ID-5100 User Evaluation & Test Report

By Adam Farson VA7OJ/AB4OJ

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Part I: Brief User Evaluation.

Introduction: This report describes the evaluation and lab test of ID-5100 S/N 05001175. I was able to spend a number of days with the ID-5100 in my lab and ham-shack, and thus had the opportunity to briefly evaluate its on-air behavior.

1. Physical "feel" of the ID-5100: IC-2820 owners should find the ID-5100 quite familiar, and will immediately feel comfortable with it. The front-panel layout is similar to that of the IC-2820, although the new touch-screen has eliminated the need for many conventional keys. The learning curve should be minimal for IC-2820 owners, although those unfamiliar with D-Star operation may need more familiarization time.

The ID-5100 is solidly constructed and superbly finished. It conveys a tight, smooth, and precise overall feel (as do other Icom radios). The main radio unit is compact and is intended for remote mounting. A 3.5m separation cable is supplied to connect the radio unit to the control head, but the only microphone jack is in the radio unit. Unlike the IC-7100, the ID-5100 does not have a MIC jack in its control head. This necessitates an OPC-440 (5m) or OPC-647 (2.5m) microphone extension cable for remote mounting.

The control head has a 5.5" (diagonal) monochrome touch-screen display which gives the user control over all frequency-entry, mode selection, setup and memory functions. The screen image is crisp and clear. (See **Figure 4**.) In addition, a comprehensive keypad on the supplied HM-207 hand microphone allows control of all basic radio functions. This is especially useful when operating mobile.

2. Control knob/key functions and menus: Thanks to the touch-screen, front panel controls are minimal. The concentric volume/squelch and "tuning dial" controls for the Main and Sub (or A and B) bands are to the left and right of the screen respectively. The Power ON/OFF button, which doubles as the speech synthesizer key, is between the controls to the right of the screen. The only other keys are MENU, DR (D-Star Repeater), HOME (home call) and QUICK (quick menu/mute) are below the screen. This clean front-panel layout is a great aid to safe mobile operation.

3. Operating Notes: After a brief perusal of the Basic Manual, I was able to configure the ID-5100 for the lab test suite (including the crossband repeater feature) and also for basic FM and D-Star operating using local repeaters, without much trouble. I called in on local 2m and 70cm FM repeaters as well as a 2m D-Star repeater, and received good audio reports despite limited antenna facilities. Due to time constraints, I did not make use of the ID-5100's extensive memory-management or GPS capabilities.

21. Acknowledgements: I would like to thank and Paul Veel VE7PVL and Jim Backeland VE7JMB at Icom Canada for making the ID-5100 available to me for testing and evaluation.

Adam Farson, VA7OJ/AB4OJ e-mail: farson@shaw.ca

Part II: Performance Tests on ID-5100 S/N 05001175

As performed in my home RF lab, August 4 – 10, 2014.

A. FM & AM Receiver Tests

1: 12 dB SINAD FM sensitivity: In this test, the DUT external speaker jack is connected to AUDIO IN on the communications analyzer ($Z_{in} = 8\Omega$), and the analyzer's RF IN/OUT port is connected to the DUT ANT port. An FM signal is applied, modulated by a 1 kHz tone with 3 kHz (FM) or 2 kHz (FM-N) peak deviation. The input signal level for 12 dB SINAD is recorded (Table 1). ***Note:*** No DV receiver tests were conducted, as a suitable test set was unavailable.

Table 1: FM Sensitivity.

12 dB SINAD	146 MHz		446 MHz	
	FM	FM-N	FM	FM-N
dBm	-124	-125	-124	-124
μV	0.14	0.13	0,14	0.14

Table 1a: FM Sensitivity (out-of-band).

12 dB SINAD	155 MHz		460 MHz	
	FM	FM-N	FM	FM-N
dBm	-124	-125	-123	-124
μV	0.14	0.13	0.16	0.13

1a: AM (Air Band) Sensitivity. Here, an AM test signal with 30% modulation at 1 kHz is applied to the DUT ANT port. The RF input power which yields 10 dB (S+N)/N is recorded (Table 2).

Table 2: AM Sensitivity.

10 dB S/N	121.0 MHz	
	AM	AM-N
dBm	-109	-110
μV	0.8	0.7

2: Squelch Sensitivity. In this test, the squelch is set at threshold, and an unmodulated signal is applied to the ANT port. The RF input level which just opens the squelch is recorded (Table 3).

Table 3: Squelch Sensitivity (FM).

	146 MHz	446 MHz
dBm	-130	-130
μV	0.7	0.7

3. CTCSS Decoding: For this test, the communications analyzer is set up to encode a 1Z (100 Hz) CTCSS tone at 700 kHz peak deviation. The test signal is modulated with this tone. The minimum RF input level for reliable decoding is recorded. Next, the RF input level is adjusted for 12 dB SINAD at the external speaker jack, the tone deviation is slowly increased from minimum and the deviation for reliable decoding is recorded.

Test Results:

a. At 146 MHz, 700 Hz deviation, minimum input level = -130 dBm (0.07 μV).
b. At 12 dB SINAD input level, decoding is reliable at 200 Hz tone deviation.

4. Audio THD: In this test, a 146 MHz FM at -96 dBm, modulated by a 1 kHz tone with 3 kHz peak deviation, is applied to the DUT. 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 read off the analyzer, and the audio output power calculated.

Test Results: Measured audio output voltage = 6.5V rms.
Thus, audio power output = $\sqrt{[(6.5)^2/8]}$ ≈ **5.3W in 8Ω**. (Spec is 5W).

5. Two-Tone 3rd-Order Dynamic Range (DR_3), EIA Method: The purpose of this test is to determine the range of signals which the receiver can tolerate in the FM mode while producing no spurious responses greater than the SINAD level.

Two test signals f_1 and f_2, of equal amplitude and spaced 20 kHz apart, are applied to the DUT antenna port. The signal 40 kHz removed from the IMD product being measured is modulated at 1 kHz, with 3 kHz deviation. The receiver is tuned to the IMD products $(2f_1\text{-}f_2)$ and $(2f_2\text{-}f_1)$. The test signal levels are then increased simultaneously by equal amounts until the IMD product reads 12 dB SINAD. The DR_3 values for the upper and lower IMD products are averaged to yield the final result (Table 4).

Test Conditions:

2m, I: 146 MHz, FM. f_1 = 146.000 MHz modulated at 1 kHz, f_2 = 146.020 MHz, modulation off. Peak deviation = 3 kHz. IMD_3 product at 146.040 MHz.

2m, II: 146 MHz, FM. f_1 = 146.000 MHz modulation off, f_2 = 146.020 MHz, modulated at 1 kHz. Peak deviation = 3 kHz. IMD_3 product at 145.980 MHz.

70cm, I: 440 MHz, FM. f_1 = 446.000 MHz modulated at 1 kHz, f_2 = 446.020 MHz, modulation off. Peak deviation = 3 kHz. IMD_3 product at 446.040 MHz.

70cm, II: 440 MHz, FM. f_1 = 446.000 MHz modulation off, f_2 = 446.020 MHz, modulated at 1 kHz. Peak deviation = 3 kHz. IMD_3 product at 445.980 MHz.

Table 4. FM DR3 at 20 kHz spacing.

Frequency MHz	DR3 dB
146	72
446	74

6. FM Receive Adjacent-Channel Selectivity: In this test, two FM signals are applied to the DUT antenna port at 20 kHz channel spacing. The desired signal is modulated at 1 kHz, and the undesired signal at 400 Hz (both at 3 kHz deviation). Initially, the desired signal level is adjusted for 12 dB SINAD, and then the undesired signal level is increased until SINAD on the desired signal is degraded to 6 dB. The adjacent-channel rejection is the ratio of the undesired to the desired signal level.

Test Conditions: 146 MHz, FM. f_1 = 146.000 MHz modulated at 1 kHz, f_2 = 146.020 MHz modulated at 400 Hz. Peak deviation = 3 kHz for f_1 and f_2.

Set f_1 level to -124 dBm (for 12 dB SINAD per ***Test 1*** above.) Increase f_2 level until measured SINAD drops to 6 dB. Note this level.

Adjacent-channel rejection = f_2 level – f_1 level (in dB.)

Repeat entire test with f_2 = 145.980 MHz. Test results should be unchanged. (Table 5).

Table 5. FM adj. chan. rejection at 20 kHz spacing.

Mode	Deviation kHz	Rej. ($f_2 > f_1$)	Rej. ($f_2 < f_1$)
FM	3	70	70

7. 1st-IF Image Rejection: In this test, the DUT is tuned to a convenient frequency $\boldsymbol{f_0}$, and an FM test signal modulated at 1 kHz with 3 kHz peak deviation, at $\boldsymbol{f_0}$ + twice the 1st IF signal, is applied to the DUT antenna port. The test signal power is increased until the analyzer reads 12 dB SINAD.

2m Test Conditions: f_0 = 146 MHz, A-Band 1st IF = 38.85 MHz. Test signal freq. = 146 + (2 * 38.85) = 223.7 MHz.

Test signal power for 12 dB SINAD = -36 dBm. 12 dB SINAD sensitivity = -124 dBm. Thus, image rejection = 124-33 = 91 dB.

70cm Test Conditions: : f_0 = 446 MHz, A-Band 1st IF = 38.85 MHz. Test signal freq. = 446 - (2 * 38.85) = 368.3 MHz.

Test signal power for 12 dB SINAD = -49 dBm. 12 dB SINAD sensitivity = -124 dBm. Thus, image rejection = 124-49 = 75 dB.

7a. 1st-IF Rejection: In this test, the DUT is tuned to a convenient frequency $\boldsymbol{f_0}$, and a test signal at the 1st IF (modulated at 1 kHz with 3 kHz peak deviation) is applied to the DUT antenna port. The test signal power is increased until the analyzer reads 12 dB SINAD.

2m Test Conditions: f_0 = 146 MHz. Test signal frequency = 38.85 MHz.

Test signal power for 12 dB SINAD ≈ -20 dBm. 12 dB SINAD sensitivity = -124 dBm. Thus, 1st-IF rejection > 100 dB.

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8. S-Meter Readings: In this test, an unmodulated test signal is applied to the DUT ANT port, and the input level increased gradually. The level corresponding to each bar on the S-meter is recorded. Refer to Table 6.

Table 6: S-meter readings vs, RF input level.

A-Band FM	Bars									
Freq. MHz	1-2	2	4	5	6	8	10	12	14	
146	-111	-108	-106	-105	-104	-102	-100	-98	-96	dBm
446	-111	-110	-106	-105	-104	-103	-101	-99	-97	dBm

B. Transmitter Tests

9: Power Output and FM Deviation. In this test, the DUT ANT port is connected to the RF IN/OUT port of the communications analyzer. The instrument can accept 75W max. RF power output is measured in FM and DV modes at the HIGH, MID and LOW settings on 146 and 440 MHz, at a primary DC supply voltage of +13.8V. Frequency error is also measured (Table 7). Voice, CTCSS and DTMF deviation are measured (Table 8).

Table 7: FM Power Output and Frequency Error.

	Freq. MHz	146			446		
	Freq. Error Hz	-25			-67		
Band	**P_O Setting**	HIGH	MID	LOW	HIGH	MID	LOW
A	**FM P_O W**	4.9	14.6	48.8	5.6	15.6	48
B	**DV P_O W**	5.8	15.6	50.2	5.5	15.6	47.7

Table 8: FM Deviation.

	FM Deviation kHz			FM-N Deviation kHz		
Freq. MHz	**Voice**	**CTCSS**	**DTMF**	**Voice**	**CTCSS**	**DTMF**
146	4	0.75	3.4	2	0.35	1.7
446	4	0.75	4	2	0.375	1.7

10: Transmitter Harmonics & Spurs. The communications analyzer is configured as a spectrum analyzer, sweeping from the fundamental to the 2^{nd} and 3^{rd} harmonic on 446 and 146 MHz respectively. A screenshot of the sweep is captured.

Test Conditions: 144 and 446 MHz, FM, P_O = 15W (MID). Center freq. & span as shown in **Figures 1 & 2.**

Figure 1: ID-5100 transmitter harmonics & spurs (146 MHz).

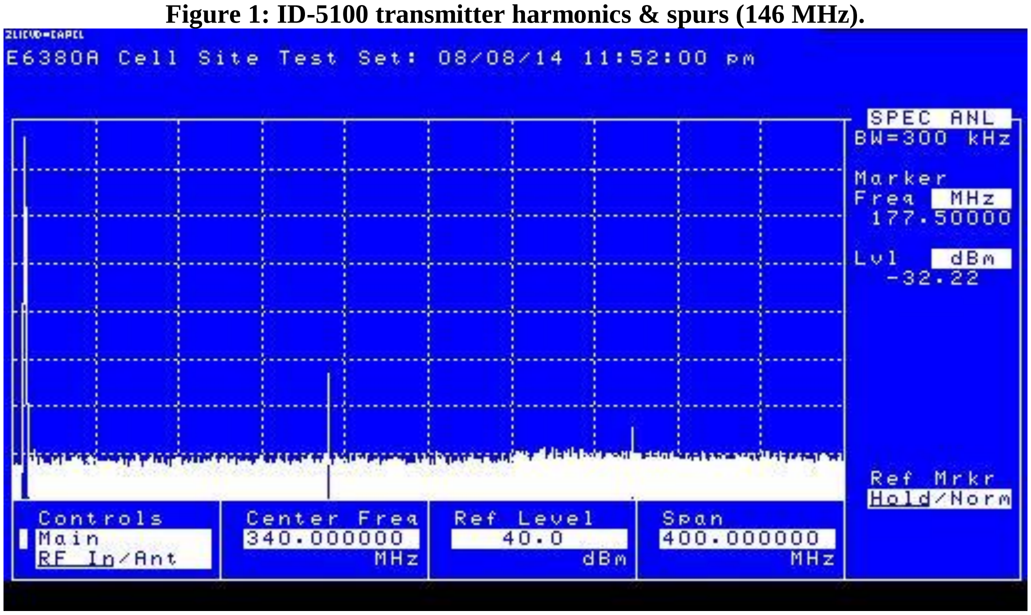
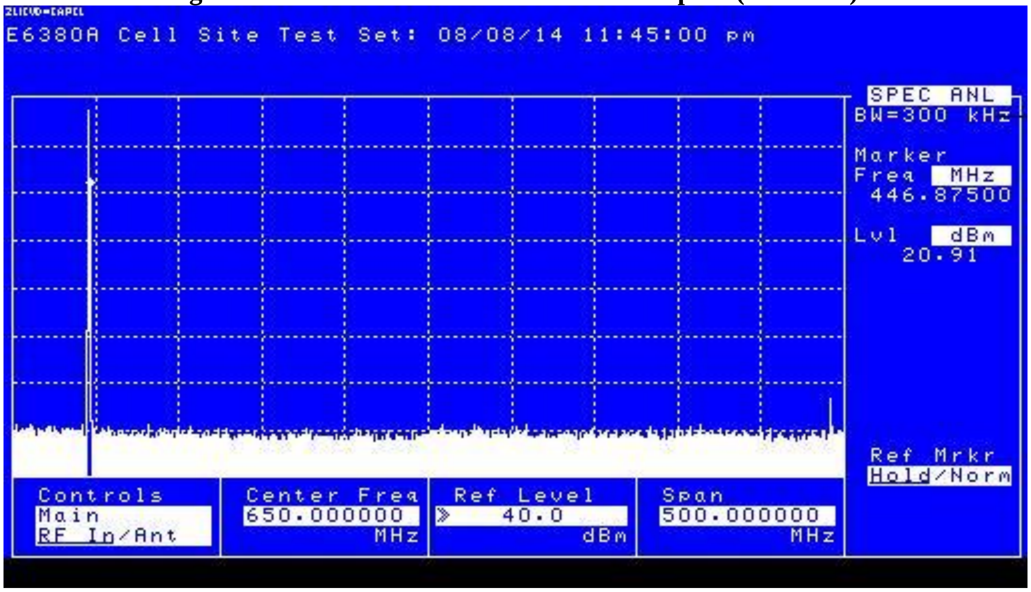


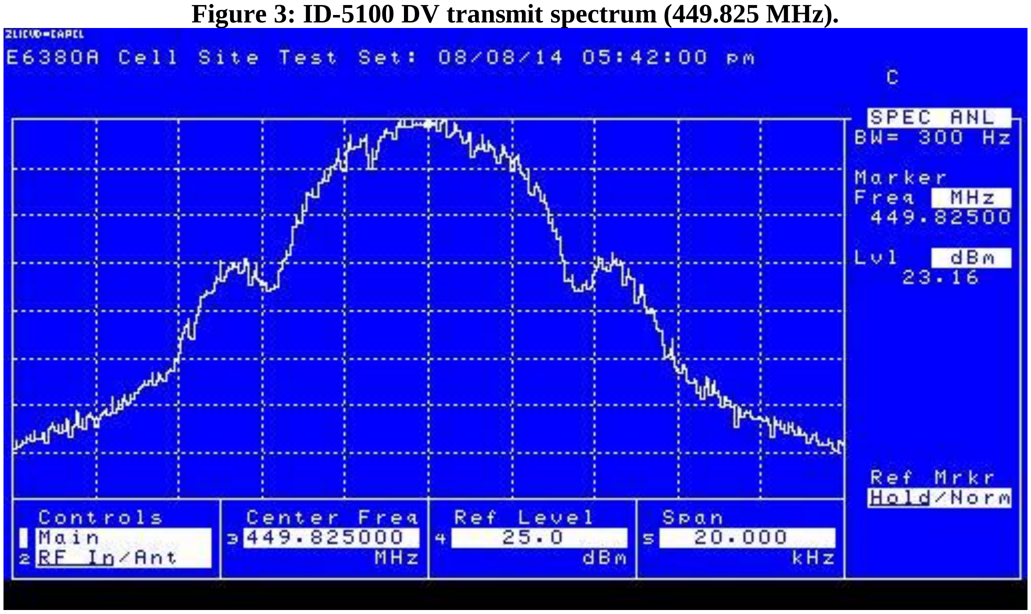
Figure 2: ID-5100 transmitter harmonics & spurs (446 MHz).



11: DV Occupied Bandwidth. This test displays the transmitted DV spectrum, from which the occupied bandwidth can be derived. The communications analyzer is set up as a spectrum analyzer and tuned to the transmit frequency. A screenshot of the sweep is captured.

Test Conditions: 144 and 446 MHz, FM, P_O = 15W (MID). Center freq. & span as shown in **Figure 3.** Occupied bandwidth ≈ 6 kHz at the -26 dBc points.

Figure 3: ID-5100 DV transmit spectrum (449.825 MHz).



12: Crossband Repeater Function. In this test, the DUT's ability to re-transmit incoming 2m signals on 70cm, and vice versa, is verified. The communications analyzer's RF IN/OUT port is connected to the DUT ANT port. The analyzer is configured for full-duplex operation (RF Generator on RF OUT and RF Analyzer on RF IN). The RF IN/OUT port is now in full-duplex mode, and the RF cable to the DUT is bi-directional. The DUT is configured as a crossband repeater, transmitting on 2m and receiving on 70cm. The test will be repeated with TX on 70cm and RX on 2m.

Test Conditions: 1. DUT: MAIN 146 MHz, SUB 446 MHz, Po LOW (5W), Repeater function activated (Menu/Others/Repeater Mode=Y, Hangup Time ON). See **Figure 4.**

2. Communications analyzer: RF Generator 146 MHz, FM Dev. 3 kHz, RF Out; RF Analyzer 446 MHz, FM, RF In, RF Power, FM DEV & SINAD meters on.

3. Increase RF Generator output until MAIN squelch opens, then increase further for 12 dB SINAD reading on RF Anl.. Read and record RF Power and FM DEV on RF Analyzer.

4. Next, set RF Generator to 446 MHz. Set RF Analyzer to 146 MHz. Repeat 3.with new settings and record results.

5. At DUT, swap MAIN and SUB. Operation should be unchanged. See Table 9.

Table 9: Crossband Repeater Test Results

Direction	DUT TX P_O W	DUT Tx Dev. kHz	Dev. Ratio
146 ► 446	5.5	2.5	0.83
446 ► 146	5.0	3.3	1.1

Figure 4: ID-5100 Crossband Repeater Screen.