

R8000 SERIES COMMUNICATIONS SYSTEM ANALYZER

AUTOTUNE USER GUIDE

Hytera DMR Portable Radios Hytera DMR Mobile Radios

Freedom Communication Technologies 2002 Synergy Blvd, Suite 200 Kilgore, Texas 75662

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FCT-1390A

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1. Introduction

The Freedom Communication Technologies R8000 Series Communications System Analyzer AutoTune™ (hereafter "AutoTune") provides an automated test and alignment solution for supported two-way radios.

2. Scope

This document includes information regarding the tests and alignments performed for supported radios by AutoTune. This document is restricted to radio-specific information for Hytera DMR Portable and Hytera DMR Mobile radios.

Please refer to the R8000 Series Communications System Analyzer Owner's Manual (FCT-1365) for an overview and basic operating instructions for AutoTune itself.

2.1. Supported Models

The following Hytera DMR models are supported:

- PD5xx
- PD6xx
- PD7xx
- X1e/X1p
- HD5xx
- HD6xx
- HD7xx
- MD7xx

3. Conventions

3.1. PPM

"ppm" is "parts per million". This specification is generally limited to frequency-related measurements. If the frequency units are in MHz, then the ppm specification is in Hz. For example, a 169.075 MHz frequency with a ± 1.5 ppm specification is allowed to vary by 1.5 * 169.075 MHz, or about ± 254 Hz.

4. Hytera DMR Portable Radio Test Setup

In order to perform the test and alignment procedures, the Hytera DMR Portable radio must be connected to the R8000 Communications System Analyzer as shown in the figure below.



Make certain that the radio under test is configured as described in the corresponding diagram **before** attempting to perform an alignment or test. Failure to do so may result in poor radio performance and/or damage to the analyzer or radio equipment under test.

4.1. Cable Sweep

Every RF cable connected between a radio under test and the analyzer attenuates the signal propagating through it. The amount of attenuation varies by several factors such as operating frequency, cable length, and cable type. Ensuring this attenuation is accounted for by the analyzer is important to the accuracy of several tests and alignments, primarily power tests.

Sweep the RF cable used between the Radio and Analyzer, label the RF cable with the stored cable sweep name, and enable the Cable Sweep feature in the analyzer System, System Settings... menu. Refer to <u>Application Note FCT-1017</u> <u>Utilizing Cable Sweep on</u> <u>the Freedom Communications System Analyzer</u> for instructions on how to perform a cable sweep.

4.2. Battery Eliminator

Battery eliminators interface portable radios to DC power supplies. They're needed because batteries cannot produce consistent voltage/current when the radio is keyed for extended time periods, as it will be during an alignment. Attempting to use even a nominally good battery will eventually result in power alignment failures. A battery eliminator should **always** be used while performing radio alignments and tests with AutoTune to achieve consistent alignment performance.

For Hytera DMR Portable models, use the following Hytera battery eliminator part. For more information, see the applicable Hytera radio service manual.

Hytera DMR Portable battery jig

• Hytera Part Number: HYT-152PD50000100 (PD5, PD6, X1)

HYT-152PD78000200 (PD7)

4.3. Hytera DMR Portable Test Setup

Refer to the diagram below for the proper test setup.



Figure 4-1. Hytera DMR Portable Test Setup Diagram.

5. Hytera DMR Portable Alignment and Test Descriptions

Note: Throughout this section are references to Test Frequency. Test Frequencies are band- and mode -specific. A table of the frequencies used by each band may be found in the respective radio service manual.

Note: All analyzer Mode settings are Standard unless otherwise indicated.

5.1. Reference Oscillator Warp

RF Control	Port	Frequency	Modulation	Attenuation
Monitor	RF IN/OUT	Test Frequency	FM	30 dB
Table 5-1. Analyzer Configuration for Reference Oscillator Warp				

5.1.1. Alignment

The radio is placed into Test Mode at a Tx Test Frequency. The analyzer is placed into Monitor mode at the radio Tx Test Frequency and nominal attenuation. The radio is set to transmit a signal at the Test Frequency. The analyzer measures the Frequency error of the signal and adjusts the softpot to obtain the least amount of frequency error. The new softpot value is then programmed into the radio. The results are written to the log file.

Name	Description
Result	Pass or Fail. Frequency Error within Max Limit, Min Limit
Frequency	Test Frequency
Frequency Error	Frequency Error measured
Min Limit	Minimum Limit (inclusive) for Frequency Error
Max Limit	Maximum Limit (inclusive) for Frequency Error
Old Softpot	Radio Softpot before alignment
New Softpot	Radio Softpot after alignment

Table 5-2. Reference Oscillator Warp alignment results

5.1.2. Test

The radio is placed into Test Mode at a Tx Test Frequency. The analyzer is placed into Monitor mode at the radio Tx Test Frequency and nominal attenuation. The radio is set to transmit a signal at the Test Frequency. The analyzer measures the Frequency error of the signal and the results are written to the log file.

Name	Description
Result	Pass or Fail. Frequency Error within Max Limit, Min Limit
Frequency	Test Frequency
Frequency Error	Frequency Error measured
Min Limit	Minimum Limit (inclusive) for Frequency Error
Max Limit	Maximum Limit (inclusive) for Frequency Error
Softpot	Current radio softpot setting

Table 5-3. Reference Oscillator Warp test results

5.2. Tx Power

RF Control	Port	Frequency	Modulation	Attenuation
Monitor	RF IN/OUT	Test Frequency	FM	30 dB

 Table 5-4. Analyzer Configuration for Tx Power

5.2.1. Alignment

The Tx Power Out alignment aligns the power output level of the radio at both low and high power levels. The radio is placed into Test Mode and commanded to transmit at the first Test Frequency and the Low power setting. For each test frequency, the output level is measured and then adjusted until near to a band-specific output level. This process is repeated for the high power settings. The results are written to the log file.

Name	Description
Result	Pass or Fail. Power Out within manufacturer limits
Frequency	Test Frequency
Power Out	Measured radio output level
Min Limit	Minimum Limit (inclusive) for Power Out
Max Limit	Maximum Limit (inclusive) for Power Out
Old Softpot	Radio Softpot before alignment
New Softpot	Radio Softpot after alignment

 Table 5-5. Tx Power alignment results

5.2.2. Test

The radio is placed into Test Mode and commanded to transmit. Beginning at the first Tx Test Frequency, the output level is measured at each Tx Test Frequency, for Low Power and High Power, and compared against test limits. The results are written to the log file.

Name	Description
Result	Pass or Fail. Power Out within Max Limit, Min Limit
Frequency	Test Frequency
Power Out	Measured radio output level
Min Limit	Minimum Limit (inclusive) for Power Out
Max Limit	Maximum Limit (inclusive) for Power Out
Softpot	Current radio softpot setting

Table 5-6. Tx Power test results

5.3. Transmit to Deviation

RF Control	Port	Frequency	Modulation	Attenuation	
Monitor	RF IN/OUT	Test Frequency	FM	30 dB	
Table 5-7. Analyzer Configuration for Transmit to Deviation					

5.3.1. Alignment

The radio is placed into Test Mode and set to generate a 100 Hz tone at the Test Frequency. The deviation is measured and the softpot is adjusted until the deviation is within the limits. The new softpot values are programmed into the radio. The results are written to the log file.

Name	Description
Result	Pass or Fail. Pass if no radio error detected.
Frequency	Test Frequency
FM Deviation	Measured deviation
Min Limit	Minimum Limit (inclusive) for Deviation
Max Limit	Maximum Limit (inclusive) for Deviation
Old Softpot	Radio softpot before alignment
New Softpot	Radio softpot after alignment

 Table 5-8. Transmit to Deviation alignment results

5.3.2. Test

There is no Transmit to Deviation test.

5.4. Tx Modulation Balance

RF Control	Port	Frequency	Modulation	Attenuation	Averaging
Monitor	RF IN/OUT	Test Frequency	FM	30 dB	+/- Peak / 2
Table 5.0. An above 0 and investigation for Table delation. Delay as all supports					

 Table 5-9. Analyzer Configuration for Tx Modulation Balance alignment

5.4.1. Alignment

The radio is placed into Test Mode at low power at the first Tx Test Frequency and commanded to transmit. The radio generates a Low Gain modulation tone and the ±Peak/2-averaged deviation of this tone is measured with the analyzer. The Low Gain softpot is adjusted until tone deviation is between Low Gain Min, Max limits. This adjustment is performed for each TX Test Frequency. The radio then generates a High Gain modulation tone and the ±Peak/2-averaged deviation of this tone is measured with the analyzer. The High Gain softpot is adjusted until the tone deviation is between High Gain Min, Max test limits. This adjustment is performed for each TX Test Frequency for each Tx Test Frequency. For PD(HD)5xx and PD(HD)6xx radios, only the High Gain alignment is performed. The results are written to the log file.

Name	Description
Result	Pass or Fail. Pass if no radio error detected.
Frequency	Test Frequency
FM Deviation	Measured deviation
Min Limit	Minimum Limit (inclusive) for Deviation
Max Limit	Maximum Limit (inclusive) for Deviation
Old Softpot	Radio softpot before alignment
New Softpot	Radio softpot after alignment

Table 5-10. Tx Modulation alignment results

5.4.2. Test

There is no Tx Modulation Balance test.

5.5. Rx Front End Filter

RF Control	Port	Frequency	Modulation	Output Level
Generate	RF IN/OUT	Test Frequency	FM	-118 dBm
Table 5.44 Analyzan Configuration for Dy Front End Filter				

Table 5-11. Analyzer Configuration for Rx Front End Filter

5.5.1. Alignment

The radio is placed into Test Mode at a Tx Test Frequency. The analyzer is placed into Generate mode at the radio Tx Test Frequency with a Fixed 1 kHz tone with 3 kHz modulation. The SINAD is read from the radio and set to transmit a signal at the Test Frequency. The analyzer measures the SINAD of the signal over the range of the softpot and selects the softpot values that produce a SINAD > 18 dBm. These softpot values are tried at two Inhibit point offsets to the Test Frequency and AutoTune checks for the SINAD to be > 12 dBm. A passing softpot value is saved to the radio and the next Test Frequency is aligned. Results are written to the log file.

The Rx Front End Filter alignment is not supported on 800-900 MHz radios.

Name	Description
Result	Pass or Fail. Pass if no radio error detected.
Frequency	Test Frequency
SINAD	Measured SINAD
Min Limit	Minimum Limit (inclusive) for Deviation
Old Softpot	Radio softpot before alignment
New Softpot	Radio softpot after alignment

Table 5-12. Rx Front End Filter alignment results

5.5.2. Test

There is no Rx Front End Filter test.

5.6. Rx Front End Gain

RF Control	Port	Frequency	Modulation	Output Level
Generate	RF IN/OUT	Test Frequency	FM	-70 dBm
Table 5.42 Analyzar Configuration for Dy Front Fred Coin				

 Table 5-13. Analyzer Configuration for Rx Front End Gain

5.6.1. Alignment

The radio is placed into Test Mode at a Tx Test Frequency. The analyzer is placed into Generate mode at the radio Tx Test Frequency with an output level of -70 dBm. The current Front End Gain value is read then saved to the radio. Results are written to the log file.

Name	Description
Result	Pass or Fail. Pass if no radio error detected.
Frequency	Test Frequency
Gain	Measured Gain
Min Limit	Minimum Limit (inclusive) for Gain
Max Limit	Maximum Limit (inclusive) for Gain

Table 5-14. Rx Front End Gain alignment results

5.6.2. Test

There is no Rx Front End Gain test.

5.7. Tx/Rx Charge Voltage (Portable Only)

5.7.1. Alignment

The radio is placed into Test Mode at the Tx Test Frequency and commanded to transmit. The current Charge Voltage value is read then saved to the radio. Results are written to the log file.

The Tx/Rx Charge Voltage alignment is not supported on PD(HD)5xx and PD(HD)6xx radios.

Name	Description
Result	Pass or Fail. Pass if no radio error detected.
Frequency	Test Frequency
Osc Voltage	Measured charge voltage
Min Limit	Minimum Limit (inclusive) for charge voltage
Max Limit	Maximum Limit (inclusive) for charge voltage
Table E 4E Tu/Du	Charge Valtere alignment reculte

Table 5-15. Tx/Rx Charge Voltage alignment results

5.7.2. Test

There is no Tx/Rx Charge Voltage test.

5.8. Tx Max Analog Deviation

RF Control	Port	Frequency	Modulation	Attenuation
Monitor	RF IN/OUT	Test Freq	FM	30 dB

 Table 5-16. Analyzer Configuration for Tx Max Analog Deviation test

5.8.1. Test

The radio is placed into Test Mode at low power at the first Tx Test Frequency and commanded to transmit generating an Analog CSQ signal. The analyzer applies a 1 kHz tone with 75 mV level to the microphone and then measures the deviation. The measurement is done at the wide (25 kHz) bandwidth, then at the narrow (12.5 kHz) bandwidth. This measurement is performed for each Tx Test Frequency. The results are written to the log file.

Name	Description
Result	Pass or Fail. Pass if no radio error detected.
Frequency	Test Frequency
Bandwidth	Bandwidth during test
Deviation	Measured Deviation
Min Limit	Minimum Limit (inclusive) for Deviation
Max Limit	Maximum Limit (inclusive) for Deviation

Table 5-17. Tx Max Analog Deviation test results

5.9. Tx Max Analog Deviation CTCSS

RF Control	Port	Frequency	Modulation	Attenuation
Monitor	RF IN/OUT	Test Freq	FM	30 dB

 Table 5-18. Analyzer Configuration for Tx Max Analog Deviation CTCSS test

5.9.1. Test

The radio is placed into Test Mode at low power at the first Tx Test Frequency and commanded to transmit generating an Analog CTCSS signal. The analyzer applies a 1 kHz tone with 75 mV level to the microphone and then measures the deviation. The measurement is done at the wide (25 kHz) bandwidth, then at the narrow (12.5 kHz) bandwidth. This measurement is performed for each Tx Test Frequency. The results are written to the log file.

Name	Description
Result	Pass or Fail. Pass if no radio error detected.
Frequency	Test Frequency
Bandwidth	Bandwidth during test
Tone	Audio tone frequency
Deviation	Measured Deviation
Min Limit	Minimum Limit (inclusive) for Deviation
Max Limit	Maximum Limit (inclusive) for Deviation
Table 5 40 Ty May	Analog Deviation CTCCC test results

 Table 5-19. Tx Max Analog Deviation CTCSS test results

5.10. Tx Max Analog Deviation CDCSS

RF Control	Port	Frequency	Modulation	Attenuation
Monitor	RF IN/OUT	Test Freq	FM	30 dB

Table 5-20. Analyzer Configuration for Tx Max Analog Deviation CDCSS

5.10.1. Test

The radio is placed into Test Mode at low power at the first Tx Test Frequency and commanded to transmit generating an Analog CDCSS signal. The analyzer applies a 1 kHz tone with 75 mV level to the microphone and then measures the deviation. The measurement is done at the wide (25 kHz) bandwidth, then at the narrow (12.5 kHz) bandwidth. This measurement is performed for each Tx Test Frequency. The results are written to the log file.

Name	Description
Result	Pass or Fail. Pass if no radio error detected.
Frequency	Test Frequency
Bandwidth	Bandwidth during test
Code	Tone code
Deviation	Measured Deviation
Min Limit	Minimum Limit (inclusive) for Deviation
Max Limit	Maximum Limit (inclusive) for Deviation

Table 5-21. Tx Max Analog Deviation CDCSS test results

5.11. Tx CTCSS Deviation

Test Freq	FM	30 dB
T	est Freq	est Freq FM

Table 5-22. Analyzer Configuration for Tx CTCSS Deviation

5.11.1. Test

The radio is placed into Test Mode at low power at the first Tx Test Frequency and commanded to transmit generating an Analog CTCSS signal. The analyzer measures the deviation. The measurement is done at the wide (25 kHz) bandwidth, then at the narrow (12.5 kHz) bandwidth. This measurement is performed for each Tx Test Frequency. The results are written to the log file.

Name	Description
Result	Pass or Fail. Pass if no radio error detected.
Frequency	Test Frequency
Bandwidth	Bandwidth during test
Tone	Audio tone frequency
Deviation	Measured Deviation
Min Limit	Minimum Limit (inclusive) for Deviation
Max Limit	Maximum Limit (inclusive) for Deviation

Table 5-23. Tx CTCSS Deviation test results

5.12. Tx CDCSS Deviation

Monitor RF IN/OUT Test Freq FM 30 dB	RF Control	Port	Frequency	Modulation	Attenuation
	Monitor	RF IN/OUT	Test Freq	FM	30 dB

Table 5-24. Analyzer Configuration for Tx CDCSS Deviation test

5.12.1. Test

The radio is placed into Test Mode at low power at the first Tx Test Frequency and commanded to transmit generating an Analog CDCSS signal. The analyzer measures the deviation. The measurement is done at the wide (25 kHz) bandwidth, then at the narrow (12.5 kHz) bandwidth. This measurement is performed for each Tx Test Frequency. The results are written to the log file.

Name	Description
Result	Pass or Fail. Pass if no radio error detected.
Frequency	Test Frequency
Bandwidth	Bandwidth during test
Code	Tone code
Deviation	Measured Deviation
Min Limit	Minimum Limit (inclusive) for Deviation
Max Limit	Maximum Limit (inclusive) for Deviation

Table 5-25. Tx CDCSS Deviation test results

5.13. Tx Modulation Sensitivity

RF Control	Port	Frequency	Modulation	Attenuation
Monitor	RF IN/OUT	Test Freq	FM	30 dB

Table 5-26. Analyzer Configuration for Tx Modulation Sensitivity test

5.13.1. Test

The radio is placed into Test Mode at low power at the first Tx Test Frequency and commanded to transmit generating an Analog CSQ signal. The analyzer applies a 1 kHz tone with 7 mV level to the microphone and then measures the deviation. The audio level is adjusted until the deviation is +/- 100 Hz, then the resulting audio level is checked against the limits. The measurement is done at the wide (25 kHz) bandwidth, then at the narrow (12.5 kHz) bandwidth. This measurement is performed for each Tx Test Frequency. The results are written to the log file.

Name	Description
Result	Pass or Fail. Pass if no radio error detected.
Frequency	Test Frequency
Bandwidth	Bandwidth during test
Deviation	Measured Deviation
Audio Level	Audio level of analyzer
Min Limit	Minimum Limit (inclusive) for Deviation
Max Limit	Maximum Limit (inclusive) for Deviation

Table 5-27. Tx Modulation Sensitivity test results

5.14. Tx BER

RF Control	Port	Frequency	Modulation	Attenuation
Monitor	RF IN/OUT	Test Freq	Digital: 0.153 test pattern	40 dB
Table 5.00 Analysis Occificantian for To DED (and				

 Table 5-28. Analyzer Configuration for Tx BER test

5.14.1. Test

The analyzer is setup to monitor for a O.153 test pattern modulated signal from the radio. The radio is placed into Test Mode at the first Tx Test Frequency. The analyzer measures the radio signal's BER level. The results are written to the log file. This process is repeated for each Tx Test Frequency.

Name	Description
Result	Pass or Fail. Pass if no radio error detected.
Frequency	Test Frequency
BER	Radio's BER measurement
Max Limit	Maximum limit (inclusive) for BER

Table 5-29. Tx BER test results

5.15. Tx Digital Tests

RF Control	Port	Frequency	Modulation	Attenuation
Monitor	RF IN/OUT	Test Freq	Digital: 0.153 test pattern	40 dB

 Table 5-30. Analyzer Configuration for Tx Digital Tests

5.15.1. Test

The analyzer is setup to monitor for a O.153 test pattern modulated signal from the radio. The radio is placed into Test Mode at the first Tx Test Frequency. The analyzer measures the radio signal's FSK Error, Symbol Deviation, and Magnitude Error values and is repeated for each Tx Test Frequency.

The results are written to the log file.

Name	Description	
Result	Pass or Fail. Pass if no radio error detected.	
Frequency	Test Frequency	
FSK Error	Radio's FSK Error measurement	
Max Limit	Maximum limit (inclusive) for FSK Error	
Table 5.24 Ty ESK Error toot reculto		

Table 5-31. Tx FSK Error test results

Name	Description
Result	Pass or Fail. Pass if no radio error detected.
Frequency	Test Frequency
Symbol Deviation	Radio's Symbol Deviation measurement
Min Limit	Minimum limit (inclusive) for Symbol Deviation
Max Limit	Maximum limit (inclusive) for Symbol Deviation

Table 5-32. Tx Symbol Deviation test results

Name	Description
Result	Pass or Fail. Pass if no radio error detected.
Frequency	Test Frequency
Magnitude Error	Radio's Magnitude Error measurement
Max Limit	Maximum limit (inclusive) for Magnitude Error

Table 5-33. Tx Magnitude Error test results

5.16. Rx Max Audio Output Power

RF Control	Port	Frequency	Modulation	Level
Generate	RF IN/OUT	Test Freq	1 kHz signal with 3 kHz (wide) or 1.5 kHz (narrow) level	-40 dBm

Table 5-34. Analyzer Configuration for Rx Max Audio Output Power test

5.16.1. Test

The analyzer is setup to apply the modulated signal in the table above to the radio. The radio is placed into Test Mode at the Rx Test Frequency. The radio volume is set to its maximum level. The analyzer measures the radio's audio level. The test is performed for a wide (25 kHz) bandwidth and a narrow (12.5 kHz) bandwidth. The results are written to the log file.

Name	Description	
Result	Pass or Fail. Pass if no radio error detected.	
Frequency	Test Frequency	
Bandwidth	Bandwidth of channel	
Audio Out	Radio's Audio volume	
Min Limit	Minimum limit (inclusive) for volume	
Max Limit	Maximum limit (inclusive) for volume	
Table 5-35, By Max Audio Output Power test results		

Table 5-35. Rx Max Audio Output Power test results

5.17. Rx Sensitivity

RF Control	Port	Frequency	Modulation	Level
Generate	RF IN/OUT	Test Freq	1 kHz signal with 3 kHz (wide) or 1.5 kHz (narrow) level	-47 dBm

Table 5-36. Analyzer Configuration for Rx Sensitivity test

5.17.1. Test

The analyzer is setup to apply the modulated signal in the table above to the radio. The radio is placed into Test Mode at the first Rx Test Frequency. The analyzer measures the radio's SINAD level. The test is performed for a wide (25 kHz) bandwidth and a narrow (12.5 kHz) bandwidth and repeated for each Rx Test Frequency. The results are written to the log file.

Name	Description	
Result	Pass or Fail. Pass if no radio error detected.	
Frequency	Test Frequency	
Bandwidth	Bandwidth of channel	
SINAD	SINAD measurement	
Min Limit	Minimum limit (inclusive) for SINAD	

Table 5-37. Rx Sensitivity test results

5.18. Rx Audio Distortion

RF Control	Port	Frequency	Modulation	Level
Generate	RF IN/OUT	Test Freq	1 kHz signal with 3 kHz (wide) or 1.5 kHz (narrow) level	-70 dBm

 Table 5-38. Analyzer Configuration for Rx Audio Distortion test

5.18.1. Test

The analyzer is setup to apply the modulated signal in the table above to the radio. The radio is placed into Test Mode at the first Rx Test Frequency. The analyzer measures the radio's audio distortion level. The test is performed for a wide (25 kHz) bandwidth and a narrow (12.5 kHz) bandwidth and repeated for each Rx Test Frequency. The results are written to the log file.

Name	Description
Result	Pass or Fail. Pass if no radio error detected.
Frequency	Test Frequency
Bandwidth	Bandwidth of channel
Distortion	Distortion measurement
Max Limit	Maximum limit (inclusive) for Distortion
Table 5 00 Du Audie D	

Table 5-39. Rx Audio Distortion test results

5.19. Rx SNR

RF Control	Port	Frequency	Modulation	Level
Generate	RF IN/OUT	Test Freq	1 kHz signal with 3 kHz (wide)	Set to
			or 1.5 kHz (narrow) level	Rated Audio

Table 5-40. Analyzer Configuration for Rx SNR test

5.19.1. Test

The analyzer is setup to apply the modulated signal in the table above to the radio. The radio is placed into Test Mode at the first Rx Test Frequency. The analyzer measures the radio's SNR level. The test is performed for a wide (25 kHz) bandwidth and a narrow (12.5 kHz) bandwidth and repeated for each Rx Test Frequency. The results are written to the log file.

Name	Description
Result	Pass or Fail. Pass if no radio error detected.
Frequency	Test Frequency
Bandwidth	Bandwidth of channel
SNR	SNR measurement
Min Limit	Minimum limit (inclusive) for SNR
Table 5 44 De OND 444	

 Table 5-41. Rx SNR test results

5.20. Rx Normal Level Squelch

RF Control	Port	Frequency	Modulation	Level
Generate	RF IN/OUT	Test Freq	1 kHz signal with 3 kHz (wide)	Set to
			or 1.5 kHz (narrow) level	Rated Audio

 Table 5-42. Analyzer Configuration for Rx Normal Level Squelch test

5.20.1. Test

The analyzer is setup to apply the modulated signal in the table above to the radio. The radio is placed into Test Mode at the first Rx Test Frequency. The analyzer signal level is set to what should produce an open squelch and the radio's Audio output level is measured. The analyzer output level is then set to what should produce a closed squelch and the radio's Audio output level is measured. The test is performed for a wide (25 kHz) bandwidth and a narrow (12.5 kHz) bandwidth and repeated for each Rx Test Frequency. The results are written to the log file.

Name	Description
Result	Pass or Fail. Pass if no radio error detected.
Frequency	Test Frequency
Bandwidth	Bandwidth of channel
Squelch	Open or Closed Squelch measurement
Audio Out	Audio level measured
Limit	Minimum (Open)/Maximum (Closed) limit (inclusive) for Audio Out
Output Level	Signal level for Audio Out measurement

 Table 5-43. Rx Normal Level Squelch test results

5.21. Rx CTCSS/CDCSS Decode

RF Control	Port	Frequency	Modulation	Level
Generate	RF IN/OUT	Test Freq	1 kHz signal with 3 kHz (wide)	Set to
			or 1.5 kHz (narrow) level	Rated Audio

 Table 5-44. Analyzer Configuration for Rx CTCSS/CDCSS Decode test

5.21.1. Test

The analyzer is setup to apply the modulated signal in the table above to the radio. The radio is placed into Test Mode at the Rx Test Frequency and set to receive an Analog CTCSS signal. The analyzer measures the Audio Output level from the radio. The measurement is done at the wide (25 kHz) bandwidth, then at the narrow (12.5 kHz) bandwidth. The results are written to the log file.

Name	Description
Result	Pass or Fail. Pass if no radio error detected.
Frequency	Test Frequency
Bandwidth	Bandwidth during test
Tone	Audio tone frequency
Audio Out	Measured audio output level
Min Limit	Minimum limit (inclusive) for Audio Output
Table 5 45 Dy CT	CSS Decede test regults

Table 5-45. Rx CTCSS Decode test results

The analyzer is setup to apply the modulated signal in the table above to the radio. The radio is placed into Test Mode at the Rx Test Frequency and set to receive an Analog CDCSS signal. The analyzer measures the Audio Output level from the radio. The measurement is done at the wide (25 kHz) bandwidth, then at the narrow (12.5 kHz) bandwidth. The results are written to the log file.

Name	Description
Result	Pass or Fail. Pass if no radio error detected.
Frequency	Test Frequency
Bandwidth	Bandwidth during test
Code	Tone code
Audio Out	Measured audio output level
Min Limit	Minimum limit (inclusive) for Audio Output

Table 5-46. Rx CDCSS Decode test results

5.22. Rx BER

RF Control	Port	Frequency	Modulation	Level		
Generate	RF IN/OUT	Test Freq	Digital: 0.153 test pattern	-116 dBm		
Table 5.47 Analyzer Configuration for Dr. DED toot						

 Table 5-47. Analyzer Configuration for Rx BER test

5.22.1. Test

The analyzer is setup to apply the modulated signal in the table above to the radio. The radio is placed into Test Mode at the first Rx Test Frequency and set to receive a Digital 0.153 test signal. The analyzer reads the radio's BER measurement. This process is repeated for each Rx Test Frequency. The results are written to the log file.

Name	Description
Result	Pass or Fail. Pass if no radio error detected.
Frequency	Test Frequency
BER	Radio's BER measurement
Max Limit	Maximum limit (inclusive) for BER

Table 5-48. Rx BER test results

6. Hytera DMR Mobile Radio Test Setup

In order to perform the test and alignment procedures, the Hytera DMR Mobile radio must be connected to the R8000 Communications System Analyzer as shown in the figure below.



Make certain that the radio under test is configured as described in the corresponding diagram **before** attempting to perform the indicated alignment or test. Failure to do so may result in poor radio performance and/or damage to the analyzer or radio equipment under test.

6.1. Cable Sweep

Every RF cable connected between a radio under test and the analyzer attenuates the signal propagating through it. The amount of attenuation varies by several factors such as operating frequency, cable length, and cable type. Ensuring this attenuation is accounted for by the analyzer is important to the accuracy of several tests and alignments, primarily power tests.

Sweep the RF cable used between the Radio and Analyzer, label the RF cable with the stored cable sweep name, and enable the Cable Sweep feature in the analyzer System, System Settings... menu. Refer to <u>Application Note FCT-1017</u> <u>Utilizing Cable Sweep on</u> <u>the Freedom Communications System Analyzer</u> for instructions on how to perform a cable sweep.

6.2. Hytera DMR Mobile Test Setup

Refer to the diagram below for the proper test setup.



Figure 6-1. Hytera DMR Mobile Test Setup Diagram.

7. Hytera DMR Mobile Alignment and Test Descriptions

Note: Throughout this section are references to Test Frequency that are band- and mode -specific. A table of the frequencies used by each band may be found in the respective radio service manual.

For all mobile alignments and tests, see section Hytera DMR Portable Alignment and Test Descriptions for details - the alignments and tests are identical.

The Tx/Rx Charge Voltage alignment is for portables only and cannot be selected for mobile radios.

8. Basic Troubleshooting

Symptom Analyzer consistently fails to communicate with radio	 Incorrect setting on cable. 	 Verify programming cable KPG-46X is set to USB or Freedom cable 203012-01 is set to USB. See the respective radio test setup sections for more information.
Alignment or test intermittently stops after partial performance.	 USB hub not present. 	 Use an externally powered USB hub to connect radio programming cable to analyzer.
Tx Max Power or Tx Power alignment or test failure	 Cable Sweep not enabled. Power supply voltage level not set to level specified on test setup diagram. Radio duty cycle too high 	 Enable Cable Sweep (Settings System Settings > Cable Sweep Table) and sweep RF cable in use so the analyzer can account for its cable loss. Note: Cable Sweep feature is available on analyzer with system software 3.8.0.0 or later. Refer to test setup diagram for proper DC power supply voltage level. Confirm this level with a calibrated multimeter. Wait 1 hour between consecutive full alignment sequences to allow the radio to cool down (while powered on and idling). If the interval is less than an hour between full alignment sequences on the same radio, power alignment failures may occur.

Table 8-1. Hytera DMR Series Troubleshooting Chart

9. Support Information

9.1. Technical Support

Telephone/Fax: 844.903.7333 Email: service@freedomcte.com Web: <u>http://freedomcte.com/support/</u>

9.2. Sales

Telephone/Fax: 844.903.7333 Email: sales@freedomcte.com Web: <u>http://freedomcte.com/sales/</u>

APPENDIX A. Test Limits

The factory limits contain the default limits as defined by the radio manufacturer and generally should not be modified. AutoTune supports modifying these limits if extenuating circumstances require it. Refer to the R8000 Series Communications System Analyzer Owner's Manual (FCT-1365) for modification instructions.

https://freedomcte.com/library/

For the recommended test limits for each Hytera DMR Portable or Mobile radio model supported by AutoTune, see the respective Hytera radio service manual available from your Hytera dealer.

APPENDIX B. Sample Test Result Report

=======	sult Pepert									
Date/Ti	me: 2/14/2020	4:32 PM					rator	ID: 6		
Info	/ 1//2020					ohe		0		
Analyze										
Model # Serial a RF Leve RF In/O RF Gen (Cable S Selected 100 MHz 1 GHz A	<pre> i i offset: ut offset: Dut offset: weep: d File: Attenuation: ttenuation:</pre>	R8100 800BEN0001 off 0.0 dB 0.0 dB 0n 6DBORANGE -0.204 dB -0.879 dB								
Radio										
Model # Serial # FLASH Ve	: #: ersion:	PD782 U5:Pc 16714D2274 A9.00.08.10	ortable 04.im	(PD7	82-т0	0G000	0-0000	00i-u5-0)-F)	
Referen	ce Oscillator	Warp Align								
Result	Frequency	Frequency E	= Error	Min Li	mit	Max L	imit	old sof	ftpot	New Softpot
Pass	941.000 MHz	26 Hz		-40 нz		40 Hz		1600		1906
Referen	ce Oscillator	Warp Test								
Result	Frequency	Frequency E	Error	Min Li	mit	Max L	imit	old sof	ftpot	New Softpot
Pass Pass Pass Pass Pass Pass	910.000 MHz 883.000 MHz 870.000 MHz 834.000 MHz 806.000 MHz	77 Hz 66 Hz 60 Hz 54 Hz 45 Hz		-250 H -250 H -250 H -250 H -250 H -250 H	z z z z z z	250 H 250 H 250 H 250 H 250 H 250 H	IZ IZ IZ IZ IZ	1600 1600 1600 1600 1600		1906 1906 1906 1906 1906 1906
TX LOW	Power Align ======									
Result	Frequency	Power Out	Min Li	mit M 	lax Li	mit 	01d Sc	oftpot	New S	Softpot
Pass Pass Pass Pass Pass Pass Pass Pass	806.000 MHz 816.000 MHz 825.000 MHz 851.000 MHz 870.000 MHz 870.000 MHz 902.000 MHz 935.000 MHz 941.000 MHz	1.20 W 1.18 W 1.25 W 1.20 W 1.21 W 1.22 W 1.22 W 1.22 W 1.22 W 1.19 W 1.23 W	1.10 W 1.10 W 1.10 W 1.10 W 1.10 W 1.10 W 1.10 W 1.10 W 1.10 W 1.10 W	1 1 1 1 1 1 1 1 1 1	30 W 30 W 30 W 30 W 30 W 30 W 30 W 30 W 30 W		1100 1400 1100 1400 1100 1400 1100 1400 1100 1400		1153 1153 1153 1170 1170 1153 1153 1153 1136 1170 1185	
тх High	Power Align									
Result	Frequency	Power Out	Min Li	mit M	ax Li	mit	old so	oftpot	New S	Softpot
Pass Pass Pass Pass Pass Pass Pass Pass	806.000 MHz 816.000 MHz 825.000 MHz 850.000 MHz 860.000 MHz 870.000 MHz 902.000 MHz 935.000 MHz 941.000 MHz	3.03 W 2.98 W 2.97 W 2.98 W 3.02 W 3.03 W 2.49 W 2.45 W 2.45 W	2.90 W 2.90 W 2.90 W 2.90 W 2.90 W 2.90 W 2.90 W 2.90 W 2.40 W 2.40 W 2.40 W	 3 3 3 3 3 3 3 2 2 2 2 2 2 2	.10 W .10 W .10 W .10 W .10 W .10 W .60 W .60 W .60 W		1600 1800 1600 1800 1600 1800 1600 1800 1600 1800		1600 1569 1535 1600 1631 1663 1470 1439 1535 1535	
Transmi	t to Deviation	n Conversion	n Align							
Result	Frequency	FM Deviatio	on Min	= Limit	Мах	Limi	t Old	d Softpo	ot Ne	ew Softpot
Pass	806.000 MHz	5.00 kHz	4.9	8 kHz	5.0	2 kHz	120	000	6	L44
rass	lation Palance	+.JJ KHZ	4.9	ο κηζ	5.0	∠ KHZ	. 120	00	5:	0.00
		ELUW PUIL A		1 imi-	Marr	1 4	+ 01-	l safter)+ N/	w softnot
Result Pass Pass Pass Pass Pass Pass Pass Pas	Requency 806.000 MHz 816.000 MHz 825.000 MHz 851.000 MHz 860.000 MHz 870.000 MHz 902.000 MHz 935.000 MHz 941.000 MHz	rm Jev1at10 4.92 kHz 4.92 kHz	мп 4.9 4.9 4.9 4.9 4.9 4.9 4.9 4.9 4.9 4.9	0 kHz 0 kHz	Max 4.9 4.9 4.9 4.9 4.9 4.9 4.9 4.9	L1M1 4 kHz 4 kHz 4 kHz 4 kHz 4 kHz 4 kHz 4 kHz 4 kHz 4 kHz	260 260 260 260 260 260 260 260 260 260	2 SOTTO 000 000 000 000 000 000 000	32 32 32 32 32 32 32 32 32 32 32 32 32 3	2008 2008 2012 2112 2100 2112 2100 2004 2008 2008 2008 2008 2008 2008 20
Tx Modu	lation Balance	е High Port	Align							
Result	Frequency	FM Deviatio	on Min	Limit	Max	Limi	t old	d Softpo	ot Ne	w Softpot
Pass Pass Pass Pass Pass	806.000 MHz 816.000 MHz 825.000 MHz 851.000 MHz	4.90 kHz 4.90 kHz 4.90 kHz 4.90 kHz 4.90 kHz	4.8 4.8 4.8 4.8 4.8	8 kHz 8 kHz 8 kHz 8 kHz 8 kHz	4.9 4.9 4.9 4.9	2 kHz 2 kHz 2 kHz 2 kHz 2 kHz	200 270 200 270)00)00)00)00	22	L984 2320 L768 0848

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Pass Pass Pass Pass Pass Pass	860.000 MHz 870.000 MHz 896.000 MHz 902.000 MHz 935.000 MHz 941.000 MHz	4.90 kHz 4.90 kHz 4.90 kHz 4.91 kHz 4.90 kHz 4.90 kHz	4.88 k 4.88 k 4.88 k 4.88 k 4.88 k 4.88 k	HZ 4. HZ 4. HZ 4. HZ 4. HZ 4. HZ 4.	92 kH 92 kH 92 kH 92 kH 92 kH 92 kH 92 kH	z 200 z 270 z 200 z 270 z 270 z 270 z 270	000 000 000 000 000 000	20600 20288 16960 16952 16184 16256
Rx Front	t End Gain Al	ign						
Result	Frequency	==== Gain Min L [.]	imit Max	Limit				
Pass Pass Pass Pass Pass Pass Pass Pass	851.075 MHz 853.075 MHz 855.075 MHz 857.075 MHz 861.075 MHz 863.075 MHz 863.075 MHz 935.075 MHz 935.075 MHz 936.075 MHz 938.075 MHz 939.075 MHz 939.075 MHz	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	 -25 -25 -25 -25 -25 -25 -25 -25 -25					
Tx Char	ae Voltage							
======================================	Erequency	Osc Voltag	- Min Li	mit Ma	v i im	i+		
Pass Pass	870.000 MHz 930.000 MHz	0.200 V -0.409 V	-0.800 -0.800	V 0. V 0.	800 V 800 V			
Rx Charg	ge Voltage							
Result	Frequency	Osc. Voltage	e Min Li	mit Ma	ıx Lim	it		
Pass Pass Pass	869.975 MHz 940.975 MHz	0.354 V 0.252 V	-0.800 -0.800	v 0. v 0.	800 V 800 V			
Tx Max A	Analog Deviat	ion Test						
Result	Frequency	Bandwidth I	Deviation	Min L	imit	Max Li	mit	
 Pass	806.000 MHz	25.0 kHz	 4.48 kHz	4.20	kHz	4.90	HZ	
Pass	806.000 MHz	12.5 kHz	2.24 kHz	2.00	kHz	2.40	HZ	
Pass	860.000 MHz	12.5 kHz	2.26 kHz	2.00	kHz	2.40	HZ	
Pass	902.000 MHz	12.5 kHz	2.27 kHz	2.00	kHz	2.40	KHZ	
Pass Pass	941.000 MHz 941.000 MHz	25.0 KHZ 12.5 kHz	4.60 kHz 2.30 kHz	4.20 2.00	кнz kHz	4.90 k 2.40 k	CHZ CHZ	
Tx Max A	Analog Deviat	ion CTCSS Te	st					
Result	Frequency	Bandwidth	=== Tone	Deviat	ion	Min Lin	nit M	1ax Limit
Pass	806.000 MHz	25.0 kнz	57.0 Hz	4.48 k	Hz	4.00 kH	iz 5	5.00 kHz
Pass Pass	806.000 MHz 860.000 MHz	12.5 kHz (25.0 kHz)	67.0 Hz 127.3 Hz	2.24 k 4.52 k	(HZ (HZ	2.00 kH 4.00 kH	iz 2 iz 5	2.50 kHz 5.00 kHz
Pass	860.000 MHz	12.5 kHz	127.3 Hz	2.26 k	HZ	2.00 kH	iz 2	2.50 kHz
Pass	902.000 MHz	12.5 kHz	254.1 Hz	2.27 k	HZ	2.00 kH	iz 2	.50 kHz
Pass Pass	941.000 MHz 941.000 MHz	25.0 KHZ 12.5 kHz	254.1 HZ 254.1 HZ	4.61 k 2.30 k	CHZ CHZ	4.00 KH 2.00 kH	iz 5 iz 2	2.50 kHz
тх Мах А	Analog Deviat	ion CDCSS Te	st					
Result	Frequency	Bandwidth (=== Code Dev	iation	Min	Limit	Max L	.imit
Pass	806.000 MHz	25.0 kHz	23 4.4	7 kHz	4.00	kнz	5.00	kнz
Pass Pass	806.000 MHz 860.000 MHz	12.5 kHz 2 25.0 kHz	23 2.2 423 4.5	3 kHz 2 kHz	2.00	kHz kHz	2.50	kHz kHz
Pass Pass	860.000 MHz 902.000 MHz	12.5 kHz 25.0 kHz	423 2.2 754 4.5	6 kHz 4 kHz	2.00	kHz kHz	2.50	kHz kHz
Pass	902.000 MHz	12.5 kHz	754 2.2	7 kHz 1 kHz	2.00	kнz kнz	2.50	kHz kHz
Pass	941.000 MHz	12.5 kHz	754 2.3	0 kHz	2.00	kнz	2.50	kHz
TX CTCS	5 Deviation T	est						
Result	Frequency	Bandwidth	Tone	Deviat	ion	Min Lin	nit M	lax Limit
Pass	806.000 MHz	25.0 kHz	67.0 Hz	707.7	HZ	500.0 H	IZ 1	L000.0 Hz
Pass	860.000 MHz	25.0 kHz	127.3 Hz	709.3	HZ	500.0 H	iz 1	000.0 Hz
Pass	902.000 MHz	25.0 kHz	254.1 Hz	707.6	HZ	500.0 F	iz 1	1000.0 Hz
Pass	902.000 MHZ 941.000 MHZ	12.5 KHZ 25.0 kHz	254.1 HZ 254.1 HZ	404.7	HZ HZ	500.0 F	iz d iz 1	1000.0 HZ
Pass	941.000 MHZ	12.5 KHZ /	254.1 HZ	405.3	HZ	300.0 H	iz e	00.0 HZ
IX CDCSS	Deviation T	EST ==== Dometric data	cada ca		Md a	1 d m d +	Mari	
Kesult	Frequency	Bandwidth (Lude Dev	1at10n	M1n	L1m1t	Max L	. I III T
Pass Pass	806.000 MHz 806.000 MHz	25.0 KHZ 12.5 kHz	23 764 23 425	.2 Hz .3 Hz	500. 300.	u Hz O Hz	1000.0	UHZ HZ
Pass Pass	860.000 MHz 860.000 MHz	25.0 kHz 12.5 kHz	423 745 423 414	.4 Hz .3 Hz	500. 300.	0 Hz 0 Hz	1000.	0 Hz) Hz
Pass	902.000 MHz	25.0 kHz	754 786	.0 Hz	500.	0 Hz 0 Hz	1000.	0 Hz
Pass	941.000 MHz	25.0 kHz	754 787	.1 Hz	500.	0 HZ	1000.	0 Hz
Tx Modu	lation Sonsit	ivity Toct		. 2 172	500.	U 11∠	500.0	, 112
======================================	Frequency	Bandwidth	Neviation	Audio		1 Mir	ı imi+	Max Limit
	·······································	Sanan Iutii I		Addito	Leve			. Hux LINIT

Pass Pass Pass Pass Pass Pass Pass Pass	806.000 MHz 806.000 MHz 860.000 MHz 902.000 MHz 902.000 MHz 902.000 MHz 941.000 MHz	25.0 kHz 12.5 kHz 25.0 kHz 12.5 kHz 25.0 kHz 12.5 kHz 12.5 kHz 25.0 kHz 12.5 kHz	2.96 kHz 1.43 kHz 2.94 kHz 1.42 kHz 2.95 kHz 1.46 kHz 2.94 kHz 1.43 kHz	9.00 mVr 8.75 mVr 9.00 mVr 8.50 mVr 8.50 mVr 8.50 mVr 8.50 mVr 8.50 mVr 8.25 mVr	rms 7.0 rms 7.0	0 mVrms 0 mVrms 0 mVrms 0 mVrms 0 mVrms 0 mVrms 0 mVrms 0 mVrms	$\begin{array}{c} 10.00\\ 10.00\\ 10.00\\ 10.00\\ 10.00\\ 10.00\\ 10.00\\ 10.00\\ 10.00\\ 10.00\\ \end{array}$	mVrms mVrms mVrms mVrms mVrms mVrms mVrms mVrms
TX BER	Test							
Result	Frequency	BER M	ax Limit					
Pass Pass Pass Pass Pass	806.000 MHz 860.000 MHz 902.000 MHz 941.000 MHz	0.000 % 0 0.000 % 0 0.000 % 0 0.000 % 0	.500 % .500 % .500 % .500 %					
TX FSK	Error Test							
Result	Frequency	FSK Error	Max Limi	t -				
Pass Pass Pass Pass	806.000 MHz 860.000 MHz 902.000 MHz 941.000 MHz	2.382 % 3.235 % 3.427 % 4.200 %	5.000 % 5.000 % 5.000 % 5.000 %					
Tx Symb	ol Deviation	Test						
Result	Frequency	Symbol Dev	iation M	lin Limit M	lax Limit			
Pass Pass Pass Pass Pass	806.000 MHz 860.000 MHz 902.000 MHz 941.000 MHz	1940 Hz 1933 Hz 1936 Hz 1933 Hz	 1 1 1 1	750 Hz 2 750 Hz 2 750 Hz 2 750 Hz 2 750 Hz 2	138 Hz 138 Hz 138 Hz 138 Hz 138 Hz			
Tx Magr	itude Error T	est						
Result	Frequency	Magnitude	Error Ma	x Limit				
Pass Pass Pass Pass Pass	806.000 MHz 860.000 MHz 902.000 MHz 941.000 MHz	0.255 % 0.253 % 0.260 % 0.279 %	1. 1. 1. 1. 1.	000 % 000 % 000 % 000 %				
Rx Max	Audio Output	Power Test						
Result	Frequency	Bandwidth	Audio Ou	t Min Limi	t Max L	imit		
Pass Pass	863.075 MHz 863.075 MHz	25.0 kнz 12.5 kнz	2.22 V 2.23 V	2.10 V 2.10 V	N/A N/A			
Rx Sens	sitivity Test							
Result	Frequency	Bandwidth	SINAD	Min Limit				
Pass Pass Pass Pass Pass Pass Pass Pass	851.075 MHz 851.075 MHz 863.075 MHz 863.075 MHz 935.075 MHz 935.075 MHz 940.975 MHz	25.0 kHz 12.5 kHz 25.0 kHz 12.5 kHz 25.0 kHz 12.5 kHz 12.5 kHz 25.0 kHz 25.0 kHz	20.6 dB 15.6 dB 17.7 dB 14.2 dB 21.8 dB 16.5 dB 22.3 dB	14.0 dB 14.0 dB 14.0 dB 14.0 dB 14.0 dB 14.0 dB 14.0 dB 14.0 dB				
Pass Ry Audi	940.975 MHZ	IZ.3 KHZ	10.9 UB	14.0 UB				
Result	Erequency	Bandwidth	Distorti	on Max Lin	i+			
Pass	863.075 MHz	25.0 kHz	1.52 %	3.0 %				
Pass	863.075 MHz	12.5 kHz	2.00 %	3.0 %				
RX SNR	Test =====							
Result	Frequency	Bandwidth	SNR	Min Limit				
Pass Pass Pass Pass Pass Pass Pass Pass	851.075 MHz 851.075 MHz 863.075 MHz 935.075 MHz 935.075 MHz 940.975 MHz 940.975 MHz	25.0 kHz 12.5 kHz 25.0 kHz 12.5 kHz 25.0 kHz 12.5 kHz 25.0 kHz 12.5 kHz	49.3 dB 42.5 dB 48.7 dB 43.4 dB 47.6 dB 41.4 dB 47.3 dB 41.5 dB	42.0 dB 37.0 dB 42.0 dB 37.0 dB 42.0 dB 37.0 dB 42.0 dB 37.0 dB 42.0 dB				
Rx Norm	nal Level Sque	lch Test						
Result	Frequency	Bandwidth	Squelch	Audio Out	Limit	Output L	eve1	
Pass	851.075 MHz	25.0 kHz	Open	1.5 V	1.0 V	-120.0 d	IBm	
Pass	851.075 MHZ 851.075 MHZ	12.5 kHz	Open Closed	1.5 V	1.0 V	-120.0 d	IBM IBm	
Pass	863.075 MHZ	25.0 kHz	Open Closed	1.5 V	1.0 V	-120.0 d	IBm IBm	
Pass	863.075 MHz	12.5 kHz	Open	1.5 V	1.0 V	-120.0 d	IBm IBm	
Pass	935.075 MHZ	25.0 kHz	Open	1.5 V	1.0 V	-120.0 d	IBm IBm	
Pass	935.075 MHZ 935.075 MHZ	25.0 KHZ 12.5 kHZ	Open	0.0 V 1.5 V	1.0 V	-126.0 d	ıвт IBm	
Pass Pass	935.075 MHz 940.975 MHz	12.5 KHZ 25.0 kHZ	Closed Open	0.0 V 1.5 V	0.1 V 1.0 V	-126.0 d	IBM IBM	
Pass Pass Pass	940.975 MHz 940.975 MHz 940.975 MHz	25.0 kHz 12.5 kHz 12.5 kHz	Closed Open Closed	0.0 V 1.5 V 0.0 V	0.1 V 1.0 V 0.1 V	-126.0 d -120.0 d -126.5 d	IBM BM BM	

Rx CTCSS Decode Test

Result	Frequency	Bandwidth	n Tone	Audio C	Out Min Limit
Pass Pass	935.075 MHz 935.075 MHz	25.0 kHz 12.5 kHz	127.3 I 127.3 I	Hz 1.43 V Hz 1.44 V	1.0 V 1.0 V
RX CDCS	S Decode Test	_			
Result	Frequency	Bandwidth	n Code	Audio Out	Min Limit
Pass Pass	935.075 MHz 935.075 MHz	25.0 kHz 12.5 kHz	754 754	1.40 V 1.42 V	1.0 V 1.0 V
RX BER	Test				
Result	Frequency	BER	Max Limi	t	
Pass Pass Pass Pass	851.075 MHz 863.075 MHz 935.075 MHz 940.975 MHz	0.080 % 0.312 % 0.035 % 0.016 %	5.000 % 5.000 % 5.000 % 5.000 %		

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Figure B-1. Sample Test Result Report

APPENDIX C. Revision History

A – Initial	T. John	M. Mullins	1/24/2023	0416
Revision – Change	Requested By	Approved By	Rel. Date	ECO#