EVALUATION KIT USERS GUIDE



For ZigBee / 802.15.4 Data Transmission





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Document N: 0002-00-08-00-000

Date Published: December 5, 2007

Preface

Purpose

This document describes how to use your Apex Evaluation Kit to set up and run functionality tests like broadcast range, current consumption, power levels, and more.

The procedures in the later chapters often depend on an understanding of the material presented in earlier chapters, so we recommend you review this from beginning to end before putting it to use.

Audience

This document is intended for use by the engineers responsible for evaluating CEL's Apex Series modules as a transmission solution in their IEEE 802.15.4 networks.

This document assumes the reader has a solid understanding of embedded systems design. Experience in networking and RF systems is expected.

Getting Help

You can use the CEL website to obtain information about all CEL products and services, and to sign up for product support.

If you have any questions about your Evaluation Kit, contact CEL at one of the following locations:

United States	CEL Headquarters
onnea states	
	4590 Patrick Henry Drive
	Santa Clara, CA 95054
	Tel. 408 919-2500
	Fax. 408 988-0279
	techsupport.zigbee@cel.com
	www.cel.com

Asia/Pacific	CEL Singapore
	Tel: + (65) 6-560-3255
	Fax: + (65) 6-560-4155

Documentation Conventions

Notation	Meaning	Examples	
Italics	A GUI label	Transmit Test	
BOLD ITALIC CAPS	A keyboard command	ENTER	
1	Delimits a hierarchy of menu options, which ends with the option to choose.	Open Save	
Arial Font	Identifies file names and program identifiers, such as constants and function names.	EMBER_SLEEPY_END_DEVICE serial.h emberStartScan ()	

Introducing the Apex Evaluation Kit

The key components of the Apex Evaluation Kit are the interface board CEL's Apex radio module. Apex modules combine an Ember[™] EM250 transceiver IC with an NEC UPG2250T5N high gain Power Amplifier and UPG2214TK high performance RFIC switch.

The interface board features a serial communication interface, a power management module, peripherals like a potentiometer and accelerometer, and GPIO headers. *(See Figure 1-2)*

The Evaluation Kit also contains four AA batteries and two USB cables.



Figure 1-1 Evaluation Interface Board and RF Module

The Apex Evaluation Kit allows you to:

- Validate CEL's Wireless Solution
- Quickly deploy a two node network for range evaluation

Each module comes preconfigured with embedded RF evaluation software that controls the various tests. It contains pre-configured modes for developing packet error rate testing, peripheral configuration, general IEEE 802.15.4-2003 tests, and more.

The evaluation software includes peripheral drivers that allow control and display through the interface board's buttons and LCD display.

Components

Apex Evaluation Kits include the following hardware components:

- 2 interface boards
- 2 Apex Modules (ZAXM-201-1)
- 4 AA batteries, two for each carrier board
- 2 USB cables
- 1 CD: Collateral and technical documents

Setting up the Hardware

1. Connect each interface board to one of the following power sources:

- *Batteries*: Use the two supplied AA batteries for mobile evaluation activities like broadcast range testing.
- *DC Power Supply (optional)*: Can be used with a DC power supply.

2. Set the *Power Switch*:

- To **VBAT** when batteries are used
- To VREG for AC power



Figure 1-2 RF Evaluation Board Components

See Bill of Materials for component details

Power is connected at the back of the interface board and can come from either batteries or an AC/DC power supply. The *Power Management* block on the interface board controls power distribution to the Apex module and peripheral components.

An onboard LCD screen displays the test names and settings, and displays basic test results when tests are running. Control buttons include:

- *UP* for changing to the previous test or test setting
- *DOWN* for changing to the next test or test setting
- *OK* for selecting a test or test setting, or for starting a test
- **EXIT** for returning to a previous menu or setting, or for stopping a test
- *RESET* for restarting the module and initializing the LCD display

The small arrows on the LCD indicate which buttons are active. For example:

- The up-arrow indicates the UP button is available to go to the previous item in the current list (test or setting).
- The right-arrow indicates the OK button is available to go to the next level to start a test, edit a value, or set a value.
- ✓ The down-arrow indicates the DOWN button is available to go to the next item in the current list (test or setting).
- The left-arrow indicates the EXIT button is available to return to the previous level, cancel an edit, or stop a test.
- The up and down arrows together indicate both the UP and DOWN buttons are available.

The module's built-in analog-to-digital converter (ADC) can be tested using the interface board's potentiometer or accelerometer.

Jumpers along the left side of the board provide access to the board's various features. A complete jumper list is provided in *Jumper Settings* in Appendix 2 on page 32.

Evaluation Test Menu

Once the board's stack powers up, a menu is activated. Press the *UP* and *DOWN* buttons to cycle through the menu's items. They're described on the following pages:

- Transmit Test page 11
- *Receive Test* page 17
- *Sleep Mode Test* page 21
- Energy Scan Test page 23
- Potentiometer Test page 24
- ZigBee Wars Game page 25
- Interface Board Settings page 26

User Tip:

To return to the top menu from lower menus entries, press the *EXIT* button until the top menu items are displayed.

Resetting the Board Stack

Press the **RESET** button to reboot the module. This will also restart the LCD screen at the beginning of the menu, and revert test settings to their defaults.

Caution: Test settings are *NOT* saved when the power is turned off. When the module is powered up, all test settings return to their defaults.

2_{Transmit Test}

In a *Transmit Test*, radio transmissions are sent from the module. A Transmit Test running on one module can be combined with a *Receive Test* running on a second module to test *Range*. The tests can be performed with or without additional test equipment as needed.

The tasks described in this chapter include:

- Running a Default Transmit Test page 11
- Editing Transmit Test Settings page 14
- Determining a module's Maximum Power page 16

Transmit Test Settings

- Channel page 12
- Power page 12
- *Boost Mode* page 12
- Send Mode page 13
- Packet Length page 13
- Packet Number page 14
- *Delay* page 14

Running a Default Transmit Test

The default Transmit Test automatically sends 100 packets and then stops.

- 1. From the top menu, press *UP* or *DOWN* until *Transmit Test* appears on the LCD.
- 2. Press OK to display Start Transmit.
- 3. Press OK again to start the default Transmit Test.
- 4. The LCD displays the number of packets being sent. See *Transmit Test Settings* on page 11 for the default test settings.
- 5. To start a *Receive Test*, see page 17.
- 6. To stop the *Transmit Test* press *EXIT*.

Channel

The *Channel Setting* identifies the radio channel in use.

16 numbered channels (11-26) are defined by the IEEE 802.15.4-2003 standard in the 2.4GHz ISM band. Channels are spaced 5MHz apart. The default is channel 20.¹

User Tip:

Channels 15, 20, 25, and 26 for IEEE 802.15.4-2003 networks are usually available. They're good choices because they don't interfere with the 802.11 network channels typically in use.

Note 1. The center frequency of these channels is defined as Fc = 2405 + 5 (k - 11) in megahertz, where k = the channel number; 11, 12, etc, through 26.

Power

Power is the transmit power in dBm that the module will transmit. The value *MAX: 20 dBm* represents the typical maximum power output of the module.

The default value is *MAX: 20 dBm* with the power amplifier enabled (see page 13). With the power amplifier disabled, the value is *MAX: 3dBm*.

The transceiver offers a programmable output range. So with the PA enabled, the power out ranges from 20 dBm to -12 dBm. With the PA disabled, the power output ranges from +3 dBm to -32 dBm.

It's a good idea to determine the actual maximum power output of the module you are using by first running a TONE transmit test using the default maximum setting. This is described in *Determining a Module's Maximum Power* on page 16. (See also *Send Mode*, described on page 14.)

After you've determined the real maximum power of the module, you can then run tests using lower values. For example, *MAX: –01dB* represents your module's maximum power less approximately 1 dBm.

Boost Mode

If *Boost Mode* is set to *ON*, power is boosted to the transmitter by about 2 dBm. The default setting is *OFF*.

It is not recommended that you set *Boost Mode ON* when enabling the external power amplifier (see *External Power Amplifier* below) because it does not allow for the same increase in dynamic range. Overdriving the input of the power amplifier can cause signal distortion and reduce the advantages of using the power amplifier.

Boost mode transmit power values are available on CEL's Apex data sheet:

http://www.cel.com/pdf/datasheets/ZAXM-200Series.pdf

External Power Amplifier

An external power amplifier is provided with the module for better transmissions. Selecting *Extern. PA* enables the external power amplifier. The default setting is *OFF*.

For more about external power amplification, see the CEL Apex data sheet:

http://www.cel.com/pdf/datasheets/ZAXM-200Series.pdf

Send Mode

Send Mode indicates what type of signal data is to be sent. The choices include:

- *PACKT*: The default, *PACKT* transmits a sequence of packets. See *Packet Length* and *Packet Number* below for details.
- *TONE*: Transmits an unmodulated tone. *TONE* can be used for measuring the module's maximum power output for compliance testing.
- CHARS: Transmits a continual stream of modulated random characters.

Packet Length

Packet length (*Packet len*) is the number of characters in a packet. This can range from 5 to 125 characters. The default is 20.

Packet Number

Packet number (*Packet #*) is the number of packets transmitted in the *PACKT* send mode. The default is 100 packets. Select *INFTY* (infinity) to continue to send packets until your test is completed. You can select the packet number from the following ranges:

- 1-9 packets
- 10-50 in increments of 5
- 50 200 in increments of 10
- 200 1000 in increments of 50
- 1000 5000 in increments of 100
- 5000 -10000 in increments of 500
- 10000 to 20000 in increments of 1000
- 20000 to 60000 in increments of 5000

Delay

You can select he delay in milliseconds (*Delay ms*) between each packet sent. The default is 60 milliseconds. Choose from the following ranges:

- 20 30 milliseconds
- 30 100 in increments of 5
- 100 1000 in increments of 50
- 1000 -10000 in increments of 500

Editing Transmit Test Settings

This section explains how to modify the settings for a Transmit Test. For details about all the settings, see *Transmit Test Settings* on page 11.

- 1. From the top menu, press *UP* or *DOWN* until *Transmit Test* appears on the LCD.
- 2. Press OK to display Start Transmit.

3. Press DOWN arrow to display the first setting - Channel.

Channel 20 BACK ◀ ♦ ▶ EDIT

4. You can edit the settings by selecting from a list of values. For example, to edit the Channel setting, press *OK*.

> Channel 20 UNDO ◀ ✦ ▸ SET

- To view the choices for the setting, press UP or DOWN.
- To return to the previous screen without changing the setting, press *EXIT*.
- To set the value, press *OK*. The display returns to the previous screen with the new value set.
- 5. Press *UP* or *DOWN* to view the various settings. For example, the *Send* mode is shown here, *PACKT* is the default:

Send mode PACKT BACK ◀ ♦ ► ALTER

- 6. You alter some settings by cycling through the possibilities. For example:
 - To alter the *Send* mode, press *OK*.

Send mode				TONE
BACK	∢	\$	▶	ALTER

• To alter the Send mode again, press OK again.

Send mode				CHARS
BACK	∢	\$		ALTER

7. When you are finished with the settings, press *EXIT* to return to the beginning of the Transmit Test.

Transmit Test

- 8. Press **OK** until the test starts and results are displayed.
- 9. To stop the Transmit Test, press *EXIT*.

How to Determine the Module's Maximum Power

1. Scroll through the top menu to until *Transmit Test* is displayed.

Transmit Test

• •

2. Press OK to display Start Transmit.

Start Transmit BACK **4**-> START

3. Press *DOWN* until the *Power* setting is displayed. Leave the default setting: *MAX: 3dB*.

Power MAX: 3dB BACK **∢**✦► EDIT

4. Continue to press **DOWN** until Send Mode is displayed.

Send Mode PACKT BACK **↓** ALTER

5. Press ALTER the change the *Send Mode* to *TONE*. Press *OK*.

Send m	ode	TONE
BACK	{\$ }	ALTER

6. Press *EXIT* to return to the beginning of the Transmit Test.

7. Press **OK** to start the test.

Sending tone

- 8. To bypass the antenna, unscrew it and connect a power meter or spectrum analyzer using a reverse polar SMA adapter (*not included with the kit.*)
- 9. Add the power output value measured to the fixed loss values of the cables and connectors between the module and the meter to get the true maximum power transmission value.
- 10. To end the test press *EXIT*. **4** EXIT

3 Receive Test

A *Receive Test* is used to set up and test the module for receiving IEEE 802.15.4-2003 packetized data. By running a *Transmit Test* on one of the modules and a *Receive Test* on the other, you can perform a *Range Test*. The tasks described in this chapter include:

- *Running a Default Receive Test* page 17
- Editing Receive Test Settings page 19

Receive Test Settings

- Channel page 18
- *Boost mode* page 18
- Sample window page 18
- Percentage error alert page 18
- RSSI alert page 19

Running a Default Receive Test

- 1. From the top menu, press *UP* or *DOWN* until the *Receive* test displays.
- 2. Press OK to display Start Receive.
- 3. Press **OK** again to start the test. The LCD displays:
 - *Rx* indicates that the *Receive* test is running.
 - *P*# displays the number of packets being received.
 - *ER* displays the percentage of errors.
 - *RS* displays the Received Signal Strength Indication (RSSI) values.
- 4. To stop the test press *EXIT*.

Channel

Channel is the radio channel setting of the receiver module. To receive, it must match the channel setting of the transmitter module. The choice of channel settings ranges from 11 to 26. The default is 20.

Channels are identified by number as defined by the IEEE 802.15.4-2003 standard.

Boost Mode

If *Boost Mode* is set to *ON*, sensitivity of the receiver is boosted by about 2 dBm. The default setting is *OFF*.

Boost Mode sensitivity values for the module can be found in the Ember[™] data sheet titled *EM250 Single-Chip ZigBee/802.15.4 Solution*. It can be found here:

http://www.ember.com/pdf/120-0082-000 EM250 Datasheet.pdf

Sample Window

The *Received Signal Strength Indication* (RSSI) results displayed during a test are calculated as an average of the individual packets within a sliding *Sample Window* (*Samp. win*). You can specify the number of packets in the sample window from either 1 to 100 or infinity (*INFTY*). 100 is the typical choice.

The default is *INFTY*. If *INFTY* is selected, the average RSSI for *all* samples is calculated.

Percentage Error Alert

A *PER alert* value represents an error rate percentage. If the error rate goes above this value, an alert sounds on the board's audio buzzer. The default is *OFF*.

The percentage values range from 1 to 99, or *OFF* which means no alert will sound. A value of 1% is typical as specified in the 802.15.4 specification.

RSSI alert

If the Received Signal Strength Indicator (RSSI) is below the RSSI alert value, an alert will sound on the buzzer. The default is *OFF*.

Values range from 10 down to -105, or *OFF*, which means no alert will sound. A typical value might be the receiver's sensitivity as defined in the chip's specification.

Editing Receive Test Settings

1. From the top menu, press *UP* or *DOWN* until *Receive Test* is displayed.

Receive Test ◆ ▶

2. Press OK to display Start Receive.

Start Receive BACK **4**-> START

3. Press *DOWN* to display the first setting, *Channel*.

Channel 20 BACK **∢**♣▶ EDIT

4. Press *UP* or *DOWN* to view the various *Receive* test settings. Details are described in "Receive Test Settings" on page 19.

5. Some settings may be edited. For example, to edit the *PER alert* setting, press *OK*.

PER ale	OFF	
UNDO	(\$)	SET

The PER alert setting is an error percentage threshold. If the error rate goes above this value, an alert sounds.

- To view the choices for the setting, press UP or DOWN.
- To return to the previous screen without changing the setting, press *EXIT*.
- To set the value, press *OK*. For example, select a value of 1 to represent the error percentage threshold of 1%. The display returns to the previous screen with the new value set.

PER alert OFF BACK **↓** EDIT

- 6. You can change settings by cycling through the selections. For example:
 - To change the *Boost Mode* setting, press **OK**.

BOOST mode ON BACK **∢♦** ALTER

• To alter the setting again, press **OK** again.

BOOST mode OFF BACK **∢♦** ► ALTER

7. When you are finished with all settings press *EXIT* to return to the start of the *Receive* test.

Receive Test 🗢 🕨

- 8. Press *OK* to start the test.
- 9. To stop the test, press *EXIT*.

4 Sleep Mode Test

To conserve energy and extend battery life, Apex modules are designed to enter *Sleep Mode* when inactive. This test measures the current draw of the module while in sleep mode.

You can test the current draw for two different sleep modes.

- *SLEEP*: This is the default setting. In this deep sleep mode the module draws less than one microamp.
- *IDLE*: The *IDLE* mode powers downs the processor core of the EM250, reducing overall power consumption. The processor core will remain powered down until any interrupt occurs or an external SIF wake-up command is seen. All peripherals of the EM250 including the radio continue to operate normally.

Sleep mode power values for the module can be found in the EmberTM data sheet titled *EM250 Single-Chip ZigBee/802.15.4 Solution*. It can be found here:

http://www.ember.com/pdf/120-0082-000_EM250_Datasheet.pdf

1. Remove the M-3VDC jumper header and connect the leads from a microammeter to the exposed jumper posts.

User Tip:

Your ammeter must be capable of measuring less than 1 microamp to measure the sub-microamp current draw in deep sleep mode.

2. In the top menu press UP or DOWN until Deep Sleep Test is displayed.

3. Press **OK** to display *Start Sleep*.

Start Sleep START ◀ ➡ ▶ BACK

4. Press DOWN to display the Sleep mode setting. DEEP is the default.

Sleep Mode DEEP BACK () ALTER

• To change the setting to *IDLE*, press *OK*.

• If you want to toggle the setting back to *DEEP*, press *OK* again.

5. To start the test press *UP*, and then press *OK* until the test starts.

6. Note the current meter reading.

7. To stop the test press *EXIT*.

5 Energy Scan Test

In an Energy Scan Test, the individual transmission channels are scanned and the relative RSSI (Received Signal Strength Indication) energy per channel is displayed.

User Tip:

To determine actual values, run the *Energy Scan Test* using Ember's *InSight Desktop* software. It can be downloaded directly from Ember's website at *www.ember.com/rfeval.html*

1. From the top menu, press UP or DOWN until Energy Scan is displayed.

Energy scan ♦ ► START

2. Press OK to start the test.

The LCD displays bars represent the relative energy for each channel, from *Channel 11* on the left to *Channel 26* on the right.

3. Press *EXIT* to stop the *Energy Scan Test*.

6 Potentiometer Test

This test uses the Apex evaluation board's potentiometer to test the voltage from the module's analog-to-digital converter (ADC).

1. From the top menu, press UP or DOWN until Potentiometer is displayed.

Potentiometer ♦ ► START

2. Press OK to start the test.

POT: +0.6150 V

The LCD displays a value for the potentiometer voltage changes.

3. Rotate the potentiometer dial to view the voltage changes.

4. Press *EXIT* to stop the test.

7 ZigBee Wars Game

ZigBee Wars is a simple game that allows two or more players to challenge each other over a ZigBee network by communicating via the Apex modules.

To play, all the Apex boards must set to the same channel. An easy way to ensure this is to press *RESET*. This sets the boards to the default (*Channel 20*).

1. From the top menu, press UP or DOWN until ZigBee Wars Game is displayed.

ZigBee Wars Game ∢ → START

- 2. Press **OK** to start the game.
- 3. Press *EXIT* to move your player *left* or *OK* to move it *right*.
- 4. Press **UP** to fire a missile.

The missile will appear in the upper row of the LCD.

The number of missiles a player has is displayed on the LCD. Five missiles is displayed as A05 (A = ammunition)

! A05

After all of a player's missiles are used, his ammunition is automatically recharged to 6 missiles (*A06*).

Each player begins the game with five lives, indicated on the LCD display as L05 (L = Life)

L05

If within 0.5 seconds of a firing a missile, the opponent's player is caught under that missile on the LCD, that player loses a "life."

The game is over for a player when their number of lives reaches 0.

5. Press *DOWN* to quit the game.

8 Interface Board Settings

The Apex interface board has settings you can change and additional board functions you can test. To view or change these settings:

1. From the top menu, press UP or DOWN until Settings is displayed.

Settings

\$ >

2. Press **OK** to view the first setting.

3. Press UP or DOWN to view additional settings.

4. To modify a setting or run a test, press OK.

Power-Save Setting

To increase battery life, the module can be set to go into sleep mode after a specific amount time of inactivity. The default setting is 5m or 5 minutes. Other settings include:

- OFF Power-save is off, the module is always powered up
- 30s The module goes into sleep mode after 30 seconds of inactivity.
- *1m* The module goes into sleep mode after 1 minute of inactivity.
- 10m The module goes into sleep mode after 10 minutes of inactivity.

Self Test

This is a series that can be run to test the board's key components.

1. From the Settings menu, press UP or DOWN until Self Test is displayed.

Self Test START

2. Press *OK* to start the tests, then follow the instructions displayed. The following components are tested:

The buzzer sounds upon completion of each test.

- *UP* button
- *OK* button
- DOWN button
- EXIT button
- *Potentiometer's low values* Rotate all the way to the left.
- Potentiometer's high values Rotate all the way to the right.

3. Press the *RESET* button when finished.

"Reset" Setting

This reboots the module and resets the LCD display. It is the same function as pressing the *RESET* button.

Appendix 1 Apex Module Features & Specifications

Features

- EmberTM EM250 platform
- 16-bit onboard microprocessor
- Designed for EmberZNet networks
- 1mW to 100mW output, software configurable
- 4000+ ft of range, line of sight
- 130mA power consumption @ 100mW output
- 2.1 to 3.6V input
- 16 general purpose I/O ports
- DMA,-SP1, I2C and UART interfaces
- FCC and CE certified

Specifications

Description	Specification
Frequency	2400 to 2483.5 MHz 16 channels, 5 MHz wide
Data Rate	250 Kbps
Dimensions	1.0 X 1.275 inches
Sensitivity	–95 dBm @ 1% PER
Power Consumption	Transmit: variable Receive: 37mA
Deep Sleep Current	5.0 µA (Max)
Voltage Input	2.1 to 3.6 V

Apex Module Pin Assignments



Figure 9-1 Pin Assignments

Pin	Name	Туре	Description
1	GROUND	GND	Ground
2	GROUND	GND	Ground
3	GROUND	GND	Ground
4	VDD	PI	Power Supply Input
5	RSTB	DI	Reset, active low

6	GPIO11	DI/DO	General Purpose Digital I/O, SC1 UART CTS, SC1 SPI master clock, or Capture Input A of Timer 2
7	GPIO12	DI/DO	General Purpose Digital I/O, SC1 UART RTS, or Capture Input B of Timer 2
8	GPIO0	DI/DO	General Purpose Digital I/O, SC2 SPI MOSI, or Capture Input A of Timer 1
9	GPIO1	DI/DO	General Purpose Digital I/O, SC2 SPI MISO, SC2 I ² C SDA, or Capture Input A of Timer 2
10	GPIO2	DI/DO	General Purpose Digital I/O, SC2 SPI master clock, SC2 I ² C SCL, or Capture Input B of Timer 2
11	GPIO3	DI/DO	General Purpose Digital I/O, SC2 SPI slave select, or Capture Input B of Timer 1
12	GPIO4	DI/DO/AI	General Purpose Digital I/O, ADC Input 0, or PTI frame signal
13	GPIO5	DI/DO/AI	General Purpose Digital I/O, ADC Input 1, or PTI data signal
14	GPIO6	DI/DO/AI	General Purpose Digital I/O, ADC Input 2, Timer 2 Clock Input, or Timer 1 Enable
15	GPIO7	DO	Regulator Enable, active high (see section 8)
16	GPIO8	DI/DO/AO	General Purpose Digital I/O, ADC Reference Output, Timer 1 Clock Input, Timer 2 Enable, or Source A Interrupt
17	GPIO9	DI/DO	General Purpose Digital I/O, SC1 TXD, SC1 MO, SC1 I ² C Data, or Capture Input A of Timer 1
18	GPIO10	DI/DO	General Purpose Digital I/O, SC1 RXD, SC1 MI, SC1 I ² C Clock, or Capture Input B of Timer 1
19	CLK	DI	SIF Interface clock
20	MISO	DO	SIF Interface master in/slave out
21	MOSI	DI	SIF Interface master out/slave in
22	LOADB	DI/DO	SIF Interface load strobe
23	GPIO16	DI/DO	General Purpose Digital I/O, Output B of Timer 1, Capture Input B of Timer 2, or Source D Interrupt
24	GPIO15	DI/DO	General Purpose Digital I/O, Output A of Timer 1, Capture Input A of Timer 2, or Source C Interrupt
25	GPIO14	DI/DO	General Purpose Digital I/O, Output B of Timer 2, Capture Input B of Timer 1, or Source B Interrupt

26	GPIO13	DI/DO	General Purpose Digital I/O, Output A of Timer 2, or Capture Input A of Timer 1
27	GROUND	GND	Ground
28	GROUND	GND	Ground

Module Interface Pins

Pin	Description	
CLK	Serial interface clock (internal pull-down.)	
MISO	Serial interface (master in/slave out.)	
MOSI	Serial interface (master out/slave in.)	
LOADB	Serial interface load strobe	
GPIO16	External interrupt pin tied to the OK button.	
GPIO15	External interrupt pin tied to the EXIT button.	
GPIO14	External interrupt pin tied to the DOWN button.	
GPIO13	PWM signal used to control the audio buzzer.	

Appendix 2 Interface Board Specifications

Jumper Settings

There are three jumpers provided on each interface board. They're provided to control the Power Amplifier (JMP1), the Apex Module (JMP2), and the interface board (JMP3).



Name	Label	Function
JMP1	PA REG ENABLE	Connect to turn PA ON, disconnect to turn PA OFF
JMP2	M–3VDC	Connect to turn Module ON, disconnect to turn OFF
JMP3	C-3VDC	Connect to turn Interface Board ON, disconnect to turn OFF

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