Smart Finder Development Guide

PCB boards：KF-4A/KF-Li

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ACE SENSOR

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Change History

Version	Date	Author	Description
1.0	Aug. 22nd 2012	Jeffrey Peng, Charlie Xia	Creation of the document based on Smart Finder firmware design.
1.1	Nov. 4th 2012	Jeffrey Peng, Charlie Xia	iOS 6 update
1.2	Nov. 16th 2013	Jeffrey Peng	iOS 7 update. Adding more examples.

Table of Contents

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1. Abstract

This document is written for developers who want to develop innovative applications using the Ace Sensor's Smart Finder products. It covers the programming aspect on access control, configuration and firmware upgrade methods for Smart Finder (PCB boards: KF-4A and KF-Li).

2. Introduction

Smart Finder products are designed for locating misplaced objects via buzzer sound and BLE signal strength. Clear audible buzzer sound and long battery life are the design objectives. Standard Bluetooth Low Energy profiles: Link Loss, Immediate Alert, Tx Power and Battery Service are supported. In addition, a tight access control mechanism allows Smart Finder products be used as basic proximity tag in areas such as external input device, home automation, office security, enterprise inventory tracking, etc. etc.

Model KF-4A

- Color: Black (other color also possible)
- Dimension: 52.7x32x10.2mm (LxWxH)
- Weight: 23g/0.8oz
- Battery: 2xAAAA batteries.
- Estimated battery life: 2+ years (3 uses per day)

Model KF-Li

- Color: White (other color also possible)
- Dimension: 58x36x10mm. (LxWxH)
- Weight: 22g/0.8oz
- Battery: Li-ion batteries with USB charging interface.
- Estimated battery life: one full charge: 6 month with no exposure to sunlight; one hour of sun exposure will last 7 days.

Both KF-4A and KF-Li are based on TI CC2541 Bluetooth Low Energy chip with 256Kb flash memory. Technical details of TI CC2541 can be found at
http://www.ti.com/general/docs/lit/getliterature.tsp?genericPartNumber=cc2541&fileType=pdf

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Ace Sensor provides a free iOS app, Smart Finder App, which works with KF-4A and KF-Li. You can download it from here: https://itunes.apple.com/app/id528460659

3. Configuration and Notification

Smart Finder tag is fully configuration driven. This makes it possible tailoring for different use scenarios. The configuration is done with a private profile in the service 0xACE0. This configuration parameters controls

- auto or manual advertising
- auto advertising interval
- access control: authorizing connection, passcode setting
- connection interval

When configuring Smart Finder tag, you need to balance battery consumption with user experience (responsiveness). If the Smart Finder tag is intended to be a standard proximity tag, the 0xACE0 service does not need to be used. For a full access control, please refer to Section 4 for how to use service 0xACE0.

The notification event is defined in service 0xFFE0 which notifies button presses.

Table 1: Configuration and Notification Private Profile Definition.

Service	Characteristics	Attribute	Description	Value	Meaning	Note
0xFFE0	Service for button press events					
	0xFFE1	Notify	Button press event	1	Left key pressed	
				2	Right key pressed	Smart Finder tag only has this button
				0	Key lifted	
0xACE0	Access Control					
	0xACE1	R/W	Advertising Interval Control	0	Manual control	The advertising will run for 30 seconds by pressing the button, 200ms Interval
			uint8	1	645 ms	
				2	768 ms	
				3	961 ms	
				4	1065 ms	
				5	1294 ms	

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				>5	Set broadcasting interval in 10ms incremental	
	0xACE2	R	Access Control	0	Off	
			uint8	1	On	When access control is turned on, if the correct passcode is not received during connection, the key fob will disconnect the unauthorized connection in 30 seconds.
	0xACE3	W	Connection Interval Control	0	Disconnect	
			uint8	<20	Connection interval in 100ms incremental	
				0xF0~0xFF	Set Keyfob side RSSI notification interval in 100ms incremental. 0xF0 turns off the interval	
	0xACE4	Notify	Authorized / RSSI notification	1	Authorized	Hold the button for over 3 seconds to authorize current connection.
			byte	-128~0	Keyfob side RSSI	
	0xACE5	Write	Set passcode	uint8[5]	Under the condition of connection being authorized, this can be used to set new passcode and turn the Access Control on. All 0 indicates turning off Access Control	When the access control is on, set the correct passcode to authorize current connection.
					When the Access Control is on, until you set the correct passcode, you have no write permission to any characteristic of this service and proximity services	Passcode and advertising interval configurations are stored in flash memory and persist during power loss.

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4. Access Control

To prevent unauthorized access over BLE, Smart Finder tag uses a private profile to support a passcode based access control mechanism. This private profile allows passcode exchange during the pairing process. When a smartphone or tablet tries to connect to the Smart Finder tag, the correct passcode must be sent within 30 seconds. Otherwise the connection is disabled and dropped.

The access control mechanism is provided by the service 0xACE0. The following is a work flow that an iOS app should do to enable access control.

Initial Setup: App adds a Smart Finder tag:

1. The app connects to the tag, turns on the Notify in Characteristics 0xACE4.
2. The app displays a message requesting the user to press and hold the button for 3 second. Once the user has done so, the app will receive a notification in Characteristics 0xACE4 with value 0x01.
3. The app writes to Characteristics 0xACE5 a 5 byte passcode. This turns on access control. Please note that the passcode cannot be all zero, which indicates turning access control off.
4. The app writes 0x05 to Characteristics 0xACE1 to turn on auto broadcasting. 0x05 indicates a slow broadcasting interval. Other broadcasting intervals are also available, see table in Section 3. If the value is set to 0x00, broadcasting only happens for 30 seconds when the button is pressed.
5. If you need to conserve battery, the connection interval should be extended. The default value is 30ms, set by iOS. Without compromise user experience, the recommended value is 0x03 for an interval of 300ms to be set in Characteristics 0xACE3.
6. Once the access control is enabled, the tag is bond to the paired iOS device and will not respond to requests from unpaired devices.

Regular Use: App connects to a paired Smart Finder tag

1. The app connects to the tag, turns on the Notify in Characteristics 0xACE4.
2. The app writes to the passcode set previously to Characteristics 0xACE5. The app will receive a notification in Characteristics 0xACE4 with value 0x01 confirming authorization.
3. If you need to conserve battery, the connection interval should be extended. The default value is 30ms, set by iOS. Without compromise user experience, the recommended value is 0x03 for an interval of 300ms to be set in Characteristics 0xACE3. If there is no data transmission in 5 seconds, the connection is closed.
4. The app and tag can then perform required interaction.

This access control process is shown in Section 6.1 with a 3rd party tool.

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5. Firmware Upgrade

5.1. Using the On-Board Debugging Interface

KF-4A/KF-Li come with on-board debugging interface. This consists of 5 through-holes (shown in the red rectangle in the picture on the right) in the dimension of 0.3-0.4mm. Distance between the pins is 2mm.

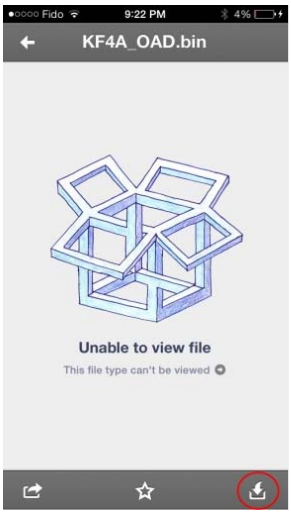
- R: Reset
- P2.1: CC2541 P2_1
- P2.2: CC2541 P2_2
- + : VDD 3.3V
- - : GND 0V

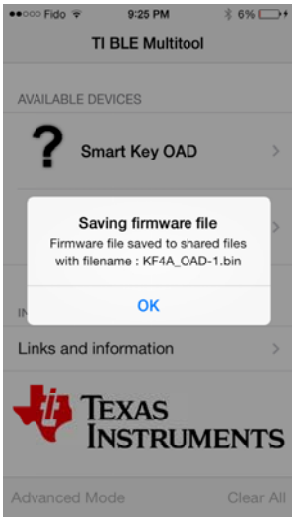
Standard 2mm touch-pin connection can be used to connect to the debugging interface. This debugging interface can be used to reprogram the firmware using TI's CC-debugger and SmartRF™ Flash Programmer. Please find the details of the CC Debugger here: http://www.ti.com/tool/cc-debugger Note that batteries should be removed when using CC-debugger.

5.2. Using the Over-The-Air Download

To upgrade the firmware using the BLE wireless interface, you'll need to install TI's BLE Multitool on your iOS device:
https://itunes.apple.com/ca/app/ti-ble-multitool/id580494818
Please follow the steps below to upgrade you firmware.

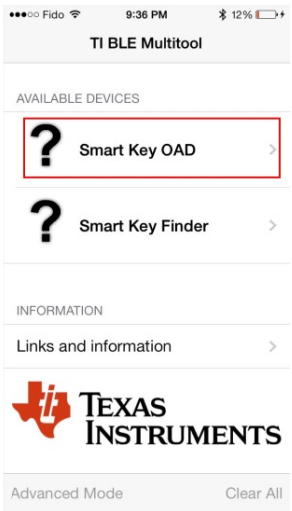
Step 1: Upload the new firmware, e.g. "KF4A-OAD.bin", via email or Dropbox to your iOS device. The following screenshots shows how to upload the new firmware from Dropbox into TI BLE Multitool.

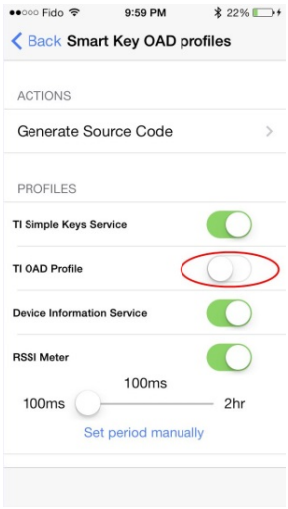




Step 2: Set the Smart Finder tag into OAD mode. Remove a battery. Press and hold the button on the Smart Finder tag while putting the battery back on. The LED will stay lit, indicating it's in OAD mode.

Step 3: Perform firmware update with TI BLE Multitool app. Note: there's a bug in iOS 64bit device, i.e. iPhone 5S, iPad air and iPad mini 2. Please use a 32bit device, i.e. iPhone 4S/5, iPad 3/4/mini or iPod Touch 5th generation. The following screenshots show this process.





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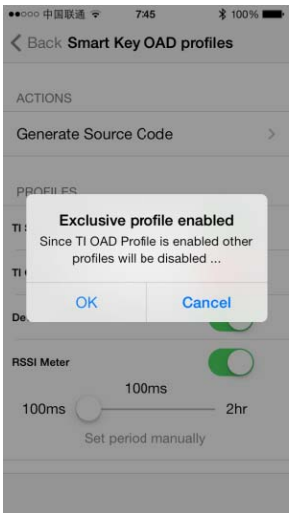

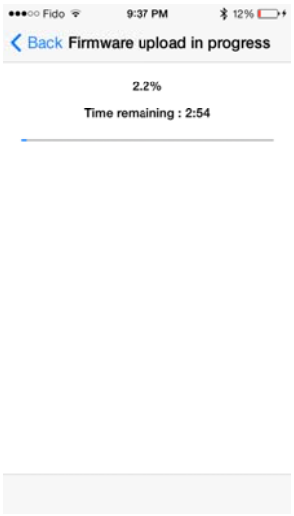

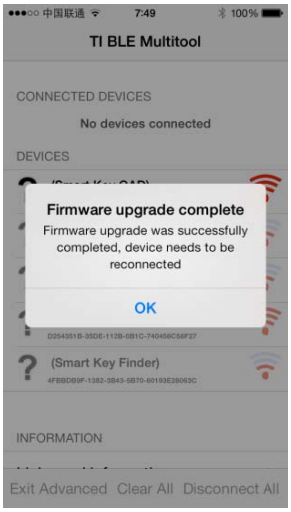

Step 4: After the firmware upgrade complete, the Smart Finder tag will reboot, beep and then LED turns off. If the LED stays on all the time, the firmware upgrade is not successful. Possible problems: (a). You're using a 64 bit iOS device. (b). You have a corrupted firmware bin file.

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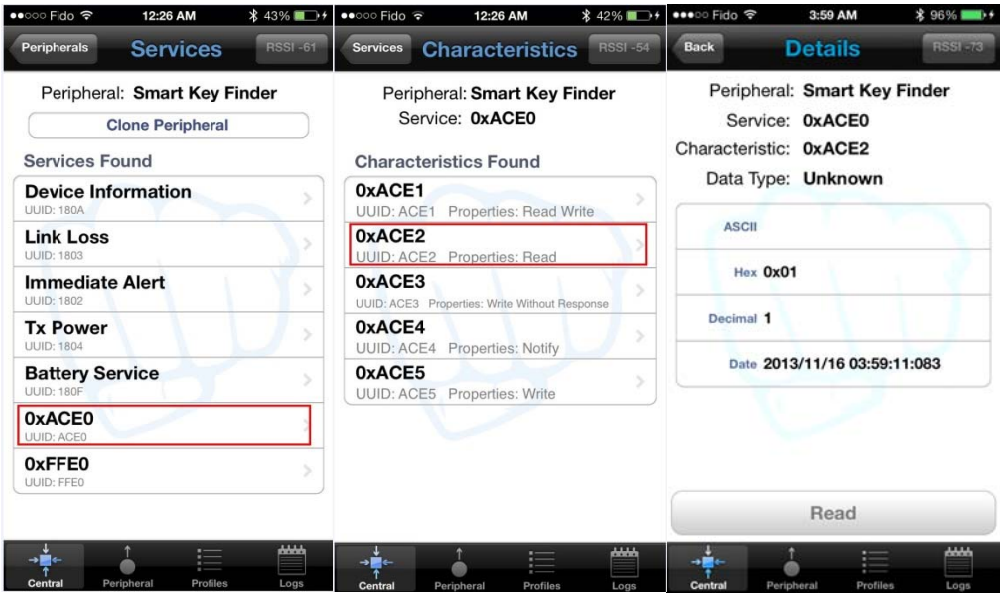
6. Testing with 3rd Party Tools

You can test the Smart Finder tag with 3rd party tools. Our favorite tool is Lightblue iOS app. https://itunes.apple.com/app/lightblue/id557428110

6.1. Turning Off Access Control

If the access control has been turned on in the Smart Finder tag, the connection will be dropped if a correct passcode is not received within 30 seconds. To turn off the access control, follow the steps below.

1. Connect Lightblue to the Smart Finder tag, to inspect service 0xACE0, if Characteristic 0xACE2 has value 0x01, the access control is on.



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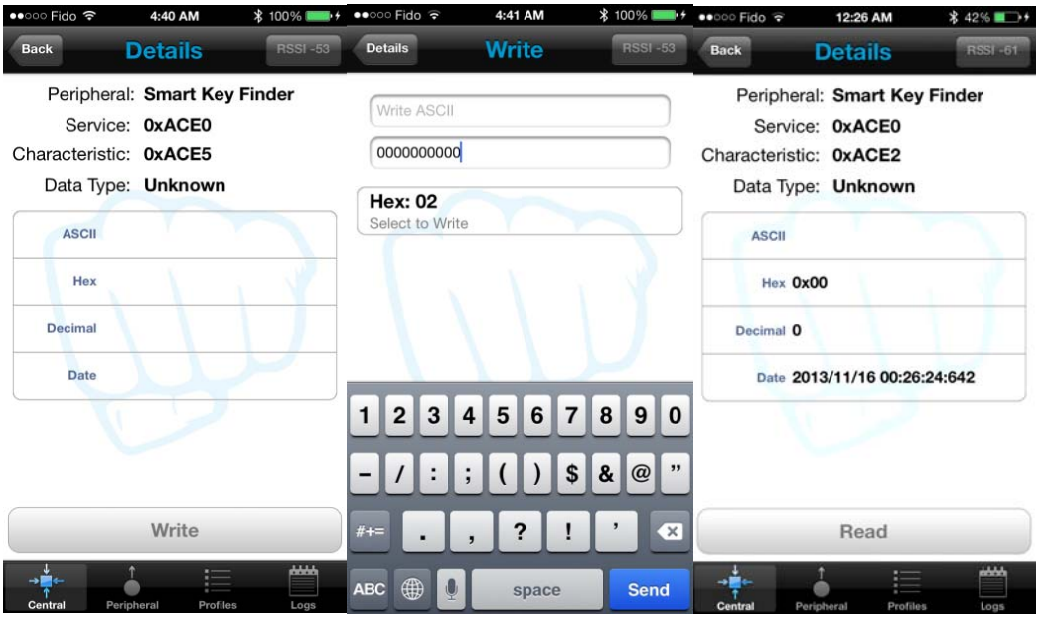
2. Press and hold the button on the Smart Finder tag for 3 second until a beep is sounded to complete pairing. Write to Characteristic 0xACE5 the value of 0x0000000000 (10 zeros, i.e. 5 bytes of 0x00). Confirm that Characteristic 0xACE2 has changed its value to 0x00. The access control has been turn off.



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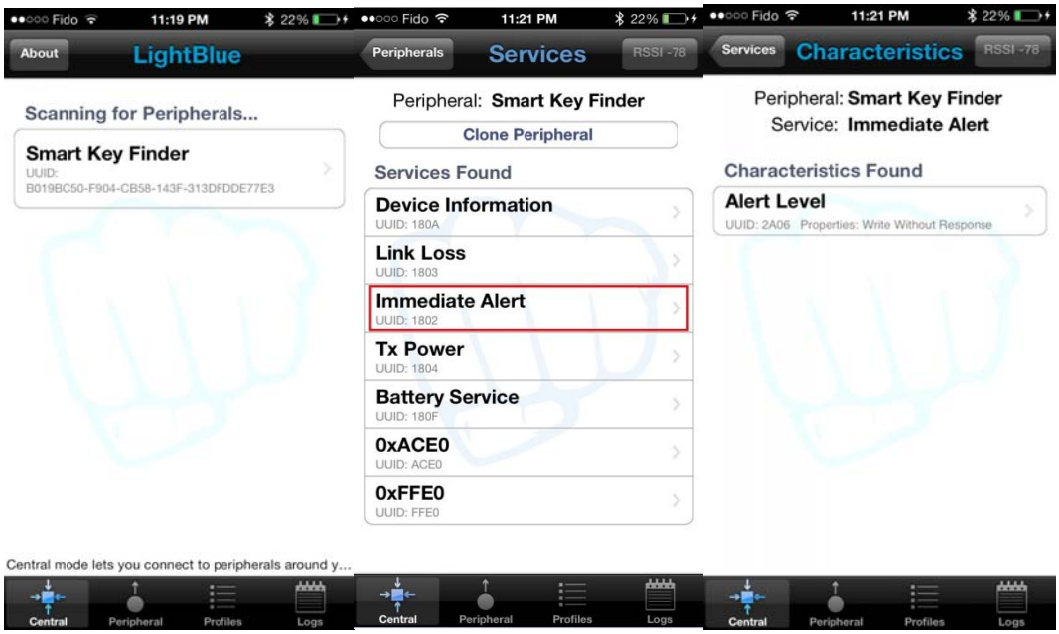
6.2. Control the Immediate Alert

Follow the steps below to turn on the buzzer and LED on the Smart Finder tag. Setting the “Alert Level” to 0x01 turns on the buzzer; 0x02 turns on the buzzer and flashing the LED; 0x00 turns off the alert.



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6.3. Notification from the Smart Finder Tag

The service 0xFFE0 provides the notification to show whether the button is pressed. When the button on the Smart Finder tag is pressed, Characteristic 0xFFE1 shows value 0x02. When the button is lifted, Characteristic 0xFFE1 shows value 0x00.

Following the steps below to receive notification from the Smart Finder tag.