

Avionics Test Mode for Freedom R8x00 Family of Communications System Analyzers

The Avionics Test Mode for the Freedom R8x00 family of communications system analyzers provides Flight Line or Ramp Testing capability for Instrument Landing System (ILS), Very High Frequency (VHF) Omni-Directional Range (VOR), Marker Beacon, and Navigation and Communications (NAV/COMM) equipment. In addition, it generates and receives Single Side-Band (SSB), Morse Code Identification, and SELCAL (selective calling) signaling formats.

The Avionics Test Mode has the following features and capabilities:

- Localizer (ILS Horizontal Guidance)
- Glide Slope (ILS Vertical Guidance)
- Marker Beacon
- NDB/ADF (Non-Directional Beacon / Automatic Direction Finder)
- VOR
- SELCAL

The Avionics Test Mode and features are accessed via the Test Mode/ Avionics selection as shown in Figure 1 and Figure 2.

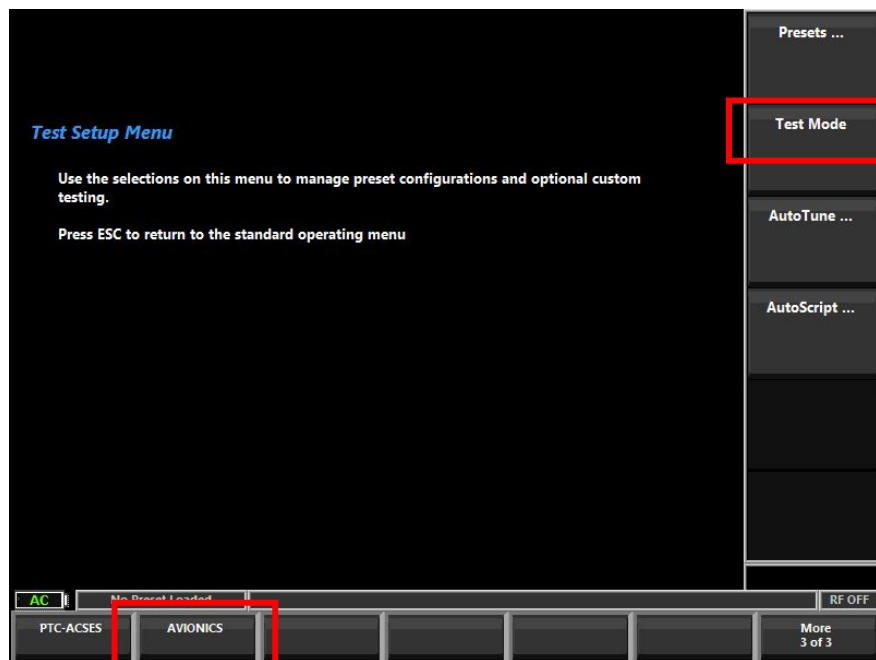


Figure 1. Avionics Test Mode

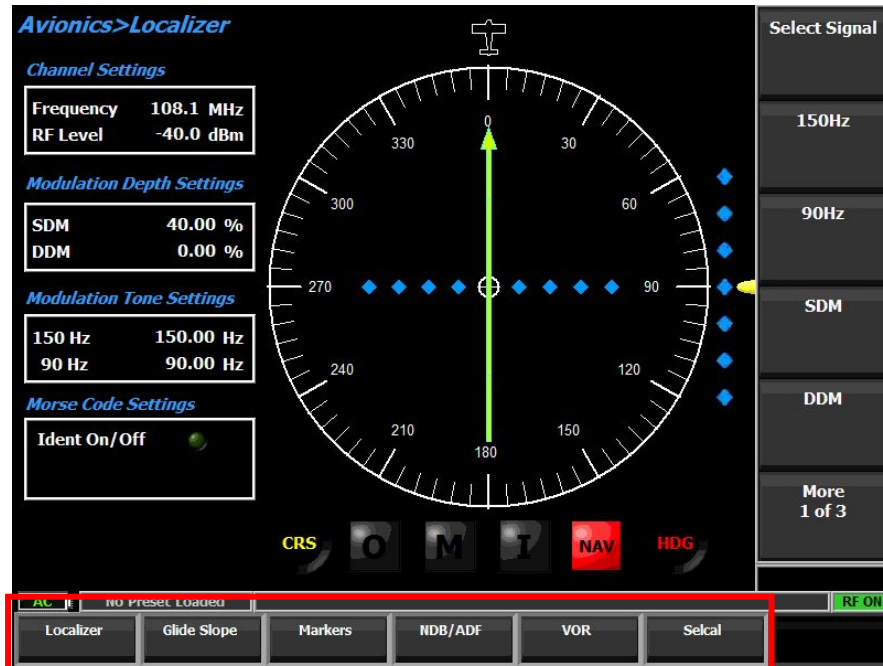


Figure 2. Avionics Test Mode Features

ILS Signal Generation (LOCALIZER/GLIDE SLOPE)

Several adjustable parameters are available for both the Localizer and Glide Slope Modes. These parameters are accessible via the Select Signal Menu, as depicted in Figure 3.

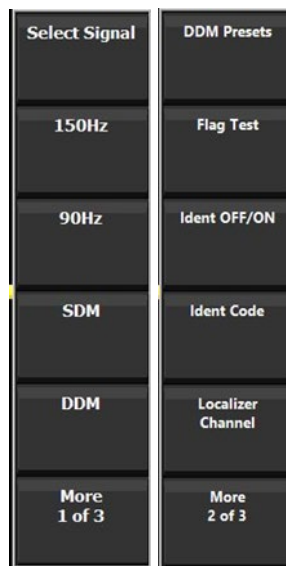


Figure 3. ILS (Localizer and Glide Slope) Parameters

Differential Depth of Modulation

Differential Depth of Modulation (DDM) adjusts the modulation depth between the two AM carriers of 90Hz and 150Hz. Upon start up, a DDM with a default = 0.0% shows the arrow pointing upward for both the Localizer and the vertical indicator for the Glider, as illustrated in Figure 4 and Figure 6, respectively. Valid DDM input ranges are -40 to 40% for the Localizer and -80 to 80% for the Glide Slope (Figure 5).

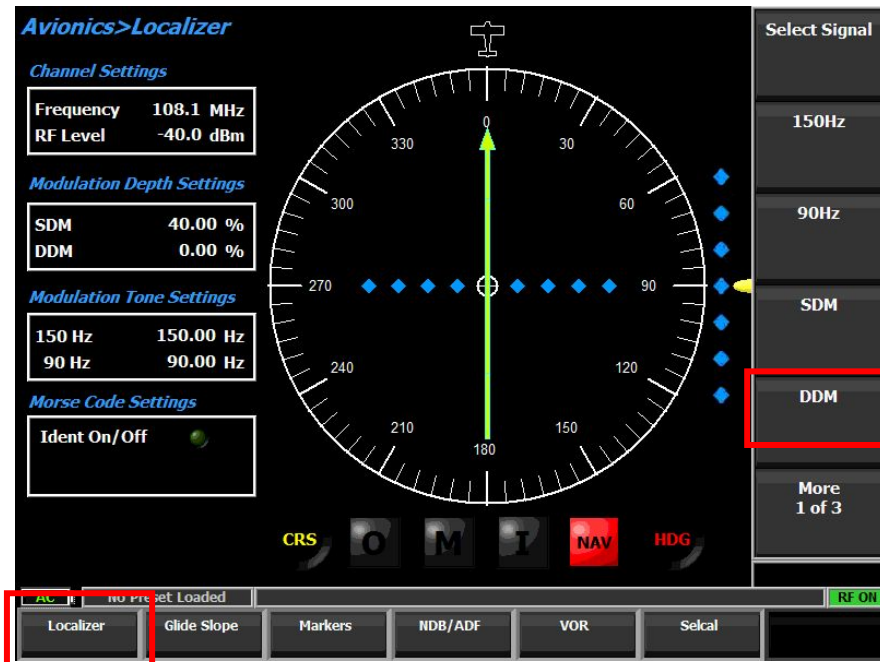


Figure 4. ILS (Localizer) Main Screen

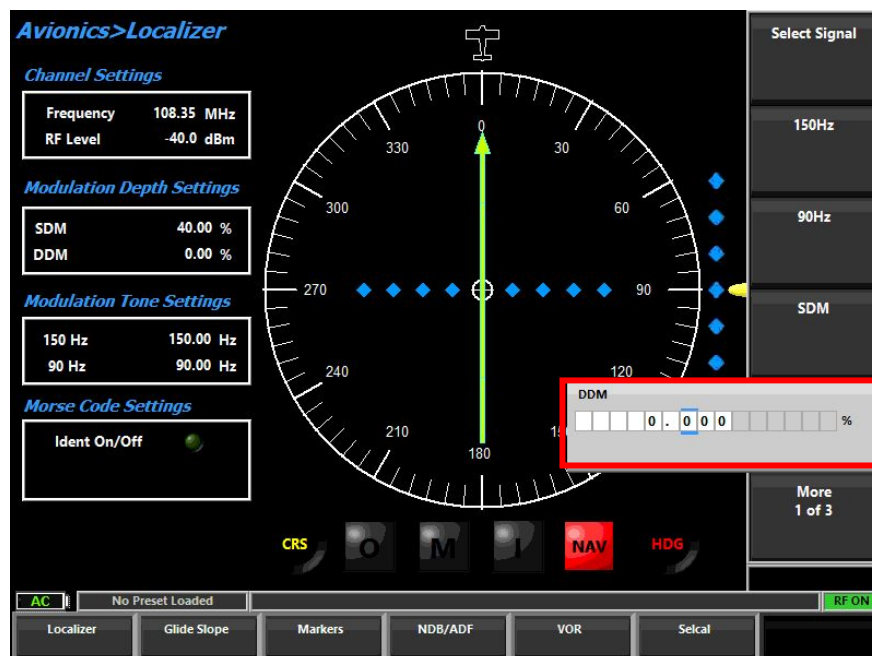


Figure 5. DDM Adjustment

Note: Users must select the Glide Slope channel pairing that matches the Localizer from a pre-populated table.

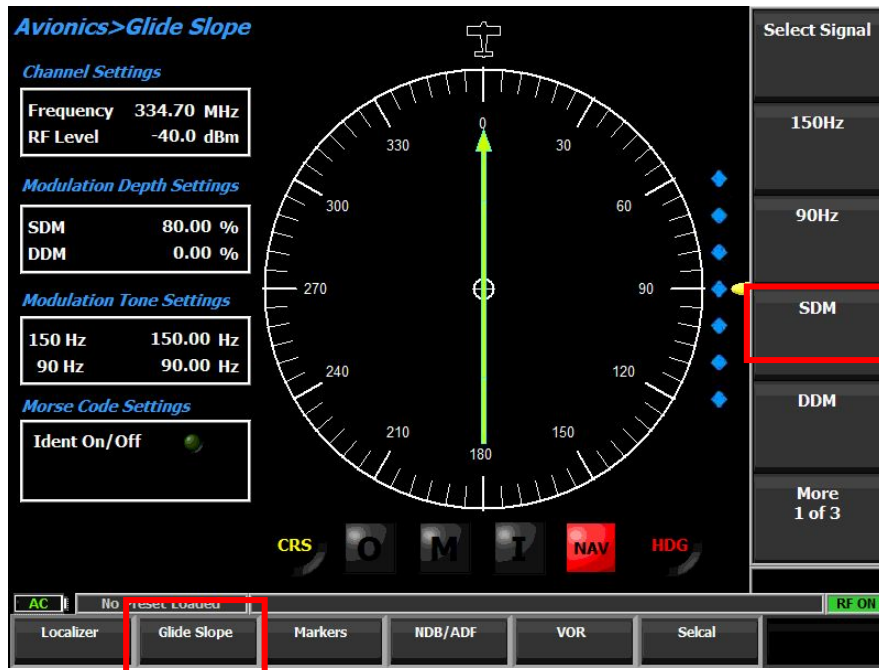


Figure 6. ILS (Glide Slope) Main Screen

Sum of Depth of Modulation

Similarly, the Sum of Depth of Modulation (SDM) has default values of 40% for the Localizer and 80% for the Glide Slope.

150Hz

The 150Hz Tone ILS Signal Component generates a 150Hz tone (Nominal Default) with 20% (nominal for the Localizer) and 40% (nominal for the Glide Slope) AM modulation depth on the RF carrier. The range is between 140 to 160Hz. In addition, the amplitude modulation depth can be adjusted explicitly via the AM Depth input (Figure 7).

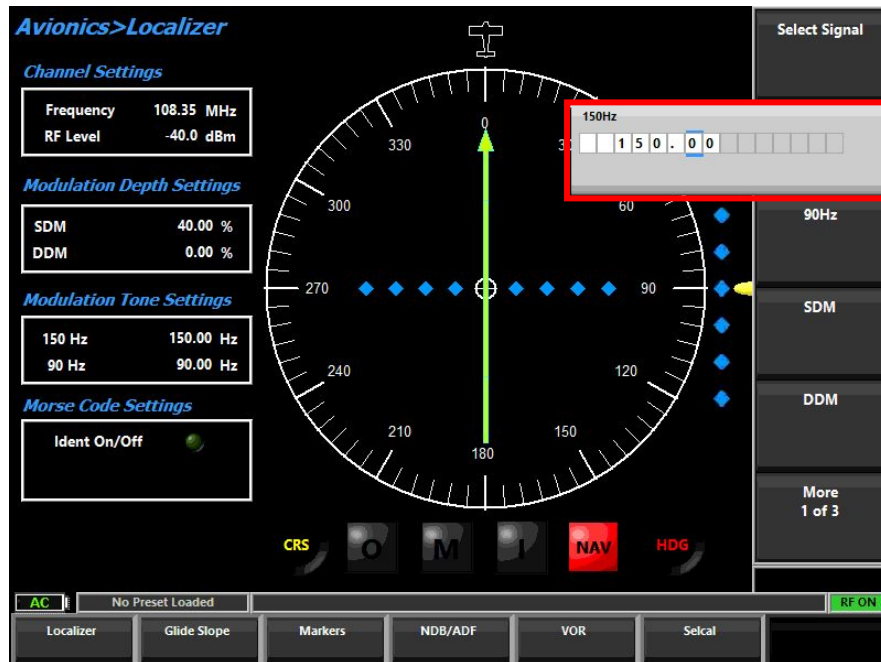


Figure 7. 150Hz ILS Tone Adjustment

90Hz

The 90Hz Tone ILS Signal Component generates a 90Hz tone with 20% (Localizer) and 40% (Glide Slope) AM modulation depth on the RF carrier. The range is between 80 to 110Hz. In addition, the amplitude modulation depth can be adjusted explicitly via the AM Depth input (Figure 8).

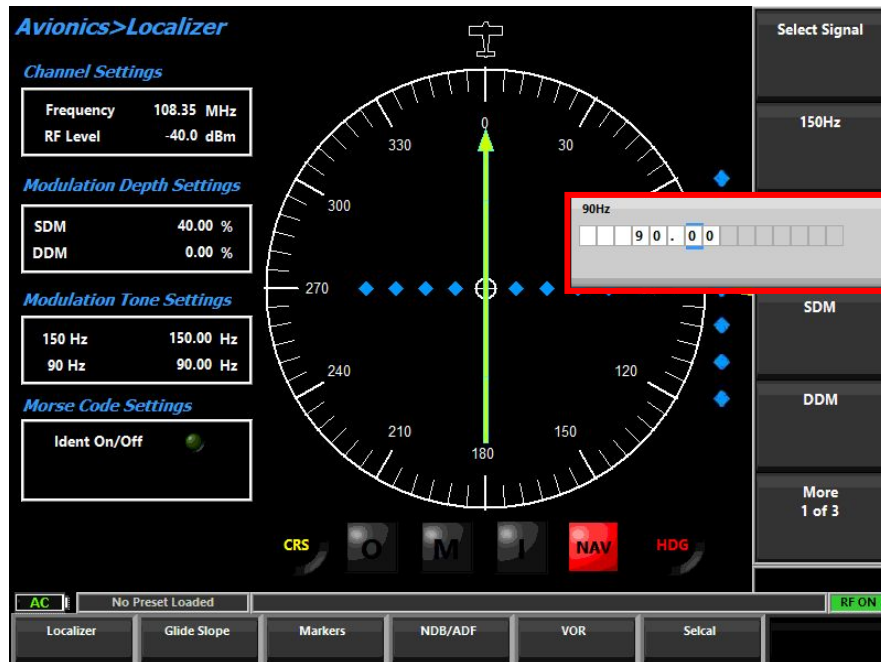


Figure 8. 90Hz ILS Tone Adjustment

Flag Test

The Flag Test is OFF (RED) by default and is used to turn the 150Hz tone off. This results in the transmission of a pure sinewave of 90Hz. Turning the 90Hz tone OFF and creating a pure 150Hz sinewave can be accomplished manually by setting the DDM input to -40%. Flag Test turns green to indicate it is now ON as shown in Figure 9. The Flag Test changes the displayed color of the NAV Flag on the main screen and toggles between Red/Green, when the Flag Test input toggles ON/OFF.

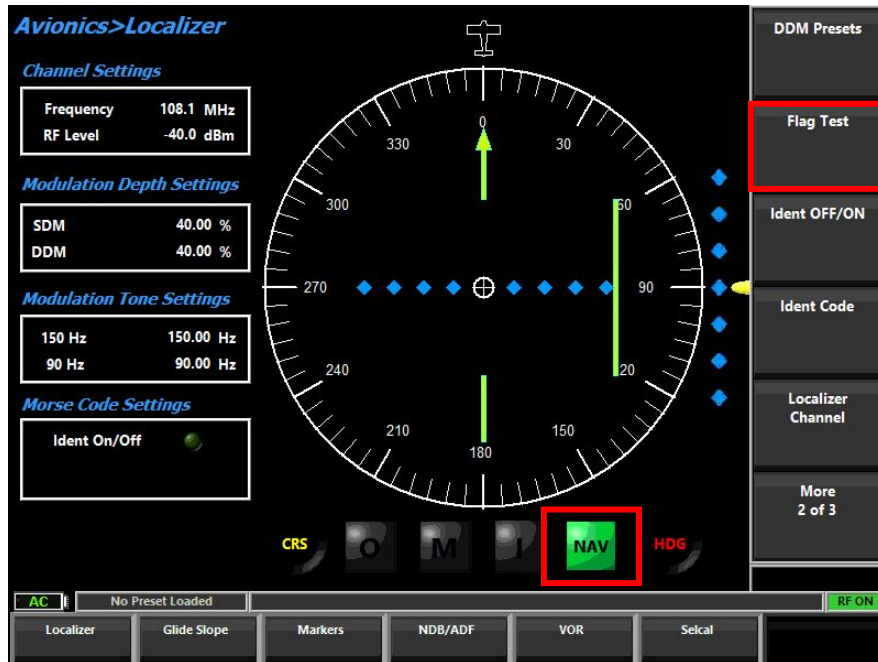


Figure 9. Active Flag Test screen

Morse Code

Morse code can be overlaid on the following signals: Localizer, Glide Slope, and VOR. It can be turned ON/OFF with the Morse code string representing an Airport code changed, as illustrated in Figure 10.



Figure 10. Morse Code Main Screen

A 3-5 digit Morse code signal for the Localizer and VOR is generated with a code tone frequency of 1020Hz and 60% AM modulation. The code, which can be turned ON/OFF, repeats at 0.3s intervals with a duration of 300ms. Digits A-Z, 0-9 can also be selected from a pre-populated Morse code table in the sub menu.

Localizer Channel

Valid Localizer channel frequencies can be selected via the Localizer Channel input selection. For ILS signals, as well as VOR, only valid channel frequencies can be chosen from a predefined list, as shown in Figure 11.



Figure 11. Localizer Channel Selection

RF Parameters

The RF port selection can be changed from the default RF I/O port to the Gen port to increase the maximum output level. The RF output level can also be adjusted via the RF Level entry as shown in Figure 12. For all generated signal supported, the RF Level may be adjusted and the Generated port may be selected (Figure 13).

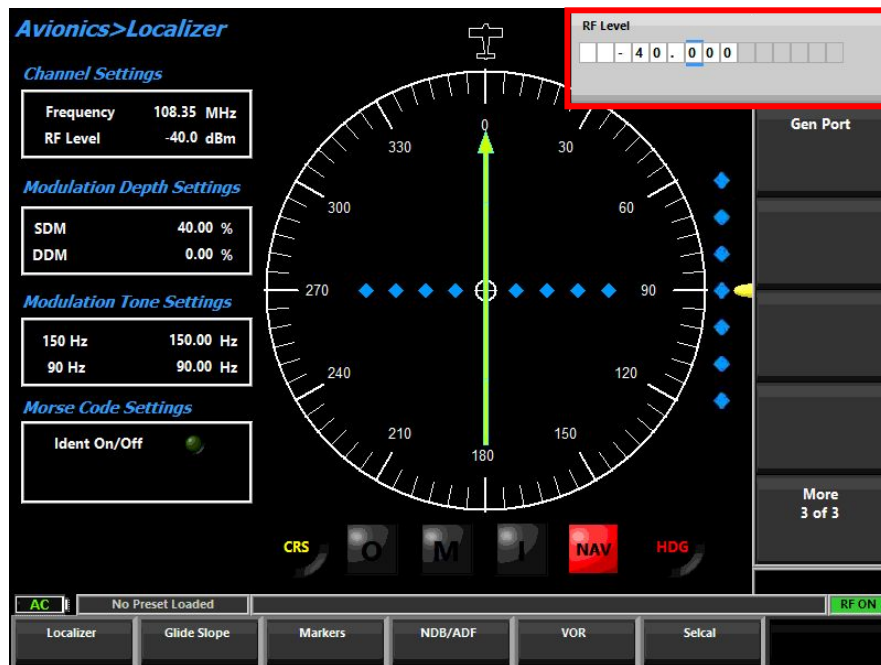


Figure 12. RF Level Adjustment

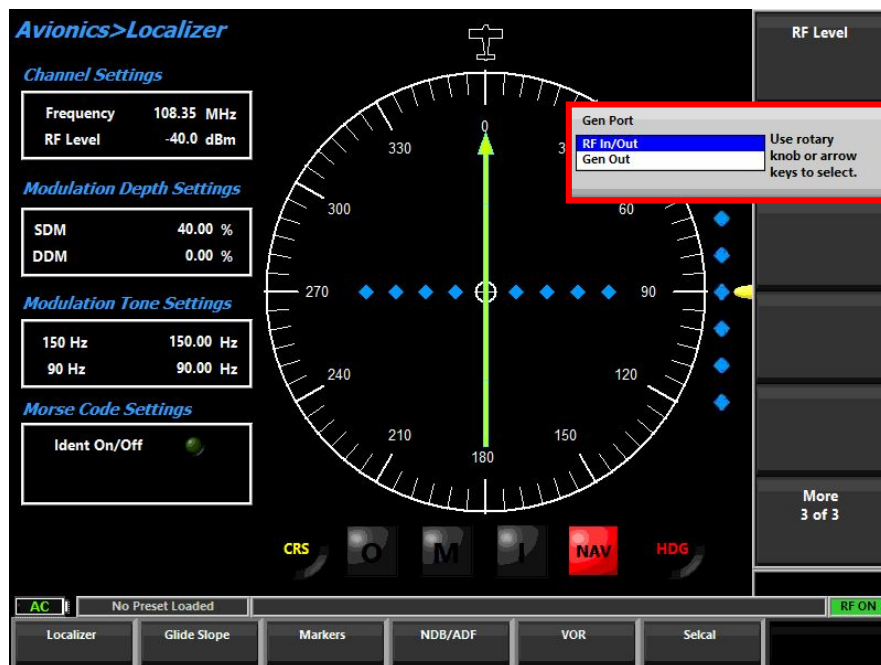


Figure 13. Generate Port Selection

Marker Beacon Signal Generation

The Marker Beacon signal generates a continuous carrier at 75MHz (default) amplitude modulated by a single tone. There are three user-selected tones from which to select (Table 1). During start up, none of the beacon markers are selected by default. After selection of one the three markers (Outer, Middle, Inner), a continuous corresponding pure sinewave will transmit via the selected RF port.

Table 1. Beacon Marker Frequencies

Beacon Marker Location	Tone Frequency [Hz]	Light Color
Outer (OM)	400	Blue/Cyan
Middle (MM)	1300	Yellow
Inner (IM)	3000	White

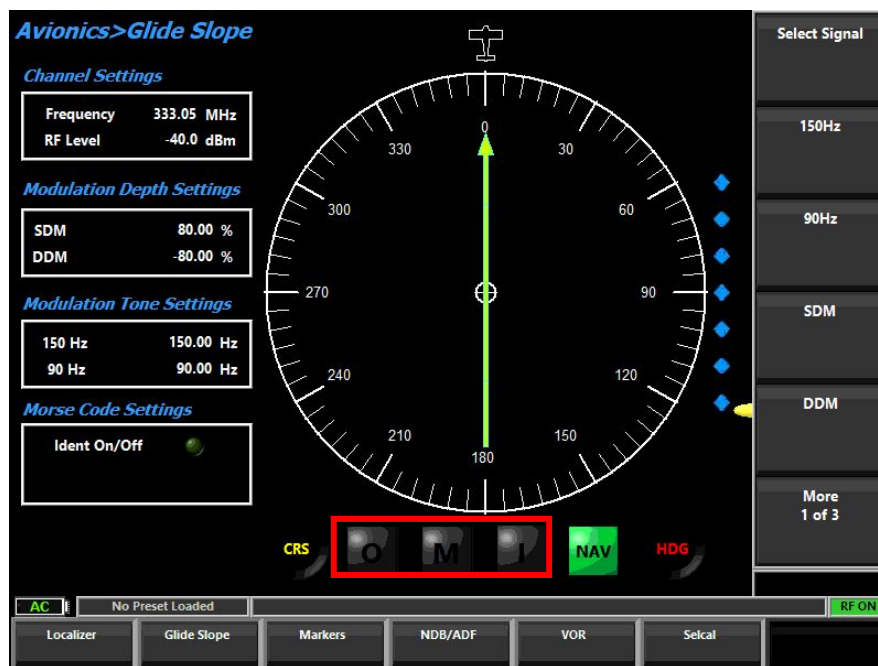


Figure 14. Beacon Marker Main Screen (default)

Figure 15, Figure 16, and Figure 17 illustrate the Outer, Middle, and Inner Marker Beacon selections, respectively.

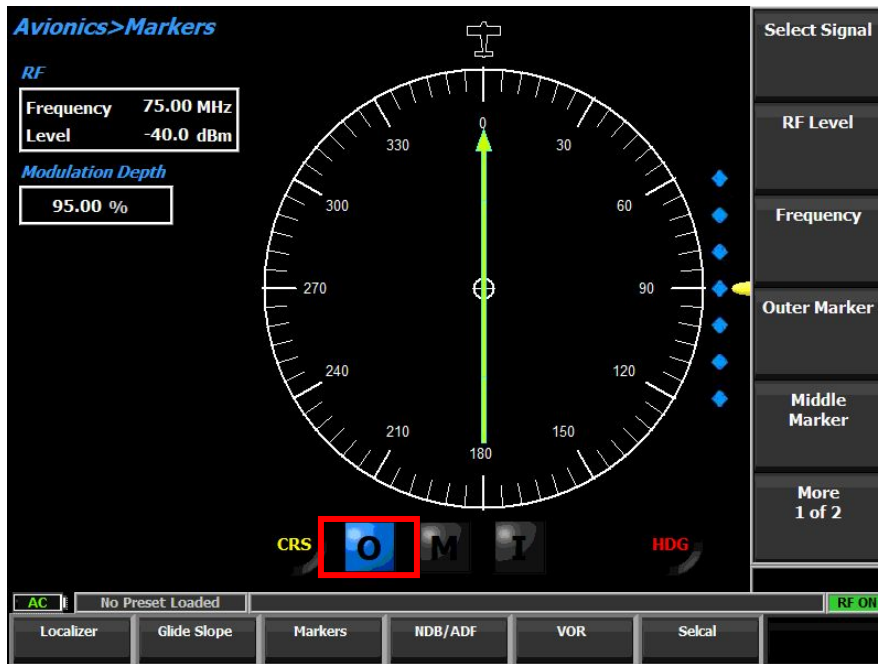


Figure 15. Outer Beacon Marker Selected



Figure 16. Middle Beacon Marker Selected

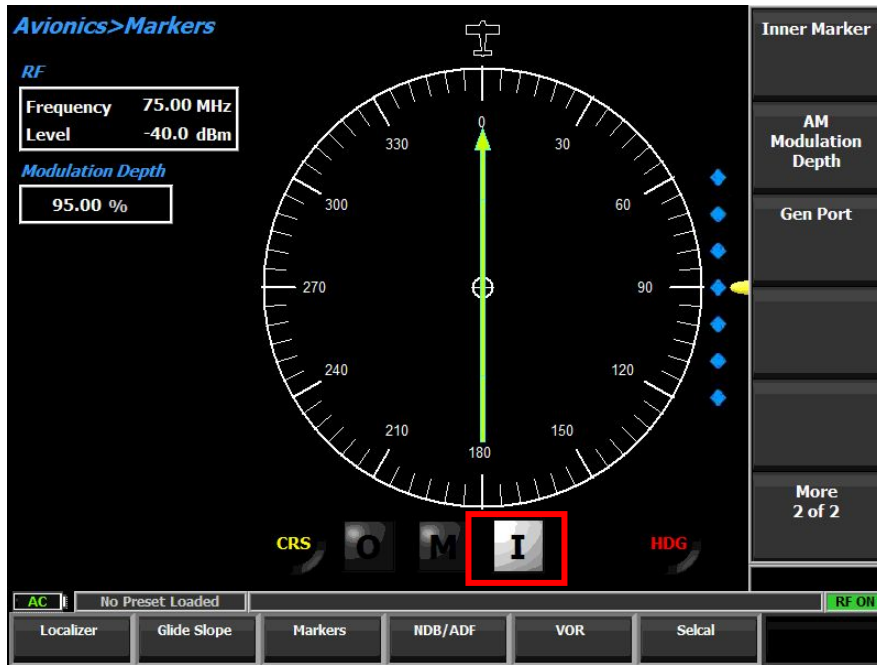


Figure 17. Inner Beacon Marker Selected

NDB/ADF Signal Generation

The Non-Directional Beacon/Automatic Direction Finder (NDB/ADF) signal transmits a 30MHz (default) amplitude modulated by a Morse code string. The NDB/ADF signal can be repeated indefinitely when the Repeat Cycle flag is True (Figure 18).

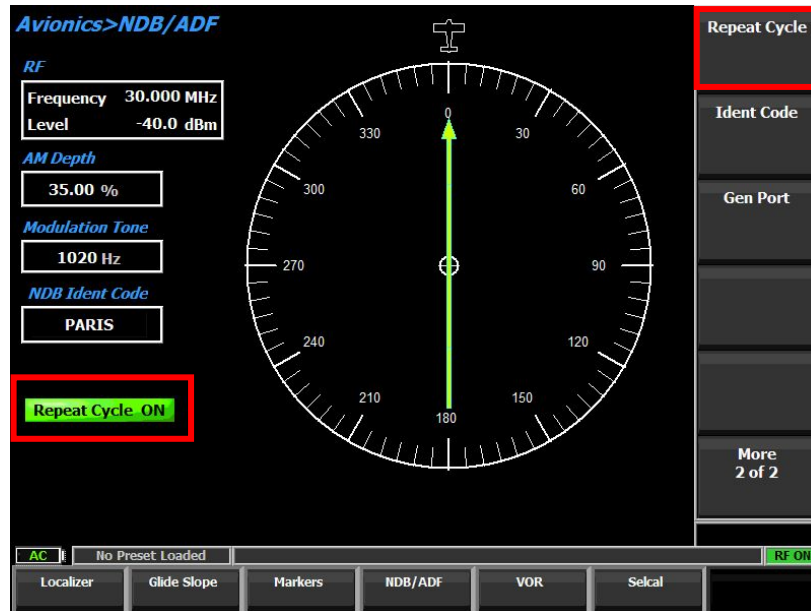


Figure 18. NDB/ADF Main Screen

When the Repeat Cycle flag is False, a single transmission of the user-specified Morse code is performed, as shown in Figure 19.

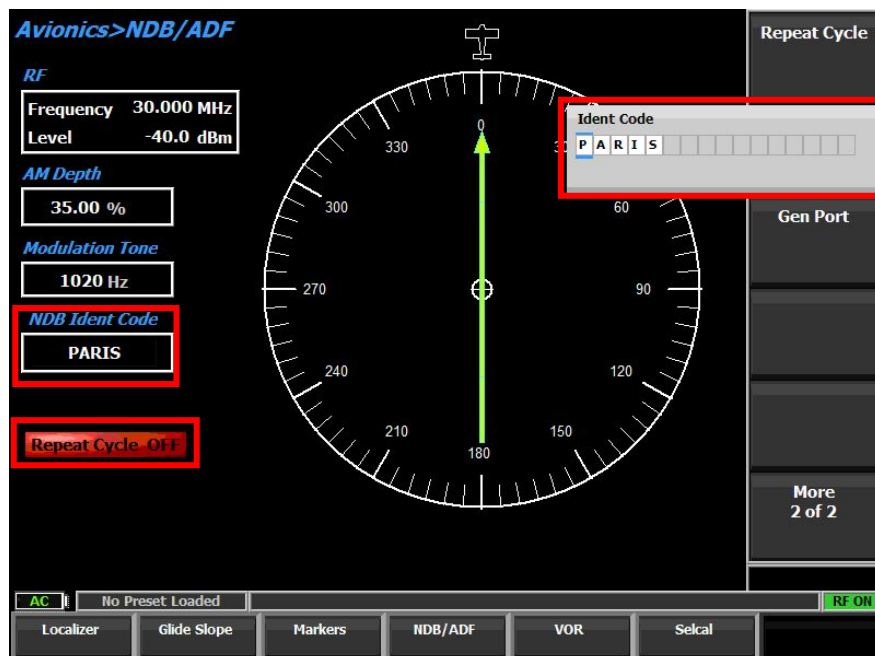


Figure 19. NDB/ADF Morse Code Selection

VHF Omni Directional Range (VOR) Signal Generation

The Very High Frequency (VHF) Omni-Directional Range (VOR) transmits a short/medium range navigation signal operating in the 108 to 117.95MHz range of frequencies (with 50kHz channel spacing). The VOR signal provides the aircraft with a bearing to the ground station location. The VOR signal may optionally include a three-letter code (derived from an Airport name, for example: London VOR is, “LON” and Dover VOR is, “DVR”). The code is modulated onto the carrier with a 1020Hz tone that the crew can listen to as a Morse code signal. As VOR operates in the same frequency range as the ILS system (108 to 111.95MHz), the two systems are differentiated by their frequency allocation within this range. VOR frequencies are allocated where the 100kHz digit is always even for each of the 50kHz increments (for example: 109.00, 109.05, 109.20, and 109.25 MHz, etc.). This pattern is applied from 108 to 111.95MHz.

Of the two types of VOR, Conventional and Doppler, the Freedom R8100 only supports the Conventional VOR Transmission. The conventional VOR (CVOR) station transmits two signals, omnidirectional and directional, on a continuous basis. The omnidirectional (reference) signal is the carrier wave frequency of the station, which contains a modulated continuous wave (MCW), 7-word-per-minute, Morse code station identifier and an AM voice channel. The 30Hz reference signal is frequency-modulated on a 9960Hz subcarrier with range of +/- 480Hz. The directional signal is radiated as a cardioid pattern rotating at 30 revolutions per second, which creates a 30Hz AM signal.



Figure 20. VOR Main Screen

The direction signal is arranged to be in phase with the reference signal when the aircraft is due north (magnetic) of the VOR station. As the cardioid pattern rotates around the station, the two signals become out of phase on a progressive basis. The difference in phase angle between the reference and direction signals is displayed to the crew as a radial from the VOR station. The VOR system can also transmit specific bearing information, referred to as a “radial”, using the Bearing softkey. The pilot can select any radial from a given VOR navigation aid and fly to or from that station. VOR radials are referenced to magnetic north and are the basis of “airways” that are used for navigation.

The VOR feature of the avionics test mode is capable of receiving and analyzing the combined reference and direction signal. The complete list of all the VOR input settings and parameters is shown in Table 2.

Table 2. VOR Input Settings

Input Name	Default	Range	Description
30Hz Variable	30Hz	20-40Hz	Adjust and enter 30Hz frequency
Variable Depth	30%	20-30%	Adjust and enter 30% AM depth
30Hz Reference	30Hz	20-40Hz	Adjust and enter 30Hz frequency
Reference Depth	30%	20-30%	Adjust and enter 9.960Hz AM depth
Sub Carrier Frequency	9960Hz	9960 +/- 10%	Adjust and enter 9.960Hz carrier frequency
Deviation	480Hz	0-500Hz	FM deviation
Bearing	0	0 to 360 Deg	Manual adjust bearing by selected increment
To/From	To	To/From	Select To/From and update directional flag
Variable On/Off	On	On/Off	Suppress variable signal component
Reference On/Off	On	On/Off	Suppress reference signal component
Sub Carrier ON/OFF	On	On/Off	Suppress sub carrier signal component
Indent	On	On/Off	
Ident Code	DFW	Morse Code String	
Bearing Slew	Off	On/Off	Checks for sticky display in older instruments
Bearing Slew Rate	Slow	Slow/Fast	Slew bearing in 1 degree increments, 30 sec duration for 360 degrees

SELCAL Signal Generation

The SELCAL signal generated is comprised of two consecutive equal tone pulses, with each pulse containing two simultaneously transmitted tones. Each pulse, of 1-second duration, is separated by an interval of about 0.2 seconds. The tones are labeled with letters A through S, excluding I, N, and O (Figure 22).



Figure 21. SELCAL Main Screen

In order to generate a valid sequence pair, the user must select four letters (2 sets of two letters), such as AB-CD with the following tone restrictions:

- A given letter can be used only once
- Letters cannot be not repeated, for example:
 - AB-CD is a valid entry (Figure 22)
 - AA-BC and AB-BC are not valid selections
- Letters in a pair must be entered in alphabetical order, for example:
 - AB-CD and CD-AB are valid entries
 - CD-BA is not a valid entry

Note: For an invalid SELCAL code entry, only a carrier is transmitted. No SELCAL signal is transmitted in this scenario.

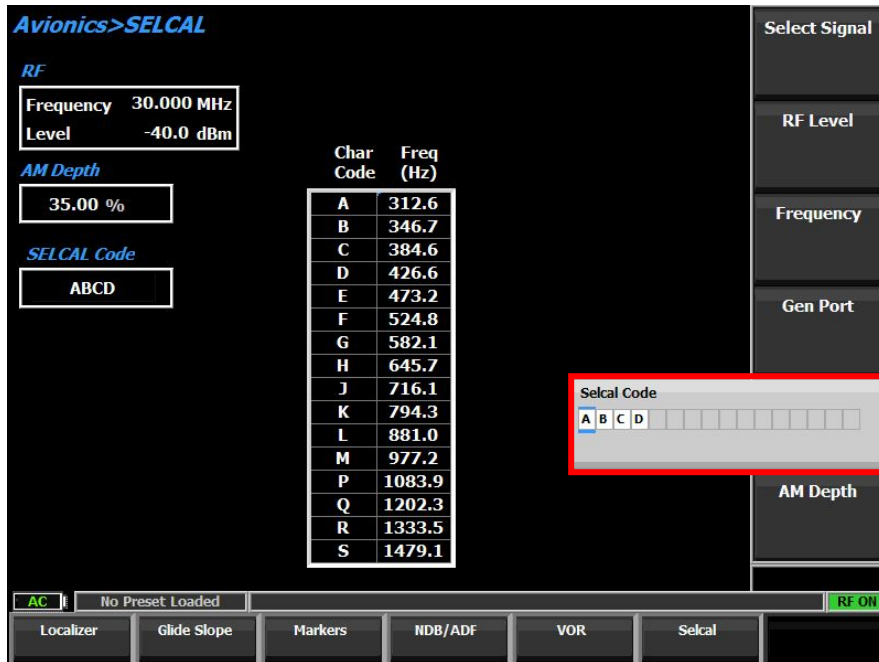


Figure 22. Valid SELCAL Code Selection