

RF Application Development Exercises

Course Software Version 2009
July 2010 Edition
Part Number 325581C-01

Copyright

© 2006–2010 National Instruments Corporation. All rights reserved.

Under the copyright laws, this publication may not be reproduced or transmitted in any form, electronic or mechanical, including photocopying, recording, storing in an information retrieval system, or translating, in whole or in part, without the prior written consent of National Instruments Corporation.

National Instruments respects the intellectual property of others, and we ask our users to do the same. NI software is protected by copyright and other intellectual property laws. Where NI software may be used to reproduce software or other materials belonging to others, you may use NI software only to reproduce materials that you may reproduce in accordance with the terms of any applicable license or other legal restriction.

Trademarks

LabVIEW, National Instruments, NI, ni.com, the National Instruments corporate logo, and the Eagle logo are trademarks of National Instruments Corporation. Refer to the *Trademark Information* at ni.com/trademarks for other National Instruments trademarks.

Other product and company names mentioned herein are trademarks or trade names of their respective companies.

Patents

For patents covering National Instruments products/technology, refer to the appropriate location: **Help»Patents** in your software, the `patents.txt` file on your media, or the *National Instruments Patent Notice* at ni.com/legal/patents.

Worldwide Technical Support and Product Information

ni.com

National Instruments Corporate Headquarters

11500 North Mopac Expressway Austin, Texas 78759-3504 USA Tel: 512 683 0100

Worldwide Offices

Australia 1800 300 800, Austria 43 662 457990-0, Belgium 32 (0) 2 757 0020, Brazil 55 11 3262 3599, Canada 800 433 3488, China 86 21 5050 9800, Czech Republic 420 224 235 774, Denmark 45 45 76 26 00, Finland 358 (0) 9 725 72511, France 01 57 66 24 24, Germany 49 89 7413130, India 91 80 41190000, Israel 972 3 6393737, Italy 39 02 41309277, Japan 0120-527196, Korea 82 02 3451 3400, Lebanon 961 (0) 1 33 28 28, Malaysia 1800 887710, Mexico 01 800 010 0793, Netherlands 31 (0) 348 433 466, New Zealand 0800 553 322, Norway 47 (0) 66 90 76 60, Poland 48 22 328 90 10, Portugal 351 210 311 210, Russia 7 495 783 6851, Singapore 1800 226 5886, Slovenia 386 3 425 42 00, South Africa 27 0 11 805 8197, Spain 34 91 640 0085, Sweden 46 (0) 8 587 895 00, Switzerland 41 56 2005151, Taiwan 886 02 2377 2222, Thailand 662 278 6777, Turkey 90 212 279 3031, United Kingdom 44 (0) 1635 523545

To comment on National Instruments documentation, refer to the National Instruments Web site at ni.com/info and enter the Info Code `feedback`.

Contents

Student Guide

A. Course Description	vii
B. What You Need to Get Started	viii
C. Installing the Course Software	ix
D. Course Goals	x
E. Course Conventions	xi

Lesson 2

Hardware Configuration Exercises

Exercise 2-1 A	Configuring Hardware in MAX	2-1
Exercise 2-1 B	Configuring Hardware in MAX	2-8

Lesson 3

RF Acquisition and Generation Exercises

Exercise 3-1	Spectrum Acquisition	3-1
Exercise 3-2	IQ Acquisition	3-5
Exercise 3-3	Scripting with NI-RFSG	3-9
Exercise 3-4	Triggering with NI-RFSA and NI-RFSA	3-14

Lesson 4

Spectral Measurements Toolkit Exercises

Exercise 4-1	Resolution Bandwidth	4-1
--------------	----------------------------	-----

Lesson 5

Phase Coherent RF Measurement Systems in PXI Express Exercises

Exercise 5-1	Phase Noise Correlation	5-1
--------------	-------------------------------	-----

Lesson 6

Additional RF Hardware and Measurements Exercises

Exercise 6-1 USB Power Meter6-1

Lesson 7

RF System Calibration Exercises

Exercise 7-1 RF System Calibration7-1

Lesson 8

Record and Playback Exercises

Exercise 8-1 A Continuous Record and Playback of FM Signal8-1
 Exercise 8-1 B Continuous Record and Playback8-5

Lesson 10

Digital Modulation Exercises

Exercise 10-1 A Generating and Modulating10-1
 Exercise 10-1 B Generating and Modulating10-8
 Exercise 10-2 A Acquisition and Demodulation10-13
 Exercise 10-2 B Acquiring and Demodulating10-19

Lesson 11

RF Reference Test Architecture and Best Practices Exercises

Exercise 11-1 A Reference Architecture Generation (SG)11-1
 Exercise 11-1 B Reference Architecture Generation (SG)11-3
 Exercise 11-2 A Reference Architecture Analysis (SA)11-5
 Exercise 11-2 B Reference Architecture Analysis (SA)11-9

Lesson 12**WLAN Test Exercises**

Exercise 12-1 A	Transmitter Test	12-1
Exercise 12-1 B	Transmitter Test	12-7
Exercise 12-2	Receiver Test	12-13

Lesson 13**GPS/GNSS Receiver Test Exercises**

Exercise 13-1	NI GPS Simulation Toolkit	13-1
---------------	---------------------------------	------

Lesson 14**Introduction to Cellular Test Exercises**

Exercise 14-1	Power Amplifier Test	14-1
---------------	----------------------------	------

Lesson 15**WiMAX Test Exercises**

Exercise 15-1	Soft Front Panels—Generation and Analysis	15-1
Exercise 15-2 A	Soft Front Panels—EVM Test	15-7
Exercise 15-2 B	Soft Front Panels—EVM Test	15-12

Lesson 16**Analog Modulation Exercises**

Exercise 16-1	Radio FM Demodulator	16-1
---------------	----------------------------	------

Sample

Record and Playback Exercises

Exercise 8-1A

Goal

Continuous Record and Playback of FM Signal

Stream RF data to an IDE disk on the PXI controller and play back the streaming data.

Implementation

1. Open Record & Playback UI.vi in the <Exercises>\RF Application Development\Record and Playback directory. The front panel and block diagram have already been built.

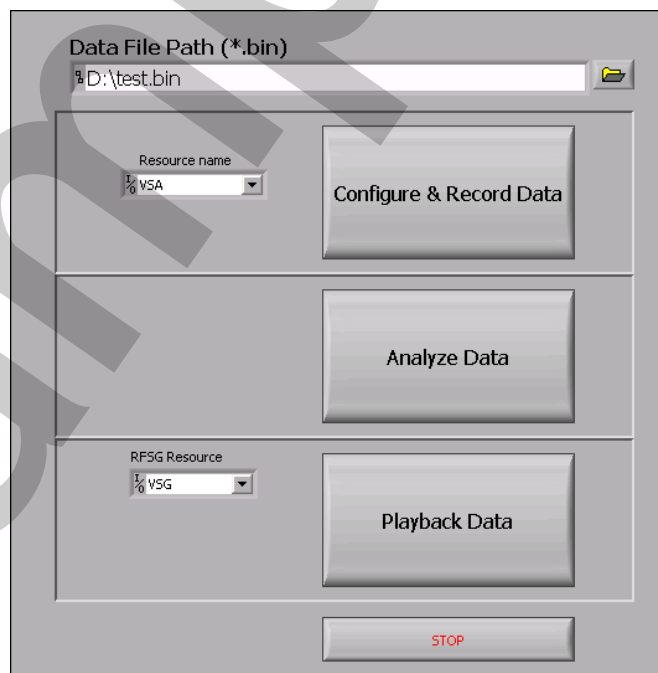


Figure 8-1. Record & Playback UI Front Panel

2. Connect one of the FM antennas to the VSA input.



Tip Screw the antenna into the SMA port by turning the antenna itself. It will pull the SMA into the thread without the need to remove the SMA to BNC adapter.

3. Select the appropriate VSA and VSG that you configured in MAX. Run the Record & Playback UI. vi and select first Configure and Record Data. You will see a new subVI with an active spectrum. Adjust the spectrum settings to get the best recorded value (most dynamic range) by adjusting the attenuation (reference level). You will probably need to turn off all attenuation by setting Reference Level to -40 . Since you have no external gain from a preamp you won't change this setting. At this point you should start to see some spectrum with the FM signals.

Sample

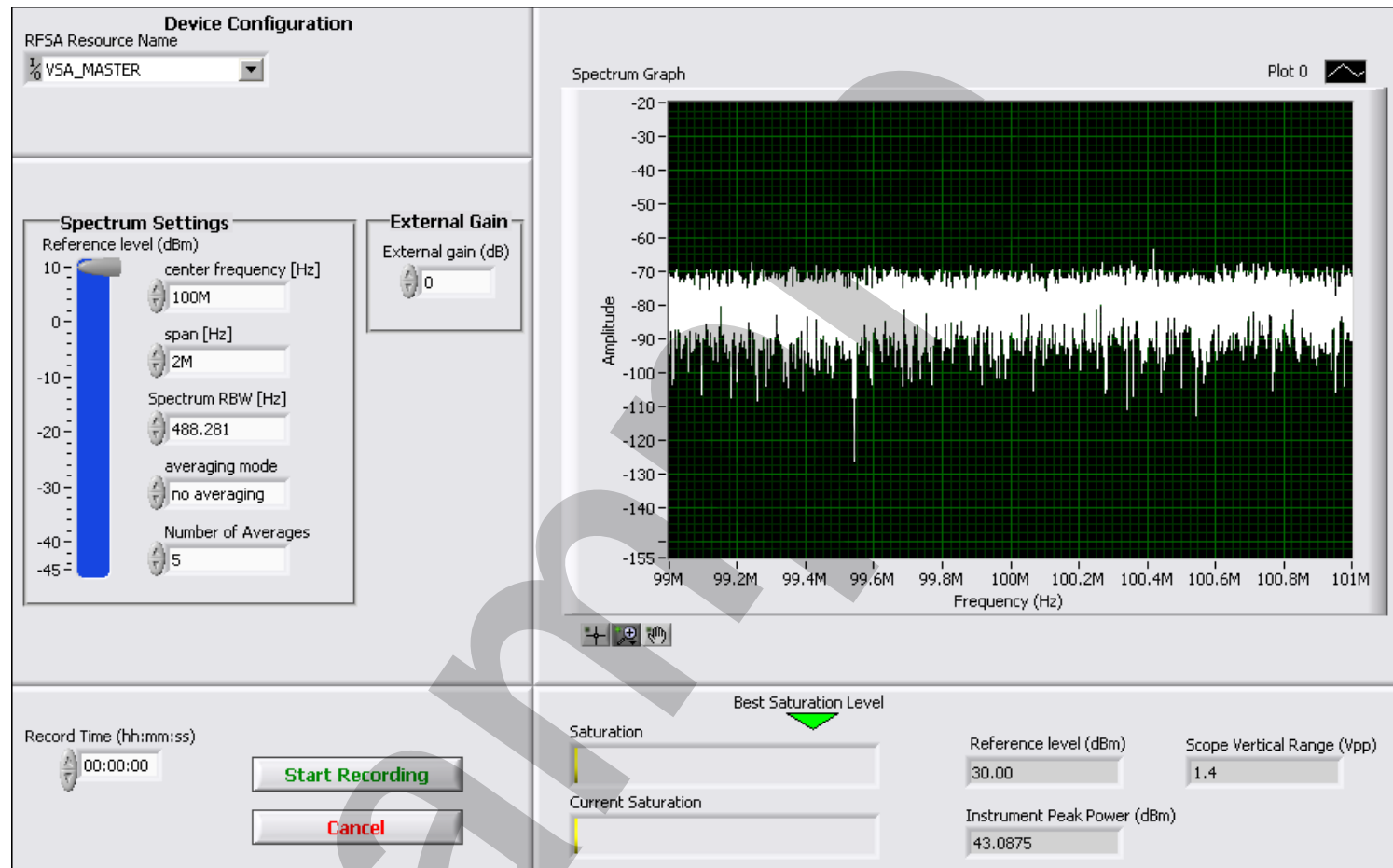


Figure 8-2. Record and Playback Record Settings



Note If there is a poor signal quality in your classroom, inform the instructor who can use his or her chassis with the NI 8260 RAID to generate previously-recorded FM signals.

4. After verifying a good signal click **Start Recording**. Make sure you have at least 5 minutes set for recording and that you file path is the D:\ drive. At this point a new window will open and start recording your data. You can allow it to play out your desired time to record or you can stop it at any point. It will return you to the main Record & Playback UI VI.
5. To playback the data you will need to move your antenna from the VSA to the VSG. Use the same method as described before.
6. You will need to bypass the output power and center frequency that normally is set to replicate the receive conditions. You can do this by selecting the Override Playback Power boolean. Leave it at 0 dBm for now and click Playback Data. It will automatically configure the VSG to output the same file you recorded earlier.
7. Pick a frequency that is not normally occupied by the FM band in your area. Recenter your output signal so that it goes to an available to FM station. Use the FM radio in the class to listen to your playback data shifted to a new radio station.
8. Close the VIs when you are done.

End of Exercise 8-1A

Exercise 8-1B

Continuous Record and Playback

Goal

Stream RF data to an IDE disk on the PXI controller and play back the streaming data.

Implementation

1. Open and examine `RFSG Playback from Disk.vi` from the `<Exercises>\RF Application Development\Demonstrations` directory. You will be pointing to FM data recorded in Austin across a 5 MHz band.
2. Set the power level to -30 dBm and choose a carrier frequency in the FM band (87.9–107.9 MHz).
3. Run the VI.
4. Open `FM Radio Receiver.vi` in the `<Exercises>\RF Application Development\Demonstrations` directory. You can use this VI to monitor and demodulate the recorded FM spectrum.

- Run the VI. You should see the FM spectrum replicated back and see something similar to Figure 8-3.

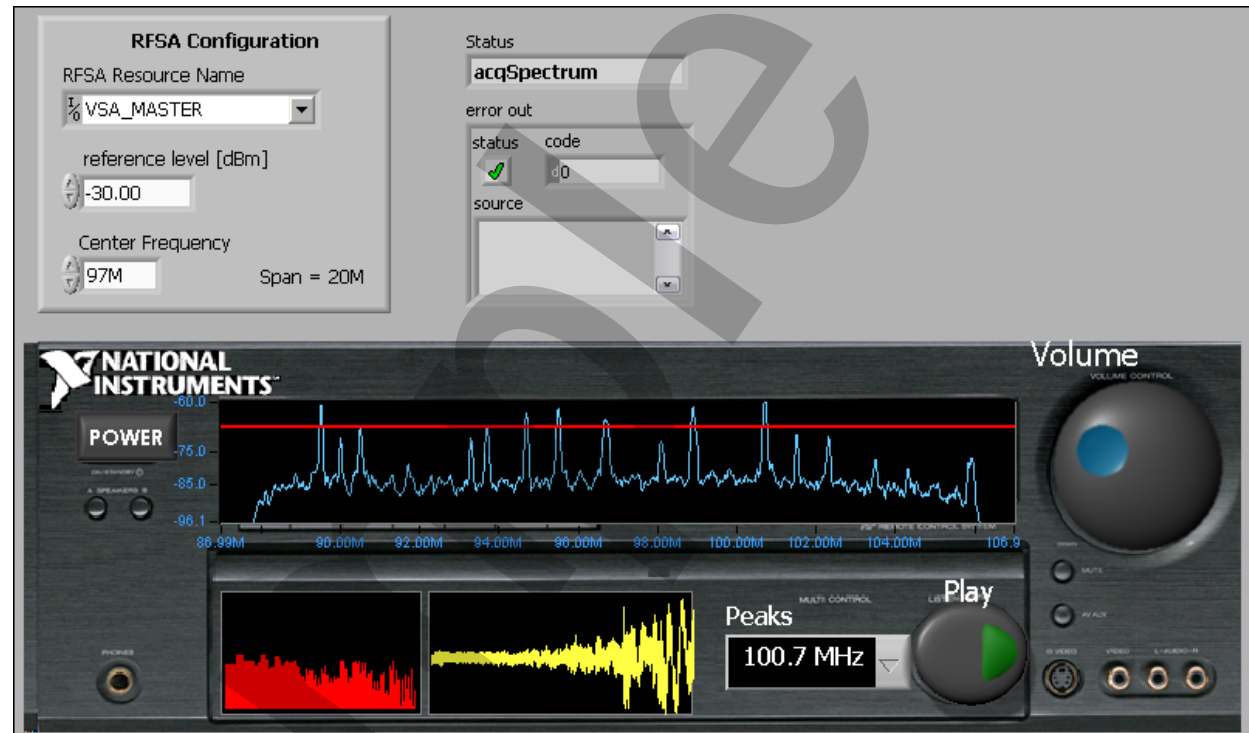


Figure 8-3. FM Radio Receiver Front Panel

- Click **Play** and it will play stations above the red threshold bar. You can adjust the bar to get better quality stations. If you have speakers on your PC it will play the recorded stations.
- Close the VIs when you are done.

End of Exercise 8-1B