FREEDOM
Communication Technologies

R8000 Series
Communications System Analyzer

AUTOTUNE USER GUIDE

Motorola MOTOTRBO™ Portable
Motorola MOTOTRBO™ Mobile

Freedom Communication Technologies
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Kilgore, Texas 75662

CG-1372 Rev. C

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. Introduction

The Freedom Communication Technologies R8000 Series Communications System Analyzer AutoTune™ (hereafter “AutoTune”) is designed to provide an automated test and alignment solution for supported two-way radios.

2. Scope

This document is intended to provide information regarding the tests and alignments performed for supported radios by AutoTune. This document is restricted to radio-specific information.

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

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. Motorola MOTOTRBO™ Portable Radio Test Setup

In order to perform the 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.

4.1. 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.

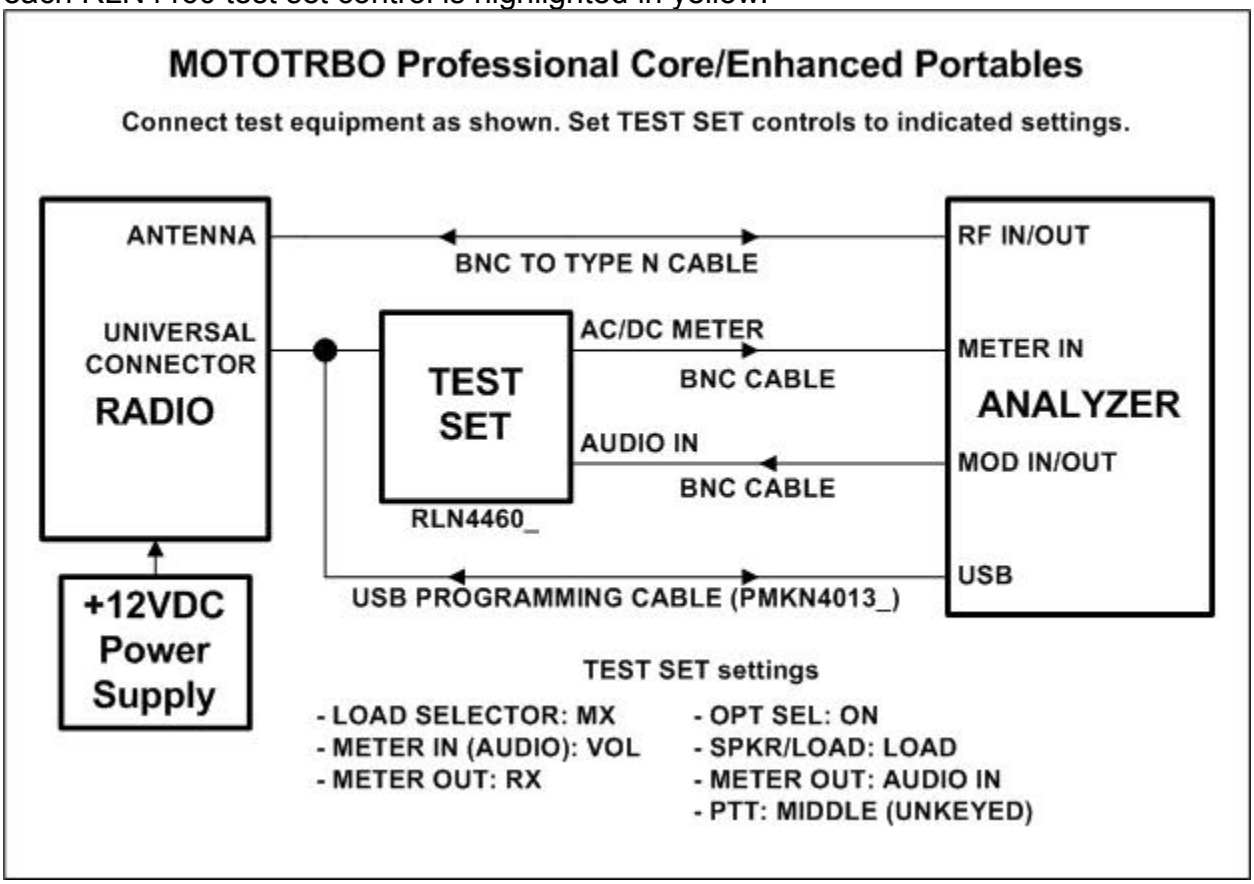

Figure 4-1. MOTOTRBO™ Portable Professional Core/Enhanced Test Setup Diagram

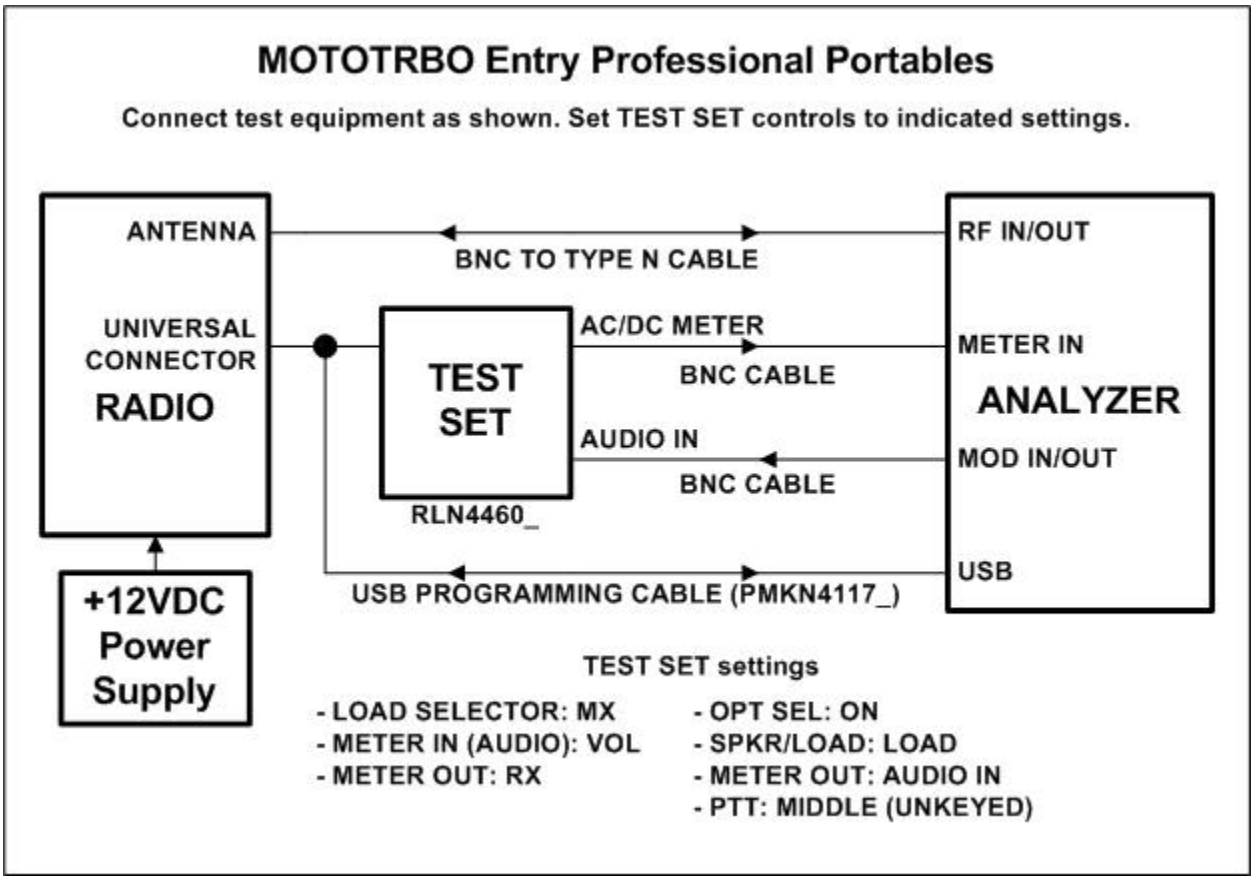

Figure 4-2. MOTOTRBO™ Portable Entry Professional Test Setup Diagram.

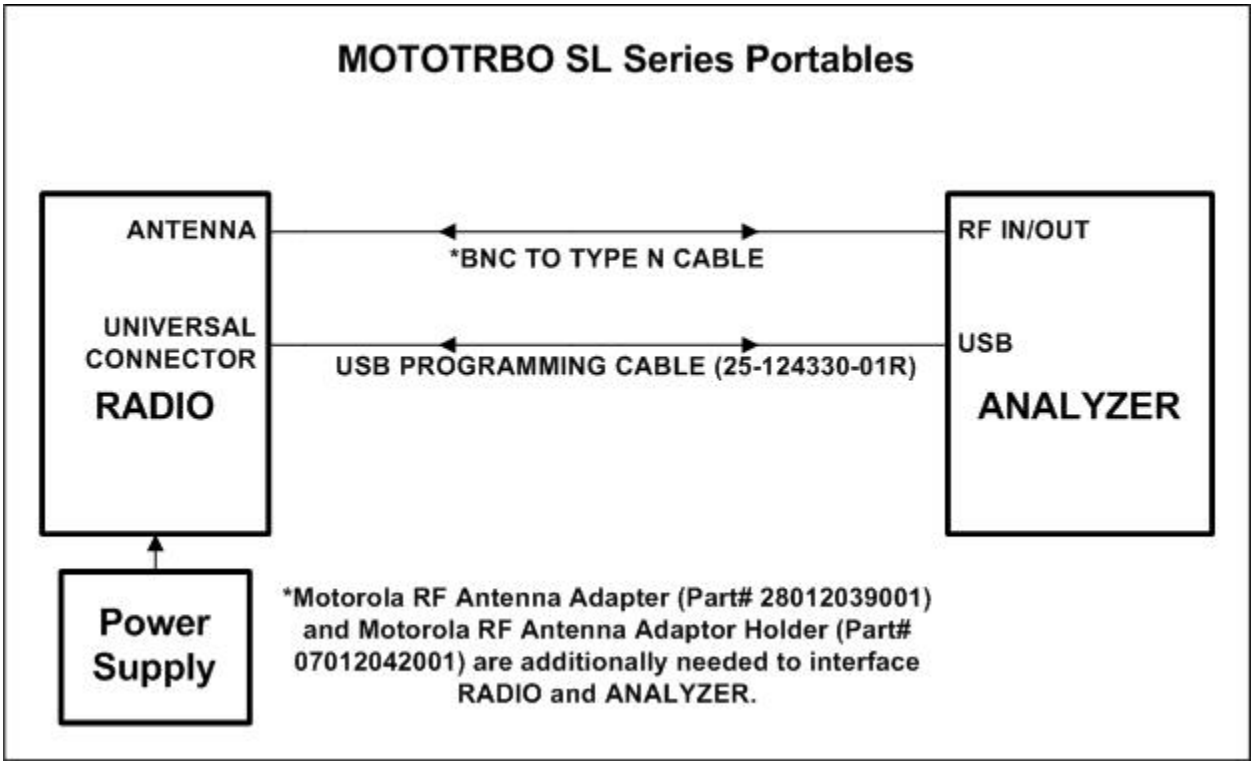

Figure 4-3. MOTOTRBO™ Portable SL Series Radio Test Setup Diagram.

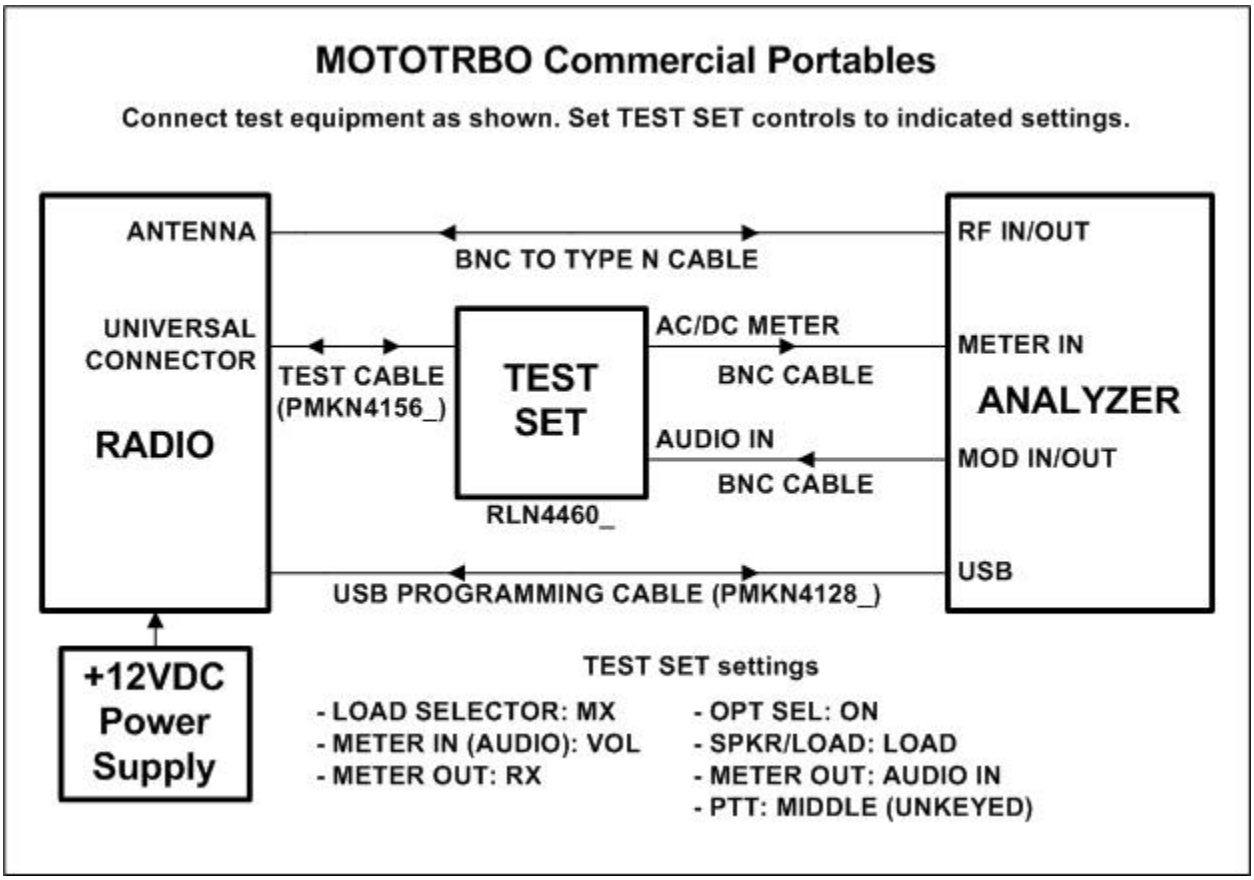

Figure 4-4. MOTOTRBO™ Portable Commercial Test Setup Diagram.

5. 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.

5.1. Reference Frequency

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

Table 5-1. Analyzer Configuration for Reference Frequency

5.1.1. 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 5-2. Reference Frequency alignment results

5.1.2. 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 5-3. Reference Frequency test results

5.2. TX Power Out

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

Table 5-4. Analyzer Configuration for TX Power Out

5.2.1. 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 5-5. 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 5-6. TX Power Out alignment results

5.2.2. Test

The radio is placed into Test Mode and commanded to transmit. Beginning at the first TX Test Frequency, the output level is measured at each TX Test Frequency, for 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 5-7. TX Power Out test results

5.3. Modulation Balance

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

Table 5-8. Analyzer Configuration for Modulation Balance test, alignment

5.3.1. 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 5-9. Modulation Balance alignment results

5.3.2. 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 5-10. Modulation Balance test results

5.4. 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 5-11. Analyzer Configuration for Front End Filter test, alignment

5.4.1. 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 5-12. Front End Filter alignment results

5.4.2. 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 5-13. Front End Filter test results

5.5. Front End Gain and Attenuation

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

Table 5-14. Analyzer Configuration for Front End Gain and Attenuation alignment

5.5.1. 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 5-15. Front End Gain and Attenuation alignment results

5.5.2. Test

No test is needed.

5.6. Distortion

This is a test only; there is no alignment.

RF Control	Port	Frequency
Generate	RF IN/OUT	Test Freq

Table 5-16. Analyzer Configuration for Distortion Test

5.6.1. Alignment

No alignment is needed.

5.6.2. 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 5-17. Distortion test results

5.7. 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 5-18. Analyzer Configuration for Sensitivity (SINAD) test

5.7.1. Alignment

No alignment is needed.

5.7.2. 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 5-19. Sensitivity (SINAD) test results

5.8. DMR Tx Tests

NOTE: This test requires an analyzer with DMR (R8-DMR) test mode capability.
The purpose of this procedure is to measure the radio transmitter performance at several test frequencies per Motorola radio service manual specifications. There are tests only; there are no alignments.

RF Control	Port	Frequency	Mon Sync Pattern	Test Pattern
Monitor	RF IN/OUT	Test Frequency	MS Sourced Voice	O.153

Table 5-20. Analyzer Configuration for DMR Tx Tests

5.8.1. Alignment

No alignment is needed.

5.8.2. Test

The analyzer is setup as specified in this section's Analyzer Configuration table. The radio is placed into Test Mode at the lowest Tx Test Frequency, ready to transmit a 4FSK-modulated signal to the analyzer. The radio is keyed and for each test frequency the following digital measurements are taken: FSK Error, Magnitude Error, and Symbol Deviation. These measurement results are compared against test limits and the final results written to the log file.

Name	Description
Result	Pass or Fail. FSK Error percentage less than or equal to Max Limit
Frequency	Test Frequency
FSK Error	Difference (%) between measured signal and ideal 4FSK signal
Max Limit	Maximum Limit (inclusive) for FSK Error to Pass

Table 5-21. DMR FSK Error test results

Name	Description
Result	Pass or Fail. Symbol Deviation within Min, Max Limits
Frequency	Test Frequency
Symbol Dev	Deviation (Hz) from transmitting the O.153 test pattern
Min Limit	Minimum Limit (inclusive) for Symbol Deviation to Pass
Max Limit	Maximum Limit (inclusive) for Symbol Deviation to Pass

Table 5-22. DMR Symbol Deviation test results

Name	Description
Result	Pass or Fail. FSK Error percentage less than or equal to Max Limit
Frequency	Test Frequency
Mag Error	Difference (%) between measured signal and ideal 4FSK signal
Max Limit	Maximum Limit (inclusive) for FSK Error to Pass

Table 5-23. DMR Magnitude Error test results

5.9. 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 5-24. Analyzer Configuration for Digital Sensitivity (RX BER) test

5.9.1. Alignment

No alignment is needed.

5.9.2. 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 5-25. Digital Sensitivity (RX BER) test results

5.10. 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 5-26. Analyzer Configuration for Digital Sensitivity (TX BER) test

5.10.1. Alignment

No alignment is needed.

5.10.2. 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 5-27. Digital Sensitivity (TX BER) test results

5.11. 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 5-28. Analyzer Configuration for Internal Voice Modulation test

5.11.1. Alignment

No alignment is needed.

5.11.2. 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 5-1). The user is also instructed to adjust the analyzer volume until about 4 kHz deviation is seen on the analyzer display (see Figure 5-2). 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 5-1. Place keyed radio next to analyzer speaker.

Figure 5-2. 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 5-29. Internal Voice Modulation test results

5.12. 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 5-30. Analyzer Configuration for External Voice Modulation test

5.12.1. Alignment

No alignment is needed.

5.12.2. 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 5-31. External Voice Modulation test results

6. 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.

6.1. 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.

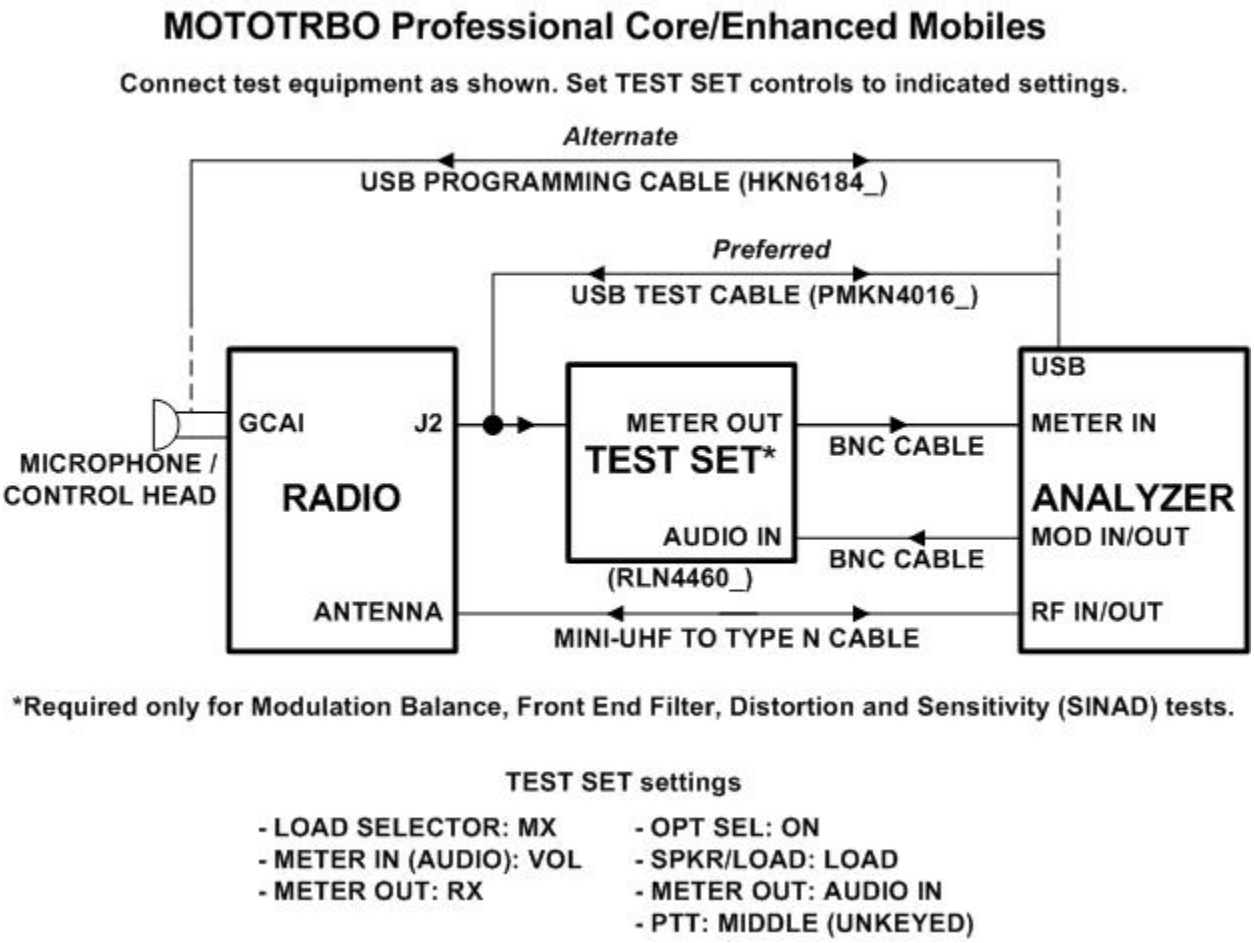

Figure 6-1. MOTOTRBO™ Mobile Professional Core/Enhanced Test Setup Diagram.

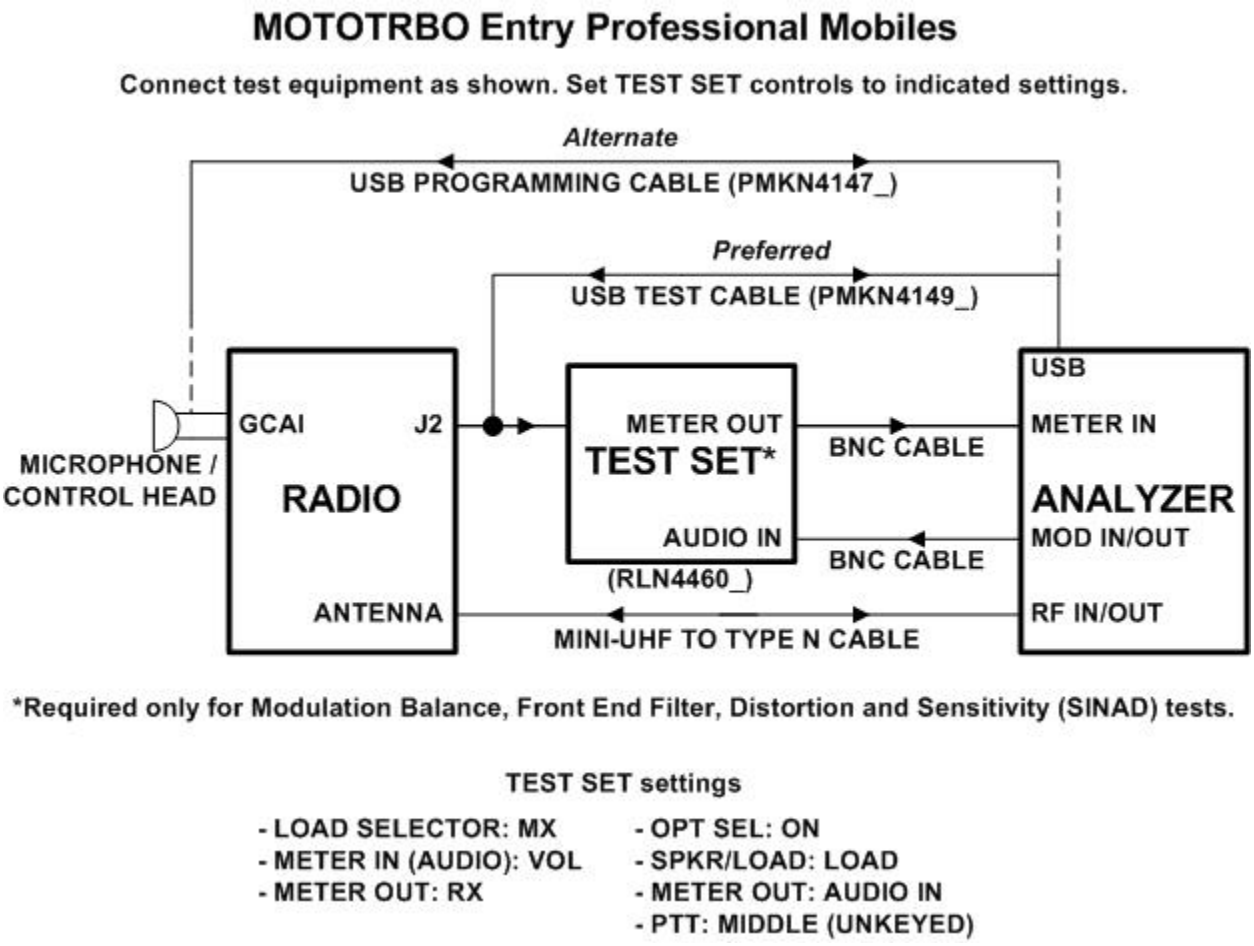

Figure 6-2. MOTOTRBO™ Mobile Entry Professional Test Setup Diagram.

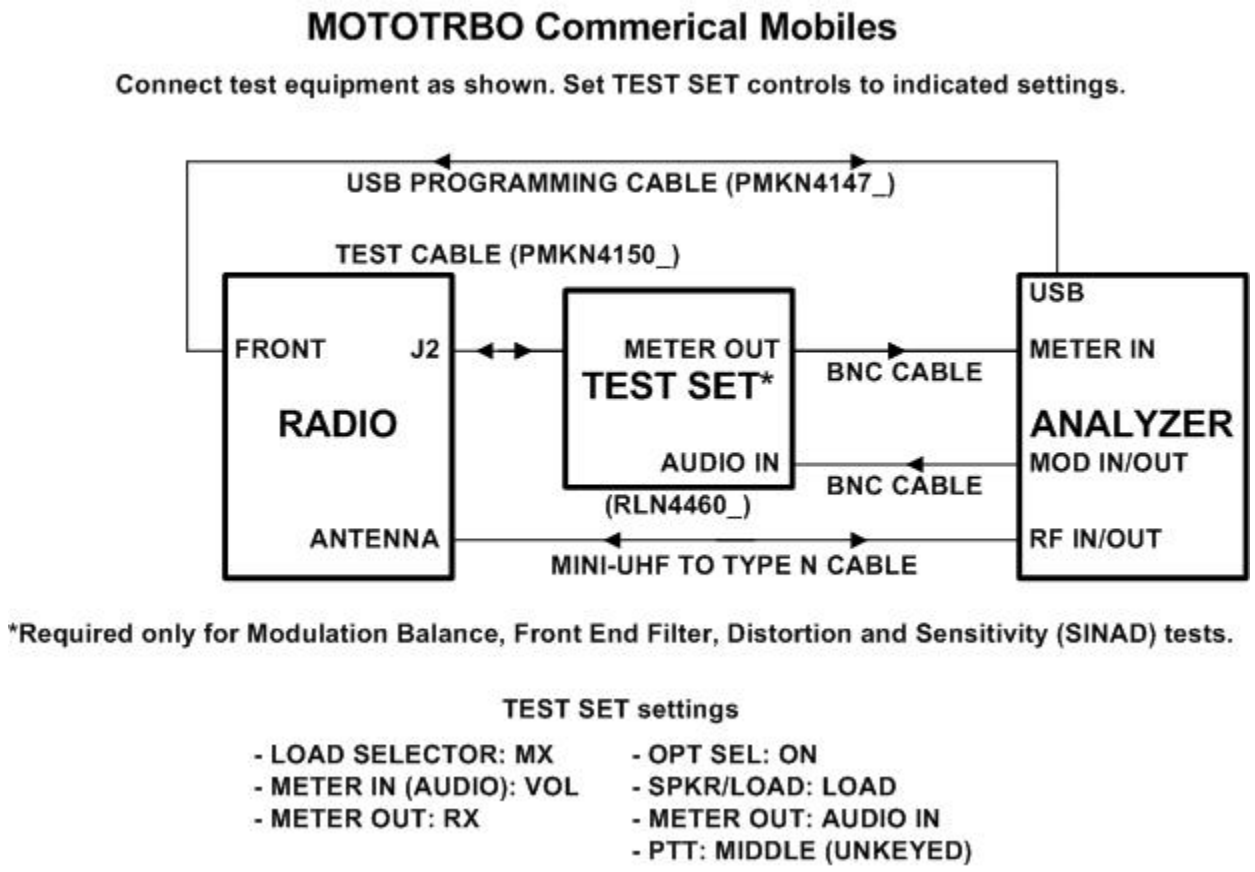

Figure 6-3. MOTOTRBO™ Mobile Commercial Test Setup Diagram.

7. 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.

7.1. Reference Frequency

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

Table 7-1. Analyzer Configuration for Reference Frequency

7.1.1. 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 7-2. Reference Frequency alignment results

7.1.2. 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 7-3. Reference Frequency test results

7.2. TX Power Out

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

Table 7-4. Analyzer Configuration for TX Power Out

7.2.1. 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 7-5 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 7-6. 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 7-7. TX Power Out alignment results

7.2.2. 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 7-8. TX Power Out test results

7.3. Deviation Balance

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

Table 7-9. Analyzer Configuration for Deviation Balance test, alignment

7.3.1. 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 7-10. Deviation Balance alignment results

7.3.2. 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 7-11. Deviation Balance test results

7.4. 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 7-12. Analyzer Configuration for Front End Filter test, alignment

7.4.1. 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 7-13. Front End Filter alignment results

7.4.2. 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 7-14. Front End Filter test results

7.5. Front End Gain and Attenuation

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

Table 7-15. Analyzer Configuration for Front End Gain and Attenuation alignment

7.5.1. 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 7-16. Front End Gain and Attenuation alignment results

7.5.2. Test

No test is needed.

7.6. Distortion

This is a test only; there is no alignment.

RF Control	Port	Frequency
Generate	RF IN/OUT	Test Freq

Table 7-17. Analyzer Configuration for Distortion Test

7.6.1. Alignment

No alignment is needed.

7.6.2. 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 7-18. Distortion test results

7.7. 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 7-19. Analyzer Configuration for Sensitivity (SINAD) test

7.7.1. Alignment

No alignment is needed.

7.7.2. 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 7-20. Sensitivity (SINAD) test results

7.8. DMR Tx Tests

NOTE: This test requires an analyzer with DMR (R8-DMR) test mode capability.
The purpose of this procedure is to measure the radio transmitter performance at several test frequencies per Motorola radio service manual specifications. There are tests only; there are no alignments.

RF Control	Port	Frequency	Mon Sync Pattern	Test Pattern
Monitor	RF IN/OUT	Test Frequency	MS Sourced Voice	O.153

Table 7-21. Analyzer Configuration for DMR Tx Tests

7.8.1. Alignment

No alignment is needed.

7.8.2. Test

The analyzer is setup as specified in this section's Analyzer Configuration table. The radio is placed into Test Mode at the lowest Tx Test Frequency, ready to transmit a 4FSK-modulated signal to the analyzer. The radio is keyed and for each test frequency the following digital measurements are taken: FSK Error, Magnitude Error, and Symbol Deviation. These measurement results are compared against test limits and the final results written to the log file.

Name	Description
Result	Pass or Fail. FSK Error percentage less than or equal to Max Limit
Frequency	Test Frequency
FSK Error	Difference (%) between measured signal and ideal 4FSK signal
Max Limit	Maximum Limit (inclusive) for FSK Error to Pass

Table 7-22. DMR FSK Error test results

Name	Description
Result	Pass or Fail. Symbol Deviation within Min, Max Limits
Frequency	Test Frequency
Symbol Dev	Deviation (Hz) from transmitting the O.153 test pattern
Min Limit	Minimum Limit (inclusive) for Symbol Deviation to Pass
Max Limit	Maximum Limit (inclusive) for Symbol Deviation to Pass

Table 7-23. DMR Symbol Deviation test results

Name	Description
Result	Pass or Fail. FSK Error percentage less than or equal to Max Limit
Frequency	Test Frequency
Mag Error	Difference (%) between measured signal and ideal 4FSK signal
Max Limit	Maximum Limit (inclusive) for FSK Error to Pass

Table 7-24. DMR Magnitude Error test results

7.9. 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 7-25. Analyzer Configuration for Digital Sensitivity (RX BER) test

7.9.1. Alignment

No alignment is needed.

7.9.2. 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 7-26. Digital Sensitivity (RX BER) test results

7.10. 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 7-27. Analyzer Configuration for Digital Sensitivity (TX BER) test

7.10.1. Alignment

No alignment is needed.

7.10.2. 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 7-28. Digital Sensitivity (TX BER) test results

7.11. 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 7-29. Analyzer Configuration for Internal Voice Modulation test

7.11.1. Alignment

No alignment is needed.

7.11.2. 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 7-1). The user is also instructed to adjust the analyzer volume until about 4 kHz deviation is seen on the analyzer display (see Figure 7-2). 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 7-1. Place keyed radio next to analyzer speaker.

Figure 7-2. 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 7-30. Internal Voice Modulation test results

7.12. 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 7-31. Analyzer Configuration for External Voice Modulation test

7.12.1. Alignment

No alignment is needed.

7.12.2. 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 7-32. External Voice Modulation test results

8. 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 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.
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.
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 8-1. AutoTune Troubleshooting Chart

9. Support Information

9.1. Technical Support

Telephone/Fax: 844.903.7333
Email: service@freedomcte.com
Web: freedomcte.com/service-support/

9.2. Sales Support

Telephone/Fax: 844.903.7333
Email: sales@freedomcte.com
Web: freedomcte.com/sales/

10. References

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

MOTOTRBO™PORTABLE BASIC SERVICE MANUAL (68009271001-C)

MOTOTRBO™ Mobile Basic Service Manual (68009272001-A)

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 (CG-1365) for modification instructions.

The following tables list the default test limits for each MOTOTRBO radio model supported by AutoTune.

Section	Test Name	Limit	Default Value
5.1	Reference Frequency	Reference Frequency Align	Min= -40 Hz Max= 40 Hz
		Reference Frequency Test GPS	Min= -0.5 ppm Max= 0.5 ppm
		Reference Frequency Test Core VHF Non-GPS	Min= -1.5 ppm Max= 1.5 ppm
		Reference Frequency Test Core UHF1 Non-GPS	Min= -1.5 ppm Max= 1.5 ppm
		Reference Frequency Test Core UHF2 Non-GPS	Min= -1.5 ppm Max= 1.5 ppm
		Reference Frequency Test Core 800-900 Non-GPS	Min= -0.5 ppm Max= 0.5 ppm
		Reference Frequency Test Enhanced VHF Non-GPS	Min= -1.5 ppm Max= 1.5 ppm
		Reference Frequency Test Enhanced UHF1 Non-GPS	Min= -0.5 ppm Max= 0.5 ppm
		Reference Frequency Test Enhanced UHF WB Non-GPS	Min= -1.5 ppm Max= 1.5 ppm
		Reference Frequency Test Enhanced UHF WB Entry Professional Non-GPS	Min= -0.5 ppm Max= 0.5 ppm
		Reference Frequency Test Enhanced UHF2 Non-GPS	Min= -0.5 ppm Max= 0.5 ppm
		Reference Frequency Test Enhanced 800 Non-GPS	Min= -0.5 ppm Max= 0.5 ppm
		Reference Frequency Test Enhanced 900 Non-GPS	Min= -0.5 ppm Max= 0.5 ppm
		Reference Frequency Test Enhanced 800-900 Non-GPS	Min= -0.5 ppm Max= 0.5 ppm
5.2	TX Power Out (High Power)	TX Power VHF	Min= 5.0 W Max= 6.0 W
		TX Power VHF Enhanced	Min= 5.2 W Max= 5.4 W
		TX Power VHF CQST	Min= 2.9 W Max= 3.1 W
		TX Power UHF1	Min= 4.0 W Max= 4.8 W
		TX Power UHF1 Enhanced	Min= 4.2 W Max= 4.4 W
		TX Power UHF1 CQST	Min= 2.9 W Max= 3.1 W
		TX Power UHF1 SL	Min= 2.0 W Max= 2.2 W
		TX Power UHF2	Min= 4.0 W Max= 4.8 W
		TX Power UHF2 SL	Min= 4.0 W Max= 4.8 W
		TX Power 350 MHz	Min= 4.0 W Max= 4.8 W
		TX Power 350 MHz Enhanced	Min= 4.2 W Max= 4.4 W
		TX Power 800-900 MHz	Min= 2.5 W Max= 2.8 W

		TX Power 800-900 MHz CSA	Min= 2.3 W Max= 2.5 W
		TX Power 800 SL	Min= 2.0 W Max= 2.2 W
		TX Power 900 SL	Min= 2.0 W Max= 2.2 W
5.2	TX Power Out (Low Power)	TX Power VHF	Min= 1.0 W Max= 1.6 W
		TX Power VHF Enhanced	Min= 1.1 W Max= 1.3 W
		TX Power VHF ATEX	Min= 1.05 W Max= 1.25 W
		TX Power UHF1	Min= 1.1 W Max= 1.3 W
		TX Power UHF1 Enhanced	Min= 1.1 W Max= 1.3 W
		TX Power UHF1 ATEX	Min= 1.05 W Max= 1.25 W
		TX Power UHF2	Min= 1.0 W Max= 1.6 W
		TX Power UHF2 SL	Min= 1.1 W Max= 1.3 W
		TX Power 350	Min= 1.0 W Max= 1.6 W
		TX Power 350 Enhanced	Min= 1.1 W Max= 1.3 W
		TX Power 800-900	Min= 1.0 W Max= 1.6 W
		TX Power 800-900 Enhanced	Min= 1.1 W Max= 1.3 W
		TX Power 800-900 CSA	Min= 1.0 W Max= 1.2 W
		TX Power 800 SL	Min= 1.0 W Max= 1.2 W
		TX Power 900 SL	Min= 1.0 W Max= 1.2 W
5.3	Modulation Balance	Modulation Balance Align	Max= 0.05 dB
		Modulation Balance Test	Max= 5 kHz
		Modulation Balance Enhanced	Max=2.4 kHz
5.4	Front End Filter Test	Front End Filter SINAD	Min=13.5 dB
		Front End Filter Enhanced SINAD	Min=12.0 dB
5.6	Distortion	Distortion	Max= 3 %
5.7	Sensitivity (SINAD)	All Limits	Max= -116 dBm
5.8	DMR Tx Tests	DMR FSK Error	Max=5%
		DMR Symbol Deviation	Max=1750 Hz
			Max=2138 Hz
		DMR Magnitude Error	Max=1%
5.9	Digital Sensitivity (RX BER)	All Limits (Core)	Max= -117.5 dBm
		All Limits (Enhanced)	Max= -119 dBm
5.10	Digital Sensitivity (TX BER)	TX BER	Max= 0 %
5.11	Internal Voice Modulation	Internal Voice Modulation	Min= 4.0 kHz Max= 5.0 kHz

5.12	External Voice Modulation	External Voice Modulation	Min= 4.0 kHz Max= 5.0 kHz

Table A-1. Default Motorola MOTOTRBO™ Portable Limits

Section	Test Name	Limit	Default Value
7.1	Reference Frequency	Reference Frequency Align	Min= -40 Hz Max= 40 Hz
		Reference Frequency Test Core VHF GPS	Min= -0.5 ppm Max= 0.5 ppm
		Reference Frequency Test Core UHF1 GPS	Min= -0.5 ppm Max= 0.5 ppm
		Reference Frequency Test Core UHF2 GPS	Min= -0.5 ppm Max= 0.5 ppm
		Reference Frequency Test Core 800-900 GPS	Min= -0.1 ppm Max= 0.1 ppm
		Reference Frequency Test Enhanced VHF GPS	Min= -0.5 ppm Max= 0.5 ppm
		Reference Frequency Test Enhanced UHF1 GPS	Min= -0.5 ppm Max= 0.5 ppm
		Reference Frequency Test Enhanced UHF2 GPS	Min= -0.5 ppm Max= 0.5 ppm
		Reference Frequency Test Core VHF Non-GPS	Min= -1.5 ppm Max= 1.5 ppm
		Reference Frequency Test Core UHF1 Non-GPS	Min= -1.5 ppm Max= 1.5 ppm
		Reference Frequency Test Core UHF2 Non-GPS	Min= -1.5 ppm Max= 1.5 ppm
		Reference Frequency Test Core 800-900 Non-GPS	Min= -0.1 ppm Max= 0.1 ppm
		Reference Frequency Test Enhanced VHF Non-GPS	Min= -0.5 ppm Max= 0.5 ppm
		Reference Frequency Test Enhanced UHF1 Non-GPS	Min= -0.5 ppm Max= 0.5 ppm
		Reference Frequency Test Enhanced UHF2 Non-GPS	Min= -0.5 ppm Max= 0.5 ppm
7.2	TX Power Out High Power Model (High Power)	TX Power VHF Core	Min= 44.0 W Max= 52.0 W
		TX Power VHF Enhanced	Min= 44.0 W Max= 52.0 W
		TX Power UHF1 Core	Min= 40.0 W Max= 48.0 W
		TX Power 350 MHz	Min= 40.0 W Max= 48.0 W
7.2	TX Power Out High Power Model (Low Power)	TX Power VHF Core	Min= 26.0 W Max= 29.0 W
		TX Power VHF Enhanced	Min= 25.0 W Max= 30.0 W
		TX Power UHF1 Core	Min= 26.0 W Max= 29.0 W
		TX Power UHF1 Enhanced	Min= 25.0 W Max= 30.0 W
		TX Power 350 MHz	Min= 25.0 W Max= 30.0 W
7.2	TX Power Out Low Power Model (High Power)	TX Power VHF Core	Min= 26.0 W Max= 29.0 W
		TX Power VHF Enhanced	Min= 25.0 W Max= 30.0 W
		TX Power UHF1 Core	Min= 26.0 W

			Max= 29.0 W
		TX Power UHF1 Enhanced	Min= 25.0 W Max= 30.0 W
		TX Power UHF2 (450-512 MHz)	Min= 40.0 W Max= 48.0 W
		TX Power UHF2 (512-527 MHz)	Min= 26.0 W Max= 29.0 W
		TX Power 350 MHz	Min= 26.0 W Max= 29.0 W
		TX Power 800 MHz	Min= 35.0 W Max= 42.0 W
		TX Power 900 MHz	Min= 30.0 W Max= 36.0 W
7.2	TX Power Out Low Power Model (Low Power)	TX Power VHF Core	Min= 1.0 W Max= 1.3 W
		TX Power VHF Enhanced	Min= 1.0 W Max= 1.3 W
		TX Power UHF1 Core	Min= 1.0 W Max= 1.3 W
		TX Power UHF1 Enhanced	Min= 1.0 W Max= 1.3 W
		TX Power UHF2 (450-512 MHz)	Min= 1.0 W Max= 1.3 W
		TX Power UHF2 (512-527 MHz)	Min= 1.0 W Max= 1.3 W
		TX Power 350 MHz	Min= 1.0 W Max= 1.3 W
		TX Power 800 MHz	Min= 10.0 W Max= 12.0 W
		TX Power 900 MHz	Min= 10.0 W Max= 12.0 W
7.3	Modulation Balance Align	Modulation Balance	Max= 0.05 dB
7.3	Modulation Balance Test	Modulation Balance	Max= 5 kHz
7.4	Front End Filter Test	Front End Filter SINAD	Min=15.0 dB
7.6	Distortion	Distortion	Max= 5 %
7.7	Sensitivity (SINAD)	All Limits	Max= -117.5 dBm
7.8	DMR Tx Tests	DMR FSK Error	Max=5%
		DMR Symbol Deviation	Max=1750 Hz
			Max=2138 Hz
		DMR Magnitude Error	Max=1%
7.9	Digital Sensitivity (RX BER)	All Limits	Max= -117.5 dBm
7.10	Digital Sensitivity (TX BER)	TX BER	Max= 0 %
7.11	Internal Voice Modulation	Internal Voice Modulation	Min= 4.0 kHz Max= 5.0 kHz
7.12	External Voice Modulation	External Voice Modulation	Min= 4.0 kHz Max= 5.0 kHz

Table A-2. Default Motorola MOTOTRBO™ Mobile Limits

APPENDIX B. Sample Test Result Report

```
================================================================================
                                Test Result Report
================================================================================
Model #:  H55TDT9JA1AN:XPR 6100          Date/Time:     2/15/2013 3:13 PM
Serial #: 778TNG5543                     Operator ID:   A. Technician

Comments:

Reference Frequency Align
=========================
Result    Frequency      Freq Error     Min Limit      Max Limit      Old Softpot    New Softpot
------    ---------      ----------     ---------      ---------      -----------    -----------
Pass      511.8250 MHz   13 Hz          -416 Hz        416 Hz         110            122

TX Power Out Align High
=======================
Result    Frequency      Power Out      Min Limit      Max Limit      Old Softpot    New Softpot
------    ---------      ---------      ---------      ---------      -----------    -----------
Pass      450.1750 MHz   4.3 W          4.0 W          4.8 W          309            309
Pass      464.1750 MHz   4.4 W          4.0 W          4.8 W          310            310
Pass      475.1750 MHz   4.3 W          4.0 W          4.8 W          298            298
Pass      486.6250 MHz   4.4 W          4.0 W          4.8 W          253            285
Pass      496.7750 MHz   4.8 W          4.0 W          4.8 W          304            304
Pass      504.7750 MHz   4.6 W          4.0 W          4.8 W          317            317
Pass      511.8250 MHz   4.3 W          4.0 W          4.8 W          322            322

TX Power Out Align Low
======================
Result    Frequency      Power Out      Min Limit      Max Limit      Old Softpot    New Softpot
------    ---------      ---------      ---------      ---------      -----------    -----------
Pass      450.1750 MHz   1.3 W          1.0 W          1.6 W          226            205
Pass      464.1750 MHz   1.2 W          1.0 W          1.6 W          197            197
Pass      475.1750 MHz   1.3 W          1.0 W          1.6 W          212            196
Pass      486.6250 MHz   1.5 W          1.0 W          1.6 W          159            191
Pass      496.7750 MHz   1.4 W          1.0 W          1.6 W          177            177
Pass      504.7750 MHz   1.3 W          1.0 W          1.6 W          176            165
Pass      511.8250 MHz   1.4 W          1.0 W          1.6 W          169            169

Modulation Balance Align
========================
Result    Frequency      Dev Ratio      Max Limit      Old Softpot    New Softpot
------    ---------      ---------      ---------      -----------    -----------
Fail      450.0000 MHz    0.08 dB       +/-0.05 dB     125            125
Pass      474.0000 MHz   -0.04 dB       +/-0.05 dB     205            205
Pass      490.0000 MHz   -0.02 dB       +/-0.05 dB     200            200
Pass      492.0000 MHz    0.00 dB       +/-0.05 dB     199            199
Pass      498.0000 MHz   -0.02 dB       +/-0.05 dB     198            198
Pass      503.0000 MHz   -0.03 dB       +/-0.05 dB     198            198
Pass      510.0000 MHz   -0.03 dB       +/-0.05 dB     198            198
Pass      512.0000 MHz    0.02 dB       +/-0.05 dB     198            198

Modulation Balance Test
=======================
Result    Frequency      20dB Aud Lvl   Deviation      Max Limit      Softpot
------    ---------      ------------   ---------      ---------      -------
Fail      450.0000 MHz   0.100 V         5.07 kHz      5.00 kHz       125
Pass      474.0000 MHz   0.130 V         4.22 kHz      5.00 kHz       205
Pass      490.0000 MHz   0.120 V         4.21 kHz      5.00 kHz       200
Pass      492.0000 MHz   0.120 V         4.21 kHz      5.00 kHz       199
Pass      498.0000 MHz   0.130 V         4.20 kHz      5.00 kHz       198
Pass      503.0000 MHz   0.130 V         4.19 kHz      5.00 kHz       198
Pass      510.0000 MHz   0.120 V         4.25 kHz      5.00 kHz       198
Pass      512.0000 MHz   0.120 V         4.25 kHz      5.00 kHz       198

Front End Filter Align
======================
Result    Frequency      Old Softpot    New Softpot
------    ---------      -----------    -----------
Pass      450.0750 MHz   263            13
Pass      464.0750 MHz   346            96
Pass      475.0750 MHz   455            205
Pass      486.5250 MHz   571            321
Pass      496.8750 MHz   685            435
Pass      504.8750 MHz   773            523
Pass      511.8750 MHz   842            592

Front End Filter Test @ -116dBm
===============================
Result    Frequency      SINAD          Min Limit
------    ---------      -----          ---------
Pass      450.0750 MHz   20.3 dB        13.5 dB
Pass      464.0750 MHz   16.8 dB        13.5 dB
Pass      475.0750 MHz   15.1 dB        13.5 dB
Fail      486.5250 MHz   12.9 dB        13.5 dB
Fail      496.8750 MHz   11.0 dB        13.5 dB
Fail      504.8750 MHz   12.0 dB        13.5 dB
Fail      511.8750 MHz   10.6 dB        13.5 dB

Front End Gain and Attenuation Align
====================================
Result    Frequency      FE Gain SP     FE Gain (dB)   Attn SP        Attn Gain (dB)
------    ---------      ----------     ------------   -------        --------------
Pass      486.5250 MHz   2048           7.69 dB        5477           21.39 dB

Distortion Test
===============
Result    Frequency      Distortion     Max Limit
------    ---------      ----------     ---------
Pass      486.5250 MHz   1.1 %          3.0 %

Sensitivity (SINAD) Test
========================
Result    Frequency      12dB SINAD     Max Limit
------    ---------      ----------     ---------
```

```
Pass      486.5250 MHz   -116.6 dBm     -116.0 dBm

Digital Sensitivity (RX BER) Test
=================================
Result    Frequency      5% BER         Max Limit
------    ---------      ------         ---------
Fail      486.5250 MHz   No Sync        -119.0

Internal Voice Modulation Test
==============================
Result    Frequency      Deviation      Min Limit      Max Limit
------    ---------      ---------      ---------      ---------
Fail      486.6250 MHz   19.333 kHz     4.100 kHz      5.000 kHz

External Voice Modulation Test
==============================
Result    Frequency      Deviation      Min Limit      Max Limit
------    ---------      ---------      ---------      ---------
Pass      486.6250 MHz   4.217 kHz      4.100 kHz      5.000 kHz

Tests performed by AutoTune - © 2013 Freedom Communication Technologies.  All Rights Reserved.
```

Figure B-1. Sample Test Result Report

APPENDIX C. Revision History

1.18 Updates – Rev B	L. Shirey	1/9/15	M. Mullins	1/9/15	14444
Original Release – Rev A	L. Shirey	3/28/13	M. Mullins	3/28/13	13249
Rev. No/change	Revised By	Date	Approved By	Date	ECO#