, and the output (P<sub>2</sub>) measured and noted. ATU insertion loss = (P<sub>2</sub> - P<sub>1</sub>).

**Test Conditions:** RTTY mode, 3.6, 14.1 and 50.1 MHz successively, P<sub>1</sub> = +50 dBm, RF power meter and 50Ω resistive load connected to ANT1.

Table 17: ATU Insertion Loss.

Freq. MHz	P <sub>1</sub> (ATU in) dBm	P <sub>2</sub> (ATU out) dBm	ATU insertion loss dB
3.6	+50.0	+49.3	0.7
14.1	+50.0	+49.3	0.7
50.1	+50.0	+49.4	0.6

**16b: Autotuner “hunting” check.** In this test, the ATU is activated and tuned at 100W output on each band in turn. On each band, a brief SSB transmission is made, during which the tester checks aurally for ATU sounds and visually for random SWR “flutter” above 1:1.

**Test Conditions:** 1: RTTY mode, midband frequency on each band in turn, P<sub>o</sub> = 100W, RF power meter and 50Ω resistive load connected to ANT1. 2: Brief voice transmission in SSB mode.

No audible or visible evidence of ATU “hunting” was observed on any band.

**16c: SWR scale accuracy.** The SWR scale is read with 50Ω and 100Ω resistive loads connected in turn to ANT1. To minimize the effect of line lengths on measurement accuracy, this test is run at 1.8 MHz. The RF POWER setting remains unchanged when switching loads.

**Test Conditions:** 1.81 MHz RTTY. P<sub>o</sub> = 10W into 50Ω load.

Table 18: SWR Scale Accuracy.

Nominal Load	DC Resistance	SWR Reading
50Ω	50.1Ω	1:1
100Ω	100.9Ω	2:1

Note that with the 100Ω load, the SWR reading is somewhat dependent on P<sub>o</sub>.

**17: SSB Peak Envelope Power (PEP).** Here, an oscilloscope is terminated in  $50\Omega$  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.

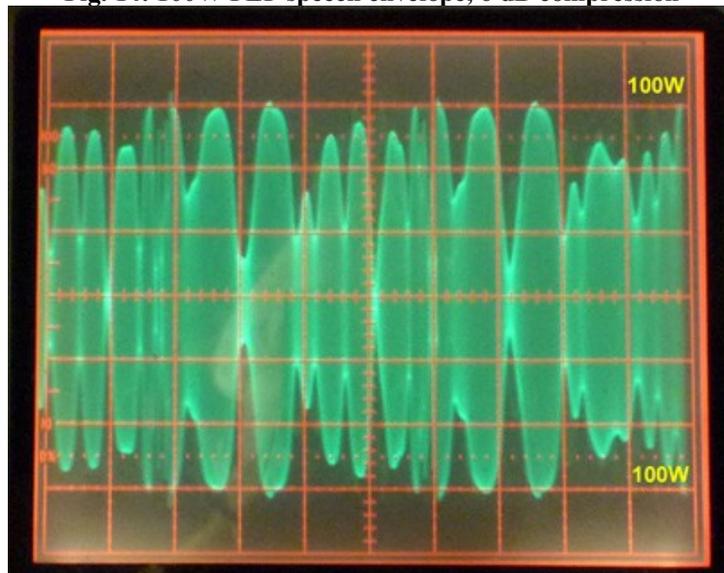
**Test Conditions:** USB mode, HM-36 mic connected, Mic Gain 45%, COMP OFF/ON, TBW = MID, COMP set at  $\approx 30\%$  (6 dB compression on voice peaks), SSB TX Bass/Treble set at 0 dB (default), supply voltage +13.8V.

Speak loudly into the microphone for full-scale ALC reading. **Figs. 13 & 14** show the envelope for 100W PEP, without and with compression respectively.

**Fig. 13: 100W PEP speech envelope, no compression**



**Fig. 14: 100W PEP speech envelope, 6 dB compression**



**17a: SSB ALC overshoot:** Reports of ALC overshoot in the IC-7410 Yahoo! Group led to an investigation of this issue. A test was performed in which white noise was applied via the USB port, and the RF envelope observed on an oscilloscope terminated in  $50\Omega$  and connected to the IC-9100 RF output via a 50 dB high-power attenuator.

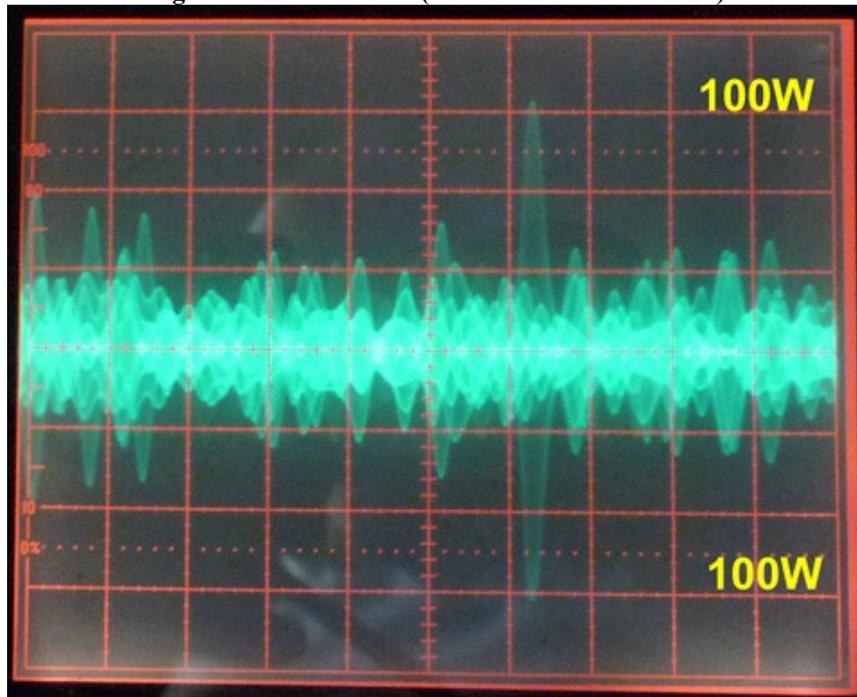
**Test Conditions:** 14100 kHz USB, COMP off, DATA OFF MOD = USB, USB MOD Level = 50% (default). Test signal: white noise. WIDE TBW (default value) selected. Supply voltage +13.8V.

Set  $P_o = 50W$  in RTTY mode. Select USB, then adjust USB Audio Codec device volume on computer for 50% ALC reading.

At 50W PEP, a leading-edge overshoot spike was observed about every two seconds, even with  $P_o$  set to 50W. The spike amplitude was +3 dB (100W). These overshoot levels are sufficiently high to fault out or even damage many amplifiers. The amplifier's ALC loop (if fitted) will not suppress the overshoot.

The ALC overshoot can be reduced to 1.5 dB by careful adjustment of baseband level (Mic Gain or USB MOD Level as appropriate) and Compression. This adjustment requires observation of the RF envelope with an oscilloscope, and is quite critical. PEP output drops sharply as the overshoot is reduced. **Fig. 15** shows a typical overshoot spike with baseband level set for 50W PEP.

**Fig. 15: ALC overshoot ( $\pm 1$  vert. div. = 100W PEP)**



**18: 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, USB Level = 50% (default). Test tones: 700 and 1700 Hz, at equal amplitudes.

On computer, adjust USB Audio Codec device volume for 100W PEP (each tone at -6 dBc). **Figs. 16, 17 and 18** show the two test tones and the associated IMD products.

**Fig. 16: Spectral display of 2-tone IMD at 3.6 MHz, 100W PEP.**

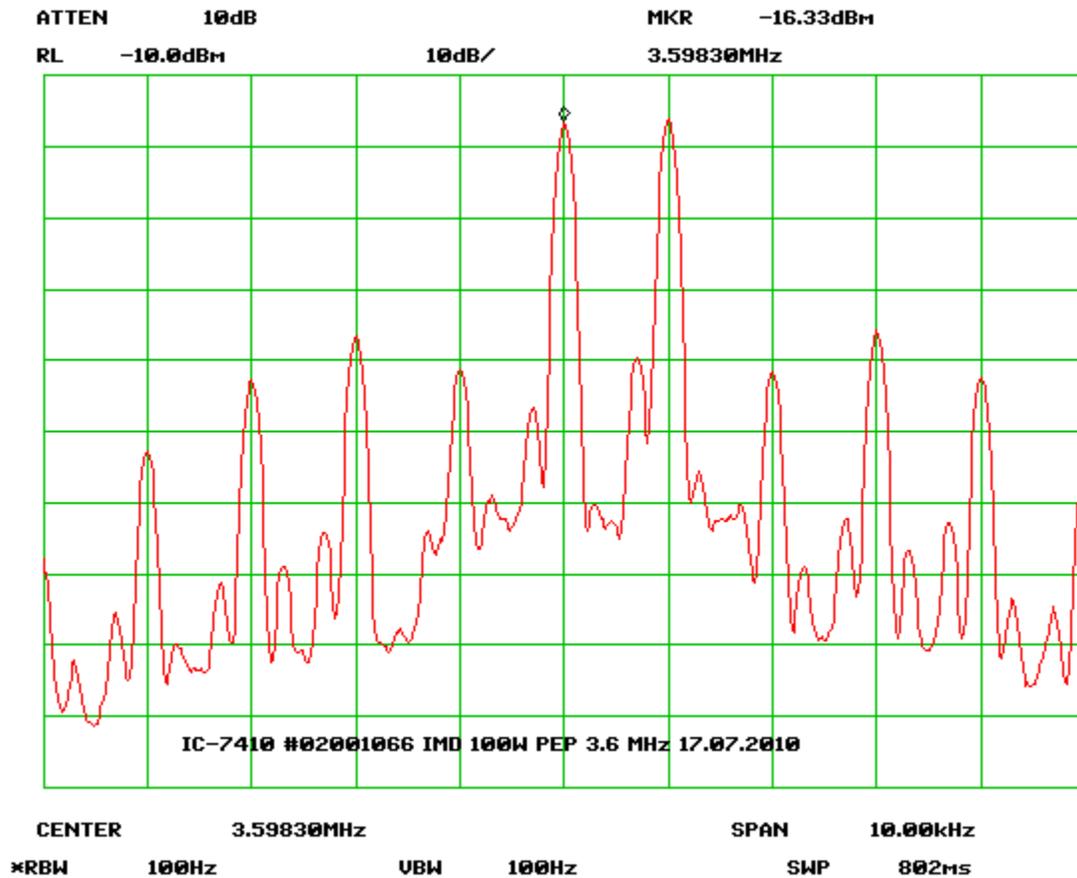


Fig. 17: Spectral display of 2-tone IMD at 14.1 MHz, 100W PEP.

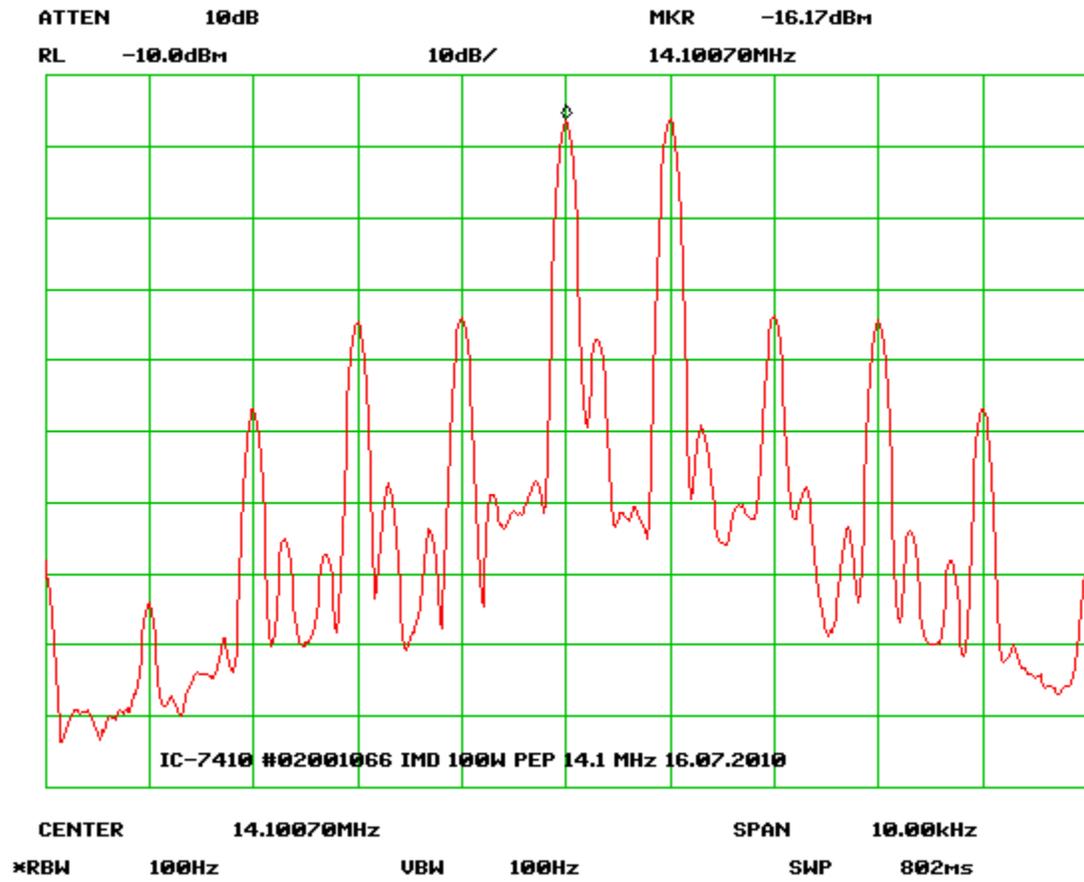


Fig. 18: Spectral display of 2-tone IMD at 50.1 MHz, 100W PEP.

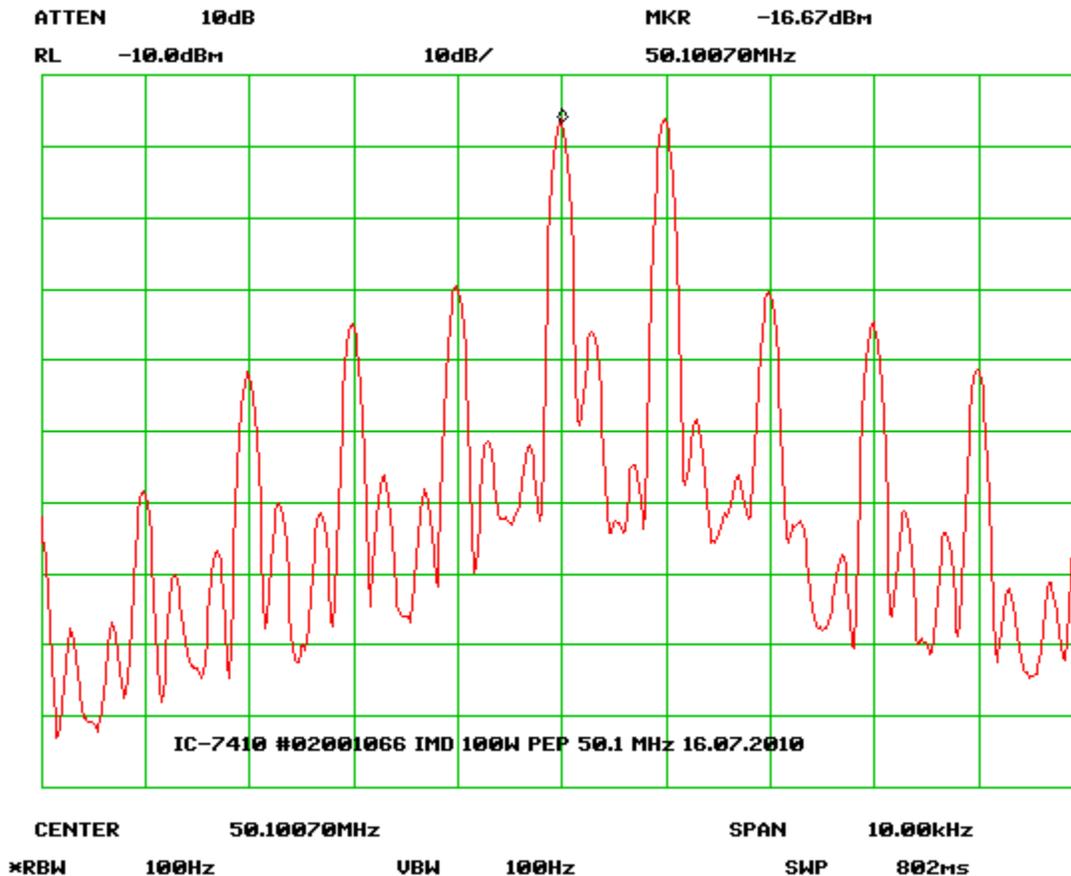


Table 19.

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 <sup>rd</sup> -order)	-42	-34	-30
IMD5 (5 <sup>th</sup> -order)	-37	-34	-35
IMD7 (7 <sup>th</sup> -order)	-43	-47	-42
IMD9 (9 <sup>th</sup> -order)	-53	-70	-56

**Fig. 19: AM Sidebands for 90% Modulation.**  
**IC-7410 #02001066 AM Sidebands 25W CXR 14.1 MHz 17.07.2010**

DISCRETE	SIDEBAND	SEARCH	RESULTS
CARRIER	FREQ:	14.10	MHz
CARRIER	POWER:	-16.0	dBm
OFFSET	FREQ	-	OFFSET
			+ OFFSET
			dBc
-----		-----	-----
.998	kHz	-6.7	-6.8
1.997	kHz	-44.5	-52.2
2.996	kHz	-32.7	-32.7
4.004	kHz	-59.5	-61.0
5.003	kHz	-49.8	-49.8
FOUND:	5	SETS	OF
			SIDEBANDS

**19: AM sidebands and THD with single-tone modulation.** As in Test 18 above, the spectrum analyzer is connected to the IC-7410 RF output via a 60 dB high-power attenuator. On the IC-7410, RF Power is adjusted for 25W resting carrier. The line sampler is adjusted to set the carrier at a convenient 0 dBc reference. A 1 kHz test tone is applied to the USB port from the tone-generator program running on the laptop computer. The spectrum analyzer records the carrier and sideband parameters.

**Test Conditions:** 14100 kHz AM, DATA OFF MOD = USB, USB Level = 50% (default).

On computer, adjust USB Codec device volume for -7 dBc test tone level (90% modulation.) **Fig. 19** shows the carrier and sideband levels. Calculated THD  $\approx$  **0.2%**.

**20: Transmitter harmonics & spectral purity.** Once again, the 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. The spectrum analyzer's harmonic capture utility is started.

**Test Conditions:** 3.6, 14.1 and 50.1 MHz RTTY, 100W output to 50Ω load. Utility start and stop frequencies are configured as shown in **Figs. 19b, 20b and 21b.**

Fig. 19a

IC-7410 #02001066 Harmonics 100W CW 3.6 MHz 17.07.2010

HARMONIC		MEASUREMENT		RESULTS	
FUNDAMENTAL		SIGNAL:		3.600	MHz
				-10.8	dBm
HARMONIC	LEVEL	dBc	FREQUENCY		
2	-83.3	*	7.200	MHz	
3	-73.7		10.80	MHz	
4	-87.5		14.40	MHz	
5	-97.3		18.00	MHz	
6	-93.0		21.60	MHz	
7	-86.7		25.20	MHz	
8	-103.3	*	28.80	MHz	
* MEASURED		LEVEL	MAY	BE	
NOISE		OR	LOST	SIGNAL.	
TOTAL	HARMONIC	DISTORTION		=	0 %
(OF	HARMONICS	MEASURED)			

Fig. 19b.

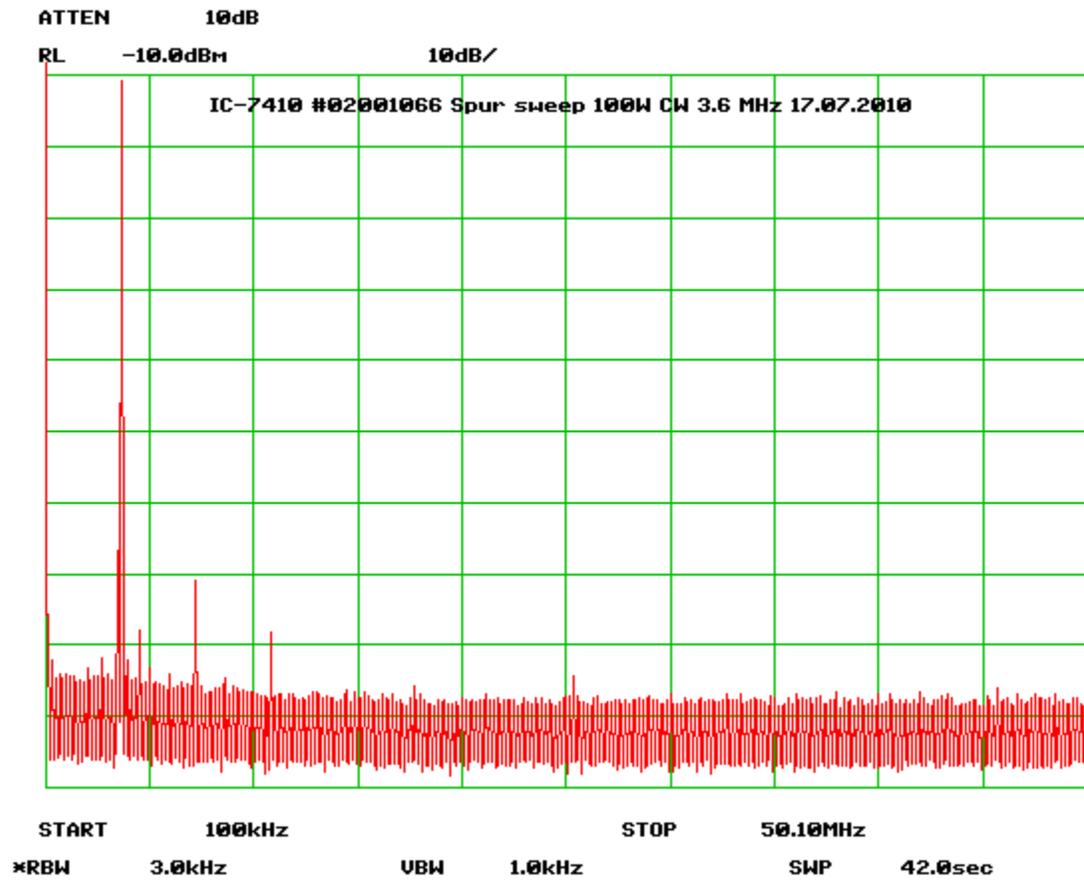


Fig. 20a.

IC-7410 #02001066 Harmonics 100W CW 14.1 MHz 17.07.2010

HARMONIC		MEASUREMENT		RESULTS	
FUNDAMENTAL		SIGNAL:		14.10	MHz
				-10.0	dBm
HARMONIC	LEVEL	dBc	FREQUENCY		
2	-73.3		28.20	MHz	
3	-66.7		42.30	MHz	
4	-85.2		56.40	MHz	
5	-88.5		70.50	MHz	
6	-96.8		84.60	MHz	
7	-98.0		98.70	MHz	
8	-105.8	*	112.8	MHz	
* MEASURED		LEVEL	MAY BE		
NOISE		OR	LOST	SIGNAL.	
TOTAL	HARMONIC	DISTORTION		=	.1 %
(OF	HARMONICS	MEASURED)			

Fig. 20b.

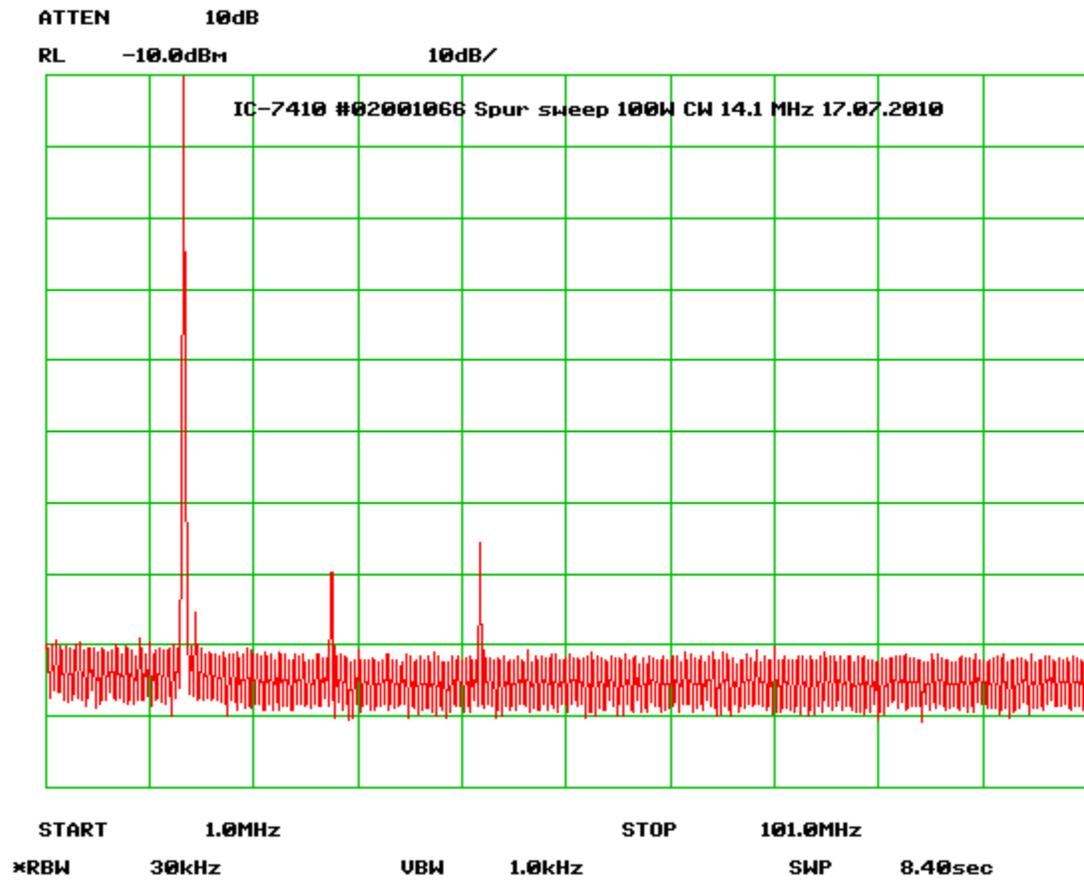
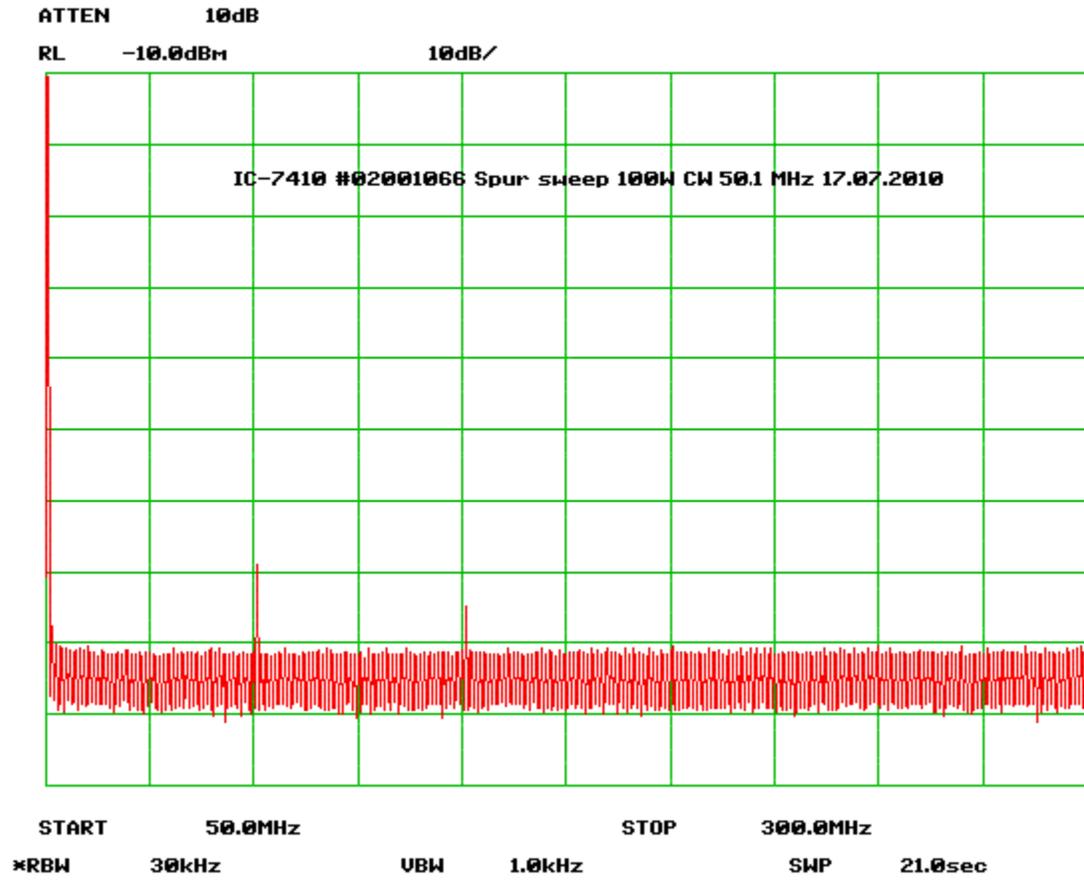


Fig. 21a.

IC-7410 #02001066 Harmonics 100W CW 50.1 MHz 17.07.2010

HARMONIC		MEASUREMENT		RESULTS	
FUNDAMENTAL		SIGNAL:		50.10	MHz
				-10.3	dBm
HARMONIC	LEVEL	dBc	FREQUENCY		
2	-86.8	*	100.2	MHz	
3	-77.8		150.3	MHz	
4	-87.8		200.4	MHz	
5	-91.3		250.5	MHz	
6	-103.0	*	300.6	MHz	
7	-99.8		350.7	MHz	
8	-104.5	*	400.8	MHz	
* MEASURED		LEVEL	MAY BE		
NOISE		OR	LOST	SIGNAL.	
TOTAL	HARMONIC	DISTORTION		=	0 %
(OF	HARMONICS	MEASURED)			

Fig. 21b.



**21: Transmitted composite noise.** As before, the 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. **Figs. 20a and 20b** 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 and spot frequencies configured as shown in **Figs. 21a, 21b and 21c.** (**Note:** The limitation of this measurement method is that the measured noise power is close to the spectrum analyzer's own noise floor.)

Fig. 21a: Composite noise at 3.6 MHz, 100W.

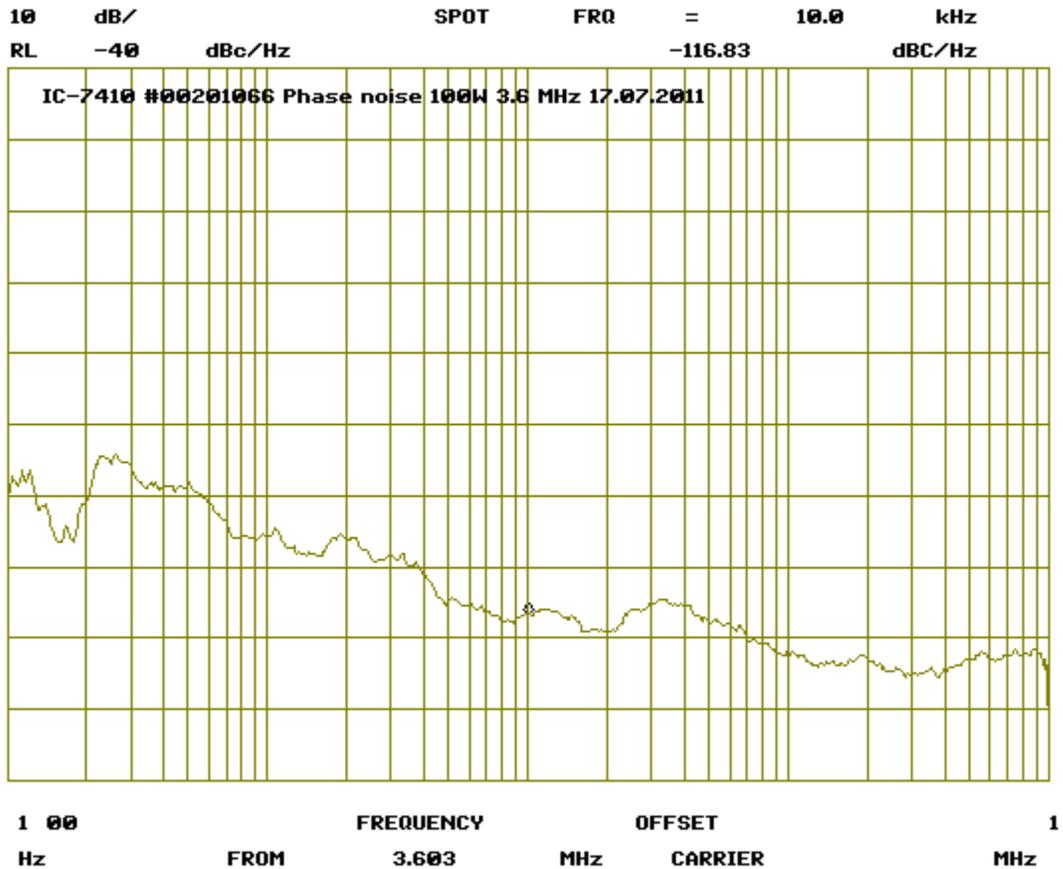


Fig. 21b: Composite noise at 14.1 MHz, 100W.

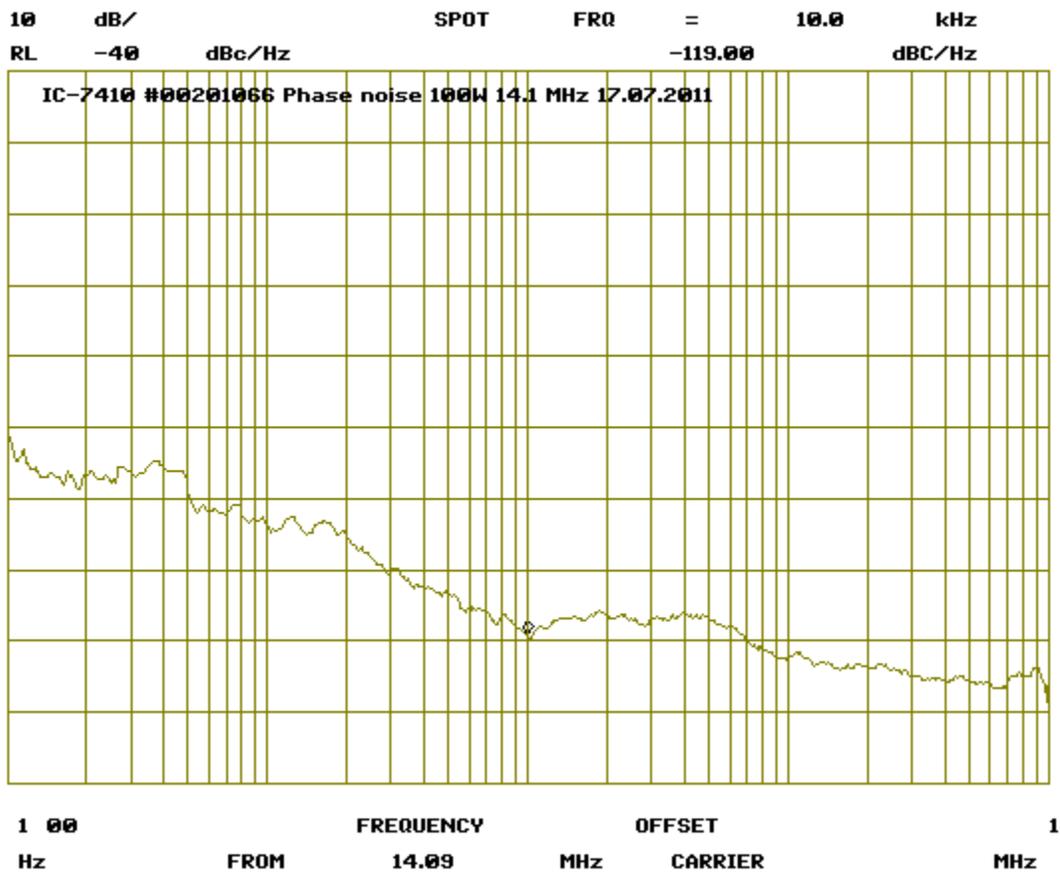
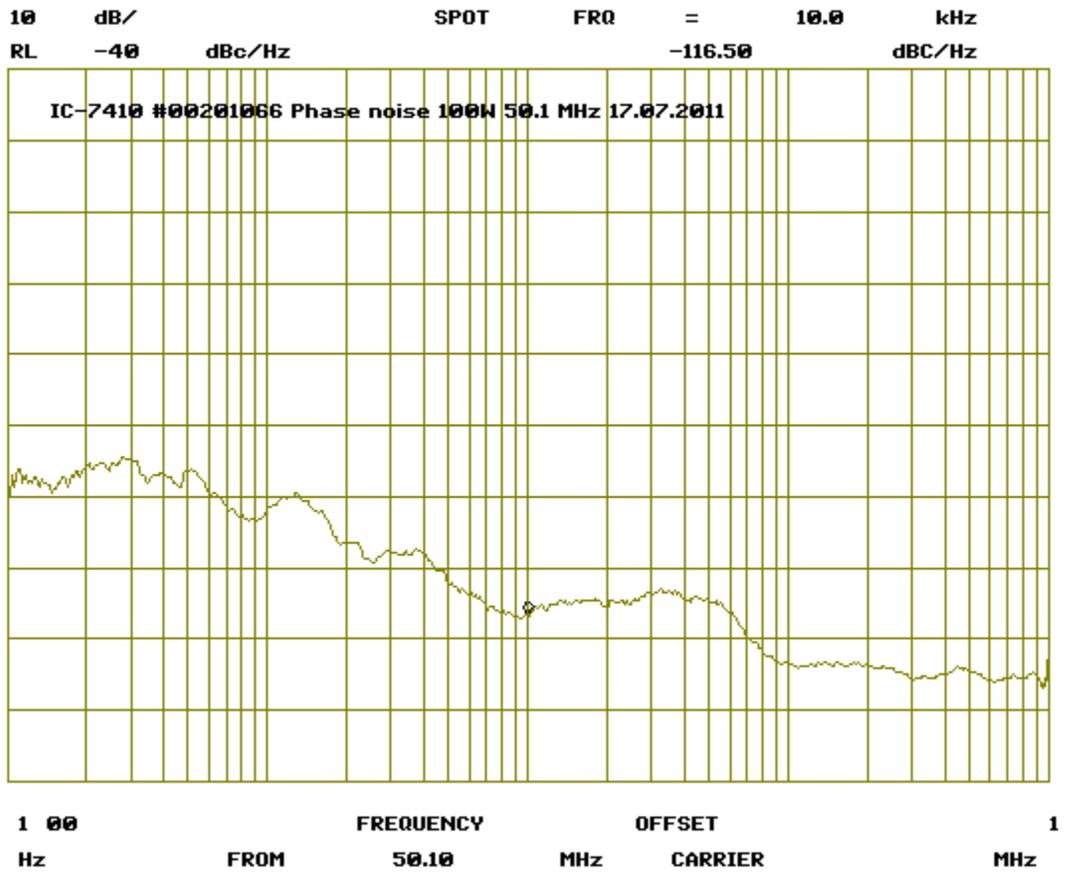


Fig. 21c: Composite noise at 50.1 MHz, 100W.



**22: Spectral display of CW keying sidebands.** Again, the 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. A series of dits is transmitted at the highest keying speed.

**Test Conditions:** 14.1 MHz CW, 100W output to 50Ω load. Equivalent keying speed ≈ 50 wpm (KEY SPEED max.) using internal keyer. CW rise time = 4 ms (default). Spectrum analyzer RBW is 10 Hz, video-averaged; sweep time < 4 sec. **Figs. 22a** and **22b** show the transmitter output ±5 kHz from the carrier.

Note the “comebacks” at ±4 kHz; these increase in amplitude as keying rate is increased and decrease at longer rise-time values. They are at < -70 dBc, so they should not normally create an on-air issue.

**Fig. 22a: Keying sidebands at ≈ 50 wpm, 4 ms rise-time 14.1 MHz, 100W.**

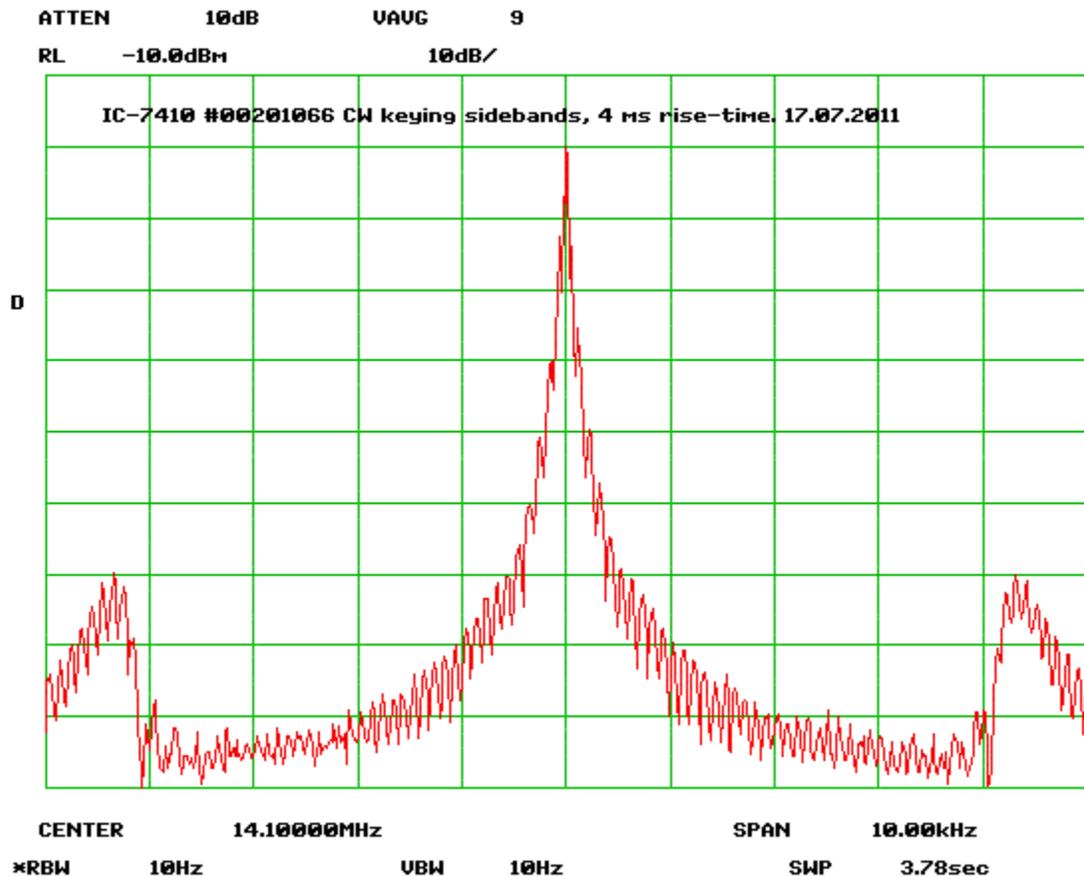
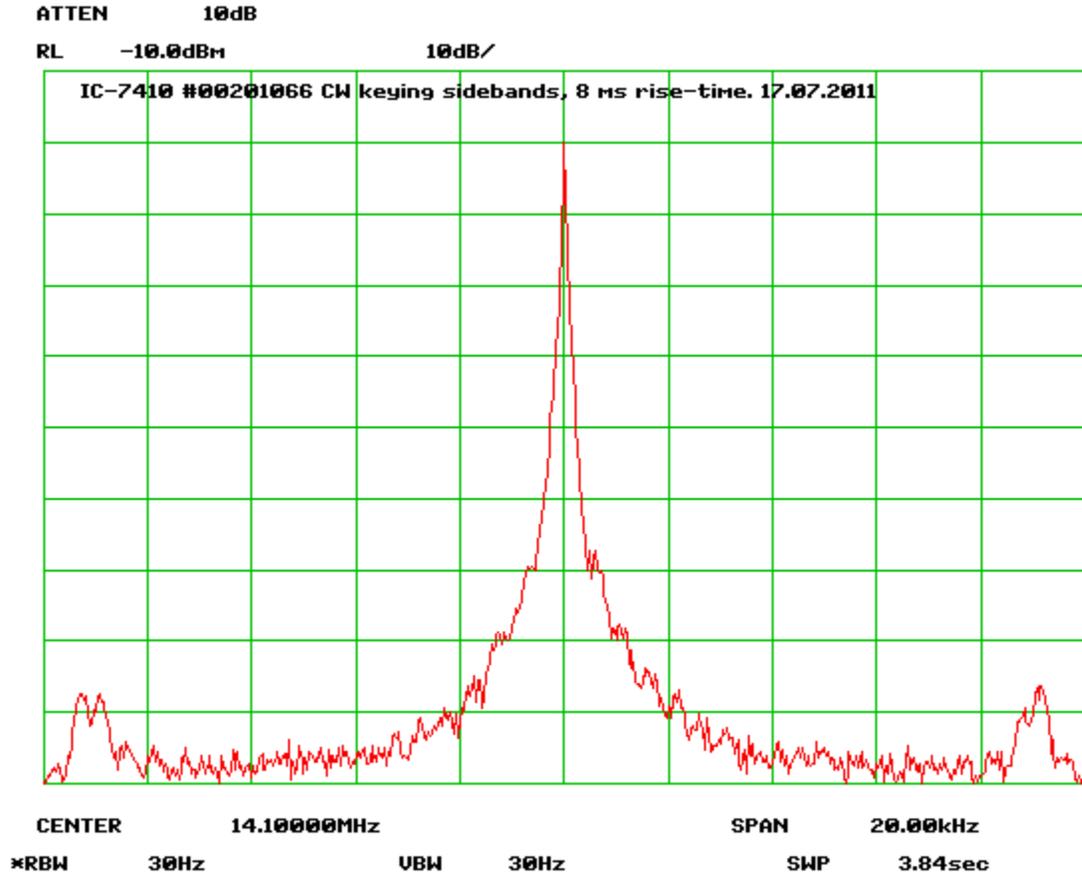


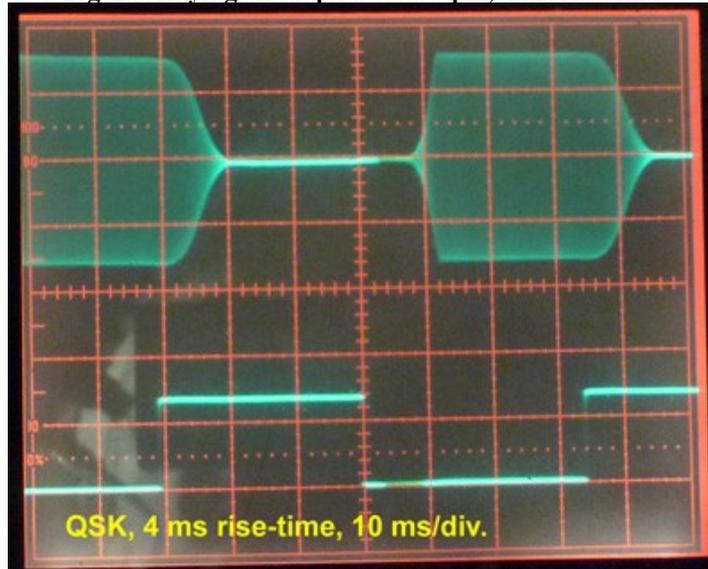
Fig. 22b: Keying sidebands at  $\approx 50$  wpm, 8 ms rise-time 14.1 MHz, 100W.



**22a. CW keying envelope:** The oscilloscope is terminated in  $50\Omega$  and connected to the IC-7410 RF output via a 60 dB high-power attenuator. A series of dits is transmitted from the internal keyer at the highest keying speed ( $\approx 50$  wpm) in QSK mode (F-BK).

**Test Conditions:** 14.1MHz CW, 100W output to  $50\Omega$  load. CW rise time = 4 ms (default).

Fig. 23: Keying envelope at  $\approx 50$  wpm, 4 ms rise time.



**22b. CW QSK recovery test:** This test was devised to address Yahoo! Group reports that CW QSK (full break-in) does not work well when using the internal keyer at speeds > 12 wpm. If a string of dits is transmitted at speeds > 12 wpm, the receiver does not recover between dits.

The IC-7410 is terminated in a 50Ω 100W load via an RF power meter. A test signal is injected into the signal path between the radio's antenna port and the power meter via a line sampler; a 20 dB attenuator at the sampling port protects the signal generator from reverse power. Test signal level is adjusted for S3...S5 at the receiver.

**Test Conditions:** 14.010 MHz CW, 500 Hz IF filter, preamp off, ATT off, NR off, NB off, F-BK on, rise time = 4 ms, KEY SPEED at max., CW Pitch at 12 o'clock. Test signal at 14.0101 MHz. Sidetone = 600 Hz, received tone = 500 Hz.

Starting at minimum KEY SPEED, transmit a continuous string of dits and increase KEY SPEED until the received tone can no longer be heard in the spaces between dits. In the test run performed on July 14, 2011, the received tone could just be heard at **12 wpm**, but was no longer audible above this speed.

**23: ACC Pin 11 (MOD, analog baseband input) level for 100W output.** A 1 kHz test tone is injected into ACC Pin 11, and the input voltage required for 100W RF output is noted.

**Test Conditions:** 14100 kHz USB, DATA OFF MOD = ACC, DATA-1 MOD = ACC, TBW = WIDE (default), test tone 1 kHz.

Adjust test tone level for 100W output in USB and USB-D1 modes. The required input levels were **35 mV rms** for USB, and **35 mV rms** for USB-D1.

A quick frequency-response check was also performed, using the spectrum analyzer. The test data are shown in **Table 20**.

**Table 20: Measured SSB TX lower and upper cutoff frequencies (via ACC Pin 11, MOD input).**

TBW	Lower (Hz)		Upper (Hz)	
	-6 dB	-28 dB	-6 dB	-20 dB
WIDE	73	60	2956	3100

**23a: Carrier and opposite-sideband suppression.** A 1 kHz test tone is applied to ACC Pin 1, or via the USB port. Carrier and opposite-sideband suppression are checked on the spectrum analyzer at 100W RF output.

**Test Conditions:** 14100 kHz USB, DATA OFF MOD = ACC, DATA-1 MOD = ACC, TBW = WIDE (default), test tone 1 kHz.

Adjust test tone level for 100W output in USB mode. Read carrier amplitude at 14100 kHz, and opposite-sideband amplitude at 14099 kHz.

**Result:** Carrier and opposite sideband both < -80 dBc.

**23b: SSB transmit audio-frequency response via USB port.** In this test, a white-noise baseband is applied to the USB port from a tone-generator program running on a laptop computer. The 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:** 14100 kHz USB, DATA OFF MOD = USB, USB Level = 50% (default). Test signal: white noise. WIDE, MID and NAR TBW are at default values.

On computer, adjust USB Audio Codec device volume for 45% ALC reading. Using Marker on spectrum analyzer, measure frequency and relative amplitude at lower passband edge. Move marker “down” 6 dB and record frequency. Move marker “down” a further 14 dB and record frequency again. Repeat procedure for upper passband edge. The test data are shown in **Table 20a**.

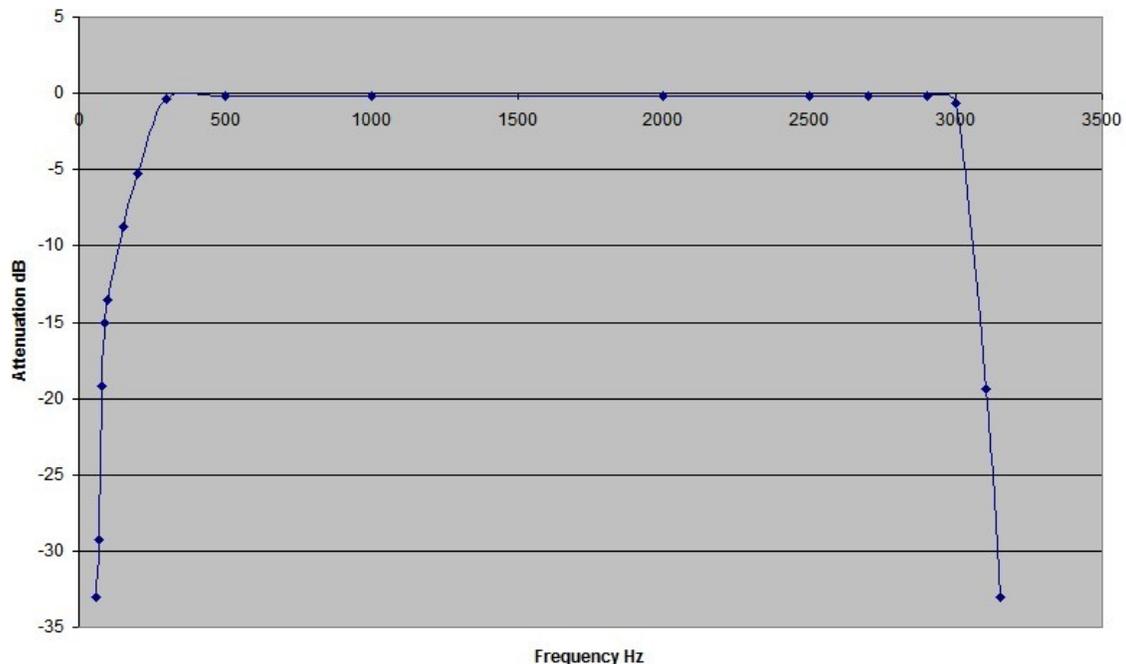
**Table 20a: Measured SSB TX lower and upper cutoff frequencies (via USB input).**

TBW	Lower (Hz)		Upper (Hz)	
	-6 dB	-20 dB	-6 dB	-20 dB
NAR	380	300	1980	2133
MID	227	133	2426	2587
WIDE	107	93	2860	2954

**23c: SSB transmit audio-frequency response via MIC socket.** To address a user enquiry concerning MIC socket frequency response, a swept measurement was performed manually with DATA OFF MOD = MIC, TBW = WIDE and a 3 mV rms test tone level. Fig. 24 shows that the MIC input is essentially flat in the range 300 Hz...3 kHz.

**Fig. 24.**

**IC-7410 MIC Input Response**



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