ASTRONICS
TEST SYSTEMS

R8000 SERIES
COMMUNICATIONS SYSTEM ANALYZER

AUTOTUNE USER GUIDE

Motorola MOTOTRBO™ Portable
Motorola MOTOTRBO™ Mobile

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FCT-1372 Rev. B

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1. Introduction

The Astronics Test Systems R8000 Series Communications System Analyzer AutoTune™ feature (hereafter “AutoTune”) provides an automated test and alignment solution for supported two-way radios.

2. Scope

This document is intended to provide information about the tests and alignments performed by AutoTune for supported Motorola MOTOTRBO™ Portable and MOTOTRBO™ Mobile radios. This document is limited to radio-specific information.

Refer to R8100 Series Communications System Analyzer Owner’s Manual (FCT-1382) for an overview and basic operating instructions for AutoTune itself.

2.1. Supported Models

Tier	North America	Asia	Europe, Africa	Latin America
Professional Core Portables	XPR 6100 / 6300 / 6350 / 6380 / 6500 / 6550 / 6580	XiR P8100 / P8200 / P8208 / P8260 / P8268 / P8800 / P8808 / P9260 / P9268	DP 3200 / 3400 / 3401 / 3600 / 3601	DGP 4050 / 4150 / 4150+ / 6150 / 6150+
Professional Core Mobiles	XPR 4350 / 4380 / 4550 / 4580	XiR M8220 / M8228 / M8260 / M8268	DM 3400 / 3401 / 3600 / 3601	DGM 4100 / 4100+ / 6100 / 6100+
Professional Enhanced Portables	XPR 7150 / 7350 / 7380 / 7550 / 7580 / MOTOTRBO R7	CP7668 GP 328D / 338D XiR E8600 / E8608 / E8628 / P8600 / P8608 / P8620 / P8628 / P8660 / P8668 / P8800 / P8808 / P8860 / P8868 / MOTOTRBO R7	DP 3441 / 3661 / 4400 / 4401 / 4600 / 4601 / 4800 / 4801 / MOTOTRBO R7	DGP 5050 / 5550 / 8050 / 8550 / MOTOTRBO R7
Professional Enhanced Mobiles	XPR 5350 / 5380 / 5550 / 5580	CM7668 XiR M8620 / M8628 / M8660 / M8668	DM 4400 / 4401 / 4600 / 4601	DGM 5000 / 5500 / 8000 / 8500
Entry Professional SL	SL 3500	SL 2M	SL 2600	SI 500
Entry Professional Portables	XPR 3300 / 3350 / 3500	XiR P6600 / P6606 / P6608 / P6620 / P6626 / P6628	DP 2400 / 2401 / 2600 / 2601	DEP 455 / 475 / 550 / 570
Entry Professional Mobile	XPR 2500	XiR M6660	DM 2600	DEM 500
Professional SL	SL 7550 / 7580 / 7590	SL 1K / 2K	SL4000 / 4010	SL8050 / 8550
Commercial SL	SL300	SL 1M / 2M	SL 1600 / 2600	SI 500
Commercial Portables	CP 100 / 200	XiR P3688	DP 1400	DEP 450
Commercial Mobiles	CM 200 / 300	XiR M3188 / M3688	DM 1400 / 1600	DEM 300 / 400

Table 2-1. AutoTune Supported MOTOTRBO Models

3. Conventions

Standard Analog RX Signal. A -47 dBm RF carrier modulated at 60% rated channel deviation.

Standard Digital RX Signal. A -47 dBm RF carrier modulated with a O.153 test pattern on a 12.5 kHz channel.

Rated Audio. Approx. 7.75 V for MOTOTRBO Mobile and 2.82 V for MOTOTRBO Portable radios across an 8 ohm speaker.

Standard TX Signal. 1 kHz audio applied to the radio with modulation level adjusted until 60% rated channel deviation is achieved.

4. Requirements

Firmware. Minimum radio firmware versions in Table 4-1 are required for AutoTune servicing.

Tier	Examples	Minimum firmware revision
Professional Core	XPR 6550, XPR 4580	R01.08.10
Professional Enhanced	XPR 7350, XPR 5550, SL 7550	R02.30.01[1]
Entry Professional	XPR 3350, XPR 2500	R01.00.00
Commercial	CP200d, CM200d	R01.00.00

Table 4-1. Minimum required firmware versions

Options. The following are required options for servicing MOTOTRBO radios.

Option Name	Reason
DMR Test Mode (R8-DMR)	Used to perform DMR Tx Tests and Digital Sensitivity tests.
Motorola MOTOTRBO (R8-AT_TRBO)	Motorola MOTOTRBO AutoTune.

Table 4-2. Required options

[1] Note: Firmware R02.50.xx contains a defect which prevents reading Modulation Balance test frequencies from the radio. This defect only affects Enhanced models. Please upgrade any Enhanced radios running this firmware to resolve defect-related test failures.

Test Accessories. The following are Motorola test aids required for servicing applicable MOTOTRBO radio models. For other regions, use Table 2-1. AutoTune Supported MOTOTRBO Models to map the equivalent radio mode.

Product	Model	Programming Cable	Battery Eliminator	Test Set	Antenna Test Adapter	Antenna Adapter Holder
CP100d	H87…	PMKN4128	PMDN4080_R	RLN4460	PMLN6154	PMLN7119
CP200d	H01…	PMKN4128	0180305K08EPP	RLN4460	5886564Z01	N/A
XPR 3300 / 3500	H02…	PMKN4117	PMNN4428	RLN4460	PMLN6154	PMLN6201
XPR 6100 / 6300 / 6350 / 6380 / 6500 / 6550 / 6580	H55…	PMKN4012	PMNN4076	RLN4460	5880348B33	N/A
XPR 7500	H56…	PMKN4012B+	PMLN6430	RLN4460	5880384G68	N/A
XPR 7350 / 7380 / 7550 / 7580	H56…	PMKN4012B+	PMNN4428	RLN4460	PMLN6154	PMLN6155
SL300 / 3500	H88…	CB000262A01 / CB000233A01	HW000405A02	RLN4460	TL000068A01	HW000406A02
SL7550 / 7580 / 7590	H81…	25-124330-01R	PMNN4429	N/A	28012039001	7012042001
MOTOTRBO R7	H06…	PMKN4231	BT000702A01	RLN4460	AY000811A01	5880384G68
CM200d / CM300d	M01…	PMKN4147	N/A	RLN4460	N/A	N/A
XPR 2500	M02…	PMKN4147 / PMKN4149	N/A	RLN4460	N/A	N/A
XPR 4350 / 4380 / 4550 / 4580	M27…	PMKN4010 / PMKN4016 / HKN6184	N/A	RLN4460	N/A	N/A
XPR 5350 / 5380 / 5550 / 5580	M28…	HKN6184	N/A	RLN4460	N/A	N/A

Table 4-3. Required test accessories.

5. Motorola MOTOTRBO™ Portable Radio Test Setup

Before servicing a radio with AutoTune, ensure the analyzer is running the current system software version. Each system version release contains issue resolutions and/or new/enhanced features.

- On the analyzer, navigate to Settings > About… Note the System version shown.
- Browse to the Astronics Test Systems software upgrades webpage: https://freedomcte.com/upgrades/
- If the first Current System Version shown on the webpage is more recent than the analyzer System version, follow the webpage instructions to download and apply the current system version software to your analyzer.

To perform test and alignment procedures, the MOTOTRBO™ 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.

5.1. MOTOTRBO™ Portable Test Setup

Refer to the diagrams below for the proper test setup. Note that the correct setting for each RLN4460 test set control is highlighted in yellow.

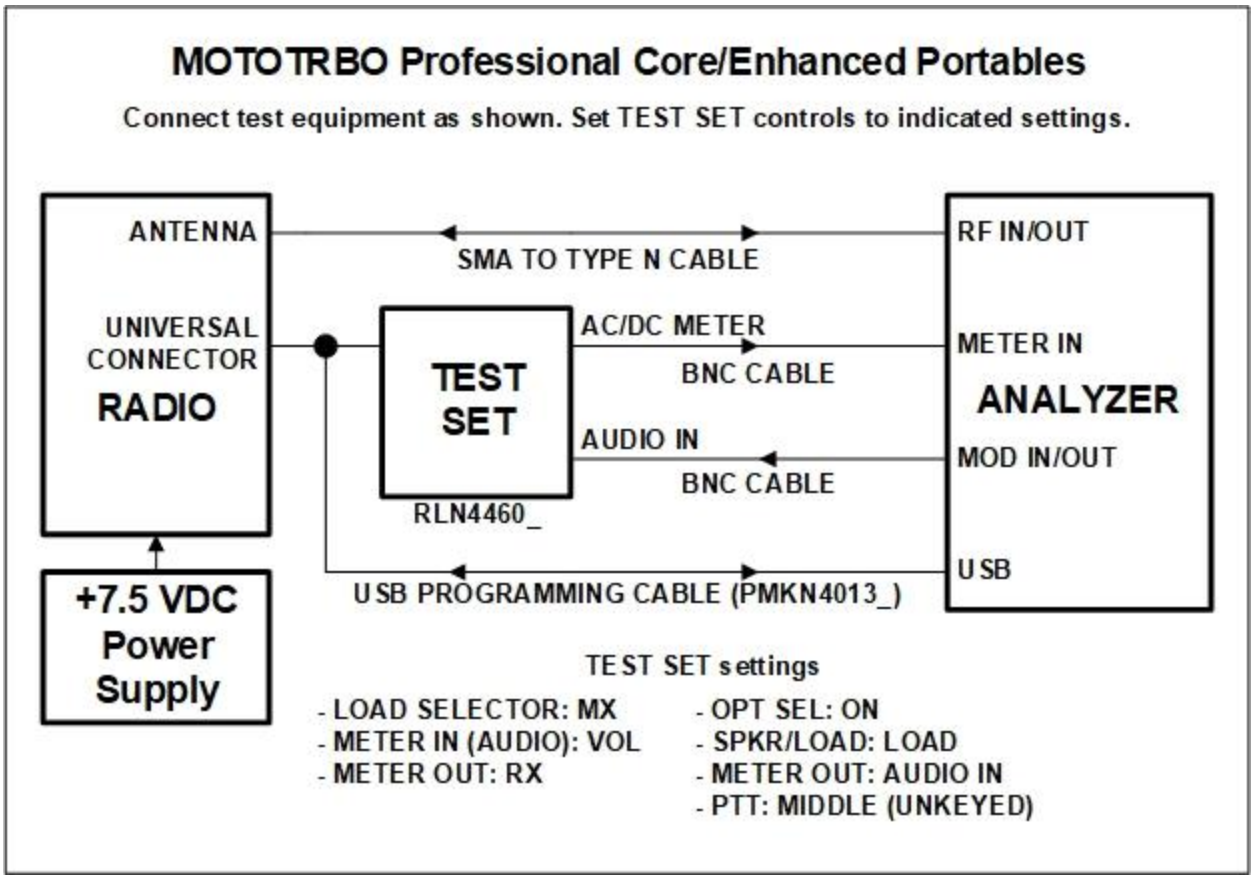

Figure 5-1. MOTOTRBO™ Portable Professional Core/Enhanced Test Setup Diagram

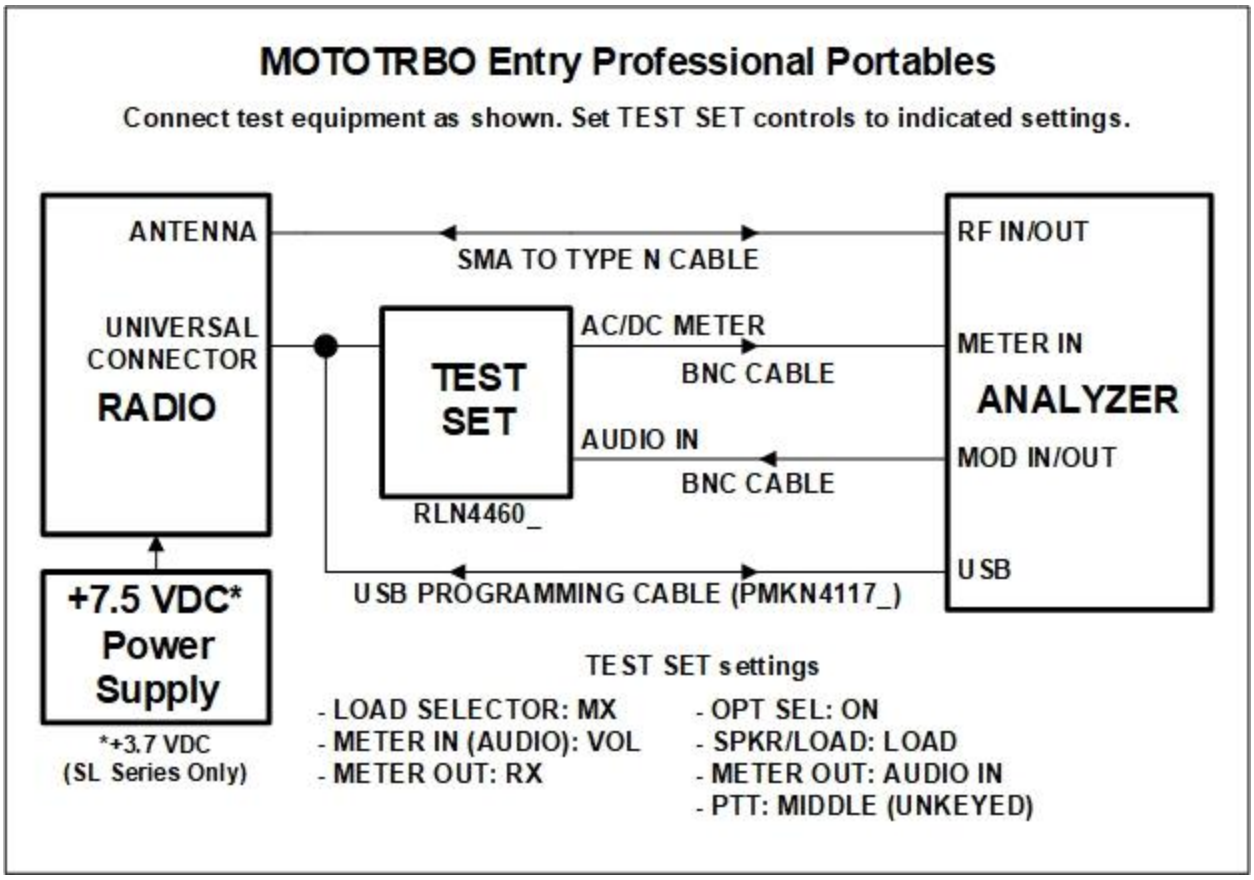

Figure 5-2. MOTOTRBO™ Portable Entry Professional Test Setup Diagram.

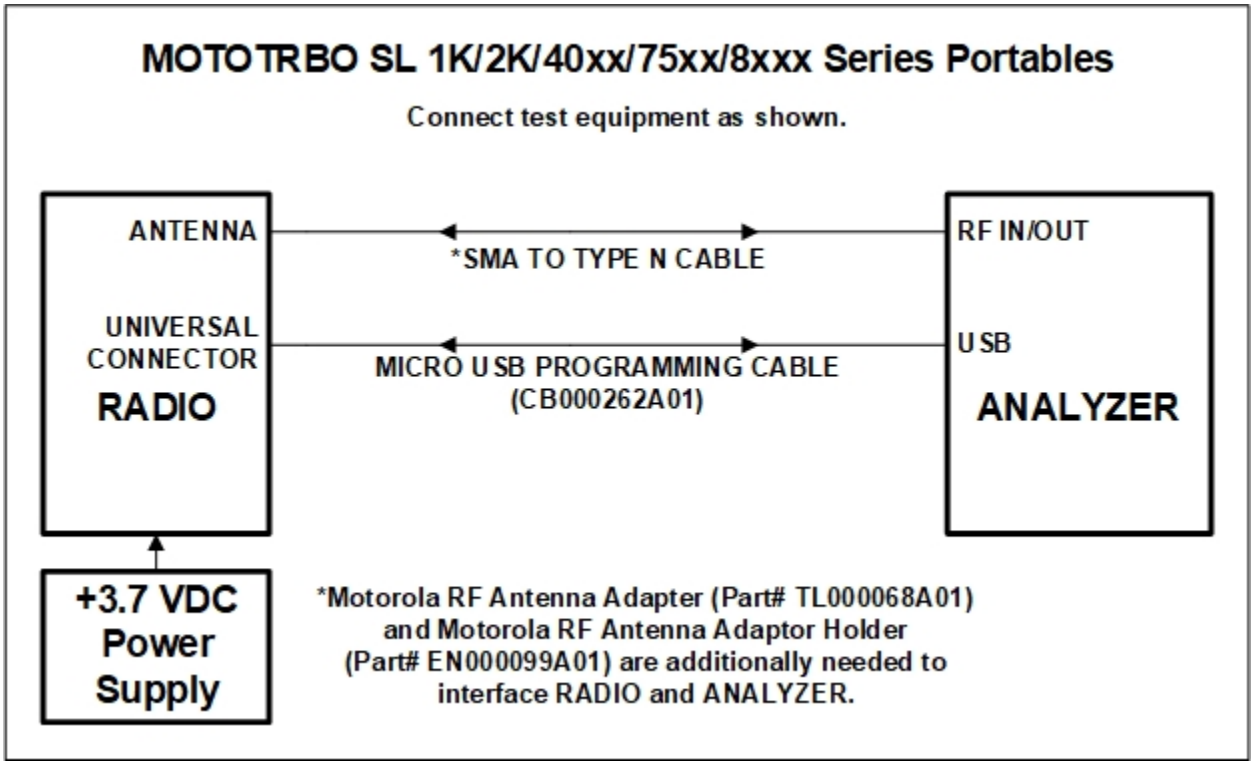

Figure 5-3. MOTOTRBO™ Portable SL Series Radio Test Setup Diagram.

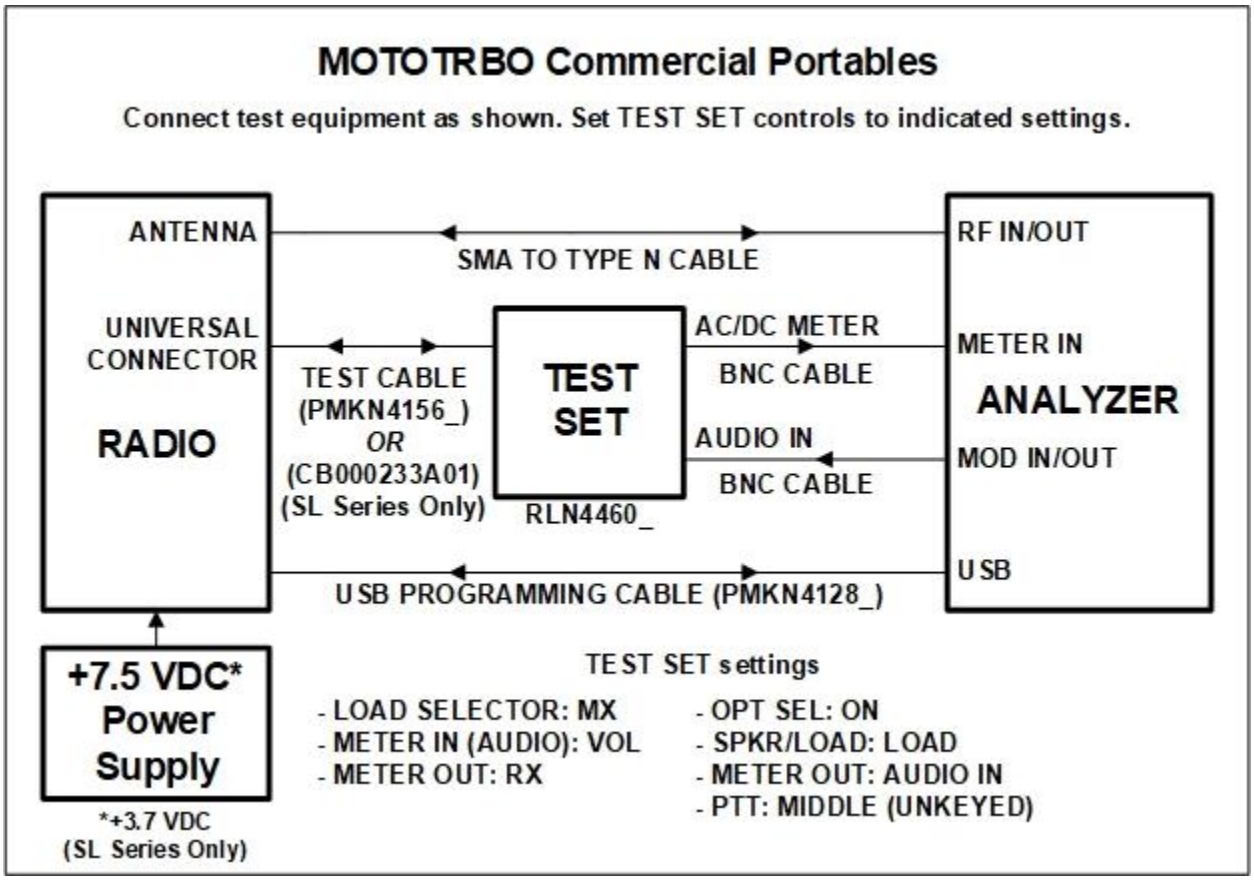

Figure 5-4. MOTOTRBO™ Portable Commercial Test Setup Diagram.

6. Motorola MOTOTRBO™ 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. See the References section for more details.

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

6.1. Reference 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 the highest 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 after alignment
Min Limit	Minimum Limit (inclusive) for frequency error
Max Limit	Maximum Limit (inclusive) for frequency error
Old Softpot	Original radio softpot setting
New Softpot	Radio softpot after alignment

Table 6-2. Reference Frequency alignment results

6.1.2. Test

The radio is placed into Test Mode at the highest 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 which yields Freq Error

Table 6-3. Reference Frequency test results

6.2. TX Power Out

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

Table 6-4. Analyzer Configuration for TX Power Out

6.2.1. Alignment

The TX Power Out alignment aligns the power output level of the radio at both High and Low power levels. The radio is placed into Test Mode and commanded to transmit at the first Test Frequency and the High power setting. For each test frequency, the output level is measured and then adjusted until near to a band-specific output level defined by the MOTOTRBO Tuner software help file.

Band	High Power Limits(W)	Low Power Limits(W)
VHF	5.0-6.0	1.0-1.6
UHF1	4.0-4.8	1.0-1.6
UHF2	4.0-4.8	1.0-1.6
UHF WB	4.0-4.8	1.0-1.6
350 MHz	4.0-4.8	1.0-1.6
800-900 MHz	2.5-2.8	1.0-1.6
XPR 6580 Canada	2.3-2.5	1.0-1.2

Table 6-5. Motorola specified target power

This process is repeated for the Low Power setting. The final 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	Original radio softpot setting
New Softpot	Radio softpot after alignment

Table 6-6. TX Power Out alignment results

6.2.2. 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 High Power and Low Power, and compared against test limits. The final 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	Radio softpot which yields Power Out

Table 6-7. TX Power Out test results

6.3. Modulation Balance

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

Table 6-8. Analyzer Configuration for Modulation Balance test, alignment

6.3.1. Alignment

The radio is placed into Test Mode at the first TX Test Frequency and commanded to transmit. The radio generates a Low modulation tone and the RMS-averaged deviation of this tone is measured with the analyzer. The radio then generates a High modulation tone and the RMS-averaged deviation of this tone is measured with the analyzer. The radio softpot is adjusted until the deviation difference between the first and second tones is within test limits. This adjustment is performed for each TX Test Frequency. The results for each TX Test Frequency are written to the log file.

The Dev Ratio is calculated as: $DevRatio = 20\log\left(\frac{Deviation_{LOW}}{Deviation_{HIGH}}\right)$

Name	Description
Result	Pass or Fail. Calculated difference between Low and High tone deviation less than or equal to Dev Ratio.
Frequency	Test Frequency
Dev Ratio	Calculated difference, in dB, between Low and High tone deviation
Max Limit	Maximum passable ratio difference (inclusive) between low and high tone deviation.
Old Softpot	Original radio softpot setting
New Softpot	Radio softpot setting after alignment

Table 6-9. Modulation Balance alignment results

6.3.2. Test

The radio is placed into Test Mode at the first TX Test Frequency and commanded to transmit. The analyzer applies an audio tone to the radio sufficient for the radio's deviation to achieve 60% rated deviation, RMS-averaged. For 25 kHz channel spacing, 60% of rated deviation (5 kHz) is 3 kHz. Once this 60% rated deviation level is achieved, the analyzer adjusts the audio level to 20 dB greater than that required to produce 60% rated deviation. The deviation level of this tone is measured with the analyzer. The percent difference is compared against test limits and written to the log file. This test is performed for each remaining TX Test Frequency.

Name	Description
Result	Pass or Fail. Deviation is less than or equal to Max Limit.
Frequency	Test Frequency
20dB Aud Lvl	Analyzer audio level used to produce Deviation
Deviation	Measured deviation level.
Max Limit	Maximum passable deviation (inclusive)
Softpot	Radio softpot which yields Deviation

Table 6-10. Modulation Balance test results

6.4. Front End Filter

Note: This alignment and test is not supported for 800/900 MHz radios. Selection of this alignment or test when testing a 800/900 MHz radio will always generate a Pass result and a note will appear on the test report indicating that this alignment or test is unsupported.

RF Control	Port	Frequency	Modulation	Attenuation
Generate	RF IN/OUT	Test Frequency	None;	30 dB

Table 6-11. Analyzer Configuration for Front End Filter test, alignment

6.4.1. Alignment

The radio is placed into Test Mode at the RX Test Frequencies specified by Motorola MOTOTRBO Tuner. At each of the test frequencies, the radio receives a -70 dBm signal with no modulation from the analyzer. The radio then automatically tunes a softpot value for that frequency. Once an autotuned value is generated for all RX Test Frequencies, updated softpots are calculated for all other test frequencies and applied to the radio. The results for all RX Test Frequencies are written to the log file.

Name	Description
Result	Pass. Alignment success is determined by a follow-up Front End Filter test.
Frequency	Test Frequency
Old Softpot	Original radio softpot setting
New Softpot	Radio softpot setting after alignment

Table 6-12. Front End Filter alignment results

6.4.2. Test

The analyzer is setup by applying a Standard Analog RX Signal to the radio and then adjusting radio volume for Rated Audio. The radio is placed into Test Mode at the first RX Test Frequency. The output level of the analyzer is then adjusted to -116 dBm. SINAD is measured and compared against test limits. The final results are written to the log file.

Name	Description
Result	Pass or Fail. Deviation is less than or equal to Max Limit.
Frequency	Test Frequency
SINAD	Measured SINAD level
Min Limit	Minimum passable SINAD (exclusive)

Table 6-13. Front End Filter test results

6.5. Front End Gain and Attenuation

RF Control	Port	Frequency	Modulation	Attenuation
Generate	RF IN/OUT	Test Frequency	None;	30 dB

Table 6-14. Analyzer Configuration for FE Gain and Attenuation alignment

6.5.1. Alignment

The radio is placed into Test Mode at the RX Test Frequencies specified by Motorola MOTOTRBO Tuner. At each of the test frequencies, the radio receives a -80 dBm signal with no modulation from the analyzer. The radio then computes and returns the RSSI and Front End attenuator values for that frequency. Updated softpots are calculated and applied to the radio. The results are written to the log file.

Name	Description
Result	Pass. Alignment success is determined by a follow-up Front End Filter test.
Frequency	Test Frequency
FE Gain SP	Front End Gain softpot setting
FE Gain (dB)	Measured RF receiver gain (dB)
Attn SP	Front End Attenuation softpot value
Attn Gain (dB)	Attenuation of RX diode in Front End

Table 6-15. Front End Gain and Attenuation alignment results

6.5.2. Test

No test is needed.

6.6. Distortion

This is a test only; there is no alignment.

RF Control	Port	Frequency
Generate	RF IN/OUT	Test Freq

Table 6-16. Analyzer Configuration for Distortion Test

6.6.1. Alignment

No alignment is needed.

6.6.2. Test

The analyzer is setup by applying a Standard Analog RX Signal to the radio and then adjusting radio volume for Rated Audio. The radio is placed into Test Mode at a RX Test Frequency. The audio signal's distortion level is then measured and compared to test limits. The final results are written to the log file.

Name	Description
Result	Pass or Fail. Distortion level within Max Limit, Min Limit
Frequency	Test Frequency
Distortion	Measured audio signal distortion level
Max Limit	Maximum Limit (inclusive) for Distortion to Pass

Table 6-17. Distortion test results

6.7. Sensitivity (SINAD)

This is a test only; there is no alignment.

RF Control	Port	Frequency	Modulation	Level
Generate	RF IN/OUT	Test Freq	FM, 1 kHz @ 3kHz deviation	-50 dBm

Table 6-18. Analyzer Configuration for Sensitivity (SINAD) test

6.7.1. Alignment

No alignment is needed.

6.7.2. Test

The analyzer is setup by applying a Standard Analog RX Signal to the radio and then adjusting radio volume for Rated Audio. The radio is placed into Test Mode at the 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.

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 12 dB
Max Limit	Maximum Limit (inclusive) for Sensitivity (SINAD) to Pass

Table 6-19. Sensitivity (SINAD) test results

6.8. Digital Sensitivity (RX BER)

NOTE: This test requires an analyzer with DMR test mode capability.
The purpose of this procedure is to measure the radio receiver's Bit Error Rate at a given frequency. The TIA/EIA standard BER rate is 5%. This is a test only; there is no alignment.

RF Control	Port	Frequency	Modulation	Level
Generate	RF IN/OUT	Test Frequency	O.153 Test Pattern	-116.0 dBm

Table 6-20. Analyzer Configuration for Digital Sensitivity (RX BER) test

6.8.1. Alignment

No alignment is needed.

6.8.2. Test

The analyzer is setup by applying a Standard Digital RX Signal to the radio. The radio is placed into Test Mode at a RX Test Frequency, ready to receive a DMR-modulated signal from the analyzer. Once BER synchronization is detected, the analyzer output level is decreased until a BER of 5% is measured. The analyzer output level at 5% BER is compared against test limits and the final results are written to the log file.

Name	Description
Result	Pass or Fail. Digital Sensitivity (RX BER) output level within Max Limit
Frequency	Test Frequency
5% BER	Analyzer output level at which the radio BER measures 5%
Max Limit	Maximum Limit (inclusive) for Digital Sensitivity (RX BER) to Pass

Table 6-21. Digital Sensitivity (RX BER) test results

6.9. Digital Sensitivity (TX BER)

NOTE: This test requires an analyzer with DMR test mode capability.
The purpose of this procedure is to measure the radio transmitter's Bit Error Rate at a given frequency. The target BER rate is 0%. This is a test only; there is no alignment.

RF Control	Port	Frequency	Modulation
Monitor	RF IN/OUT	Test Frequency	O.153 Test Pattern

Table 6-22. Analyzer Configuration for Digital Sensitivity (TX BER) test

6.9.1. Alignment

No alignment is needed.

6.9.2. Test

The analyzer is setup via the configuration section at the beginning of this section. The radio is placed into Test Mode at a TX Test Frequency, ready to generate a O.153 test pattern DMR-modulated signal to the analyzer. The radio is keyed and its BER error measured by the analyzer. The measured radio TX BER is compared against test limits and the final results are written to the log file.

Name	Description
Result	Pass or Fail. Digital Sensitivity (TX BER) output level within Max Limit
Frequency	Test Frequency
BER	Measured radio BER error
Max Limit	Maximum Limit (inclusive) for Digital Sensitivity (TX BER) to Pass

Table 6-23. Digital Sensitivity (TX BER) test results

6.10. Internal Voice Modulation

The purpose of this procedure is to test the ability of the radio's internal microphone audio circuit to accurately transfer the received signal.

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

Table 6-24. Analyzer Configuration for Internal Voice Modulation test

6.10.1. Alignment

No alignment is needed.

6.10.2. Test

The radio is placed into Test Mode at a TX Test Frequency. The analyzer is setup as specified in this section's Analyzer Configuration table. The user is instructed to key the connected radio and place it next to the analyzer speaker (see Figure 6-1). The user is also instructed to adjust the analyzer volume until about 4 kHz deviation is seen on the analyzer display (see Figure 6-2). The deviation level is then measured by the analyzer and the user is instructed when to un-key the radio. The measured deviation is compared against test limits and the final results are written to the log file.

Figure 6-1. Place keyed radio next to analyzer speaker.

Figure 6-2. Adjust analyzer volume until about 4 kHz deviation is measured.

Name	Description
Result	Pass or Fail. Deviation within Min Limit, Max Limit
Frequency	Test Frequency
Deviation	Measured modulation deviation level
Min Limit	Minimum Limit (inclusive) for Deviation to Pass
Max Limit	Maximum Limit (inclusive) for Deviation to Pass

Table 6-25. Internal Voice Modulation test results

6.11. External Voice Modulation

The purpose of this procedure is to test the ability of an external microphone attached to the radio to effectively transfer the received signal.

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

Table 6-26. Analyzer Configuration for External Voice Modulation test

6.11.1. Alignment

No alignment is needed.

6.11.2. Test

The radio is placed into Test Mode at the lowest TX Test Frequency. The analyzer is setup as specified in this section's Analyzer Configuration table. The analyzer generates a 1 kHz signal at 80 mV into the radio's external microphone accessory port via the radio test set. The radio is commanded to transmit and the resulting Power-Weight averaged deviation level is then measured by the analyzer. The measured deviation is compared against test limits and the final results are written to the log file.

Name	Description
Result	Pass or Fail. Deviation within Min Limit, Max Limit
Frequency	Test Frequency
Deviation	Measured modulation deviation level
Min Limit	Minimum Limit (inclusive) for Deviation to Pass
Max Limit	Maximum Limit (inclusive) for Deviation to Pass

Table 6-27. External Voice Modulation test results

7. Motorola MOTOTRBO™ Mobile Radio Test Setup

In order to perform the test and alignment procedures, the MOTOTRBO™ 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.

7.1. MOTOTRBO™ Mobile Test Setup

Refer to the diagrams below for the proper test setup. Note that the correct setting for each applicable RLN4460 test set control is listed at the bottom of each diagram.

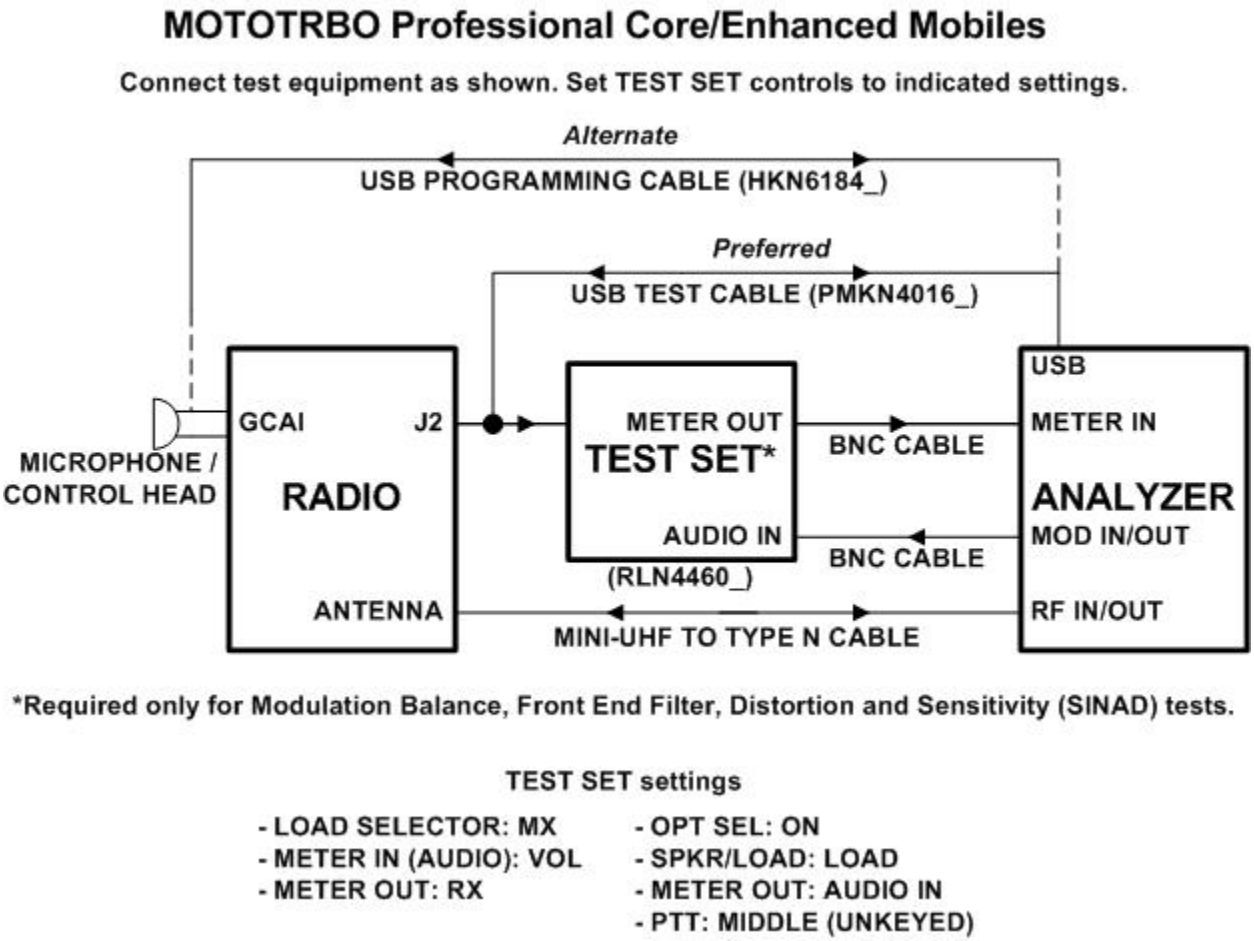

Figure 7-1. MOTOTRBO™ Mobile Professional Core/Enhanced Test Setup Diagram.

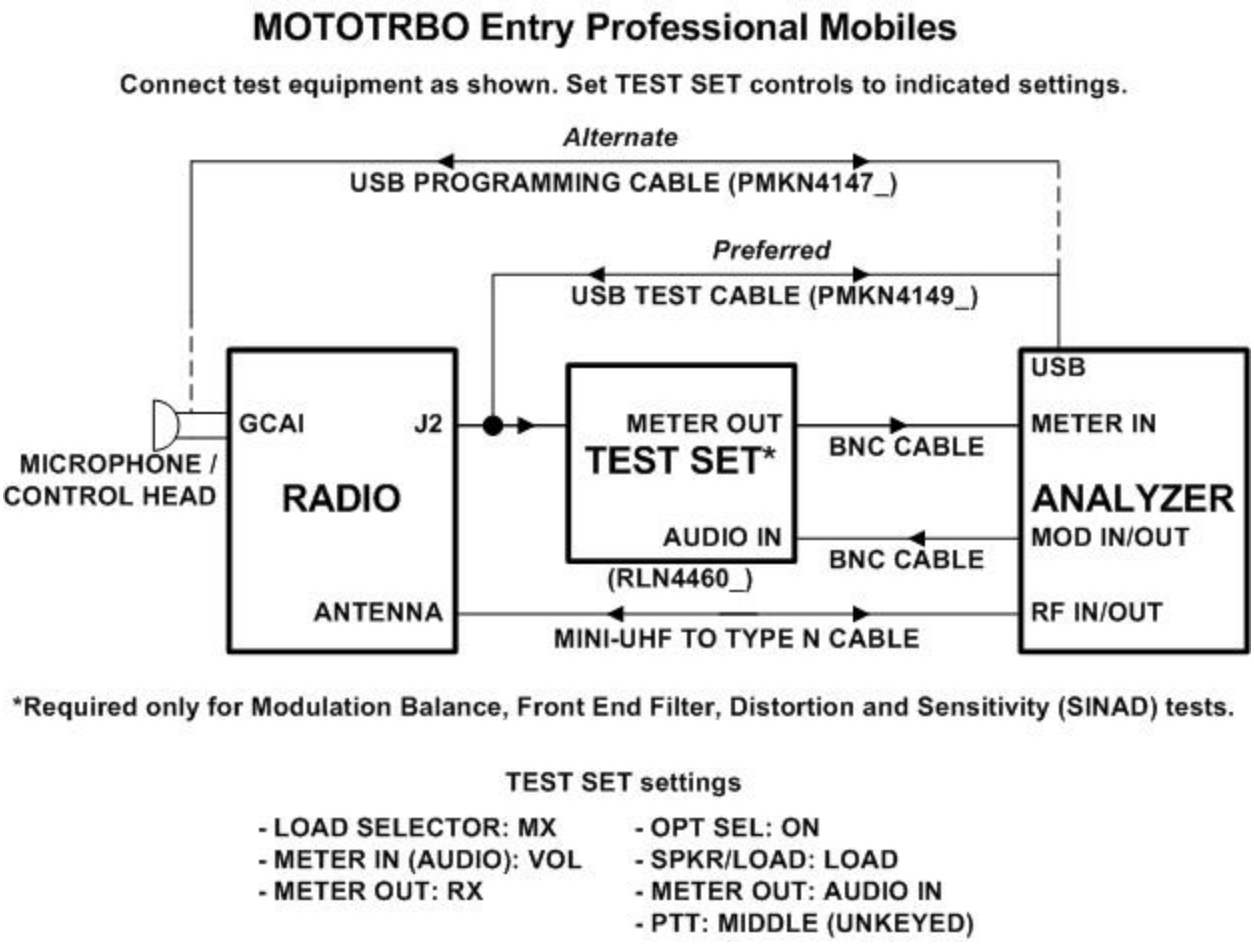

Figure 7-2. MOTOTRBO™ Mobile Entry Professional Test Setup Diagram.

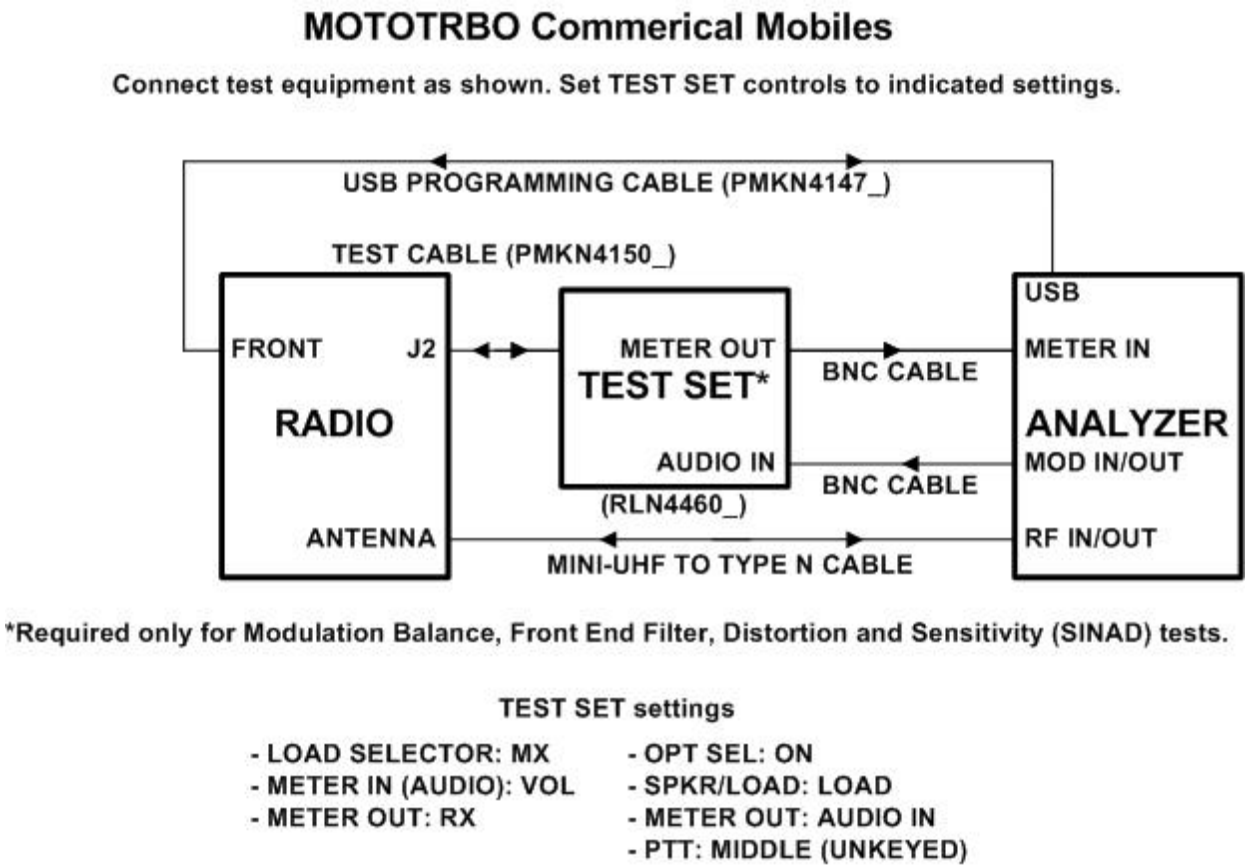

Figure 7-3. MOTOTRBO™ Mobile Commercial Test Setup Diagram.

8. Motorola MOTOTRBO™ 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. See the References section for more details.

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

Warning: During performance of the Front End Filter, Distortion, and Sensitivity (SINAD) tests, audio will be heard coming from the radio's internal speaker. Unfortunately, this audio is necessary for testing and cannot be muted by the AutoTune software. If desired, strips of duct tape or sound-deadening foam may be placed across the radio's internal speaker grille to reduce the audio level.

8.1. Reference Frequency

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

Table 8-1. Analyzer Configuration for Reference Frequency

8.1.1. Alignment

The radio is placed into Test Mode at the highest 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 after alignment
Min Limit	Minimum Limit (inclusive) for frequency error
Max Limit	Maximum Limit (inclusive) for frequency error
Old Softpot	Original radio softpot setting
New Softpot	Radio softpot after alignment

Table 8-2. Reference Frequency alignment results

8.1.2. Test

The radio is placed into Test Mode at the highest 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
Max Limit	Maximum Limit (inclusive) for frequency error
Min Limit	Minimum Limit (inclusive) for frequency error
Softpot	Radio softpot which yields Freq Error

Table 8-3. Reference Frequency test results

8.2. TX Power Out

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

Table 8-4. Analyzer Configuration for TX Power Out

8.2.1. Alignment

The TX Power Out alignment adjusts the Power Characterization Points for each Test Frequency to account for the variability of the power detection circuitry between radios. The radio is placed into Test Mode and commanded to transmit at the first Test Frequency. For each Power Characterization Point, the radio output level is measured and then adjusted until near to a band-specific and power characterization point-specific output level. New softpot values are calculated based on the resulting power characterization points and then programmed into the radio. The results are then written to the log file.

After all Power Characterization Points for all Test Frequencies have been aligned, the radio performs a verification at both High and Low power levels beginning at the first Test Frequency using the power limits defined in the Motorola MOTOTRBO Tuner help file.

Band	Low Power Limits (W)	High Power Limits (W)
VHF	1.0-1.2	26.0-29.0
VHF (High Power)	26.0-29.0	40.0-50.0
UHF1	1.0-1.2	26.0-29.0
UHF1 (High Power)	26.0-29.0	40.0-48.0
UHF2 (450-512 MHz)	1.0-1.2	40.0-48.0
UHF2 (512-527 MHz)	1.0-1.2	26.0-29.0
350 MHz	1.0-1.2	26.0-29.0
350 MHz (High Power)	1.0-1.2	40.0-48.0
800MHz	10.0-12.0	35.0-42.0
900MHz	10.0-12.0	30.0-36.0

Table 8-5 Motorola MOTOTRBO™ Mobile specified target power

This process is repeated for all test frequencies. The final results are written to the log file.

Name	Description
Result	Pass or Fail. Meas Power within manufacturer limits
Power Point	Power Characterization Point
Power Out	Measured radio output level
Min Limit	Minimum Limit (inclusive) for Power Out
Max Limit	Maximum Limit (inclusive) for Power Out

Table 8-6. TX Power Out alignment results

After the TX Power Out alignment is complete, the power output level is measured again at each TX Test Frequency for both High and Low power levels and compared against test limits. The final 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

Table 8-7. TX Power Out alignment results

8.2.2. 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 and compared against test limits. The final 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

Table 8-8. TX Power Out test results

8.3. Deviation Balance

RF Control	Port	Frequency	Modulation	Attenuation
Monitor	RF IN/OUT	Test Frequency	FM	20 dB

Table 8-9. Analyzer Configuration for Deviation Balance test, alignment

8.3.1. Alignment

The radio is placed into Test Mode at the highest TX Test Frequency and commanded to transmit. The radio generates an 80 Hz modulation tone and the deviation of this tone is measured with the analyzer. The radio then generates a 3 kHz modulation tone and the deviation of this tone is measured with the analyzer. The radio softpot is adjusted until the deviation difference between the first and second tones is as small as possible. This adjustment is performed for each TX Test Frequency and the percent difference is compared against test limits. The results for each TX Test Frequency are written to the log file.

Dual-Band: This alignment is performed consecutively for all test frequencies in both bands.

Name	Description
Result	Pass or Fail. Percent difference between low and high tone deviation less than or equal to Variance.
Frequency	Test Frequency
Variance	Measured difference between low and high tone deviation
Max Limit	Maximum passable percent difference (inclusive) between low and high tone deviation
Old Softpot	Original radio softpot setting
New Softpot	Radio softpot setting after alignment

Table 8-10. Deviation Balance alignment results

8.3.2. Test

The radio is placed into Test Mode at the highest TX Test Frequency and commanded to transmit. The radio generates an 80 Hz modulation tone and the deviation of this tone is measured with the analyzer. The radio then generates a 3 kHz modulation tone and the deviation of this tone is measured with the analyzer. The percent difference is compared against test limits and written to the log file. This test is performed for each remaining TX Test Frequency.

Dual-Band: This test is performed consecutively for all test frequencies in both bands.

Name	Description
Result	Pass or Fail. Percent difference between low and high tone deviation less than or equal to Variance.
Frequency	Test Frequency
Variance	Measured difference between low and high tone deviation
Max Limit	Maximum passable percent difference (inclusive) between low and high tone deviation

Table 8-11. Deviation Balance test results

8.4. Front End Filter

Note: This alignment and test is not supported for 800/900 MHz radios. Selection of this alignment or test when testing an 800/900 MHz radio will always generate a Pass result and a note will appear on the test report indicating that this alignment or test is unsupported.

RF Control	Port	Frequency	Modulation	Attenuation
Generate	RF IN/OUT	Test Frequency	None;	30 dB

Table 8-12. Analyzer Configuration for Front End Filter test, alignment

8.4.1. Alignment

The radio is placed into Test Mode at the RX Test Frequencies specified by Motorola MOTOTRBO Tuner. At each of the test frequencies, the radio receives a -70 dBm signal with no modulation from the analyzer. The radio then automatically tunes a softpot value for that frequency. Once an autotuned value is generated for all RX Test Frequencies, updated softpots are calculated for all other test frequencies and applied to the radio. The results for all RX Test Frequencies are written to the log file.

Name	Description
Result	Pass. Alignment success is determined by a follow-up Front End Filter test.
Frequency	Test Frequency
Old Softpot	Original radio softpot setting
New Softpot	Radio softpot setting after alignment

Table 8-13. Front End Filter alignment results

8.4.2. Test

The analyzer is setup by applying a Standard Analog RX Signal to the radio and then adjusting radio volume for Rated Audio. The radio is placed into Test Mode at the first RX Test Frequency. The output level of the analyzer is then adjusted to -116 dBm. SINAD is measured and compared against test limits. The final results are written to the log file.

Name	Description
Result	Pass or Fail. Deviation is less than or equal to Max Limit.
Frequency	Test Frequency
SINAD	Measured SINAD level
Min Limit	Minimum passable SINAD (exclusive)

Table 8-14. Front End Filter test results

8.5. Front End Gain and Attenuation

RF Control	Port	Frequency	Modulation	Attenuation
Generate	RF IN/OUT	Test Frequency	None;	30 dB

Table 8-15. Analyzer Configuration for FE Gain and Attenuation alignment

8.5.1. Alignment

The radio is placed into Test Mode at the RX Test Frequencies specified by Motorola MOTOTRBO Tuner. At each of the test frequencies, the radio receives a -80 dBm signal with no modulation from the analyzer. The radio then computes and returns the RSSI and Front End attenuator values for that frequency. Updated softpots are calculated and applied to the radio. The results are written to the log file.

Name	Description
Result	Pass. Alignment success is determined by a follow-up Front End Filter test.
Frequency	Test Frequency
FE Gain SP	Front End Gain softpot setting
FE Gain (dB)	Measured RF receiver gain (dB)
Attn SP	Front End Attenuation softpot value
Attn Gain (dB)	Attenuation of RX diode in Front End

Table 8-16. Front End Gain and Attenuation alignment results

8.5.2. Test

No test is needed.

8.6. Distortion

This is a test only; there is no alignment.

RF Control	Port	Frequency
Generate	RF IN/OUT	Test Freq

Table 8-17. Analyzer Configuration for Distortion Test

8.6.1. Alignment

No alignment is needed.

8.6.2. Test

The analyzer is setup by applying a Standard Analog RX Signal to the radio and then adjusting radio volume for Rated Audio. The radio is placed into Test Mode at a RX Test Frequency. The audio signal's distortion level is then measured and compared to test limits. The final results are written to the log file.

Name	Description
Result	Pass or Fail. Distortion level within Max Limit, Min Limit
Frequency	Test Frequency
Distortion	Measured audio signal distortion level
Max Limit	Maximum Limit (inclusive) for Distortion to Pass

Table 8-18. Distortion test results

8.7. Sensitivity (SINAD)

This is a test only; there is no alignment.

RF Control	Port	Frequency	Modulation	Level
Generate	RF IN/OUT	Test Freq	FM, 1 kHz @ 3kHz deviation	-50 dBm

Table 8-19. Analyzer Configuration for Sensitivity (SINAD) test

8.7.1. Alignment

No alignment is needed.

8.7.2. Test

The analyzer is setup by applying a Standard Analog RX Signal to the radio and then adjusting radio volume for Rated Audio. The radio is placed into Test Mode at the 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.

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 12 dB
Max Limit	Maximum Limit (inclusive) for Sensitivity (SINAD) to Pass

Table 8-20. Sensitivity (SINAD) test results

8.8. Digital Sensitivity (RX BER)

NOTE: This test requires an analyzer with DMR test mode capability.
The purpose of this procedure is to measure the radio receiver's Bit Error Rate at a given frequency. The TIA/EIA standard BER rate is 5%. This is a test only; there is no alignment.

RF Control	Port	Frequency	Modulation	Level
Generate	RF IN/OUT	Test Frequency	O.153 Test Pattern	-116.0 dBm

Table 8-21. Analyzer Configuration for Digital Sensitivity (RX BER) test

8.8.1. Alignment

No alignment is needed.

8.8.2. Test

The analyzer is setup by applying a Standard Digital RX Signal to the radio. The radio is placed into Test Mode at a RX Test Frequency, ready to receive a DMR-modulated signal from the analyzer. Once BER synchronization is detected, the analyzer output level is decreased until a BER of 5% is measured. The analyzer output level at 5% BER is compared against test limits and the final results are written to the log file.

Name	Description
Result	Pass or Fail. Digital Sensitivity (RX BER) output level within Max Limit
Frequency	Test Frequency
5% BER	Analyzer output level at which the radio BER measures 5%
Max Limit	Maximum Limit (inclusive) for Digital Sensitivity (RX BER) to Pass

Table 8-22. Digital Sensitivity (RX BER) test results

8.9. Digital Sensitivity (TX BER)

NOTE: This test requires an analyzer with DMR test mode capability.
The purpose of this procedure is to measure the radio transmitter's Bit Error Rate at a given frequency. The target BER rate is 0%. This is a test only; there is no alignment.

RF Control	Port	Frequency	Modulation
Monitor	RF IN/OUT	Test Frequency	O.153 Test Pattern

Table 8-23. Analyzer Configuration for Digital Sensitivity (TX BER) test

8.9.1. Alignment

No alignment is needed.

8.9.2. Test

The analyzer is setup via the configuration section at the beginning of this section. The radio is placed into Test Mode at a TX Test Frequency, ready to generate a O.153 test pattern DMR-modulated signal to the analyzer. The radio is keyed and its BER error measured by the analyzer. The measured radio TX BER is compared against test limits and the final results are written to the log file.

Name	Description
Result	Pass or Fail. Digital Sensitivity (TX BER) output level within Max Limit
Frequency	Test Frequency
BER	Measured radio BER error
Max Limit	Maximum Limit (inclusive) for Digital Sensitivity (TX BER) to Pass

Table 8-24. Digital Sensitivity (TX BER) test results

8.10. Internal Voice Modulation

The purpose of this procedure is to test the ability of the radio's internal microphone audio circuit to accurately transfer the received signal.

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

Table 8-25. Analyzer Configuration for Internal Voice Modulation test

8.10.1. Alignment

No alignment is needed.

8.10.2. Test

The radio is placed into Test Mode at a TX Test Frequency. The analyzer is setup as specified in this section's Analyzer Configuration table. The user is instructed to key the connected radio and place it next to the analyzer speaker (see Figure 8-1). The user is also instructed to adjust the analyzer volume until about 4 kHz deviation is seen on the analyzer display (see Figure 8-2). The deviation level is then measured by the analyzer and the user is instructed when to un-key the radio. The measured deviation is compared against test limits and the final results are written to the log file.

Figure 8-1. Place keyed radio next to analyzer speaker.

Figure 8-2. Adjust analyzer volume until about 4 kHz deviation is measured.

Name	Description
Result	Pass or Fail. Deviation within Min Limit, Max Limit
Frequency	Test Frequency
Deviation	Measured modulation deviation level
Min Limit	Minimum Limit (inclusive) for Deviation to Pass
Max Limit	Maximum Limit (inclusive) for Deviation to Pass

Table 8-26. Internal Voice Modulation test results

8.11. External Voice Modulation

The purpose of this procedure is to test the ability of an external microphone attached to the radio to effectively transfer the received signal.

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

Table 8-27. Analyzer Configuration for External Voice Modulation test

8.11.1. Alignment

No alignment is needed.

8.11.2. Test

The radio is placed into Test Mode at the lowest TX Test Frequency. The analyzer is setup as specified in this section's Analyzer Configuration table. The analyzer generates a 1 kHz signal at 800 mV into the radio's external microphone accessory port via the radio test set. The radio is commanded to transmit and the resulting deviation level is then measured by the analyzer. The measured deviation is compared against test limits and the final results are written to the log file.

Name	Description
Result	Pass or Fail. Deviation within Min Limit, Max Limit
Frequency	Test Frequency
Deviation	Measured modulation deviation level
Min Limit	Minimum Limit (inclusive) for Deviation to Pass
Max Limit	Maximum Limit (inclusive) for Deviation to Pass

Table 8-28. External Voice Modulation test results

9. Basic Troubleshooting

Symptom	Possible Cause	Possible Solution
MOTOTRBO Mobile radio won't power up	Loose PMKN4016_ cable connection	Verify cable connection is OK.
	Motorola CPS Ignition Switch setting	Use Motorola CPS software to set Radio Wide, Advanced, Ignition Switch setting to "Blank". This setting lets radio power up for testing without an ignition signal present. Be sure to return this setting to its original value when testing completed.
Analyzer consistently fails to communicate with MOTOTRBO portable radio	Worn programming cable connection	Verify programming cable connection to radio is sound. Using same connection, verify radio can be queried using Motorola Tuner software.
	Radio firmware version doesn't support AutoTune	See section 4 for minimum firmware version requirements.
Radio consistently fails TX Power Out test and/or alignment	MOTOTRBO Family CPS Transmit Power Level settings limiting radio output power.	Using MOTOTRBO Family CPS, adjust Codeplug Configuration Mode>Radio Wide>Transmit Power Level settings to factory defaults. This change lets radio output expected power levels for correct AutoTune TX Power Out testing and alignment.
Modulation Balance test and/or alignment consistently fails. Odd test frequencies are present for Modulation Balance test report results.	Enhanced radio model running R02.50.xx firmware.	Radio firmware R02.50.xx contains a defect which prevents reading Modulation Balance test frequencies from the radio. This defect only affects Enhanced models. Please upgrade any Enhanced radios running this firmware to resolve Modulation Balance test failures.
Front End Filter test fails one or more points.	Poor RF cable	Use a known good quality RF cable when performing the Front End Filter alignment or test. Recommended cable: MegaPhase RF Orange™ Type N to BNC cable.

Symptom	Possible Cause	Possible Solution
Cannot adjust measured deviation during Internal Voice Modulation test.	General Settings > Mic Selection Rule set to 'Default.'	When Mic Selection Rule is set to Default, the external microphone is effectively always on, preventing the radio's internal microphone from picking up audio. For the Internal Voice Modulation test to work, the radio's internal microphone must be enabled. Change the Mic Selection Rule setting to 'Mic Follow PTT' to allow radio internal microphone to be enabled when the radio PTT is pressed.

Table 9-1. AutoTune Troubleshooting Chart

10. Support Information

10.1. Technical Support

Document Library:	freedomcte.com/library/
Video Library:	freedomcte.com/videos/
Phone:	903.985.8999
Email:	Freedom.TechnicalSupport@astronics.com

10.2. Sales Support

Phone:	903.985.8999
Email:	LMRSales@astronics.com

11. References

MOTOTRBO™PORTABLE BASIC SERVICE MANUAL (6880309T30 -F)

MOTOTRBO™PORTABLE BASIC SERVICE MANUAL (68009271001-C)

MOTOTRBO™ Mobile Basic Service Manual (68009272001-A)

APPENDIX A. Sample Test Result Report

```
================================================================================
                                Test Result Report
================================================================================
Date/Time: 8/28/2023 10:28 AM                    Operator ID: Tech1

Info
----------------------------------------
Analyzer
---------
Model #:             R8100
Serial #:            810LSU0015
Ref Clock Mode:      Output
Application:         4.5
RF Level Offset:     Off
RF In/Out Offset:    0.0 dB
RF Gen Out Offset:   0.0 dB
Cable Sweep:         Off
Selected File:
100 MHz Attenuation: 0.000 dB
1 GHz Attenuation:   0.000 dB

Radio
------
Model #:             H88JCP9JA2AN:SL300
Serial #:            546TSV3940
Radio Host:          R01.01.49.0000
DSP:                 R01.01.49.0000
Region:              AA
RF Band:             VHF
----------------------------------------

Reference Frequency Align
=========================
Result  Frequency     Freq Error  Min Limit  Max Limit  Old Softpot  New Softpot
------  ------------  ----------  ---------  ---------  -----------  -----------
Pass    173.9850 MHz  -1 Hz       -40 Hz     40 Hz      -496         -1200

TX Power Out Align High
=======================
Result  Frequency     Power Out  Min Limit  Max Limit  Old Softpot  New Softpot
------  ------------  ---------  ---------  ---------  -----------  -----------
Pass    136.0350 MHz  3.1 W      2.7 W      3.5 W      855          855
Pass    142.5350 MHz  3.1 W      2.7 W      3.5 W      849          849
Pass    148.9350 MHz  3.1 W      2.7 W      3.5 W      846          846
Pass    155.4350 MHz  3.2 W      2.7 W      3.5 W      851          851
Pass    161.8350 MHz  3.2 W      2.7 W      3.5 W      891          891
Pass    167.3350 MHz  3.2 W      2.7 W      3.5 W      894          894
Pass    173.9850 MHz  2.9 W      2.7 W      3.5 W      863          863

TX Power Out Align Low
======================
Result  Frequency     Power Out  Min Limit  Max Limit  Old Softpot  New Softpot
------  ------------  ---------  ---------  ---------  -----------  -----------
Pass    136.0350 MHz  1.2 W      0.9 W      1.5 W      777          777
Pass    142.5350 MHz  1.2 W      0.9 W      1.5 W      773          773
Pass    148.9350 MHz  1.2 W      0.9 W      1.5 W      768          768
Pass    155.4350 MHz  1.1 W      0.9 W      1.5 W      763          763
Pass    161.8350 MHz  1.3 W      0.9 W      1.5 W      762          762
Pass    167.3350 MHz  1.3 W      0.9 W      1.5 W      764          764
Pass    173.9850 MHz  1.3 W      0.9 W      1.5 W      767          767

Modulation Balance Align
========================
Result  Frequency       Dev Ratio  Max Limit   Old Softpot  New Softpot
------  --------------  ---------  ----------  -----------  -----------
Pass    136.000000 MHz   0.00 dB   +/-0.05 dB  375          375
Pass    146.000000 MHz   0.00 dB   +/-0.05 dB  445          445
Pass    159.000000 MHz   0.02 dB   +/-0.05 dB  515          515
Pass    167.000000 MHz   0.04 dB   +/-0.05 dB  538          538
Pass    168.000000 MHz   0.04 dB   +/-0.05 dB  540          540
Pass    170.000000 MHz  -0.01 dB   +/-0.05 dB  543          547
Pass    172.000000 MHz  -0.00 dB   +/-0.05 dB  550          553
Pass    174.000000 MHz   0.03 dB   +/-0.05 dB  559          559

Modulation Balance Test
=======================
Result  Frequency       20dB Aud Lvl  Deviation  Max Limit  Softpot
------  --------------  ------------  ---------  ---------  -------
Pass    136.000000 MHz  0.120 V        4.37 kHz  5.00 kHz   375
Pass    146.000000 MHz  0.110 V        4.37 kHz  5.00 kHz   445
Pass    159.000000 MHz  0.120 V        4.38 kHz  5.00 kHz   515
Pass    167.000000 MHz  0.110 V        4.38 kHz  5.00 kHz   538
Pass    168.000000 MHz  0.120 V        4.38 kHz  5.00 kHz   540
Pass    170.000000 MHz  0.110 V        4.37 kHz  5.00 kHz   547
Pass    172.000000 MHz  0.120 V        4.38 kHz  5.00 kHz   553
Pass    174.000000 MHz  0.110 V        4.34 kHz  5.00 kHz   559

Front End Filter Align - Unsupported for Enhanced VHF models
============================================================
Result  Frequency  Old Softpot  New Softpot
------  ---------  -----------  -----------
Pass    N/A        N/A          N/A

Front End Gain and Attenuation Align
====================================
Result  Frequency     FE Gain SP  FE Gain (dB)  Attn 1 SP  Attn Gain (dB)  Int Attn SP  Int Gain (dB)
------  ------------  ----------  ------------  ---------  --------------  -----------  -------------
Pass    155.4560 MHz  11008       42.99 dB      2          0.01 dB         2863         11.18

Distortion Test - Unsupported for Enhanced SL Series models
===========================================================
Result  Frequency  Distortion  Max Limit
------  ---------  ----------  ---------
```

```
Pass    N/A        N/A         N/A

Sensitivity (SINAD) Test - Unsupported for Enhanced SL Series models
=====================================================================
Result  Frequency  12dB SINAD  Max Limit
------  ---------  ----------  ---------
Pass    N/A        N/A         N/A

FSK Error
==========
Result  Frequency     FSK Error  Max Limit
------  ------------  ---------  ---------
Pass    136.0350 MHz  1.098 %    5 %
Pass    142.5350 MHz  0.996 %    5 %
Pass    148.9350 MHz  0.991 %    5 %
Pass    155.4350 MHz  1.005 %    5 %
Pass    161.8350 MHz  1.026 %    5 %
Pass    167.3350 MHz  1.144 %    5 %
Pass    173.9850 MHz  1.019 %    5 %

Symbol Deviation
=================
Result  Frequency     Symbol Dev  Min Limit  Max Limit
------  ------------  ----------  ---------  ---------
Pass    136.0350 MHz  1901 Hz     1750 Hz    2138 Hz
Pass    142.5350 MHz  1905 Hz     1750 Hz    2138 Hz
Pass    148.9350 MHz  1899 Hz     1750 Hz    2138 Hz
Pass    155.4350 MHz  1895 Hz     1750 Hz    2138 Hz
Pass    161.8350 MHz  1899 Hz     1750 Hz    2138 Hz
Pass    167.3350 MHz  1894 Hz     1750 Hz    2138 Hz
Pass    173.9850 MHz  1900 Hz     1750 Hz    2138 Hz

Magnitude Error
===============
Result  Frequency     Mag Error  Max Limit
------  ------------  ---------  ---------
Pass    136.0350 MHz  0.252 %    1 %
Pass    142.5350 MHz  0.243 %    1 %
Pass    148.9350 MHz  0.257 %    1 %
Pass    155.4350 MHz  0.240 %    1 %
Pass    161.8350 MHz  0.262 %    1 %
Pass    167.3350 MHz  0.205 %    1 %
Pass    173.9850 MHz  0.200 %    1 %

Digital Sensitivity (TX BER) Test
=================================
Result  Frequency     BER     Max Limit
------  ------------  ------  ---------
Pass    155.4350 MHz  0.00 %  0.00 %

Digital Sensitivity (RX BER) Test
=================================
Result  Frequency     5% BER      Max Limit
------  ------------  ----------  ----------
Pass    173.9550 MHz  -127.2 dBm  -119.0 dBm

Internal Voice Modulation Test - Unsupported for Enhanced SL Series models
==========================================================================
Result  Frequency  Deviation  Min Limit  Max Limit
------  ---------  ---------  ---------  ---------
Pass    N/A        N/A        N/A        N/A

External Voice Modulation Test
==============================
Result  Frequency     Deviation  Min Limit  Max Limit
------  ------------  ---------  ---------  ---------
Pass    155.4350 MHz  4.3 kHz    4.0 kHz    5.0 kHz

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```

Figure A-1. Sample Test Result Report

APPENDIX B. Revision History

B-Supported Models, options	M. Mullins	M. Hammer	5/1/24	0438
A-from CG1372	M. Mullins	M. Humphries	7/24/17	0139
Rev. No/change	Requested By	Approved By	Date	ECO#