# SG-2020 Transceiver

## Test/Calibration Procedure

### SG-2020 TEST DOCUMENT

This SG-2020 Test Document is divided into two sections:

Section One: Basic & Simple Test
Section Two: Full Test & Calibration

This test document is provided to SGC dealers, technicians and engineers who have full knowledge and experience with electronics and HF radio communications. The tests and calibration described must be performed using appropriate, calibrated, good quality instruments.

Note that Section Two is not covered under the Warranty of the SG-2020. Any information concerning this document must be executed in writing only. These procedures are provided as informational only to assist qualified technicians or engineers with field use and service of the SG-2020 transceiver.

**SGC**
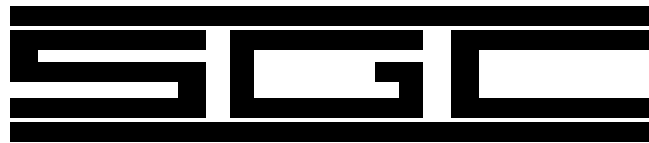
*"No Compromise Communications"*

## SG-2020 BASIC PERFORMANCE TESTS

The SGC factory test procedures as well as the test procedures detailed in the ARRL Handbook chapter 26 can be used to fully measure the performance of the radio. The following are simple tests which do not require laboratory test equipment and can be used to determine if the unit is generally operating properly.

### 1.  Receiver Sensitivity:

The measurement of sensitivity with signal levels below one micro volt requires a well shielded signal generator due to the very low level signal involved. Inexpensive generators of the sort used by amateurs or for service work leak signals which causes inaccurate readings at low signal levels.

By using a larger signal level and verifying the expected AGC response, a reasonable sensitivity check can be obtained with an inexpensive signal generator.
   a. Set the SG-2020 to the desired frequency with mode USB and BW 2.2 KHz. Be sure to turn the RF gain fully clockwise.
   b. Set the signal generator to the same frequency plus 1 KHz and set its output level to 50 micro volts.
   c. Verify that the 5 LED's in the bargraph display are lit. If the bargraph reads more than 2 LED's below the expected value, the unit requires service.

### 2.  Transmit Quality:

Listen to the voice quality on another receiver being careful to avoid over-load. Most defects can be heard with critical listening tests.
A quantitative measurement of linearity requires a two-tone audio generator with the results normally viewed on a spectrum analyzer. However, with care it is possible to use an attenuator and receiver in place of the spectrum analyzer.

### 3.  Transmit Power:

The transmitter is connected to a power meter and dummy load. The measured power is compared to the power setting of the SG-2020.

Note that the power meters usually sold for amateur use are not very accurate. A calibrated Bird or similar meter is needed for reliable results.

## 4. SWR Shutdown:

Transmit 20 watts in CW mode with no antenna connected.  You should get less than 5 LED's on for  forward power and full scale reading (all LED's on) for reverse power.  as indicated by the bargraph display.

# SGC TEST DESCRIPTION

**NOTE:  Any adjustments made to the SG-2020, besides the R46 CW sidetone adjustment are NOT covered by the warranty.**
The following are tests performed on a fully assembled SG-2020 transceiver.

## TEST EQUIPMENT REQUIRED

Audio Signal Generator
   (Audio out applied to the microphone connector of SG-2020 under test)
RF Noise Generator
RF Sinusoidal Signal Generator
RF Spectrum Analyzer in addition to a RF Sweep Generator
   (Connected through an attenuator of min. 35 dB to the dummy load output.)
Oscilloscope  Tektronix 465B or equivalent
Current meter   0-1 Amp Range
Current meter   0-10 Amp Range
Voltmeter  Fluke 77 or equivalent
Power Supply  PS-10 or equivalent 10-amp power supply
Frequency Counter (connected to the vertical output of oscilloscope.)
Audio Distortion Analyzer (connected at the speaker/headphone jack)
Bird Wattmeter model 43 or equivalent.

## 1.0  L.O. PLL ERROR VOLTAGE

1.1   Connect voltmeter to TP3 and GND on the Exciter PCB.
1.2   Dial 29700.0 KHz on the display.
1.3   Verify voltage reading is less than 16 VDC. If not, adjust the spacing between the windings on L18. Pull the windings together for a lower-voltage reading or spread windings for a higher-voltage reading.
1.4   Change the frequency to 1800.0 KHz.
1.5   Verify new voltage reading is approximately 3 VDC.

## 2.0  ALIGN RECEIVE IF TRANSFORMERS

2.1   Connect signal generator to antenna input.
2.2   Connect voltmeter to AGC TP13 and GND on the Exciter PCB.
2.3   Set display frequency to 14150.0 KHz USB, signal generator to receiver frequency +1 KHz and adjust output level of signal generator (typically 10 μV) for 5 VDC reading on the voltmeter.
2.4   Adjust T3 and T4 for maximum AGC voltage, while reducing signal generator output as necessary to keep AGC voltage near 5 VDC.

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### 3.0 LPA BIAS

**This is not a routine procedure and should be done only when the final transistors are replaced.**

3.1 Set display for 14150.0 KHz, USB.

3.2 Connect voltmeter across bias test points TP1 and TP2 on LPA (across R29, LPA page 3/3), key the SG-2020 (with no RF input), and verify that the meter reads 7 mV. Readjust R7 on LPA if necessary.

### 4.0 ADJUST REVERSE DETECT VOLTAGE

4.1 Set the display for 14150.0 KHz USB.

4.2 Connect audio generator to microphone input. Set for 1300 Hz @ 15 mV output.

4.3 Connect voltmeter set on millivolt scale to TP5 (REV) and GND on the LPA.

4.4 Set power to P20 by pressing "CMD" + "NB" then adjust spinner to 20. Press "MEM".

4.5 Key PTT and verify 20 watts output power. Readjust the audio generator below the ALC level kick-in (or until 20 watts reads on wattmeter).

4.6 Adjust C56 on LPA for min. voltage on TP5 (less than 50 millivolts)

### 5.0 RADIO CALIBRATION

5.1 Set the radio to 3,700.0 KHz, USB.

5.2 Turn off power.

5.3 Turn power back on and immediately press and hold CMD until "C" appears on display.

5.4 Release "CMD" button and then immediately (before function time-out occurs) press "BW" button - "CA" should be shown on display.

5.5 Immediately press 'LIGHT' button - "CAL" should be displayed. You are now in calibration mode and the number 1 (one) should appear on left side of display along with a reference reading on the right side.

**Identify calibration data for the exciter in the radio**

5.6 You will need the data results from the test **N920ExcFilterSweep** (Exciter filter sweep).

**Calibration**

5.7 **The radio should be warmed up for at least 20 minutes to allow everything to stabilize.** Connect oscilloscope probe to the indicated REF. point in paragraph 5.9 and adjust tuning knob until desired frequency is displayed on the frequency counter (connected with the scope). Observe and record reading on LCD display and press 'MEM' to store this reading.

5.8    Continue on through step A

| | | Ref. Point | Step | Adj. Tuning Knob for: |
|---|---|---|---|---|
| VCXO ADJ. | USB | LO TP5 | 1 | 61,656.269 KHz |
| | LSB | | 2 | 61,666.294 KHz |
| | CW | | 3 | 61,663.157 KHz |

5.8.1  Adjust display for 3200.
5.8.2  Adjust C146 for maximum amplitude on scope at TP6.
5.8.3  Adjust T6 for maximum amplitude.
5.8.4  Readjust C146 until the frequency counter is within 100 Hz of the BFO crystal sort value.

| | | | | |
|---|---|---|---|---|
| BFO ADJ. | USB | BFO TP6 | 5 | See page 12 |
| | LSB | | 6 | See page 12 |
| | CW | | 7 | See page 12 |
| LO ADJ. | USB | LO TP5 | 8 | See page 12 |
| | LSB | | 9 | See page 12 |
| | CW | | A | See page 12 |

**LED Test**
5.9  After completion of step A, press 'MEM' and the display should step through the LED cycle test.  Check that all LED's are functional, and that no LED is tied to another.


**Display Calibration**
5.10  Connect frequency counter to audio output (J7 at rear of radio)
5.11  Place radio at these settings:
   A. Display to 1.850 MHz
   B. Mode to USB
   C. BW to 2.7 KHz
5.12 Inject a 1.851-MHz, 3-uV signal and observe that the frequency counter reads 1,000Hz +/- 10Hz. Adjust the spinner knob if necessary to achieve 1,000Hz +/- 10Hz. Note: Skip step 5.13 if adjustment is not necessary.
5.13 Press CMD + XCVE and verify that the XCVE, RIT, and SPLIT LEDs light. Adjust spinner until display reads 1.850 MHz. Press MEM.
   5.14 Change the mode to LSB and the signal generator to 1.849 MHz.
   5.15 Verify that the frequency counter reads 1,000 Hz plus or minus 100Hz.

5.16 Set all 20 default channels to factory preset frequencies. See page 20 of th SG-2020 Operations manual, Version 2.01.

## 6.0 TRANSMIT SSB BALANCE (USB vs LSB) CHECK

6.1 Set display for 1850.0 KHz, USB and key microphone.
6.2 Increase level of audio generator applied at the microphone jack (1.3 KHz, sinusoidal) until output power reads 10 watts.
6.3 Unkey mic, change to LSB and rekey mic. Power output in LSB must be within 5 watts of USB.
6.4 Set whichever SSB is higher to 10 W, and check that the other SSB is 5W or greater .
6.5 Repeat the above steps for frequencies: 3700.0, 7140.0, 14150.0, 18150.0, 29700.0 KHz then verify that USB/LSB difference is less than 5W.

**Carrier Level Check( TX 20W, USB, BW=2.7, 1.3 KHz at microphone)**
6.6 Set radio to 1850.0 KHz, USB.
6.7 Connect 1300 Hz audio signal to mic input.
6.8 Key radio and adjust output level of audio generator until radio is transmitting 20 watts.
6.9 Adjust frequency knob on the spectrum analyzer until the signal transmitted is displayed. Read the dB level of this signal.
6.10 Remove the signal from the microphone and check that the carrier level decreases to at least 40 dB below the dB level of the applied signal.

## 7.0 Power - Meter LED's

This test checks that the power meter indicates properly for FWD and REV power readings. **NOTE: Precise calibration is not supported.**

**Forward power**
7.1 Set radio to 14150.0 KHz, USB, BW=2.7, connect audio input to microphone connector and key mic box.
7.2 Increase audio input (1.3 KHz) while observing the LED's and watt meter.
7.3 At approximately 14W - all 5 green LED's should light.
7.4 At approximately 20W - all 5 green and 2 red LED's should light.
7.5 At approximately 25W - all 10 LED's should light

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**Reverse Power**

7.6   Depress 'REV' while transmitting 20W into a dummy load and verify that 2 LED's light.

7.7   Depress 'REV' while transmitting 20 W without any antenna or dummy load connected and verify that all 10 LED's light.

(**NOTE: Do not transmit for more than 5 sec. Watch the current meter, it should be reduced to less than 2 Amps by the ALC/REV protection circuitry**)

## 8.0  POWER CALIBRATION TEST

This test will check/readjust the radio for max. 20W RF OUT .

8.1   Set P for 20 watts after setting the frequency to 14150.0 KHz.

8.2   Set power to M (maximum)

8.3   Attach the radio to a 50-ohm dummy load.

8.4   Key mic and increase audio input level (1.3 KHz, and not more than 20 mV) until maximum power is achieved (just below the saturation level.)

8.5   Press ('CMD' + 'NB') and adjust RF out to 20W on watt meter. Read the P value on the display and press 'MEM' button.

**Load P Value in all 20 channels**

8.6   Go to Channel 1 frequency, press ('CMD'+'NB') and adjust knob for the new power setting P(from above) and then press 'MEM' to store this P value temporarily (for as long you are in this channel). Press ('FAST'+'MEM') together for storing permanently this value in this channel's memory.

8.7   Repeat the above step for the remaining 19 channels/frequencies.

## 9.0  TRANSMITTER RESPONSE (into a 50 ohm dummy load)

**NOTE**:  Power response and spurs readings can be taken at the same time.

**Power response** (Avoid continuous TX for more than 10 sec.)

9.1   Set display for 1800.0 KHz, USB and key in transmit.

9.2   Increase audio generator level until maximum power is achieved while staying within the limits of ALC, current, and voltage values indicated on the table on the following page.

9.3   Repeat the above steps for all frequencies in the table on the following page, and measure **input drive**, **input DC voltage**, **ALC voltage** and **output power** and compare these readings with the values and limits set.

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**Spurious transmissions check( @ 20W  USB)**

9.4   While doing the power response test (above), compare any spurs trans-
       mitted with the peak power signal.  There should be none higher than -
       40 dB.

9.5   Repeat the above steps for all the frequencies listed on the following
       table.

| FREQ. MHz | VDC | Amp | ALC VDC | W PEP | AF mV |
|---|---|---|---|---|---|
| 1.80 | 12 - 18 | **max.** 4.5 | 3 - 5 | => **18** | **max. 20** |
| 3.70 | 12 - 18 | **max.** 4.5 | 3 - 5 | => **19** | **max. 20** |
| 7.14 | 12 - 18 | **max.** 4.5 | 3 - 5 | => **19** | **max. 20** |
| 14.15 | 12 - 18 | **max.** 4.5 | 3 - 5 | => **19** | **max. 20** |
| 18.15 | 12 - 18 | **max.** 4.5 | 3 - 5 | => **19** | **max. 20** |
| 29.70 | 12 - 18 | **max.** 4.5 | 3 - 5 | => **14** | **max. 20** |

## 10.0  TRANSMIT QUALITY TEST

This will test for good quality of voice transmitted into a dummy load,
and received in a close-by radio set on the same frequency and mode.

10.1  Use a known good microphone and transmit a few phrases of test signal
       to a near-by radio set on the same frequency.

10.2  Listen to the quality of the voice in the other radio while monitoring
       modulation on the scope attached at the output of your radio's dummy
       load.

## 11.0  RECEIVER CURRENT TEST

11.1  Connect RF Generator at the antenna connector, and an ammeter in series
       with the radio.

11.2  Radio settings - 14150.0 KHz USB, AF max., RF max., BW 2.7 KHz.

11.3  Measure current readings on the ammeter for each of the situations:

| Backlite | ON | OFF | |
|---|---|---|---|
| Standby | < 450 mA | < 380 mA | No RF Input |
| Max. Signal | < 900 mA | | 1 V @ Antenna Input |
| Idle | < 0.3 mA | | Power Off |

## 12.0  RECEIVER SENSITIVITY TEST

**RMS level**

12.1  Set radio to 1800.0 KHz, RF max., AF max.

12.2  Set audio distortion analyzer function to voltage reading, 0.1 V range.

12.3  Set RF signal generator to 1800.0 KHz, 0.5 µv output level and adjust fine tune for 1300 Hz on the frequency counter (and monitor it at the speaker).

12.4  Read the RMS audio output level on audio analyzer, and compare it with the expected range of values listed below:

| Freq. | USB/LSB @ | 0.5 µV Input |
|---|---|---|
| MHz | dB | V RMS |
| 1.80 | > 10 | 0.2 - 0.3 |
| 3.70 | > 10 | 0.3 - 0.5 |
| 7.14 | > 10 | 0.4 - 0.6 |
| 14.15 | > 10 | 0.5 - 0.7 |
| 21.35 | > 10 | 0.5 - 0.7 |
| 29.70 | > 10 | 0.5 - 0.7 |

**Decibel level**

12.5  Change the audio analyzer function switch to distortion position, meter range to -10 to -20 position, and adjust switch sensitivity to give mid-scale reading.

12.6  Adjust vernier control for 0 dB, switch RF output of signal generator off, and check for minimum of 10 dB drop, as expected on the table above.

12.7  Repeat the above tests for USB & LSB in all frequencies listed above, and verify your readings against the listed reference values (USB = LSB ± 2 dB).

## 13.0  RECEIVER AGC TEST

13.1  Set radio to 14150.0 KHz, USB, 2.7 KHz bandwidth, RF max., AF max.

13.2  Set RF signal generator to 14151.0 KHz, output level 0.3 µV.

13.3   Set audio analyzer to voltmeter position,.

13.4  Fine tune signal generator for 1300 Hz on frequency counter.

13.5  Compare the RMS (SPK) voltmeter readings on the analyzer to the RMS (SPK) readings listed below.

13.6 Repeat the above steps for the remaining input.

| Input(ANT) | 0.3 µV | 3 µV | 30 µV | 3 mV | 3 V |
|---|---|---|---|---|---|
| RMS (SPK) | 0.2-0.4 V | 1.5-3 V | 3-3.5 V | 3-3.5 V | 3-3.5V |

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13.6 Set RF generator output level to 50 µV and observe that at least 3 LED's from the left of the bargraph display lights. **Accurate calibration is not supported.**

## 14.0  NOISE BLANKER TEST

14.1  Set radio for 14150.0 KHz, USB, BW to 2.7KHz.

14.2  Turn on speaker and set volume for mid range.

14.3  Inject 14151.0 KHz, 30 µV signal at antenna, and monitor audio on the speaker and oscilloscope connected at the speaker output.

14.4  Loosen shield on antenna coax connector and turn on the Noise Generator.

14.5  Listen to noise in speaker while toggling ON/OFF the 'NB' button. There should be a noticeable difference in the audio quality.

14.6  Monitor the difference of signals on the oscilloscope while toggling the 'NB' button. The noise spikes should be diminished without attenuating the main signal.

## 15.0  REINSERTING THE RADIO INTO CASE

15.1  To reinsert, push gently down on the speaker rim and push the chassis into the case slowly.  Secure radio to case with two screws and flip-foot with one screw.

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5
Calibra
tion
Label

Operator Calibration [      ]   **RadioSerialNumber** [      ]

**Exciter** [            ] [            ]

PrintCalInfo

**Computed Offset** [        ]

If zero enter .0001----->>**New Offset** [        ]

**Final Offset** [        ]

LCD displayed values

**Step 1**   **Dial and enter   61,656,269 hz**     Step1 [        ]

**Step 2**   **Dial and  enter  61,666,294 hz**     Step2 [        ]

**Step 3**   **Dial and  enter  61,663,157 hz**     Step3 [        ]

**Step 5**   **BFO  USB** [        ] **hz**     Step5 [        ]

**Step 6**   **BFO  LSB** [        ] **hz**     Step6 [        ]

**Step 7**   **BFO  CW** [        ] **hz**     Step7 [        ]

**Step 8**   **LO  USB** [        ] **hz**     Step8 [        ]

**Step 9**   **LO  LSB** [        ] **hz**     Step9 [        ]

**Step A**   **LO  CW** [        ] **hz**     StepA [        ]