Motorola APX™ Auto-Test and Alignment

3920B Radio Test Platform

VIAVI

This guide describes how to setup and use the Motorola APX Auto-Test application on the 3920B.

Supported Models

APX 900	APX 3000	APX 6500	APX NEXT
APX 1000	APX 4000	APX 7000	SRX 2200
APX 1500	APX 4500	APX 7000XE	
APX 2000	APX 5000	APX 7500	
APX 2500	APX 6000	APX 8500	

Equipment Requirements

3920B with options
- Option 061 – Tracking Generator
- Option 200 – P25 Conventional Operation
- Option 218 – Auto-Test II for P25
- Option 220 – (Optional – Allows testing of Phase II TX and RX)
- Option 604 – Motorola APX Series Auto-Test and Alignment
- Option 644 – Motorola APX 8000 (Requires Option 604)
- Option 645 – Motorola APX "B" Series (Requires Option 604)
- Option 646 – Motorola APX NEXT™ Series (Requires Option 604)

Test Hardware
- VIAVI 112277 – 10 Amp Current Shunt 0.01 Ohm (for Mobile PA BIAS Alignment)
- VIAVI 82556 – 6 dB / 150 Watt 1.5 GHz Attenuator – For testing High Power mobiles
- Radio programming cable
    - o Motorola PMKN4012 or PMKN4013 for portables
    - o Motorola HKN6184 for mobiles
- Variable Power Supply (30 Amp rating for High Power mobiles)
- Battery Eliminator and Interface Box (for APX 900, APX 1000, APX 2000, APX 3000, APX 4000)
    - o Motorola 66-012031001
    - o Motorola RLN4510 if available
- Battery Eliminator (for APX 6000, APX 7000, APX 8000, SRX 2200)
    - o Motorola 66-009254002
- Test Cable (Double Shielded RG-223 recommended) BNC (M) – BNC (M)
- Reference Cable (Short 6") BNC (M) – BNC (M)
- 3 or 6 dB Attenuator BNC (M) – BNC (F) (Optional but recommended for best accuracy)
- Connector Adapters
    - o BNC (F) – BNC (F)
    - o BNC (F) – SMA (F) Motorola 58-80384G68 (for portables)
    - o BNC (F) – UHF Mini (M)
    - o TNC (M) – BNC (F)
    - o N (M) – BNC (F)
- For best accuracy, the 3920B should be connected and configured to use an external 10 MHz Standard.
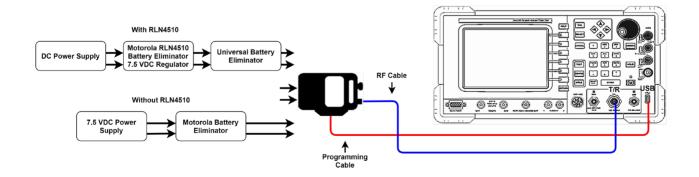
Before you Begin

- Before testing begins, be sure to check the system software version of your 3920. Press the UTILS key (twice) to access the Utilities menu. Choose Software Settings>Software Upgrade to see the installed software versions.

- The system software version is indicated next the "BASE_CONFIG". The Motorola APX application version is indicated to the right of OPTION_604.

Software Upgrade			
Package Name	Version	Upgrade Version	Check for Upgrades
☐ BASE_CONFIG_02	3.7.8		
☐ OPTION_050	3.7.8		

- Check for software updates on the VIAVI 3920 Series Software webpage at www.viavisolutions.com/en-us/software-download/3920-series-software. The current system software version is displayed next to 3920 Series Software Update.

- If the system software version is older than the version listed on this site, download the software, release notes, and installation instructions and update your system software. The system software download includes the latest Auto-Test Software Update.

- If the system software version is current, check your Auto-Test application version, as the test scripts are updated more frequently than system software. The Auto-Test Release Notes will list current versions in order of most recently updated.

- The Auto-Test Software Update includes all currently released test scripts.
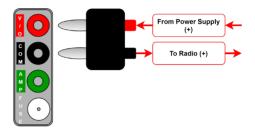
APX Portable Interconnect

1. Connect a 12 VDC power supply to the RLN4510 or battery eliminator.

2. If the RLN4510 is not available, set the power supply to 7.5 VDC. The power supply should be rated at 5 Amps.

3. Connect radio ANT to 3920 T/R Port.
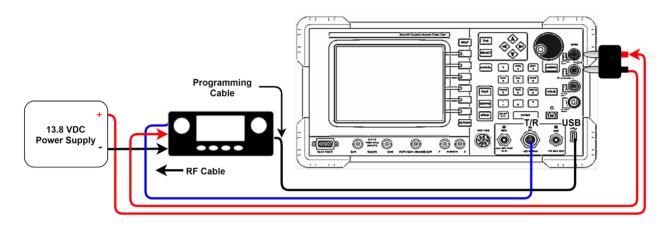
4. Connect radio programming cable to 3920 USB port.

APX Mobile Interconnect

1. Connect radio TX Out to 3920 T/R port.

2. Connect radio programming cable to 3920 USB port.

3. Connect power supply to mobile with positive lead through the current shunt if PA BIAS alignment is to be performed. The current shunt is not required for power testing.

4. The power supply should be capable of supplying the required amount of current and the current limiting should not be set too low. Proper gauge wires should also be used.

Access to the Application through Auto-Test II

1. On the 3920, press the CONFIG key (twice) to gain access to the System menu and select Auto-Test II. This can also be accomplished by right clicking with a mouse and selecting Auto-Test II.

2. Select the Motorola APX Auto-Test from the Auto-Test II menu.

Test Screen - Test Selections

The selections on this screen allow any combination of tests or alignments to be performed. Single or multiple bands may be selected. The application will not attempt to perform invalid operations on the radio if the test or alignment is not supported by the radio that is connected.

Select All Tests - This will enable all tests.

Reset Test Menu - This will disable all tests.

VHF / UHF / 800 band selections

- Only selected bands will be tested.

- All bands may be selected and only bands that exist in the radio will be tested.

Note: The reference oscillator will be tested on the highest band and frequency that is selected for test.

View Results while testing

- When selected and the test or alignment function has been executed, the screen will change and will display all tests and alignments as they occur. If not selected, the application will stay on this screen and show only the current status, Testing / Passed / Failed / Skipped.

Test Low Power

- Some users do not use low power on the radios. Enabling this selection reduces the test time by not testing low power levels.

Beep at end of test

- The 3920 will produce an audible beep at the completion of all tests and alignments to notify the operator that the test or alignment is complete.

Enable long format logging

- Diagnostic mode that shows all adjustments to soft pot values.

Connect messages beep when waiting

- When testing dual band mobiles, you will be prompted to move the test cable when moving from one band connector to the other. This option will produce an audible beep to prompt the operator to change the cable connection. Note: The highest frequency band that is selected is always tested first.

Create log file

- Will create a log file for diagnostic purposes.

Test Screen - Function keys

F1 – **Test**
- Starts testing the radio. No alignments will be made. A test report of Pass / Fail results will be recorded. Radio model will be automatically identified, and the appropriate specification table will be used for testing.

F2 – **Align and Test**
- All selected items that are capable of being aligned will be aligned. Performance tests will also be performed to validate the alignment.

F3 – **Test and Align**
- All selected tests will be tested. Any failed item will be aligned and then re-tested after alignment.

F4 – **Edit Specs Cable Loss**
- Only required when initially setting up the system for a specific model of radio. Must be reviewed prior to testing a new model of radio or when changing test cables.

F5 – **View Results**
- Views results of the last test performed. Also allows test results to be copied to a USB drive.

F6 – **More**
- Access to Admin, Radio Connect diagrams and special features.
- Reset Messages button:
    - Will re-write the Default.cfg file
    - Reset pop up messages that have been skipped
    - Reset Autosave selection

Note: Motorola recommends retuning of radios only if it is a part of an issue resolution or engineering recommendation. Reference oscillator should be checked and tuned (if necessary) for radios in storage for six months or more.

Admin Menu

Create a Password
- Allows entry of a password for access to the Edit Specs screen. If users are not allowed to make changes to the radio test specifications, a password may be entered here and must be entered to gain access to the Edit Specs screen.

Reset Password
- After a password has been entered, the only way to remove it is to enter a Reset Password. This Reset Password can be provided by VIAVI Tech Support (techsupport.avcomm@viavisolutions.com).

- After this value has been entered, press the Reset Password button and the password protection will be removed and a new password may be entered if desired.

Edit Specs Screen

Info lines
- Allows three lines of user text to be entered that will be visible at the beginning of the printout in the Test Results file. These could be used to identify a Technician ID, Company Name or anything that might be useful at the beginning of the printout.

F1 – **Save As**
- Save all modifications to specifications to a user specified file. Information on all models is saved in a single file.

F2 – **Save**
- Save all modifications of specifications to the currently loaded specification configuration file.

F3 – **Recall**
- Recall a saved specification file from memory.

F4 – **Recall Current Radio**
- Interrogate the connected radio for model number and show the specifications for that radio.

F5 – **Cable Loss**
- Access to the cable loss measurement application.
  Note: This is one of the first things that should be done prior to testing a radio.

F6 – **Restore Defaults**
- Resets specifications to the factory defaults. Note, these values are not permanently stored unless you answer yes when prompted or press the Save Key. This does not impact Radio selection, Info lines, Offset or cable selections.
  ** This operation should be performed after updating the application to a new version.

Model Selection
- This is used to access the specifications for supported models. Note that the specifications used when testing a radio are automatically determined after the radio model has been identified at the beginning of a test sequence.

Copy
- Copies currently selected Cable to:
  - All Portables
  - All Mobiles
  - All Radios

Copy (continued)

- Additionally allows copying entries in the info lines to the selected list.

Note: This will automatically save to the currently selected specification file.

Offset / Cable Loss

- These values are used to correct the power meter for TX Tests and RF Generator for RX Tests. If you are using an external 6 dB high power attenuator, you can enter a *negative* value as an offset. You can additionally use a cable sweep plot to compensate for a test cable. This feature is primarily needed for testing or aligning Transmitter power levels.

Note: If it is not possible to perform the cable sweep, enter a fixed negative value in the offset field to compensate for the connecting cable. This value will be used at all frequencies to compensate the power meter. A higher loss value entry would cause the Power meter to read higher values.

- The offset entry will be applied in addition to a cable loss selection.

Power Levels

- For Portables and Mobiles, the default values should match the MIN and MAX values in the radio's code plug. These are the TEST MODE power levels that Auto-Test uses. Auto-Test cannot transmit the user programmed power levels.

Reference Oscillator

- These values are used for test evaluation only. If Alignment is selected, the radio will be aligned to within 30 Hz error. Note that an External Reference is recommended.

RX BER Tests

- The number of frames is the number of frames that are averaged in the radio prior to reporting a BER reading. The BER Level is the RF Injection level from the 3920. The radio should have 5% or less BER at this test level.
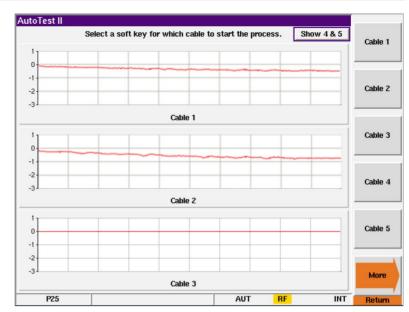
Cable Loss Screen

Cable 1 - 5

• Sweep up to 5 different cable plots. These are initially flat with no calibration. After making a selection, prompts will be provided for cable connection and the cable insertion loss will be measured.

More

• Access to Delete cable data or Modify cable data.
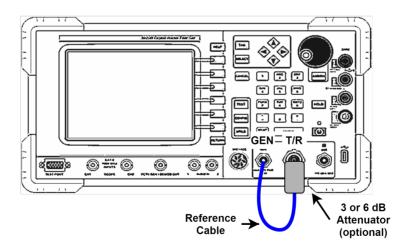

Test Cable Calibration

Reference Cable

• The 3920 will use its spectrum analyzer and tracking generator to sweep a reference cable and will establish this sweep as a zero reference.

• This cable is used ONLY for calibration purposes and will not be used for testing the radio.

Getting more accurate results

• To obtain better results from this process, use a 3 or 6 dB attenuator at the end of the reference cable that is connected to the T/R port of the 3920. This will improve the VSWR of the cable when it is connected to the Radio Testing Cable.

Reference Cable Sweep

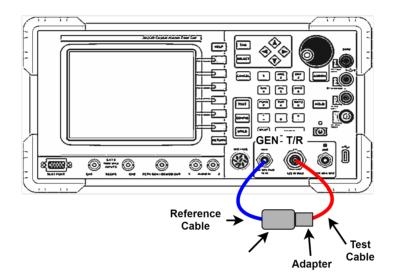• Gen port -> Reference Cable -> 3 or 6 dB Attenuator (optional) ->TR port

Radio Testing Cable Sweep

- After the Reference cable sweep has been completed, you will be prompted to connect the Radio Testing Cable in line with the Reference cable. The 3920 will again use its spectrum analyzer and tracking generator to sweep the combined cables and will plot the difference between the two sweeps as the insertion loss of the cable that was added.

Radio Testing Sweep

- Gen port -> Reference Cable -> 3 or 6 dB Attenuator (optional) -> Adapter -> Radio Testing Cable -> TR port

NOTE: The on-screen instructions make no mention of the use of an external attenuator for this calibration.
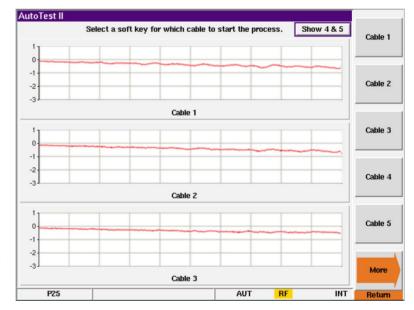

Results of Cable Calibration

Cable 1

- This calibration was performed as directed without the use of the 6 dB external attenuator.

Cable 2

- This calibration was performed with the same Radio Test Cable but a 6 dB attenuator was used as explained above.

Cable 3

- This calibration was performed with the external 6 dB attenuator and a high quality, low loss, double shielded Radio Test Cable.

The Difference

- Results will vary depending on the quality and length of the test cable. This test was done with a 3ft RG-58 test cable.
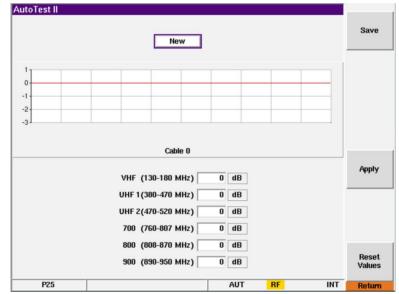
- Notice that Cable 1 response is not as smooth as the Cable 2 response. These waves are caused by a VSWR mismatch at the point where the cables are connected together. Use of the 6 dB attenuator at this junction improves the VSWR and minimizes some of these standing waves.

The Impact

- When calibrating the transmitter power, even small amounts of error in the insertion loss measurement can cause the radio to fail the test. An insertion loss of 0.4 dB that is not accounted for can cause up to a 10% error in power measurement.

- With Dual Band radios, it is important to note that the insertion loss at low frequencies is less than the insertion loss at higher frequencies so one fixed entry for cable loss will not correct the power meter in both bands correctly.

Cable Loss - Modify Data

If loss values are already known, it is possible to create a trace offset through the Modify Data feature. This allows creation of banded loss factors with known loss values. Enter negative values to account for loss.
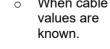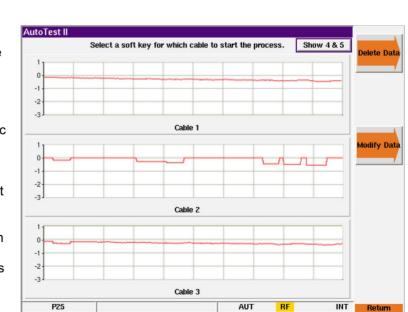

Cable 1
- This is a standard Trace Sweep.

Cable 2
- This trace was created by entering band specific offset levels.
- Use this when:
  - Appropriate adapters are not available.
  - The tracking generator option is not installed.
  - When cable loss values are known.

Cable 3

- Modified trace allows power meter matching to a Bench Power Meter standard.

View Results

Displays the most recent test result.

- Shows Time Date stamp along with the 3920's serial number and version information for both the system and the application.
- Shows radio model, serial number along with radio software versions and configurations.
- Shows the Flash Code

Load File

- Allows a different test results file to be loaded and displayed.

Print Results

- Prints the test results to a printer that is connected to the 3920 or a network printer if configured for this in the systems printer configuration screen.

Clear

- Clears the currently displayed results from the screen.

Copy Results to USB

- Copies ALL test result files from the 3920's hard drive to a connected USB flash drive.

Clear Results Data

- Deletes all test results files from the 3920's hard drive.

Running the Auto-Test, Step by Step

1. Select the Auto-Test II system and select the Motorola APX Auto-Test.

2. Connect the Portable or Mobile radio to be tested.

3. Edit Specs Screen

    1. Connect the radio to be tested and select "Recall Current Radio" button on the Edit Specs screen.

    2. Verify specifications are set appropriately.

    3. If cable loss factors have not been created, then access the Cable Loss screen and either sweep the test cable or enter appropriate correction factors if known.

    4. Select the cable to be used for this radio on the Edit Specs screen.

    5. Press Return.

4. Main Test Screen

    1. Select the frequency band or bands to be tested. The application will automatically detect the bands that are supported by the radio.

    2. Select the tests or alignments to be performed.

    3. Press the Test, Align and Test, or Test and Align softkey.

5. Failed tests should be confirmed by re-testing.

Additional Options 644, 645, and 646

Option 644 – APX 8000 series allows testing of the APX 8000 and APX 8000H portables and APX 8500 mobile radios.

- Power supply current rating should have 5 Amp capability for portables.
- The minimum software version for the radio is 14.50.00.
- The minimum APX application version for the APX 8000 is 4.6.2.
- All power specifications are preset.

Option 645 – APX "B" series allows testing of radio models ending with "BN". This is currently the 6000B and 5000B radios.

- Power supply current rating should have 5 Amp capability for portables.
- The minimum APX application version for the "B" radios is 4.5.2.

Option 646 – APX NEXT series allows testing of APX NEXT series radios.

- The minimum APX application version for the APX NEXT radios is 5.1.7.