FREEDOM
Communication Technologies

# R8000 SERIES
# COMMUNICATIONS SYSTEM ANALYZER

# AUTOTUNE USER GUIDE

## Motorola MOTOTRBO™ Portable
## Motorola MOTOTRBO™ Mobile

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FCT-1372 Rev. A

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# 1. Introduction

The Freedom Communication Technologies ("FCT") 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. Requirements

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

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

**Table 4-1. Minimum required firmware versions**

[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.

# 5. 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.

## 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.

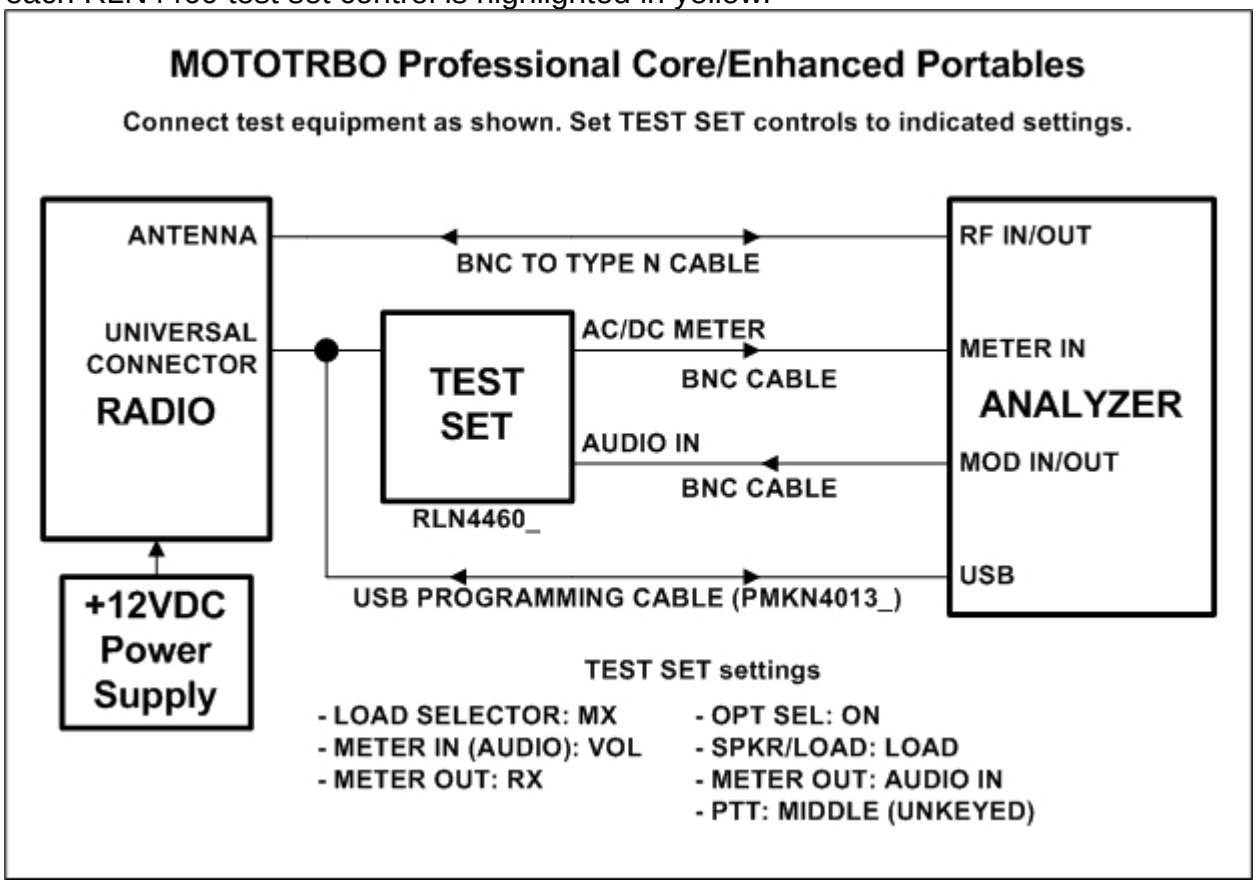


**Figure 5-1. MOTOTRBO™ Portable Professional Core/Enhanced Test Setup Diagram**

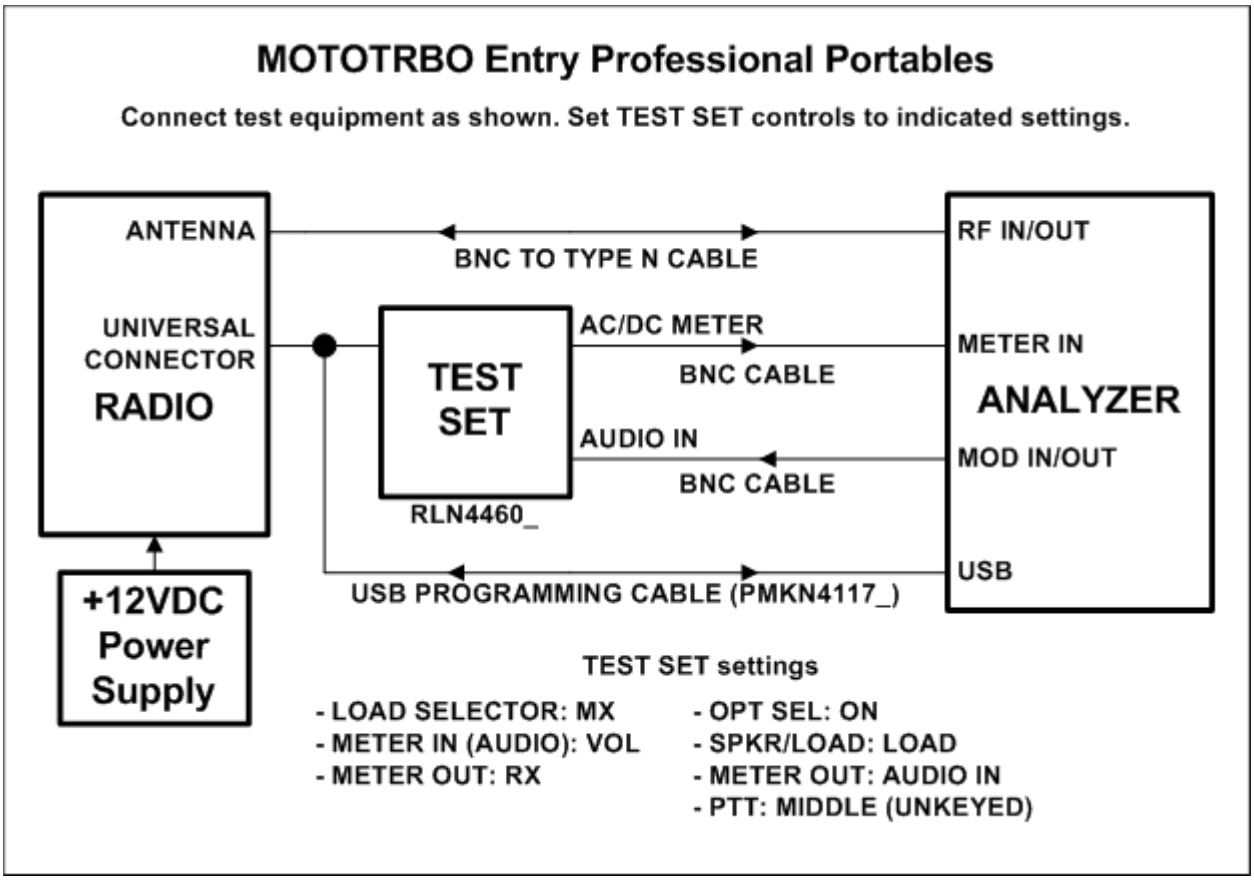


**Figure 5-2. MOTOTRBO™ Portable Entry Professional Test Setup Diagram.**

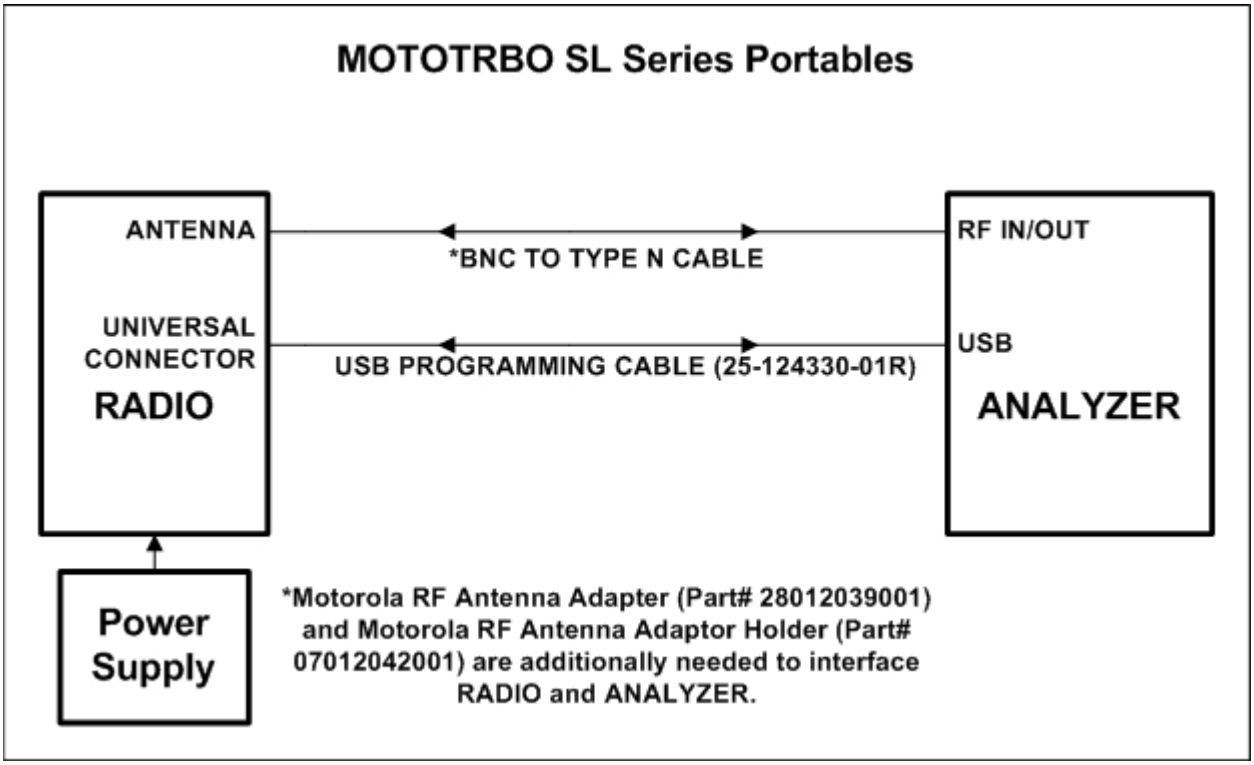


**Figure 5-3. MOTOTRBO™ Portable SL Series Radio Test Setup Diagram.**

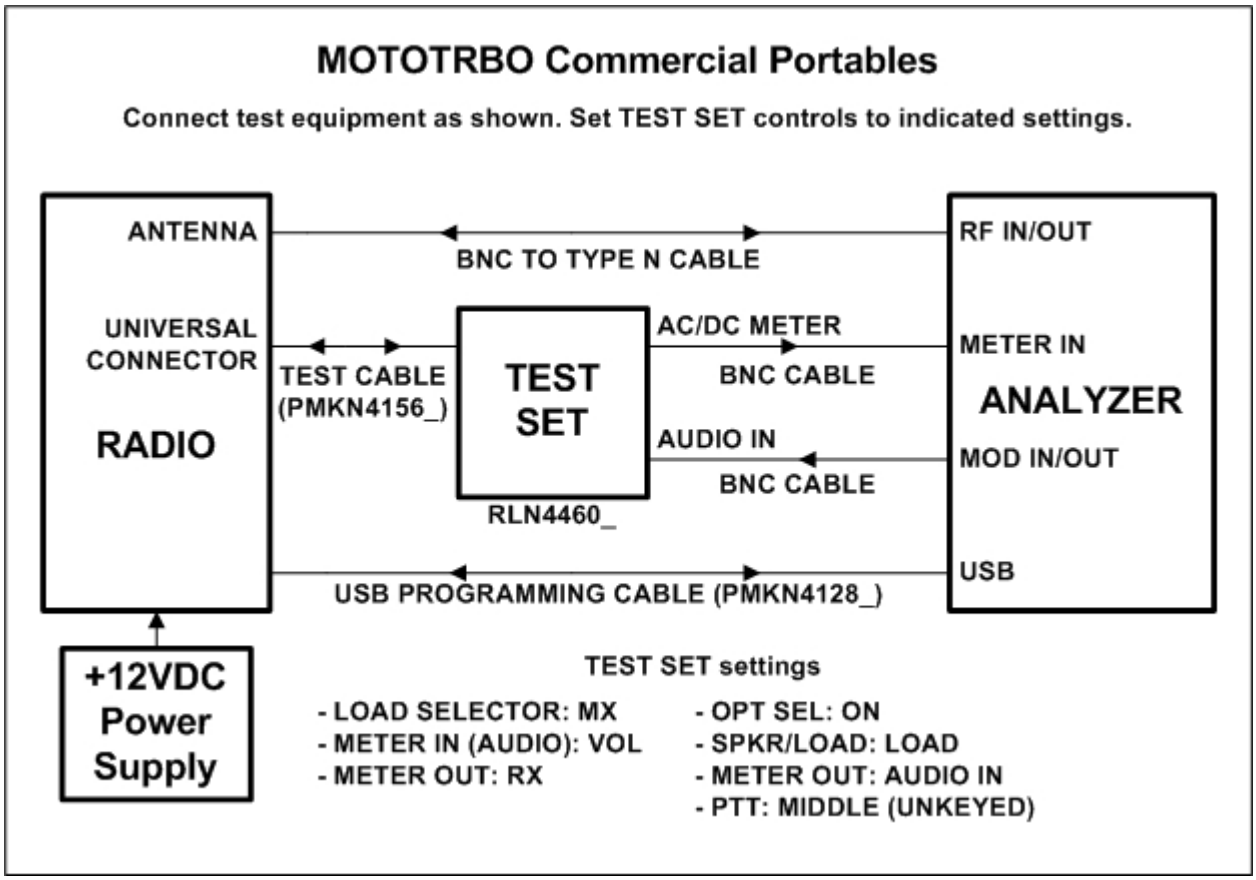


**Figure 5-4. MOTOTRBO™ Portable Commercial Test Setup Diagram.**

# 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.

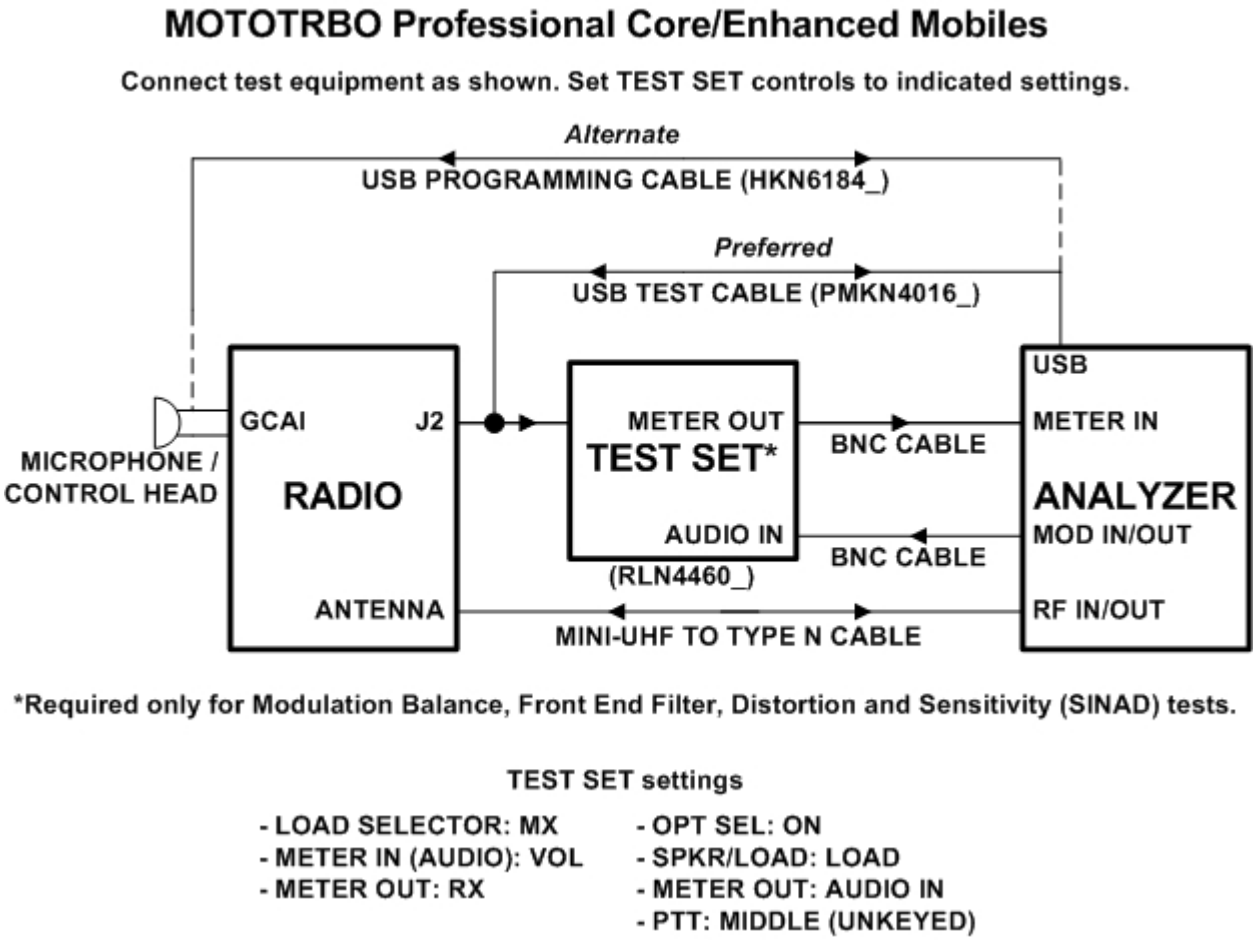


**Figure 7-1. MOTOTRBO™ Mobile Professional Core/Enhanced Test Setup Diagram.**

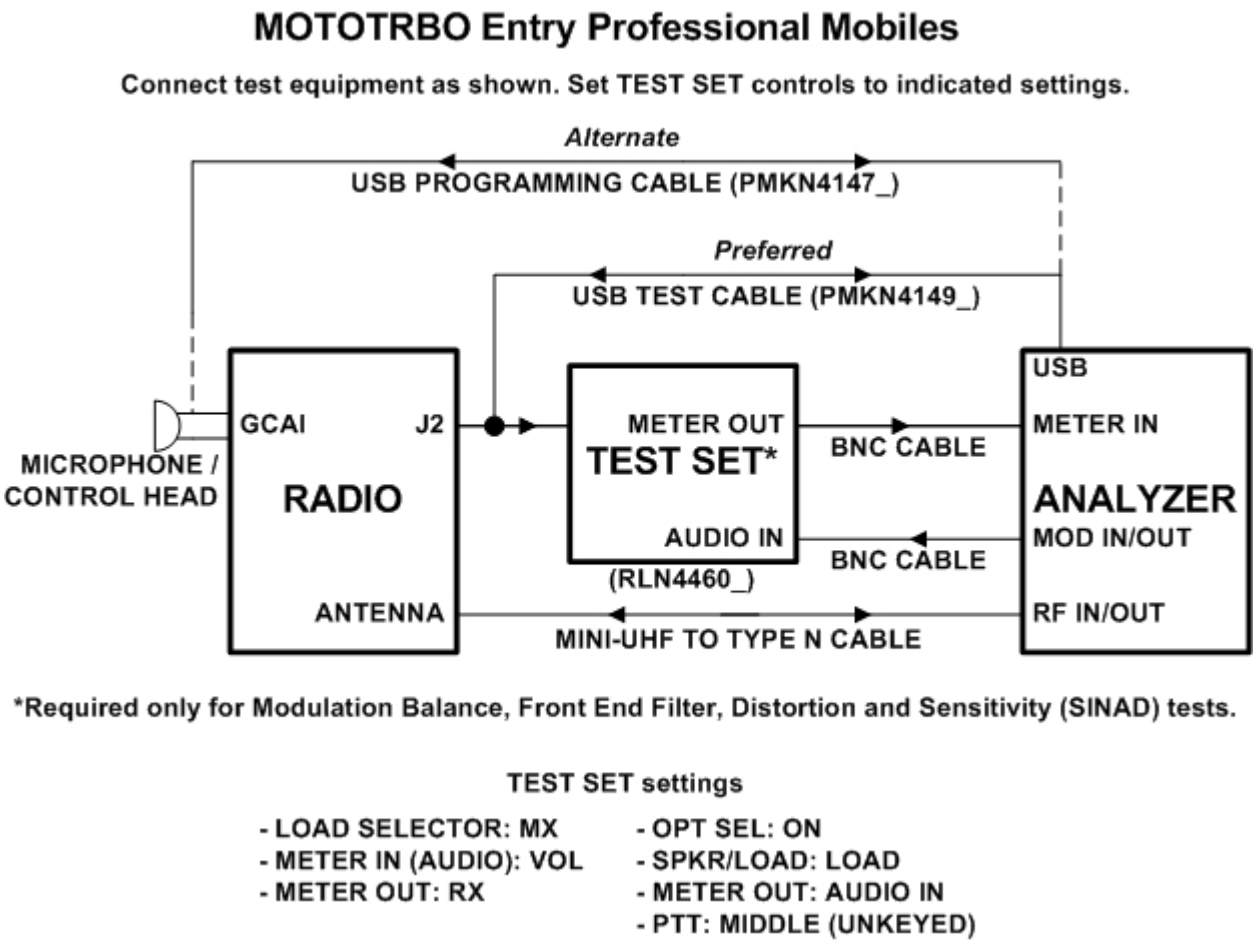


**Figure 7-2. MOTOTRBO™ Mobile Entry Professional Test Setup Diagram.**

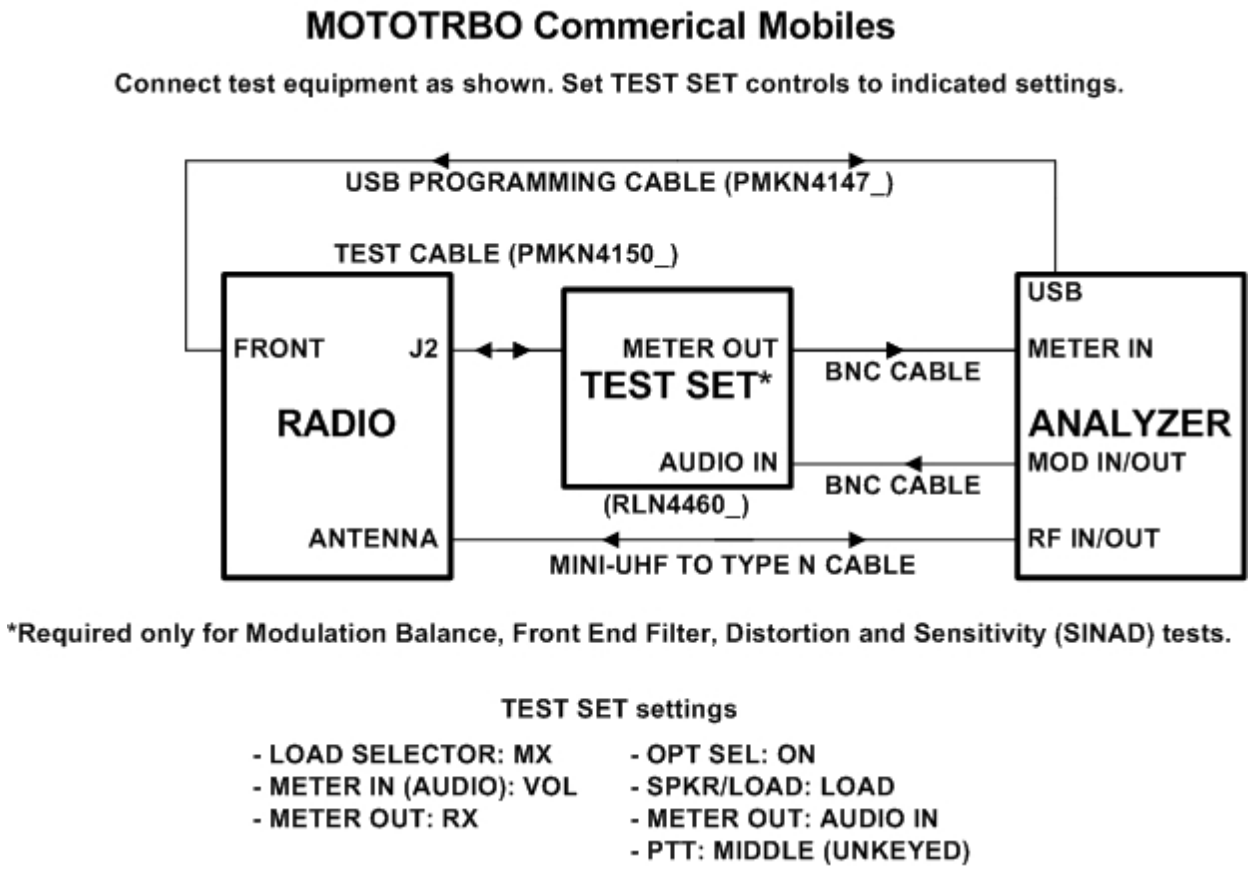


**Figure 7-3. MOTOTRBO™ Mobile Commercial Test Setup Diagram.**

# 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

Telephone: 480.441.0664
Fax: 480.441.4535
Email: CTE@gdsatcom.com

## 10.2. Sales Support

Telephone: 480.441.0664
Fax: 480.441.6915
Mobile: 602.721.5889
Email: CTE@gdsatcom.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. 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 |
|---|---|---|---|
| 6.1 | Reference Frequency | Reference Frequency Align | Min= -40 Hz<br>Max= 40 Hz |
| | | Reference Frequency Test GPS | Min= -0.5 ppm<br>Max= 0.5 ppm |
| | | Reference Frequency Test Core VHF Non-GPS | Min= -1.5 ppm<br>Max= 1.5 ppm |
| | | Reference Frequency Test Core UHF1 Non-GPS | Min= -1.5 ppm<br>Max= 1.5 ppm |
| | | Reference Frequency Test Core UHF2 Non-GPS | Min= -1.5 ppm<br>Max= 1.5 ppm |
| | | Reference Frequency Test Core 800-900 Non-GPS | Min= -0.5 ppm<br>Max= 0.5 ppm |
| | | Reference Frequency Test Enhanced VHF Non-GPS | Min= -1.5 ppm<br>Max= 1.5 ppm |
| | | Reference Frequency Test Enhanced UHF1 Non-GPS | Min= -0.5 ppm<br>Max= 0.5 ppm |
| | | Reference Frequency Test Enhanced UHF WB Non-GPS | Min= -1.5 ppm<br>Max= 1.5 ppm |
| | | Reference Frequency Test Enhanced UHF WB Entry Professional Non-GPS | Min= -0.5 ppm<br>Max= 0.5 ppm |
| | | Reference Frequency Test Enhanced UHF2 Non-GPS | Min= -0.5 ppm<br>Max= 0.5 ppm |
| | | Reference Frequency Test Enhanced 800 Non-GPS | Min= -0.5 ppm<br>Max= 0.5 ppm |
| | | Reference Frequency Test Enhanced 900 Non-GPS | Min= -0.5 ppm<br>Max= 0.5 ppm |
| | | Reference Frequency Test Enhanced 800-900 Non-GPS | Min= -0.5 ppm<br>Max= 0.5 ppm |
| 6.2 | TX Power Out (High Power) | TX Power VHF | Min= 5.0 W<br>Max= 6.0 W |
| | | TX Power VHF Enhanced | Min= 5.2 W<br>Max= 5.4 W |
| | | TX Power VHF CQST | Min= 2.9 W<br>Max= 3.1 W |
| | | TX Power UHF1 | Min= 4.0 W<br>Max= 4.8 W |
| | | TX Power UHF1 Enhanced | Min= 4.2 W<br>Max= 4.4 W |
| | | TX Power UHF1 CQST | Min= 2.9 W<br>Max= 3.1 W |
| | | TX Power UHF1 SL | Min= 2.0 W<br>Max= 2.2 W |
| | | TX Power UHF2 | Min= 4.0 W<br>Max= 4.8 W |
| | | TX Power UHF2 SL | Min= 4.0 W<br>Max= 4.8 W |
| | | TX Power 350 MHz | Min= 4.0 W<br>Max= 4.8 W |
| | | TX Power 350 MHz Enhanced | Min= 4.2 W<br>Max= 4.4 W |
| | | TX Power 800-900 MHz | Min= 2.5 W<br>Max= 2.8 W |

| | | | |
|---|---|---|---|
| | | TX Power 800-900 MHz CSA | Min= 2.3 W<br>Max= 2.5 W |
| | | TX Power 800 SL | Min= 2.0 W<br>Max= 2.2 W |
| | | TX Power 900 SL | Min= 2.0 W<br>Max= 2.2 W |
| 6.2 | TX Power Out (Low Power) | TX Power VHF | Min= 1.0 W<br>Max= 1.6 W |
| | | TX Power VHF Enhanced | Min= 1.1 W<br>Max= 1.3 W |
| | | TX Power VHF ATEX | Min= 1.05 W<br>Max= 1.25 W |
| | | TX Power UHF1 | Min= 1.1 W<br>Max= 1.3 W |
| | | TX Power UHF1 Enhanced | Min= 1.1 W<br>Max= 1.3 W |
| | | TX Power UHF1 ATEX | Min= 1.05 W<br>Max= 1.25 W |
| | | TX Power UHF2 | Min= 1.0 W<br>Max= 1.6 W |
| | | TX Power UHF2 SL | Min= 1.1 W<br>Max= 1.3 W |
| | | TX Power 350 | Min= 1.0 W<br>Max= 1.6 W |
| | | TX Power 350 Enhanced | Min= 1.1 W<br>Max= 1.3 W |
| | | TX Power 800-900 | Min= 1.0 W<br>Max= 1.6 W |
| | | TX Power 800-900 Enhanced | Min= 1.1 W<br>Max= 1.3 W |
| | | TX Power 800-900 CSA | Min= 1.0 W<br>Max= 1.2 W |
| | | TX Power 800 SL | Min= 1.0 W<br>Max= 1.2 W |
| | | TX Power 900 SL | Min= 1.0 W<br>Max= 1.2 W |
| 6.3 | Modulation Balance | Modulation Balance Align | Max= 0.05 dB |
| | | Modulation Balance Test | Max= 5 kHz |
| | | Modulation Balance Enhanced | Max=2.4 kHz |
| 6.4 | Front End Filter Test | Front End Filter SINAD | Min=13.5 dB |
| | | Front End Filter Enhanced SINAD | Min=12.0 dB |
| 6.6 | Distortion | Distortion | Max= 3 % |
| 6.7 | Sensitivity (SINAD) | All Limits | Max= -116 dBm |
| 6.8 | Digital Sensitivity (RX BER) | All Limits (Core) | Max= -117.5 dBm |
| | | All Limits (Enhanced) | Max= -119 dBm |
| 6.9 | Digital Sensitivity (TX BER) | TX BER | Max= 0 % |
| 6.10 | Internal Voice Modulation | Internal Voice Modulation | Min= 4.0 kHz<br>Max= 5.0 kHz |
| 6.11 | External Voice Modulation | External Voice Modulation | Min= 4.0 kHz<br>Max= 5.0 kHz |

**Table A-1. Default Motorola MOTOTRBO™ Portable Limits**

| Section | Test Name | Limit | Default Value |
|---|---|---|---|
| 8.1 | Reference Frequency | Reference Frequency Align | Min= -40 Hz<br>Max= 40 Hz |
| | | Reference Frequency Test Core VHF GPS | Min= -0.5 ppm<br>Max= 0.5 ppm |
| | | Reference Frequency Test Core UHF1 GPS | Min= -0.5 ppm<br>Max= 0.5 ppm |
| | | Reference Frequency Test Core UHF2 GPS | Min= -0.5 ppm<br>Max= 0.5 ppm |
| | | Reference Frequency Test Core 800-900 GPS | Min= -0.1 ppm<br>Max= 0.1 ppm |
| | | Reference Frequency Test Enhanced VHF GPS | Min= -0.5 ppm<br>Max= 0.5 ppm |
| | | Reference Frequency Test Enhanced UHF1 GPS | Min= -0.5 ppm<br>Max= 0.5 ppm |
| | | Reference Frequency Test Enhanced UHF2 GPS | Min= -0.5 ppm<br>Max= 0.5 ppm |
| | | Reference Frequency Test Core VHF Non-GPS | Min= -1.5 ppm<br>Max= 1.5 ppm |
| | | Reference Frequency Test Core UHF1 Non-GPS | Min= -1.5 ppm<br>Max= 1.5 ppm |
| | | Reference Frequency Test Core UHF2 Non-GPS | Min= -1.5 ppm<br>Max= 1.5 ppm |
| | | Reference Frequency Test Core 800-900 Non-GPS | Min= -0.1 ppm<br>Max= 0.1 ppm |
| | | Reference Frequency Test Enhanced VHF Non-GPS | Min= -0.5 ppm<br>Max= 0.5 ppm |
| | | Reference Frequency Test Enhanced UHF1 Non-GPS | Min= -0.5 ppm<br>Max= 0.5 ppm |
| | | Reference Frequency Test Enhanced UHF2 Non-GPS | Min= -0.5 ppm<br>Max= 0.5 ppm |
| 8.2 | TX Power Out High Power Model (High Power) | TX Power VHF Core | Min= 44.0 W<br>Max= 52.0 W |
| | | TX Power VHF Enhanced | Min= 44.0 W<br>Max= 52.0 W |
| | | TX Power UHF1 Core | Min= 40.0 W<br>Max= 48.0 W |
| | | TX Power 350 MHz | Min= 40.0 W<br>Max= 48.0 W |
| 8.2 | TX Power Out High Power Model (Low Power) | TX Power VHF Core | Min= 26.0 W<br>Max= 29.0 W |
| | | TX Power VHF Enhanced | Min= 25.0 W<br>Max= 30.0 W |
| | | TX Power UHF1 Core | Min= 26.0 W<br>Max= 29.0 W |
| | | TX Power UHF1 Enhanced | Min= 25.0 W<br>Max= 30.0 W |
| | | TX Power 350 MHz | Min= 25.0 W<br>Max= 30.0 W |
| 8.2 | TX Power Out Low Power Model (High Power) | TX Power VHF Core | Min= 26.0 W<br>Max= 29.0 W |
| | | TX Power VHF Enhanced | Min= 25.0 W<br>Max= 30.0 W |
| | | TX Power UHF1 Core | Min= 26.0 W |

| | | | |
|---|---|---|---|
| | | | Max= 29.0 W |
| | | TX Power UHF1 Enhanced | Min= 25.0 W<br>Max= 30.0 W |
| | | TX Power UHF2 (450-512 MHz) | Min= 40.0 W<br>Max= 48.0 W |
| | | TX Power UHF2 (512-527 MHz) | Min= 26.0 W<br>Max= 29.0 W |
| | | TX Power 350 MHz | Min= 26.0 W<br>Max= 29.0 W |
| | | TX Power 800 MHz | Min= 35.0 W<br>Max= 42.0 W |
| | | TX Power 900 MHz | Min= 30.0 W<br>Max= 36.0 W |
| 8.2 | TX Power Out Low Power Model (Low Power) | TX Power VHF Core | Min= 1.0 W<br>Max= 1.3 W |
| | | TX Power VHF Enhanced | Min= 1.0 W<br>Max= 1.3 W |
| | | TX Power UHF1 Core | Min= 1.0 W<br>Max= 1.3 W |
| | | TX Power UHF1 Enhanced | Min= 1.0 W<br>Max= 1.3 W |
| | | TX Power UHF2 (450-512 MHz) | Min= 1.0 W<br>Max= 1.3 W |
| | | TX Power UHF2 (512-527 MHz) | Min= 1.0 W<br>Max= 1.3 W |
| | | TX Power 350 MHz | Min= 1.0 W<br>Max= 1.3 W |
| | | TX Power 800 MHz | Min= 10.0 W<br>Max= 12.0 W |
| | | TX Power 900 MHz | Min= 10.0 W<br>Max= 12.0 W |
| 8.3 | Modulation Balance Align | Modulation Balance | Max= 0.05 dB |
| 8.3 | Modulation Balance Test | Modulation Balance | Max= 5 kHz |
| 8.4 | Front End Filter Test | Front End Filter SINAD | Min=15.0 dB |
| 8.6 | Distortion | Distortion | Max= 5 % |
| 8.7 | Sensitivity (SINAD) | All Limits | Max= -117.5 dBm |
| 8.8 | Digital Sensitivity (RX BER) | All Limits | Max= -117.5 dBm |
| 8.9 | Digital Sensitivity (TX BER) | TX BER | Max= 0 % |
| 8.10 | Internal Voice Modulation | Internal Voice Modulation | Min= 4.0 kHz<br>Max= 5.0 kHz |
| 8.11 | External Voice Modulation | External Voice Modulation | Min= 4.0 kHz<br>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

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```

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

# APPENDIX C. Revision History

| | | | | |
|---|---|---|---|---|
| | | | | |
| A-was CG | M. Mullins | M. Humphries | 7/24/17 | 0139 |
| Rev. No/change | Requested By | Approved By | Date | ECO# |