



## R8000 SERIES COMMUNICATIONS SYSTEM ANALYZER

# AUTOTUNE USER GUIDE

Harris XG-100 Mobile

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

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FCT-1001A

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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 Harris XG-100 Mobile series 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.

## 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  $\pm 1.5$  ppm specification is allowed to vary by  $1.5 * 169.075$  MHz, or about  $\pm 254$  Hz.

### 3.2. Rated Audio

Rated audio voltage target is **2 V<sub>RMS</sub>** for portable models and **7.745 V<sub>RMS</sub>** for mobile models.

## 4. Important Notes

### 4.1. Required firmware

All Harris XG-100 Mobile series radios must be running **XGP or XLP** firmware for AutoTune to successfully service them. Older ECP firmware is not currently supported. Contact Harris Technical Assistance Center (TAC) for information on acquiring XGP firmware.

### 4.2. Conventional channel selection

The radio must have a conventional channel selected before AutoTune servicing begins. A trunked channel if selected is known to cause radio communication initialization failures.

### **4.3. Supported models**

The following Harris XG-100 Mobile series models are supported by AutoTune:

- XM-100F
- XM-100F-D01
- XM-100F-D02
- XM-100F-D03
- XM-100LPA

## 5. Harris XG-100 Mobile Radio Test Setup

In order to perform the test and alignment procedures, the XG-100 Mobile radio must be connected to the R8000 Communications System Analyzer as shown in the figures below. Note that connections differ between CH-721 and CH-100 control heads.



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.

### 5.1. XG-100 Mobile Test Setup

Refer to the diagrams below for proper test setup.

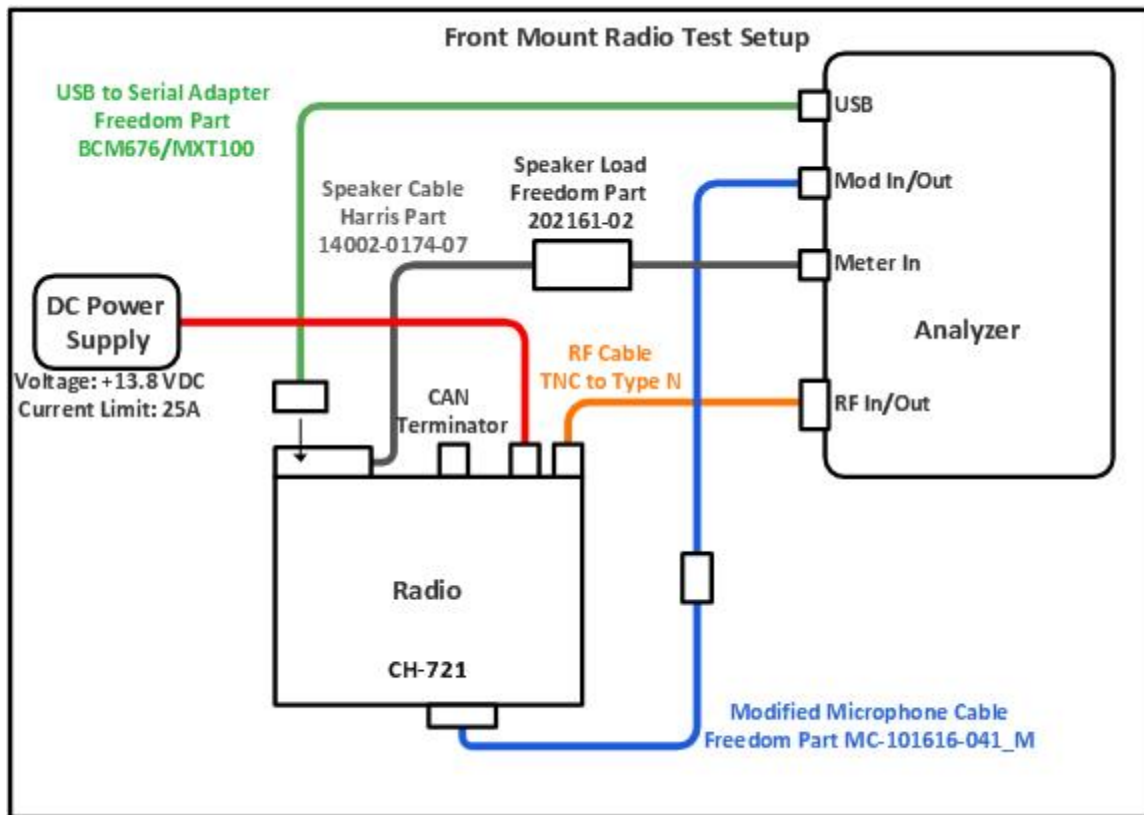


Figure 5-1. XG-100 Mobile Front Mount CH-721 Test Setup Diagram

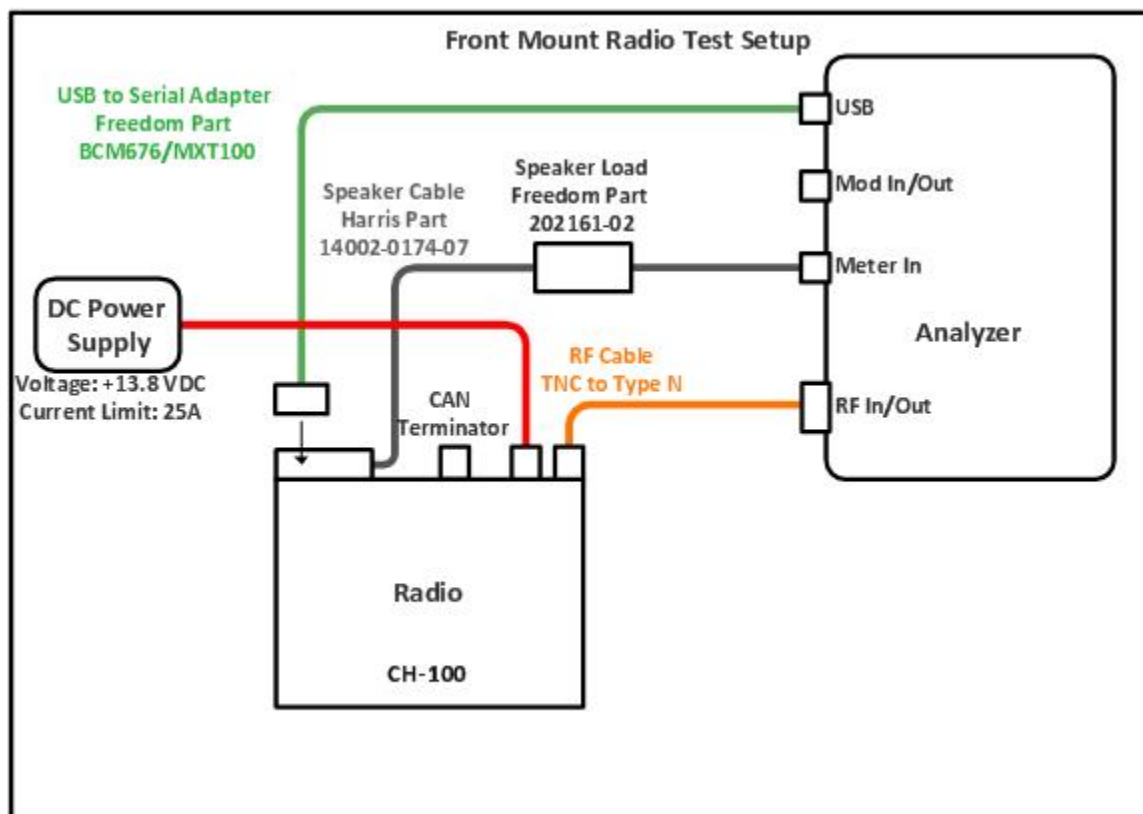


Figure 5-2. XG-100 Mobile Front Mount CH-100 Test Setup Diagram

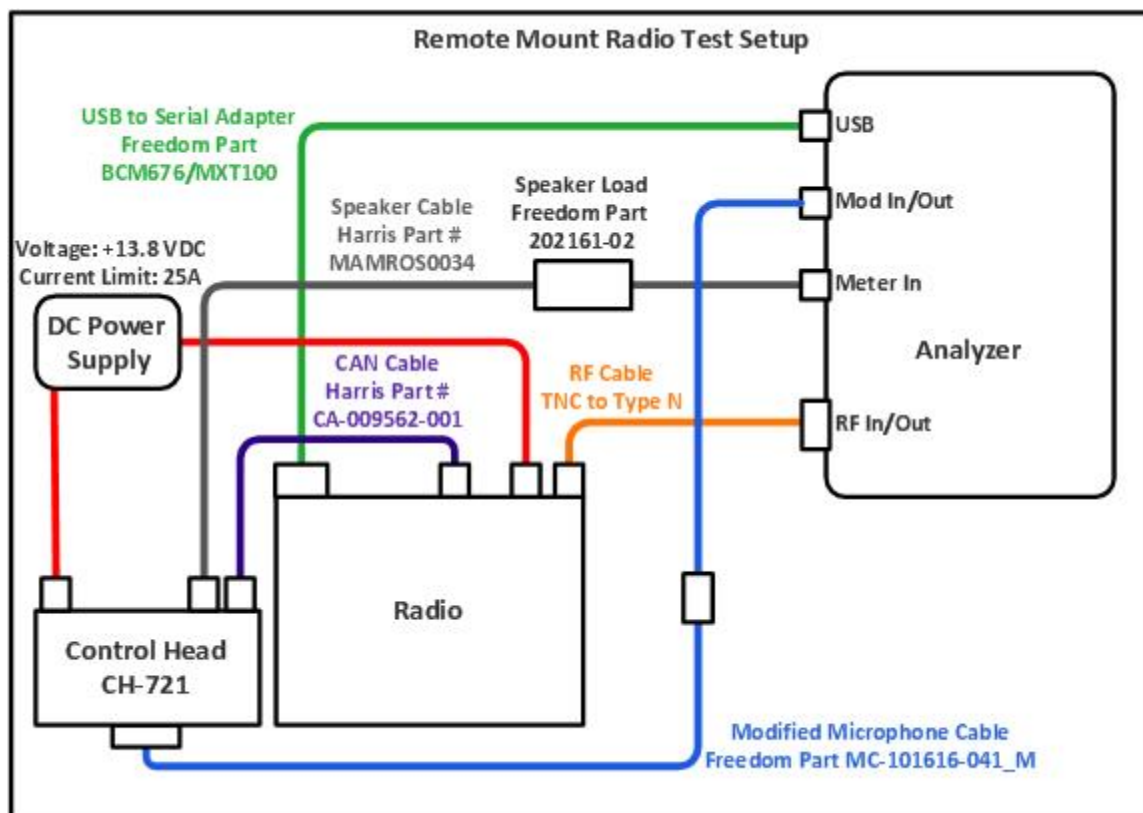


Figure 5-3. XG-100 Mobile Remote Mount CH-721 Test Setup Diagram

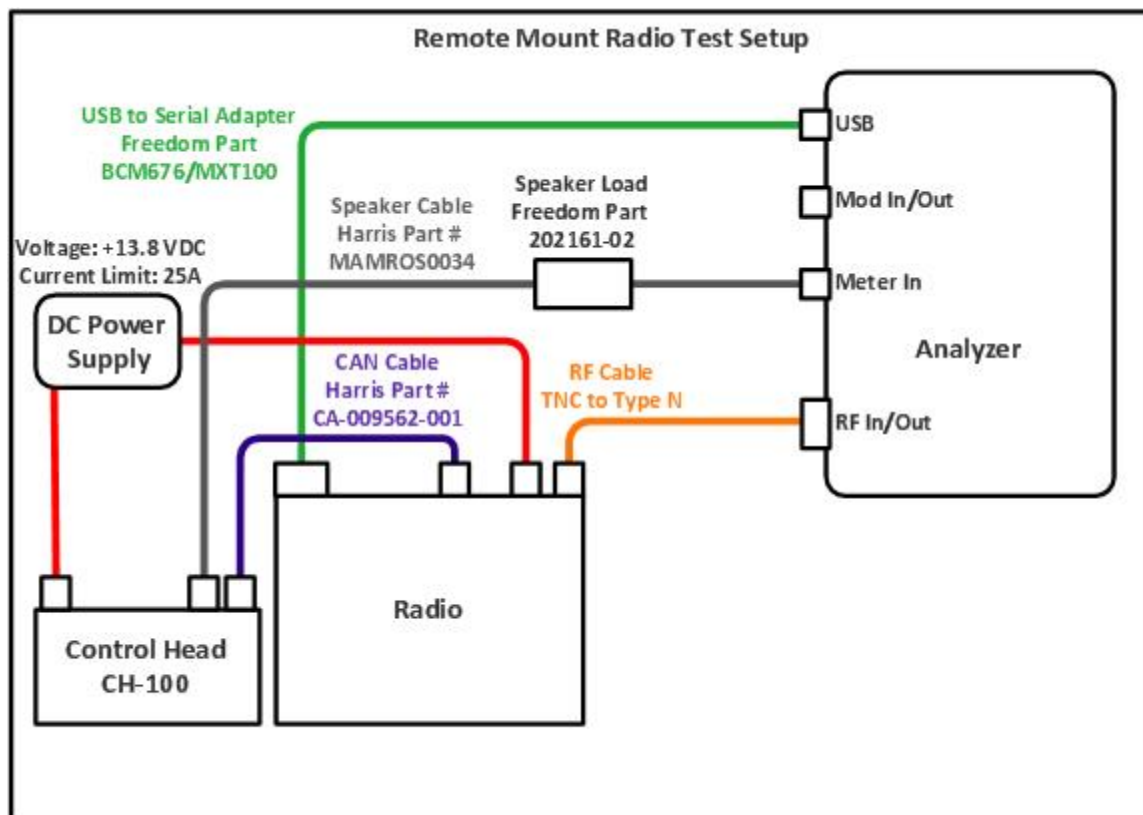


Figure 5-4. XG-100 Mobile Remote Mount CH-100 Test Setup Diagram

## 6. Harris XG-100 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.

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

### 6.1. TCXO Frequency

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

**Table 6-1. Analyzer Configuration for Reference Frequency**

#### 6.1.1. Alignment

The radio is placed into Test Mode at a Tx Test Frequency and commanded to transmit. Using a best linear fit algorithm, two frequency error measurements are taken at two different radio softpot values. These frequency error measurements are used to calculate the softpot value which minimizes frequency error. After programming this new softpot value into the radio, the radio softpot is fine tuned until minimum frequency error is detected. The frequency error is compared against test limits and the final results written to the log file.

| Name        | Description                                                |
|-------------|------------------------------------------------------------|
| Result      | Pass or Fail. Frequency Error within Max Limit, Min Limit. |
| Frequency   | Test Frequency                                             |
| Freq Error  | Measured frequency error                                   |
| Min Limit   | Minimum Limit (inclusive) for frequency error alignment    |
| Max Limit   | Maximum Limit (inclusive) for frequency error alignment    |
| Old Softpot | Radio softpot before alignment                             |
| New Softpot | Radio softpot after alignment                              |

**Table 6-2. TCXO Frequency alignment results**

#### 6.1.2. Test

The radio is placed into Test Mode at a Tx Test Frequency and commanded to transmit. The frequency error is measured by the analyzer and compared to test limits. The final results are written to the log file.

| Name       | Description                                                |
|------------|------------------------------------------------------------|
| Result     | Pass or Fail. Frequency Error within Max Limit, Min Limit. |
| Frequency  | Test Frequency                                             |
| Freq Error | Measured frequency error                                   |
| Min Limit  | Minimum Limit (inclusive) for frequency error              |
| Max Limit  | Maximum Limit (inclusive) for frequency error              |
| Softpot    | Radio softpot producing the Freq Error                     |

**Table 6-3. TCXO Frequency test results**

## 6.2. TX Power

| RF Control | Port      | Frequency      | Modulation | Attenuation |
|------------|-----------|----------------|------------|-------------|
| Monitor    | RF IN/OUT | Test Frequency | FM         | 40 dB       |

**Table 6-4. Analyzer Configuration for TX Power**

### 6.2.1. 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 the current radio power configuration (Low or High Power), and compared against test limits. The final results are written to the log file.

To change current radio power level configuration, refer to the radio maintenance manual.

| Name      | Description                                         |
|-----------|-----------------------------------------------------|
| Result    | Pass or Fail. Power Out within Max Limit, Min Limit |
| Power Out | Measured radio output level                         |
| Min Limit | Minimum Limit (inclusive) for Power Out             |
| Max Limit | Maximum Limit (inclusive) for Power Out             |

**Table 6-5. TX Power test results**

### 6.3. Tx Analog Modulation

The Tx Analog Modulation test measures the radio's 60% and maximum deviation levels, audio distortion, and peak deviation differences for each test frequency.

**Note:** This test is not currently supported for XG-100M radios with CH-100 control heads. Running it on a XG-100M with a CH-100 will always return a 'Pass' with a test report note about its exclusion.

| RF Control | Port      | Frequency      | Modulation | Attenuation | Dev Avg     |
|------------|-----------|----------------|------------|-------------|-------------|
| Monitor    | RF IN/OUT | Test Frequency | FM         | 30 dB       | +/-Peak / 2 |

Table 6-6. Analyzer Configuration for Tx Analog Modulation test

#### 6.3.1. Tx Analog Modulation Test

The radio is placed into Test Mode. For each test frequency and bandwidth (Wide, Narrow, NPSPAC) supported, the radio transmits analyzer-generated tones at both 60% and maximum deviation levels. The  $\pm$ Peak / 2-averaged deviations of these tones are measured with the analyzer, along with the audio distortion and  $\pm$ peak deviation level differences. The test results are written to the log file.

| Name                                   | Description                                                                                                                                                                                                |
|----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Result                                 | Pass or Fail. 60% and maximum deviation levels are both within limits AND audio level is within limits and audio distortion is within limits and $\pm$ peak deviation level differences are within limits. |
| Frequency                              | Test Frequency                                                                                                                                                                                             |
| 60% Dev                                | Measured deviation level at 60% rated channel deviation                                                                                                                                                    |
| Aud Lvl<Test Limit                     | Analyzer audio level used to achieve 60% Dev                                                                                                                                                               |
| Dist<Test Limit                        | Measured audio distortion at 60% Dev                                                                                                                                                                       |
| Min Test Limit<Meas Dev<Max Test Limit | Measured maximum deviation level, along with minimum and maximum test limits                                                                                                                               |
| Pk Dev Diff<Test Limit                 | Peak positive deviation – peak negative deviation.                                                                                                                                                         |

Table 6-7. Tx Analog Modulation test results

## 6.4. Tx CTCSS/CDCSS Modulation and Composite Deviation

The Tx CTCSS/CDCSS Modulation test measures the radio's CTCSS, CDCSS and composite deviation levels, and tone or code accuracy for each test frequency.

**Note:** This test is not currently supported for CH-100 control heads. Running it on a XG-100M with a CH-100 will always return a 'Pass' with a test report note about its exclusion.

| RF Control | Port      | Frequency      | Modulation | Attenuation | Dev Avg     |
|------------|-----------|----------------|------------|-------------|-------------|
| Monitor    | RF IN/OUT | Test Frequency | FM         | 30 dB       | +/-Peak / 2 |

**Table 6-8. Analyzer Configuration for Tx CTCSS/CDCSS Modulation test**

### 6.4.1. Tx CTCSS/CDCSS Modulation Test

The radio is placed into Test Mode. For each test frequency and bandwidth (Wide, Narrow, NPSPAC) supported, the radio transmits analyzer-generated CTCSS tones and CDCSS codes at rated deviation levels. The  $\pm$ Peak / 2-averaged deviations of these individual tones/codes and the composite levels are measured with the analyzer, CTCSS tone and CDCSS code accuracy. The test results are written to the log file.

| Name                | Description                                                                                                                                                                                                      |
|---------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Result              | Pass or Fail. CTCSS deviation levels are within limits and CTCSS tone is accurate AND CDCSS deviation levels are within limits and CDCSS code is accurate AND composite deviation levels are within test limits. |
| Frequency           | Test Frequency                                                                                                                                                                                                   |
| CTCSS Dev           | Measured CTCSS or CDCSS deviation level                                                                                                                                                                          |
| Aud Lvl<Test Limit  | Analyzer audio level used to achieve 60% Dev                                                                                                                                                                     |
| Min Dev             | Minimum CTCSS or CDCSS deviation level (inclusive)                                                                                                                                                               |
| Max Dev             | Maximum CTCSS or CDCSS deviation level (inclusive)                                                                                                                                                               |
| Meas Tone Meas Code | Measured CTCSS tone frequency OR CDCSS code                                                                                                                                                                      |
| Comp Dev            | Measured composite CTCSS CDCSS and 1 kHz tone @ 3 kHz deviation level                                                                                                                                            |
| Min Dev             | Minimum composite deviation level (inclusive)                                                                                                                                                                    |
| Max Dev             | Maximum composite deviation level (inclusive)                                                                                                                                                                    |
| Meas Tone Meas Code | Measured CTCSS tone OR CDCSS code during composite test                                                                                                                                                          |

**Table 6-9. Tx CTCSS/CDCSS Modulation test results**

## 6.5. P25 Phase 1 Tx Modulation (C4FM) Test

The Tx P25 Phase 1 Tx Modulation (C4FM) test measures the radio's P25 Phase 1 C4FM modulation level at a specific test frequency for both High and Low Patterns.

| RF Control | Port      | Frequency      | Modulation | Attenuation | Dev Avg  |
|------------|-----------|----------------|------------|-------------|----------|
| Monitor    | RF IN/OUT | Test Frequency | FM         | 30 dB       | Peak Avg |

**Table 6-10. Analyzer Configuration for P25 Phase 1 Tx Modulation (C4FM) test**

### 6.5.1. P25 Phase 1 Tx Modulation (C4FM) Test

The radio is placed into Test Mode at low power at the last Tx Test Frequency and commanded to transmit both Low and High deviation patterns. The Peak-averaged deviation of this tone is measured with the analyzer. This test is performed at a single Tx Test Frequency. The test results are written to the log file.

| Name      | Description                                                 |
|-----------|-------------------------------------------------------------|
| Result    | Pass or Fail. Deviation is between Min Limit and Max Limit. |
| Frequency | Test Frequency                                              |
| Meas Dev  | Measured P25 Phase 1 C4FM deviation                         |
| Min Dev   | Minimum passable deviation level                            |
| Max Dev   | Maximum passable deviation level                            |

**Table 6-11. Tx P25 Phase 1 Modulation (C4FM) test results**

## 6.6. Tx P25 Phase 2 Tx Modulation (TDMA) Test

The Tx P25 Phase 2 Tx Modulation (TDMA) test measures the radio's P25 Phase 2 TDMA modulation level at a specific test frequency.

| RF Control | Port      | Frequency      | Modulation | Attenuation | Dev Avg     |
|------------|-----------|----------------|------------|-------------|-------------|
| Monitor    | RF IN/OUT | Test Frequency | FM         | 30 dB       | +/-Peak / 2 |

**Table 6-12. Analyzer Configuration for P25 Phase 2 Tx Modulation (TDMA) test**

### 6.6.1. Tx P25 Phase 2 Tx Modulation (TDMA) Test

The radio is placed into Test Mode at low power at the last Tx Test Frequency and commanded to transmit a P25 Phase 2 TDMA High Deviation pattern. The analyzer measures the +/-Peak / 2-averaged deviation of this pattern. This test is performed at a single Tx Test Frequency. The test results are written to the log file.

| Name      | Description                                                 |
|-----------|-------------------------------------------------------------|
| Result    | Pass or Fail. Deviation is between Min Limit and Max Limit. |
| Frequency | Test Frequency                                              |
| Meas Dev  | Measured P25 Phase 2 TDMA deviation                         |
| Min Dev   | Minimum passable deviation level                            |
| Max Dev   | Maximum passable deviation level                            |

**Table 6-13. Tx P25 Phase 2 Tx Modulation (TDMA) test results**

## 6.7. Rx Audio Level and Distortion

Rx Audio Level and Distortion test verifies the receiver audio amplitude and distortion are at appropriate levels.

| RF Control | Port      | Frequency      | Modulation | Output  |
|------------|-----------|----------------|------------|---------|
| Generate   | RF IN/OUT | Test Frequency | FM         | -47 dBm |

**Table 6-14. Analyzer Configuration for Rx Audio Level and Distortion test**

### 6.7.1. RX Audio Level and Distortion Test

The radio is placed into Test Mode, receive operation at Wide bandwidth and highest Rx Test Frequency. The analyzer generates a modulation tone and the audio voltage and distortion of the radio's demodulated signal is measured with the analyzer. Both the audio level and the distortion are compared against test limits and written to the log file.

| Name        | Description                                                       |
|-------------|-------------------------------------------------------------------|
| Result      | Pass or Fail. Distortion is less than or equal to Max Limit.      |
| Frequency   | Test Frequency                                                    |
| Min Vol Lvl | Minimum audio voltage level required to pass the test             |
| Meas Volume | Audio volume level generated by the radio near max volume setting |
| Max Vol Lvl | Maximum audio voltage level required to pass the test             |
| Distortion  | Measured distortion percentage at mid volume setting              |
| Max Limit   | Maximum passable distortion (inclusive)                           |

**Table 6-15. Rx Audio Level and Distortion test results**

## 6.8. RX Sensitivity (SINAD)

Rx Sensitivity (SINAD) test verifies the receiver analog audio sensitivity is at an appropriate level.

| RF Control | Port      | Frequency | Modulation    | Output Level |
|------------|-----------|-----------|---------------|--------------|
| Generate   | RF IN/OUT | Test Freq | 1 kHz @ 3 kHz | -47 dBm      |

Table 6-16. Analyzer Configuration for RX Sensitivity test

### 6.8.1. Test

The analyzer is setup by applying the Modulation signal in Table 6-16 to the radio and then adjusting radio volume for Rated Audio. The radio is placed into Test Mode at the first bandwidth and first RX Test Frequency. The output level of the analyzer is then adjusted until the radio audio signal's SINAD level measures about 12 dB. The current analyzer output level is then compared against test limits. The final results are written to the log file. This process is repeated for each bandwidth and each RX Test Frequency.

| Name       | Description                                                               |
|------------|---------------------------------------------------------------------------|
| Result     | Pass or Fail. Sensitivity (SINAD) level within Max Limit                  |
| Frequency  | Test Frequency                                                            |
| 12dB SINAD | Analyzer output level at which the radio SINAD level measures about 12 dB |
| Max Limit  | Maximum Limit (inclusive) for RX Sensitivity to Pass                      |

Table 6-17. RX Sensitivity test results

## 6.9. P25 Phase 1 Rx Sensitivity (C4FM) Test

The P25 Phase 1 Rx Sensitivity (C4FM) test measures the radio's P25 Phase 1 C4FM sensitivity level at several Rx test frequencies.

| RF Control | Port      | Frequency      | Modulation | Output Level |
|------------|-----------|----------------|------------|--------------|
| Generate   | RF IN/OUT | Test Frequency | C4FM       | -116 dBm     |

**Table 6-18. Analyzer Configuration for P25 Phase 1 Rx Sensitivity (C4FM) test**

### 6.9.1. Test

The analyzer is setup by applying the Modulation signal in Table 6-18 to the radio. The radio is placed into Test Mode at C4FM bandwidth and first RX Test Frequency. The radio's reported BER level is measured and compared against test limits. The final results are written to the log file. This process is repeated for each Test Frequency.

| Name      | Description                                                 |
|-----------|-------------------------------------------------------------|
| Result    | Pass or Fail. BER level within Max Limit                    |
| Frequency | Test Frequency                                              |
| BER       | Radio Bit Error Rate (BER) level                            |
| Max Limit | Maximum Limit (inclusive) for Rx Sensitivity (C4FM) to Pass |
| Min Limit | Minimum Limit (exclusive) for Rx Sensitivity (C4FM) to Pass |

**Table 6-19. P25 Phase 1 Rx Sensitivity (C4FM) test results**

## 6.10. P25 Phase 2 Rx Sensitivity (TDMA) Test

The P25 Phase 2 Rx Sensitivity (TDMA) test measures the radio's P25 Phase 2 TDMA sensitivity level at several Rx test frequencies.

| RF Control | Port      | Frequency      | Modulation | Output Level |
|------------|-----------|----------------|------------|--------------|
| Generate   | RF IN/OUT | Test Frequency | TDMA       | -116 dBm     |

**Table 6-20. Analyzer Configuration for P25 Phase 2 Rx Sensitivity (TDMA) test**

### 6.10.1. Test

The analyzer is setup by applying the Modulation signal in Table 6-20 to the radio. The radio is placed into Test Mode at the first RX Test Frequency. The radio's reported BER level is measured and compared against test limits. The final results are written to the log file. This process is repeated for each Test Frequency.

| Name      | Description                                                 |
|-----------|-------------------------------------------------------------|
| Result    | Pass or Fail. BER level within Max Limit                    |
| Frequency | Test Frequency                                              |
| BER       | Radio Bit Error Rate (BER) level                            |
| Max Limit | Maximum Limit (inclusive) for Rx Sensitivity (TDMA) to Pass |
| Min Limit | Minimum Limit (exclusive) for Rx Sensitivity (TDMA) to Pass |

**Table 6-21. P25 Phase 2 Rx Sensitivity (TDMA) test results**

## 6.11. Basic Troubleshooting

| Symptom                                               | Possible Cause                                                                                     | Possible Solution                                                                                                                                                                                                                                                                                                                                                                          |
|-------------------------------------------------------|----------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Analyzer consistently fails to communicate with radio | <ul style="list-style-type: none"> <li>Radio not running XGP or XLP firmware</li> </ul>            | <ul style="list-style-type: none"> <li>AutoTune only supports test and alignment on XG-100 series radios running XGP or XLP firmware. Update radio firmware to use one of these supported firmware generations.</li> </ul>                                                                                                                                                                 |
|                                                       | <ul style="list-style-type: none"> <li>Unsupported USB to serial adapter (mobiles only)</li> </ul> | <ul style="list-style-type: none"> <li>Approved USB to serial adapters for connecting the R8000 analyzer to the Harris XG-100 Mobile series radio under test include any adapters which utilize an FTDI FT232_USB to serial UART interface OR Prolific Technology Inc. PL-2303 USB to serial controller interface. See <a href="#">Amazon</a> for a compatible adapter example.</li> </ul> |
|                                                       | <ul style="list-style-type: none"> <li>Radio on a trunking channel</li> </ul>                      | <ul style="list-style-type: none"> <li>Change radio channel to a conventional channel. Trunking channel mode can prevent AutoTune from placing radio into test mode.</li> </ul>                                                                                                                                                                                                            |
| Analyzer occasionally fails to communicate with radio | <ul style="list-style-type: none"> <li>USB hub in use</li> </ul>                                   | <ul style="list-style-type: none"> <li>USB hubs are known to occasionally prevent or drop radio communication. Connect the radio programming cable directly to an analyzer USB port.</li> </ul>                                                                                                                                                                                            |

|                                                                   |                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|-------------------------------------------------------------------|-----------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>Tx Power test power output levels are lower than expected.</p> | <ul style="list-style-type: none"> <li>• Cable Sweep not enabled</li> </ul> | <ul style="list-style-type: none"> <li>• Enable Settings &gt; System Settings... &gt; Cable Sweep &gt; Cable Sweep. Change cable attenuation values to correspond with the RF cable in use. For example, if 0.5 dB of loss expected at 100 MHz and 1.5 dB of loss is expected at 1 GHz, enter “-0.5 dB” as the 100 MHz loss value and “-1.5 dB” as the 1 GHz loss value. <b>Cable losses are entered as negative values.</b></li> </ul> |
|-------------------------------------------------------------------|-----------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

Table 6-22. Harris XG-100 Mobile Series Troubleshooting Chart

## **7. Support Information**

### **7.1. Technical Support**

Telephone/Fax: 903.985.8999

Email: [service@freedomcte.com](mailto:service@freedomcte.com)

Web: <http://freedomcte.com/support/>

### **7.2. Sales**

Telephone/Fax: 903.985.8999

Email: [sales@freedomcte.com](mailto:sales@freedomcte.com)

Web: <http://freedomcte.com/sales/>

## **APPENDIX A. Test Limits**

The factory limits contain the default limits as defined by the radio manufacturer and generally should not be modified. However, if extenuating circumstances cause a need to modify the limits this is accommodated by AutoTune. Refer to the R8000 Series Communications System Analyzer Owner's Manual (FCT-1365) for modification instructions.

The following tables list the default test limits for each Harris XG-100 Mobile radio model supported by AutoTune.

**Table A-1. Default Harris XG-100 Mobile Limits**

| Section | Test Name                                         | Limit                                      | Default Value                                         |
|---------|---------------------------------------------------|--------------------------------------------|-------------------------------------------------------|
| 6.1     | TCXO Frequency                                    | Reference Oscillator Align                 | Min= -0.1 ppm<br>Max= 0.1 ppm                         |
|         |                                                   | Reference Oscillator Test                  | Min= -0.25 ppm<br>Max= 0.25 ppm                       |
| 6.2     | TX Power (Test)                                   | TX Power Test VHF Low                      | Min = 4.45 W<br>Max = 5.61 W                          |
|         |                                                   | TX Power Test UHF Low                      | Min = 4.45 W<br>Max = 5.61 W                          |
|         |                                                   | TX Power Test 700MHz Low                   | Min = 1.78 W<br>Max = 2.24 W                          |
|         |                                                   | TX Power Test 800MHz Low                   | Min= 1.78 W<br>Max= 2.24 W                            |
|         |                                                   | TX Power Test VHF High                     | Min=47.2 W<br>Max=53.0 W                              |
|         |                                                   | TX Power Test UHF High                     | Min=47.2 W<br>Max=53.0 W                              |
|         |                                                   | TX Power Test 700MHz High                  | Min=25.1 W<br>Max=30.9 W                              |
|         |                                                   | TX Power Test 800MHz High                  | Min=33.0 W<br>Max=37.1 W                              |
| 6.3     | Tx Analog Modulation                              | Tx Analog Modulation Deviation Wide        | Min = 4.0 kHz<br>Max = 4.8 kHz                        |
|         |                                                   | Tx Analog Modulation Deviation Narrow      | Min=2.0 kHz<br>Max=2.4 kHz                            |
|         |                                                   | Tx Analog Modulation Deviation NPSPAC      | Min=3.2 kHz<br>Max=3.9 kHz                            |
|         |                                                   | Tx Analog Modulation 60% Deviation Wide    | Min=2.9 kHz<br>Max=3.1 kHz                            |
|         |                                                   | Tx Analog Modulation 60% Deviation Narrow  | Min=1.4 kHz<br>Max=1.6 kHz                            |
|         |                                                   | Tx Analog Modulation 60% Deviation NPSPAC  | Min=2.3 kHz<br>Max=2.5 kHz                            |
|         |                                                   | Tx Analog Modulation Distortion            | Max=1.25%                                             |
|         |                                                   | Tx Analog Modulation Audio Level           | Min=50 mV <sub>RMS</sub><br>Max=120 mV <sub>RMS</sub> |
| 6.4     | Tx CTCSS/CDCSS Modulation and Composite Deviation | Tx CTCSS/CDCSS Modulation Deviation Wide   | Min=0.5 kHz<br>Max=1.0 kHz                            |
|         |                                                   | Tx CTCSS/CDCSS Modulation Deviation Narrow | Min=0.35 kHz<br>Max=0.5 kHz                           |
|         |                                                   | Tx CTCSS/CDCSS Modulation Deviation NPSPAC | Min=0.4 kHz<br>Max=0.8 kHz                            |
| 6.5     | P25 Phase1 Tx Modulation C4FM                     | P25 Phase1 Tx Modulation C4FM High         | Min=2.545 kHz<br>Max=3.111 kHz                        |
|         |                                                   | P25 Phase1 Tx Modulation C4FM Low          | Min=0.849 kHz<br>Max=3.111 kHz                        |
| 6.6     | P25 Phase2 Tx Modulation TDMA                     | P25 Phase2 Tx Modulation TDMA High         | Min=2.995 kHz<br>Max=3.310 kHz                        |
| 6.7     | Rx Audio Level and Distortion                     | Rx Audio Distortion CH-721                 | Max=5 %                                               |
|         |                                                   | Rx Audio Distortion CH-100                 | Max=3 %                                               |

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|      |                                  |                                |                                                      |
|------|----------------------------------|--------------------------------|------------------------------------------------------|
|      |                                  | Rx Audio Voltage               | Max=8.1 V <sub>RMS</sub><br>Min=7.5 V <sub>RMS</sub> |
| 6.8  | RX Sensitivity (SINAD)           | SINAD                          | Max=-119 dBm                                         |
| 6.9  | P25 Phase1 Rx Sensitivity (C4FM) | P25 Phase1 Rx Sensitivity C4FM | Min=0 %<br>Max=5 %                                   |
| 6.10 | P25 Phase2 Rx Sensitivity (TDMA) | P25 Phase2 Rx Sensitivity TDMA | Min=0 %<br>Max=5 %                                   |

**Table A-2. Default Harris XG-100 Mobile Limits**

**APPENDIX B. Sample Test Result Report**

Note: Results shown below are representative of actual results. Actual results and report format may vary.

| Test Result Report                                            |              |                             |           |             |             |             |         |         |             |
|---------------------------------------------------------------|--------------|-----------------------------|-----------|-------------|-------------|-------------|---------|---------|-------------|
| Model #: XG100M                                               |              | Date/Time: 3/6/2017 4:08 AM |           |             |             |             |         |         |             |
| Serial #: A40201011459                                        |              | Operator ID: 6              |           |             |             |             |         |         |             |
| Info: FLASH Version: XGPR06D13                                |              |                             |           |             |             |             |         |         |             |
| TCX0 Frequency Align                                          |              |                             |           |             |             |             |         |         |             |
| Result                                                        | Frequency    | Freq Error                  | Min Limit | Max Limit   | Old Softpot | New Softpot |         |         |             |
| Pass                                                          | 869.9875 MHz | 15 Hz                       | -87 Hz    | 87 Hz       | 50          | 146         |         |         |             |
| TCX0 Frequency Test                                           |              |                             |           |             |             |             |         |         |             |
| Result                                                        | Frequency    | Freq Error                  | Min Limit | Max Limit   | Softpot     |             |         |         |             |
| Pass                                                          | 869.9875 MHz | 18 Hz                       | -217 Hz   | 217 Hz      | 146         |             |         |         |             |
| Pass                                                          | 794.0125 MHz | 16 Hz                       | -199 Hz   | 199 Hz      | 146         |             |         |         |             |
| Pass                                                          | 520.0000 MHz | 11 Hz                       | -130 Hz   | 130 Hz      | 146         |             |         |         |             |
| Pass                                                          | 380.0000 MHz | 8 Hz                        | -95 Hz    | 95 Hz       | 146         |             |         |         |             |
| Pass                                                          | 174.0000 MHz | 3 Hz                        | -44 Hz    | 44 Hz       | 146         |             |         |         |             |
| Pass                                                          | 136.0000 MHz | 2 Hz                        | -34 Hz    | 34 Hz       | 146         |             |         |         |             |
| TX Power Test                                                 |              |                             |           |             |             |             |         |         |             |
| Result                                                        | Frequency    | Power Out                   | Min Limit | Max Limit   |             |             |         |         |             |
| Pass                                                          | 869.9875 MHz | 1.9 W                       | 1.8 W     | 2.2 W       |             |             |         |         |             |
| Pass                                                          | 794.0125 MHz | 1.8 W                       | 1.8 W     | 2.2 W       |             |             |         |         |             |
| Pass                                                          | 520.0000 MHz | 4.8 W                       | 4.5 W     | 5.6 W       |             |             |         |         |             |
| Pass                                                          | 380.0000 MHz | 4.6 W                       | 4.5 W     | 5.6 W       |             |             |         |         |             |
| Pass                                                          | 174.0000 MHz | 4.9 W                       | 4.5 W     | 5.6 W       |             |             |         |         |             |
| Pass                                                          | 136.0000 MHz | 5.1 W                       | 4.5 W     | 5.6 W       |             |             |         |         |             |
| Tx Analog Modulation Wide                                     |              |                             |           |             |             |             |         |         |             |
| Result                                                        | Frequency    | 60% Dev                     | Aud Lvl   | Dist <1.25% | Meas Dev    | Min Dev     | Max Dev | Pk Dev  | Diff <100Hz |
| Pass                                                          | 136.0250 MHz | 3.0 kHz                     | 95 mVrms  | 0.46 %      | 4.5 kHz     | 4.0 kHz     | 4.8 kHz | 32 Hz   |             |
| Pass                                                          | 173.9750 MHz | 3.0 kHz                     | 95 mVrms  | 0.38 %      | 4.5 kHz     | 4.0 kHz     | 4.8 kHz | 11 Hz   |             |
| Pass                                                          | 380.0250 MHz | 3.0 kHz                     | 95 mVrms  | 0.51 %      | 4.5 kHz     | 4.0 kHz     | 4.8 kHz | 10 Hz   |             |
| Pass                                                          | 519.9750 MHz | 3.0 kHz                     | 95 mVrms  | 0.40 %      | 4.5 kHz     | 4.0 kHz     | 4.8 kHz | 23 Hz   |             |
| Pass                                                          | 815.0125 MHz | 3.0 kHz                     | 95 mVrms  | 0.48 %      | 4.5 kHz     | 4.0 kHz     | 4.8 kHz | 16 Hz   |             |
| Pass                                                          | 860.0125 MHz | 3.0 kHz                     | 95 mVrms  | 0.55 %      | 4.5 kHz     | 4.0 kHz     | 4.8 kHz | 32 Hz   |             |
| Tx Analog Modulation Narrow                                   |              |                             |           |             |             |             |         |         |             |
| Result                                                        | Frequency    | 60% Dev                     | Aud Lvl   | Dist <1.25% | Meas Dev    | Min Dev     | Max Dev | Pk Dev  | Diff <100Hz |
| Pass                                                          | 136.0250 MHz | 1.5 kHz                     | 98 mVrms  | 0.45 %      | 2.2 kHz     | 2.0 kHz     | 2.4 kHz | 3 Hz    |             |
| Pass                                                          | 173.9750 MHz | 1.5 kHz                     | 98 mVrms  | 0.45 %      | 2.2 kHz     | 2.0 kHz     | 2.4 kHz | 13 Hz   |             |
| Pass                                                          | 380.0250 MHz | 1.5 kHz                     | 98 mVrms  | 0.51 %      | 2.2 kHz     | 2.0 kHz     | 2.4 kHz | 4 Hz    |             |
| Pass                                                          | 519.9750 MHz | 1.5 kHz                     | 98 mVrms  | 0.48 %      | 2.2 kHz     | 2.0 kHz     | 2.4 kHz | 13 Hz   |             |
| Pass                                                          | 794.0125 MHz | 1.5 kHz                     | 97 mVrms  | 0.71 %      | 2.2 kHz     | 2.0 kHz     | 2.4 kHz | 5 Hz    |             |
| Tx Analog Modulation NPSPEC                                   |              |                             |           |             |             |             |         |         |             |
| Result                                                        | Frequency    | 60% Dev                     | Aud Lvl   | Dist <1.25% | Meas Dev    | Min Dev     | Max Dev | Pk Dev  | Diff <100Hz |
| Pass                                                          | 815.0125 MHz | 2.4 kHz                     | 96 mVrms  | 0.51 %      | 3.6 kHz     | 3.2 kHz     | 3.9 kHz | 3 Hz    |             |
| Pass                                                          | 860.0125 MHz | 2.4 kHz                     | 96 mVrms  | 0.60 %      | 3.5 kHz     | 3.2 kHz     | 3.9 kHz | 77 Hz   |             |
| Tx CTCSS (156.7 Hz) Modulation and Composite Deviation Wide   |              |                             |           |             |             |             |         |         |             |
| Result                                                        | Frequency    | CTCSS Dev                   | Min Dev   | Max Dev     | Meas Tone   | Comp Dev    | Min Dev | Max Dev | Meas Tone   |
| Pass                                                          | 174.0000 MHz | 0.7 kHz                     | 0.5 kHz   | 1.0 kHz     | 156.7 Hz    | 4.3 kHz     | 4.0 kHz | 4.8 kHz | 156.4 Hz    |
| Pass                                                          | 520.0000 MHz | 0.7 kHz                     | 0.5 kHz   | 1.0 kHz     | 156.8 Hz    | 4.3 kHz     | 4.0 kHz | 4.8 kHz | 157.3 Hz    |
| Pass                                                          | 869.9875 MHz | 0.7 kHz                     | 0.5 kHz   | 1.0 kHz     | 156.7 Hz    | 4.3 kHz     | 4.0 kHz | 4.8 kHz | 157.2 Hz    |
| Tx CDCSS (627) Modulation and Composite Deviation Wide        |              |                             |           |             |             |             |         |         |             |
| Result                                                        | Frequency    | CDCSS Dev                   | Min Dev   | Max Dev     | Meas Code   | Comp Dev    | Min Dev | Max Dev | Meas Code   |
| Pass                                                          | 174.0000 MHz | 0.7 kHz                     | 0.5 kHz   | 1.0 kHz     | 627         | 4.3 kHz     | 4.0 kHz | 4.8 kHz | 627         |
| Pass                                                          | 520.0000 MHz | 0.7 kHz                     | 0.5 kHz   | 1.0 kHz     | 627         | 4.3 kHz     | 4.0 kHz | 4.8 kHz | 627         |
| Pass                                                          | 869.9875 MHz | 0.7 kHz                     | 0.5 kHz   | 1.0 kHz     | 627         | 4.3 kHz     | 4.0 kHz | 4.8 kHz | 627         |
| Tx CTCSS (156.7 Hz) Modulation and Composite Deviation Narrow |              |                             |           |             |             |             |         |         |             |
| Result                                                        | Frequency    | CTCSS Dev                   | Min Dev   | Max Dev     | Meas Tone   | Comp Dev    | Min Dev | Max Dev | Meas Tone   |
| Pass                                                          | 174.0000 MHz | 0.39 kHz                    | 0.35 kHz  | 0.5 kHz     | 156.8 Hz    | 2.1 kHz     | 2.0 kHz | 2.4 kHz | 157.4 Hz    |
| Pass                                                          | 520.0000 MHz | 0.39 kHz                    | 0.35 kHz  | 0.5 kHz     | 156.8 Hz    | 2.2 kHz     | 2.0 kHz | 2.4 kHz | 157.2 Hz    |
| Pass                                                          | 794.0125 MHz | 0.39 kHz                    | 0.35 kHz  | 0.5 kHz     | 156.6 Hz    | 2.2 kHz     | 2.0 kHz | 2.4 kHz | 155.9 Hz    |
| Tx CDCSS (627) Modulation and Composite Deviation Narrow      |              |                             |           |             |             |             |         |         |             |
| Result                                                        | Frequency    | CDCSS Dev                   | Min Dev   | Max Dev     | Meas Code   | Comp Dev    | Min Dev | Max Dev | Meas Code   |
| Pass                                                          | 174.0000 MHz | 0.38 kHz                    | 0.35 kHz  | 0.5 kHz     | 627         | 2.1 kHz     | 2.0 kHz | 2.4 kHz | 627         |
| Pass                                                          | 520.0000 MHz | 0.39 kHz                    | 0.35 kHz  | 0.5 kHz     | 627         | 2.1 kHz     | 2.0 kHz | 2.4 kHz | 627         |
| Pass                                                          | 794.0125 MHz | 0.39 kHz                    | 0.35 kHz  | 0.5 kHz     | 627         | 2.1 kHz     | 2.0 kHz | 2.4 kHz | 627         |
| Tx CTCSS (156.7 Hz) Modulation and Composite Deviation NPSPEC |              |                             |           |             |             |             |         |         |             |
| Result                                                        | Frequency    | CTCSS Dev                   | Min Dev   | Max Dev     | Meas Tone   | Comp Dev    | Min Dev | Max Dev | Meas Tone   |
| Pass                                                          | 869.9875 MHz | 0.5 kHz                     | 0.4 kHz   | 0.8 kHz     | 156.7 Hz    | 3.4 kHz     | 3.2 kHz | 3.9 kHz | 155.8 Hz    |
| P25 Phase 1 Tx Modulation C4FM High Pattern                   |              |                             |           |             |             |             |         |         |             |
| Result                                                        | Frequency    | Meas Dev                    | Min Dev   | Max Dev     |             |             |         |         |             |
| Pass                                                          | 869.9875 MHz | 2.733 kHz                   | 2.545 kHz | 3.111 kHz   |             |             |         |         |             |
| P25 Phase 1 Tx Modulation C4FM Low Pattern                    |              |                             |           |             |             |             |         |         |             |
| Result                                                        | Frequency    | Meas Dev                    | Min Dev   | Max Dev     |             |             |         |         |             |
| Pass                                                          | 869.9875 MHz | 0.931 kHz                   | 0.849 kHz | 1.037 kHz   |             |             |         |         |             |
| P25 Phase 2 Tx Modulation TDMA High Pattern                   |              |                             |           |             |             |             |         |         |             |
| Result                                                        | Frequency    | Meas Dev                    | Min Dev   | Max Dev     |             |             |         |         |             |

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```
Pass      869.9875 MHz  3.095 kHz  2.995 kHz  3.310 kHz

Rx Audio Level and Distortion
=====
Result  Frequency      Min Vol Lvl  Meas Volume  Max Vol Lvl  Distortion  Max Limit
-----
Pass    136.000000 MHz  7.5 Vrms    8.05 Vrms    8.1 Vrms     3.0 %      5.0 %

Rx Sensitivity (SINAD) Test
=====
Result  Frequency      12dB SINAD  Max Limit
-----
Pass    136.000000 MHz  -123.6 dBm  -119.0 dBm
Pass    174.000000 MHz  -122.6 dBm  -119.0 dBm
Pass    380.000000 MHz  -123.5 dBm  -119.0 dBm
Pass    520.000000 MHz  -123.7 dBm  -119.0 dBm
Pass    764.012500 MHz  -121.3 dBm  -119.0 dBm
Pass    869.987500 MHz  -121.5 dBm  -119.0 dBm

P25 Rx Sensitivity BER (C4FM)
=====
Result  Frequency      BER          Max Limit  Min Limit
-----
Pass    136.0000 MHz  1.573 %     5.0 %      0.0 %
Pass    174.0000 MHz  2.271 %     5.0 %      0.0 %
Pass    380.0000 MHz  2.219 %     5.0 %      0.0 %
Pass    520.0000 MHz  1.906 %     5.0 %      0.0 %
Pass    764.0125 MHz  3.271 %     5.0 %      0.0 %
Pass    869.9875 MHz  3.990 %     5.0 %      0.0 %

P25 Phase2 Rx Sensitivity TDMA
=====
Result  Frequency      BER          Max Limit  Min Limit
-----
Pass    136.0000 MHz  0.949 %     5.0 %      0.0 %
Pass    174.0000 MHz  1.324 %     5.0 %      0.0 %
Pass    380.0000 MHz  0.908 %     5.0 %      0.0 %
Pass    520.0000 MHz  0.799 %     5.0 %      0.0 %
Pass    764.0125 MHz  2.707 %     5.0 %      0.0 %
Pass    869.9875 MHz  2.748 %     5.0 %      0.0 %

Tests performed by AutoTune © 2017 Freedom Communication Technologies, Inc. All Rights Reserved.
APP Version 2.3.4.0
```

**Figure B-1. Sample Test Result Report**

**APPENDIX C.      Revision History**

|                      |              |              |           |                      |
|----------------------|--------------|--------------|-----------|----------------------|
|                      |              |              |           |                      |
| A – Original Release | M. Mullins   | M. Humphries | 07/25/17  | <a href="#">0130</a> |
| Revision – Change    | Requested By | Approved By  | Rel. Date | ECO#                 |