

MC13883 Demo Kit

User's Guide

MC13883DKUG

Rev. 1.1

02/2010

Contents

| | |
|---|------------|
| About This Book | V |
| Audience | v |
| Organization..... | v |
| Contents of MC13883 Demo Kit..... | v |
| Definitions, Acronyms, and Abbreviations..... | vi |
| References..... | vi |
| Chapter 1 Getting Started | 1-1 |
| 1.1 Installing MC13883 Demo Software..... | 1-1 |
| 1.2 Setting Up the Board | 1-1 |
| Chapter 2 Demo Software | 2-1 |
| 2.1 Starting the Software | 2-1 |
| 2.2 Using the Software | 2-2 |
| 2.2.1 DEMO PROGRAM Page..... | 2-3 |
| 2.2.2 CONTROL BIT MAP Page | 2-10 |
| Chapter 3 Demo Board | 3-1 |
| 3.1 Charging Mode..... | 3-2 |
| 3.2 USB Mode | 3-2 |
| 3.3 Audio Mode..... | 3-2 |
| Chapter 4 Appendix..... | 5 |
| 4.1 Demo Board Schematics | 5 |
| 4.2 Demo Board Layout | 5 |
| 4.3 Jumpers Default Configuration | 5 |

About This Book

This user's guide provides a detailed description of the hardware and control support of the MC13883 demo kit. It documents the algorithms and settings for the charging, USB, UART, and audio modes of the MC13883 demo board.

Audience

This manual is primarily intended for the end user of the MC13883 demo board.

Organization

This document is organized into four chapters.

| | |
|-----------|--|
| Chapter 1 | Getting Started |
| Chapter 2 | Demo Software |
| Chapter 3 | Demo Board: Hardware configuration |
| Chapter 4 | Appendix: Demo board schematics, layout, and jumpers default configuration |

Contents of MC13883 Demo Kit

The demo kit is intended to enable a full evaluation of the MC13883 stand-alone IC in its own application environment. Software and PC interfacing is included for flexibility in programming the device. The kit is composed of:

- MC13883 demo board
- Demo software: `EMUApp.exe` (on CD-ROM)
- *MC13883 Demo Kit User's Guide* (this document), including schematics and layout diagram (appended at end of this User's Guide and as separate files on CD-ROM)

Definitions, Acronyms, and Abbreviations

The following list defines the abbreviations used in this document.

| <u>Abbreviation</u> | <u>Spelled-out meaning</u> |
|---------------------|----------------------------------|
| CEA | Consumer Electronics Association |
| OTG | On-the-Go |
| PC | Personal computer |
| USB | Universal Serial Bus |

References

The following documents were referenced to build this document:

1. *MC13883 Integrated Charger USB Interface* data sheet (document number MC13883)
2. USB CarKit Interface specification, CEA-936A

Revision History

Revision 1.1 updates are to prepare the document for public release.

Chapter 1

Getting Started

This chapter describes how to install the demo software and set up the MC13883 demo board.

1.1 Installing MC13883 Demo Software

The demo software is designed for a PC that is running on Windows 2000 or Windows XP and has a COM port to connect to the MC13883 demo board. Install the software (from the CD-ROM) as follows:

1. Double click the EMUapp icon to self-extract the demo board software (EMUapp.exe) from the ZIP format.
2. In Parent directory\Installer\, click setup.exe to install the program. Follow the instructions of the installer. When the installation is complete, restart the PC as prompted.
3. The executable MC13883 demo program EMUapp.exe, including all extensions needed for correct functionality, is now installed on the PC.
4. Create a shortcut to the installed executable on the PC desktop for convenience.

1.2 Setting Up the Board

Refer to Figure 1 when performing this procedure:

1. To the demo board, connect a DC voltage between 5.5 V and 10 V for the microprocessor on the power jack, CN7, and connect a DC voltage between 0 V and 4.65 V across Test Point 1 (TP1) and the Ground port. In the test case (see Chapter 2), the latter voltage source serves as the battery voltage.
2. Ensure that all jumpers are at their default location according to Chapter 4.
3. Press the Reset button (SW1).
4. Connect a standard RS-232 cable between the PC and demo board.
5. Start the MC13883 demo software by following the instructions in Chapter 2.

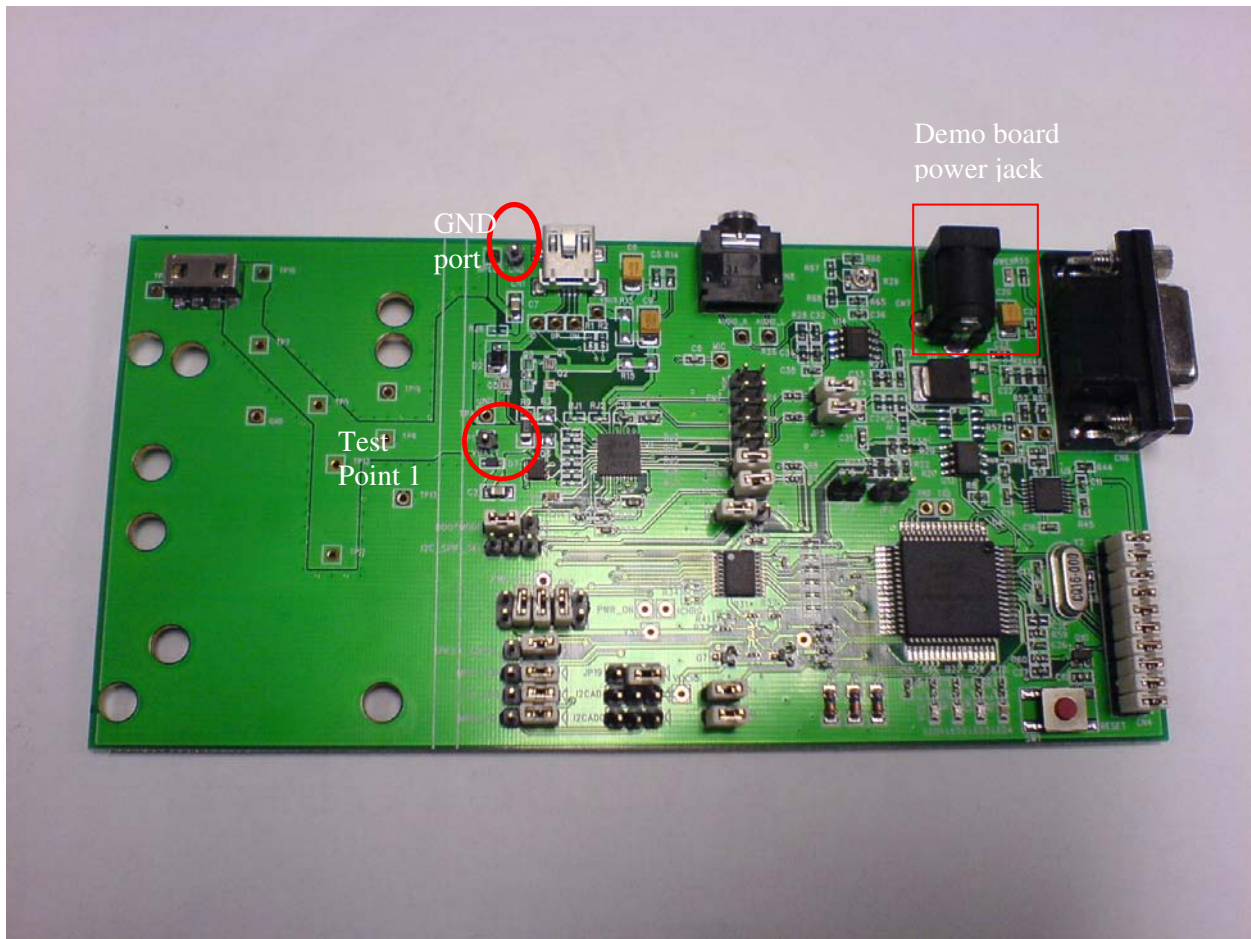


Figure 1. MC13883 Demo Board with 7.8 V and 3.5 V Power Supplies Highlighted

Chapter 2

Demo Software

The MC13883 demo software provides a graphical user interface in a PC environment that shows an application demo and allows the user to control the MC13883's registers. It was developed with LABVIEW but then compiled to a stand-alone executable program, including all the necessary modules, that runs without the LABVIEW tool. The software is expected to be run on a PC with Microsoft Windows 2000 or XP.

2.1 Starting the Software

After installing the software and setting up the board as described in Chapter 1:

1. Start the software by double clicking the `EMUApp.exe` file.
2. The program's **TEST COMMUNICATION** page appears as shown in Figure 2. It is highly recommended to use this page to start the demo.

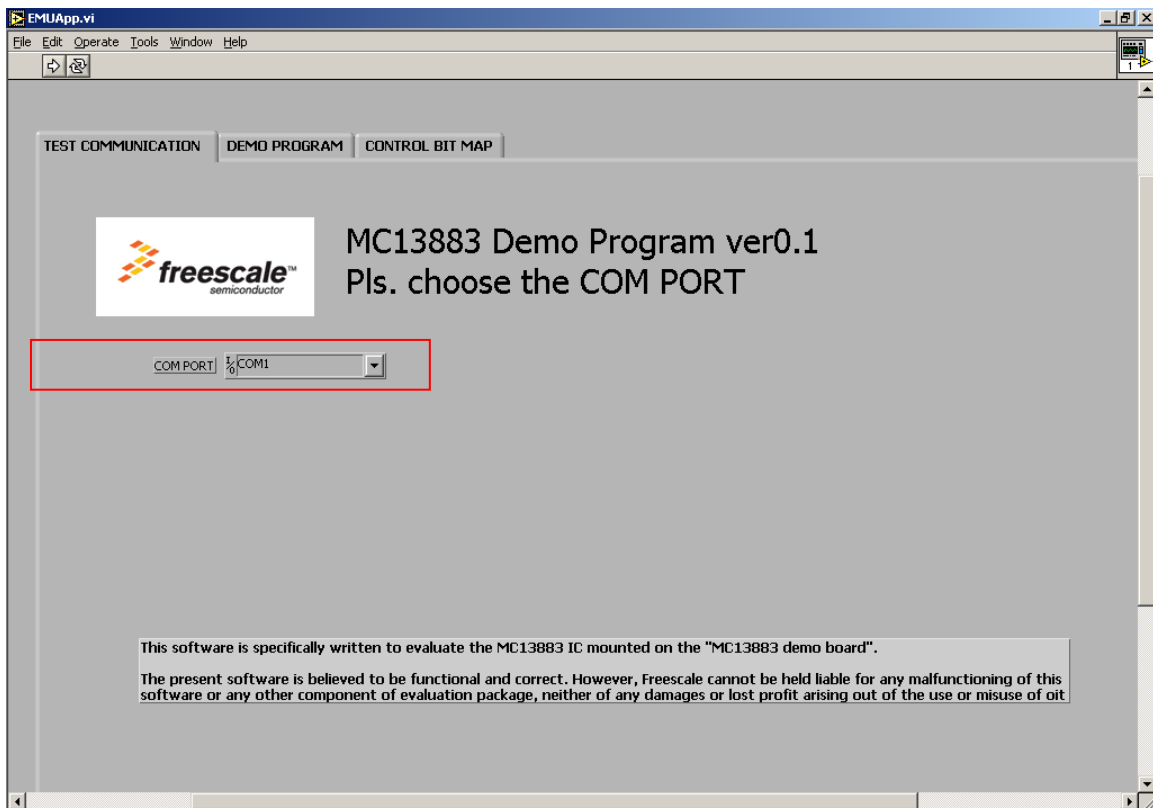


Figure 2. TEST COMMUNICATION Page for Selecting the Communication Port

3. Select the proper communication port for driving the MC13883 demo board. When the demo is run, the selected port is used and cannot be changed during the demo. The recommended baud rate is 9.6 kbps.

Note: If the communication between the demo program and the board fails, check the setting on the serial communication port.

After passing the **TEST COMMUNICATION** page, the program provides access to the MC13883 register map or the demo flow to show the typical accessory detection procedures.




2.2 Using the Software

The MC13883 demo program's graphical user interface includes three main pages:

- **TEST COMMUNICATION**
- **DEMO PROGRAM**
- **CONTROL BIT MAP**

Table 1 identifies the buttons in the interface.

Table 1. Buttons in Software Interface

| Button Icon | Button Name |
|---|------------------|
|  | Run |
|  | Run Continuously |
|  | STOP DEMO |

When viewing the **DEMO PROGRAM** page, click the Run button to start the demo program and the **STOP DEMO** button to terminate the program.

When viewing the **CONTROL BIT MAP** page, click the Run Continuously button to start the evaluation. Double clicking the Run Continuously button terminates the **CONTROL BIT MAP** page.

Each window in the program sends new register data to the MC13883 automatically. When you click the Run Continuously button, the software writes the registers used in the window into the MC13883, reads the same registers, and displays the state of the internal registers of the MC13883.

When you stop the demo program, click the Run Continuously button again.

2.2.1 DEMO PROGRAM Page

The **DEMO PROGRAM** control page shows a typical flow control example of device and accessory detection with the MC13883, which includes:

- a) Detection of a self-powered device such as a carkit, of the charger and USB HOST, and of a phone-powered device such as a hands-free earpiece.
- b) Charging algorithm.
- c) Audio routing to the hands-free earpiece upon the detection of the related accessory.

The GUI of the **DEMO PROGRAM** control page includes five main output boxes:

1. **STATUS** output box
2. **Registers and ADC window** output box
3. **MC13883 IC VERSION** output box
4. **Accessory control** output box
5. **IRQ Window** interrupt status output box

2.2.1.1 STATUS Output Box

The **STATUS** output box, as its name suggests, displays the status of the MC13883 demo flow. It also displays the required instructions to run through the demo software. See Figure 3.

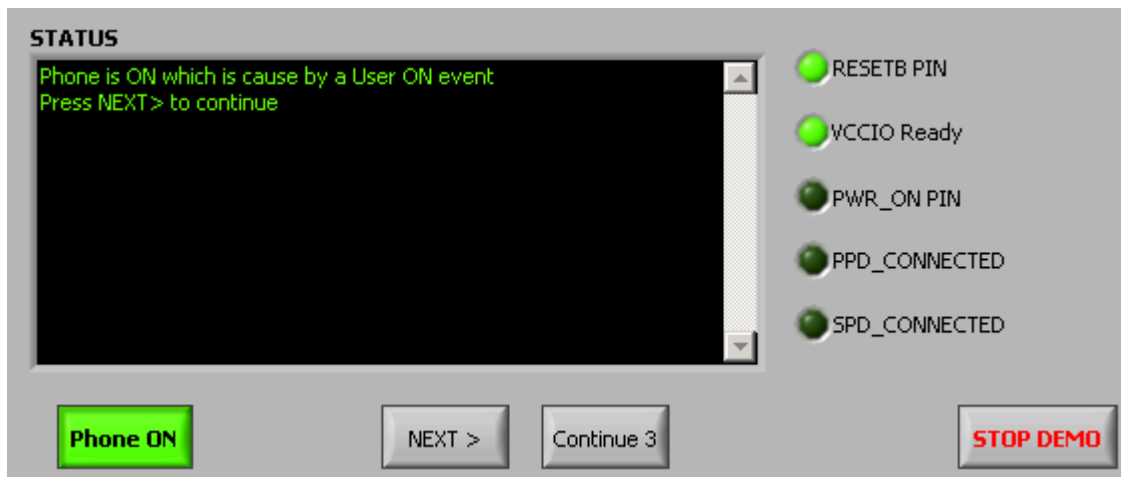


Figure 3. STATUS Output Box

The general control keys of the **STATUS** output box are:

- **Phone ON** emulates the power-on button of the phone. It enables the MC13883 to switch from power-off mode to normal operating mode by enabling the on-board 1.8 V regulator to supply the VCCIO of the MC13883 and release the RESETB (from logic 0 to logic 1). Note that this button serves as an indicator by turning green after it generates a valid power-on event to the MC13883.
- The **STOP DEMO** button terminates the demo program.
- The **START**, **NEXT**, and **QUIT FACTORY TEST** buttons display under certain conditions during device detection. In these cases, related instructions appear in the status window.

The right side of the **STATUS** output box includes five indicators:

- The **RESETB PIN** indicator provides the status of the logic level input to the RESETB pin of the MC13883. If the green light is on, the logic state of RESETB is high.
- The **PPD_CONNECTED** indicator shows whether a phone-powered device is attached.
- The **SPD_CONNECTED** indicator shows whether a self-powered device is attached.
- The **VCCIO Ready** indicator shows whether the VCCIO voltage connected to the MC13883 is ready (meaning that it is more than 1.5 V).
- The **PWR_ON PIN** indicator shows the status of the PWR_ON pin. It displays a logic state of high (green) if the measured voltage on the MC13883's PWR_ON pin is more than 2.5 V.

2.2.1.2 Registers and ADC window Output Box

The **Registers and ADC window** output box (see Figure 4) shows the value of the SPI registers on the MC13883. For more information about the registers, refer to the register table summary in reference [1].

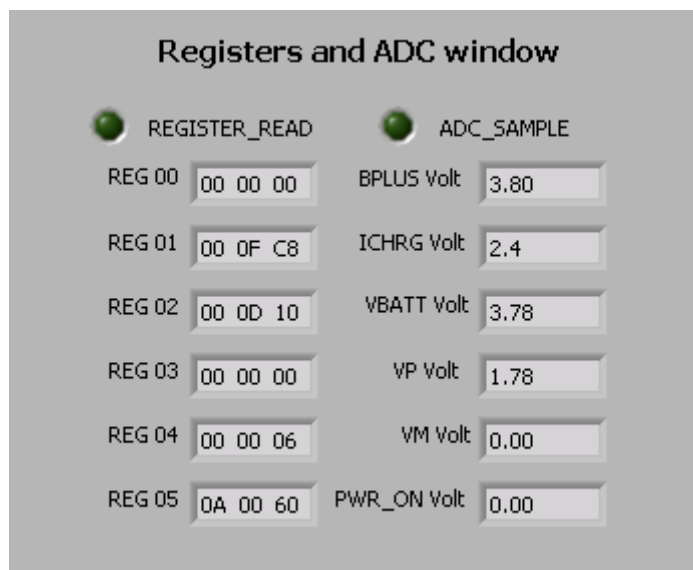


Figure 4. ADC and Register Output Box

When the green light of the **REGISTER_READ** indicator is on, the PC is reading the status of the registers. Figure 5 shows the location of the LSB digit of each register.

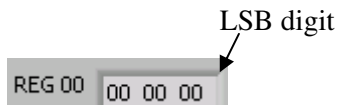


Figure 5. LSB Location in REGISTER_READ Display

The **ADC_SAMPLE** output box displays the measured values of the indicated voltages. By means of its on-chip 8-bit ADC, the on-board MCU (AB32) monitors the voltage levels of BPLUS, ICHRG, VBATT, VP, VM, and PWR_ON of the MC13883.

2.2.1.3 MC13883 IC VERSION Output Box

The **IC VERSION** output box shows the IC version of the MC13883. See Figure 6. Register 02 of the MC13883 (see reference [1]) indicates the version of the MC13883.

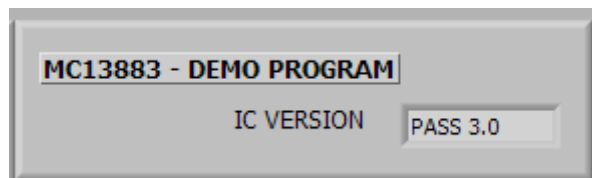


Figure 6. IC VERSION Output Box

2.2.1.4 Accessory Control Output Box

The accessory control area of the **DEMO PROGRAM** page (see Figure 7) displays and provides an interface for controlling two major types of auto-detected accessories: self-powered devices (such as a charger) and phone-powered devices (such as a hands-free accessory). After the software auto-detects an accessory and its type, additional type-specific interface elements appear in the accessory control area for controlling the accessory.

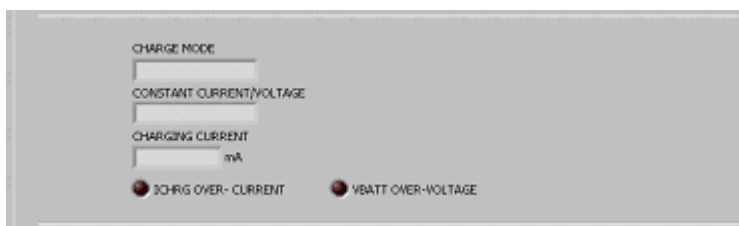


Figure 7. Accessory Control Output Box

2.2.1.4.1 Charging Algorithm Output

When a charger defined by CEA-936A is attached to the mini-USB jack, the demo software detects the type of connected charger: Type 1 (medium current) or Type 2 (high current). In the case of a Type 1 charger, the **Start Type 1 Charging** button appears as shown in Figure 8 (the button's name would be

Start Type 2 Charging in the case of a Type 2 charger). Pressing the **Start Type 1 Charging** button initiates an imitation of the charging process.

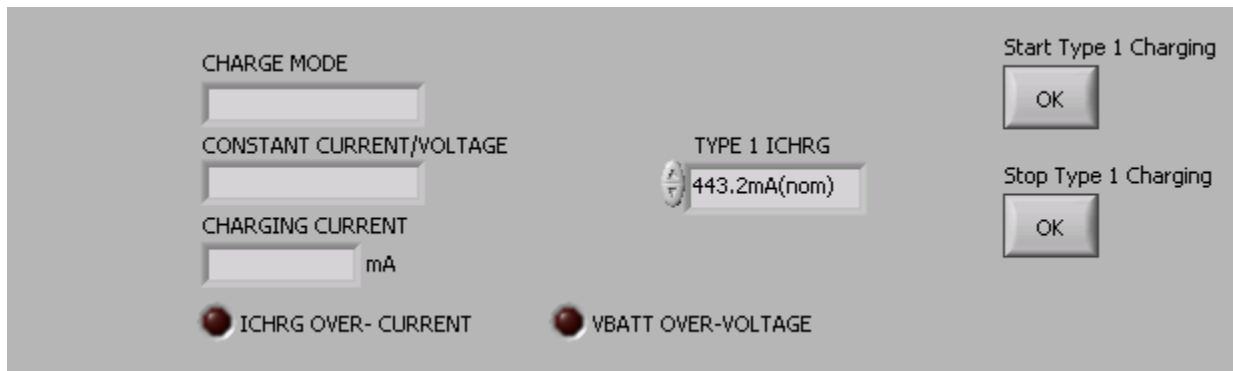


Figure 8. Charging Algorithm Display in Accessory Control Output Box

The **CHARGE MODE** output box indicates which mode of charging is used. The MC13883 has two modes: trickle charging and Full Rate charging.

When the voltage of the battery is less than 3.4 V, trickle charging is used. The register ICHR_TR[2:0] is pre-set to 111 and the trickle charge current is 84 mA. If the voltage of the battery is more than 3.4 V, the **TYPE 1 ICHRG** control box appears, which enables control of the battery charge current setting (ICHRG[3:0]).

If the charger is plugged into the mini-USB jack, the **TYPE 1 ICHRG** control box appears and the ICHRG[3:0] bits set the maximum current for the charger (see Figure 9). The displayed current is the actual current that flows through the 100 mohm sense resistor. During the demo, the ICHRG bits are fixed.

If the charger cannot provide the current that the ICHRG bits set, the charging action stops and the warning “Charger Current Limited” appears.

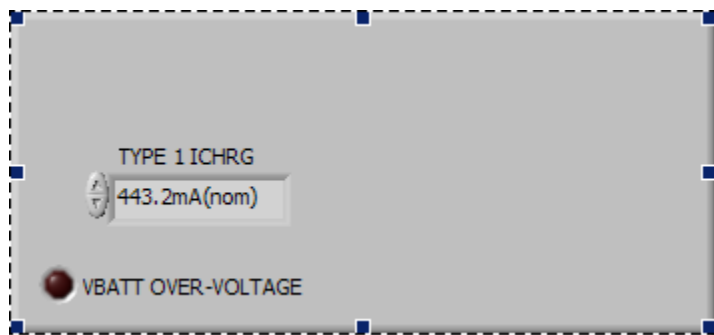


Figure 9. ICHRG Bits Control Box

The **CONSTANT CURRENT/VOLTAGE** output box shows the charge mode indicator:

- CC: Constant current charging

- CV: Constant voltage charging

The **CHARGING CURRENT** output box shows the charging current in mA in the Full Rate charging mode. The ICHRG pin outputs either a voltage that is proportional to the current through the Rs sense resistor or a voltage that is proportional to the ID pin voltage.

When the charge regulator is enabled, the ICHRG pin outputs a voltage that is proportional to the current through Rs resistor. On the demo board, this voltage is measured by the microprocessor's ADC and is scaled from 0 V to 2.3 V for currents from 0 A to 1.8 A (full scale).

$$\text{Charging current (A)} = \text{ICHRG (V)} * 1.8/2.3$$

If the charging current is over-limited, the **ICHRG OVER-CURRENT** indicator turns on (red) as shown in Figure 10.

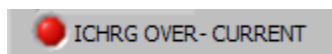


Figure 10. ICHRG Over-Current Indicator

2.2.1.4.2 Mono Audio Headset Mode

When a mono audio headset is attached to the mini-USB jack, mono headset control options are displayed in the accessory control output box. As the **Error! Reference source not found.** message shows, the **Device ON** and **Exit Mono Headset** buttons appear. Also, in the **STATUS** output box, the **PPD_CONNECTED** indicator turns on.

Pressing the **Device ON** button launches the mono audio headset mode. If the audio signal (from the PC) is provided from the audio jack of the demo board, it is audible in the headset.

Pressing the **Exit Mono Headset** button disables the mono audio headset mode.

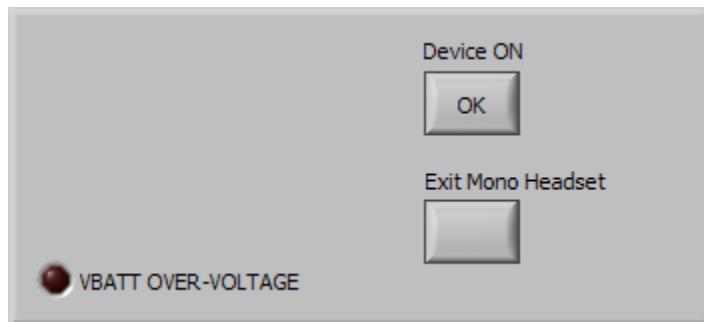


Figure 11. Mono Headset Control Display in Accessory Control Output Box

2.2.1.5 Interrupt Status Output Box

Figure 12 shows the **IRQ Window** interrupt status output box.

- The **IRQ received** output box shows the Interrupt Sense Register (register 02) in hexadecimal format. The demo program decodes the interrupt and shows it in **IRQ STATUS**.
- The **Interrupt Call** indicator turns on if any interrupt is made by the MC13883.
- The **IRQ STATUS** output box decodes the Interrupt Sense Register (register 02) and displays the interrupt generated by the MC13883.

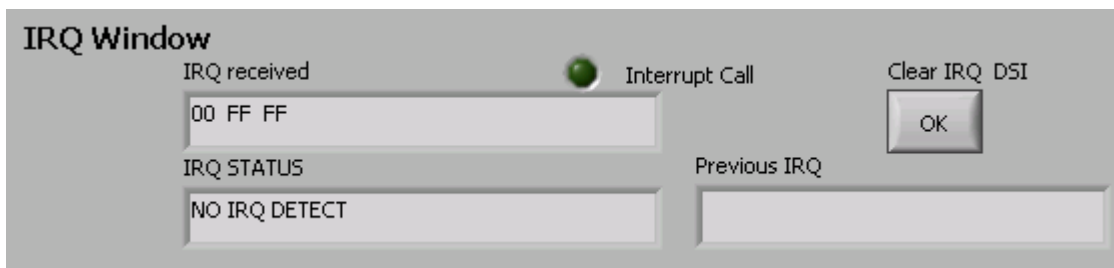


Figure 12. IRQ Window Interrupt Status Output Box

2.2.1.6 Output Box Displays as Demo Program Starts

Initially, the program simulates the status when the phone is powered down. BATTTP is connected to the battery and provides the supply voltage to the MC13883. The **RESET STATUS** and **PHONE STATUS** show the phone is in off mode: the RESETB pin of the MC13883 is low, and VCCIO is disabled.

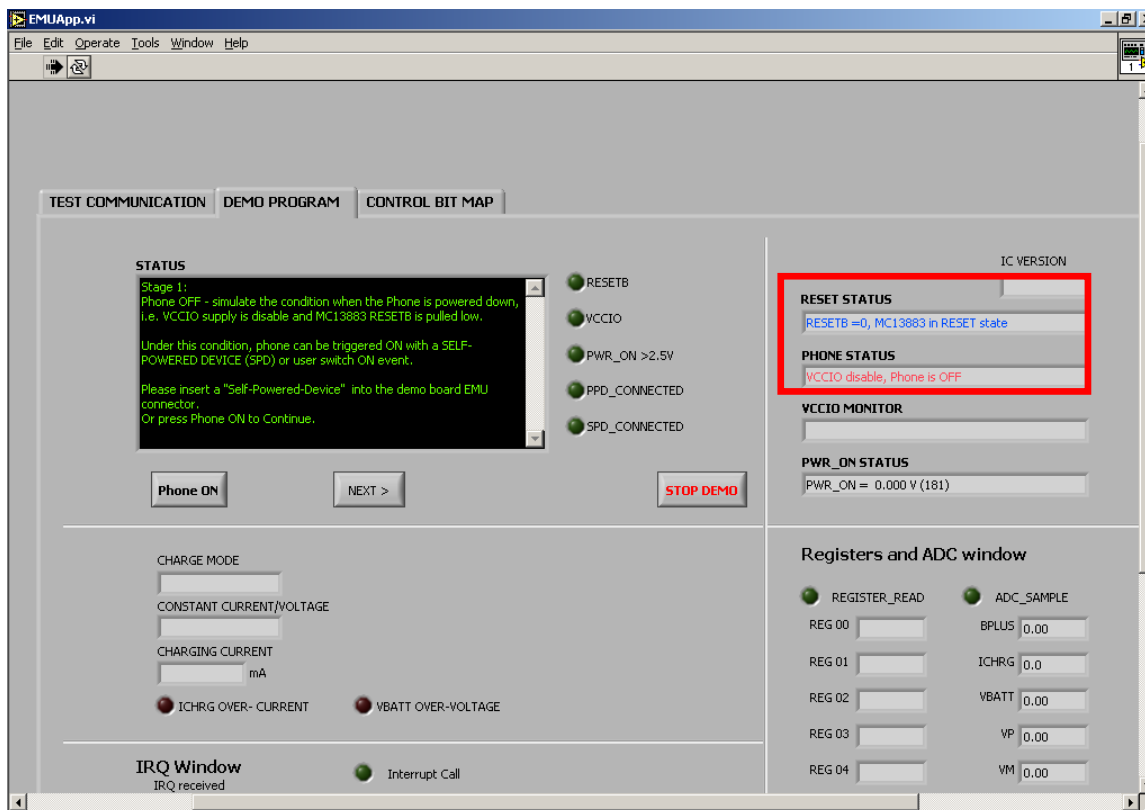


Figure 13. Demo Program Shows Phone Is Off

When the **Phone ON** and **NEXT** buttons (in the **STATUS** area) are pressed, VCCIO of the MC13883 becomes 1.8 V. At this stage, the demo board is ready to detect phone-powered and self-powered devices. See Figure 14.

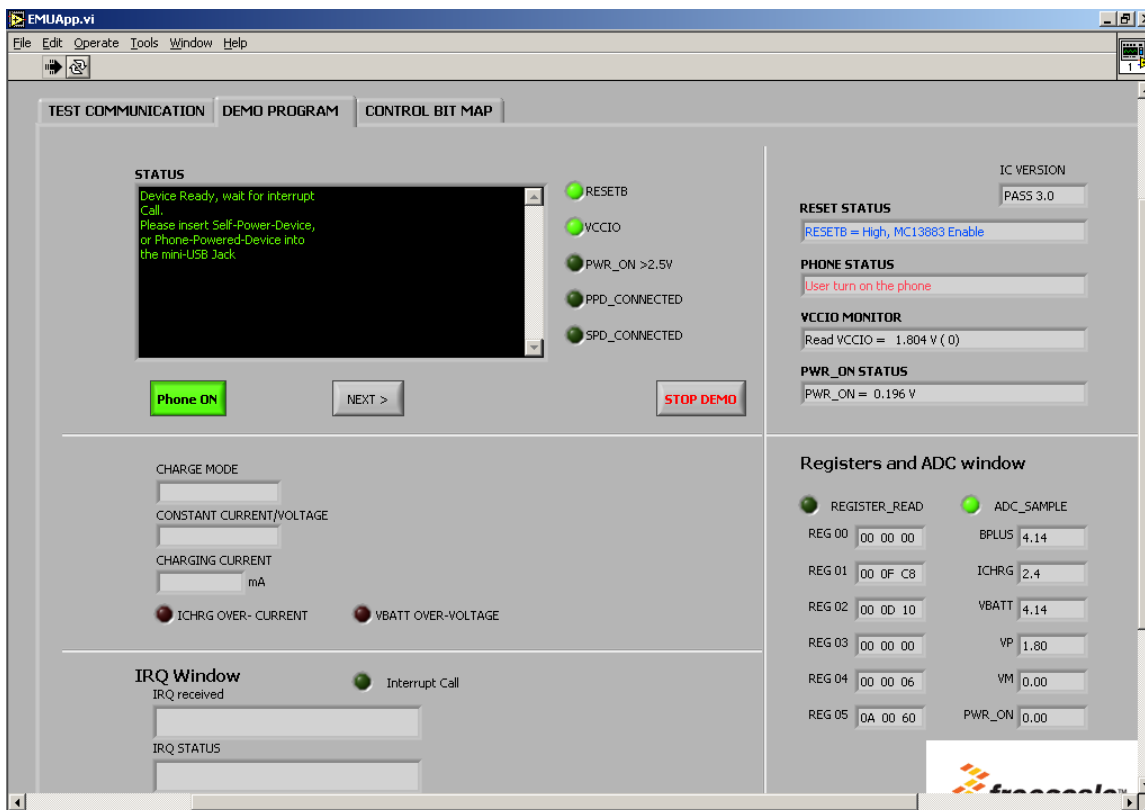


Figure 14. Demo Board Shows Phone Is On and MC13883 Is Ready to Detect Devices

If the MC13883 has not powered up and a self-powered device is plugged into the mini-USB jack, the PWR_ON pin has provided a turn-on signal to the MCU (shown in Figure 15). In this case, the **START** button appears in the **STATUS** area. Press **START** to initiate the MC13883 power-on procedure, and VCCIO is set to 1.8 V.

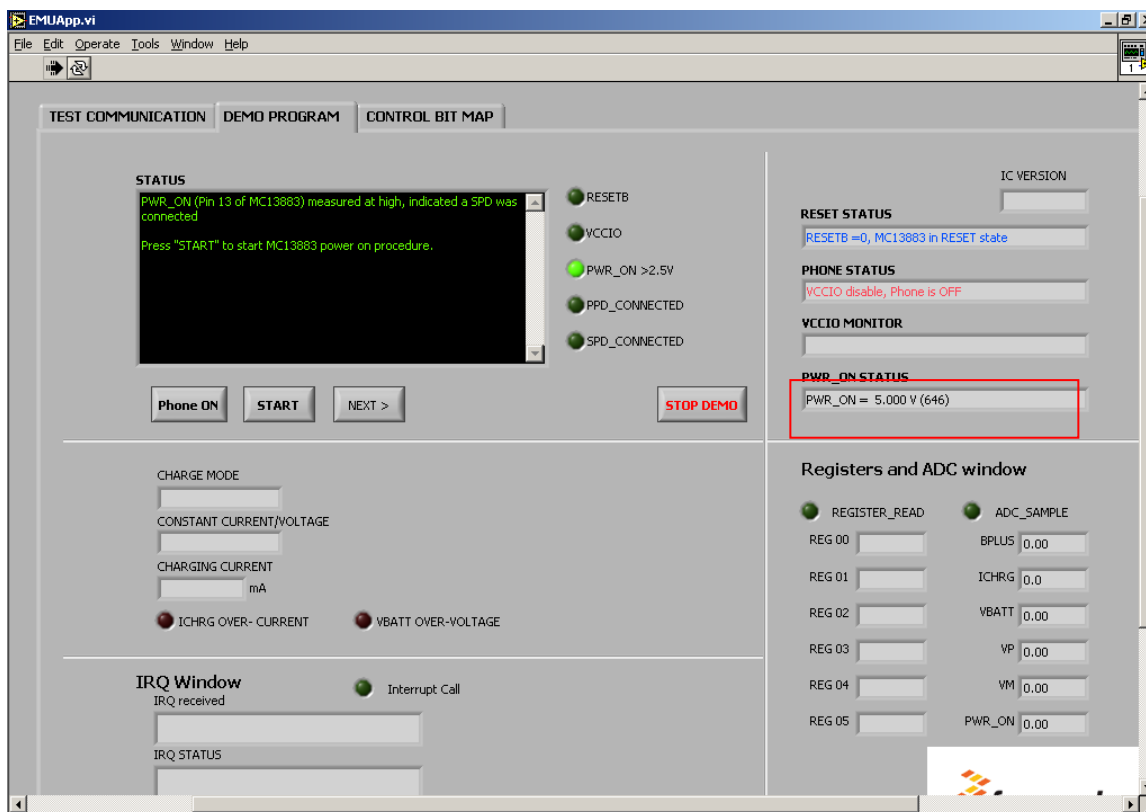


Figure 15. PWR_ON Signal Pin of MC13883 Is Switched to 5 V

2.2.2 CONTROL BIT MAP Page

The **CONTROL BIT MAP** control window provides a graphic user interface for performing read/write operations on the MC13883's internal registers, which include (see reference [1]):

- Register 00: Interrupt Status
- Register 01: Interrupt Mask
- Register 02: Interrupt Sense
- Register 03: Power Control 0
- Register 04: Power Control 1
- Register 05: Connectivity Control

2.2.2.1 Reading and Writing to Registers

For each register, the display has two main areas:

- Read content (red color indicator): the bit content read from the corresponding register set on the MC13883. Light red indicates a logic 1 and dark red indicates a logic 0. The demo program reads the registers through the COM port.

- Write content (green color indicator): the bit content to write into the MC13883 register.

To perform a write operation (see Figure 16):

1. Set the target control bit by clicking the corresponding green indicator. Light green indicates a logic 1 and dark green indicates a logic 0.
2. Press the **REGx WRITE ENABLE** button to send the content to the MC13883.

For register 00, writing a 1 into the bits clears the interrupts.

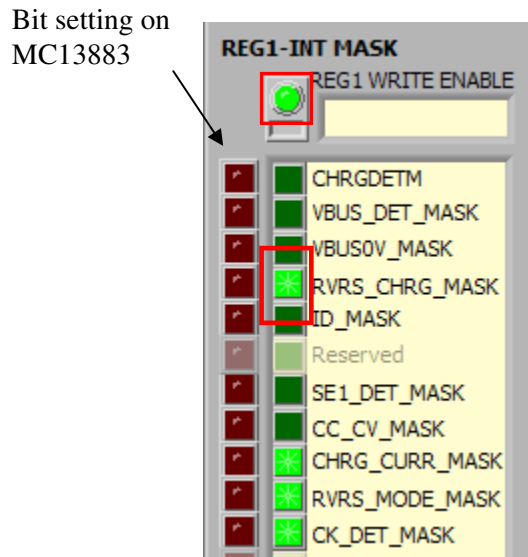


Figure 16. CONTROL BIT MAP Page Display: Register 01

2.2.2.2 First Steps on CONTROL BIT MAP Page

After first opening the **CONTROL BIT MAP** control window, do the following (see Figure 17):

1. Click **VCCIO Enable** to supply power to the VCCIO pin on the MC13883.
2. Click **RESETB** to reset the demo board. Then release the **RESETB** button (turn it off) to verify any register changes.



Figure 17. VCCIO Enable and RESETB Buttons

3. ID_INT of REG0 (Interrupt Status Register) and ID_FLOAT of REG2 (Interrupt Sense Register) are activated, as shown in Figure 18.

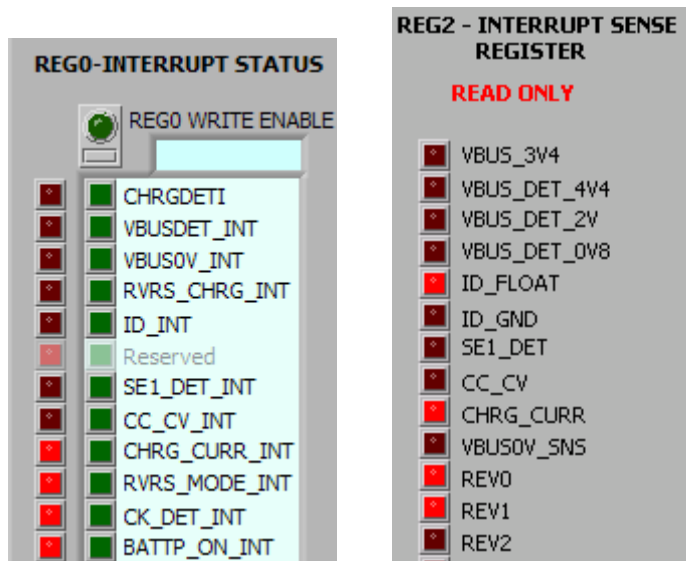


Figure 18. REG0 and REG2 after VCCIO Enable Is On and RESETB Button Is Off

Some registers—such as REV[2:0], ICHRG[3:0], ICHRG_TR[2:0], VBUS_PULSE_TMR[2:0], and MODE[2:0]—are decoded and shown in the demo program. See Figure 19.

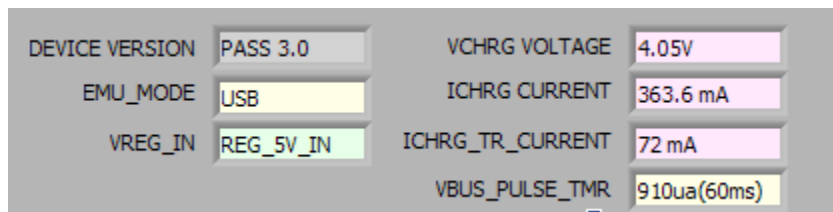


Figure 19. Settings of MC13883 Registers

Seven pins of the MC13883 are connected to the ADC of the microprocessor. The table (shown in Figure 20) provides the voltage of those seven pins.

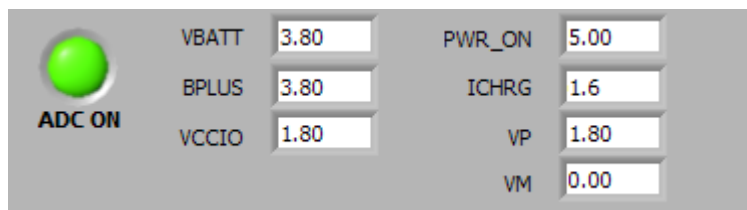


Figure 20. Values of ADC on Microprocessor

Chapter 3 Demo Board

The MC13883 demo board has an RS-232 port connected to the microprocessor that reads and writes to the registers of the MC13883. The demo board is shipped with the default jumpers configuration set to a four-wire USB interface and dual-path charging. Check the corresponding jumpers, and see Chapter 4 for the default jumper configuration.

The demo board is supplied with a 7.8 V and a 3.8 V power supply, as Figure 21 shows. The 7.8 V power supply is for the Freescale microprocessor of the MC68HC9 series, which translates the instructions to the MC13883. A PC controls the demo board through the RS-232 serial port at the 9.6 kbps baud rate.

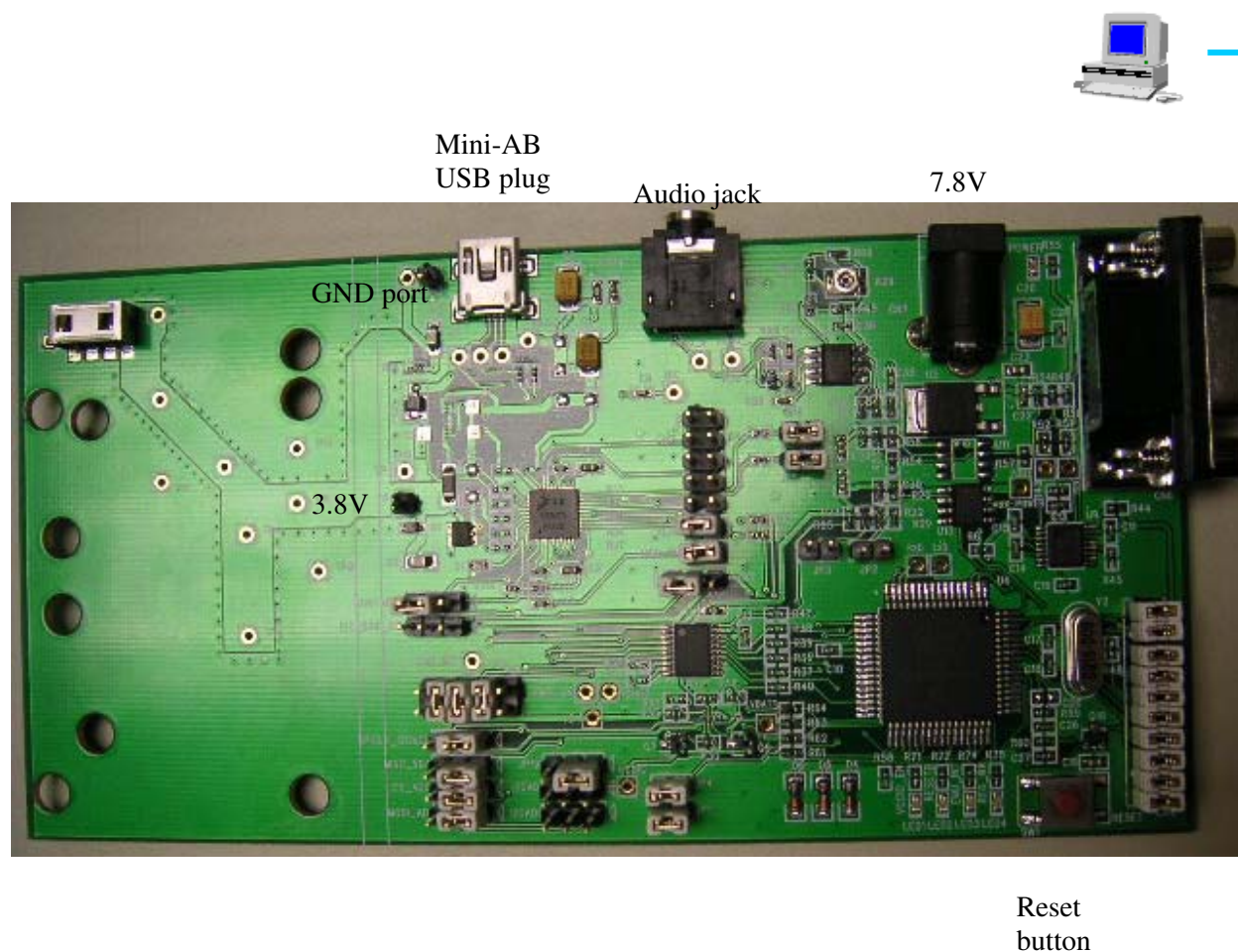


Figure 21. MC13883 Demo Board

3.1 Charging Mode

The MC13883 IC allows charging via the mini-USB pin. This pin delivers power from a variety of devices including traditional charging sources, such as wall chargers and carkits, as well as sources that traditionally are not used in charging. As the CHRGMODE pin (RJ14 on the demo board) is shorted to ground, the MC13883 demo board uses dual-path charging (see reference [1]). The basic feature of dual-path charging is that there are two separate current paths from the external charger input (VBUS) to the internal phone supply rail (B+). This path is used to charge the battery and the charge path. The other path is a non-charging path through the FET to the main phone supply node, which supplies the power for the functionality of the phone.

3.2 USB Mode

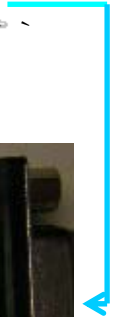
The MC13883 contains a USB OTG transceiver that is compliant with the USB 2.0 specification and the USB On-the-Go supplement. For the demo board, the default setting on BOOTMODE (JPS2 jumper) is grounded. The transceiver powers up in DAT_SE0 unidirectional (six-wire) mode (the default state of DAT_SE0 = 1, and the default state of BI_DI = 0).

In six-wire mode, if TXENB is low, the complementary transmit data present on DAT_VP and SE0_VM is output differentially on DP and DM. If TXENB is high, the transmit buffer is disabled and the data received differentially on DP and DM is output on RCV.

3.3 Audio Mode

The MC13883 supports mono and stereo audio modes in which audio signals are multiplexed on DP/DM lines. For the MC13883 demo board, the mono USB headset can be attached to the mini-USB jack and audio source (from a PC and CD player) for the audio demonstration. Two 22-ohm resistors placed externally in series with the DP and DM lines do not affect the audio signals. See Figure 22.

For the demo board, the op-amp MC33172 is used for the buffer between the audio source and the MC13883. A 2.1 V reference voltage is used for the op-amp (pin 3). With the variable resistor R29, the reference voltage can be trimmed.



Audio jack

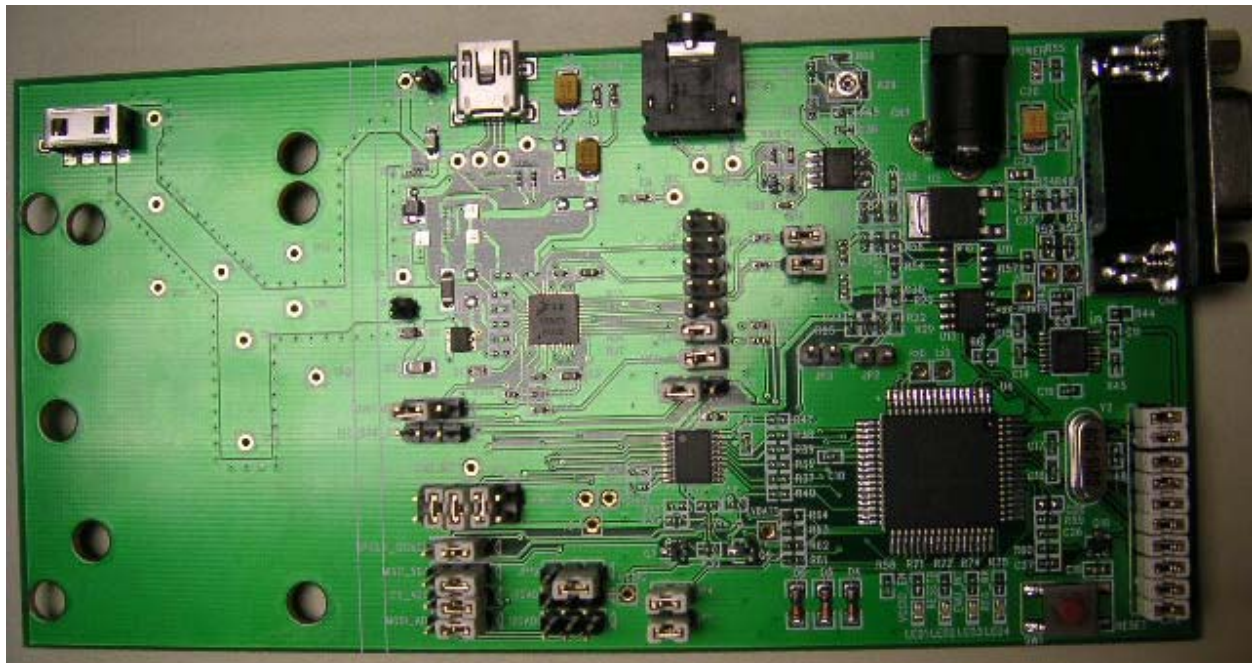


Figure 22. MC13883 Demo Board in Mono Audio Mode

Chapter 4 Appendix

This appendix contains schematics and the board layout for the demo board as well as the default configuration of the jumpers.

4.1 Demo Board Schematics

The four-page schematic is appended after this chapter in the User's Guide. It is also provided as a separate file, MC13883_sch.pdf, on the CD-ROM included in the demo kit.



MC13883_sch.pdf

4.2 Demo Board Layout

The one-page layout diagram is appended after the four-page schematic in the User's Guide. It is also provided as a separate file, MC13883_component.pdf, on the CD-ROM included in the demo kit.



MC13883_component.pdf

4.3 Jumpers Default Configuration

Table 2 provides this information.

Table 2. Default Configuration of Demo Board Jumpers

| Reference Number | Default Setting | Description |
|------------------|-----------------------|-------------------------|
| JPS2 | Short pin 2 to pin 3 | BOOTMODE is shorted. |
| CN2 | Pin 7 short to Pin8 | VM connect to USB_EN |
| | Pin 9 short to Pin 10 | DAT_VP connect to TXENB |

| Reference Number | Default Setting | Description |
|------------------|--|--|
| CN4 | Pin 1 short to pin 2 Pin 3 short to pin 4 Pin 5 short to pin 6 Pin 7 short to pin 8 Pin9 short to Pin 10 Pin 11 short to pin 12 Pin 13 short to pin 14 Pin 15 short to pin 16 Pin 17 short to pin 18 Pin 19 short to pin 20 | TEST PURPOSE |
| CN5 | Pin 3 short to pin 4 Pin 5 short to pin 6 Pin 7 short to pin 8 | init signal pin VCCIO supply signal path 5 V power supply to MC13883 |
| JP1 | Shorted | Power on pin |
| JP4 | Shorted | ICharge pin |
| JP5 | Shorted | |
| JP6 | Shorted | |
| JP13 | Pin 1 short to pin 2 | Communication pins between MCU and MC13883 |
| JP14 | Pin 1 short to pin 2 | |
| JP15 | Pin 1 short to pin 2 | |
| JP16 | Pin 1 short to pin 2 | |
| JP19 | Pin 1 short to pin 2 | |

How to Reach Us:**Home Page:**

www.freescale.com

Web Support:

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

USA/Europe or Locations Not Listed:

Freescale Semiconductor, Inc.
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 China Ltd.
Exchange Building 23F
No. 118 Jianguo Road
Chaoyang District
Beijing 100022
China
+86 010 5879 8000
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

MC13883DKUG

Rev. 1.1

02/2010

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. 2010. All rights reserved.