



Increasing TB8100 Wide Band Maximum Deviation (PROVISIONAL)

Issue No.: AN020-01

Author: TEA Engineering



General

This application note applies to TB8100's configured as Wide Band, however the methodology used to increase the deviation levels may equally be adapted to TB8100's configured as Narrow or Mid band, if required.

The TB8100 as sent out from the factory is setup to never go over the 5kHz compliance deviation limit (not even an instantaneous peak over the limit, that the T800 may possibly do on occasions). In some circumstances there may be a need to be able to achieve a higher deviation than is available from the standard setup.

This application note explains how to achieve a greater maximum deviation from the TB8100 transmitter than can be gained from calibrating and configuring the TB8100 using the approved standard method, however, this may result in levels that are over the 5kHz compliance limit. As with any radio device setting up the radio equipment to go over the regulatory authority's authorized compliance levels is done at your own risk.

Currently (with V2.00 software and firmware), the standard setup of the TB8100 for wide band means that the maximum deviation that can be transmitted will be limited to approximately 3.7kHz with no encode CTCSS tone or 3.7kHz + CTCSS tone level if CTCSS tone is encoded (ie. 3.7kHz + 500Hz of CTCSS would result in a total maximum deviation of 4.2kHz).

Some users require that the limiting be closer to or greater than 5kHz when used as either a talk through repeater or when transmitting line audio from the Tx Line In from the SIF connector. This application note will explain how to set up the TB8100 to increase the maximum deviation. It will require the use of the TB8100 Calibration Test Unit, TB8100 Calibration Kit software, TB8100 Service Kit software and a communications test set. Please ensure you have all of these items before proceeding.

Note:

- Ensure V2.00 or greater Service Kit and Calibration Kit software and V2.00 or greater PMU, Reciter & PA firmware are used.
- V2.00 Service Kit includes the 'Max Tx deviation has subaudible signaling' field on the 'Signal Path' page which allows the base to:
 - **Superimpose** CTCSS to the speech audio (ie. -10dBm of 1kHz tone into the 'Tx line in' and 10% of encode CTCSS 'superimposed' = 3.5kHz total deviation or 3kHz of tone + 500Hz of CTCSS)
 - or
 - **Include** CTCSS and speech audio (ie. -10dBm of 1kHz tone into the 'Tx line in' and 10% of encode CTCSS 'included' = 3kHz total deviation or 2.5kHz of 1kHz tone and 500Hz of CTCSS).
- Future firmware and software upgrades to the TB8100 may make this application note

redundant.

- All the levels in this documentation refer to wide band, 25kHz

Parts

The parts required are as follows:

Part #	Description	Supplier	Qty.
TBA0ST1	TB8100 Calibration Test Unit Kit (CTU)	Tait	1
TBA0P00	TB8100 V2.00+ Service Kit (SK) & Calibration Kit (CK)	Tait	1
Various	Communications Test Set	Various	1
Various	BNC & N type coax cables	Various	

Procedure

1. Ensure V2.00 or greater firmware is installed in the PMU, Reciter & PA
2. Ensure V2.00 or greater SK & CK installed on the computer.
3. Ensure that there is *NO* CTCSS tones programmed into the TB8100 SK 'Signaling Profile' or 'Channel Table' before using the CK. Use the SK to confirm this. Having CTCSS programmed into the TB8100 while using the CK will result in a lower maximum deviation levels (see Results of Testing – Test 1). After using the CK it is OK to put the CTCSS back into the TB8100 SK 'Signaling Profile' or 'Channel Table'.
4. Remove the reciter from the rack and place the reciter on the top of the TB8100 rack frame with the SMA and DC connector plugged into the reciter and placed in such a way that there is access to the Rx and Tx VCO adjustment points.
5. Connect the reciter SIF connector to the CTU SIF connector using the 15 or 25 way Drange cable supplied in the CTU kit and also connect the computer to the TB8100 via the RS232 cable.
6. 'Connect' the CK to the TB8100 in the standard method.
7. The sections of the TB8100 CK that are relevant to setting up the deviation are the first 3 steps of the 'Reciter Calibration' menu:
 - 1) FCL Auto Tuning
 - 2) FCL Calibration
 - 3) VCO Calibration
8. Do 'FCL Auto-Tuning'.
9. Do 'FCL Calibration' as follows:
 - 1) Select the Reciter Calibration tab, and double-click FCL Calibration. The FCL Calibration Wizard appears.
 - 2) Attach an appropriate Load and Modulation meter to the PA or exciter output, set the meter to measure the *peak* deviation, and then click Next. (If you are using a PA, it will now transmit.)
 - 3) Insert the tuning tool into the exciter VCO tuning hole and adjust the trimmer to roughly centre the exciter VCO on the band specified. Click Next.
 - 4) Use the slider to adjust the deviation at 30Hz until it is **3.8kHz peak**.
 - 5) Select the 1kHz Modulation Test and adjust the deviation at 1kHz until it is **3.8kHz peak**.

- 6) Repeat steps 4 and 5 until the modulation is **3.8kHz peak** at both 30Hz and 1 kHz.
- 7) Click Finish. (If you are using a PA, it will now stop transmitting.)

*Note: The 'standard' way to calibrate the FCL is to use 3.0 kHz peak, in order to achieve a higher maximum deviation we are calibrating the FCL to **3.8kHz peak**. Calibrating to levels much greater than **3.8kHz** may cause issues with the E-pot sliders reaching the end of the slider adjustment range.*

10. Do the 'VCO Calibration' as follows:

- 1) Select the Reciter Calibration tab, and double-click VCO Calibration.
- 2) Attach an appropriate Load and Modulation meter to the PA or exciter output, set the meter to measure the **peak** deviation, and then click Next. (If you are using a PA, it will now transmit.)
- 3) Using the scale in the dialog box to help you, adjust the exciter lock band trimmer to centre the exciter VCO on the sub-band indicated and then click Next.
- 4) For each of the seven frequencies shown, adjust the slider until the deviation shown on the modulation meter is **3.8kHz peak**. When you have finished, click Next Band.
- 5) For each sub-band repeat steps 3 and 4.
- 6) Click Finish. (If you are using a PA, it will now stop transmitting.)

*Note: The 'standard' way to calibrate the VCO is to use 3.0 kHz peak, in order to achieve a higher maximum deviation we are calibrating the VCO to **3.8kHz peak**. Calibrating to levels much greater than **3.8kHz** may cause issues with the E-pot slider bars reaching the end of the slider adjustment range.*

11. You may want to do the rest of the reciter or PA calibration, when you have finished 'Disconnect' from the CK.
12. Load and 'Connect' the TB8100 to the SK.
13. You may want to put CTCSS back into the configuration if you had to remove it previously (see step 3).
14. The 2 sections of the SK that are relevant to the maximum deviation are the **Configure/Channel Profiles/General** (see Fig. 1) and also **Configure/Channel Profiles/Signal Path** (Fig. 2).

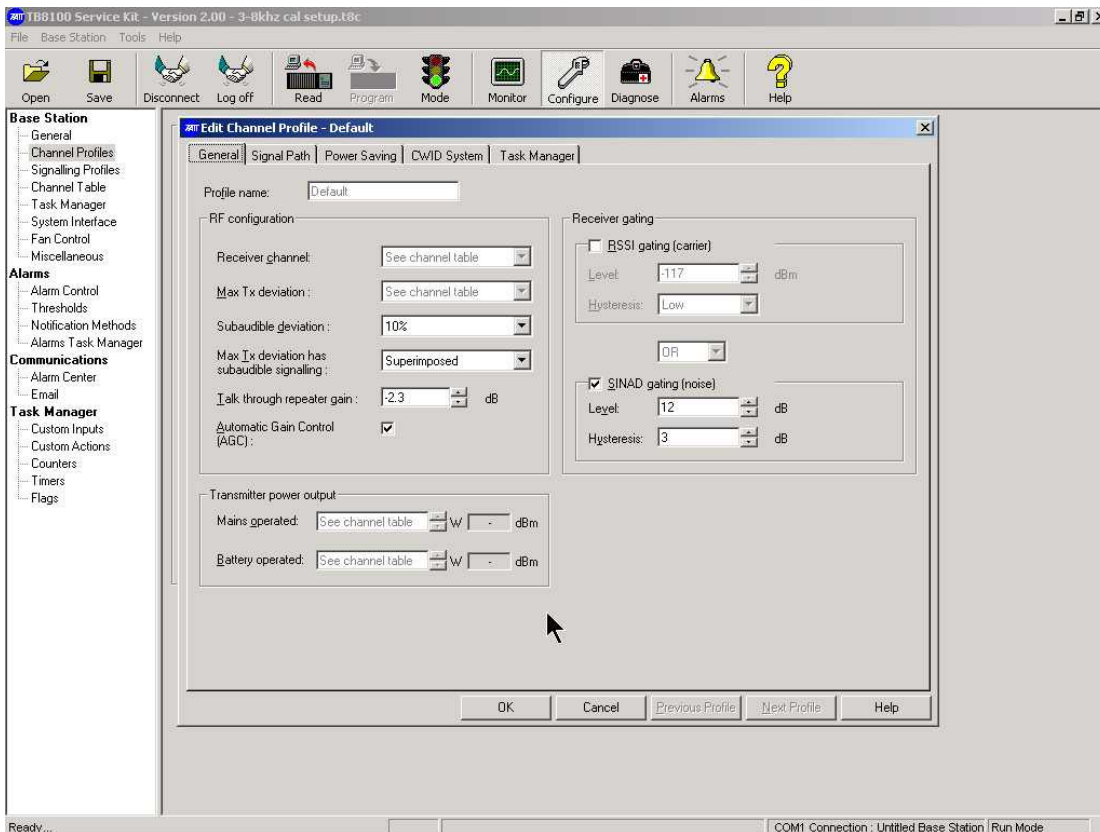


Fig. 1 - Configure/Channel Profiles/General page

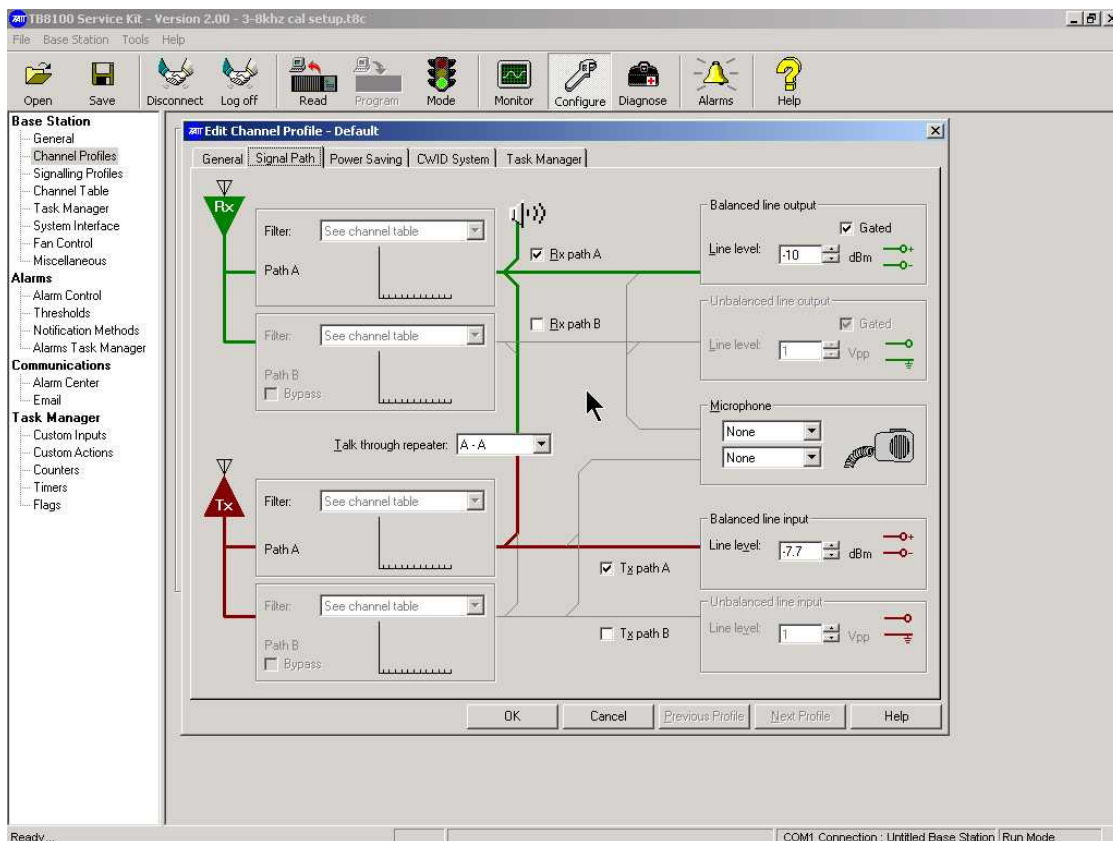


Fig. 2 - Configure/Channel Profiles/Signal Path page

15. The following assumes that the TB8100 is configured as either a Talk Through Repeater with unity gain (ie. 3kHz in = 3kHz out) and/or Line Controlled using -10dBm of signal into the Tx Line In resulting in 3kHz deviation out.
16. Go to the *Configure/Channel Profiles/General* page and change the 'Talk through repeater gain' field to **-2.3dBm**.
17. Make 'Sub-audible deviation' field '10%'.
18. Make 'Max Tx deviation has subaudible signaling' field 'Superimposed'
19. Go to the *Configure/Channel Profiles/Signal Path* page and change the 'Balanced line input' line level field to **-7.7dBm**.
20. The changes to TTR gain and Balanced Line input in steps 16 and 19 are to compensate for the higher deviations that the base is now calibrated at.
21. Do any other configuration changes that are required on the TB8100, then program them into the base and then put the base back into 'Run' mode.

Results of Testing

The following tests were performed to show the different relative deviations of received signals into the reciter to transmitted signals out the PA using different calibration methods, varying 'TTR gain' and 'Tx Line In levels' and using or not using CTCSS.

1. The base was calibrated using the CTU and CK *with* CTCSS programmed into the configuration.
 - 1) The base was set up as a TTR with Talk Through repeater gain field set to 0dB.
 - 2) The signal path audio was pre/deemphasized speech audio.
 - 3) 1kHz tone used, and where CTCSS is used then 151.4Hz CTCSS tone at 10% (approx. 500Hz) of max. deviation was generated into the reciter antenna input
 - 4) Results:
No CTCSS encode:
3kHz (1kHz tone) in reciter = 2.75kHz out PA
5kHz (1kHz tone) in reciter = 3.37kHz out PA

With 151.4Hz of CTCSS encode at 10% (500Hz) dev. 'superimposed':
3kHz (1kHz tone) + 10% CTCSS in reciter = 3.17kHz out PA (total incl. 1kHz tone + CTCSS)
5kHz (1kHz tone) + 10% CTCSS in reciter = 3.80kHz out PA (total incl. 1kHz tone + CTCSS)
2. The base was calibrated using the CTU and CK with *NO* CTCSS programmed into the configuration.
 - 1) The base was set up as a TTR with Talk Through repeater gain field set to 0dB.
 - 2) The signal path audio was pre/deemphasized speech audio.
 - 3) 1kHz tone used, and where CTCSS is used then 151.4Hz CTCSS tone at 10% (approx. 500Hz) of max. deviation was generated into the reciter antenna input
 - 4) Results:
No CTCSS encode:
3kHz (1kHz tone) in reciter = 3.05kHz out PA
5kHz (1kHz tone) in reciter = 3.72kHz out PA

With 151.4Hz of CTCSS encode at (10%) 500Hz dev. 'superimposed':
3kHz (1kHz tone) + 10% CTCSS in reciter = 3.52kHz out PA (total incl. 1kHz tone + CTCSS)
5kHz (1kHz tone) + 10% CTCSS in reciter = 4.2kHz out PA (total incl. 1kHz tone + CTCSS)
3. The base was calibrated using the CTU and CK with *NO* CTCSS programmed into the

configuration and *the CK FCL and VCO modulations were set-up using 3.8kHz.*

Refer to the diagrams Fig. 3 through to Fig. 8. These are pictures of the waveforms and test set settings.

- 1) The base was set up as a TTR with Talk Through repeater gain field set to **-2.3dB**.
- 2) The signal path audio was pre/deemphasized speech audio.
- 3) 1kHz tone used, and where CTCSS is used then 151.4Hz CTCSS tone at 10% (approx. 600Hz) of max. deviation was generated into the reciter antenna input.
- 4) **Red** indicates above compliance levels for either inputted levels being generated or for outputted resulting levels.
- 5) Results:
No CTCSS encode:
3kHz (1kHz tone) in reciter = 3.00kHz out PA
5kHz (1kHz tone) in reciter = 4.67kHz out PA
6kHz (1kHz tone) in reciter = 4.78kHz out PA

With 151.4Hz of CTCSS encode at 10% (600-700Hz) dev. 'superimposed':

- 3kHz (1kHz tone) + 10% CTCSS in reciter = 3.60kHz out PA (total incl. 1kHz tone + CTCSS)
- 5kHz (1kHz tone) + 10% CTCSS in reciter = **5.30kHz** out PA (total incl. 1kHz tone + CTCSS)
- 6kHz (1kHz tone) + 10% CTCSS in reciter = 5.45kHz** out PA (total incl. 1kHz tone + CTCSS)

4. The base was calibrated using the CTU and CK with **NO** CTCSS programmed into the configuration and *the CK FCL and VCO modulations were set-up using 3.8kHz.*
 - 1) The base was set up as a Line controlled base with the 'Balanced line output' field set to -10dBm and 'Balanced line input' field set to **-7.7dBm**.
 - 2) The signal path audio was pre/deemphasized speech audio.
 - 3) 1kHz tone at -15, -10 & -5dBm levels was generated into the 'Balanced line input' connector on the SIF.
 - 4) Results:
no CTCSS encode:
-15dBm of 1kHz tone = 1.75kHz out the PA
-10dBm of 1kHz tone = 2.99kHz out the PA
-5dBm of 1kHz tone = 4.75kHz out the PA

With 151.4Hz of CTCSS encode at 10% (600-700Hz) dev. 'superimposed':

- 15dBm of 1kHz tone = 2.35kHz out the PA (total incl. 1kHz tone + CTCSS)
- 10dBm of 1kHz tone = 3.60kHz out the PA (total incl. 1kHz tone + CTCSS)
- 5dBm of 1kHz tone = **5.40kHz** out the PA (total incl. 1kHz tone + CTCSS)

Pictures from 'Results step 3 – 3.8kHz CK and -2.3dB TTR gain'

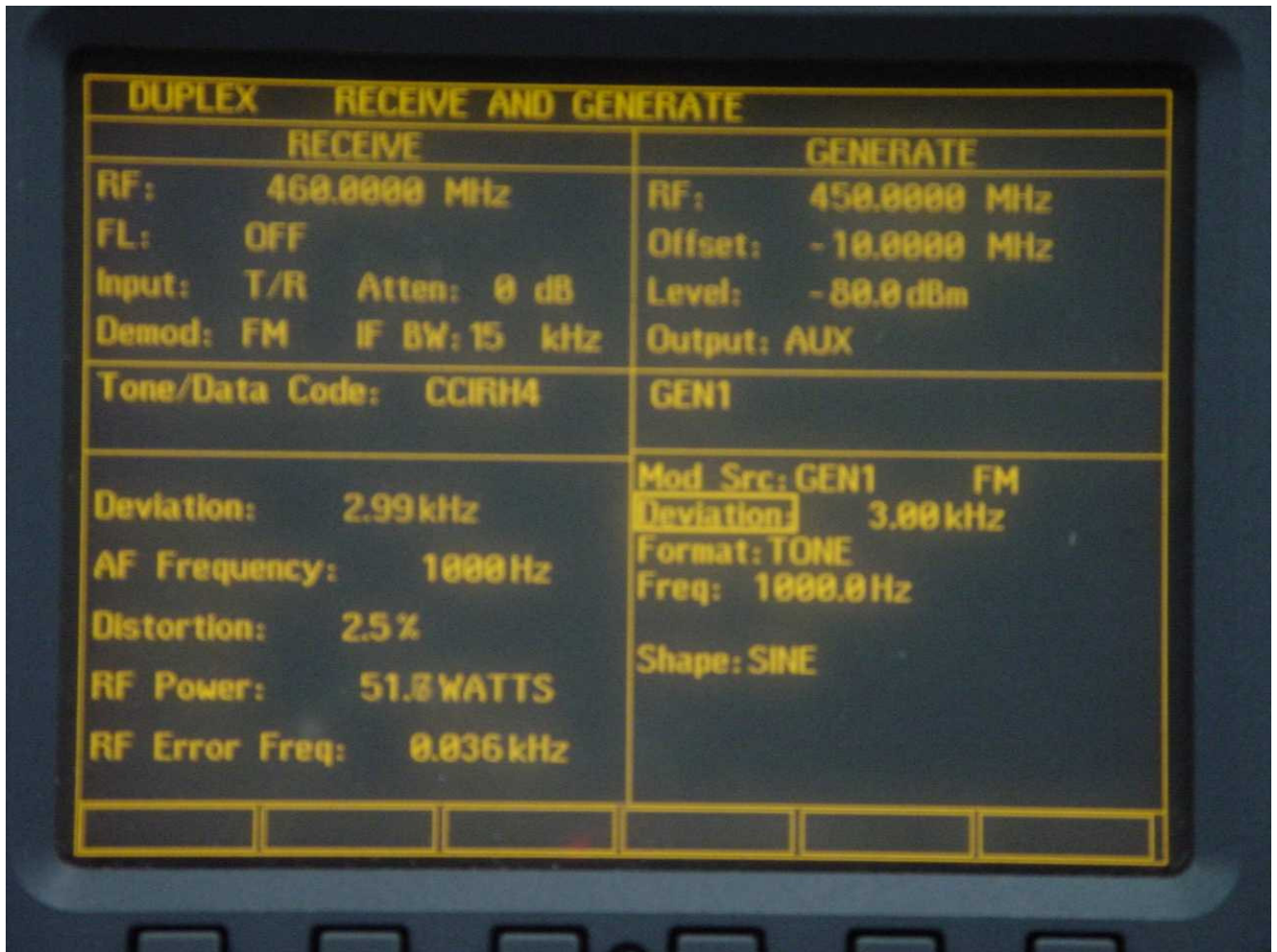


Fig 3. – COM120B duplex screen shows generating 3kHz of 1kHz tone into the reciter results in 2.99kHz out the PA

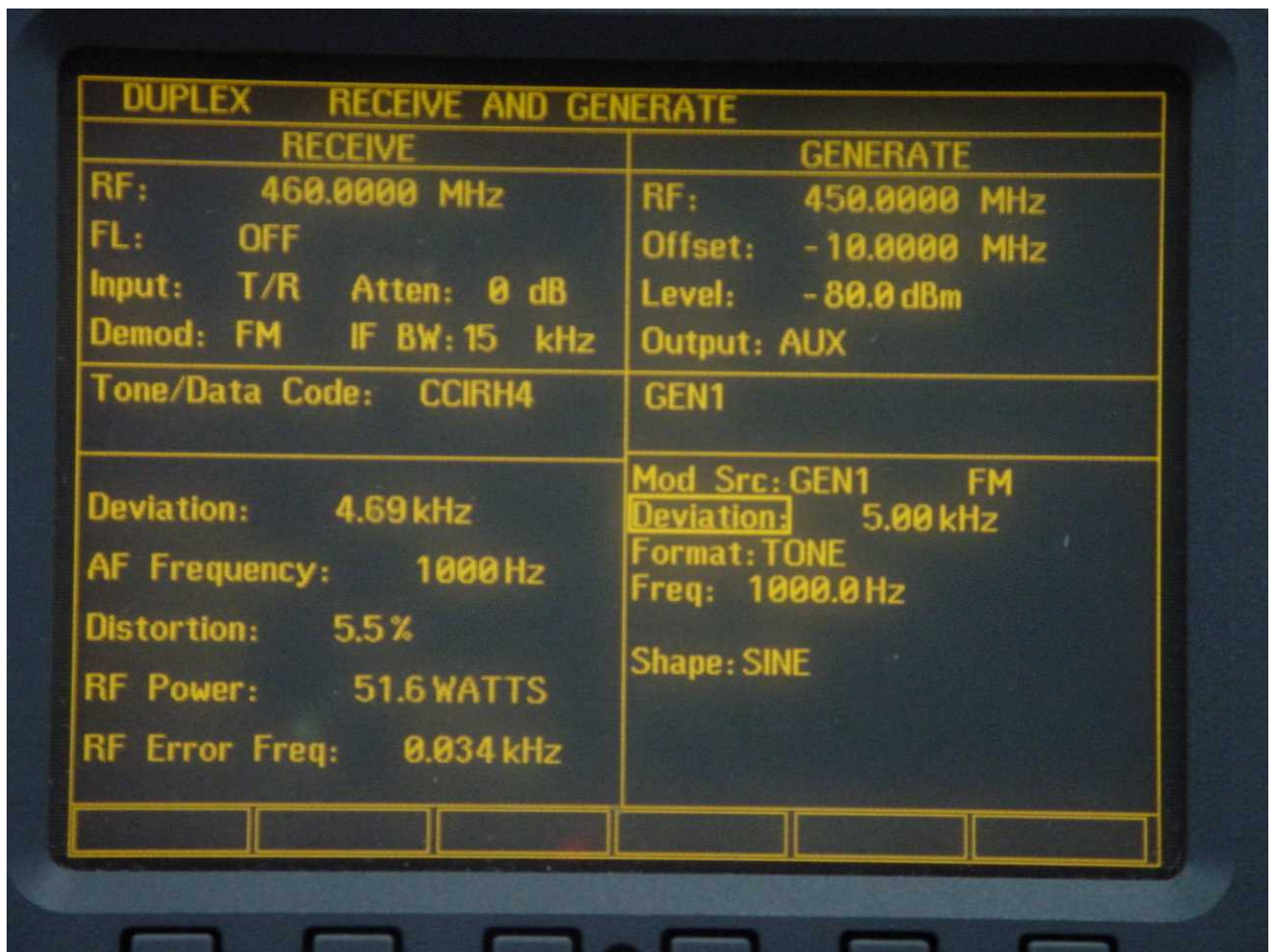


Fig 4. – COM120B duplex screen shows generating 5kHz of 1kHz tone into the reciter results in 4.69kHz out the PA.

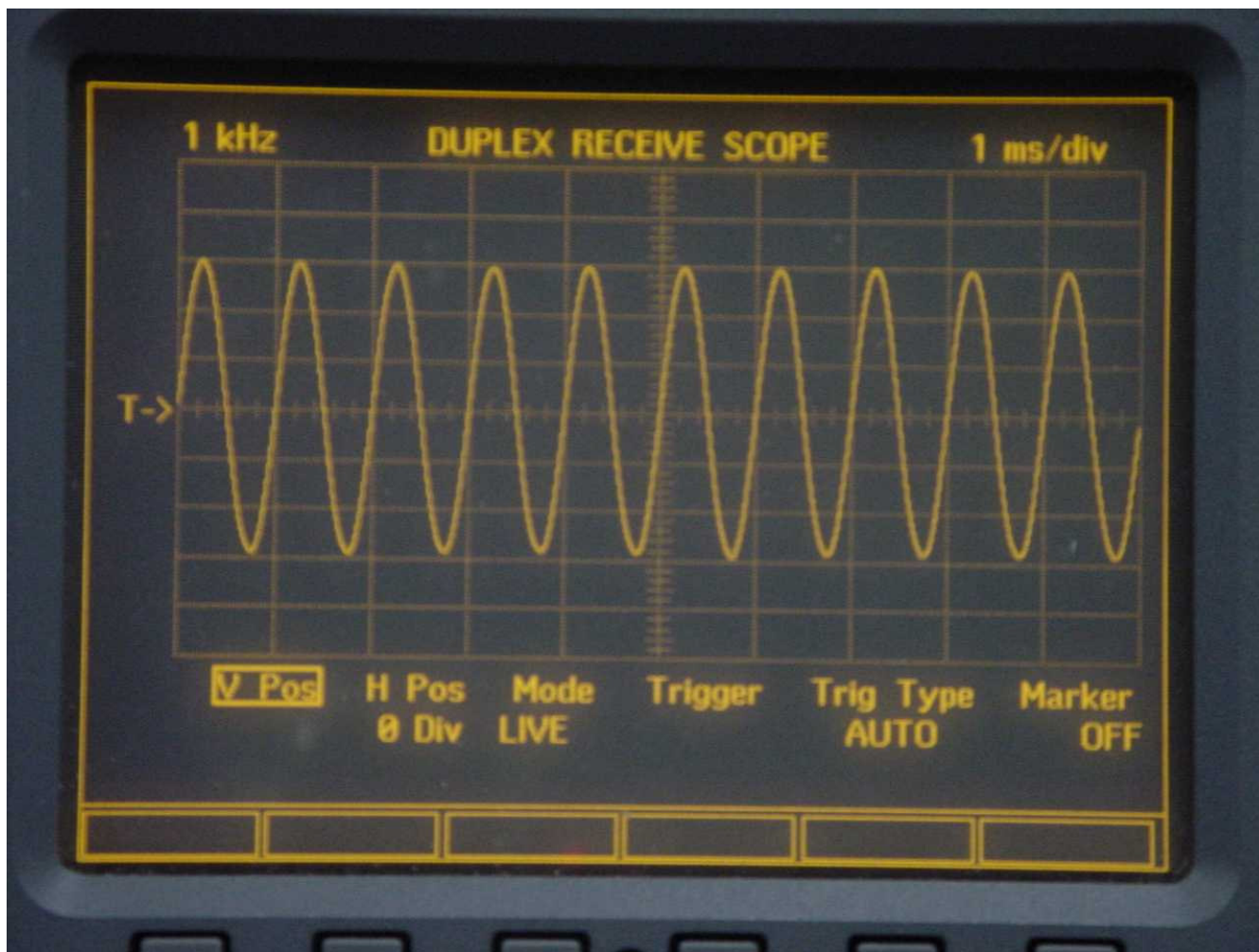


Fig 5. – COM120B duplex receive modulation scope screen shows the waveform resulting from generating 3kHz of 1kHz tone into the reciter resulting in 2.99kHz out the PA.

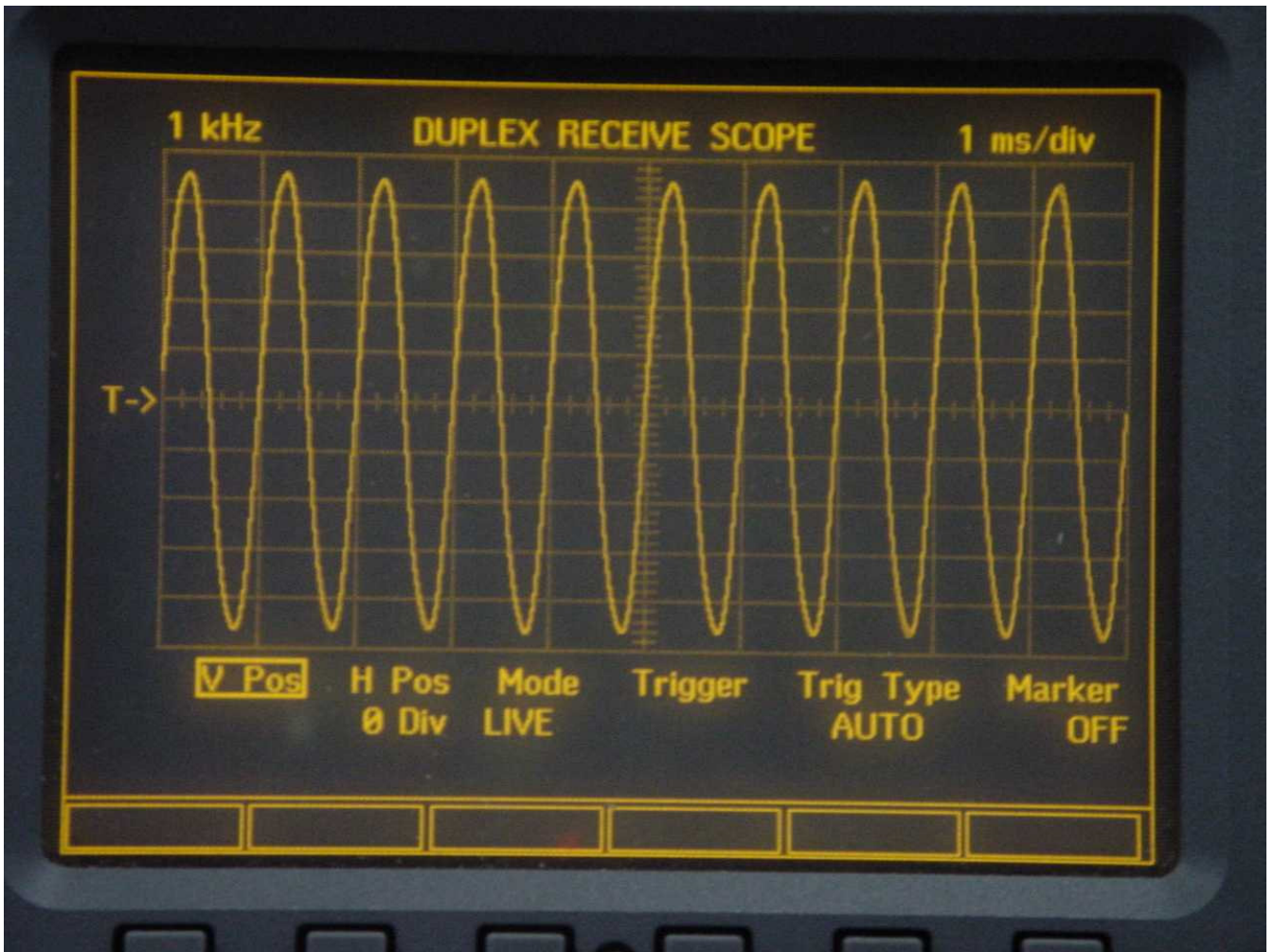


Fig 6. – COM120B duplex receive modulation scope screen shows the waveform resulting from generating 5kHz of 1kHz tone into the reciter resulting in 4.67kHz out the PA.

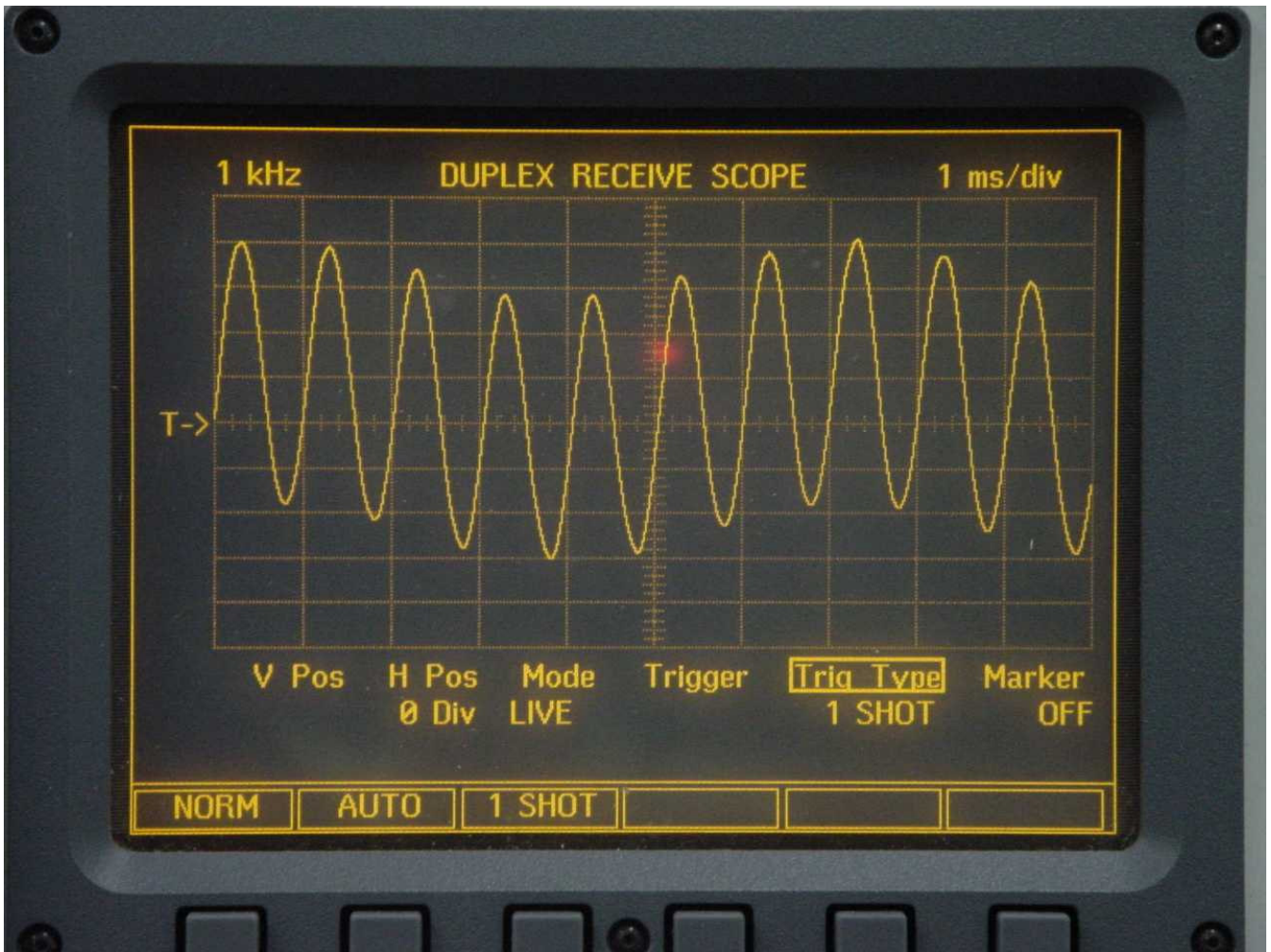


Fig 7. – COM120B duplex receive modulation scope screen shows the waveform resulting from generating 3kHz of 1kHz tone + 500Hz of 151.4Hz CTCSS into the reciter resulting in 3.66kHz (incl. 1kHz + CTCSS) out the PA.

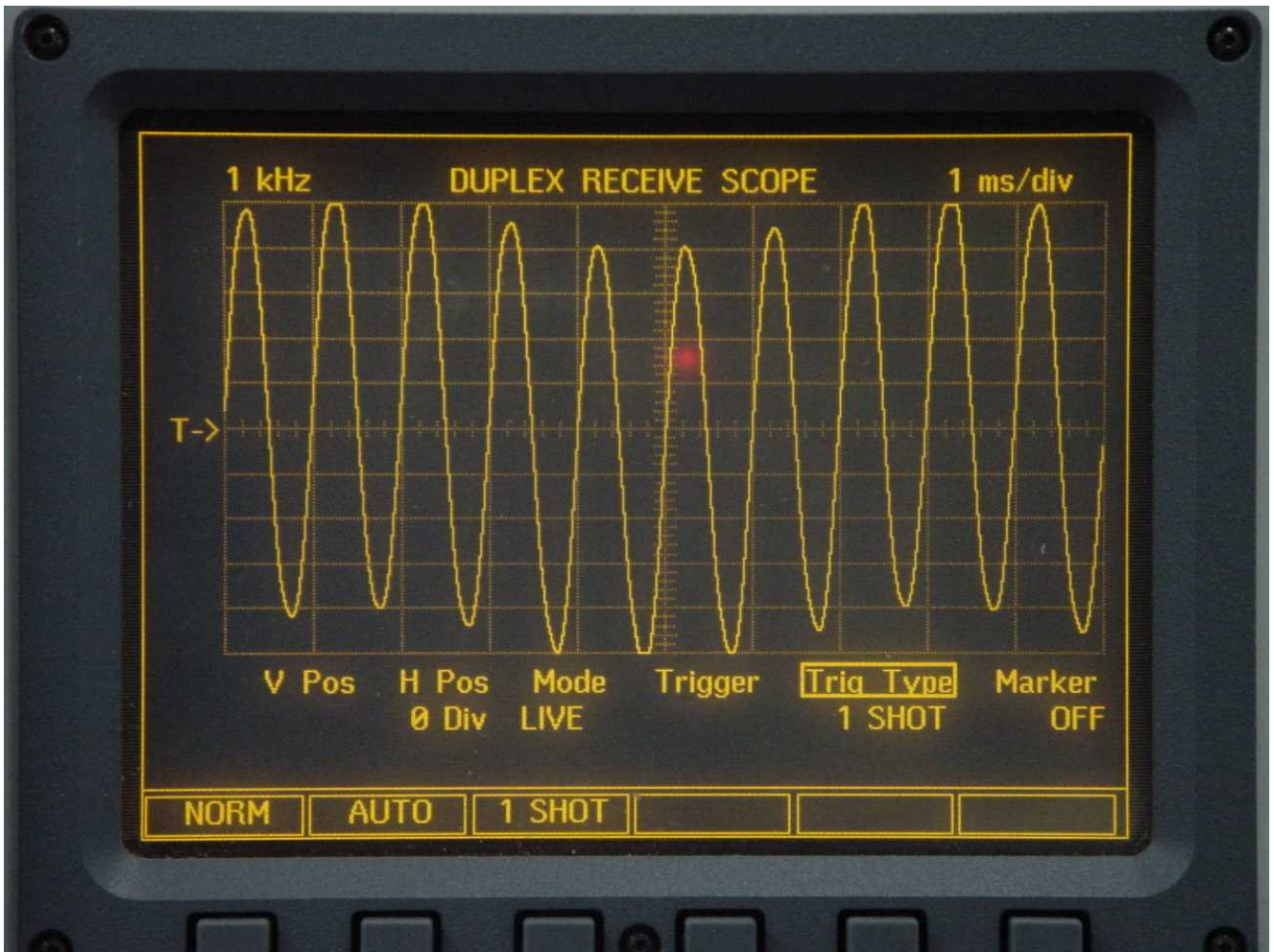


Fig 7. – COM120B duplex receive modulation scope screen shows the waveform resulting from generating 5kHz of 1kHz tone + 500Hz of 151.4Hz CTCSS into the reciter resulting in 5.3kHz (incl. 1kHz + CTCSS) out the PA.