FREEDOM
Communication Technologies

R8000 SERIES
COMMUNICATIONS SYSTEM ANALYZER

AUTOTUNE USER GUIDE

Kenwood Viking Portable Radios
Kenwood Viking Mobile Radios

Freedom Communication Technologies
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FCT-1383A

AUTOTUNE™ SOFTWARE LICENSE AGREEMENT

The software license agreement governing use of the R8000 Series Communications System Analyzer AutoTune™ software is located in FCT-1365 R8000 Series Communications System Analyzer Operator's Manual.

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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") provides an automated test and alignment solution for supported two-way radios.

2. Scope

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

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

2.1. Supported Models

The following Kenwood Viking models are supported:

- VP5230
- VP5330
- VP5430
- VP6230
- VP6330
- VP6430
- VM5730
- VM5830
- VM5930
- VM6730
- VM6830
- VM6930
- VM7630H
- VM7730
- VM7730H
- VM7830
- VM7930

2.2. Firmware Versions

To perform AutoTune servicing, a Viking radio should be running **8.34.xx** or later firmware. If a Viking radio is running **8.32.xx** or earlier firmware, the radio **must** have an analog channel available in its codeplug and this channel must be selected prior to starting AutoTune servicing. There are various edge cases where not being on an analog conventional channel with **8.32.xx** or earlier Viking firmware prevent the radio from entering tune mode successfully.

If the Viking radio is running **8.32.xx** or earlier firmware and not on an analog conventional channel, an AutoTune warning message will appear, and radio servicing will stop.

3. Conventions

3.1. PPM

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

4. Kenwood Viking Portable Radio Test Setup

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

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

4.1. Cable Sweep

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

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

4.2. Battery Eliminator

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

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

Viking Portable battery jig

- Kenwood Part Number: **W3F-0001-00**

4.3. Viking Portable Test Setup

Refer to the diagram below for the proper test setup.

Note: For reliable radio communication with the analyzer, use an externally powered USB hub from a reputable vendor as shown in the diagram.

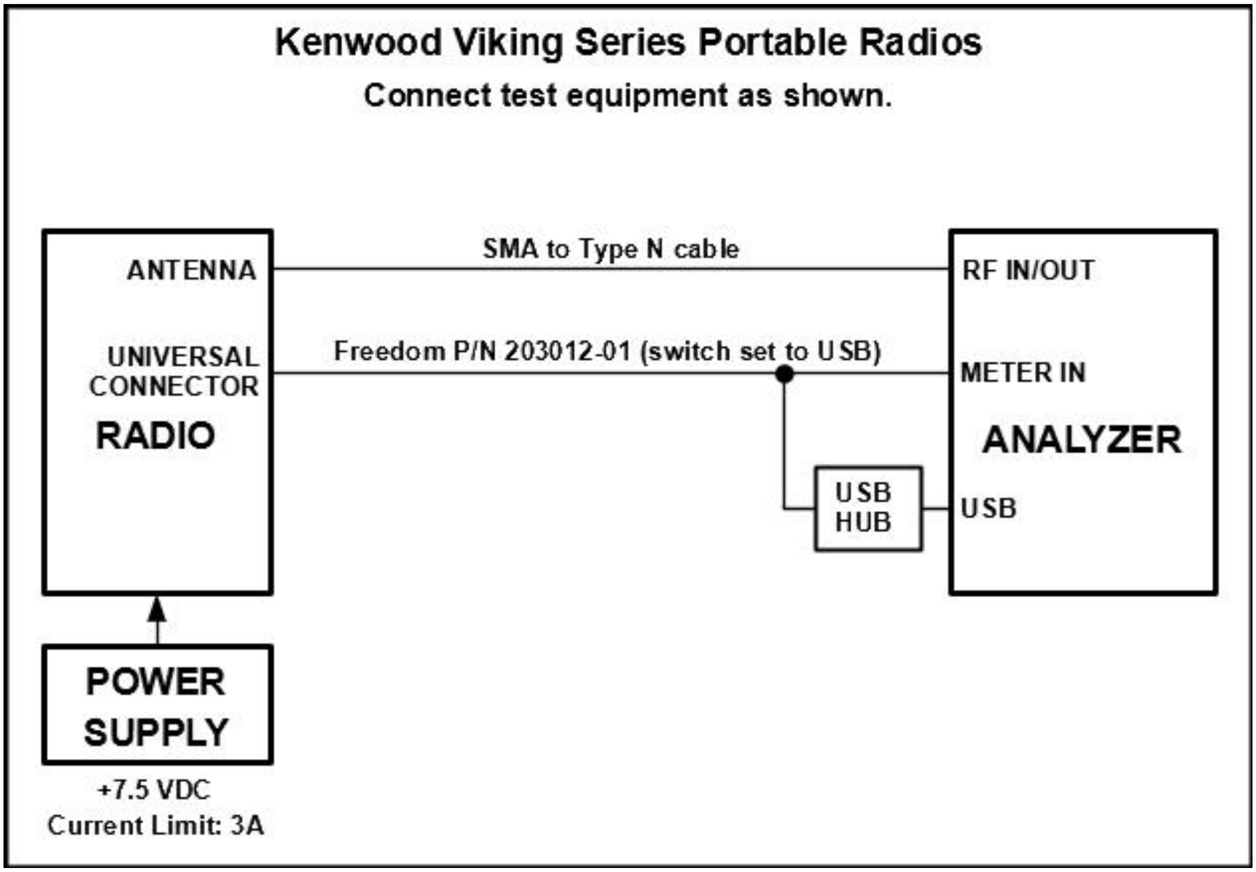

Figure 4-1. Viking Portable Test Setup Diagram with Freedom 203012-01 Cable.

Note: When using the Freedom programming cable (which is a modified Kenwood KPG-36X cable), the switch on the cable must be set to “USB” in order for the Analyzer to communicate with the radio.

5. Kenwood Viking Portable Alignment and Test Descriptions

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

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

5.1. Assist

5.1.1. Alignment

The Assist alignments helps ensure fast VCO lock time. The radio is placed into Test Mode and its VCO lock voltage is adjusted at several Rx and Tx Test Frequency points. The new softpot values for the voltages are then programmed into the radio.

Name	Description
Result	Pass or Fail. Pass as long as no radio error detected.
Frequency	Test Frequency
Old Param	Radio softpot before alignment
New Param	Radio softpot after alignment
Target	Target voltage
Meas	Measured voltage
Diff	Difference between Target and Measured values

Table 5-1. Assist Voltage alignment results

5.1.2. Test

There is no Assist test.

5.2. Ramp Offset

5.2.1. Alignment

The radio is placed into Test Mode and its ramp voltage is optimized. This is an internal radio adjustment which requires no analyzer setup or measurements. The new softpot values for the voltages are then programmed into the radio.

Name	Description
Result	Pass or Fail. Pass as long as no radio error detected.
Meas	Measured value (from radio)
Target	Target value
Up Old	Ramp Up softpot before alignment
Up New	Ramp Up softpot after alignment
Down Old	Ramp Down softpot before alignment
Down New	Ramp Down softpot after alignment

Table 5-2. Ramp Offset alignment results

5.2.2. Test

There is no Ramp Offset test.

5.3. Rx Filters

RF Control	Port	Frequency	Modulation	Output Level
Generate	RF IN/OUT	Test Frequency	FM	SINAD: -120 dBm Portable / -118.5 dBm Mobile RSSI: -100 dBm

Table 5-3. Analyzer Configuration for Rx Filters

Note: For portables, only the UHF 380 band models support Rx Filters alignment. For mobiles, all models support the Rx Filters alignment except 700/800 MHz band models. If this alignment is selected for a model that does not support the alignment, the test report will indicate the Rx Filters alignment is not applicable.

5.3.1. Alignment

The radio is placed into Test Mode and its Rx filters are adjusted. For mobiles with VHF, VHF Low, or VHF 110 bands, a Sensitivity (RSSI) alignment is performed. For all other models (portable and mobile) a Sensitivity (SINAD) alignment is performed. Using the Output Level indicated in Table 5-3, the softpots are adjusted to obtain 12 dB SINAD, or RSSI value greater than a minimum value. The new softpot values are then programmed into the radio.

Name	Description
Result	Pass or Fail. Pass if no radio error detected.
Frequency	Test Frequency
Old Softpot	Radio softpot before alignment
New Softpot	Radio softpot after alignment
SINAD	SINAD value measured
Target (12 dB)	Difference between Target and measured SINAD values

Table 5-4. Rx Filters Sensitivity (SINAD) alignment results

Name	Description
Result	Pass or Fail. RSSI above Min Limit
Frequency	Test Frequency
Old Softpot	Radio softpot before alignment
New Softpot	Radio softpot after alignment
RSSI	RSSI value measured
Min Limit	Minimum Limit (inclusive) for RSSI

Table 5-5. Rx Filters Sensitivity (RSSI) alignment results

5.3.2. Test

There is no Rx Filters test.

5.4. TCXO Frequency

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

Table 5-6. Analyzer Configuration for TCXO Frequency

5.4.1. Alignment

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

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

Table 5-7. TCXO Frequency alignment results

5.4.2. Test

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

Name	Description
Result	Pass or Fail. Frequency Error within Max Limit, Min Limit
Frequency	Test Frequency
Min Limit	Minimum Limit (inclusive) for Frequency Error
Max Limit	Maximum Limit (inclusive) for Frequency Error
Freq Error	Frequency Error measured
Pendulum	Pendulum softpot

Table 5-8. TCXO Frequency test results

5.5. Tx Modulation (Balance)

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

Table 5-9. Analyzer Configuration for Tx Modulations alignment

5.5.1. Tx Modulation Alignment

The radio is placed into Test Mode at low power at the first TX Test Frequency and commanded to transmit. The radio generates a Mod 2 (TXCO) modulation tone and the ±Peak/2-averaged deviation of this tone is measured with the analyzer. Mod 2 softpot is adjusted until tone deviation is between Mod 2 Min, Max test limits. The radio then generates a Mod 1 (VCO) modulation tone and the ±Peak/2-averaged deviation of this tone is measured with the analyzer. The Mod 1 softpot is adjusted until the tone deviation is between Mod 1 Min, Max test limits. Mobile and UHF radios only, the radio is set to generate a fine tune modulation tone using the previously found Mod 2 and Mod 1 softpot. Mod 1 and Mod 2 are adjusted by the same percentage until the tone deviation is between the fine tune modulation Min, Max test limits. This adjustment is performed for each TX Test Frequency. The results for each TX Test Frequency are written to the log file.

Name	Description
Result	Pass or Fail
Frequency	Test Frequency
Dev	Measured deviation
Dev Min	Minimum passable deviation (inclusive)
Dev Max	Minimum passable deviation (inclusive)
Mod 2/Mod 1 Old	Mod 2 or Mod 1 softpot before alignment
Mod 2/Mod 1 New	Mod 2 or Mod 1 softpot after alignment

Table 5-10. Tx Modulation alignment results

Name	Description
Result	Pass or Fail.
Frequency	Test Frequency
Fine Tune Dev	Measured deviation
Fine Tune Dev Min	Minimum passable deviation (inclusive)
Fine Tune Dev Max	Minimum passable deviation (inclusive)
Mod 1 Old	Mod1 softpot before alignment
Mod 1 New	Mod1 softpot after alignment
Mod 2 Old	Mod2 softpot before alignment
Mod 2 New	Mod2 softpot after alignment

Table 5-11. Tx Modulation Fine Tune alignment results

5.5.2. Tx Modulation Test

There is no Tx Modulation test.

5.6. Tx Power

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

Table 5-12. Analyzer Configuration for Tx Power

5.6.1. 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 Low power setting. For each test frequency, the output level is measured and then adjusted until near to a band-specific output level. This process is repeated for the High power settings. The results are written to the log file.

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

Table 5-13. Tx Power alignment results

5.6.2. Test

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

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

Table 5-14. Tx Power test results

5.7. Squelch

RF Control	Port	Frequency	Modulation	Level
Generate	RF IN/OUT	Test Freq	**Analog:** Wide: 1 kHz @ 3 kHz Narrow: 1 kHz @ 1.5 kHz	Varies

Table 5-15. Analyzer Configuration for Squelch

5.7.1. Alignment

The analyzer is setup by applying the Modulation signal in Table 5-15 to the radio and then setting radio volume level. The radio is placed into Test Mode at the analog wide channel spacing and Rx Test Frequency. The output level of the analyzer is then adjusted until the radio audio signal's SINAD level measures about 10 dB. The radio Unsquelch threshold values are then queried and programmed into radio. The output level of the analyzer is then adjusted until the radio audio signal's SINAD level measures about 6 dB. The radio Squelch threshold values are then queried and programmed into radio. The results are written to the log file. This process is repeated for narrow channel spacing.

Note: For UHF 380 band portables, an EU squelch alignment is performed after the normal squelch alignment. For the EU squelch alignment, the radio is commanded to use European sensitivity voltage parameters and then to start EU squelch tuning.

Name	Description
Result	Pass or Fail. Difference within Max Limit, Min Limit
Frequency	Test Frequency
Squelch Type	One of: Wideband Squelch or Unsquelch, or Narrowband Squelch or Unsquelch
Output Level	Analyzer output level used to generate squelch level
SINAD	SINAD level (in dB) when Squelch/Unsquelch occurs
Threshold	Measured radio squelch, unsquelch levels

Table 5-16. Squelch alignment results

5.7.2. Test

No test is currently available.

5.8. Rx Sensitivity

RF Control	Port	Frequency	Modulation	Level
Generate	RF IN/OUT	Test Freq	Narrow: 1 kHz @ 1.5 kHz	Model specific

Table 5-17. Analyzer Configuration for Rx Sensitivity test

5.8.1. Test

The analyzer is setup by applying the Modulation signal in Table 5-17 to the radio and then setting radio volume. 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 results are written to the log file. This process is repeated for each Rx Test Frequency.

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

Table 5-18. Rx Sensitivity test results

5.9. P25 Tx Tests

RF Control	Port	Frequency	Modulation	Attenuation
Monitor	RF IN/OUT	Test Frequency	C4FM	40 dB

Table 5-19. Analyzer Configuration for P25 Tx Tests

5.9.1. Test

The radio is set to a digital channel at low power at the first Tx Test Frequency and commanded to transmit a P25 deviation pattern. The modulation fidelity and symbol deviation of this tone is measured with the analyzer. This process is repeated for each Test Frequency. The test results are written to the log file.

Name	Description
Result	Pass or Fail. Pass is modulation fidelity is below Max Limit
Frequency	Test Frequency
Measured	Measured P25 Modulation Fidelity
Max	Maximum passable Modulation Fidelity level (inclusive)

Table 5-20. Tx P25 Modulation Fidelity results

Name	Description
Result	Pass or Fail. Pass is symbol deviation is between Min and Max Limits
Frequency	Test Frequency
Measured	Measured P25 Symbol Deviation
Min	Minimum Symbol Deviation (inclusive)
Max	Maximum Symbol Deviation (inclusive)

Table 5-21. Tx P25 Symbol Deviation results

5.10. Sensitivity (P25 BER)

RF Control	Port	Frequency	Modulation	Level
Generate	RF IN/OUT	Test Freq	**Digital**: P25 Phase 1:1011 Hz test pattern	-117 dBm

Table 5-22. Analyzer Configuration for Sensitivity (P25 BER) test

5.10.1. Test

The analyzer is setup by applying the Modulation signal in Table 5-22 to the radio. The radio is placed into Test Mode at the first Rx Test Frequency. The analyzer retrieves the radio's BER level measured. The BER level is then compared against test limits. The results are written to the log file. This process is repeated for each Rx Test Frequency.

Name	Description
Result	Pass or Fail. Sensitivity (P25 BER) level less than Max Limit
Frequency	Test Frequency
Bit Error	Number of bit errors in two superframes
BER	Radio's BER measurement
Max	Maximum BER level (inclusive) allowed for test to Pass

Table 5-23. Sensitivity (P25 BER) test results

6. Kenwood Viking Mobile Radio Test Setup

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

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

6.1. Cable Sweep

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

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

6.2. Viking Mobile Test Setup

Refer to the diagram below for the proper test setup.

Note: For reliable radio communication with the analyzer, use an externally powered USB hub from a reputable vendor as shown in the diagram.

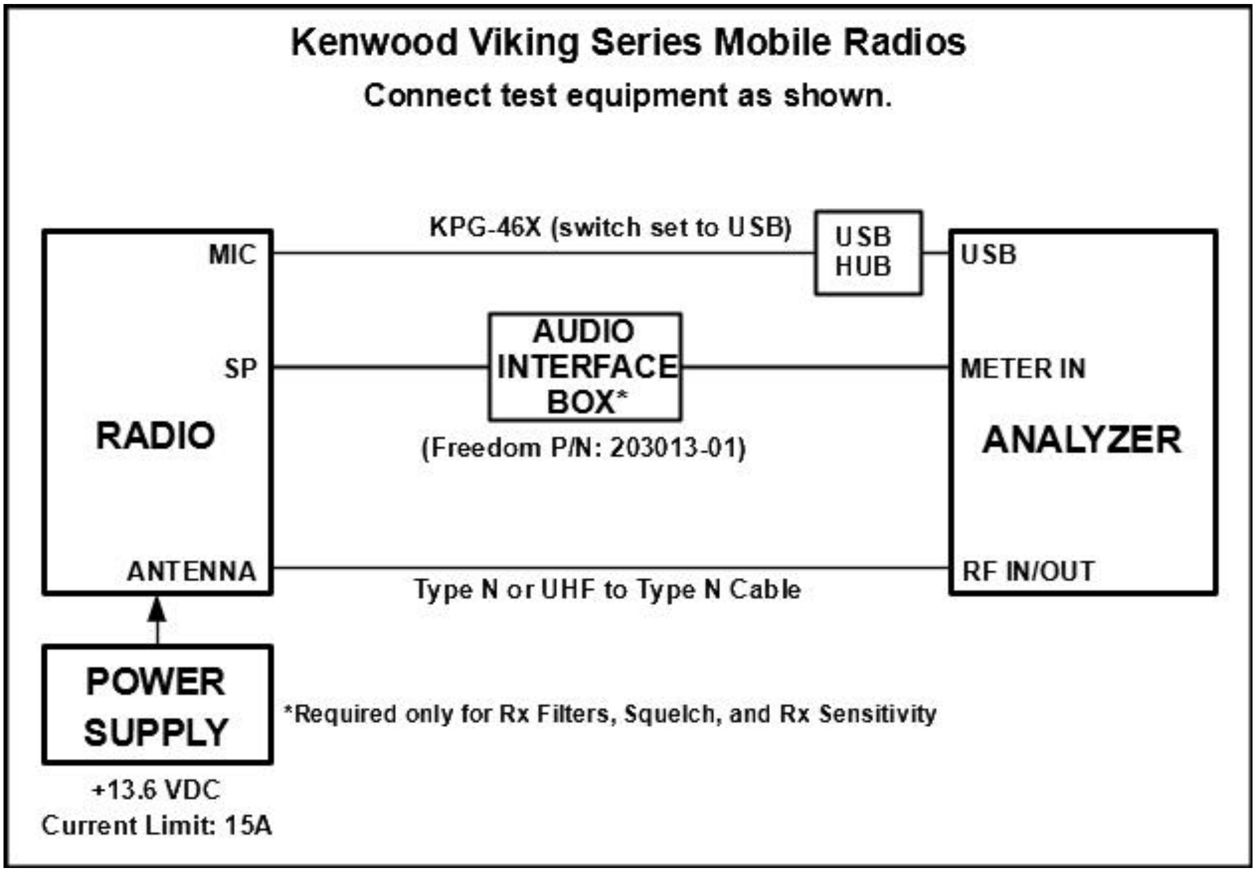

Figure 6-1. Viking Mobile Test Setup Diagram with 203013-01 Audio Interface Box.

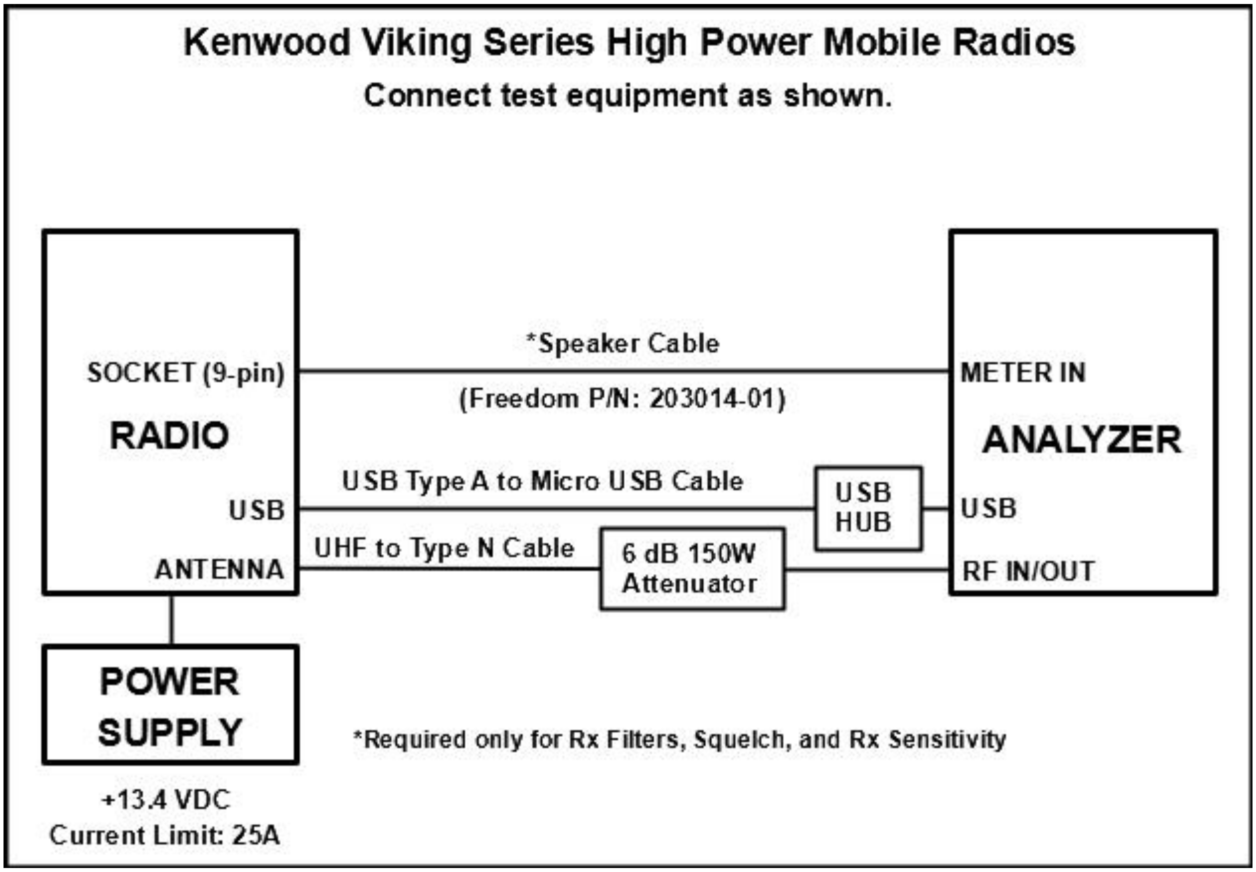

Figure 6-2. Viking Mobile Test Setup Diagram with Freedom 203014-01 Cable.

6.3. Kenwood Viking Mobile USB Cables

For mid-power mobiles, the Freedom Audio Interface Box is used to route the radio 3.5mm speaker output to the analyzer Meter In port. This box allows all alignments and tests to be performed.

For high power mobiles, the Freedom Speaker Cable routes the radio speaker connector output to the analyzer Meter In port. This cable allows all alignments and tests to be performed.

When using a Kenwood USB cable without an Audio Interface Box (mid-power mobiles) or speaker cable (high power mobiles), radio audio signals cannot be routed to the Analyzer for measurement. The USB programming cables do not route radio audio signals. The following tests cannot be run without an Audio Interface Box (mid-power mobiles) or speaker cable (high power mobiles) to connect the Radio directly to the Analyzer:

- Rx Filters
- Squelch
- Rx Sensitivity

Note: When using the KPG-46X cable, the switch on the cable must be set to “USB” in order for the Analyzer to communicate with the radio.

7. Kenwood Viking 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.

A Tx Max Power alignment is added for the Kenwood Viking Mobile radios. For all other mobile alignments and tests, see section Kenwood Viking Portable Alignment and Test Descriptions for details - the alignments and tests are identical.

For Low Band VHF Mobile radios, the Ramp Offset alignment is moved in the function order to follow the Tx Max Power alignment.

7.1. Tx Max Power

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

Table 7-1. Analyzer Configuration for Tx Max Power

7.1.1. Alignment

The Tx Max Power alignment aligns the power output level of the mobile radio at its maximum power level. The radio is placed into Test Mode and commanded to transmit at the first Test Frequency and the Maximum 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 respective Kenwood Viking Portable radio service manuals.

Model	High Power Limits(W)
Low Band VHF	115 – 135
VHF 110W	123 – 127
700 MHz	43 – 47
800 MHz	38 – 42
All other models	53 – 57

Table 7-2. Kenwood Viking Mobile specified target max power

The results are written to the log file.

Name	Description
Result	Pass or Fail. Power Out within manufacturer limits
Frequency	Test Frequency
Power	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 7-3. Tx Max Power alignment results

7.1.2. Test

There is no Tx Max Power test.

8. Basic Troubleshooting

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

Table 8-1. Kenwood Viking Series Troubleshooting Chart

9. Support Information

9.1. Technical Support

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

9.2. Sales

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

APPENDIX A. Test Limits

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

https://freedomcte.com/library/

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

APPENDIX B. Sample Test Result Report

Test Result Report

Date/Time: 6/1/2022 4:22 PM Operator ID: MM

Info

Analyzer

Model #:	R8100
Serial #:	810LSJ0011
Ref Clock Mode:	Output
Application:	4.4
RF Level Offset:	Off
RF In/Out Offset:	0.0 dB
RF Gen Out Offset:	0.0 dB
Cable Sweep:	On
Selected File:	RF_ORANGE_N2N
100 MHz Attenuation:	-0.201 dB
1 GHz Attenuation:	-0.688 dB

Radio

Model #:	VMx830
Serial #:	F0-83-00-00-00-00-03-84
Band:	UHF 380
Firmware Version:	8.32.10
Bootloader Version:	32.9
DSP Version:	5.32.9

Tx Assist

Result	Frequency	Old Param	New Param	Target	Meas	Diff
Pass	380.1000 MHz	768	770	128	128	0
Pass	385.6000 MHz	874	874	128	128	0
Pass	391.1000 MHz	971	974	128	127	-1
Pass	396.6000 MHz	1069	1069	128	127	-1
Pass	402.6000 MHz	1169	1172	128	127	-1
Pass	408.1000 MHz	1266	1266	128	128	0
Pass	413.6000 MHz	1361	1361	128	128	0
Pass	419.1000 MHz	1458	1458	128	129	1
Pass	425.1000 MHz	1567	1570	128	127	-1
Pass	430.6000 MHz	1670	1672	128	128	0
Pass	436.1000 MHz	1779	1779	128	129	1
Pass	441.6000 MHz	1892	1892	128	128	0
Pass	447.6000 MHz	2017	2017	128	129	1
Pass	453.1000 MHz	2134	2136	128	128	0
Pass	458.6000 MHz	2257	2257	128	129	1
Pass	464.1000 MHz	2382	2385	128	127	-1
Pass	469.9000 MHz	2520	2520	128	129	1

Rx Assist

Result	Frequency	Old Param	New Param	Target	Meas	Diff
Pass	380.0500 MHz	790	790	128	128	0
Pass	385.5500 MHz	909	909	128	129	1
Pass	391.0500 MHz	1023	1023	128	128	0
Pass	396.5500 MHz	1131	1134	128	127	-1
Pass	402.5500 MHz	1249	1249	128	129	1
Pass	408.0500 MHz	1358	1358	128	129	1
Pass	413.5500 MHz	1469	1469	128	128	0
Pass	419.0500 MHz	1580	1580	128	129	1
Pass	425.0500 MHz	1708	1708	128	128	0
Pass	430.5500 MHz	1827	1827	128	129	1
Pass	436.0500 MHz	1949	1952	128	128	0
Pass	441.5500 MHz	2077	2077	128	129	1
Pass	447.5500 MHz	2217	2220	128	127	-1
Pass	453.0500 MHz	2351	2351	128	129	1
Pass	458.5500 MHz	2488	2488	128	129	1
Pass	464.0500 MHz	2628	2628	128	129	1
Pass	469.9500 MHz	2784	2784	128	129	1

Ramp Offset Align

Result	Meas	Target	Up Old	Up New	Down Old	Down New
Pass	50	50	622	622	342	342

Rx Filters

Result	Frequency	Old Softpot	New Softpot	SINAD	Target (12 dB)
Pass	380.0500 MHz	184	183	9.4 dB	Diff: 2.62 dB
Pass	402.5500 MHz	160	160	11.3 dB	Diff: 0.75 dB
Pass	425.0500 MHz	133	134	11.8 dB	Diff: 0.22 dB
Pass	447.5500 MHz	106	104	10.6 dB	Diff: 1.42 dB
Pass	469.9500 MHz	73	71	11.7 dB	Diff: 0.31 dB

TCXO Frequency Align

Result	Frequency	Min Limit	Max Limit	Freq Error	Pendulum Old	Pendulum New
Pass	402.5000 MHz	-3 Hz	3 Hz	2 Hz	-3005	-3005

Tx Modulation Align - Fine Tune

Result	Frequency	Dev	Dev Min	Dev Max	Mod1 Old	Mod1 New	Mod2 Old	Mod2 New
Pass	380.00000 MHz	3129 Hz	3103 Hz	3203 Hz	2002	2002	-4500	-4500
Pass	387.50000 MHz	3158 Hz	3103 Hz	3203 Hz	2057	2057	-4492	-4492

Pass	395.00000 MHz	3172 Hz	3103 Hz	3203 Hz	2111	2111	-4549	-4549
Pass	402.50000 MHz	3156 Hz	3103 Hz	3203 Hz	2157	2157	-4544	-4544
Pass	410.00000 MHz	3152 Hz	3103 Hz	3203 Hz	2205	2205	-4434	-4434
Pass	417.50000 MHz	3129 Hz	3103 Hz	3203 Hz	2244	2244	-4488	-4488
Pass	425.00000 MHz	3135 Hz	3103 Hz	3203 Hz	2300	2300	-4459	-4459
Pass	432.50000 MHz	3142 Hz	3103 Hz	3203 Hz	2366	2366	-4465	-4465
Pass	440.00000 MHz	3152 Hz	3103 Hz	3203 Hz	2431	2431	-4474	-4474
Pass	447.50000 MHz	3145 Hz	3103 Hz	3203 Hz	2488	2488	-4477	-4477
Pass	455.00000 MHz	3135 Hz	3103 Hz	3203 Hz	2539	2539	-4485	-4485
Pass	462.50000 MHz	3129 Hz	3103 Hz	3203 Hz	2596	2596	-4482	-4482
Pass	470.00000 MHz	3149 Hz	3103 Hz	3203 Hz	2660	2660	-4467	-4467

Tx Max Power Align
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Result	Frequency	Power	Min Limit	Max Limit	Old Softpot	New Softpot
Pass	380.0000 MHz	56.6 W	53.0 W	57.0 W	190	207
Pass	387.5000 MHz	54.3 W	53.0 W	57.0 W	170	181
Pass	395.0000 MHz	54.7 W	53.0 W	57.0 W	169	169
Pass	402.5002 MHz	55.1 W	53.0 W	57.0 W	158	183
Pass	410.0005 MHz	53.5 W	53.0 W	57.0 W	173	173
Pass	417.5000 MHz	54.7 W	53.0 W	57.0 W	182	182
Pass	425.0000 MHz	53.0 W	53.0 W	57.0 W	161	161
Pass	432.5000 MHz	55.0 W	53.0 W	57.0 W	159	183
Pass	440.0007 MHz	53.2 W	53.0 W	57.0 W	172	172
Pass	447.5005 MHz	54.3 W	53.0 W	57.0 W	171	192
Pass	455.0005 MHz	57.0 W	53.0 W	57.0 W	179	217
Pass	462.5005 MHz	54.8 W	53.0 W	57.0 W	190	190
Pass	470.0000 MHz	54.3 W	53.0 W	57.0 W	177	177

Tx Power Align - Low Power
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Result	Frequency	Power	Min	Max	Old	New
Pass	380.00000 MHz	4.95 W	4.50 W	5.50 W	3130	3130
Pass	387.50000 MHz	4.86 W	4.50 W	5.50 W	3136	3136
Pass	395.00000 MHz	4.77 W	4.50 W	5.50 W	3136	3136
Pass	402.50000 MHz	4.76 W	4.50 W	5.50 W	3136	3136
Pass	410.00000 MHz	4.74 W	4.50 W	5.50 W	3136	3136
Pass	417.50000 MHz	4.73 W	4.50 W	5.50 W	3136	3136
Pass	425.00000 MHz	4.70 W	4.50 W	5.50 W	3136	3136
Pass	432.50000 MHz	4.69 W	4.50 W	5.50 W	3136	3136
Pass	440.00000 MHz	4.57 W	4.50 W	5.50 W	3136	3136
Pass	447.50000 MHz	4.52 W	4.50 W	5.50 W	3136	3136
Pass	455.00000 MHz	4.99 W	4.50 W	5.50 W	3170	3170
Pass	462.50000 MHz	4.91 W	4.50 W	5.50 W	3173	3173
Pass	470.00000 MHz	4.91 W	4.50 W	5.50 W	3180	3180

Tx Power Align - High Power
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Result	Frequency	Power	Min	Max	Old	New
Pass	380.00000 MHz	39.92 W	36.00 W	44.00 W	3791	3791
Pass	387.50000 MHz	39.57 W	36.00 W	44.00 W	3799	3799
Pass	395.00000 MHz	39.52 W	36.00 W	44.00 W	3804	3804
Pass	402.50000 MHz	39.79 W	36.00 W	44.00 W	3808	3808
Pass	410.00000 MHz	39.59 W	36.00 W	44.00 W	3809	3809
Pass	417.50000 MHz	40.17 W	36.00 W	44.00 W	3776	3816
Pass	425.00000 MHz	39.89 W	36.00 W	44.00 W	3815	3815
Pass	432.50000 MHz	37.87 W	36.00 W	44.00 W	3800	3800
Pass	440.00000 MHz	37.18 W	36.00 W	44.00 W	3800	3800
Pass	447.50000 MHz	36.72 W	36.00 W	44.00 W	3800	3800
Pass	455.00000 MHz	40.82 W	36.00 W	44.00 W	3840	3840
Pass	462.50000 MHz	39.61 W	36.00 W	44.00 W	3840	3840
Pass	470.00000 MHz	38.91 W	36.00 W	44.00 W	3840	3840

Squelch
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Result	Frequency	Squelch Type	Output Level	SINAD	Threshold
Pass	428.3625 MHz	Wideband Squelch	-119.0 dBm	8.8 dB	60137
Pass	428.3625 MHz	Wideband Unsquelch	-119.7 dBm	6.3 dB	58953
Pass	428.3625 MHz	Narrowband Squelch	-119.0 dBm	9.6 dB	58905
Pass	428.3625 MHz	Narrowband Unsquelch	-120.4 dBm	6.2 dB	56354

Rx Sensitivity
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Result	Frequency	SINAD	Output Level	Max Level
Pass	380.0500 MHz	11.9 dB	-118.5 dBm	-117.0 dBm
Pass	425.0500 MHz	11.6 dB	-117.8 dBm	-117.0 dBm
Pass	469.9500 MHz	11.9 dB	-119.4 dBm	-117.0 dBm

P25 Tx Tests - Modulation Fidelity
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Result	Frequency	Measured	Max
Pass	380.00000 MHz	0.9 %	5.0 %
Pass	402.50000 MHz	1.0 %	5.0 %
Pass	425.00000 MHz	1.1 %	5.0 %
Pass	447.50000 MHz	1.1 %	5.0 %
Pass	470.00000 MHz	1.3 %	5.0 %

P25 Tx Tests - Symbol Deviation
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Result	Frequency	Measured	Min	Max
Pass	380.00000 MHz	1786 Hz	1620 Hz	1980 Hz
Pass	402.50000 MHz	1798 Hz	1620 Hz	1980 Hz
Pass	425.00000 MHz	1782 Hz	1620 Hz	1980 Hz
Pass	447.50000 MHz	1790 Hz	1620 Hz	1980 Hz
Pass	470.00000 MHz	1787 Hz	1620 Hz	1980 Hz

Sensitivity (P25 BER)
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Result	Frequency	Bit Error	BER	Max
Pass	380.05000 MHz	147	2.34 %	5.00 %

Pass	402.55000 MHz	230	3.67 %	5.00 %
Pass	419.05000 MHz	301	4.80 %	5.00 %
Pass	441.55000 MHz	217	3.46 %	5.00 %
Pass	469.95000 MHz	140	2.23 %	5.00 %

Figure B-1. Sample Test Result Report

APPENDIX C. Revision History

A – Initial	T.John	M. Mullins	7/14/22	0403
Revision – Change	Requested By	Approved By	Rel. Date	ECO#