
MFi Accessory Testing Specification

Release R7



2011-04-04



Apple Inc.
© 2011 Apple Inc.
All rights reserved.

No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, mechanical, electronic, photocopying, recording, or otherwise, without prior written permission of Apple Inc., with the following exceptions: Any person is hereby authorized to store documentation on a single computer for personal use only and to print copies of documentation for personal use provided that the documentation contains Apple's copyright notice.

The Apple logo is a trademark of Apple Inc.

Use of the "keyboard" Apple logo (Option-Shift-K) for commercial purposes without the prior written consent of Apple may constitute trademark infringement and unfair competition in violation of federal and state laws.

No licenses, express or implied, are granted with respect to any of the technology described in this document. Apple retains all intellectual property rights associated with the technology described in this document. This document is intended to assist application developers to develop applications only for Apple-labeled computers.

Every effort has been made to ensure that the information in this document is accurate. Apple is not responsible for typographical errors.

Apple Inc.
1 Infinite Loop
Cupertino, CA 95014
408-996-1010

App Store is a service mark of Apple Inc.

Apple, the Apple logo, FireWire, iPhone, iPod, iPod shuffle, iTunes, Mac, Macintosh, and Safari are trademarks of Apple Inc., registered in the United States and other countries.

iPad is a trademark of Apple Inc.

iOS is a trademark or registered trademark of Cisco in the U.S. and other countries and is used under license.

Simultaneously published in the United States and Canada.

Even though Apple has reviewed this document, APPLE MAKES NO WARRANTY OR REPRESENTATION, EITHER EXPRESS OR IMPLIED, WITH RESPECT TO THIS DOCUMENT, ITS QUALITY, ACCURACY,

MERCHANTABILITY, OR FITNESS FOR A PARTICULAR PURPOSE. AS A RESULT, THIS DOCUMENT IS PROVIDED "AS IS," AND YOU, THE READER, ARE ASSUMING THE ENTIRE RISK AS TO ITS QUALITY AND ACCURACY.

IN NO EVENT WILL APPLE BE LIABLE FOR DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES RESULTING FROM ANY DEFECT OR INACCURACY IN THIS DOCUMENT, even if advised of the possibility of such damages.

THE WARRANTY AND REMEDIES SET FORTH ABOVE ARE EXCLUSIVE AND IN LIEU OF ALL OTHERS, ORAL OR WRITTEN, EXPRESS OR IMPLIED. No Apple dealer, agent, or employee is authorized to make any modification, extension, or addition to this warranty.

Some states do not allow the exclusion or limitation of implied warranties or liability for incidental or consequential damages, so the above limitation or exclusion may not apply to you. This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

Contents

Introduction **Introduction 9**

- Organization of This Document 9
- Self-Certification 10
- Independent Laboratory Certification 10
- Specification Terms 11

Chapter 1 **Electrical Testing and Certification 13**

- Connectivity Requirements 13
- General Power Supply Tests and Design Guidelines 13
 - Identity Signals: D+, D- 13
 - Output Voltage Regulation 13
 - Ripple and Noise 14
 - Dynamic Load Response 14
 - Overload Protection 15
 - Overvoltage Protection 15
- AC Adapter Design 15
 - Fuse Protection 15
 - Short Circuit Response 15
 - Switching Frequency 15
- Car Charger Tests 16
 - Input Voltage Surge 16
 - Dynamic Line Response 16
 - Turn-On and Turn-Off Characteristics 16

Chapter 2 **TDMA Noise Testing and Certification 19**

- Certification Procedures 19
- Required Tests 20
- TDMA Testing Environment 20
- TDMA Noise Simulator 21
- TDMA Noise Test for Built-In Speakers 22
 - Test Environment 22
 - TDMA Noise Generation 23
 - SPL Meter Requirements 23
 - Speaker Volume Calibration 23
 - Test Setup 24
 - Test Procedure 25
 - Pass/Fail Criterion 25
- TDMA Noise Test for Line-Level and Headphone Output Connectors 25
 - Test Environment 26

| | |
|--|----|
| TDMA Noise Generation | 26 |
| Spectrum Analyzer Requirements | 26 |
| Test Setup | 26 |
| Test Procedure | 26 |
| Pass/Fail Criteria | 27 |
| TDMA Noise Test for Speaker Output Connectors | 28 |
| Test Environment | 28 |
| TDMA Noise Generation | 28 |
| Spectrum Analyzer Requirements | 28 |
| Test Setup | 28 |
| Test Procedure | 29 |
| Pass/Fail Criteria | 30 |
| TDMA Noise Test for FM Transmitters | 30 |
| Test Environment | 30 |
| TDMA Noise Generation | 30 |
| FM Receiver Requirements | 31 |
| Spectrum Analyzer Requirements | 31 |
| Test Setup | 31 |
| Test Procedure | 31 |
| Pass/Fail Criterion | 33 |
| TDMA Noise Test for Automotive Head Units | 33 |
| Test Environment | 33 |
| TDMA Noise Generation | 33 |
| Spectrum Analyzer Requirements | 33 |
| Test Setup | 34 |
| Test Procedures | 34 |
| Pass/Fail Criteria | 36 |
| TDMA Noise Test for FM Tuners | 37 |
| Test Environment | 37 |
| TDMA Noise Generation | 37 |
| Equipment Requirements | 37 |
| Test Setup | 38 |
| Test Procedure | 39 |
| Pass/Fail Criterion | 40 |
| TDMA Noise Test for Headphone Remote and Mic Systems | 40 |
| Test Environment | 40 |
| TDMA Noise Generation | 40 |
| Speaker System Requirements | 40 |
| SPL Meter Requirements | 40 |
| Sound Recording Requirements | 40 |
| Head and Torso Simulator Requirements | 40 |
| Speaker Volume Calibration | 41 |
| Test Setup | 41 |
| Test Procedure | 42 |
| Pass/Fail Criterion | 43 |

Chapter 3 RF Testing and Certification 45

- RF Certification Setup 45
- Typical Speaker System Test Setup 47
- Typical Test Setup for Cable-Connected Accessories 47
- Alternate TRP/EIS/TIS/RS Test Plans 48
- Measuring TRP 49
- Measuring EIS 50
 - EIS Testing 50
 - RS Testing 51

Chapter 4 Headset Accessory Certification 53

- Operability Tests 53
- Other Tests 54
- Test Reports 54

Chapter 5 FireWire to USB Power Converter Certification 55

- Test Setup 55
- Test Requirements 55
 - Output Ripple 55
 - Dynamic load response 56
 - Efficiency 56
 - Catastrophic Input Over-Voltage and Output Protection 56
 - Short Circuit Protection 57
 - Burn-In and Thermal Test 57
 - D+/D- Charging 57
 - USB Tests 57
 - Switching Frequencies 57
 - Interoperability Tests 57
- Test Reports 57

Glossary 59

Document Revision History 61

Figures and Tables

Chapter 1 **Electrical Testing and Certification 13**

Table 1-1 Power supply voltage outputs 14

Chapter 2 **TDMA Noise Testing and Certification 19**

Figure 2-1 Acoustic testing room 23
Figure 2-2 Cable deployment 24
Figure 2-3 Automotive head unit test environment 33
Figure 2-4 After-market head unit test configurations 36
Figure 2-5 FM tuner test equipment layout 38
Figure 2-6 HATS and iPhone configuration 41
Table 2-1 Required TDMA noise test products 19
Table 2-2 Required TDMA noise tests 20
Table 2-3 Network simulator setup 21
Table 2-4 Line-level and headphone volume settings and pass/fail criteria 27
Table 2-5 Speaker output volume settings and pass/fail criteria 30
Table 2-6 88 to 108 MHz test frequency ranges 32
Table 2-7 76 to 90 MHz test frequency ranges 32
Table 2-8 Line-level output pass/fail criteria 36
Table 2-9 Speaker output pass/fail criteria 37

Chapter 3 **RF Testing and Certification 45**

Figure 3-1 iPhone orientation coordinates 45
Figure 3-2 Freestanding iPhone RF measurement setup (setup may vary) 46
Figure 3-3 Docking speaker system test setup (setup may vary) 47
Figure 3-4 Directly-connected accessory test setup (setup may vary) 48
Figure 3-5 Cable-connected accessory test setup (setup may vary) 48
Table 3-1 Selective TRP testing channels 49
Table 3-2 TRP measurement parameters 50
Table 3-3 EIS band frequencies and degradation factors 51
Table 3-4 Bit error rate (BER) 51
Table 3-5 iPhone 4 (CDMA model) frame error rate 52

Chapter 4 **Headset Accessory Certification 53**

Figure 4-1 Headset accessory test setup 53
Table 4-1 Required mic_bias voltages 54

Introduction

NOTICE OF PROPRIETARY PROPERTY: THE INFORMATION CONTAINED HEREIN IS THE PROPRIETARY PROPERTY OF APPLE INC. THE POSSESSOR AGREES TO THE FOLLOWING: (I) TO MAINTAIN THIS DOCUMENT IN CONFIDENCE, (II) NOT TO REPRODUCE OR COPY IT, (III) NOT TO REVEAL OR PUBLISH IT IN WHOLE OR IN PART, (IV) ALL RIGHTS RESERVED.

ACCESS TO THIS DOCUMENT AND THE INFORMATION CONTAINED THEREIN IS GOVERNED BY THE TERMS OF THE MFI LICENSE AGREEMENT AND/OR THE IPOD-IPHONE AIS EVALUATION AGREEMENT. ALL OTHER USE SHALL BE AT APPLE'S SOLE DISCRETION.

Under the MFi program, third-party electronic accessories for iPods, iPhones, or iPads must pass Apple-specified certification procedures. This document specifies those procedures.

Note: This document does not apply to the first- and second-generation iPods, nor to the iPod shuffle.

Note: In addition to the specifications in this document, accessories must meet all applicable government regulatory requirements for the geographical regions in which they are sold.

IMPORTANT: This document uses the term "Apple device" to refer generically to iPods, iPhones, and iPads, all of which support the iPod Accessory Protocol (iAP) interface. Among these products, those that also run iOS (Apple's mobile operating system) are referred to as "iOS devices." Specifications in this document that are designated for iOS devices apply only to those products. Specifications designated for iPods apply only to Apple devices that are not iOS devices.

Organization of This Document

The specifications in this document are arranged in the following chapters:

- **"Electrical Testing and Certification"** (page 13) describes the setup and testing procedures required to certify the power supply function of accessories for Apple devices.
- **"TDMA Noise Testing and Certification"** (page 19) specifies the tests required to certify that an iPhone or iPad accessory does not produce an excessive level of audible or visible TDMA noise.
- **"RF Testing and Certification"** (page 45) describes the test setups and required test procedures for certifying that an attached accessory does not degrade the RF performance of the iPhone beyond acceptable limits.
- **"Headset Accessory Certification"** (page 53) specifies the procedures and documentation required for self-certifying headset accessories designed in accordance with "Headphone Remote and Mic System" in *MFi Accessory Hardware Specification*.

- “FireWire to USB Power Converter Certification” (page 55) describes the self-certification procedures for FireWire-to-USB power converter accessories for Apple devices.

At the end of this document are a glossary of terms and a document revision history.

Self-Certification

Certain types of third-party accessories must pass Apple-specified self-certification procedures. These procedures consist of the following steps:

1. The third-party licensee must subject a sample accessory to the tests specified below.
2. The third-party licensee must certify the test results and submit them to Apple, along with supporting documentation as specified in the test procedure.
3. Apple must accept the self-certification results before the accessory may be manufactured.

All required self-certification tests for accessories are spelled out in the Self-Certification Form that can be accessed at Apple's MFi portal. The following self-certification tests for certain products are further described in this document:

- All accessories must pass the tests and certification procedures described in “Electrical Testing and Certification” (page 13).
- Headset accessories that use the technology specified by “Headphone Remote and Mic System” in *MFi Accessory Hardware Specification* must pass the tests and certification procedures described in “Headset Accessory Certification” (page 53).
- FireWire-to-USB power converter accessories must pass the tests and certification procedures described in “FireWire to USB Power Converter Certification” (page 55). A reference design for such accessories is presented in “FireWire to USB Reference Design” in *MFi Accessory Hardware Specification*.

Independent Laboratory Certification

Accessories that have successfully completed the testing and certification procedures specified in “RF Testing and Certification” (page 45) must declare their RF certification for specific iPhone models by sending an `AccInfoToken`, with info type “Accessory RF Certifications,” during the IDPS process; see *MFi Accessory Firmware Specification*, Release R40 or later. Accessories that work with iPhones or iPads must also pass the testing and certification procedures described in “TDMA Noise Testing and Certification” (page 19).

Except for tests on automotive head units, these tests must be conducted by an independent laboratory which sends the results to Apple. The laboratory must be certified by Apple; self-certification by the licensee is not sufficient. Contact the Made for iPod licensing department for information about Apple-certified laboratories.

Specification Terms

Parts of this document contain specification requirements that are incorporated by reference into legal agreements between Apple Inc. and its licensees. The use of the words “must,” “should,” and “may” in these specifications have the following meanings:

- “Must” means that the specification is an absolute requirement.
- “Must not” means that the specification is an absolute prohibition.
- “Should” means that there may be valid reasons in particular circumstances to ignore the specification, but their full implications must be understood and carefully weighed before choosing to do so.
- “Should not” means that there may be valid reasons in particular circumstances that make the specified action or feature acceptable, but their full implications must be understood and carefully weighed before choosing to include it.
- “May” means that the indicated action or feature does not contravene this specification.

Electrical Testing and Certification

Many types of accessories provide power to Apple devices. Accessories such as battery packs may provide power directly, while car chargers and AC adapters charge the Apple device's internal battery. In addition, accessories such as speaker systems typically charge an attached Apple device while providing other functions. This chapter describes the setup and testing procedures required to certify the power supply function of an Apple device accessory. Third-party licensees may perform and self-certify these tests, as described in [“Self-Certification”](#) (page 10).

Connectivity Requirements

Power supply accessories for Apple devices must provide 5 V power over USB Vbus (pin 8 of the 30-pin connector). The accessory must also supply the correct resistor network on D+ and D– (pins 4 and 6), as specified in “USB 2.0” in *MFi Accessory Hardware Specification*. Accessories that supply 500 mA, 1 A, or 2.1 A resistor networks must be capable of providing at least 500 mA, 1 A, or 2.1 A, respectively, to the Apple device at all times.

Note: Accessories that charge an Apple device must not wait for Accessory Power (pin 13 of the 30-pin connector) to go high before supplying power. They must start supplying power as soon as iPod Detect (pin 30) is grounded.

General Power Supply Tests and Design Guidelines

This section offers design guidelines and describes the required test conditions and pass/fail criteria for certifying the electrical characteristics of any power supply accessory for an Apple device.

Identity Signals: D+, D–

Pass/Fail criteria: The power supply accessory's D+ and D– signals must comply with the requirements specified in “USB 2.0” in *MFi Accessory Hardware Specification*.

Output Voltage Regulation

Test conditions: At an ambient temperature of 25 °C, the load on the power supply accessory's output must be increased in steps to produce the following output currents: 0, 250, 500, 700, 1000, 1500, and 2100 mA. If the accessory is a car charger, the test must be repeated with input voltages of 10, 12, and 14 V DC. The output voltage must be noted for each combination of input voltage and output current.

Note: Only power supply accessories that identify themselves as supporting a 1000 mA load need to be tested for 700 and 1000 mA, and only those that identify themselves as supporting a 2100 mA load need to be tested for 1500 and 2100 mA.

Pass/Fail criteria: For every combination of input voltage and output current, the output measured at the dock connector of the power supplies listed in [Table 1-1](#) (page 14) must remain between the minimum and maximum voltages shown.

Table 1-1 Power supply voltage outputs

| Supply rating | Minimum output | Maximum output |
|-------------------------------|----------------|----------------|
| 500 mA or 1 A | 4.70 V | 5.25 V |
| 2.1 A delivering up to 1.0 A | 4.70 V | 5.25 V |
| 2.1 A delivering 1.0 to 2.1 A | 4.55 V | 5.25 V |

Ripple and Noise

Test conditions: Ripple voltage and noise must be measured at each output pin of the 30-pin connector while the output is decoupled by a high-frequency 0.1 μ F capacitor. The measurement bandwidth must be 0 to 20 MHz.

Pass/Fail criteria: Periodic and Random Deviation (PARD) on each output pin must be less than 100 mV while the power supply accessory is loaded to produce the following output currents: 0, 250, 500, 700, 1000, 1500, and 2100 mA.

Note: Only power supply accessories that identify themselves as supporting a 1000 mA load need to be tested for 700 and 1000 mA, and only those that identify themselves as supporting a 2100 mA load need to be tested for 1500 and 2100 mA.

Dynamic Load Response

Test conditions: The power supply accessory must be subjected to 500 mA load increases and decreases. Power supplies that furnish 1 A or 2.1 A must also be subjected to load increases and decreases between 80 mA and 1 A, and power supplies that provide 2.1 A must be subjected to increases and decreases from 0 to 500 mA, 500 to 1000 mA, 1000 to 1500 mA, and 1500 to 2100 mA. In all tests the load slew rate must not be less than 100 mA/ μ sec.

The frequency of change must be set to give the most readable deviation and settling times. If the accessory is a car charger, the input voltage must be 12 V DC. No load capacitors may be used to stabilize the output.

Pass/Fail criteria: With a decoupling capacitor of 10 μ F and an ambient temperature of 25 °C, the power supply accessory output, as measured at the dock connector, must not undershoot below the minimum output voltage or overshoot above the maximum output voltage for each type of power supply listed in [Table 1-1](#) (page 14).

Overload Protection

Overloads applied to the power supply output, at a rate faster than 100 mA/μsec, should cause the output to disconnect before they cause damage to the accessory or the Apple device, and the output should remain disconnected until the overload is removed. This design goal for overload protection also applies to any single fault condition. It must not be possible for a power supply to provide more than 2.5 A rms in any overload situation.

Overvoltage Protection

Taking into account the delay time of the overvoltage protection circuit, no single-point fault should be able to cause a sustained overvoltage condition on the power supply output. The power supply should provide a latch-mode overvoltage protection circuit that resets itself within 30 seconds. Optionally, a power off/on cycle could restore normal operation. An overvoltage fault can be simulated by opening the feedback loop that regulates the output voltage. A voltage greater than 6.3 V must not be possible during a single-point failure.

AC Adapter Design

This section contains recommendations for AC adapter design.

Note: AC adapter accessories are required to pass the tests specified in “General Power Supply Tests and Design Guidelines” (page 13).

Fuse Protection

A fuse should be present at the input of the power supply accessory circuitry to protect it under any fault condition.

Short Circuit Response

The output of the power supply accessory should drop or fold back if its output is shorted to the secondary common, and no damage should result. A short circuit is defined as less than 10 milliohms resistance.

Switching Frequency

AC adapter designs must comply with the “Power Guidelines” section of “iPhone Accessory Design Guidelines” in *MFi Accessory Hardware Specification*.

Car Charger Tests

Besides passing the electrical tests specified in “General Power Supply Tests and Design Guidelines” (page 13), car chargers must pass the certification tests defined in this section.

Input Voltage Surge

Test conditions: While the charging accessory is operating at both maximum load and minimum load, the line voltage must be switched 5 times to the surge voltage in a 50% duty cycle, as follows:

1. From 12 V DC to 40 V DC; hold for 16 msec.
2. Back to 12 V DC; hold for 16 msec.
3. Repeat 5 times.

Pass/Fail criteria: The accessory’s power supply must survive the repeated applications of the input voltage surge with no component damage. Voltages and logic signals must remain within specification limits during and after the line transients (making it a “transparent surge”). Loss of function or performance must not occur. Permanent damage must not occur. A fuse opening is a failure.

Dynamic Line Response

Test conditions: The car charger must be subjected to instantaneous ± 2 V DC input variations. The frequency of change must be set to give the most readable deviation and settling times. Output loads must be chosen to produce worst-case conditions. No load capacitors may be used to stabilize the output.

Pass/Fail criteria: The car charger output, as measured at the dock connector, must not undershoot below 4.75 V or overshoot above 5.25 V.

Turn-On and Turn-Off Characteristics

Test conditions: 12 V DC input voltage must be applied to and removed from the car charger input, with 5 μ F capacitive loading on the output.

Pass/Fail criteria: The following measurements must all be within the limits stated:

- **Turn-on delay:** The car charger output must settle to a value between 4.75 and 5.25 V within 4 seconds after the DC input is applied.
- **Output rise time:** The rise time between 10% and 90% of the nominal output voltage must be ≤ 20 ms.
- **Overshoot:** The output voltage overshoot upon application or removal of the input voltage must be less than 10% above the nominal voltage.

- **Voltage ramp:** There must be a smooth and continuous ramp of the DC output voltage from 10% to 90% of its final value within a range of 4.75 to 5.25 V, while the output is loaded as specified above under “Test conditions.” Voltages of opposite polarity must not be present on the output at any time during turn-on or turn-off.

TDMA Noise Testing and Certification

This chapter specifies the tests required to certify that an iPhone or iPad accessory does not produce an excessive level of audible or visible TDMA noise. To claim compatibility with various Apple products, you must test your accessory with one of the products shown in [Table 2-1](#) (page 19).

Note: In this specification, the accessory being tested is referred to as the DUT (Device Under Test).

Table 2-1 Required TDMA noise test products

| If your accessory claims compatibility with this product | You must test it with one of these products |
|--|---|
| iPhone | iPhone, iPhone 3G, or iPhone 3GS |
| iPhone 3G | iPhone 3G or iPhone 3GS |
| iPhone 3GS * | iPhone 3G or iPhone 3GS |
| iPhone 4 * | iPhone 4 (GSM model) |
| iPad | iPad (Wi-Fi + 3G) or iPhone 4 (GSM model) |
| iPad (Wi-Fi + 3G) | iPad (Wi-Fi + 3G) or iPhone 4 (GSM model) |
| iPad 2 | iPad (Wi-Fi + 3G) or iPhone 4 (GSM model) |
| iPad 2 (Wi-Fi + 3G) | iPad (Wi-Fi + 3G) or iPhone 4 (GSM model) |

* Testing with this product is required for all accessories that claim to be “Made for iPhone.”

Accessories with no audio or video capabilities may omit the tests described in this chapter.

Certification Procedures

Tests on accessories other than automotive head units must be performed and certified by an Apple-certified independent testing laboratory, as specified in [“Independent Laboratory Certification”](#) (page 10). The testing of automotive head units must follow these rules:

- Automotive head units may either be self-certified, as specified in [“Self-Certification”](#) (page 10), or certified by an independent laboratory as specified in [“Independent Laboratory Certification”](#) (page 10).
- If the automotive head unit is self-certified, and if the tester has access to a GSM network, the test may be performed by loading a Web page through Safari, as described in [“TDMA Noise Simulator”](#) (page 21). Otherwise the tester must use a network simulator.

- If the automotive head unit is tested by an independent laboratory, a network simulator must be used as specified in “[TDMA Noise Simulator](#)” (page 21).

Note: All TDMA tests must be performed with the iPhone’s or iPad’s battery fully charged.

Required Tests

Automotive head units and head unit adapters must pass the test and certification procedures specified in “[TDMA Noise Test for Automotive Head Units](#)” (page 33). Other kinds of accessories with built-in speakers, line-level output or headphone connectors, speaker output connectors, or a built-in FM transmitter must perform the test and certification procedures specified in [Table 2-2](#) (page 20).

Note: An iPhone 3G or 3GS, or an iPad (Wi-Fi + 3G), must be used in TDMA noise testing, using only GSM/EDGE.

Table 2-2 Required TDMA noise tests

| If your accessory has this feature | You must perform this test |
|---|--|
| A built-in speaker | “ TDMA Noise Test for Built-In Speakers ” (page 22) |
| Line-level output or headphone connectors | “ TDMA Noise Test for Line-Level and Headphone Output Connectors ” (page 25) |
| Speaker output connectors | “ TDMA Noise Test for Speaker Output Connectors ” (page 28) |
| A built-in analog FM transmitter | “ TDMA Noise Test for FM Transmitters ” (page 30) |
| A built-in analog FM tuner | “ TDMA Noise Test for FM Tuners ” (page 37) |
| A headphone remote and mic system | “ TDMA Noise Test for Headphone Remote and Mic Systems ” (page 40) |

If the DUT (Device Under Test) handles audio or video in any way, but does not have any of the features listed in [Table 2-2](#) (page 20), it must still be tested to ensure that the iPhone or iPad does not add any audible noise or video artifacts while the DUT is in normal operation. If the DUT handles video, the tests must be performed twice: once playing video that is resident on the iPhone or iPad and once playing video that is being streamed from the Internet or a media server. The results of these tests may be self-certified.

During both audio and video testing, the DUT must be positioned relative to the iPhone or iPad in a way that simulates its normal usage.

TDMA Testing Environment

TDMA testing may be affected by conductive surfaces near the DUT, the iPhone or iPad, other test equipment, or their connecting cables. For a successful test, observe these cautions:

- Use test benches and other furniture made of wood, plastic, or other nonconductive material. Avoid resin-bonded wood composites such as particle board.
- If metal surfaces cannot be avoided, place styrofoam at least 5 inches thick under the test items.
- Keep cables well clear of metal table legs or other conductive surfaces.
- If the test results show unexpected failures, try rearranging the test items to avoid their proximity to metal in the environment.

The TDMA testing area must be capable of receiving signals in the GSM frequency bands listed in “Supported Wireless Standards” in the latest release of *MFi Accessory Hardware Specification*.

TDMA Noise Simulator

In all tests, TDMA noise must be provided by a network simulator with EGPRS capability and an antenna. Suitable network simulator models include the Agilent E5515C with EGPRS Lab Application and the Rohde & Schwarz CMU200 with EGPRS and the application test extension. The network simulator settings must be as shown in [Table 2-3](#) (page 21). All tests must be performed twice, using settings in the GSM 850 and in the 1900 bands.

Table 2-3 Network simulator setup

| Setting | GSM 850 band | GSM 1900 band |
|--------------------------------|--|---------------|
| Cell type | EGPRS | |
| Cell power | -50 dBm (may vary, depending on the RF configuration and antenna used) | |
| Broadcast channel | 150 | 512 |
| Traffic channel | 160 | 698 |
| MS TX level, for all timeslots | 5 | 0 |
| Frequency hopping | On | |
| Modulation coding scheme | MCS8 | |
| Multislot configuration | 4 Down, 2 Up | |
| Timing advance | 0 | |
| Data connection type | ETSI Type A | |
| MSC/SHSN release | R99 | |
| PBCCH | Off | |
| Mobile DTX | Off | |
| Ciphering | On | |
| GSM ciphering algorithm | A5/1 | |

| Setting | GSM 850 band | GSM 1900 band |
|--------------------------|--------------|---------------|
| GPRS ciphering algorithm | GEA1 | |

To approximate actual test conditions, the iPhone's GSM network capability may be used; however, TDMA noise testing using GSM is adequate for certification only when self-certifying automotive head units. To do a pre-test of other types of accessories, using GSM, follow this procedure:

1. From the main screen, select the Settings icon.
2. Switch Airplane Mode to Off. Set Wi-Fi to Off.
3. Still in Settings, select General > Network, and switch Enable 3G to Off.
4. Return to the main screen and select the Safari icon.
5. Using Safari, enter the URL www.apple.com.
6. Verify that the Apple Web page is loaded using only GSM.

TDMA Noise Test for Built-In Speakers

This section specifies the tests required to certify that an iPhone or iPad accessory with built-in speakers does not create an excessive level of audible TDMA noise.

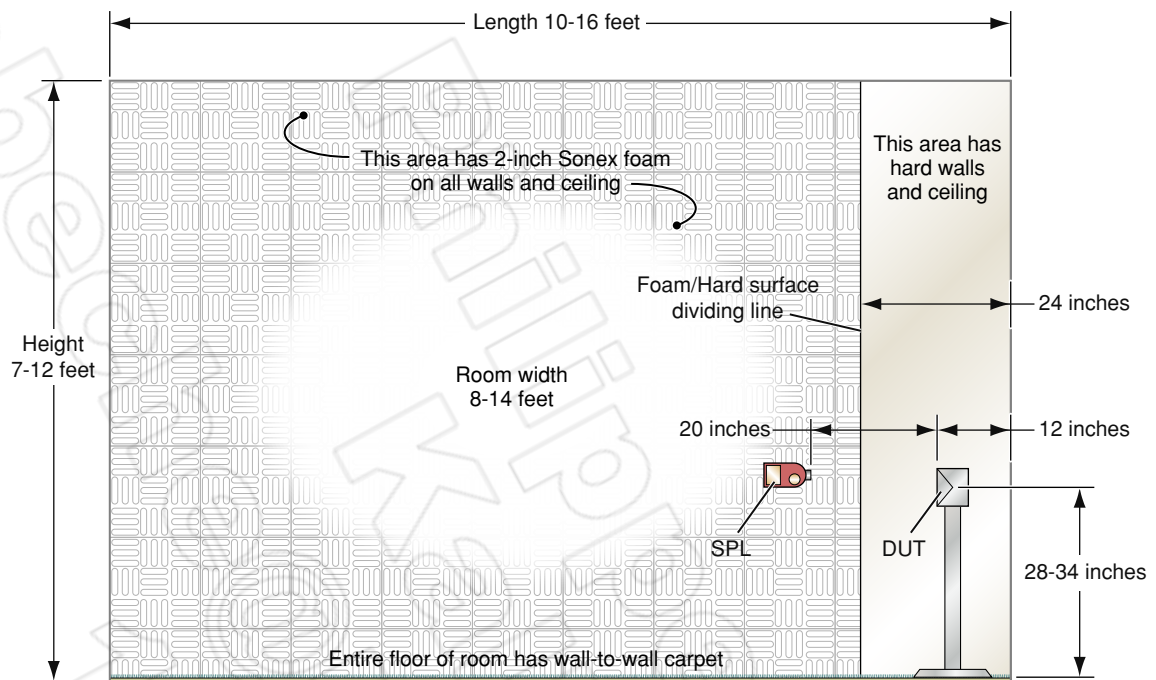
Test Environment

The speaker system must be tested in an acoustically-isolated room that has a noise floor below 30 dBA, A-weighted. A typical testing room is illustrated in [Figure 2-1](#) (page 23). As part of certification, pictures and a drawing of the testing room must be submitted to Apple.

The room dimensions must be within the following ranges:

- Height: 7 to 12 feet
- Width: 8 to 14 feet (width is defined as the shorter wall dimension)
- Depth: 10 to 16 feet

The floor of the testing room must be covered with carpet. The wall behind the DUT must be on the shorter side of the room. This wall and 2 feet of the adjoining walls must not have acoustic foam or other acoustic treatment. Other wall surfaces must be treated with 2-inch Sonex acoustic foam. (see www.sonex-online.com/Acoustical%20Foams.htm). Tables or other sound-reflecting surfaces must not be present.

Figure 2-1 Acoustic testing room

TDMA Noise Generation

During the test, TDMA noise must be generated by the network simulator specified in [“TDMA Noise Simulator”](#) (page 21).

SPL Meter Requirements

A sound pressure level (SPL) meter must be used to adjust the sound level produced by the DUT. The SPL meter must be a Class 2 device, as defined by the ANSI and IEC 651 standards. It must have fast and slow response settings, must make both A- and C-weighted dB measurements, and must have a range of at least 35 to 90 dBA.

Speaker Volume Calibration

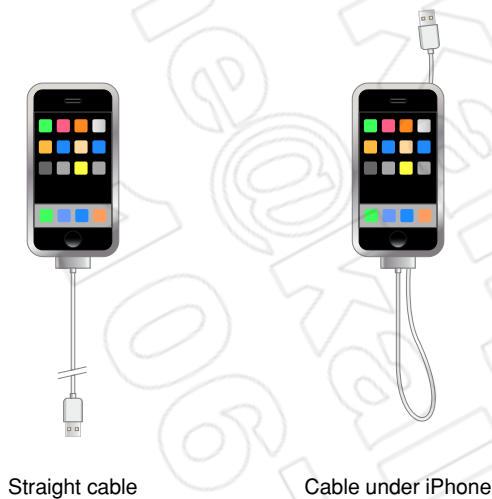
To calibrate the test configuration, an Apple-supplied TDMA calibration file containing pink noise must be loaded into the iPhone or iPad and played while the iPhone or iPad is connected to the DUT. The DUT's sound volume must be adjusted until the SPL meter measures 65 dBA.

Test Setup

The speaker system and iPhone or iPad must be placed on a stand or similar object centered in the width of the acoustically-isolated test room. The speaker must be positioned such that its mid- and high-frequency speakers are located between 28 and 34 inches above the floor and 12 inches away from the wall behind them (see [Figure 2-1](#) (page 23)). The SPL meter must be located 20 inches from the speakers and aimed toward their center. It must be set to A-weighted, slow-response operation.

If the iPhone or iPad connects to the speaker by a cable, the tests must be performed three times: once with the iPhone or iPad located as a user would normally place it (near or on top of the DUT); once with the cable deployed under the iPhone or iPad (crossing its internal antenna, as shown in [Figure 2-2](#) (page 24)); and once with the cable straight.

Figure 2-2 Cable deployment



Before the test, the iPhone or iPad's music storage must be loaded with the Apple-supplied test files `TDMA_Speakers_SPL_calibration_R1.aiff` and `TDMA_Speakers_TDMA_noise_R1.aiff`. Instructions for obtaining these files are sent to licensed developers by email.

The iPhone or iPad must be initialized through these steps:

1. From the main screen, select the Settings icon.
2. Scroll and select iPod.
3. Ensure that Sound Check, EQ and Volume Limit are all set to Off.
4. From the main screen, select the Settings icon.
5. Slide Airplane Mode to ON. This will also turn Wi-Fi off.

Test Procedure

Ensure that the test environment is quiet and free of devices in operation that produce noise. Verify that the requirements specified in [“Test Setup”](#) (page 24) have been met. Perform the test through these steps:

1. Connect the iPhone or iPad to the DUT and turn on DUT power.
2. Ensure that the DUT's input is set to enable the iPhone or iPad as an audio source.
3. From the main screen, select the iPod icon and select the More icon in the lower right of the display.
4. Tap Songs; select and play TDMA_Speakers_SPL_calibration_R1.aiff.
5. While watching the sound level displayed by the SPL meter, adjust the DUT's output sound volume until the SPL meter maintains 65 dBA (with the meter set to A weighting, slow response). Stand away from both the SPL meter and the DUT when reading measurements. No object may be located between the SPL meter and the DUT.
6. On the iPhone or iPad, select and play TDMA_Speakers_TDMA_noise_R1.aiff. Face the mid- and high-frequency speakers of the DUT from a distance of 20 inches and listen to the sound level. This part of the test is done by ear, not with the SPL meter. The listener should be able to hear the TDMA test file playing but it should be fairly quiet.
7. Stop the playback of TDMA_Speakers_TDMA_noise_R1.aiff and tap the iPhone or iPad's select button.
8. From the main screen, select the Settings icon.
9. Switch Airplane Mode to Off. Set Wi-Fi to Off.
10. Open a data connection between the network simulator and the iPhone or iPad, as specified in [“TDMA Noise Simulator”](#) (page 21). Once the simulator has confirmed that a loopback is established and data is being transferred, continue the test.
11. Assume the same listening position as specified in step 6. Listen to the sound level of the noise generated during the data transfer. The sound level must not exceed the level heard during step 6. This part of the test is done by ear, not with the SPL meter.
12. Repeat steps 6 through 11 as needed until a reliable and reproducible test is completed.

Pass/Fail Criterion

The TDMA noise volume from the DUT, as measured by ear, may not exceed the volume of the Apple-supplied TDMA audio test file.

TDMA Noise Test for Line-Level and Headphone Output Connectors

This section specifies the tests required to certify that an accessory with line-level and/or headphone output connectors does not create an excessive level of audible TDMA noise.

Test Environment

The DUT must be tested in an environment that is quiet and free of any other devices in operation that produce noise.

TDMA Noise Generation

During the test, TDMA noise must be generated by the network simulator specified in “[TDMA Noise Simulator](#)” (page 21).

Spectrum Analyzer Requirements

A spectrum analyzer must be used to measure the signal-to-noise ratio (SNR) of the line output from the DUT. The spectrum analyzer must be able to measure SNR over the range 20 Hz to 20 kHz and take a screen capture of the display that shows the full 20 Hz to 20 kHz range in a logarithmic scale.

Test Setup

The DUT must be connected to the iPhone or iPad in its normal user configuration and its line-level output or headphone output must be connected to the spectrum analyzer. An optional speaker may be connected to enable audible monitoring of the TDMA noise.

Before the test, the iPhone or iPad’s music storage must be loaded with the Apple-supplied test file `TDMA_1_kHz_tone_R1.aiff`. Instructions for obtaining this file are sent to licensed developers by email.

The iPhone or iPad must be initialized through these steps:

1. From the main screen, select the Settings icon.
2. Scroll and select iPod.
3. Ensure that Sound Check, EQ and Volume Limit are all set to Off.
4. From the main screen, select the Settings icon.
5. Ensure that Airplane Mode is Off. Set Wi-Fi to Off.

Test Procedure

Perform each TDMA noise test for line-level and headphone output connectors through these steps:

1. Power-on the spectrum analyzer.
2. Connect the iPhone or iPad to the DUT. If the DUT connects using a cable, select a cable configuration as described below.

3. From the main screen, select the iPod icon and select the More icon in the lower right of the display. Tap Songs and select 1 KHz tone.
4. While the 1 kHz tone is playing, open a data connection between the network simulator and the iPhone or iPad, as specified in “[TDMA Noise Simulator](#)” (page 21). Once the simulator has confirmed that a loopback is established and data is being transferred, continue the test.
5. On the spectrum analyzer, measure the minimum SNR between the 1 kHz peak and surrounding frequencies. When measuring the SNR, ignore peaks at 2 kHz, 3 kHz, and 4 kHz that are due to harmonic distortion, and peaks at 60, 120, and 180 Hz (or 50, 100, and 150 Hz) that are due to power supply harmonics.
6. Repeat steps 4 and 5 as needed to ensure a reliable and reproducible test.

The foregoing test procedure must be repeated for each combination of two output channels, one or two cable configurations, and up to nine volume settings. This requires a maximum of 36 complete test cycles:

- For all accessories, the test must be performed twice for left and right output channels.
- If the iPhone or iPad connects to the DUT by a cable, the test procedure must be performed twice: once with the cable deployed under the iPhone or iPad (crossing its internal antenna, as shown in [Figure 2-2](#) (page 24)) and once with the cable straight. If the DUT does not have a cable, the test must be performed once with the iPhone or iPad directly connected to the DUT.
- If the DUT supports volume controls, the test must be performed up to nine times at the different volume settings shown in [Table 2-4](#) (page 27). In this table, a volume setting of 0 dB equals 1 volt. If the volume range of the DUT is limited, tests out of the DUT’s range may be skipped. If the DUT supports only discrete volume settings, the settings closest to each required volume setting should be used.

Pass/Fail Criteria

The signal-to-noise ratio (SNR) must exceed the following values for all tested volumes, left and right channels, and cable configurations. Developers must submit a screen capture of the spectrum analyzer output for each tested configuration showing the full 20 Hz to 20 kHz range in a logarithmic scale. For DUTs with fixed volume output, the SNR must exceed –85 dB. For automotive accessories such as car chargers with fixed volume output, the SNR must exceed –70 dB. For all other DUTs with variable volume output the SNR requirements are shown in [Table 2-4](#) (page 27).

Table 2-4 Line-level and headphone volume settings and pass/fail criteria

| Volume setting | Minimum SNR |
|----------------|--|
| Above – 20 dBV | – 85 dB |
| – 20 dBV | – 85 dB |
| – 30 dBV | – 80 dB or below the noise floor of the output |
| – 40 dBV | – 70 dB or below the noise floor of the output |
| – 50 dBV | – 60 dB or below the noise floor of the output |

| Volume setting | Minimum SNR |
|----------------|--|
| – 60 dBV | – 45 dB or below the noise floor of the output |
| – 70 dBV | – 35 dB or below the noise floor of the output |
| – 80 dBV | – 25 dB or below the noise floor of the output |
| Below – 80 dBV | – 25 dB or below the noise floor of the output |

TDMA Noise Test for Speaker Output Connectors

This section specifies the tests required to certify that an accessory with speaker output connectors does not create an excessive level of audible TDMA noise.

Test Environment

The DUT must be tested in an environment that is quiet and free of any other devices in operation that produce noise.

TDMA Noise Generation

During the test, TDMA noise must be generated by the network simulator specified in [“TDMA Noise Simulator”](#) (page 21).

Spectrum Analyzer Requirements

A spectrum analyzer must be used to measure the signal-to-noise ratio (SNR) of the line output from the DUT. The spectrum analyzer must be able to measure SNR over the range 20 Hz to 20 kHz and take a screen capture of the display that shows the full 20 Hz to 20 kHz range in a logarithmic scale.

Test Setup

The DUT must be connected to the iPhone or iPad in its normal user configuration and its speaker output must be connected to the spectrum analyzer. A speaker matching the DUT’s design impedance may be connected to enable audible monitoring of the TDMA noise; if a speaker is not connected, the output must be loaded with an equivalent resistor.

Before the test, the iPhone or iPad’s music storage must be loaded with the Apple-supplied test file `TDMA_1_kHz_tone_R1.aiff`. Instructions for obtaining this file are sent to licensed developers by email.

The iPhone or iPad must be initialized through these steps:

1. From the main screen, select the Settings icon.

2. Scroll and select iPod.
3. Ensure that Sound Check, EQ and Volume Limit are all set to Off.
4. From the main screen, select the Settings icon.
5. Ensure that Airplane Mode is Off. Set Wi-Fi to Off.

Test Procedure

Perform each TDMA noise test for speaker output connectors through these steps:

1. Power-on the spectrum analyzer.
2. Connect the iPhone or iPad to the DUT. If the DUT connects using a cable, select a cable configuration as described below.
3. From the main screen, select the iPod icon and select the More icon in the lower right of the display. Tap Songs and select 1 KHz tone.
4. While the 1 kHz tone is still playing, open a data connection between the network simulator and the iPhone or iPad, as specified in “[TDMA Noise Simulator](#)” (page 21). Once the simulator has confirmed that a loopback is established and data is being transferred, continue the test.
5. On the spectrum analyzer, measure the minimum SNR between the 1 kHz peak and surrounding frequencies. When measuring the SNR, ignore peaks at 2 kHz, 3 kHz, and 4 kHz that are due to harmonic distortion, and peaks at 60, 120, and 180 Hz (or 50, 100, and 150 Hz) that are due to power supply harmonics.
6. Repeat steps 4 and 5 as needed to ensure a reliable and reproducible test.

The foregoing test procedure must be repeated for each combination of two output channels, one or two cable configurations, and up to nine volume settings. This requires a maximum of 36 complete test cycles:

- For all accessories, the test must be performed twice for left and right output channels.
- If the iPhone or iPad connects to the DUT by a cable, the test procedure must be performed twice: once with the cable deployed under the iPhone or iPad (crossing its internal antenna, as shown in [Figure 2-2](#) (page 24)) and once with the cable straight. If the DUT does not have a cable, the test must be performed once with the iPhone or iPad directly connected to the DUT.
- If the DUT supports volume controls, the test must be performed up to nine times at the different volume settings shown in [Table 2-5](#) (page 30). In this table, a volume setting of 0 dB is referenced to 2.83 V or 1 watt into 8 Ω . If the volume range of the DUT is limited, tests out of the DUT's range may be skipped. If the DUT supports only discrete volume settings, the settings closest to each required volume setting should be used.

Pass/Fail Criteria

The signal-to-noise ratio (SNR) must exceed the following values for all tested volumes, left and right channels, and cable configurations. Developers must submit a screen capture of the spectrum analyzer output for each tested configuration showing the full 20 Hz to 20 kHz range in a logarithmic scale.

Table 2-5 Speaker output volume settings and pass/fail criteria

| Volume setting | Minimum SNR |
|----------------|--|
| Above 0 dB * | – 85 dB |
| – 10 dB | – 78 dB or below the noise floor of the amplifier output |
| – 20 dB | – 68 dB or below the noise floor of the amplifier output |
| – 30 dB | – 58 dB or below the noise floor of the amplifier output |
| – 40 dB | – 45 dB or below the noise floor of the amplifier output |
| – 50 dB | – 35 dB or below the noise floor of the amplifier output |
| – 60 dB | – 25 dB or below the noise floor of the amplifier output |
| – 70 dB | – 15 dB or below the noise floor of the amplifier output |
| Below – 70 dB | – 15 dB or below the noise floor of the amplifier output |

* 0 dB is equal to 2.83 V.

TDMA Noise Test for FM Transmitters

This section specifies the tests required to certify that an analog FM transmitter accessory which produces an audio output without built-in speakers does not create an excessive level of audible TDMA noise.

Test Environment

The DUT must be tested in an environment that is audibly quiet and free of any devices in operation that produce RF noise.

TDMA Noise Generation

During the test, TDMA noise must be generated by the network simulator specified in [“TDMA Noise Simulator”](#) (page 21).

FM Receiver Requirements

A WWi-certified automotive head unit must be used as the FM receiver. It must have an external whip antenna and a line output that can be attached to a spectrum analyzer. The FM receiver must operate across the entire frequency range required for the FM transmitter being tested.

Spectrum Analyzer Requirements

A spectrum analyzer must be used to measure the signal-to-noise ratio (SNR) of the line output from the DUT. The spectrum analyzer must be able to measure SNR over the range 20 Hz to 20 kHz and take a screen capture of the display that shows the full 20 Hz to 20 kHz range in a logarithmic scale.

Test Setup

The iPhone or iPad and FM transmitter must be connected and placed on a stand or similar object 3 feet in front of the FM receiver. The antenna must be connected to the FM receiver and placed directly above the receiver. Line output from the FM receiver must be connected to the spectrum analyzer. An optional speaker may be connected to the FM receiver to assist in tuning it and hearing the TDMA noise.

Before the test, the iPhone or iPad's music storage must be loaded with the Apple-supplied test file `TDMA_1_kHz_tone_R1.aiff`. Instructions for obtaining this file are sent to licensed developers by email.

The iPhone or iPad must be initialized through these steps:

1. From the main screen, select the Settings icon.
2. Scroll and select iPod.
3. Ensure that Sound Check, EQ and Volume Limit are all set to Off.
4. From the main screen, select the Settings icon.
5. Ensure that Airplane Mode is Off. Set Wi-Fi to Off.

Test Procedure

Perform each FM transmitter accessory test through these steps:

1. Power-on the spectrum analyzer.
2. Power-on the FM receiver and tune to an unused FM frequency.
3. Connect the iPhone or iPad to the FM transmitter and power-on the DUT. If the DUT connects using a cable, select a cable configuration as described above.
4. Tune the FM transmitter to the frequency used in step 2.
5. From the main screen, select the iPod icon and select the "More" icon in the lower right of the display. Tap "Songs" and select "1 KHz tone."

6. While the 1 kHz tone is still playing, open a data connection between the network simulator and the iPhone or iPad, as specified in “[TDMA Noise Simulator](#)” (page 21). Once the simulator has confirmed that a loopback is established and data is being transferred, continue the test.
7. On the spectrum analyzer, measure the minimum signal-to-noise ratio between the 1 kHz peak and surrounding frequencies. When measuring the signal-to-noise ratio, ignore peaks at 2 kHz, 3 kHz, and 4 kHz that are due to harmonic distortion, and peaks at 60, 120, and 180 Hz (or 50, 100, and 150 Hz) that are due to power supply harmonics.
8. Repeat steps 6 and 7 as needed to ensure a reliable and reproducible test.

The foregoing test procedure must be repeated for each combination of two output channels, two or three operating frequencies, and one or two cable configurations. This requires a maximum of 12 complete test cycles:

- For all FM transmitters, the test must be performed once each for the left and right output channels.
- For FM transmitters that operate in the 88 to 108 MHz range, the test must be repeated three times: once each in the low, middle, and high frequency ranges shown in [Table 2-6](#) (page 32). If the DUT does not support emissions in the specified frequency range, that test may be skipped.
- For FM transmitters that operate in the 76 to 90 MHz range, the test must be repeated twice: once each in the low and high frequency ranges shown in [Table 2-7](#) (page 32). If the DUT does not support emissions in the specified frequency range, that test may be skipped.
- If the iPhone or iPad connects to the FM transmitter by a cable, the tests must be performed twice: once with the cable deployed under the iPhone or iPad and crossing its internal antenna, as shown in [Figure 2-2](#) (page 24), and once with the cable straight. If the FM transmitter does not have a cable, the test must be performed once with the iPhone or iPad directly connected to the DUT.

Table 2-6 88 to 108 MHz test frequency ranges

| Designation | Frequency range |
|-------------|-----------------|
| Low | 88 to 94 MHz |
| Middle | 95 to 101 MHz |
| High | 102 to 108 MHz |

Table 2-7 76 to 90 MHz test frequency ranges

| Designation | Frequency range |
|-------------|-----------------|
| Low | 76 to 82 MHz |
| High | 83 to 90 MHz |

Pass/Fail Criterion

The signal-to-noise ratio must exceed -55 dB at all tested combinations of output channels, frequencies, and cable configurations. Developers must submit a screen capture of the spectrum analyzer output for each tested configuration showing the full 20 Hz to 20 kHz range in a logarithmic scale.

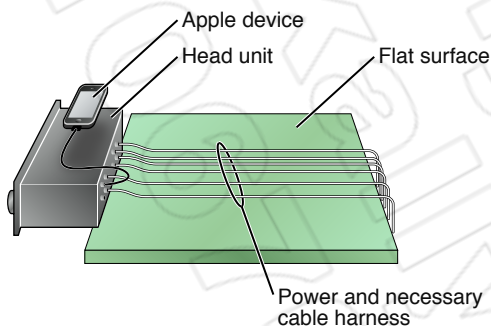
TDMA Noise Test for Automotive Head Units

This section specifies the tests required to certify that an automotive head unit or head unit adapter does not create an excessive level of audible TDMA noise.

Test Environment

The DUT must be tested in an environment that is quiet and free of any other devices in operation that produce noise. The cables to the DUT should be draped over a flat nonconductive surface as shown in [Figure 2-3](#) (page 33).

Figure 2-3 Automotive head unit test environment



TDMA Noise Generation

During the test, TDMA noise must be generated either by accessing a GSM network through Safari or by using a network simulator, as specified in [“Certification Procedures”](#) (page 19).

Spectrum Analyzer Requirements

A spectrum analyzer must be used to measure the signal-to-noise ratio (SNR) of the line output from the DUT. The spectrum analyzer must be able to measure SNR over the range 20 Hz to 20 kHz and take a screen capture of the display showing the full 20 Hz to 20 kHz range in a logarithmic scale.

Test Setup

The DUT must be connected to the iPhone or iPad in its normal user configuration, and its line-level output or speaker output must be connected to the spectrum analyzer. A speaker matching the DUT's design impedance may be connected to enable audible monitoring of the TDMA noise; if a speaker is not connected, the output must be loaded with an equivalent resistor. Before the test, the iPhone or iPad must be updated with the latest available software and the iPhone or iPad's music storage must be loaded with the Apple-supplied test file `TDMA_1_kHz_tone_R1.aiff`. Instructions for obtaining this file are sent to licensed developers by email.

The iPhone or iPad must be initialized through these steps:

1. From the main screen, select the Settings icon.
2. Ensure that Airplane Mode is Off. Set Wi-Fi to Off.
3. Scroll and select iPod.
4. Ensure that Sound Check, EQ, and Volume Limit are all set to Off.

Test Procedures

If using a network simulator, perform each TDMA noise test for line-level output and speaker output through these steps:

1. Turn on the spectrum analyzer.
2. Connect the iPhone or iPad to the DUT. If appropriate, select a cable configuration as described below.
3. From the main screen, select the iPod icon and then select the More icon in the lower right of the display. Tap Songs and select 1 KHz tone.
4. While the 1 kHz tone is playing, open a data connection between the network simulator and the iPhone or iPad, as specified in ["TDMA Noise Simulator"](#) (page 21). Once the simulator has confirmed that a loopback is established and data is being transferred, continue the test.
5. Using the spectrum analyzer, measure the minimum SNR between the 1 kHz peak and surrounding frequencies. When measuring the SNR ignore peaks at 2 kHz, 3 kHz, and 4 kHz that are due to harmonic distortion, and peaks at 60, 120, and 180 Hz (or 50, 100, and 150 Hz) that are due to power supply harmonics.
6. Repeat steps 4 and 5 as needed to ensure a reliable and reproducible test.

If accessing a GSM network through Safari on an iPhone, perform each TDMA noise test for line-level output and speaker output through these steps:

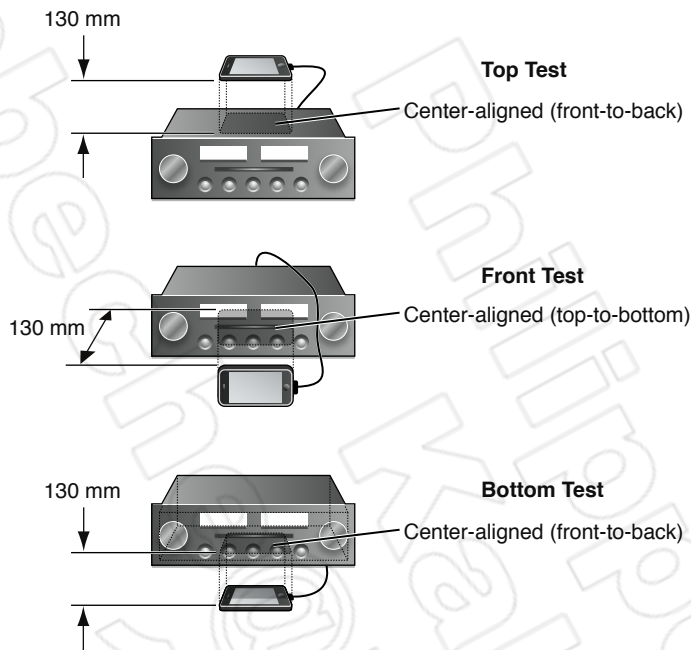
1. Turn on the spectrum analyzer.
2. Connect the iPhone to the DUT. If appropriate, select a cable configuration as described below.
3. From the main screen, select the Settings icon.

4. Switch Airplane Mode to Off. Set Wi-Fi to Off.
5. Still in Settings, select General > Network, and switch Enable 3G to Off.
6. From the main screen, select the iPod icon and then select the More icon in the lower right of the display. Tap Songs and select 1 KHz tone.
7. Return to the main screen and select the Safari icon.
8. Using Safari, enter the URL www.apple.com.
9. Verify that the Apple Web page is loading using only GSM.
10. Using the spectrum analyzer, measure the minimum SNR between the 1 kHz peak and surrounding frequencies. When measuring the SNR ignore peaks at 2 kHz, 3 kHz, and 4 kHz that are due to harmonic distortion, and peaks at 60, 120, and 180 Hz (or 50, 100, and 150 Hz) that are due to power supply harmonics.
11. Repeat steps 8 through 10 as needed to ensure a reliable and reproducible test.

Either of the foregoing test procedure must be repeated for each combination of line-level output or speaker output, left and right output channel, up to three cable configurations, and up to five volume settings, as follows:

- If the DUT does not feature a line-level output or speaker output capability, the corresponding test may be skipped.
- For all accessories, the test must be performed once each for the left and right output channels.
- If the iPhone or iPad is located in a fixed position in the car, such as plugged into a factory-installed head unit with a fixed-location 30-pin connector, the test procedure must be performed once with the iPhone or iPad configured in its intended position.
- If the iPhone or iPad is not located in a fixed position in the car (for example, connected to an after-market head unit), the test procedure must be performed three times with the following configurations: once with the iPhone or iPad center-aligned 130 mm directly above the DUT, once with the iPhone or iPad center-aligned 130 mm directly below the DUT, and once with the iPhone or iPad center-aligned 130 mm directly in front of the DUT. When testing these configurations, there must be no material between the iPhone or iPad and the DUT. The DUT must be oriented as shown in [Figure 2-4](#) (page 36).
- If the DUT supports volume controls, the test must be performed up to four times at the different volume settings shown in [Table 2-8](#) (page 36) and [Table 2-9](#) (page 37). If the volume range of the DUT is limited, tests beyond the DUT's range may be skipped.

Testing all the foregoing combinations may require as many as 30 complete test cycles.

Figure 2-4 After-market head unit test configurations

Pass/Fail Criteria

The signal-to-noise ratio (SNR) must exceed the following values for line-level output or speaker output, left and right channels, cable configurations, and all tested volumes. Developers must submit a screen capture of the spectrum analyzer output for each tested configuration showing the full 20 Hz to 20 kHz range in a logarithmic scale. For accessories with a fixed volume output, the SNR must exceed -65 dB. For all other DUTs with variable volume output the SNR requirements for line-level output and speaker output are shown in [Table 2-8](#) (page 36) and [Table 2-9](#) (page 37). If the DUT supports only discrete volume settings, the settings closest to each required volume setting should be used.

Note: If the noise floor of the DUT is less than the minimum SNR value, then the measured SNR must not exceed the noise floor.

Table 2-8 Line-level output pass/fail criteria

| Volume setting | Minimum SNR |
|----------------|--------------|
| Above 0 dBV | -65 dB SNR |
| -10 dBV | -65 dB SNR |
| -20 dBV | -62 dB SNR |
| -40 dBV | -50 dB SNR |

Note: 0 dBV is referenced to 1 V. The SNR should drop no more than 10 dB for every 10 dB in volume reduction below –40 dBV.

Table 2-9 Speaker output pass/fail criteria

| Volume setting | Minimum SNR |
|----------------|-------------|
| Above 0 dB | –65 dB SNR |
| –10 dB | –62 dB SNR |
| –20 dB | –58 dB SNR |
| –40 dB | –40 dB SNR |

Note: The SNR should drop no more than 10 dB for every 10 dB in volume reduction below –40 dBV.

TDMA Noise Test for FM Tuners

This section specifies the tests required to certify that an iPhone or iPad accessory with a built-in analog FM tuner does not create an excessive level of audible TDMA noise when the FM tuner is being operated.

Test Environment

The test must be performed in an environment that is quiet and free of any other devices in operation that produce noise.

TDMA Noise Generation

During the test, TDMA noise must be generated by the network simulator specified in [“TDMA Noise Simulator”](#) (page 21).

Equipment Requirements

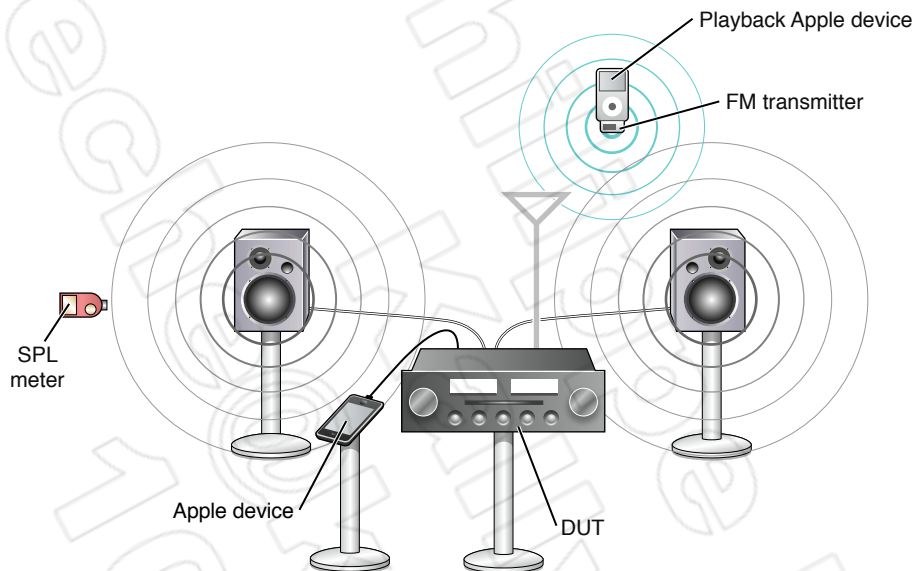
This test requires the following equipment:

- The DUT, an iPhone or iPad accessory with a built-in FM tuner
- A test iPhone or iPad, to be connected to the DUT
- A Playback Device, which can be any Apple device capable of playing media
- The DUT, an approved MFi FM transmitter accessory, to be connected to the Playback Device
- An SPL (sound pressure level) meter

- If the DUT does not have built-in speakers, an external speaker system.

These items of equipment, and their relative positions during testing, are shown in [Figure 2-5](#) (page 38). Tables or other sound-reflecting surfaces must not be present.

Figure 2-5 FM tuner test equipment layout



Test Setup

This test must be performed after completing all other TDMA noise tests that apply to the DUT.

The DUT must be connected to the test iPhone or iPad in its normal user configuration. If the DUT does not have built-in speakers, speakers must be connected to enable audible monitoring of the TDMA noise.

The FM transmitter accessory must be connected to the Playback Device.

The test iPhone or iPad connected to the DUT must be initialized through these steps:

1. From the main screen, select the Settings icon.
2. Set Airplane Mode to Off.
3. Ensure that Airplane Mode is Off. Set Wi-Fi to Off.
4. If testing with an iPhone, select Sounds.
5. If testing with an iPhone, set Vibrate to Off.
6. Return to Settings.
7. Scroll down and select iPod.
8. Set Sound Check, EQ and Volume Limit to Off.

9. If testing with an iPhone, turn off the ringer. The iPhone should not ring or vibrate when it receives an incoming call.

The Playback Device connected to the FM transmitter must be initialized through these steps:

1. Load the Playback Device with the Apple-supplied test files TDMA_Speakers_SPL_calibration_R1.aiff and TDMA_FM_tuner_piano_R1.aiff. Instructions for obtaining these file are sent to licensed developers by email.
2. Set Sound Check, EQ and Volume Limit to Off.
3. If the Playback Device is an iPhone, set Airplane Mode to On and set Wi-Fi to Off.

Test Procedure

For FM tuners that operate in the 88 to 108 MHz range, the following test procedure must be repeated three times: once each in the low, middle, and high frequency ranges shown in [Table 2-6](#) (page 32). If the DUT does not support emissions in the specified frequency range, that test may be skipped.

1. Connect the test iPhone or iPad to the DUT and turn on DUT power.
2. Connect the Playback Device to the FM transmitter and turn on FM transmitter power if necessary.
3. Tune the DUT and FM transmitter to the same frequency. Select a frequency that is free of external interference.
4. On the Playback Device, select and play the song TDMA_Speakers_SPL_calibration_R1.aiff over the FM link to the DUT.
5. While watching the sound level displayed by the SPL meter, adjust the DUT's output sound volume until the SPL meter maintains a reading of 65 dBA with the meter set to A weighting and slow response. Stand away from both the SPL meter and the DUT when taking measurements. No object may be located between the SPL meter and the DUT. See [Figure 2-1](#) (page 23) for instructions on how to position the SPL meter relative to the DUT.
6. From the Playback Device connected to the FM transmitter, select and play the song TDMA_FM_tuner_piano_R1.aiff. Position the mid- and high-frequency speakers of the DUT at a distance of 20 inches and listen to their sound. This part of the test is done by ear, not with the SPL meter. The listener should be able to hear the piano test file being transmitted over the FM link, but it should be fairly quiet.
7. Open a data connection between the network simulator and the iPhone or iPad, as specified in ["TDMA Noise Simulator"](#) (page 21). Once the simulator has confirmed that a loopback is established and data is being transferred, continue the test.
8. Assume the same listening position as specified in step 6. Listen to the sound level of the noise generated by the DUT while the test iPhone or iPad is loading the web site. The TDMA noise from the DUT may not be audible (as measured by ear) when the piano test file is playing. This part of the test is done by ear, not with the SPL meter.
9. Repeat steps 6 through 8 as needed until a reliable and reproducible test is completed.

Pass/Fail Criterion

TDMA noise from the DUT must not be audible (as measured by ear) when the piano test file is playing.

TDMA Noise Test for Headphone Remote and Mic Systems

This section specifies the tests required to certify that a headphone remote and mic system does not create an excessive level of audible TDMA noise.

Test Environment

The DUT must be tested in an environment that is quiet and free of any other devices in operation that produce noise.

TDMA Noise Generation

During the test, TDMA noise must be generated by the network simulator specified in [“TDMA Noise Simulator”](#) (page 21).

Speaker System Requirements

A high-quality speaker system for the iPhone or iPad, certified under the Made for iPod program, must be used to play back the calibration and recording sample sound files.

SPL Meter Requirements

A sound pressure level (SPL) meter must be used to adjust the sound level produced by the speaker. The SPL meter must be a Class 2 device, as defined by the ANSI and IEC651 standards. It must have fast and slow response settings, must make both A- and C-weighted dB measurements, and must have a range of at least 35 to 90 dBA.

Sound Recording Requirements

The iPhone application Voice Memos, for iOS 3.0 or later, must be downloaded from Apple’s App Store and loaded into the iPhone or iPad.

Head and Torso Simulator Requirements

A head and torso simulator (HATS or equivalent-size Phantom), as shown in [Figure 2-6](#) (page 41), must be used to perform the test.

Speaker Volume Calibration

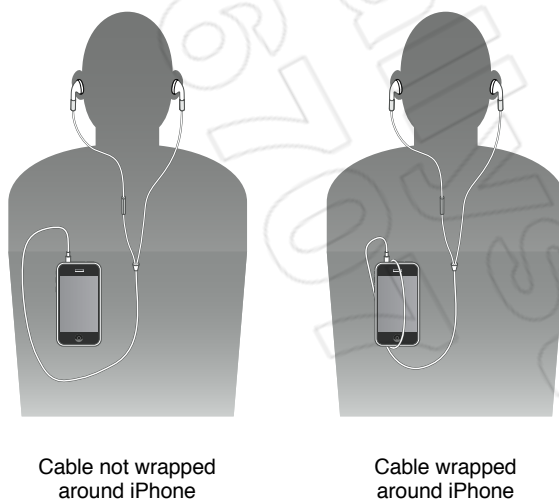
To calibrate the test configuration, the Apple-supplied TDMA calibration file `TDMA_Headphone_SPL_calibration_R1.aiff` must be loaded into the iPhone and played while the iPhone is connected to the speaker system. This file contains pink noise for headphones. The speaker system's sound volume must be adjusted until the SPL meter measures 65 dBA.

Test Setup

The test consists of two parts:

- In Part One, the HATS must be placed on a wooden stand or similar object with the iPhone positioned as shown in [Figure 2-6](#) (page 41). The DUT must be attached to the iPhone headphone jack and headphones (if present) must be placed in the ears on the HATS. The tests must be performed twice: once with the DUT headphone cable wrapped around the iPhone and once with the DUT headphone cable draped in front of the iPhone. For an iPad the test must be performed once only, with the iPad positioned at the base of the HATS and the DUT's headphone cable draped in front of the iPad.
- In Part Two, the speaker system and iPhone must be placed on a stand or similar object centered in the width of the acoustically-isolated test room. The speaker must be positioned such that its mid- and high-frequency speakers are located between 28 and 34 inches above the floor and 12 inches away from the wall behind them. The SPL meter must be located 20 inches from the speakers and aimed toward their center. It must be set to "A" weighted, slow-response operation.

Figure 2-6 HATS and iPhone configuration



Before the test, the iPhone's music storage must be loaded with the Apple-supplied test files `TDMA_Headphone_SPL_calibration_R1.aiff` and `TDMA_Headphone_TDMA_noise_R1.aiff`. Instructions for obtaining these files are sent to licensed developers by email.

The iPhone must be initialized through these steps:

1. From the iPhone's main screen, select the Settings icon.

2. Scroll and select iPod.
3. Ensure that Sound Check, EQ and Volume Limit are all set to Off.
4. Ensure that the iPhone's 3G capability is turned off.

Test Procedure

Ensure that the test environment is quiet and free of devices in operation that produce noise. Verify that the requirements specified in [“Test Setup”](#) (page 41) have been met. Perform the test through these steps:

Part One

The following steps must be performed to complete Part One of the TDMA noise test for headphone remote and mic systems.

1. Position the iPhone and connected DUT on the HATS as shown in [Figure 2-6](#) (page 41).
2. From the iPhone's main screen, launch the Voice Memos application and tap “Record”.
3. Open a data connection between the network simulator and the iPhone, as specified in [“TDMA Noise Simulator”](#) (page 21). Once the simulator has confirmed that a loopback is established and data is being transferred, continue the test.
4. On the iPhone, tap “Stop” to save the recording sample.
5. Remove the iPhone from the HATS and disconnect the DUT.

Part Two

The following steps must be performed to complete Part Two of the TDMA noise test for headphone remote and mic systems.

1. Connect the iPhone to the speaker system.
2. Ensure that the speaker's input is set to enable the iPhone as an audio source.
3. From the iPhone's main screen, select the iPod icon and select the More icon in the lower right of the display.
4. Tap Songs; select and play `TDMA_Headphone_SPL_calibration_R1.aiff`.
5. While watching the sound level displayed by the SPL meter, adjust the speaker output sound volume until the SPL meter maintains 65 dBA (with the meter set to A-weighting, slow response). Stand away from both the SPL meter and the speaker when reading measurements. No object may be located between the SPL meter and the speaker.
6. On the iPhone, select and play `TDMA_Headphone_TDMA_noise_R1.aiff`. Face the mid- and high-frequency speakers from a distance of 20 inches and listen to the sound level. This part of the test is done by ear, not with the SPL meter. The listener should be able to hear the TDMA test file playing.

7. Stop the playback of TDMA_Headphone_TDMA_noise_R1.aiff and tap the iPhone's home button.
8. From the iPhone's main screen, launch the Voice Memos application.
9. Select the recording sample obtained in step 4, and tap "Play" to play the recording sample.
10. Assume the same listening position as specified in Step 6. Listen to the sound level of the noise in the recording sample. The sound level must not exceed the level heard during Step 6. This part of the test is done by ear, not with the SPL meter.

Repeat Parts One and Two as needed until a reliable and reproducible test is completed.

Pass/Fail Criterion

The TDMA noise volume in the loudest recorded sample, as measured by ear, may not exceed the volume of the Apple-supplied TDMA audio test file TDMA_Headphone_TDMA_noise_R1.aiff.

RF Testing and Certification

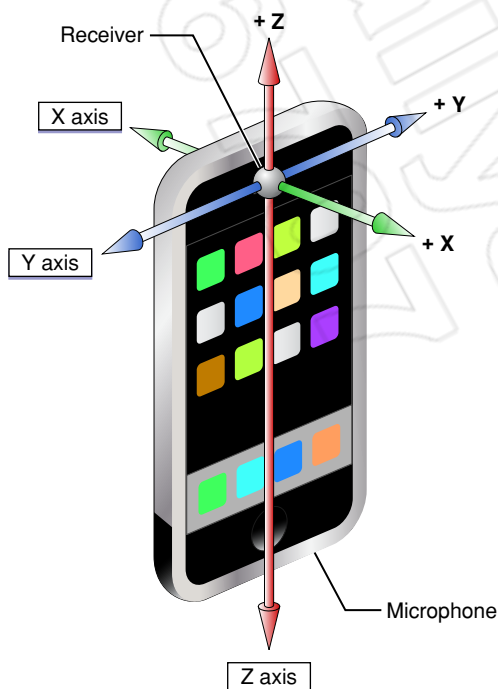
This chapter describes the test setups and procedures for certifying that an attached iPhone accessory does not degrade the RF performance of the iPhone beyond acceptable limits. These tests must be performed and certified by an Apple-certified independent testing laboratory, as described in [“Independent Laboratory Certification”](#) (page 10).

Note: In addition to the testing specified in this chapter, every accessory that communicates with the iPhone using the iPod Accessory Protocol must declare its RF certification for specific iPhone models by sending an `AccInfoToken`, with info type “Accessory RF Certifications,” during the IDPS process; see *MFi Accessory Firmware Specification*, Release R40 or later.

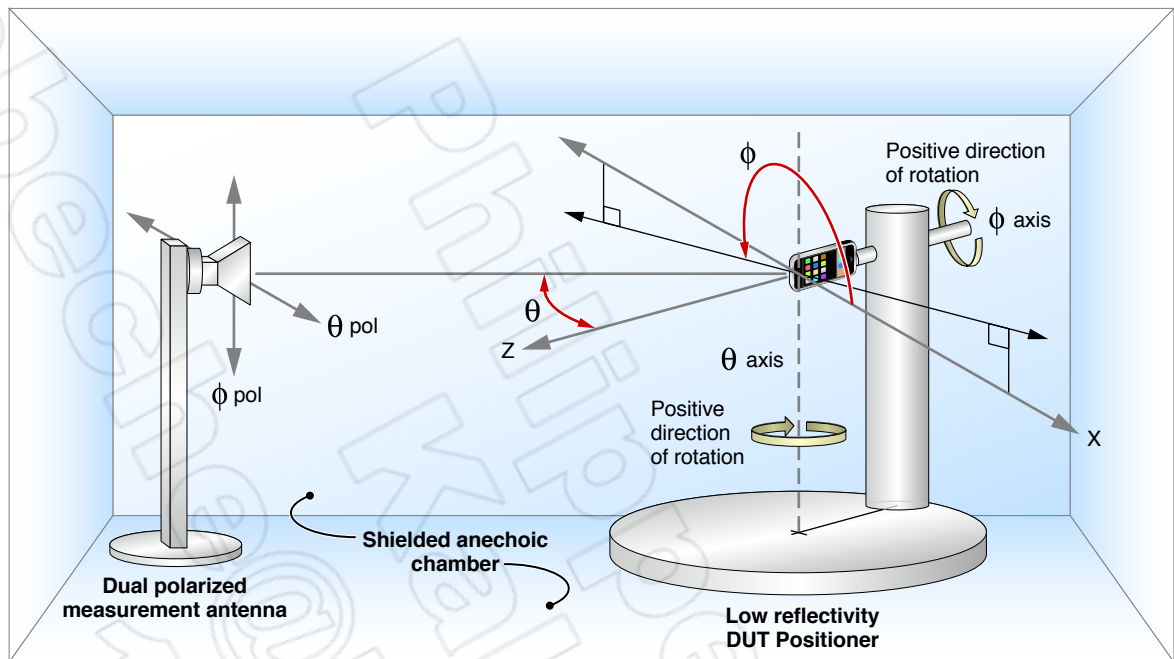
RF Certification Setup

The orientation coordinates applicable to the iPhone in the following discussion are shown in [Figure 3-1](#) (page 45).

Figure 3-1 iPhone orientation coordinates



Using these orientation coordinates, [Figure 3-2](#) (page 46) shows a typical RF measurement setup with a freestanding iPhone.

Figure 3-2 Freestanding iPhone RF measurement setup (setup may vary)

Note: In all test setups involving RF, the iPhone's antenna area must be completely free to radiate and receive RF signals. The antenna area is shown in the iPhone drawing available at developer.apple.com/programs/mfi/cases.html.

During RF testing, the iPhone must be configured as follows:

- WiFi must be turned off (use Settings > WiFi), unless the DUT uses WiFi to communicate directly with the iPhone.
- Bluetooth must be turned off (use Settings > General > Bluetooth), unless the DUT uses Bluetooth to communicate directly with the iPhone.
- The iPhone must be fully charged. TRP measurements are not valid if the iPhone battery level is below 50%.

During RF testing, the DUT must be configured as follows:

- The DUT must be powered on during EIS testing.
- Primary DUT features, such as an HD radio, must be turned on during EIS testing.

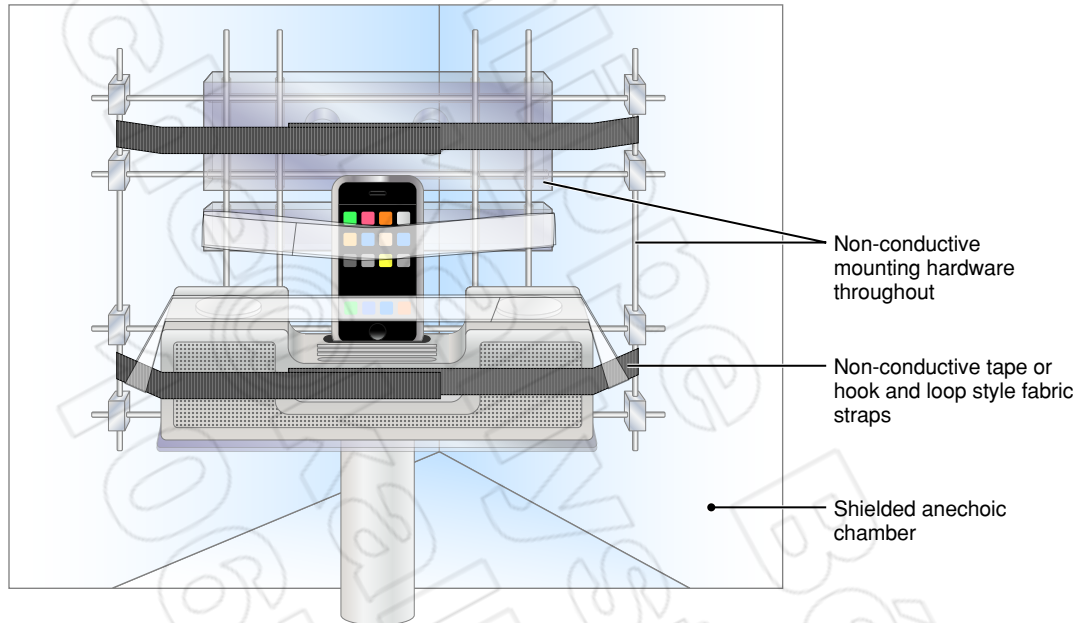
The following tests must be passed successfully for an iPhone accessory to be certified:

- Total radiated power (TRP), as specified in “Measuring TRP” (page 49).
- Effective isotropic sensitivity (EIS) over the iPhone's operating frequencies, including RS testing of relative sensitivity on intermediate channels, as specified in “Measuring EIS” (page 50).

Typical Speaker System Test Setup

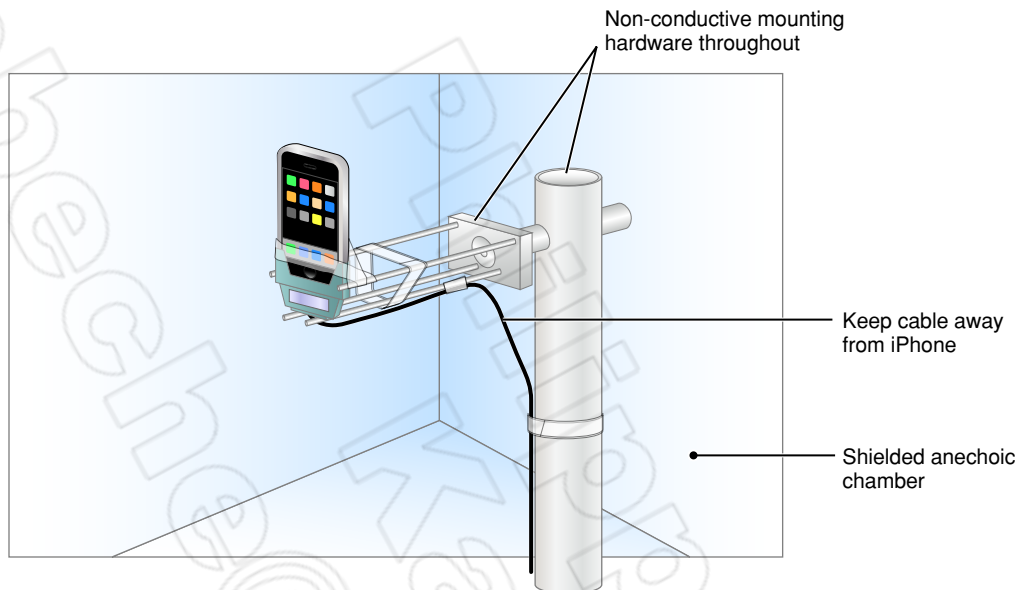
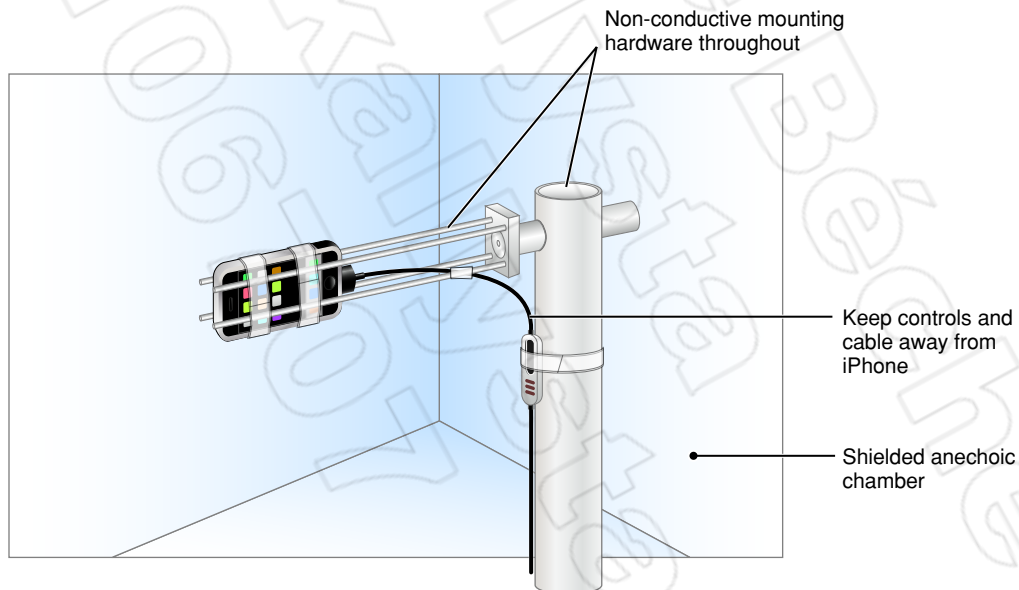
A typical iPhone and DUT setup for testing and certifying a speaker system with an iPhone dock is shown in [Figure 3-3](#) (page 47); the setup may vary, depending on the form factor of the DUT. The DUT mounting material must have a very low dielectric constant. Acceptable mounting standards are specified in the current 3GPP specification.

Figure 3-3 Docking speaker system test setup (setup may vary)



Typical Test Setup for Cable-Connected Accessories

The setup for testing and certification of a cable-connected accessory that mounts directly on the iPhone is shown in [Figure 3-4](#) (page 48). The setup for testing and certification of an accessory connected by cable to the iPhone (such as a car charger) is shown in [Figure 3-5](#) (page 48).

Figure 3-4 Directly-connected accessory test setup (setup may vary)**Figure 3-5** Cable-connected accessory test setup (setup may vary)

Alternate TRP/EIS/TIS/RS Test Plans

Accessory manufacturers may choose either of two alternate plans for testing TRP, TIS, EIS, and RS. Under either plan, all tests must be made by an independent laboratory certified by Apple; see [“Independent Laboratory Certification”](#) (page 10):

- **General Testing.** Perform and certify the following tests:

1. Test for TRP as specified in [“Measuring TRP”](#) (page 49).
2. Test for EIS as specified in [“Measuring EIS”](#) (page 50).
3. Test for RS as specified in [“RS Testing”](#) (page 51).

■ **Selective Testing.** Perform and certify the following tests:

1. Test for TRP as specified in [“Measuring TRP”](#) (page 49) only on the channels listed for each band in [Table 3-1](#) (page 49).
2. Test for total isotropic sensitivity (TIS) by measuring EIS, as specified in [“Measuring EIS”](#) (page 50), only on the middle channel for each band.
3. Test for RS as specified in [“RS Testing”](#) (page 51). If the intermediate channel test fails when testing at the peak orientation derived from Step 2, then repeat steps 2 and 3. When repeating Step 2, use either the low channel or the high channel, depending on where the failure occurred.

Table 3-1 Selective TRP testing channels

| Band | Channel |
|----------------|---------|
| GSM 850 | Low |
| GSM 900 | High |
| GSM 1800 | Low |
| GSM 1900 | High |
| UMTS Band I | High |
| UMTS Band II | None |
| UMTS Band V | None |
| UMTS Band VIII | None |
| CDMA BC0 | Low |
| CDMA BC1 | High |

Measuring TRP

The total radiated RF power of the iPhone, when it is in operation and connected to an accessory, is measured by sampling its radiated transmit power at various locations. Data points must be taken every 30 degrees in both the theta and phi axes for each band. The DUT must not be connected to power during TRP testing.

This test must be made by an independent laboratory certified by Apple; see [“Independent Laboratory Certification”](#) (page 10).

TRP measurements must be taken at the frequencies shown in [Table 3-2](#) (page 50). The same table shows the maximum allowable degradation in measured TRP values between the iPhone operating in free space and the iPhone operating in conjunction with the DUT.

Table 3-2 TRP measurement parameters

| Band | Frequency | Maximum degradation |
|-------------|-------------|---------------------|
| GSM 850 | 824.2 MHz | 9 dB |
| GSM 900 | 914.8 MHz | |
| GSM 1800 | 1710.2 MHz | 4.5 dB |
| GSM 1900 | 1909.8 MHz | |
| UMTS Band I | 1977.6 MHz | |
| CDMA BC0 | 824.7 MHz | 9 dB |
| CDMA BC1 | 1908.75 MHz | 4.5 dB |

Measuring EIS

The effective isotropic sensitivity (EIS) of the iPhone with an accessory attached is measured using a base station emulator and the free-space test setup described in [“RF Certification Setup”](#) (page 45). The DUT must be mounted using materials with very low dielectric constants. The current 3GPP specification lists free-space mounting materials that can be used.

EIS measurement consists of two tests, EIS testing and Relative Sensitivity (RS) testing. Both tests must be conducted by an independent laboratory certified by Apple; see [“Independent Laboratory Certification”](#) (page 10).

Note: If the DUT is designed to charge the iPhone or to be powered externally for any other reason, it must be connected to external power during testing. If the DUT can be powered either by battery or AC power, it must be tested separately both ways.

EIS Testing

EIS measurements must be taken at the frequencies shown in [Table 3-3](#) (page 51). The same table shows the maximum allowable degradation in measured EIS values between the iPhone operating in free space and the iPhone operating in conjunction with the DUT.

Table 3-3 EIS band frequencies and degradation factors

| Band | Frequency | Maximum degradation |
|----------------|------------|---------------------|
| GSM 850 | 881.6 MHz | –7.0 dB |
| GSM 900 | 947.4 MHz | |
| GSM 1800 | 1842.6 MHz | –4.5 dB |
| GSM 1900 | 1960 MHz | |
| UMTS Band I | 2140 MHz | –5.0 dB |
| UMTS Band II | 1960 MHz | –5.3 dB |
| UMTS Band V | 881.6 MHz | –9.6 dB |
| UMTS Band VIII | 942.6 MHz | |
| CDMA BC0 | 881.52 MHz | –5.3 dB |
| CDMA BC1 | 1960 MHz | |

RS Testing

After EIS testing has been completed, RS tests (Relative Sensitivity on Intermediate Channels) must be performed, one for each band.

Note: If more than 3 dB difference was observed across the EIS values in a band, then each of its sub-bands (low, middle, and high) must be tested separately. The peak location must be determined separately for each sub-band and the DUT oriented to that location.

Each RS test must be performed as follows:

1. Decrease the RF power being sent from the base station emulator to the iPhone until the bit error rate (BER) specified in [Table 3-4](#) (page 51) and the frame error rate specified in [Table 3-5](#) (page 52) are observed.
2. Increase the output power of the base station emulator by the degradation amount specified in [Table 3-3](#) (page 51).
3. Sweep through the entire band (or sub-band), taking sensitivity data points at every channel frequency. Each band (including all its sub-bands) must not show more than a total of 10 exceptions to the sensitivity requirements shown in [Table 3-3](#) (page 51).

Table 3-4 Bit error rate (BER)

| Frequency band | iPhone | iPhone 3G, iPhone 3GS, and iPhone 4 (GSM model) |
|----------------|--------|---|
| GSM 850 | 2.44% | 2.44% |

| Frequency band | iPhone | iPhone 3G, iPhone 3GS, and iPhone 4 (GSM model) |
|----------------|--------|---|
| GSM 900 | 2.44% | 2.44% |
| GSM 1800 | 2.44% | 2.44% |
| GSM 1900 | 2.44% | 2.44% |
| UMTS Band I | N/A | 1.20% |
| UMTS Band II | N/A | 1.20% |
| UMTS Band V | N/A | 1.20% |
| UMTS Band VIII | N/A | 1.20% |

Table 3-5 iPhone 4 (CDMA model) frame error rate

| Frequency band | Maximum frame count | Frame error rate |
|----------------|---------------------|------------------|
| CDMA BC0 | 2000 frames | 0.5% |
| CDMA BC1 | 2000 frames | 0.5% |

Headset Accessory Certification

This chapter describes the procedures and documentation required for self-certifying headset accessories that incorporate the transmitter chip described in “Headphone Remote and Mic System” in *MFi Accessory Hardware Specifications*. The self-certification process is described in “Self-Certification” (page 10).

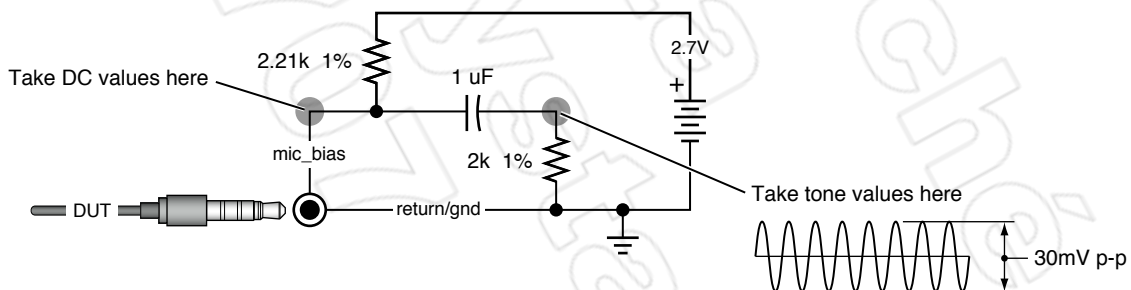
Operability Tests

The following items are required to perform operability testing:

- A precision power supply
- A 4-pin audio jack, 3.5 mm diameter, such as Digikey SJ-43515RS-SMT
- An oscilloscope with measuring capabilities
- A 2.21 k Ω 1% resistor
- A 2 k Ω 1% resistor
- A 1 μ F capacitor

These items must be connected as shown in [Figure 4-1](#) (page 53).

Figure 4-1 Headset accessory test setup



Testing must demonstrate the following:

- All tones must have a peak-to-peak amplitude of at least 30 mV as measured across the 2 k Ω load.
- The accessory tester must provide labeled oscilloscope pictures of all button press tones, button release tones, and acknowledgment tones, showing their amplitudes. The button release frequency of 99 kHz must have an amplitude of at least 30 mV peak-to-peak.
- Microphone-enabled accessories must have a static DC voltage at the mic_bias point between 1.85 and 2.0 V. The accessory tester must provide labeled oscilloscope pictures showing that the voltage at the mic_bias point is stable and within specification before 50 msec after power-up.

- The accessory must also be operable in button mode. To put transmitter in button mode, the accessory tester must set the power supply in the test circuit to 2.0 V. Oscilloscope screen pictures must then be provided to demonstrate DC shifts occurring during button presses, with static DC mic_bias voltages as shown in [Table 4-1](#) (page 54).

Table 4-1 Required mic_bias voltages

| Switch closure | Voltage |
|----------------|-------------------|
| S_0 | 0.000 V $\pm 1\%$ |
| S_1 | 1.510 V $\pm 1\%$ |
| S_2 | 1.603 V $\pm 1\%$ |

The accessory tester must perform interoperability tests on all Apple devices that the accessory is designed to support, and must provide a summary report.

Other Tests

The accessory tester must perform industry standard EMC and ESD tests on the accessory and must provide summary reports.

The accessory must pass the “TDMA Noise Test for Line-Level and Headphone Output Connectors” specified in [“TDMA Noise Test for Headphone Remote and Mic Systems”](#) (page 40).

Test Reports

All test results must be presented in the form of a table or checklist, with an appendix for oscilloscope screen shots.

In all cases, submitted oscilloscope screen shots must be legible and properly scaled to clearly show the information of interest. Cursors or measurements must be shown, clearly demonstrating that the specification is being met.

FireWire to USB Power Converter Certification

This chapter describes the procedures and documentation required for self-certifying FireWire-to-USB Power Converters for Apple devices. The self-certification process is described in [“Self-Certification”](#) (page 10).

For converter design guidelines, see “FireWire to USB Reference Design” in *MFi Accessory Hardware Specifications*.

Test Setup

The following items are required to test a FireWire-to-USB power converter designed to be compatible with any Apple device:

- A precision power supply capable of 30 V output at 1 A.
- An electronic load (e-load) capable of dissipating 5 W. A static load may be substituted if it can be rapidly switched in and out to modulate loading on the circuit.
- An oscilloscope.

Test Requirements

Testing must demonstrate compliance with the requirements in this section.

Output Ripple

The converter must not present voltage ripple greater than 100 mV peak-to-peak, measured at the converter’s output capacitor, across all supported input voltages and output currents.

The accessory tester must submit oscilloscope screen shots of output voltage ripple for all the following combinations:

- $V_{in} = 8, 14, 24, \text{ and } 30 \text{ V}$
- $I_{out} = 5, 80, 200, 500, \text{ and } 1000 \text{ mA}$

Dynamic load response

The accessory tester must plot on the oscilloscope the maximum AC ringing occurring due to the output current load changing rapidly. Oscilloscope screen shots of the output voltage under the following conditions must be submitted:

- Output load current transitions from 0 mA to 500 mA
- Output load current transitions from 500 mA to 1 A
- Output load current transitions from 80 mA to 1 A

In all cases, the slew rate of the load step must be at least 0.5 A per μ sec. The output voltage must not go outside the range 4.75 to 5.25 V.

Efficiency

There is no efficiency requirement, but efficiencies in the high 80% range are easily obtained. The actual efficiency must be reported, using the following combinations as test conditions:

- $V_{in} = 8, 14, 24, \text{ and } 30 \text{ V}$
- $I_{out} = 5, 80, 200, 500, \text{ and } 1000 \text{ mA}$

Catastrophic Input Over-Voltage and Output Protection

For this test, the converter circuit must be reworked so the input can be switched directly to the switch node (regulator output), effectively shorting input to output. This simulates a catastrophic input over-voltage.

The accessory tester must perform the test in these steps:

1. Provide a 30 V input to the converter.
2. Short the input to the output.
3. Provide an oscilloscope picture that shows both the output voltage and the switch node voltage in regular operation and at the moment of the input-to-output short, on the same plot. The plot must show the maximum voltage seen on the output of the converter.
4. Repeat steps 2 and 3 at both 80 mA and 1 A output loads.

To pass this test, adequate protection must be provided in the converter design so that the maximum voltage across the load at any time is 6 V.

Short Circuit Protection

The accessory tester must submit an oscilloscope picture of the output being shorted with 10 milliohms or less while attached to a 500 mA load current. The picture must show the resulting output waveform. The accessory tester must also submit a record of the peak case and component temperatures following a 4 hour test with the output shorted.

Burn-In and Thermal Test

The maximum case temperature must be reported. It must not exceed 75° C during normal use on a hard surface or 105° C during fault conditions such as a short circuit.

D+/D- Charging

The accessory tester must report the voltage on both the D- and D+ pins of the converter's 30-pin connector during normal operation. The accessory's D- and D+ signals must comply with the requirements specified in "USB 2.0" in Chapter 2 of the most recent release of *MFi Accessory Hardware Specifications*.

USB Tests

If the converter design contains USB signaling or charging pathways, the accessory tester must submit a USB compliance eye diagram report. The accessory tester must also submit reports on the converter's FireWire-to-USB power switching functionality to show that it has been tested.

Switching Frequencies

Accessory testers must verify that they have read the "Converter Switching Frequency Guidelines" section of "iOS Device Power Supply Requirements" in *MFi Accessory Hardware Specifications* and specify how the converter design minimizes its effect on iPhone multitouch operation and RF reception.

Interoperability Tests

The accessory tester must perform and report on standard interoperability tests on all Apple devices with which the converter is compatible.

Test Reports

All test results must be presented in the form of a table or checklist, with an appendix for oscilloscope screen shots.

In all cases, submitted oscilloscope screen shots must be legible and properly scaled to clearly show the information of interest. Cursors or measurements must be shown, clearly demonstrating that the specification is being met.

Glossary

authentication A mechanism used by an Apple device to verify whether an attached device is an authorized accessory and by an accessory to authenticate the Apple device, if desired.

checksum The byte sum of packet bytes from the payload length through the last packet byte. This is used to validate the contents of a command packet. For a valid packet, the sum of the bytes, including the checksum byte, must be 0x00. The packet checksum byte—the last byte in a packet—must be the 2's complement (the negative) of the sum of the payload length byte up to, but not including, the packet checksum byte.

deprecated Used to describe a technology or feature that is supported but whose use is discouraged and not recommended. Such a technology or feature has typically been replaced by a newer one and is likely to become unsupported in the future.

DUT (Device Under Test) The third-party accessory being tested for compatibility with Apple devices.

HID (Human Interface Device) HID is a standard USB class. A USB host such as a PC or Macintosh will recognize any attached USB device that supports a HID interface and makes it available to the application layers of the operating system via a set of programming interfaces. A common application of a HID interface is a USB mouse or joystick.

HID report A single unit of data that is used to send information to the HID interface of an Apple device or from the Apple device to the host. iAP packets are broken into HID reports before being sent across the USB port link and are reassembled on the receiving side.

iUI (iPod USB Interface) A configuration of an Apple device when attached as an accessory over USB. This configuration allows the Apple device to be controlled using iAP, using a USB HID class interface as a transport mechanism.

LCB (Link Control Byte) A byte used by the iUI to indicate report sets and manage data flow.

lingo The command category used by an accessory. There is a General lingo that must be supported by all accessories. Other lingo's are designed for use by specific accessories, such as simple remote controls and microphones.

link The logical connection between an external accessory and an Apple device via serial port or other physical connection.

packet The logical set of bytes that compose a valid command sequence. This set includes the packet start byte, packet payload length, payload, and payload checksum. Note that a sync byte is appended to the beginning of the packet when using the UART serial port as the data transport link. There are two different packet types: small format and large format.

payload The sequence of bytes consisting of the lingo, command, and data that are contained within a packet.

Playback Device An Apple device, capable of playing media, used in TDMA testing.

podcasting A way to publish multimedia files on the Internet that lets users receive new files automatically by subscription. Podcast files are typically downloaded to Apple devices through Apple's iTunes application.

RDS/RBDS (Radio [Broadcast] Display System) A technology for broadcasting and displaying artist, album, track titles, and similar information on FM radio receivers.

resistor-based accessory An accessory that uses an Accessory Identify resistor to access only limited functions in an Apple device. Compare Serial accessory.

RSSI (Receive Signal Strength Indicator) A measure of the strength of an RF signal coming into a radio frequency tuner.

serial accessory An accessory that uses the iPod Accessory Protocol Interface to access a range of Apple device functions. Compare Resistor-based accessory.

UART (Universal Asynchronous Receiver/Transmitter) A piece of computer hardware that translates between parallel and serial bits of data. A UART is usually an integrated circuit used for serial communications over a computer or peripheral device serial port.

USB (Universal Serial Bus) An interface standard for communication between a computer and external peripherals over a cable using biserial transmission.

USB descriptor A standard USB data structure that is passed from a USB device to the host upon request. Descriptors are used by the USB device to communicate its characteristics and resource requirements to the host.

USB endpoint A logical connection point that is used to set up a data transfer pipe between a USB host and the interface on a USB device. For instance, the HID interface on an Apple device uses an interrupt-type endpoint to enable a pipe for transferring data to the USB Host.

USB host A single computer connected to one or more USB devices or functions. The host is responsible for recognizing that a USB device has been attached to it and for driving the communications with the device. For the purposes of this document, an Apple device is a USB device that provides a function, and the accessory is the USB host.

X.509 certificate A standard defined by the International Telecommunication Union (ITU) that governs the format of certificates used for authentication and sender identity verification in public-key cryptography. In the iAP, X.509 certificates contain the public keys used in the authentication process.

Document Revision History

This table describes the changes to *MFi Accessory Testing Specification*.

| Date | Notes |
|------------|---|
| 2011-04-04 | <i>Release R7:</i> Updated for iPad 2 and iPhone 4 (CDMA model). |
| | Updated "Notice of Proprietary Property" (page 9). |
| | Updated Table 2-1 (page 19). |
| | Revised Chapter 3, "RF Testing and Certification" (page 45) to include iPhone 4 (CDMA model). |
| 2010-11-29 | <i>Release R6:</i> |
| | Corrected generic references to Apple devices, iOS devices, and iPods throughout the document; see "IMPORTANT" (page 9). |
| 2010-07-23 | <i>Release R5:</i> |
| | Clarified TDMA testing requirements in Table 2-1 (page 19). |
| | Updated RF certification declaration requirements; see "Note" (page 45). |
| 2010-06-24 | <i>Release R4:</i> Updated for iPhone 4. |
| | Changed document name from "iPod/iPhone/iPad Accessory Testing and Certification Specification" to "MFi Accessory Testing Specification." |
| | Changed name of "iPhone OS" to "iOS." |
| | Added firmware declaration requirement to "RF Testing and Certification" (page 45). |
| | Removed section "RF Certification Exceptions." |
| | Specified test products to be used for TDMA testing (see Table 2-1 (page 19)). |
| 2010-04-09 | <i>Release R3:</i> |
| | Added section "RF Certification Exceptions." |
| | Updated the chapter "Electrical Testing and Certification" (page 13) for iPad specifications. |
| | Updated the chapter "TDMA Noise Testing and Certification" (page 19) for iPad testing. |

| Date | Notes |
|------------|---|
| 2010-01-11 | <i>Release R2:</i> |
| | Replaced EDGE with GSM throughout as iPhone data source. |
| | Added new section “ Alternate TRP/EIS/TIS/RS Test Plans ” (page 48). |
| | Updated TDMA testing requirements for automotive head units. |
| | Made numerous other updates and clarifications. |
| 2009-09-09 | <i>Release R1: First release.</i> |
| | Imported most of the content from discontinued book <i>iPhone Accessory Interface Specification</i> , Release R9. |
| | Imported some content from <i>iPod Accessory Protocol Interface Specification</i> , Release R36. |