
MC13853 LNA

Evaluation Board User's Guide

Document Number: MC13853EVBUG
Rev. 1.3
10/2007

How to Reach Us:

Home Page:
www.freescale.com

Web Support:
<http://www.freescale.com/support>

USA/Europe or Locations Not Listed:
Freescale Semiconductor
Technical Information Center, EL516
2100 East Elliot Road
Tempe, Arizona 85284
+1-800-521-6274 or +1-480-768-2130
www.freescale.com/support

Europe, Middle East, and Africa:
Freescale Halbleiter Deutschland GmbH
Technical Information Center
Schatzbogen 7
81829 Muenchen, Germany
+44 1296 380 456 (English)
+46 8 52200080 (English)
+49 89 92103 559 (German)
+33 1 69 35 48 48 (French)
www.freescale.com/support

Japan:
Freescale Semiconductor Japan Ltd.
Headquarters
ARCO Tower 15F
1-8-1, Shimo-Meguro, Meguro-ku,
Tokyo 153-0064, Japan
0120 191014 or +81 3 5437 9125
support.japan@freescale.com

Asia/Pacific:
Freescale Semiconductor Hong Kong Ltd.
Technical Information Center
2 Dai King Street
Tai Po Industrial Estate
Tai Po, N.T., Hong Kong
+800 2666 8080
support.asia@freescale.com

For Literature Requests Only:
Freescale Semiconductor Literature Distribution Center
P.O. Box 5405
Denver, Colorado 80217
1-800-441-2447 or 303-675-2140
Fax: 303-675-2150
LDCForFreescaleSemiconductor@hibbertgroup.com

Information in this document is provided solely to enable system and software implementers to use Freescale Semiconductor products. There are no express or implied copyright licenses granted hereunder to design or fabricate any integrated circuits or integrated circuits based on the information in this document.

Freescale Semiconductor reserves the right to make changes without further notice to any products herein. Freescale Semiconductor makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does Freescale Semiconductor assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation consequential or incidental damages. "Typical" parameters that may be provided in Freescale Semiconductor data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals", must be validated for each customer application by customer's technical experts. Freescale Semiconductor does not convey any license under its patent rights nor the rights of others. Freescale Semiconductor products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or other applications intended to support or sustain life, or for any other application in which the failure of the Freescale Semiconductor product could create a situation where personal injury or death may occur. Should Buyer purchase or use Freescale Semiconductor products for any such unintended or unauthorized application, Buyer shall indemnify and hold Freescale Semiconductor and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that Freescale Semiconductor was negligent regarding the design or manufacture of the part.

Freescale™ and the Freescale logo are trademarks of Freescale Semiconductor, Inc. All other product or service names are the property of their respective owners.

© Freescale Semiconductor, Inc. 2006, 2007. All rights reserved.

Contents

About This Book

Audience	v
Organization	v
Revision History	v
Conventions	v
Definitions, Acronyms, and Abbreviations	vi
References.	vi

Chapter 1 Initial Instructions

1.1	Overview.	1-1
1.2	Serial Peripheral Interface	1-2
1.3	Assembly Instructions.	1-4
1.4	Operation Under SPI Control	1-5
1.5	Graphical User Interface (GUI)	1-5

Chapter 2 Evaluation Board Layout and Schematic

Chapter 3 Basic Test Equipment Setup

3.1	Overview.	3-1
3.2	List of Test Equipment	3-3

Appendix A DC and Control Wiring Harness



About This Book

This user's guide provides a detailed description of the hardware of the MC13853 evaluation board demo kit. It documents the RF, DC, and control requirements for proper operation in three bands (GSM850, PCS1900, and WCDMA 2100).

The objective of this manual is to establish guidelines to facilitate the use of this LNA on a PCB evaluation board, namely:

- The RF interface, input and output.
- The DC supplies and logic control inputs.
- The serial peripheral interface (SPI).

Audience

This manual is intended for the end-user of the MC13853 evaluation board.

Organization

This document is organized into three chapters and one appendix:

Chapter 1: Initial Instructions

Chapter 2: Evaluation Board

Chapter 3: Test Equipment Bench Line-up

Appendix: DC and Control Wiring Harness

Revision History

The following table summarizes revisions to this document since the previous release (Rev. 1.2).

Revision History

Location	Revision
Chapter 1	Replaced Figure 1-3 . Inserted a new Step 7 on page 6 . Replaced images in Figure 1-4 .
Chapter 2	Replaced Figure 2-1 .

Conventions

Please note the following:

- All RF interconnections are to be with low loss coaxial cabling using clean SMA type RF connectors, including using the correct manufacturer's torque at the connecting point.
- All DC supply lines must be able to safely carry peak currents in excess of 2 A under minimum voltage drop.
- All control lines (SPI lines and parallel cable) must be kept away from strong RF fields.

- ESD protection procedures must be followed. As a minimum, test equipment should be grounded, a grounded hand strap must be used, and the lab bench fitted with a conductive mat (not exceeding 1 M Ω to ground).

Definitions, Acronyms, and Abbreviations

The following list defines the acronyms and abbreviations used in this document.

DCS1800	1800 MHz cellular band, MS transmit 1710 to 1785 MHz
EDGE	Enhanced Data Rates for GSM Evolution, uses 3pi/8 PSK modulation
EGSM900	900 MHz cellular band, MS transmit 880 to 915 MHz
EGPRS	Enhanced General Packet Radio Service
ESD	Electrostatic Discharge
EVB	Evaluation Board, usually a multilayer printed circuit
GPIO	General Purpose Instrumentation Bus, uses IEEE488.2 standard
GSM	Global System Mobile, uses GMSK modulation
GSM850	850 MHz cellular band, MS transmit 824.0 to 849.0 MHz
PCS1900	1900 MHz cellular band, MS transmit 1850 to 1910 MHz
SPI	Serial Peripheral Interface
VSWR	Voltage Standing Wave Ratio

References

1. MC13853 Data Sheet, Rev. 1.6, 08/2007 Freescale Semiconductor, Tempe AZ.
2. Digital Cellular Telecommunications System - Radio Transmission And Reception- 3GPP TS 05.05; TS 100 910. European Telecommunications Standard Institute (ETSI Sophia Antipolis France, www.etsi.org).
3. Digital Cellular Telecommunications System - Mobile Station Conformance Specification - GSM 11.10 European Telecommunications Standard Institute (ETSI Sophia Antipolis France, www.etsi.org).

Chapter 1

Initial Instructions

1.1 Overview

This chapter describes the RF and control basic requirements of the MC13853 LNA evaluation board (Iota VI).

The following items are supplied with the Freescale MC13853 Demo Kit:

1. MC13853 LNA evaluation board (Iota)
2. Serial peripheral interface (SPI) board (MMM6038SPI)
3. Control software CD-ROM
4. DC and control cable harness

The evaluation board interconnects with the MMM6038SPI via a eight wire cable. The MMM6038SPI connects via a parallel port cable to the PC computer.

On the evaluation board, all the coaxial RF connectors are of the SMA type. In order to minimize damage to these, connections are to be made using low loss flexible coaxial cables with male SMA connectors mating towards the evaluation board. The mating surfaces must be clean (tissue paper and standard grade isopropyl alcohol can be used); if not, the amplifier performance can be affected. The applied torque via a 5/16" wrench at the connecting point must not exceed the manufacturers specification. There are a total of 6 SMA female connectors attached to the evaluation board. The DC and control connector is of a 8-pin, right-angle header type. The [Appendix A, "DC and Control Wiring Harness"](#) provides the details and cable harness wiring.

Before any RF or DC cabling is attached, caution must be used that the board is grounded first. This prevents ESD when attaching the remaining cables.

NOTE

Do not exceed the maximum ratings as given in the MC13853 Data Sheet, in particular the maximum applied DC voltage and RF input level. Operate in a safe ESD environment on the test bench.

Refer to [Figure 1-1](#). Attach the DC and control cable harness (detailed in [Appendix A, "DC and Control Wiring Harness"](#)) to the evaluation board:

Attach the cable harness end labeled SPI into the interface board as shown in [Figure 1-1](#).

1.2 Serial Peripheral Interface

Control of the basic functions of the MC13853 can be accomplished via a SPI three-wire (data, clock, and frn) connection to the evaluation board. In order to control the LNA the following is required:

- PC computer laptop:
 - Parallel port
 - Microsoft[®] Windows[®] NT or better (such as Windows 2000 or Windows XP) operating system installed
 - CD-ROM drive at least 40 MB of free hard drive space
 - 256 MB of RAM
- SPI control software installed on the PC
- Freescale MMM6038SPI
- Small power supply to deliver +5 VDC at approximately 5 mA to the MMM6038SPI
- Parallel cable with DB25 connectors (PC to SPI)
- Short length of wire ribbon between the SPI board and the evaluation board. Set the length to accommodate movement of the evaluation board on the test bench.

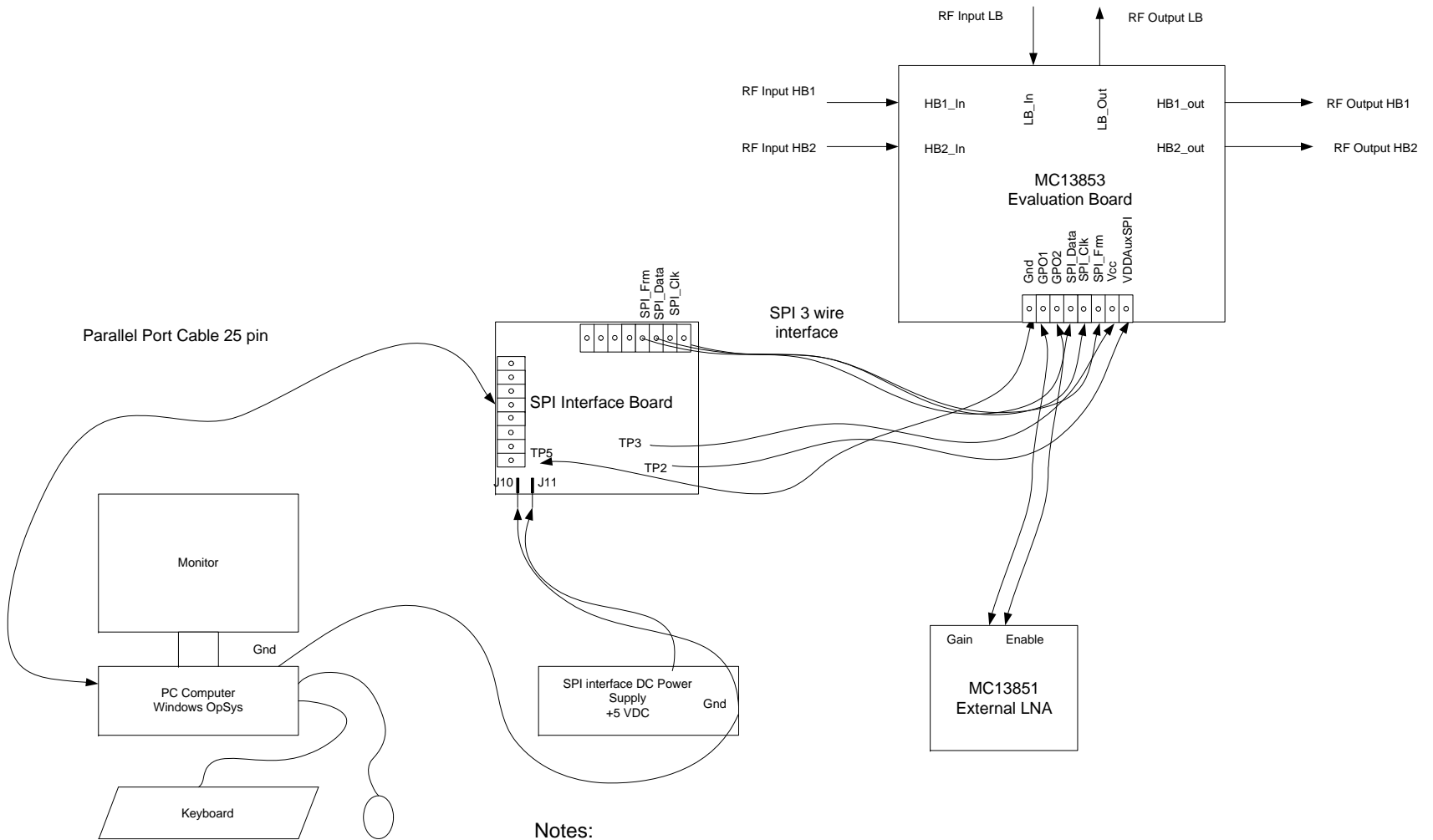
The control software resides in the PC computer running Microsoft Windows operating system. A parallel interface is used between the PC and the MMM6038SPI.

Keep all control wiring away from the strong RF fields created by the power amplifier, particularly around the module and antenna connection. ESD precautions should be taken in the set-up and as a minimum all equipment, SPI and EVB components should be grounded. [Figure 1-1](#) shows the SPI to EVB interconnecting details. [Figure 1-2](#) illustrates the actual top view of the MMM6038SPI.

Details of the GUI and controlled parameters are shown in [Figure 1-4](#).

NOTE

The MMM6038SPI contains a FPGA (Lattice Semiconductor) with the code written into a flash memory (ST Microelectronics). Aside from interconnections, no user intervention is required. The board is powered by +5 VDC connected to the red jack and the black jack is ground. Once the supply is applied, a green LED will turn on indicating the presence of power. Various LDO internal regulators provide the necessary operating voltages.



Notes:

- 1) ESD precautions must be taken when interconnecting cables and boards. Ensure that all test equipment, PC computer, interface and evaluation boards have a common ground.
- 2) SPI control code executable file resides in PC computer running Windows Op System.
- 3) Communication PC to SPI interface board is via parallel port with parallel cable.
- 4) Communication SPI interface board to the LNA EVB is via 8 wire interface (SPI_Data, SPI_Clock & SPI_Frm).
- 5) Ground all DC Power Supplies and PC computer.

Figure 1-1. SPI to EVB Interconnecting Diagram

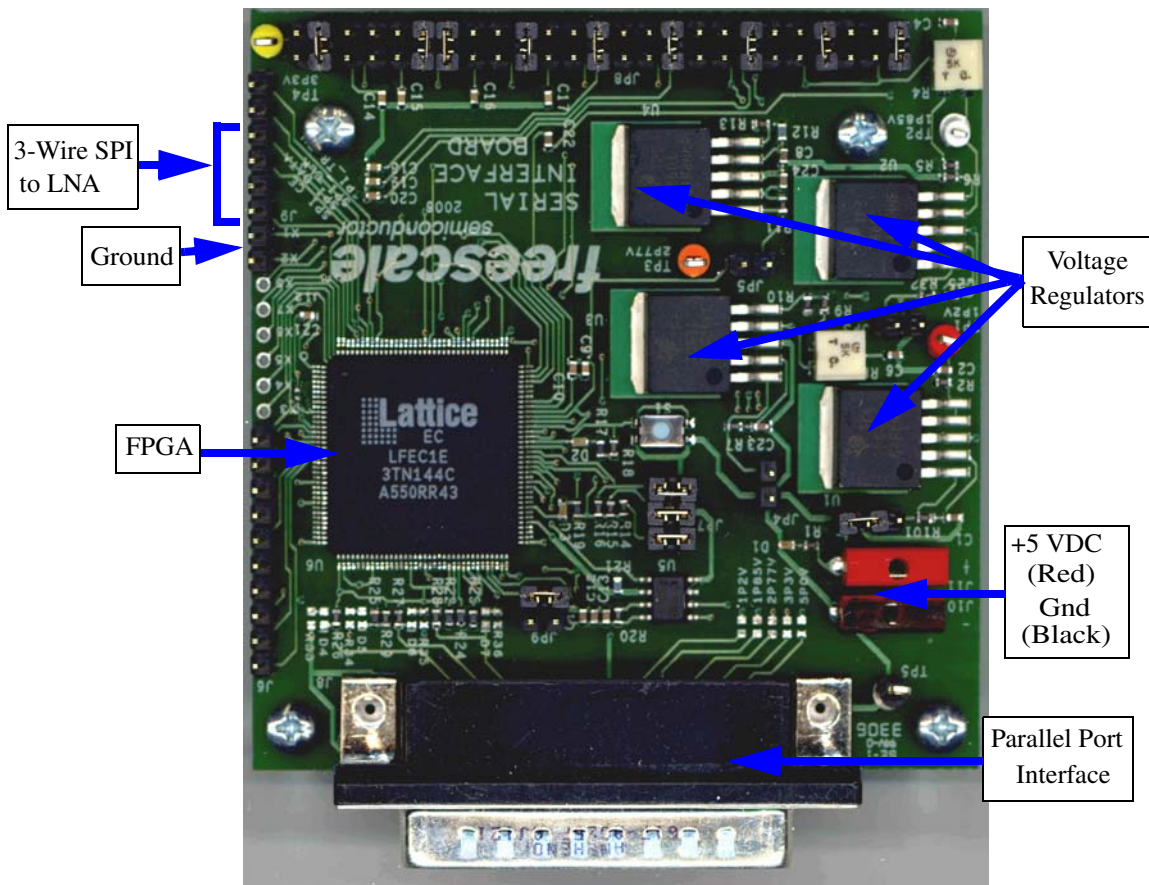


Figure 1-2. Serial Peripheral Interface Board (Top View)

1.3 Assembly Instructions

1. Interconnect the evaluation board, MMM6038SPI, PC computer, power supplies as shown in [Figure 1-1](#).
2. Confirm on the MC13853 evaluation board that all DC voltages are present at the correct level indicated in the MC13853 Data Sheet.
3. Verify on the MMM6038SPI at the red terminal that the voltage is +5 VDC.
4. An active green LED indicates DC “On” and an active green LED indicates that the FPGA has been loaded successfully with the code from the flash memory.
5. The test equipment requirements and line-up are given in [Chapter 3, “Basic Test Equipment Setup”](#), [Figure 3-1](#).
6. Install the supplied software from the CD-ROM in the chosen computer operating under Windows NT or better (such as Windows 2000 or Windows XP). Minimum requirements for the PC computer are: 40 MB of free hard drive space, 256 MB of RAM, CD-ROM drive, and a parallel port I/O.
7. Connect the wire ribbon between the 8 pin header of the MC13853 evaluation board and the MMM6038SPI board. On the MMM6038SPI board, the 8 pin connector goes on J9, the VDDAuxSPI lead goes on TP2, the VCC lead goes on TP3 and ground (Gnd) goes on TP5.

1.4 Operation Under SPI Control

SPI control of the MC13853 uses the SPI bit word structure shown in Figure 1-3. Any communication over the SPI that is not 30 bits in length or data without the correct address will be ignored.

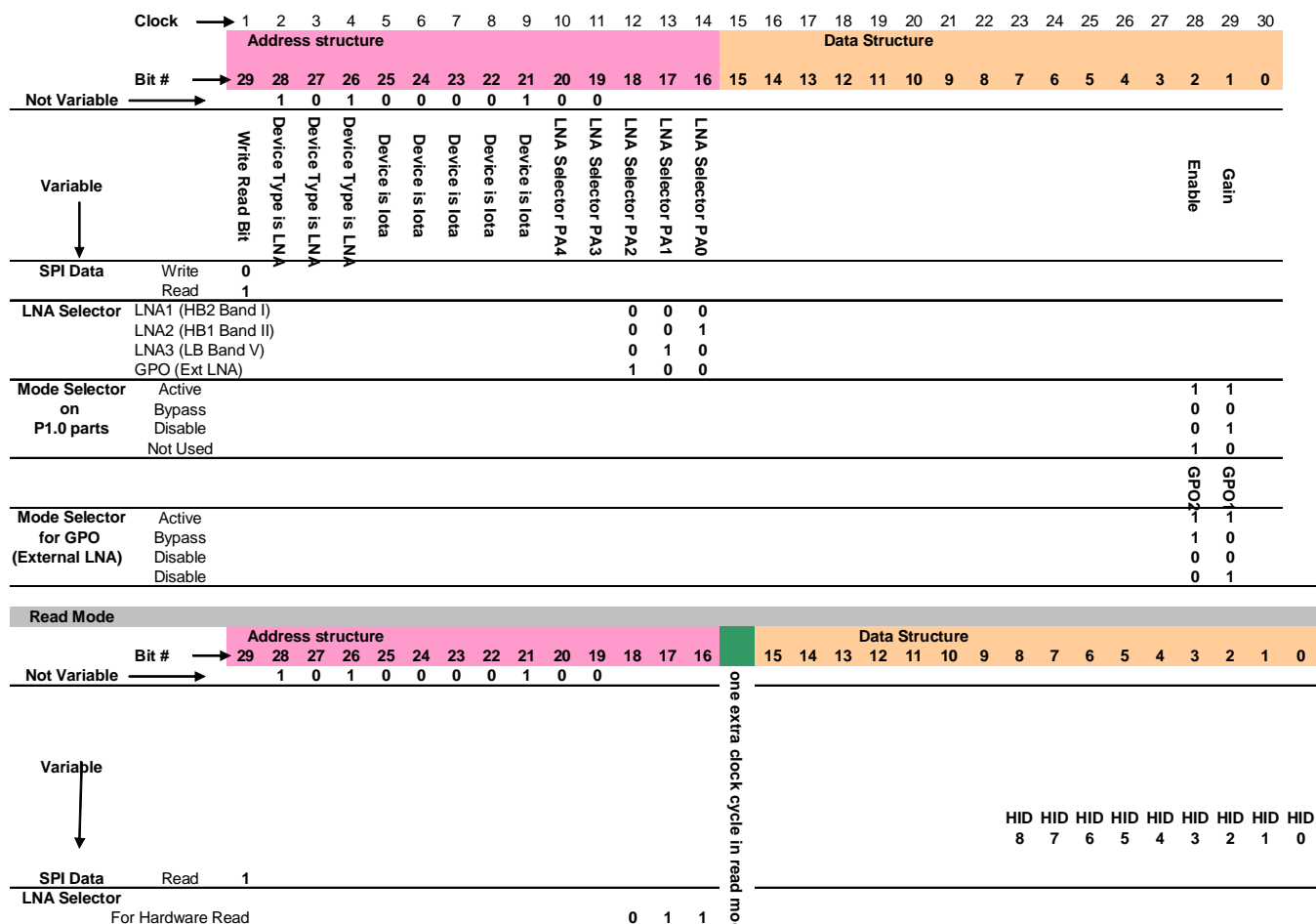


Figure 1-3. MC13853 SPI Bit Word Structure

1.5 Graphical User Interface (GUI)

Once the control software on the CD-ROM (LabView executable file) is loaded onto the PC computer and running, the GUI screen appears on the monitor.

As illustrated in Figure 1-4:

1. Load the program “AuxSpiControl.vi”.
2. Click the arrow to run.
3. Select “MC13853 Dual + Tri” in the Setting Selector window.
4. To select the LNA, select “LNA Selector” in the SPI Var List window. Select the “LNA” in the middle window.
5. To select the mode, select “enable” on the SPI Var List window and “1” or “0” in the middle window. Select the same for the gain.

6. The truth table is:
 - a) Active mode: enable 1, gain 1.
 - b) Bypass mode: enable 0, gain 0.
 - c) Disable mode: enable 0, gain 1.
7. To select the current setting, select “current =” on the SPI Var list window and one of the eight current settings in the middle window.
8. To control the external LNA MC13851, select “LNA Selector” in the SPI Var List window and “GPO” in the middle window. Set the enable and gain.
9. Auto Send SPI:
 - a) If “On”, SPI command sent whenever a SPI value changes.
 - b) If “Off”, use “Send SPI” (F1) to send.
10. Send SPI (F1): Command is sent whenever pressed.
11. Write to DUT button:
 - a) Activates either condition.
 - b) Data can be sent to (write) or read from the device.
 - c) If write is shown, the SPI is writing.
12. View Waveform:
 - a) Activates view of data sent in waveform format.
13. Command History:
 - a) Displays the data sent (written) or received (read) from the device.
 - b) Choice of hex or binary format.

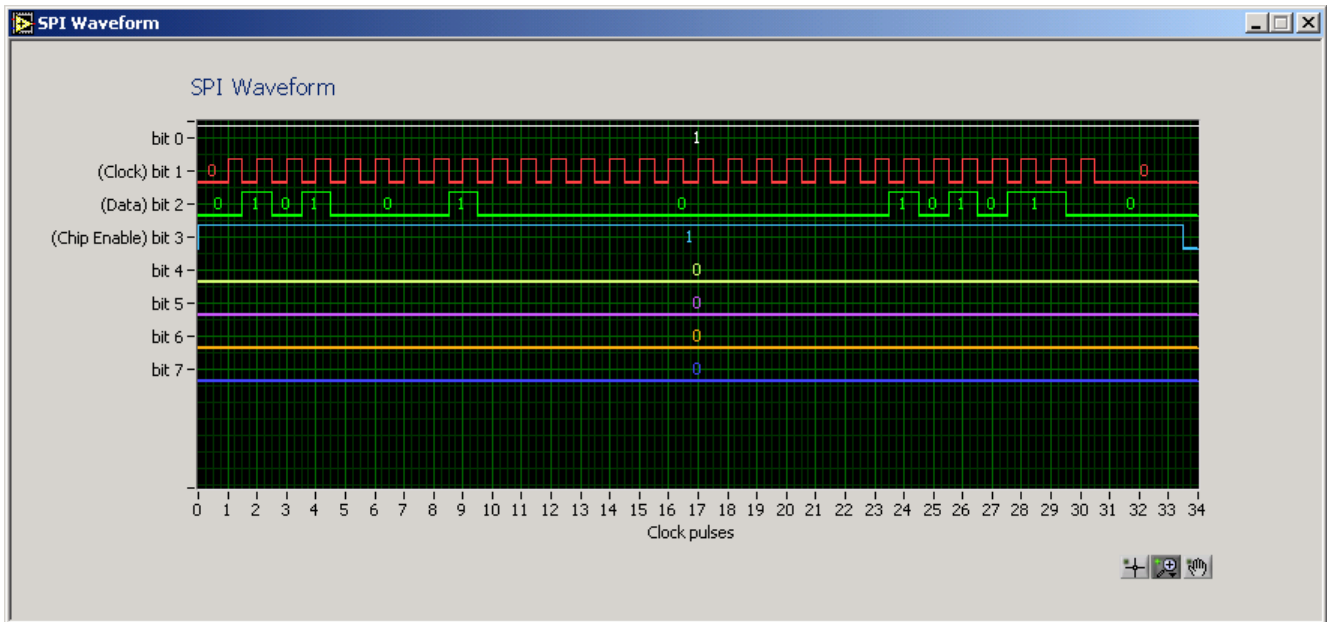
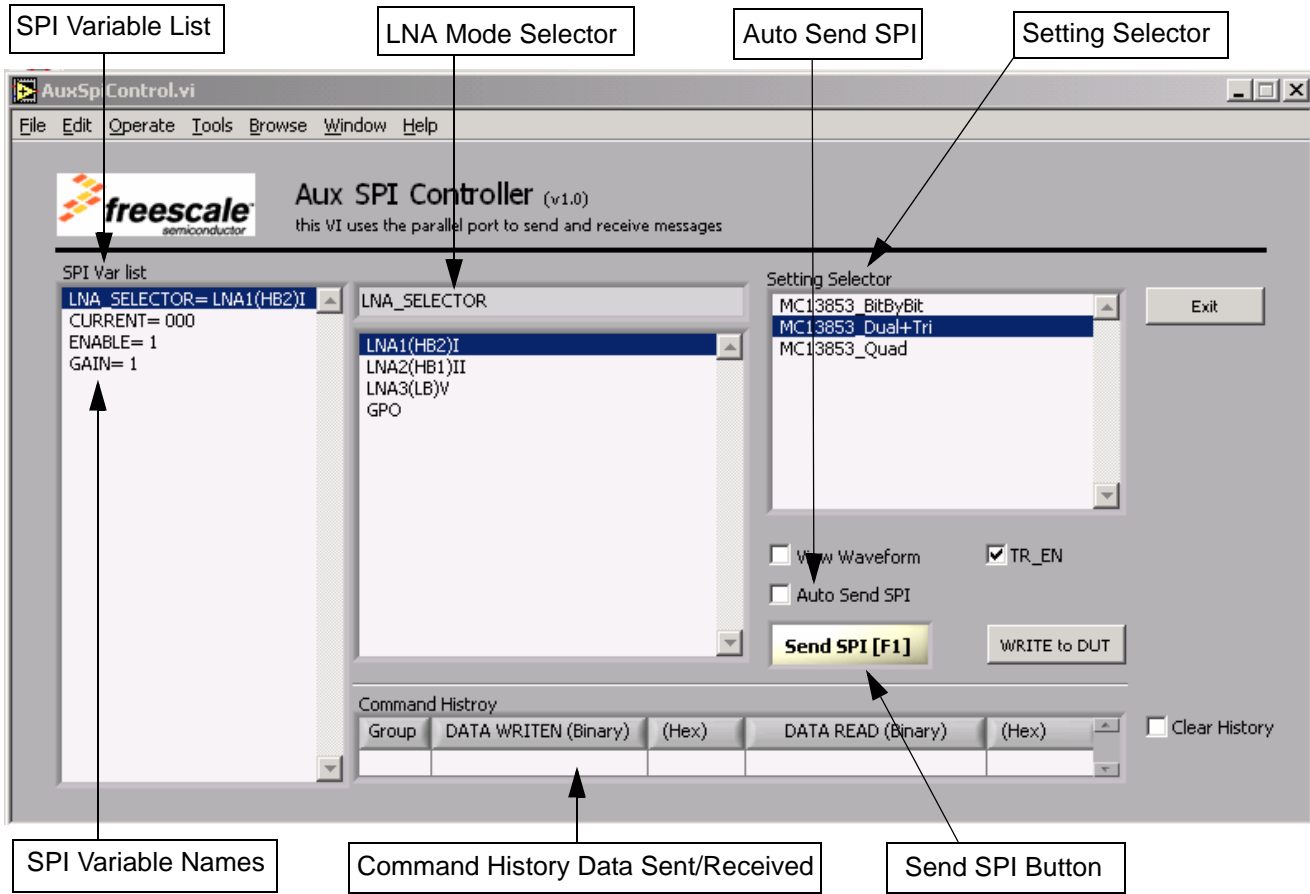


Figure 1-4. Graphical User Interface Screen



Initial Instructions

Chapter 2 Evaluation Board Layout and Schematic

The MC13853 LNA is mounted in a multi-layer evaluation board. The top view is shown in [Figure 2-1](#) and the schematic is located in the *MC13853 Data Sheet* (document number: MC13853/D).

NOTE

Refer to the location of RF coaxial connectors, DC and control connecting points via headers and the grounding banana jacks. The amplifier and supporting circuits on the evaluation board are not shielded. Keep all cabling away from the evaluation board, in particular the antenna SMA connector J23.

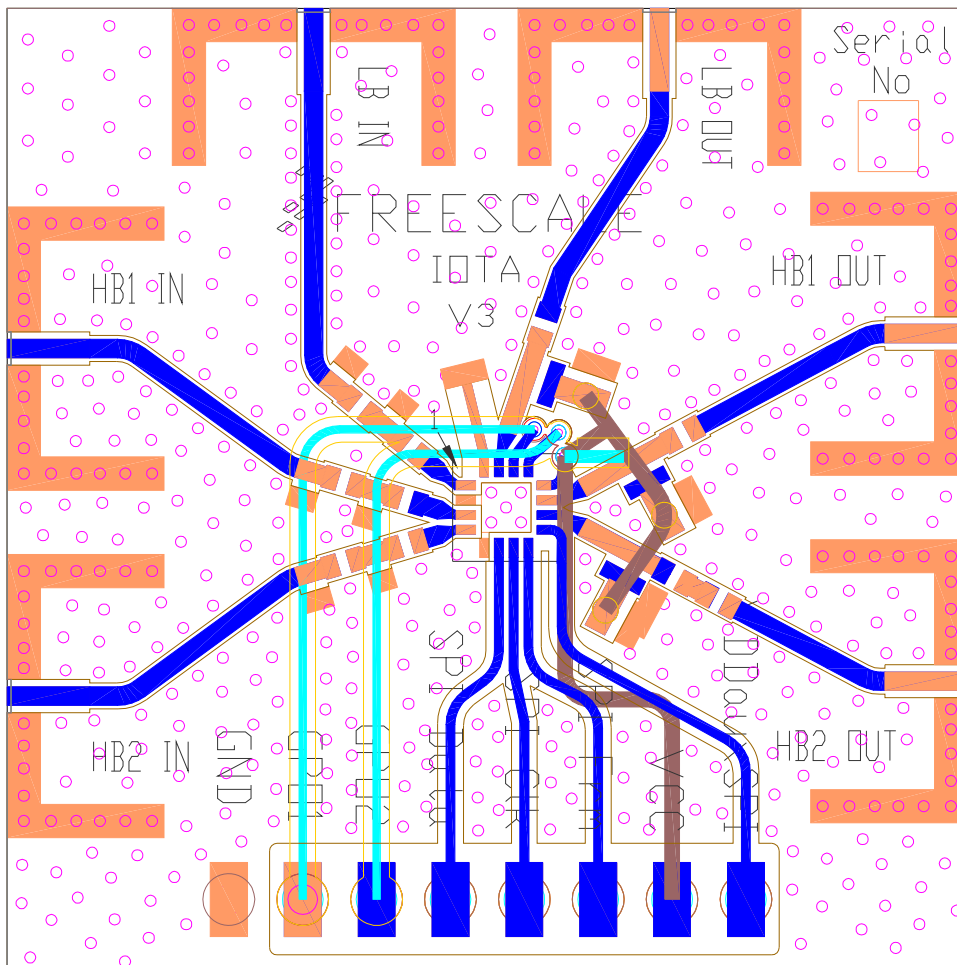


Figure 2-1. MC13853 Evaluation Board - Assembly (Top View)

Chapter 3

Basic Test Equipment Setup

3.1 Overview

To test and evaluate the performance of the MC13853 LNA on its EVB environment, a test plan and a test equipment bench set-up in the lab is necessary. A basic test plan can be made by following the MC13853 data sheet and obtaining the same measured parameters. However, the results are dependent on the test equipment configuration. In order to establish a basic test set-up, the details and equipment interconnections are given in [Figure 3-1](#).

All test equipment used must be calibrated with a valid calibration due date. Also, it is important to perform an internal instrument calibration of the main items, such as the RF digital signal generator, the spectrum analyzer and function generator. Since the RF power and its sensors require a separate calibration procedure, it is very important that this is done before valid data is taken.

Once the test equipment is configured and connected, a bench calibration must be conducted at the frequencies of interest in order to determine the offset values for the RF power meter and spectrum analyzer.

The DC and control interconnecting cable harness is detailed in the [Appendix A, “DC and Control Wiring Harness”](#). This should be available before the test and evaluation of the MC13853.

There are three test equipment setups required to make all of the measurements. The following steps are recommended:

1. From the list of test equipment given in [Section 3.2, “List of Test Equipment”](#), on page 3-3, assemble the line-up as given in [Figure 3-1](#), [Figure 3-2](#), and [Figure 3-3](#).
2. Calibrate each individual instrument first following the manufacturer’s procedure.
3. Calibrate the RF power meter and its sensors at the desired band and frequencies.
4. Conduct a bench calibration at each required frequency. Record all results and enter these as offsets into the RF power meter and spectrum analyzer.
5. Test the set-up without the evaluation board and verify that the bench calibration is correct by setting the RF digital signal generator level to 0 dBm at the desired band and frequency.
6. If (5) fails, repeat steps (1) through (4) until measurements are correct.
7. If (5) passes, connect the MC13853 into the circuit.

Basic Test Equipment Setup

Notes:

- 1) RF Cabling is 50 ohm low loss.
- 2) RF Connectors are SMA.
- 3) Zero and Calibrate all RF power sensors before measurement.
- 4) SPI interface details are not shown
- 5) Internally calibrate test equipment before using

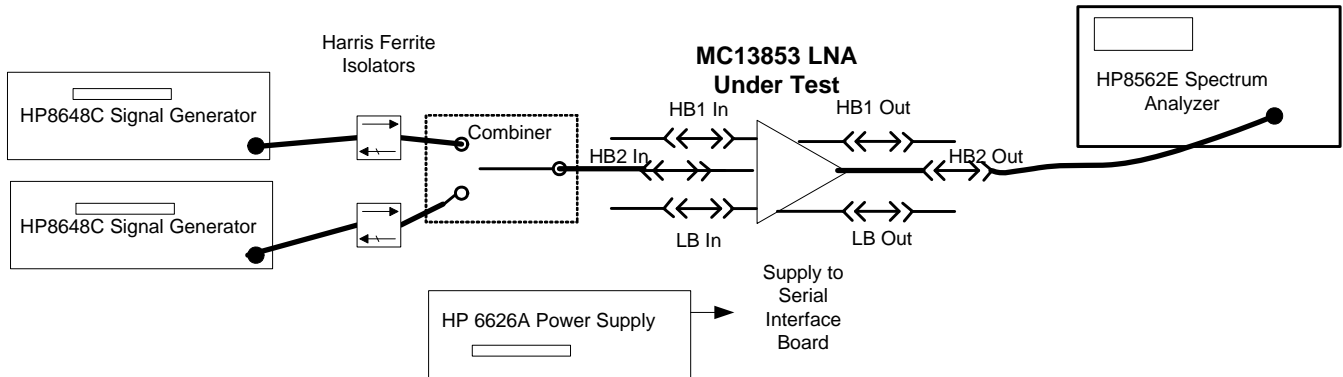


Figure 3-1. MC13853 Power Management Test Equipment Block Diagram

Notes:

- 1) RF Cabling is 50 ohm low loss.
- 2) RF Connectors are SMA.
- 3) Zero and Calibrate all RF power sensors before measurement.
- 4) SPI interface details are not shown
- 5) Internally calibrate test equipment before using

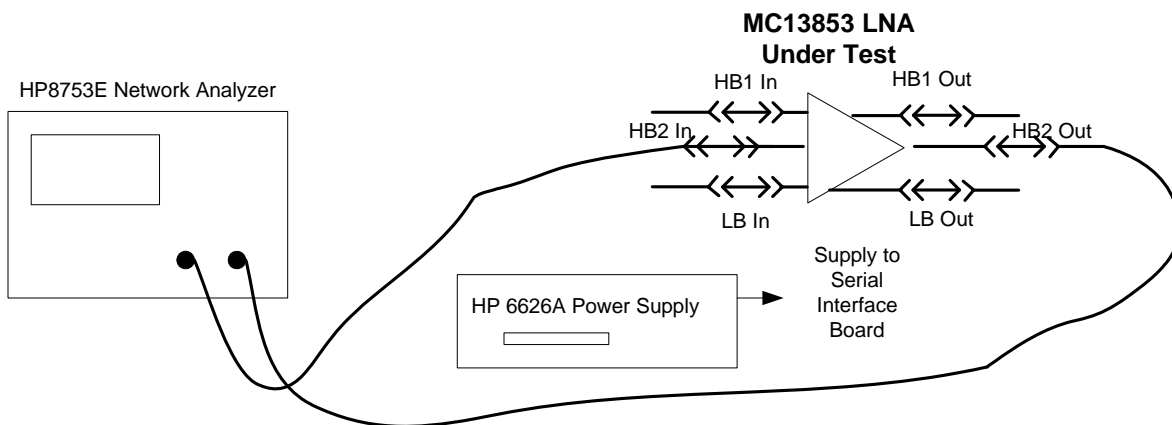


Figure 3-2. MC13853 S Parameter Test Equipment Block Diagram

- Notes:
- 1) RF Cabling is 50 ohm low loss.
 - 2) RF Connectors are SMA.
 - 3) Zero and Calibrate all RF power sensors before measurement.
 - 4) SPI interface details are not shown
 - 5) Internally calibrate test equipment before using

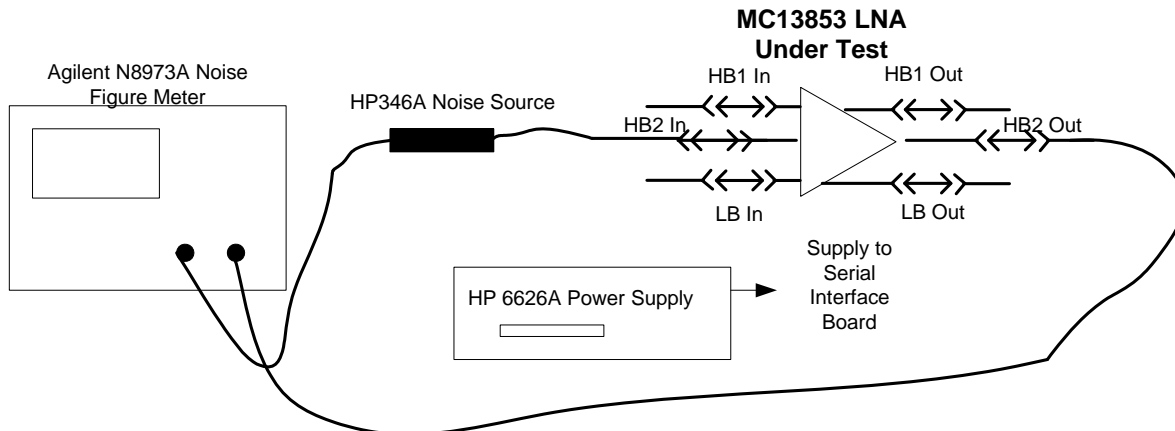


Figure 3-3. MC13853 Noise Figure Test Equipment Block Diagram

3.2 List of Test Equipment

The following test equipment is required:

- Agilent 8753E network analyzer or equivalent.
- HP 8562E spectrum analyzer or equivalent.
- RF power meter, Gigatronics 8542C with sensors or equivalent.
- Two signal generators, HP 8648C or equivalent.
- Agilent N8973A noise figure meter or equivalent with HP 346A noise source.
- DC system power supplies, HP 6632A or equivalent.
- Input isolators.
- Control computer, PC with accessories, Microsoft Windows NT or XP operating system.
- Interconnecting RF coaxial cables, DC and control lines.

Appendix A

DC and Control Wiring Harness

The DC and control cable harness is described in [Figure A-1](#).

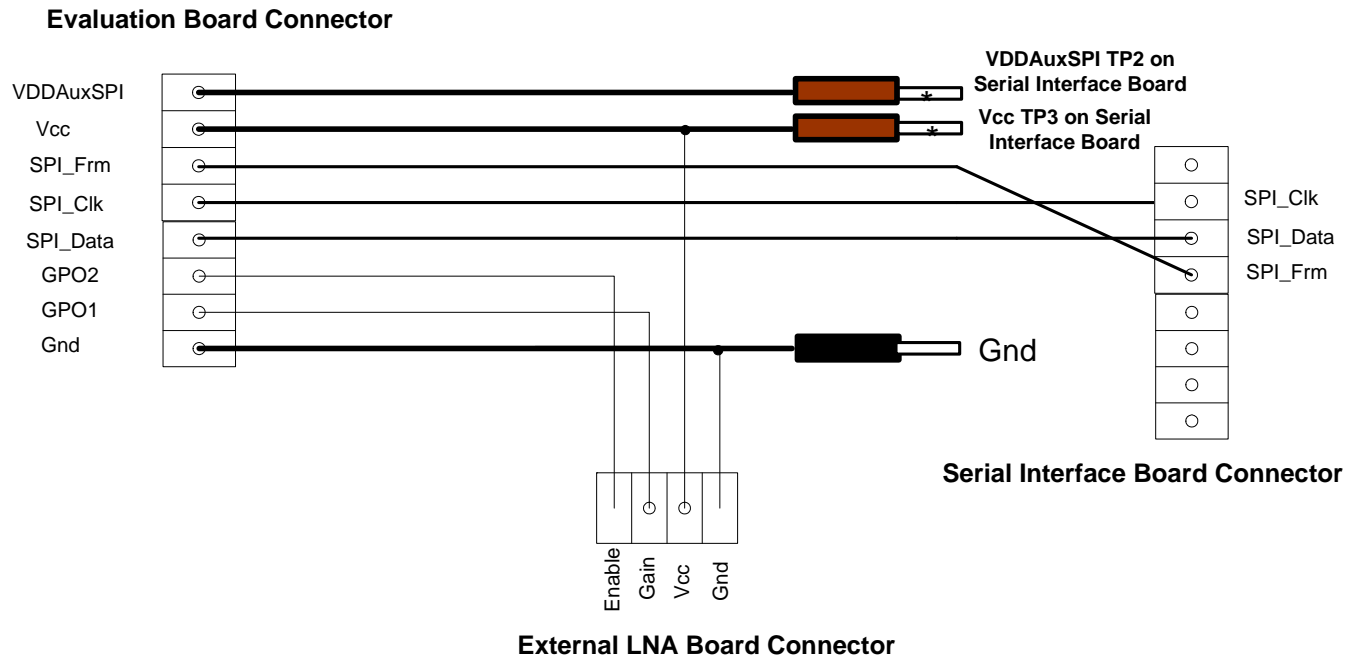


Figure A-1. MC13853 DC and Control Cable Harness

