FREEDOM
Communication Technologies

R8000 SERIES
COMMUNICATIONS SYSTEM ANALYZER

AUTOTUNE USER GUIDE

Kenwood NX-3000/5000 Portable Radios
Kenwood NX-3000/5000 Mobile Radios

Freedom Communication Technologies
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FCT-1381B

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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 NX-3000/5000 Portable and NX-3000/5000 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 NX-3000, NX-5000, and TK-5x30 models are supported:

- NX-3200
- NX-3220
- NX-3300
- NX-3320
- NX-3720
- NX-3820
- NX-5200
- NX-5300
- NX-5400
- NX-5700
- NX-5800
- NX-5900
- TK-5230
- TK-5330
- TK-5430
- TK-5730
- TK-5830
- TK-5930

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.

3.2. Rated Audio

Rated audio voltage target is approximately 0.90 Vrms for Kenwood NX-5x00 Portables, 0.63 Vrms for Kenwood NX-3xx0 Portables, and 1.41 Vrms for Kenwood NX-3000/5000 Mobile radios across a 8 Ω speaker.

4. Kenwood NX-3000/5000 Portable Radio Test Setup

In order to perform the test and alignment procedures, the NX-3000/5000 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 NX-3000/5000 Portable models, use the following Kenwood battery eliminator parts. For more information, see the applicable Kenwood radio service manual.

NX-5xxx portable battery jig

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

NX-3xxx portable battery jig

- Part Number: **W05-0909-00**

4.3. NX-3000/5000 Portable Test Setup

Refer to the diagram below for the proper test setup. Note that the correct setting for each test set switch is listed in TEST SET SETTINGS.

Note: Approved USB to serial adapters for connecting the R8000 analyzer to the Kenwood NX series radio under test include any adapters which utilize an FTDI FT232_USB to serial UART interface. See http://www.ftdichip.com/Products/ICs/FT232R.htm for more detail.

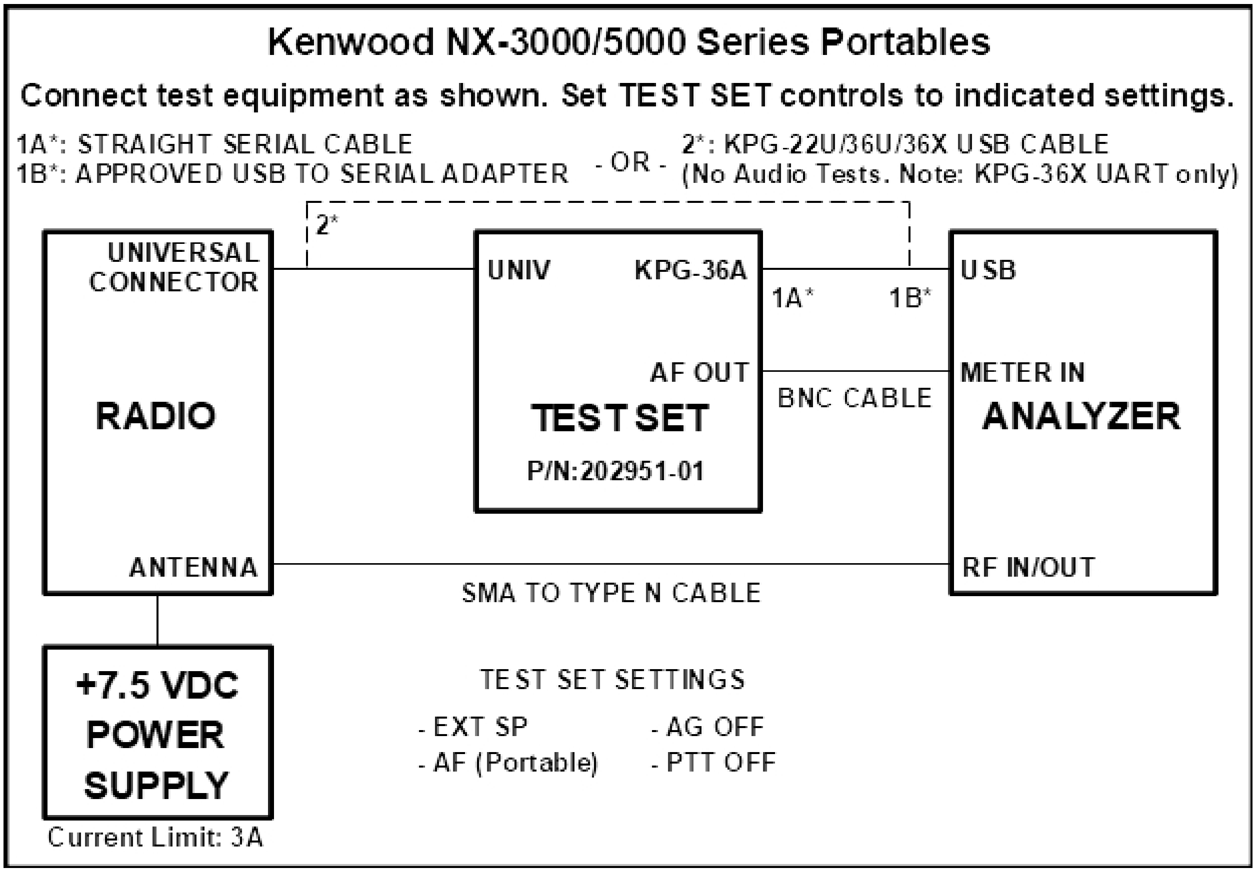

Figure 4-1. NX-3000/5000 Portable Test Setup Diagram with 202951-01 Test Set.

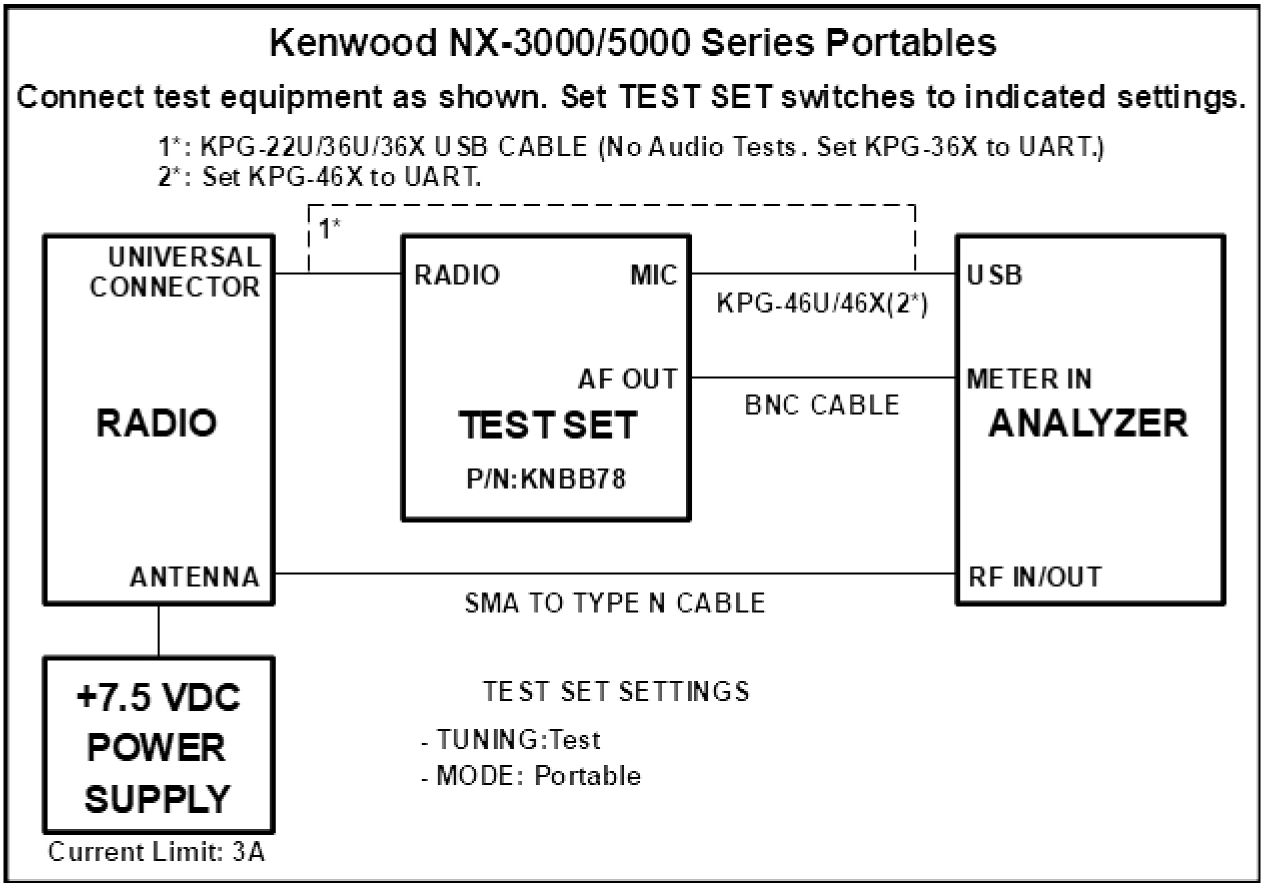

Figure 4-2. NX-3000/5000 Portable Test Setup Diagram with KNBB78 Test Set.

4.4. Kenwood NX-3000/5000 Portable USB Cables

When using a Kenwood USB cable(KPG-22U/36U/36X) to connect the Radio directly to the Analyzer, the Test Set is bypassed. The Kenwood USB cables do not route radio audio signals. Therefore, the following tests cannot be run when using a Kenwood USB cable:

- RX Sensitivity
- RX Squelch
- RX RSSI

When a Kenwood NX-3000/5000 Portable is selected as the radio to be tested, a new display group appears below the Activity Group (Test Only, Test and Align). This new group displays the current selection for the NX-3000/5000 Portable radio interface cable - either Serial, or USB. Use the “Serial or USB Cable” softkey on the right side of the screen to select the cable being used. The list of tests available will update depending on the selection of the cable and the test Activity.

Note: When using the KPG-36X cable, the switch on the cable must be set to “UART” for the Analyzer to communicate with the radio. The cable selection on the Analyzer must still be set to “USB”, because the audio tests are not supported when using either the KPG-36U or 36X cables.

5. Kenwood NX-3000/5000 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 Voltage

5.1.1. Alignment

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.
Softpot	Radio softpot after alignment

Table 5-1. Assist Voltage alignment results

5.1.2. Test

There is no Assist Voltage test.

5.2. Frequency

RF Control	Port	Frequency	Modulation	Output Level
Generate	RF IN/OUT	Test Frequency	FM	-30 dBm

Table 5-2. Analyzer Configuration for Reference Frequency

5.2.1. Alignment

The radio is placed into Test Mode at a RX Test Frequency. The analyzer is placed into Generate mode at the radio RX Test Frequency and nominal output level. The radio auto-alignment for Frequency is run, which adjusts the radio's "IF20" value to a minimum. After programming this new softpot value into the radio, the radio is then placed into Transmit mode and its Frequency Error measured. The frequency error is compared against test limits and the final results written to the log file.

Name	Description
Result	Pass or Fail. Pass as long as no radio error returned
Frequency	Test Frequency
Old Softpot	Radio softpot before alignment
New Softpot	Radio softpot after alignment
Temp	Internal radio temperature, in Celsius.
Min Temp	Minimum radio temperature. Note alignment will not fail if radio temperature is below this limit.
Max Temp	Maximum radio temperature. Note alignment will not fail if radio temperature is above this limit.

Table 5-3. Reference Frequency alignment results

5.2.2. Test

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

Name	Description
Result	Pass or Fail. Frequency Error within Max Limit, Min Limit
Frequency	Test Frequency
Freq Error	Measured frequency error
Min Freq Err	Minimum Limit (inclusive) for frequency error
Max Freq Err	Maximum Limit (inclusive) for frequency error
Temp	Internal radio temperature, in Celsius.
Min Temp	Minimum radio temperature. Note test will not fail if radio temperature is below this limit.
Max Temp	Maximum radio temperature. Note test will not fail if radio temperature is above this limit.

Table 5-4. Reference Frequency test results

5.3. Ramp Offset

RF Control	Port	Frequency	Modulation	Output Level
Generate	RF IN/OUT	Test Frequency	FM	-30 dBm

Table 5-5. Analyzer Configuration for Ramp Offset

5.3.1. Alignment

The radio is placed into Test Mode and its ramp voltage is optimized. This is an internal radio adjustment which requires no analyzer measurement. 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.
Ramp Up	Ramp Up softpot
Ramp Down	Ramp Down softpot
Monitor	Monitor voltage softpot
Min Limit	Minimum limit for Monitor voltage softpot

Table 5-6. Ramp Offset alignment results

5.3.2. Test

There is no Ramp Offset test.

5.4. IQ Phase Align

RF Control	Port	Frequency	Modulation	Output Level
Generate	RF IN/OUT	Test Frequency	FM	-53 dBm

Table 5-7. Analyzer Configuration for IQ Phase

5.4.1. Alignment

The radio is placed into Test Mode and its IQ phase difference corrected. The new softpot values are then programmed into the radio.

Name	Description
Result	Pass or Fail. Pass as long as no radio error detected.
Frequency	Test frequency
Output Level	Analyzer signal level at which the alignment is performed
Old Softpot	Previous softpot value
New Softpot	Aligned softpot value

Table 5-8. IQ Phase alignment results

5.4.2. Test

There is no IQ Phase test.

5.5. TX Power

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

Table 5-9. Analyzer Configuration for TX Power

5.5.1. Alignment

The TX Power Out alignment aligns the power output level of the radio at both High and Low power levels. A Medium power level alignment is also performed for certain models. 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 respective Kenwood NX-3000/5000 Portable radio service manuals.

Model	High Power Limits(W)	Low Power Limits(W)
NX-5200 (VHF)	5.9 - 6.1	0.9 – 1.1
NX-5400 (700 MHz)	2.8 – 3.0	0.85 – 0.95
NX-5400 (800 MHz)	2.9 – 3.1	0.85 – 0.95
All other models	4.9 – 5.1	3.9 – 4.1

Table 5-10. Kenwood NX-3000/5000 Portable specified target power

This process is repeated for the Low, and if applicable, Medium, power settings. The final 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 5-11. TX Power alignment results

5.5.2. 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

Table 5-12. TX Power test results

5.6. Balance

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

Table 5-13. Analyzer Configuration for Balance test, alignment

5.6.1. Balance 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 Low modulation tone and the ±Peak/2-averaged deviation of this tone is measured with the analyzer. This low tone deviation is checked to be between Min, Max test limits. The radio then generates a High modulation tone and the ±Peak/2-averaged deviation of this tone is measured with the analyzer. The radio softpot is adjusted until the deviation difference between the Low and High tones is close to midpoint between 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 difference is calculated as: $Difference(\%) = \left(\frac{Deviation_{Low} - Deviation_{High}}{Deviation_{Low} * 100}\right)$

Name	Description
Result	Pass or Fail. Calculated difference between Low and High tone deviation is within Max Limit.
Frequency	Test Frequency
20Hz Dev	Measured Low Tone deviation
2kHz|6kHz Dev	Measured High Tone deviation. Note NX-5300/5800 use 6 kHz audio tones.
Min	Minimum passable deviation (inclusive)
Max	Minimum passable deviation (inclusive)
% Diff	Calculated difference, in %, between Low and High tone deviation
Max % Diff	Maximum passable % difference (inclusive) between low and high tone deviation.
Old	Original radio softpot setting
New	Radio softpot setting after alignment

Table 5-14. Balance alignment results

5.6.2. Balance Test

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 ±Peak/2-averaged deviation of this tone is measured with the analyzer. This low tone deviation is checked to be between Min, Max test limits. The radio then generates a High modulation tone and the ±Peak/2-averaged 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.

Name	Description
Result	Pass or Fail. Deviation is less than or equal to Max Limit.
Frequency	Test Frequency
20Hz Dev	Measured low tone deviation level.
2kHz|6kHz Dev	Measured high tone deviation level.
Min Limit	Minimum passable deviation (inclusive)
Max Limit	Maximum passable deviation (inclusive)
Softpot	Current radio softpot setting

Table 5-15. Balance test results

5.7. Tx Maximum Deviation

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

Table 5-16. Analyzer Configuration for Tx Signaling test, alignment

5.7.1. Tx Maximum Deviation Alignment

The radio is placed into Test Mode at low power at the first channel spacing, first TX Test Frequency and commanded to transmit. The radio generates a 1 kHz modulation tone and the ±Peak/2-averaged deviation of this tone is measured with the analyzer. The radio softpot is adjusted until the deviation is within test limits. This adjustment is performed for each channel spacing and Tx Test Frequency. The results for each channel spacing at the center Tx Test Frequency are written to the log file.

Name	Description
Result	Pass or Fail. Measured Deviation is between Min Limit and Max Limit.
Frequency	Test Frequency
Deviation	Measured maximum deviation level
Min Limit	Minimum passable deviation level
Max Limit	Maximum passable deviation level
Old Softpot	Original radio softpot setting
New Softpot	Radio softpot setting after alignment

Table 5-17. Tx Maximum Deviation alignment results

5.7.2. TX Maximum Deviation Test

The radio is placed into Test Mode at low power at the first channel spacing, center Tx Test Frequency and commanded to transmit. The radio generates a 1 kHz modulation tone and the ±Peak/2-averaged deviation of this tone is measured with the analyzer. This test is performed for each channel spacing. The test results for each channel spacing at the center Tx Test Frequency are written to the log file.

Name	Description
Result	Pass or Fail. Measured Deviation is between Max Limit and Min Limit.
Frequency	Test Frequency
Deviation	Measured maximum deviation level
Min Limit	Minimum passable deviation level
Max Limit	Maximum passable deviation level
Softpot	Radio softpot which yields Deviation

Table 5-18. Tx Maximum Deviation test results

5.8. Tx Signaling

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

Table 5-19. Analyzer Configuration for Tx Signaling test, alignment

5.8.1. TX Signaling Alignment

The radio is placed into Test Mode at low power at the modulation-specific channel spacing and first TX Test Frequency and commanded to transmit. The radio modulates the Test Frequency using the modulation types in Table 5-20 in sequence. The ±Peak/2-averaged modulation deviation is measured with the analyzer. The radio softpot is adjusted until the deviation is within test limits. This adjustment is performed for each modulation type and Tx Test Frequency. The results for each modulation, channel spacing, and Tx Test Frequency are written to the log file.

Modulation	Description
P25 High	Project 25 High Symbol Rate
P25 H-CPM	Project 25 Phase 2 Harmonized Continuous Phase Modulation
NXDN	NXDN Maximum Deviation Pattern
DMR	DMR Maximum Deviation Pattern
QT	Quiet Talk
DQT	Digital Quiet Talk
LTR	Logic Trunked Radio
DTMF	Dual-tone multi-frequency
Single Tone	Single modulation frequency
MSK	Minimum-shift keying
CWID	Continuous Wave Identification

Table 5-20. TX Signaling modulation types

Name	Description
Result	Pass or Fail. Calculated difference between Low and High tone deviation less than or equal to Dev Ratio.
Frequency	Test Frequency
Deviation	Measured modulation deviation level
Min Limit	Minimum passable deviation (inclusive)
Max Limit	Maximum passable deviation (inclusive)
Old Softpot	Original radio softpot setting
New Softpot	Radio softpot setting after alignment

Table 5-21. TX Signaling alignment results

5.8.2. TX Signaling Test

The radio is placed into Test Mode at the modulation-specific channel spacing and first TX Test Frequency and commanded to transmit. The ±Peak/2-averaged modulation deviation is measured with the analyzer. The deviation is compared against test limits and written to the log file. This test is performed for each modulation type and Tx Test Frequency.

Name	Description
Result	Pass or Fail. Deviation is less than or equal to Max Limit.
Frequency	Test Frequency
Deviation	Measured modulation deviation level
Min Limit	Minimum passable deviation (inclusive)
Max Limit	Maximum passable deviation (inclusive)
Softpot	Radio softpot which yields Deviation

Table 5-22. TX Signaling test results

5.9. RX Sensitivity

RF Control	Port	Frequency	Modulation	Level
Generate	RF IN/OUT	Test Freq	Wide(5k): 1 kHz @ 3 kHz Wide(4k): 1 kHz @ 2.4 kHz Narrow: 1 kHz @ 1.5 kHz	Model-specific

Table 5-23. Analyzer Configuration for RX Sensitivity test

5.9.1. Alignment

Alignment not currently available.

5.9.2. Test

The analyzer is setup by applying the Modulation signal in Table 5-23 to the radio and then adjusting radio volume for rated audio. The radio is placed into Test Mode at the first channel spacing and first RX Test Frequency. The output level of the analyzer is then adjusted until the radio audio signal's SINAD level measures about 12 dB. The current analyzer output level is then compared against test limits. The final results are written to the log file. This process is repeated for each channel spacing and each RX Test Frequency.

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

Table 5-24. RX Sensitivity test results

5.10. RX Squelch

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

Table 5-25. Analyzer Configuration for RX Squelch test

5.10.1. Alignment

The analyzer is setup by applying the Modulation signal in Table 5-25 to the radio and then adjusting radio volume for Rated Audio. The radio is placed into Test Mode at the analog narrow channel spacing and first Rx Test Frequency. The output level of the analyzer is then adjusted until the radio audio signal's SINAD level measures about 12 dB. The current analyzer output level is then offset by a channel spacing-, modulation-, and squelch type-specific amount. The radio softpots for Open/Tight Squelch values are then queried and programmed into radio. The final results are written to the log file. This process is repeated for each squelch type, channel spacing, and Rx Test Frequency.

Name	Description
Result	Pass or Fail. Difference within Max Limit, Min Limit
Frequency	Test Frequency
Output Level	Analyzer output level used to generate squelch level. Same as 12dB SINAD level in previous step on this section.
Softpot	Current programmed squelch softpot value
Squelch Level	Measured radio squelch level
Min Limit	Minimum Limit (inclusive) for RX Squelch to Pass
Difference	Difference between Softpot and Squelch Level
Max Limit	Maximum Limit (inclusive) for RX Squelch to Pass

Table 5-26. Rx Squelch alignment results

5.10.2. Test

No test is currently available.

5.11. RX RSSI

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

Table 5-27. Analyzer Configuration for RX RSSI test

5.11.1. Alignment

The analyzer is set up by applying the appropriate Modulation signal in Table 5-27 to the radio and then adjusting radio volume for Rated Audio. The radio is placed into Test Mode at the first bandwidth, first RX Test Frequency and first RSSI type (Reference, Reference1, Reference2, Reference3, Reference4, Low, or High). If measuring any Reference RSSI, the output level of the analyzer is then adjusted until the radio audio signal's SINAD level measures about 12 dB plus a fixed offset. If measuring Low RSSI, an output level of -118 dBm is used. If measuring High RSSI, an output of -80 dBm is used.

After turning on the analyzer's RF, the radio RSSI level is requested from and then applied to the radio. The value written for certain frequencies within an RSSI type may be a result of an average of prior RSSI level readings from other frequencies. The final results are written to the log file. This process is repeated for each bandwidth, RX Test Frequency, and RSSI type.

Name	Description
Result	Pass or Fail. Pass if 12 dB SINAD level within Max Limit.
Tuning Item	RSSI type (Reference, Reference1, Reference2, Reference3, Reference4, Low, or High)
Frequency	Test Frequency
Old Softpot	Original radio softpot setting
New Softpot	Radio softpot setting after alignment

Table 5-28. RX RSSI sensitivity results

5.11.2. Test

No test is currently available.

5.12. Digital Sensitivity

NOTE: This test supports several digital modulation types and thus requires an analyzer with the following digital protocol options to fully perform:

- P25 Phase 1 and Phase 2 test package (R8-P25 and R8-P25_II)
- NXDN test package (R8-NXDN or R8-NXDNTYPC option)
- DMR test package (R8-DMR)

NOTE: AutoTune only performs BER tests for radio-enabled digital protocols, even if the radio is optioned for the digital protocol. KPG-D1* (NX-5000 series) or KPG-D3* (NX-3000 series) can be used to determine whether a digital protocol is optioned and enabled. Below is a KPG-D1N Product Information screen highlighting the digital protocol enablement state for a NX-5300 portable. In this example, only NXDN and DMR protocols are enabled and therefore only their BER tests will be performed.

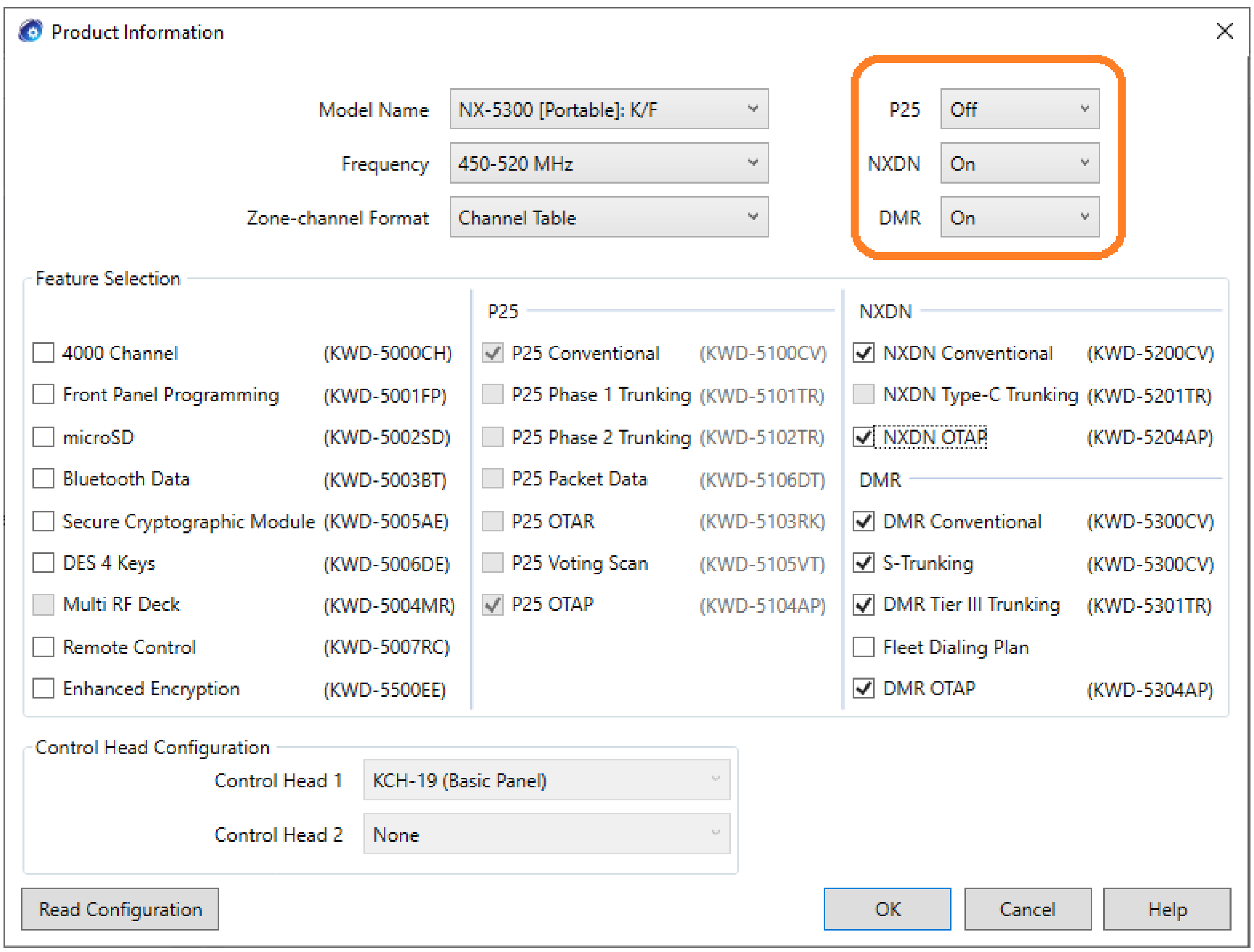

Figure 3. KPG-D1N Product Information

NOTE: For Kenwood NX-5000 series models only 2 of the supported digital protocols (P25/NXDN/DMR) can be enabled at one time. This means BER testing will be performed for at most two digital protocols.

NOTE: For Kenwood NX-3000 series models, only one of the supported digital protocols (NXDN/DMR) can be enabled at one time. This means BER testing will be performed for a single digital protocol at most. Note P25 isn't a supported protocol for NX-3000 series models.

RF Control	Port	Frequency	Modulation	Level
Generate	RF IN/OUT	Test Freq	**Digital**: NXDN:FSW+PN9 test pattern P25 Phase 1:1011 Hz test pattern P25 Phase 2:1031 Hz test pattern DMR:SYNC (Each Slot)+PN9 burst pattern	Model-specific

Table 5-29. Analyzer Configuration for Digital Sensitivity test

5.12.1. Alignment

Alignment not currently available.

5.12.2. Test

The analyzer is setup by applying the Modulation signal in Table 5-23 to the radio. The radio is placed into Test Mode at the center channel spacing and first Rx Test Frequency. The output level of the analyzer is then adjusted until the radio's BER level measures about 5%. The current analyzer output level is then compared against test limits. The final results are written to the log file. This process is repeated for each channel spacing and each Rx Test Frequency.

Name	Description
Result	Pass or Fail. Sensitivity (SINAD) level within Max Limit
Signaling	Type of digital signaling (P25/NXDN/DMR)
Frequency	Test Frequency
5% BER Level	Analyzer output level at which the radio Bit Error Rate (BER) level measures about 5%
Max Level	Maximum Output Level (inclusive) allowed for 5% BER for test to Pass

Table 5-30. RX Sensitivity test results

6. Kenwood NX-3000/5000 Mobile Radio Test Setup

In order to perform the test and alignment procedures, the NX-3000/5000 Mobile radio must be connected to the R8000 Communications System Analyzer as shown in the figure below.

CAUTION

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. NX-3000/5000 Mobile Test Setup

Refer to the diagram below for the proper test setup.

Note: Approved USB to serial adapters for connecting the R8000 analyzer to the Kenwood NX series radio under test include any adapters which utilize an FTDI FT232_USB to serial UART interface. See http://www.ftdichip.com/Products/ICs/FT232R.htm for more detail.

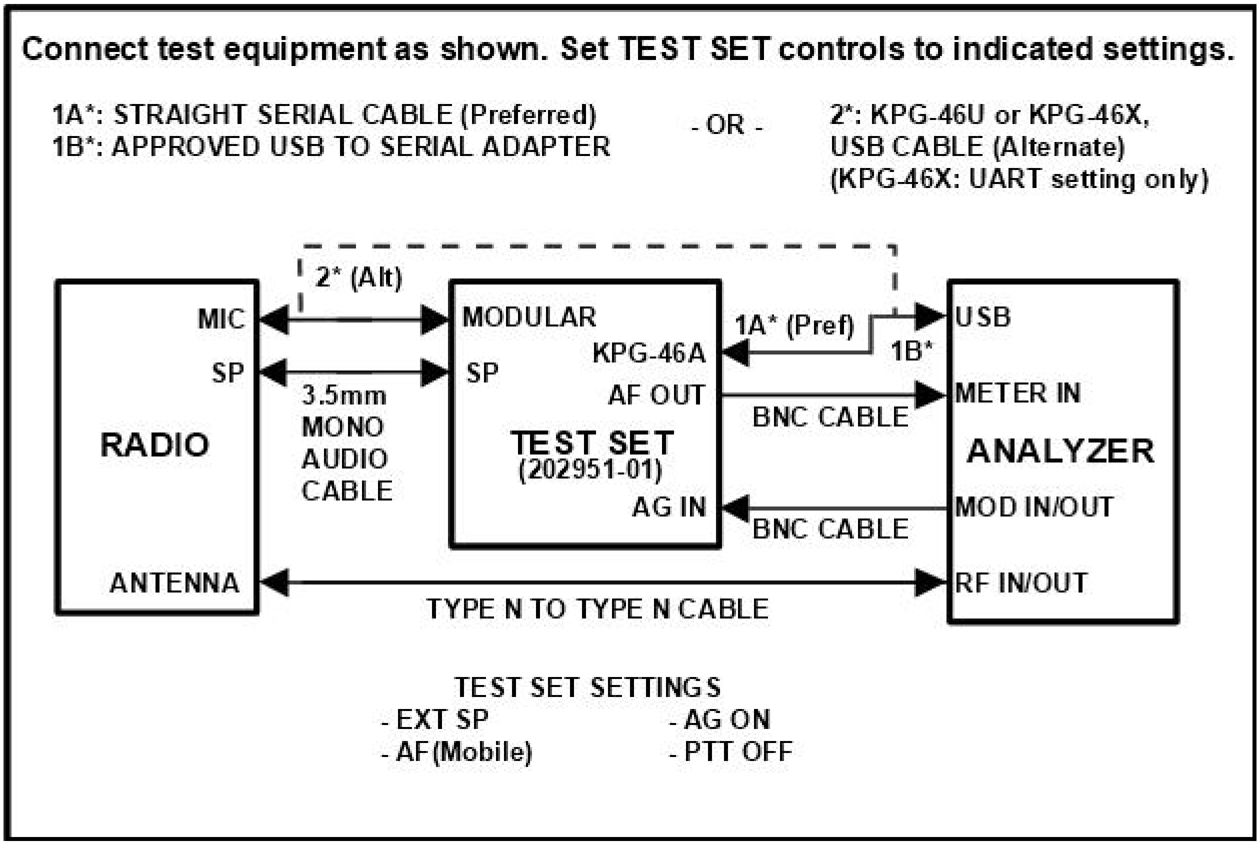

Figure 6-1. NX-3000/5000 Mobile Test Setup Diagram with 202951-01 Test Set.

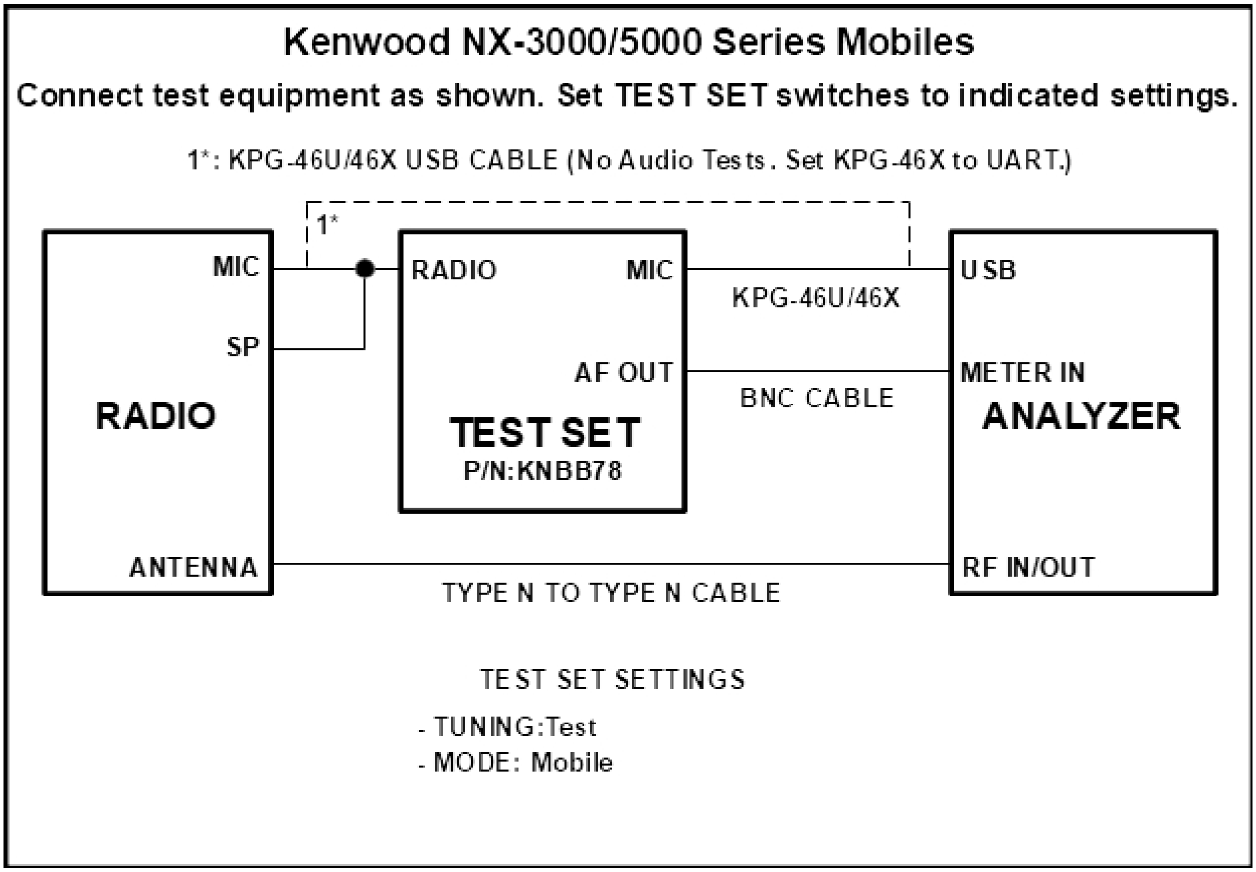

Figure 6-2. NX-3000/5000 Mobile Test Setup Diagram with KNBB78 Test Set.

6.3. Kenwood NX-3000/5000 Mobile USB Cables

When using a Kenwood USB cable with the 202951-01 Test Set, a 3.5mm mono audio cable is still used for routing audio signals. Unlike the NX-3000/5000 Portable, when used with the 202951-01 Test Set a NX-3000/5000 Mobile radio with the USB cable can still run all tests.

When using a Kenwood USB cable without a Test Set, radio audio signals cannot be routed to the Analyzer for measurement. The Kenwood USB cables do not route radio audio signals. The following tests cannot be run when using only a Kenwood USB cable (KPG-46U/46X) to connect the Radio directly to the Analyzer:

- RX Sensitivity
- RX Squelch
- RX RSSI

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

7. Kenwood NX-3000/5000 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 section Kenwood NX-3000/5000 Portable Alignment and Test Descriptions for details. The alignments and tests are identical.

8. Basic Troubleshooting

Symptom	Possible Cause	Possible Solution
Analyzer consistently fails to communicate with radio	• Incorrect KPG-144AT port connection	• Verify programming cable is connected to the correct KPG-144AT test set serial connector. See the respective radio test setup sections for more information.
Alignment or test intermittently stops after partial performance.	• USB hub running on analyzer USB port power.	• Use an externally powered USB hub. Analyzer USB port cannot supply adequate power to external USB hub.
Tx Power alignment or test failure	• Cable Sweep not enabled.	• 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.
Balance, Tx Maximum Deviation, and/or Tx Signaling tests fail.	• Radio in odd state • Radio duty cycle too high	• Manually power cycle radio by turning volume knob off then on for a portable or pressing the control head power button for a mobile. • Wait 10 minutes between consecutive test sequences to reduce duty cycle.
DMR BER testing not performed.	• DMR BER testing currently unsupported.	• DMR BER testing will be added in upcoming R8x00 software release.

Table 8-1. Kenwood NX-3K5K 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 NX-3000/5000 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: 11/13/2020 7:26 AM   Operator ID: PLV

Info

Analyzer

Model #:	R8100
Serial #:	800LSL0003
RF Level Offset:	Off
RF In/Out Offset:	0.0 dB
RF Gen Out Offset:	0.0 dB
Cable Sweep:	On
Selected File:	MEGAPHASE
100 MHz Attenuation:	-0.214 dB
1 GHz Attenuation:	-0.748 dB

Radio

Model #:	NX-5200 K3
Serial #:	B9910838
Firmware:	K 4.02.00

Assist Voltage Align

Result	Monitor	Min Limit	Max Limit
Pass	2.00 V	1.90 V	2.10 V

Frequency Align

Result	Frequency	Old Softpot	New Softpot	Temp	Min Temp	Max Temp
Pass	155.0500 MHz	2202	2156	24.6 °C	22.0 °C	33.0 °C

Frequency Test

Result	Frequency	FreqError	Min FreqError	Max FreqError	Temp	Min Temp	Max Temp
Pass	155.1000 MHz	-3 Hz	-78 Hz	78 Hz	25.0 °C	22.0 °C	33.0 °C

Ramp Offset Align

Result	Ramp Up	Ramp Down	Monitor	Min Limit
Pass	424	354	72	N/A

Transmit Power Align - High

Result	Frequency	Power	Min Limit	Max Limit	Old Softpot	New Softpot
Pass	136.1000 MHz	6.0 W	5.9 W	6.1 W	795	772
Pass	145.6000 MHz	5.9 W	5.9 W	6.1 W	778	754
Pass	155.1000 MHz	6.0 W	5.9 W	6.1 W	778	760
Pass	164.6000 MHz	6.0 W	5.9 W	6.1 W	795	783
Pass	173.9000 MHz	6.0 W	5.9 W	6.1 W	791	770

Transmit Power Align - Medium

Result	Frequency	Power	Min Limit	Max Limit	Old Softpot	New Softpot
Pass	136.1000 MHz	4.9 W	4.9 W	5.1 W	738	738
Pass	145.6000 MHz	4.9 W	4.9 W	5.1 W	718	718
Pass	155.1000 MHz	5.1 W	4.9 W	5.1 W	731	731
Pass	164.6000 MHz	5.0 W	4.9 W	5.1 W	756	756
Pass	173.9000 MHz	5.0 W	4.9 W	5.1 W	739	739

Transmit Power Align - Low

Result	Frequency	Power	Min Limit	Max Limit	Old Softpot	New Softpot
Pass	136.1000 MHz	1.0 W	0.9 W	1.1 W	590	590
Pass	145.6000 MHz	1.1 W	0.9 W	1.1 W	584	584
Pass	155.1000 MHz	1.0 W	0.9 W	1.1 W	589	589
Pass	164.6000 MHz	1.0 W	0.9 W	1.1 W	603	603
Pass	173.9000 MHz	1.1 W	0.9 W	1.1 W	604	604

Transmit Power Test - High

Result	Frequency	Power	Min Limit	Max Limit
Pass	155.1000 MHz	6.1 W	5.0 W	7.0 W
Pass	136.1000 MHz	6.1 W	5.0 W	7.0 W
Pass	173.9000 MHz	6.1 W	5.0 W	7.0 W

Transmit Power Test - Low

Result	Frequency	Power	Min Limit	Max Limit
Pass	155.1000 MHz	1.0 W	0.7 W	1.4 W
Pass	136.1000 MHz	1.0 W	0.7 W	1.4 W
Pass	173.9000 MHz	1.1 W	0.7 W	1.4 W

Balance Align

Result	Frequency	20Hz Dev	2kHz Dev	Min	Max	% Diff	Max % Diff	Old	New
Pass	136.1000 MHz	2.51 kHz	2.50 kHz	2.45 kHz	2.55 kHz	-0.1 %	+/- 1.0 %	495	495
Pass	145.6000 MHz	2.50 kHz	2.50 kHz	2.45 kHz	2.55 kHz	0.0 %	+/- 1.0 %	418	418
Pass	155.1000 MHz	2.51 kHz	2.51 kHz	2.45 kHz	2.55 kHz	-0.0 %	+/- 1.0 %	358	356

Pass	164.6000 MHz	2.51 kHz	2.51 kHz	2.45 kHz	2.55 kHz	0.0 %	+/- 1.0 %	305	305
Pass	173.9000 MHz	2.50 kHz	2.50 kHz	2.45 kHz	2.55 kHz	0.1 %	+/- 1.0 %	264	264

Maximum Deviation Align - Analog Wide 5k

Result	Frequency	Deviation	Min Limit	Max Limit	Old Softpot	New Softpot
Pass	136.1000 MHz	4.189 kHz	4.150 kHz	4.250 kHz	499	499
Pass	145.6000 MHz	4.214 kHz	4.150 kHz	4.250 kHz	503	503
Pass	155.1000 MHz	4.201 kHz	4.150 kHz	4.250 kHz	500	500
Pass	164.6000 MHz	4.209 kHz	4.150 kHz	4.250 kHz	502	502
Pass	173.9000 MHz	4.184 kHz	4.150 kHz	4.250 kHz	499	499

Maximum Deviation Align - Analog Wide 4k

Result	Frequency	Deviation	Min Limit	Max Limit	Old Softpot	New Softpot
Pass	136.1000 MHz	3.345 kHz	3.310 kHz	3.410 kHz	508	508
Pass	145.6000 MHz	3.358 kHz	3.310 kHz	3.410 kHz	509	509
Pass	155.1000 MHz	3.369 kHz	3.310 kHz	3.410 kHz	510	510
Pass	164.6000 MHz	3.354 kHz	3.310 kHz	3.410 kHz	509	509
Pass	173.9000 MHz	3.361 kHz	3.310 kHz	3.410 kHz	510	510

Maximum Deviation Align - Analog Narrow

Result	Frequency	Deviation	Min Limit	Max Limit	Old Softpot	New Softpot
Pass	136.1000 MHz	2.093 kHz	2.050 kHz	2.150 kHz	503	503
Pass	145.6000 MHz	2.089 kHz	2.050 kHz	2.150 kHz	503	503
Pass	155.1000 MHz	2.090 kHz	2.050 kHz	2.150 kHz	503	503
Pass	164.6000 MHz	2.093 kHz	2.050 kHz	2.150 kHz	503	503
Pass	173.9000 MHz	2.087 kHz	2.050 kHz	2.150 kHz	503	503

P25 High Deviation Align

Result	Frequency	Deviation	Min Limit	Max Limit	Old Softpot	New Softpot
Pass	136.1000 MHz	2.837 kHz	2.771 kHz	2.883 kHz	512	512
Pass	145.6000 MHz	2.834 kHz	2.771 kHz	2.883 kHz	511	511
Pass	155.1000 MHz	2.808 kHz	2.771 kHz	2.883 kHz	506	506
Pass	164.6000 MHz	2.833 kHz	2.771 kHz	2.883 kHz	511	511
Pass	173.9000 MHz	2.832 kHz	2.771 kHz	2.883 kHz	511	511

P25 H-CPM Deviation Align

Result	Frequency	Deviation	Min Limit	Max Limit	Old Softpot	New Softpot
Pass	136.1000 MHz	3.155 kHz	3.090 kHz	3.215 kHz	491	491
Pass	145.6000 MHz	3.157 kHz	3.090 kHz	3.215 kHz	491	491
Pass	155.1000 MHz	3.129 kHz	3.090 kHz	3.215 kHz	486	486
Pass	164.6000 MHz	3.126 kHz	3.090 kHz	3.215 kHz	486	486
Pass	173.9000 MHz	3.125 kHz	3.090 kHz	3.215 kHz	486	486

NXDN Deviation Align - Narrow

Result	Frequency	Deviation	Min Limit	Max Limit	Old Softpot	New Softpot
Pass	136.1000 MHz	3.068 kHz	2.995 kHz	3.117 kHz	512	512
Pass	145.6000 MHz	3.064 kHz	2.995 kHz	3.117 kHz	511	511
Pass	155.1000 MHz	3.037 kHz	2.995 kHz	3.117 kHz	506	506
Pass	164.6000 MHz	3.064 kHz	2.995 kHz	3.117 kHz	511	511
Pass	173.9000 MHz	3.032 kHz	2.995 kHz	3.117 kHz	506	506

NXDN Deviation Align - Very Narrow

Result	Frequency	Deviation	Min Limit	Max Limit	Old Softpot	New Softpot
Pass	136.1000 MHz	1.344 kHz	1.311 kHz	1.363 kHz	512	512
Pass	145.6000 MHz	1.342 kHz	1.311 kHz	1.363 kHz	511	511
Pass	155.1000 MHz	1.330 kHz	1.311 kHz	1.363 kHz	506	506
Pass	164.6000 MHz	1.344 kHz	1.311 kHz	1.363 kHz	511	511
Pass	173.9000 MHz	1.344 kHz	1.311 kHz	1.363 kHz	512	512

QT Deviation Align - Wide 5k

Result	Frequency	Deviation	Min Limit	Max Limit	Old Softpot	New Softpot
Pass	136.1000 MHz	0.736 kHz	0.700 kHz	0.800 kHz	514	514
Pass	145.6000 MHz	0.744 kHz	0.700 kHz	0.800 kHz	514	514
Pass	155.1000 MHz	0.738 kHz	0.700 kHz	0.800 kHz	514	514
Pass	164.6000 MHz	0.742 kHz	0.700 kHz	0.800 kHz	514	514
Pass	173.9000 MHz	0.737 kHz	0.700 kHz	0.800 kHz	514	514

QT Deviation Align - Wide 4k

Result	Frequency	Deviation	Min Limit	Max Limit	Old Softpot	New Softpot
Pass	136.1000 MHz	0.596 kHz	0.550 kHz	0.650 kHz	514	514
Pass	145.6000 MHz	0.596 kHz	0.550 kHz	0.650 kHz	514	514
Pass	155.1000 MHz	0.596 kHz	0.550 kHz	0.650 kHz	514	514
Pass	164.6000 MHz	0.596 kHz	0.550 kHz	0.650 kHz	514	514
Pass	173.9000 MHz	0.598 kHz	0.550 kHz	0.650 kHz	514	514

QT Deviation Align - Narrow

Result	Frequency	Deviation	Min Limit	Max Limit	Old Softpot	New Softpot
Pass	136.1000 MHz	0.347 kHz	0.300 kHz	0.400 kHz	514	514
Pass	145.6000 MHz	0.347 kHz	0.300 kHz	0.400 kHz	514	514
Pass	155.1000 MHz	0.347 kHz	0.300 kHz	0.400 kHz	514	514
Pass	164.6000 MHz	0.346 kHz	0.300 kHz	0.400 kHz	514	514
Pass	173.9000 MHz	0.348 kHz	0.300 kHz	0.400 kHz	514	514

DQT Deviation Align - Wide 5k

Result	Frequency	Deviation	Min Limit	Max Limit	Old Softpot	New Softpot
Pass	136.1000 MHz	0.736 kHz	0.700 kHz	0.800 kHz	457	457

Pass	145.6000 MHz	0.740 kHz	0.700 kHz	0.800 kHz	450	450
Pass	155.1000 MHz	0.751 kHz	0.700 kHz	0.800 kHz	461	461
Pass	164.6000 MHz	0.761 kHz	0.700 kHz	0.800 kHz	460	460
Pass	173.9000 MHz	0.749 kHz	0.700 kHz	0.800 kHz	464	464

DQT Deviation Align - Wide 4k

Result	Frequency	Deviation	Min Limit	Max Limit	Old Softpot	New Softpot
Pass	136.1000 MHz	0.606 kHz	0.550 kHz	0.650 kHz	457	457
Pass	145.6000 MHz	0.597 kHz	0.550 kHz	0.650 kHz	450	450
Pass	155.1000 MHz	0.615 kHz	0.550 kHz	0.650 kHz	461	461
Pass	164.6000 MHz	0.610 kHz	0.550 kHz	0.650 kHz	460	460
Pass	173.9000 MHz	0.622 kHz	0.550 kHz	0.650 kHz	464	464

DQT Deviation Align - Narrow

Result	Frequency	Deviation	Min Limit	Max Limit	Old Softpot	New Softpot
Pass	136.1000 MHz	0.348 kHz	0.300 kHz	0.400 kHz	457	457
Pass	145.6000 MHz	0.340 kHz	0.300 kHz	0.400 kHz	450	450
Pass	155.1000 MHz	0.355 kHz	0.300 kHz	0.400 kHz	461	461
Pass	164.6000 MHz	0.351 kHz	0.300 kHz	0.400 kHz	460	460
Pass	173.9000 MHz	0.354 kHz	0.300 kHz	0.400 kHz	464	464

LTR Deviation Align - Wide 5k

Result	Frequency	Deviation	Min Limit	Max Limit	Old Softpot	New Softpot
Pass	136.1000 MHz	1.000 kHz	0.950 kHz	1.050 kHz	532	532
Pass	145.6000 MHz	0.986 kHz	0.950 kHz	1.050 kHz	517	517
Pass	155.1000 MHz	0.983 kHz	0.950 kHz	1.050 kHz	519	519
Pass	164.6000 MHz	0.987 kHz	0.950 kHz	1.050 kHz	517	517
Pass	173.9000 MHz	0.981 kHz	0.950 kHz	1.050 kHz	518	518

LTR Deviation Align - Wide 4k

Result	Frequency	Deviation	Min Limit	Max Limit	Old Softpot	New Softpot
Pass	136.1000 MHz	0.752 kHz	0.700 kHz	0.800 kHz	424	424
Pass	145.6000 MHz	0.751 kHz	0.700 kHz	0.800 kHz	423	423
Pass	155.1000 MHz	0.750 kHz	0.700 kHz	0.800 kHz	420	420
Pass	164.6000 MHz	0.757 kHz	0.700 kHz	0.800 kHz	424	424
Pass	173.9000 MHz	0.750 kHz	0.700 kHz	0.800 kHz	423	423

LTR Deviation Align - Narrow

Result	Frequency	Deviation	Min Limit	Max Limit	Old Softpot	New Softpot
Pass	136.1000 MHz	0.750 kHz	0.700 kHz	0.800 kHz	517	517
Pass	145.6000 MHz	0.753 kHz	0.700 kHz	0.800 kHz	518	518
Pass	155.1000 MHz	0.755 kHz	0.700 kHz	0.800 kHz	519	519
Pass	164.6000 MHz	0.752 kHz	0.700 kHz	0.800 kHz	520	520
Pass	173.9000 MHz	0.750 kHz	0.700 kHz	0.800 kHz	519	519

DTMF Deviation Align - Wide 5k

Result	Frequency	Deviation	Min Limit	Max Limit	Old Softpot	New Softpot
Pass	136.1000 MHz	2.501 kHz	2.450 kHz	2.550 kHz	549	549
Pass	145.6000 MHz	2.499 kHz	2.450 kHz	2.550 kHz	544	544
Pass	155.1000 MHz	2.481 kHz	2.450 kHz	2.550 kHz	542	542
Pass	164.6000 MHz	2.503 kHz	2.450 kHz	2.550 kHz	545	545
Pass	173.9000 MHz	2.495 kHz	2.450 kHz	2.550 kHz	549	549

DTMF Deviation Align - Wide 4k

Result	Frequency	Deviation	Min Limit	Max Limit	Old Softpot	New Softpot
Pass	136.1000 MHz	2.004 kHz	1.950 kHz	2.050 kHz	549	549
Pass	145.6000 MHz	1.988 kHz	1.950 kHz	2.050 kHz	544	544
Pass	155.1000 MHz	1.988 kHz	1.950 kHz	2.050 kHz	542	542
Pass	164.6000 MHz	1.996 kHz	1.950 kHz	2.050 kHz	545	545
Pass	173.9000 MHz	2.008 kHz	1.950 kHz	2.050 kHz	549	549

DTMF Deviation Align - Narrow

Result	Frequency	Deviation	Min Limit	Max Limit	Old Softpot	New Softpot
Pass	136.1000 MHz	1.249 kHz	1.200 kHz	1.300 kHz	549	549
Pass	145.6000 MHz	1.233 kHz	1.200 kHz	1.300 kHz	544	544
Pass	155.1000 MHz	1.230 kHz	1.200 kHz	1.300 kHz	542	542
Pass	164.6000 MHz	1.239 kHz	1.200 kHz	1.300 kHz	545	545
Pass	173.9000 MHz	1.249 kHz	1.200 kHz	1.300 kHz	549	549

Single Tone Deviation Align - Wide 5k

Result	Frequency	Deviation	Min Limit	Max Limit	Old Softpot	New Softpot
Pass	136.1000 MHz	2.992 kHz	2.950 kHz	3.050 kHz	514	514
Pass	145.6000 MHz	3.021 kHz	2.950 kHz	3.050 kHz	514	514
Pass	155.1000 MHz	3.007 kHz	2.950 kHz	3.050 kHz	514	514
Pass	164.6000 MHz	3.018 kHz	2.950 kHz	3.050 kHz	514	514
Pass	173.9000 MHz	2.992 kHz	2.950 kHz	3.050 kHz	514	514

Single Tone Deviation Align - Wide 4k

Result	Frequency	Deviation	Min Limit	Max Limit	Old Softpot	New Softpot
Pass	136.1000 MHz	2.392 kHz	2.350 kHz	2.450 kHz	514	514
Pass	145.6000 MHz	2.399 kHz	2.350 kHz	2.450 kHz	514	514
Pass	155.1000 MHz	2.406 kHz	2.350 kHz	2.450 kHz	514	514
Pass	164.6000 MHz	2.396 kHz	2.350 kHz	2.450 kHz	514	514
Pass	173.9000 MHz	2.400 kHz	2.350 kHz	2.450 kHz	514	514

Single Tone Deviation Align - Narrow

Result	Frequency	Deviation	Min Limit	Max Limit	Old Softpot	New Softpot

Pass	136.1000 MHz	1.491 kHz	1.450 kHz	1.550 kHz	514	514
Pass	145.6000 MHz	1.498 kHz	1.450 kHz	1.550 kHz	514	514
Pass	155.1000 MHz	1.495 kHz	1.450 kHz	1.550 kHz	514	514
Pass	164.6000 MHz	1.491 kHz	1.450 kHz	1.550 kHz	514	514
Pass	173.9000 MHz	1.494 kHz	1.450 kHz	1.550 kHz	514	514

MSK Deviation Align - Wide 5k

Result	Frequency	Deviation	Min Limit	Max Limit	Old Softpot	New Softpot
Pass	136.1000 MHz	2.996 kHz	2.950 kHz	3.050 kHz	505	505
Pass	145.6000 MHz	3.010 kHz	2.950 kHz	3.050 kHz	501	501
Pass	155.1000 MHz	2.987 kHz	2.950 kHz	3.050 kHz	500	500
Pass	164.6000 MHz	3.010 kHz	2.950 kHz	3.050 kHz	502	502
Pass	173.9000 MHz	3.002 kHz	2.950 kHz	3.050 kHz	505	505

MSK Deviation Align - Wide 4k

Result	Frequency	Deviation	Min Limit	Max Limit	Old Softpot	New Softpot
Pass	136.1000 MHz	2.395 kHz	2.350 kHz	2.450 kHz	505	505
Pass	145.6000 MHz	2.387 kHz	2.350 kHz	2.450 kHz	501	501
Pass	155.1000 MHz	2.388 kHz	2.350 kHz	2.450 kHz	500	500
Pass	164.6000 MHz	2.392 kHz	2.350 kHz	2.450 kHz	502	502
Pass	173.9000 MHz	2.411 kHz	2.350 kHz	2.450 kHz	505	505

MSK Deviation Align - Narrow

Result	Frequency	Deviation	Min Limit	Max Limit	Old Softpot	New Softpot
Pass	136.1000 MHz	1.496 kHz	1.450 kHz	1.550 kHz	505	505
Pass	145.6000 MHz	1.510 kHz	1.450 kHz	1.550 kHz	510	510
Pass	155.1000 MHz	1.485 kHz	1.450 kHz	1.550 kHz	500	500
Pass	164.6000 MHz	1.489 kHz	1.450 kHz	1.550 kHz	502	502
Pass	173.9000 MHz	1.493 kHz	1.450 kHz	1.550 kHz	505	505

CWID Deviation Align - Narrow

Result	Frequency	Deviation	Min Limit	Max Limit	Old Softpot	New Softpot
Pass	136.1000 MHz	1.002 kHz	0.900 kHz	1.100 kHz	463	463
Pass	145.6000 MHz	0.999 kHz	0.900 kHz	1.100 kHz	462	462
Pass	155.1000 MHz	0.996 kHz	0.900 kHz	1.100 kHz	459	459
Pass	164.6000 MHz	1.000 kHz	0.900 kHz	1.100 kHz	463	463
Pass	173.9000 MHz	1.000 kHz	0.900 kHz	1.100 kHz	462	462

Rx Sensitivity Test

Result	Channel Spacing	Frequency	12dB SINAD	Max Limit
Pass	Analog Narrow	155.0500 MHz	-120.6 dBm	-117.0 dBm
Pass	Analog Wide 5k	155.0500 MHz	-121.7 dBm	-117.0 dBm

AF Setting Align

Result	AF Voltage	Min Limit	Max Limit	Volume Lvl
Pass	0.82 V	0.80 V	1.00 V	158

Rx Squelch Align - Open Squelch Analog Narrow

Result	Frequency	Output Level	Old Softpot	New Softpot
Pass	136.0500 MHz	-123.0 dBm	74	52
Pass	145.5500 MHz	Average	65	53
Pass	155.0500 MHz	-123.7 dBm	55	54
Pass	164.5500 MHz	Average	55	55
Pass	173.9500 MHz	-123.2 dBm	55	56

Rx Squelch Align - Open Squelch Analog Wide 5k

Result	Frequency	Output Level	Old Softpot	New Softpot
Pass	136.0500 MHz	-123.0 dBm	74	52
Pass	145.5500 MHz	Average	65	53
Pass	155.0500 MHz	-123.7 dBm	55	54
Pass	164.5500 MHz	Average	55	55
Pass	173.9500 MHz	-123.2 dBm	55	56

Rx Squelch Align - Open Squelch P25 Phase1 Narrow (C4FM)

Result	Frequency	Output Level	Old Softpot	New Softpot
Pass	136.0500 MHz	-123.0 dBm	89	67
Pass	145.5500 MHz	Average	80	68
Pass	155.0500 MHz	-123.7 dBm	70	69
Pass	164.5500 MHz	Average	70	70
Pass	173.9500 MHz	-123.2 dBm	70	71

Rx Squelch Align - Open Squelch P25 Phase1 Narrow (LSM)

Result	Frequency	Output Level	Old Softpot	New Softpot
Pass	136.0500 MHz	-123.0 dBm	89	67
Pass	145.5500 MHz	Average	80	68
Pass	155.0500 MHz	-123.7 dBm	70	69
Pass	164.5500 MHz	Average	70	70
Pass	173.9500 MHz	-123.2 dBm	70	71

Rx Squelch Align - Open Squelch NXDN Narrow

Result	Frequency	Output Level	Old Softpot	New Softpot
Pass	136.0500 MHz	-123.0 dBm	94	72
Pass	145.5500 MHz	Average	85	73
Pass	155.0500 MHz	-123.7 dBm	75	74
Pass	164.5500 MHz	Average	75	75

Pass	173.9500 MHz	-123.2 dBm	75	76

Rx Squelch Align - Open Squelch NXDN Very Narrow

Result	Frequency	Output Level	Old Softpot	New Softpot
Pass	136.0500 MHz	-123.0 dBm	89	67
Pass	145.5500 MHz	Average	80	68
Pass	155.0500 MHz	-123.7 dBm	70	69
Pass	164.5500 MHz	Average	70	70
Pass	173.9500 MHz	-123.2 dBm	70	71

Rx Squelch Align - Open Squelch DMR

Result	Frequency	Output Level	Old Softpot	New Softpot
Pass	136.0500 MHz	-123.0 dBm	114	92
Pass	145.5500 MHz	Average	105	93
Pass	155.0500 MHz	-123.7 dBm	95	94
Pass	164.5500 MHz	Average	95	95
Pass	173.9500 MHz	-123.2 dBm	95	96

Rx Squelch Align - Tight Squelch Analog Narrow

Result	Frequency	Output Level	Old Softpot	New Softpot
Pass	136.0500 MHz	-114.0 dBm	216	193
Pass	145.5500 MHz	Average	205	193
Pass	155.0500 MHz	-114.7 dBm	193	193
Pass	164.5500 MHz	Average	193	193
Pass	173.9500 MHz	-114.2 dBm	194	193

Rx Squelch Align - Tight Squelch Analog Wide 5k

Result	Frequency	Output Level	Old Softpot	New Softpot
Pass	136.0500 MHz	-114.0 dBm	216	193
Pass	145.5500 MHz	Average	205	193
Pass	155.0500 MHz	-114.7 dBm	193	193
Pass	164.5500 MHz	Average	193	193
Pass	173.9500 MHz	-114.2 dBm	194	193

Rx RSSI Align

Result	Tuning Item	Frequency	Old Softpot	New Softpot
Pass	RSSIReference	136.05 MHz	139	136
Pass	RSSIReference	155.05 MHz	137	137
Pass	RSSIReference	173.95 MHz	133	134
Pass	RSSIReference	145.55 MHz	138	136
Pass	RSSIReference	164.55 MHz	135	135
Pass	LowRSSI	136.05 MHz	145	145
Pass	LowRSSI	155.05 MHz	166	159
Pass	LowRSSI	173.95 MHz	143	205
Pass	LowRSSI	145.55 MHz	155	152
Pass	LowRSSI	164.55 MHz	154	182
Pass	HighRSSI	136.05 MHz	220	221
Pass	HighRSSI	155.05 MHz	232	236
Pass	HighRSSI	173.95 MHz	219	219
Pass	HighRSSI	145.55 MHz	226	228
Pass	HighRSSI	164.55 MHz	225	227

Digital Sensitivity Test

Result	Signaling	Frequency	5% BER Level	Max Level
Pass	P25 Phase 1	155.0500 MHz	-121.7 dBm	-117.0 dBm
Pass	P25 Phase 2	155.0500 MHz	-122.3 dBm	-117.0 dBm
Pass	NXDN	155.0500 MHz	-122.0 dBm	-117.0 dBm

APP Version 4.x

Figure B-1. Sample Test Result Report

APPENDIX C. Alternate Test Set

A custom test set jig may be constructed for performing AutoTune tests and alignments in place of the 202951-01 Test Set supplied by Freedom Communication Technologies. For required programming cable and audio connections, please see the radio service manual for the model under test.

For Kenwood NX-3000/5000 Portable radios, a custom test jig interface requires the Kenwood KPG-22U, KPG-36 or KPG-36A interface cable be modified to tap into the audio wires.

Kenwood offers some tuning cables which make this job easier, such as the W3F-0381-00 tuning cable which connects with the KPG-22U USB cable to expose Speaker and Microphone pins for creating custom interfaces to test equipment.

For Kenwood NX-3000/5000 Mobile radios, a custom test jig interface requires the Kenwood adapter cable E30-3383-05, which connects with KPG-46U/X to bring out the audio wires used for injecting audio into the transceiver.

Refer to Figure 4-1. NX-3000/5000 Portable Test Setup Diagram and/or Figure 6-1. NX-3000/5000 Mobile Test Setup Diagram for general connector information.

Note: Approved USB to serial adapters for connecting the R8000 analyzer to the Kenwood NX-3000/5000 Portable or Mobile series radio under test include any adapters which utilize an FTDI FT232_USB to serial UART interface. See http://www.ftdichip.com/Products/ICs/FT232R.htm for more detail.

APPENDIX D. Revision History

B See ECO	M.Mullins	M. Humphries	2/26/2001	0337
A – Initial	M.Mullins	M. Humphries	1/13/2021	0329
Revision – Change	Requested By	Approved By	Rel. Date	ECO#