

APX™ Mobile and Portable Automated Test and Alignment



Operational Requirements

APX Automatic Test and Alignment

- Aeroflex 3920
 - 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 “B” Series (Requires Option 604) / **APX Autotest minimum version is 4.5.2**
 - AC24011 – 10 AMP Current Shunt 0.01 Ohm (for Mobile PA BIAS Alignment)
 - AC25059 – 6 dB / 150 Watt 1.5 GHz Attenuator – For testing High Power mobiles
- Variable Power Supply (30 Amp rating for High Power mobiles)
 - Battery Eliminator (for portables) – (Motorola 66009254001)
 - Battery Eliminator Interface box (for portables) – (Motorola RLN 4510 if available)
- Test Cable (Double Shielded RG-223 recommended) BNC (M) – BNC (M)
- Reference Cable (Short 6”) BNC (M) – BNC (M)
 - 6 dB Pad BNC (M) – BNC (F) (Optional but recommended for best accuracy)
- Connector Adapters
 - BNC (F) – BNC (F)
 - BNC (F) – SMA (F)
 - BNC (F) – UHF Mini (M)
 - TNC (M) – BNC (F)
 - N (M) – BNC (F)
- For best accuracy, use the 3920B should be connected and configured to use an external 10 MHz Standard. The Stanford Research Systems FS725 is recommended for a portable Rubidium Frequency Standard.

Before you begin !

Check your 3920 system version to see that it is the latest version

- Before testing begins, be sure to check the version of system release of your 3920. Press the UTILS key (twice) to gain access to the system menu. Choose Software Settings>Software Upgrade to see the installed software versions.
- The system version is indicated next the “BASE_CONFIG”.
- The APX application version is indicated to the right of OPTION_604.
- Autotest applications are released independently from the 3920B system release as radio test scripts change on a more frequent basis.

Click Here

- Go to the Cobham / Aeroflex website:
- Click on the “Software” Tab and scroll to the section called “Software”.
- If your system version is older than the version listed on this site, then download the software, release notes and installation instructions and update your system software.

Package Name	Version	Upgrade Version
<input type="checkbox"/> BASE_CONFIG_02	3.7.3	
<input type="checkbox"/> OPTION_050	3.7.3	
<input type="checkbox"/> OPTION_221	3.7.3	
<input type="checkbox"/> OPTION_240	3.7.3	
<input type="checkbox"/> OPTION_600	4.1.2.201703241331	
<input type="checkbox"/> OPTION_601	4.1.0.201509231557	
<input type="checkbox"/> OPTION_602	4.1.2.201703241331	
<input type="checkbox"/> OPTION_603	4.0.0.201504101351	
<input type="checkbox"/> OPTION_604	4.7.5.201801081602	
<input type="checkbox"/> OPTION_606	4.0.0.201504101344	
<input type="checkbox"/> OPTION_607	4.0.1.201511180900	
<input type="checkbox"/> OPTION_608	4.0.0.201504011059	
<input type="checkbox"/> OPTION_610	4.5.0.201708101008	
<input type="checkbox"/> OPTION_611	4.0.1.201509151524	
<input type="checkbox"/> OPTION_614	4.0.0.201504011059	
<input type="checkbox"/> OPTION_615	4.0.0.201504011059	
<input type="checkbox"/> OPTION_616	5.2.0.201712041231	

Title	Version/Part#	Date	Download
3900 Series Software Update	3.7.2	04-26-2016	
3920B Release Notes	3.7.2	04-26-2016	
3920 Software Upgrade Procedure		12-17-2015	
3920 Scripts Installation Instructions		09-25-2013	
National Instruments Lab view Driver for Analog Duplex for the 3920	1.0	06-26-2009	
3900 Series Lab Windows/CVI Driver for Analog Duplex	1.2	06-09-2009	

Before you begin !

Check your APX application version to see that it is the latest version

- Before testing begins, be sure to check the version of the Autotest application and look on the Aeroflex Website to ensure you are using the latest release. This application is updated frequently to resolve issues, add models etc.
- Autotest applications are released independently from the 3920B system release as radio test scripts change on a more frequent basis.
- Go to the Cobham / Aeroflex website:
- Click on the “Software” Tab and scroll to the bottom of the screen to the section called “3920 Auto-Test II Update”.
- All 3920 test scripts are available in a single file that can be downloaded and installed to update the radio test applications.
- A release notes document will show what the current release is and installation instructions are available as well.

[Click Here](#)

Package Name	Version	Upgrade Version
<input type="checkbox"/> BASE_CONFIG_02	3.7.3	
<input type="checkbox"/> OPTION_050	3.7.3	
<input type="checkbox"/> OPTION_221	3.7.3	
<input type="checkbox"/> OPTION_240	3.7.3	
<input type="checkbox"/> OPTION_600	4.1.2.201703241331	
<input type="checkbox"/> OPTION_601	4.1.0.201509231557	
<input type="checkbox"/> OPTION_602	4.1.2.201703241331	
<input type="checkbox"/> OPTION_603	4.0.0.201504101351	
<input checked="" type="checkbox"/> OPTION_604	4.7.5.201801081602	
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<input type="checkbox"/> OPTION_610	4.5.0.201708101008	
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<input type="checkbox"/> OPTION_615	4.0.0.201504011059	
<input type="checkbox"/> OPTION_616	5.2.0.201712041231	

P25 AUT RF INT Return

3920 Auto-Test II Update

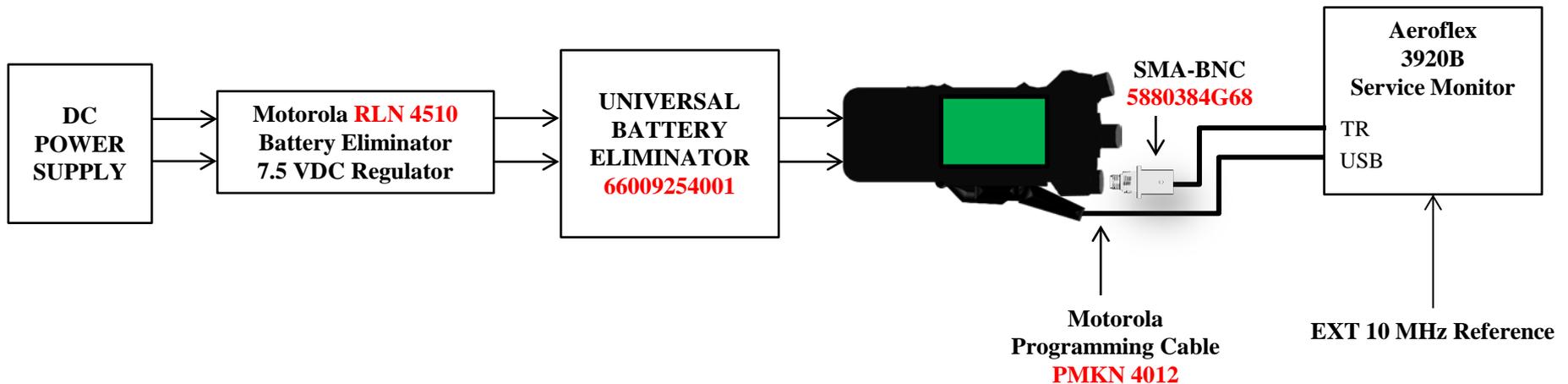
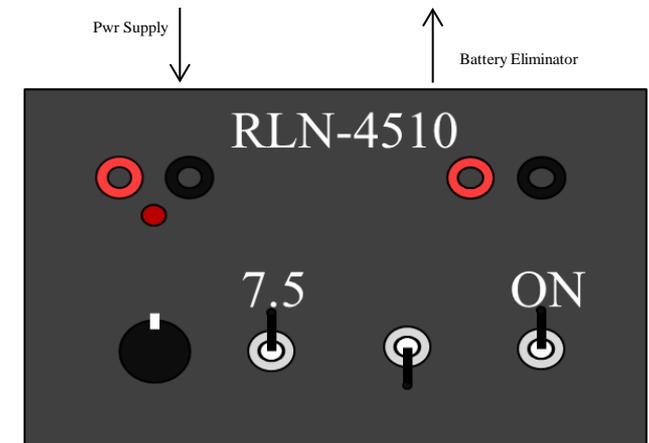
Script updates require a minimum system firmware version of 3.6.0. It is recommended that you update the 3920B to the latest system release prior to the installation of any Script updates.

You must [login](#) to download this software

Title	Version/Part#	Date	Download
3920 Auto-Test Update	May 2017	05-17-2017	
3920 Auto-Test Update Release Notes	May 2017	05-17-2017	
Aeroflex 3901/3902/3920 Option Installation Procedure		06-17-2016	

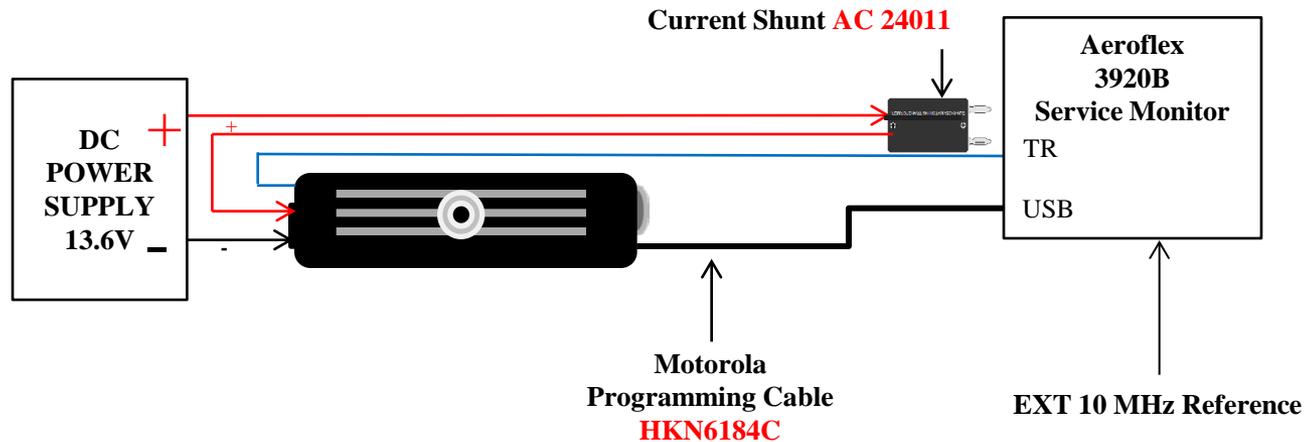
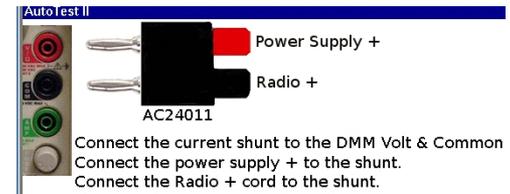
APX Portable Interconnect

- Connect a 12 VDC power supply to the RLN-4510.
- Connect Radio ANT to 3920 TR Port.
- Connect Radio Programming cable to 3920 USB port.
- If the RLN 4510 is not available, set the Power Supply to 7.5 VDC. The power supply should be rated at 5 Amps.



APX Mobile Interconnect

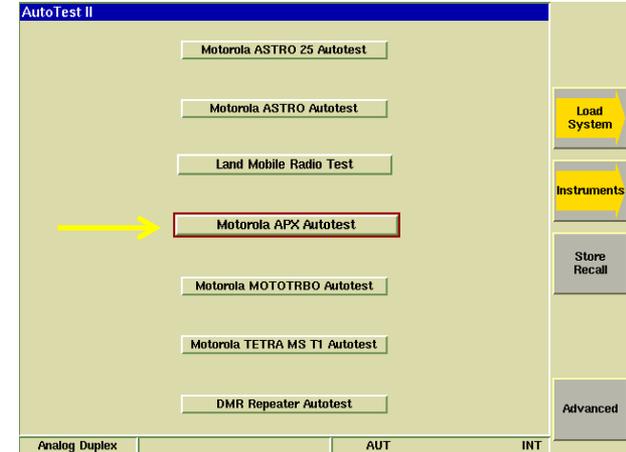
- Connect Mobile TX Out to 3920 TR port.
- Connect Mobile Programming cable to 3920 USB port.
- Connect Power supply to Mobile with Positive lead through the AC 24011 Current shunt if PA BIAS alignment is to be performed.



Autotest II Menu

Access to the Application and System through Auto-Test II

- The Auto-Test II Menu can be accessed by:
 - Right click with mouse and select Auto-Test II.
 - Select Auto-Test II from the system menu. Access to this menu can be accomplished by selecting the CONFIG key twice to access the system menu.
 - Select Motorola APX Auto-Test from the Auto-Test II menu.

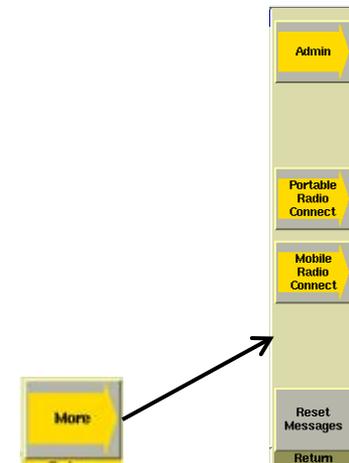
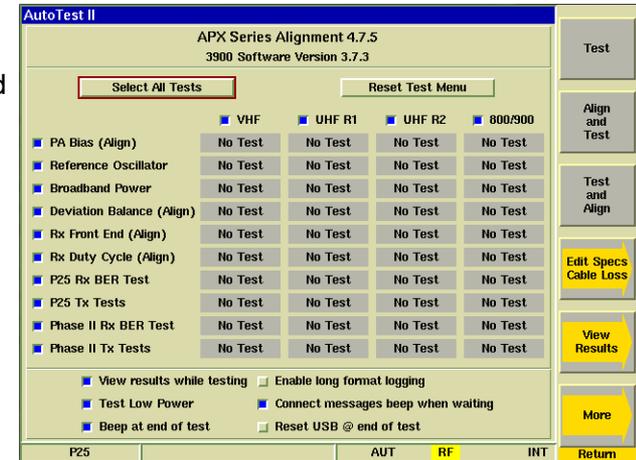


APX Primary Test Screen

Function Keys

- F1 – Test
 - Start testing the radio. No alignments will be made. Only a test report of pass/fail results. Radio model will be automatically identified and 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
 - Allows access to the test results display. Test results may be viewed, recalled or backed up to a USB memory device.
- 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

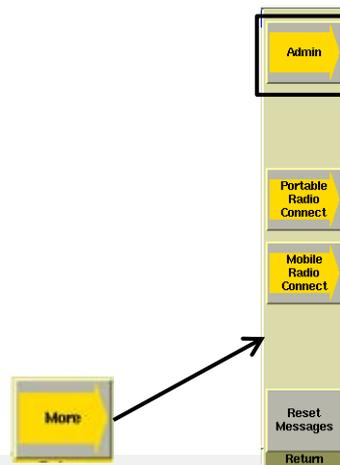
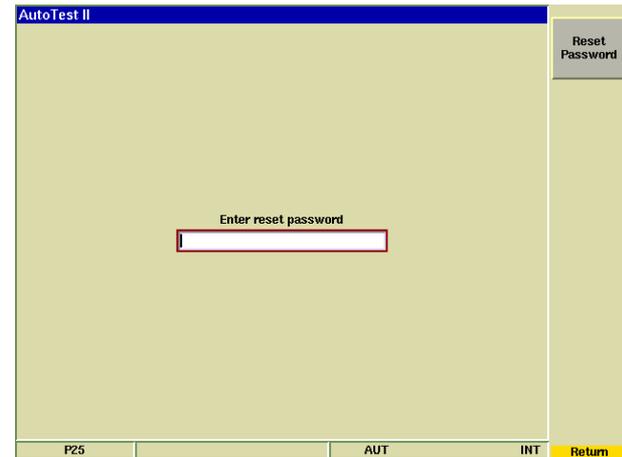
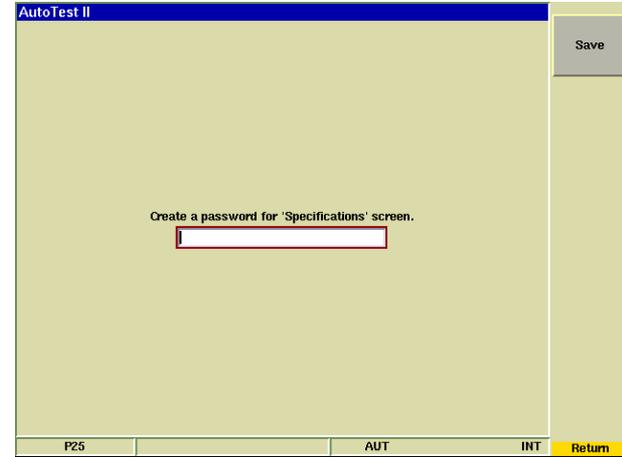
Note: Motorola recommends retuning of radios only if it is a part of an issue resolution or engineering recommendation. Reference oscillator should be checked and tuned (if necessary) for radios in storage for six months or more.



APX Administration Page

Administration

- 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 the following Reset Password value:
 - 85856767
 - 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.

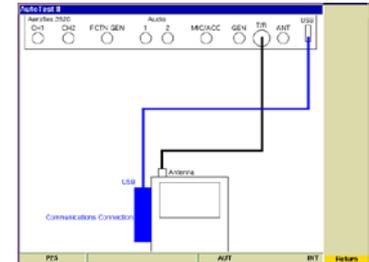


APX Radio Interconnect Diagrams

Radio Connections to the 3920

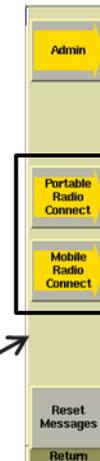
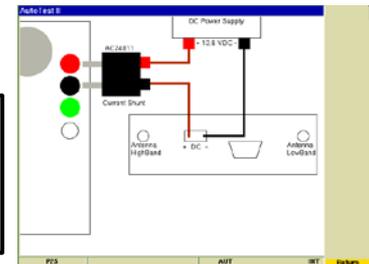
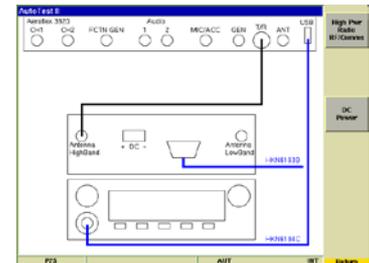
• Interconnect for Portable Radio

1. The Portable radio requires a USB connection from the radio to one of the Aeroflex 3920 USB ports.
2. Requires an RF Cable connection from the 3920 TR port to the radio ANT port.
3. Recommended connection to a battery eliminator and power supply.



• Interconnect for Mobile Radio

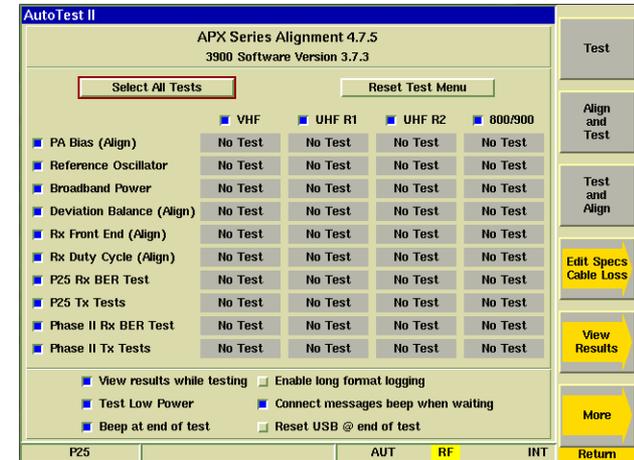
1. The Mobile radio requires a USB connection from the radio to one of the Aeroflex 3920 USB ports. The radio may be connected through the connector on the radios rear section or to the radios control head.
2. The AC24011 current shunt must be used and connected as the diagram indicates only for Power alignment. The current shunt is not required for power testing.
3. The power supply should be capable of supplying the required amount of supply and the current limiting should not be set too low. Proper gauge wires should also be used.
4. For connection to the current shunt, the positive wire must be connected to the current shunt as indicated in the drawing. The current shunt is connected to the 3920's V/ohm and COM connectors on the DMM.



APX Primary Test Screen

Test Selections

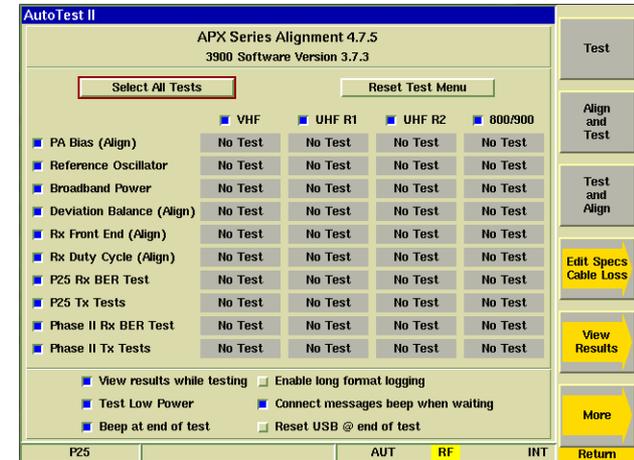
- Allows any combination of tests or alignments to be performed. Single or multiple bands may be selected.
- Any test or band can be selected. The application will not attempt to perform invalid operations on the radio if the test or alignment is not supported by the radio that is connected.
- Select 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 the application will only tests bands that exist in the radio being tested.
 - Note: The reference oscillator will be tested on the highest band and frequency that is selected for test.



APX Primary Test Screen

Test Selections

- View Results while testing
 - The application will stay on this screen and show only current status Testing/Passed/Failed if not selected. When selected and the test or alignment function has been executed, the screen will change and all testing can be viewed as it occurs.
- Test Low Power
 - Some users do not use low power on the radios and they can reduce test time by not testing low power levels if this option is enabled.
- Beep at end of test
 - The 3920 will produce an audible beep at the completion of the test to draw attention to the operator that the test or alignment is done.
- 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 for the operator to change the cable connection. Note: The highest frequency band that is selected is always tested first.
- Reset USB @ end of test
 - Some mobiles require this setting to be enabled. It does not cause any issue to have it selected for other radios.



APX Edit Specs Screen

Function Keys

- Info lines
 - Allows entry of Text that will appear at the top 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 different specification file.
- 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 all of the specifications to all of the radios from memory. This the factory default specifications. 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.**

The screenshot displays the 'AutoTest II' software interface for editing specifications. The title bar reads 'AutoTest II' and the file name is 'default.cfg'. The interface includes three 'Info' lines for text entry. Below these are buttons for 'Copy', 'Offset' (set to 0 dB), 'Manual', and 'Loss'. The main configuration area is divided into sections: 'VHF Band' with parameters for 136-174 LP, 764-805 LP, and 806-870 LP; '700-800 Band' with parameters for LP and HP; 'Ref. Osc. VHF' (175 Hz) and 'Ref. Osc. UHF/800' (250 Hz); 'Mod. Fidelity' (5.00 %); 'P25 BER Frames' (20) and 'Phase II BER Frames' (10); and 'BER Level 800' (-116 dBm) and 'BER Level VHF' (-116 dBm). At the bottom, there are radio selection buttons: P25, AUT, RF (highlighted), and INT. A vertical toolbar on the right contains buttons for 'Save As', 'Save', 'Recall', 'Recall Current Radio', 'Cable Loss', 'Restore Defaults', and 'Return'. A black arrow points from the 'Restore Defaults' button in the list to the 'Restore Defaults' button in the software interface.

APX Edit Specs Screen

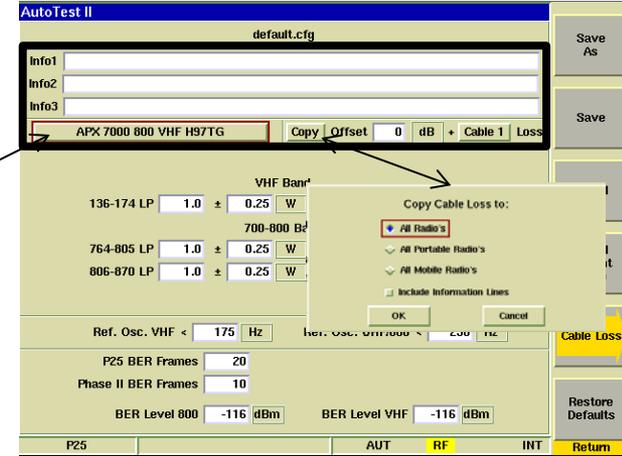
Edit Specification Values

- 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
- 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.



APX Edit Specs Screen

Edit Specification Values

- Power Levels

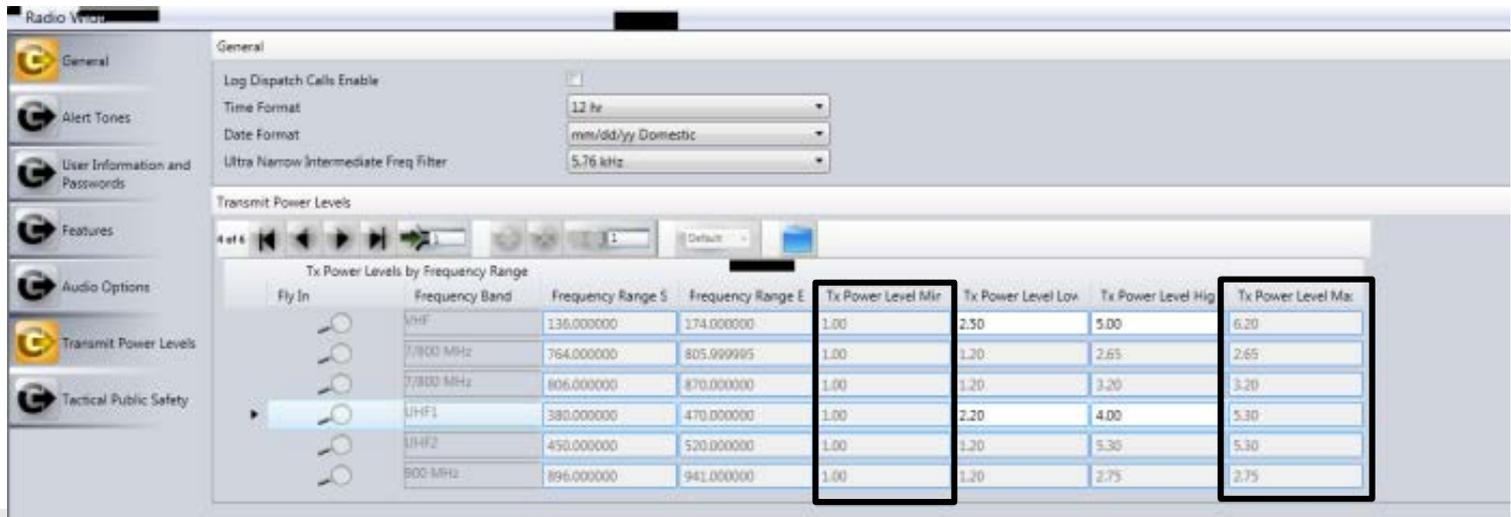
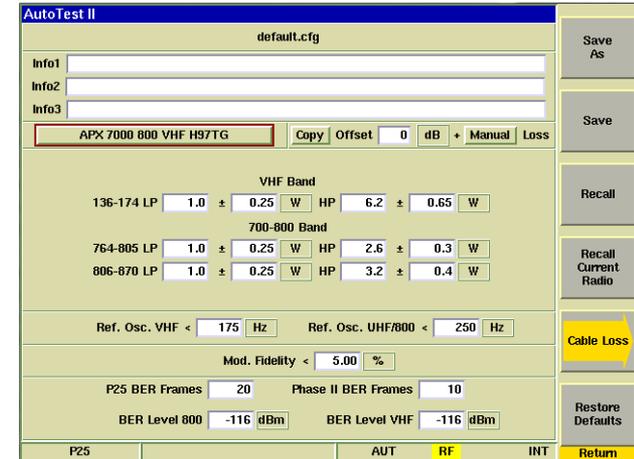
- For Portables and Mobiles, the default values should match the MIN and MAX values in the radio's code plug. These are the TEST MODE power levels that Autotest uses. Autotest cannot transmit the user programmed power levels.

- 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.



APX Cable Loss

Function Keys

- Cable 1 - 5
 - Choose 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.

AutoTest II
default.cfg

Info1
Info2
Info3

APX 7000 800 VHF H97TG Copy Offset 0 dB + Manual Loss

VHF Band
136-174 LP 1.0 ± 0.25 W HP 6.2 ± 0.65 W

700-800 Band
764-805 LP 1.0 ± 0.25 W HP 2.6 ± 0.3 W
806-870 LP 1.0 ± 0.25 W HP 3.2 ± 0.4 W

Ref. Osc. VHF < 175 Hz Ref. Osc. UHF/800 < 250 Hz

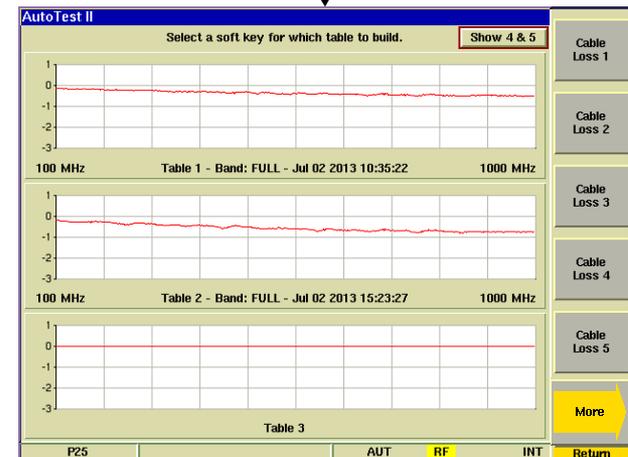
Mod. Fidelity < 5.00 %

P25 BER Frames 20 Phase II BER Frames 10

BER Level 800 -116 dBm BER Level VHF -116 dBm

P25 AUT RF INT Return

Save As
Save
Recall
Recall Current Radio
Cable Loss
Restore Defaults



APX Cable Loss

Test Cable Calibration

- Reference Cable

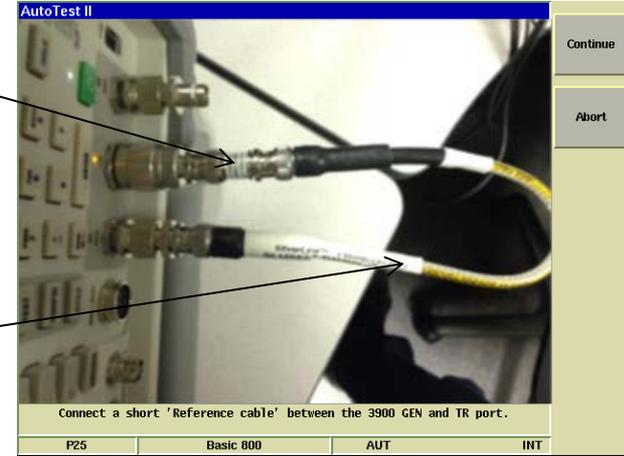
- The 3920 will use its spectrum analyzer and tracking generator to sweep a reference cable and will establish this sweep as a zero reference.
- This cable is used ONLY for calibration purposes and will not be used for testing the radio.

- Getting more accurate results

- To obtain better results from this process, use a 3 or 6 dB pad at the end of the reference cable that is connected to the TR port of the 3920. This will improve the VSWR of the cable for when it is connected to the Radio Testing Cable.
- Reference Sweep
- Gen port -> Reference Cable -> 6 dB Pad -> TR port

3 or 6 dB Pad

Reference Cable



- (1) N (M) – BNC (F) Adapter (TR Port)
- (1) TNC (M) – BNC (F) Adapter (GEN Port)
- (1) BNC (F) – BNC (F) Barrel
- (1) BNC (F) – BNC (M) 6 dB attenuator
- (1) Short BNC (M) – BNC (M) REF cable
- (1) BNC (M) – BNC (M) Test cable
- (1) BNC – SMA Adapter
- (1) BNC – Mini UHF Adapter

APX Cable Loss

Test Cable Calibration

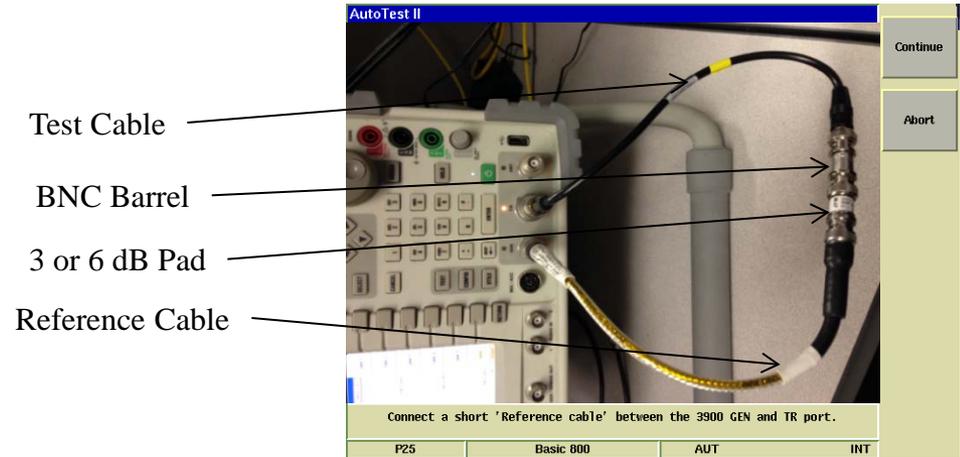
- Radio Testing Cable Sweep

- 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 -> 6 dB Pad -> Adapter -> Radio Testing Cable -> TR port

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

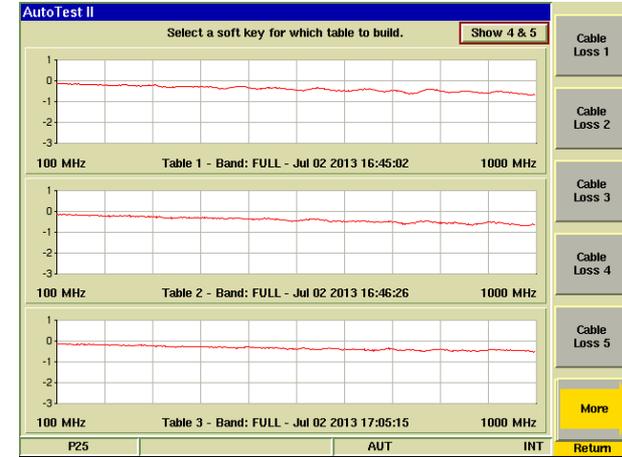


- (1) N (M) – BNC (F) Adapter (TR Port)
- (1) TNC (M) – BNC (F) Adapter (GEN Port)
- (1) BNC (F) – BNC (F) Barrel
- (1) BNC (F) – BNC (M) 6 dB attenuator
- (1) Short BNC (M) – BNC (M) REF cable
- (1) BNC (M) – BNC (M) Test cable
- (1) BNC – SMA Adapter
- (1) BNC – Mini UHF Adapter

APX Cable Loss

Results of cable calibration

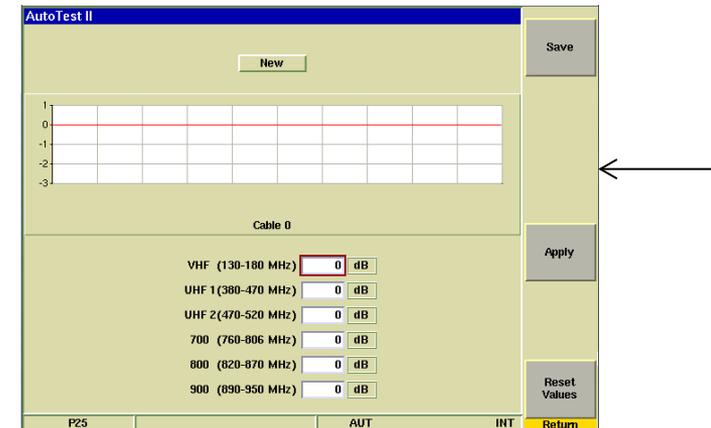
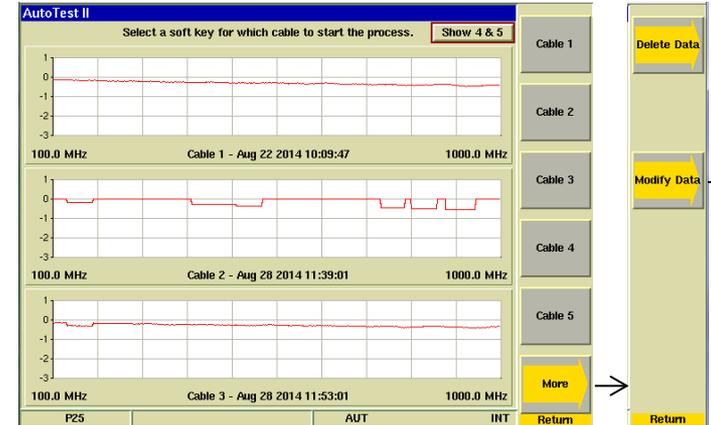
- Trace 1
 - This calibration was done as directed without the use of the 6 dB external attenuator.
- Trace 2
 - This calibration was done with the same Radio Test Cable but a 6 dB attenuator was used when calibrating the Reference cable.
- Trace 3
 - This calibration is done with the external 6 dB attenuator and a high quality, low loss, double shielded 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 Trace 1 is not as flat as trace two. These waves are caused by a VSWR mismatch at the point where the cables are connected together. Use of the 6 dB pad 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.



APX Cable Loss

Modify Cable Sweeps

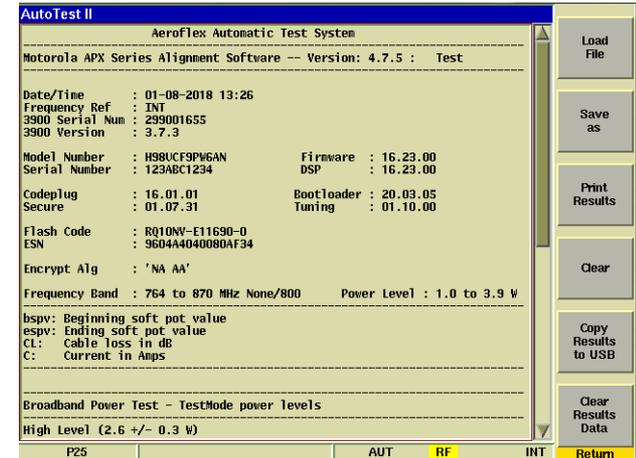
- It is possible to create a trace offset if loss values are already known through the Modify Data feature.
- Allows creation of banded loss factors if loss values are known. Enter negative values to account for loss.
- Allows matching the 3920 Power meter to a higher accuracy Bench power meter.
- Trace 1
 - This is a standard Trace Sweep.
- Trace 2
 - This trace was created by entering band specific offset levels.
 - Use this when:
 - Appropriate adapters are not available.
 - The tracking generator is not installed.
 - When cable loss values are known.
- Trace 3
 - Modified trace allows power meter matching to a Bench Power meter standard.



APX Test Results

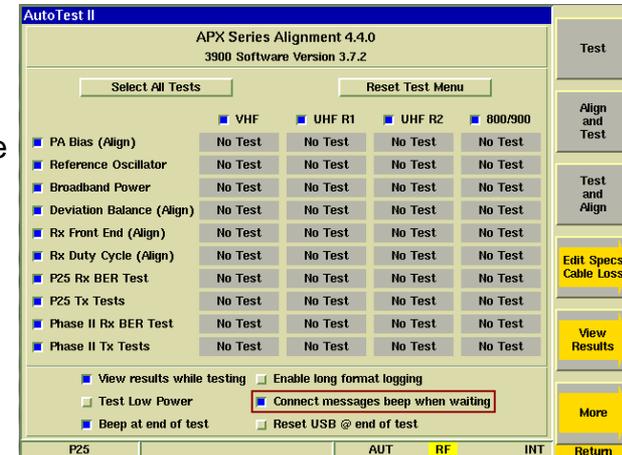
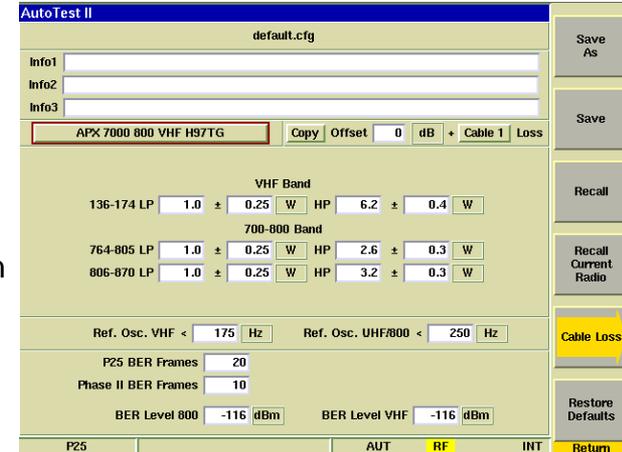
Radio Test Screen

- Test Results Screen
 - 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 memory stick.
- Clear Results Data
 - Deletes all test results files from the 3920's hard drive.
- Test Results
 - As tests are performed, the results along with pass/fail information is provided.



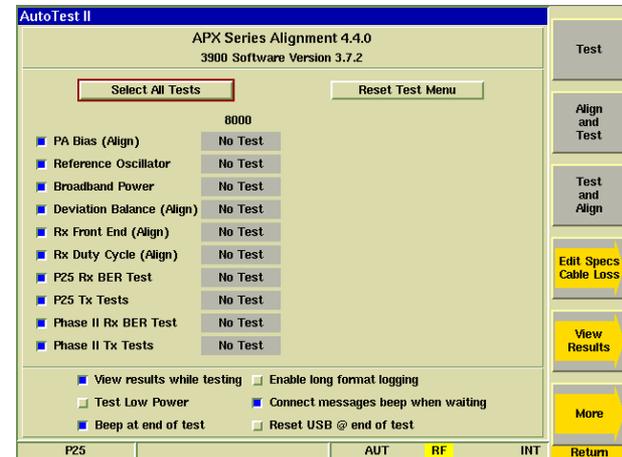
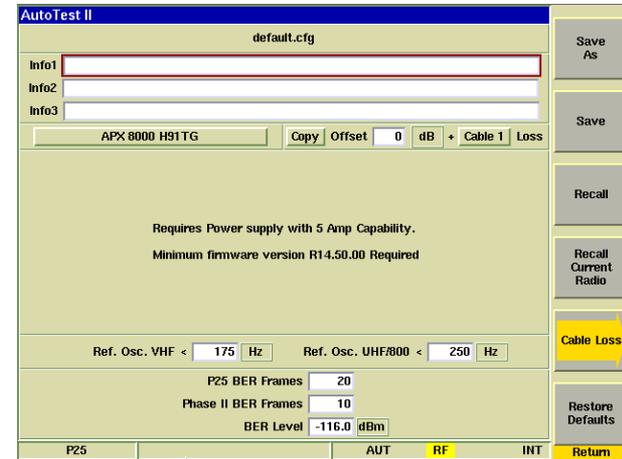
Step by Step Procedure

1. Connect the 3920 to an EXT. 10 MHz Reference if available.
2. Select the Autotest II system and execute the APX Autotest.
3. Connect the Portable or Mobile radio to be tested.
4. 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 go to 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.
5. Main Test Screen
 1. Select all bands or only a single band if only one band is to be tested. The application will automatically detect what bands are in the radio.
 2. Select all test items.
 3. Begin the Test or Alignment.
6. Failed tests should be confirmed by re-testing.



Options 644 and 645

- Option 644 – APX 8000 allows testing of the APX 8000 portable 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 application version for the 3920B APX 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.
- The minimum 3920B APX application version for the “B” radios is 4.5.2.
- Both Option 644 and 645 require option 604 – APX automatic test and alignment.



Thank You

APX Mobile and Portable Automated Test and Alignment

