# iPod Accessory Protocol Interface Specification

**Release R38**



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# Introduction



This document specifies the electrical and software interfaces to the Apple iPod that are available to accessory devices. The iPod models covered by this specification are shown in Table I-1 (page 30).

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

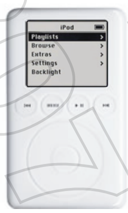
To determine if a command or feature is supported in a particular iPod model or firmware release, see Table 1-4 (page 38) and Table 1-5 (page 39).

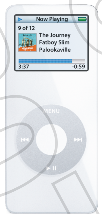
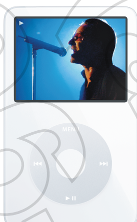
**Note:** The iPhone and iPod touch share the same iPod Accessory Protocol (iAP) interface except where specified otherwise in this document. All accessories for the iPhone must meet additional electrical and RF design requirements. These requirements are described in the iPhone license agreement and in Apple's *iPod/iPhone Accessory Testing and Certification Specification*.

The minimum iPod System Software versions supported by this specification are:

- Version 2.0 of the third-generation (3G) iPod.
- Version 3.0 of the fourth-generation (4G) iPod.
- Version 1.0 of the iPod mini, fourth-generation iPod (color display), iPod nano, fifth-generation iPod (5G), second-generation iPod nano, iPod classic, and iPod 3G nano.
- Version 1.0.2 of the 4G nano.
- Version 1.1 of the iPhone, iPhone 3G, and iPod touch.
- Version 2.1.1 of the 2G iPod touch.
- Version 3.0.0 of the iPhone 3GS.

**Table I-1** iPod and iPhone products

| **3G iPod** | | |
|---|---|---|
|  | *Product name:* iPod (3rd generation) | *Shipped:* 04/2003 |
| | *Compatibility icons:*<br>**iPod** 3rd generation 10GB 15GB 20GB<br>**iPod** 3rd generation 30GB 40GB | |
| | *Connectivity:* Dock connector, headphone jack | |
| **iPod mini** | | |
|  | *Product name:* iPod mini | *Shipped:* 01/2004 |
| | *Compatibility icon:*<br>**iPod mini** 4GB 6GB | |
| | *Connectivity:* Dock connector, headphone jack | |
| **4G iPod** | | |
|   | *Product names:* iPod (4th generation), iPod photo, iPod photo (2nd generation), iPod 4th generation (color display) | *Shipped:* 07/2004, 09/2004, 02/2005, 06/2005 |
| | *Compatibility icons:*<br>**iPod** 4th generation 20GB<br>**iPod** 4th generation 40GB<br>**iPod** 4th generation (color display) 20GB 30GB<br>**iPod** 4th generation (color display) 40GB 60GB | |
| | *Connectivity:* Dock connector, headphone jack | |

| | | |
|---|---|---|
| **iPod nano** | | |
|  | *Product name:* iPod nano | *Shipped:* 09/2005 |
| | *Compatibility icon:*<br>iPod nano<br>1st generation<br>1GB 2GB 4GB | |
| | *Connectivity:* Dock connector, headphone jack | |
| **5G iPod** | | |
|  | *Product name:* iPod with video | *Shipped:* 10/2005 |
| | *Compatibility icons:*<br>iPod<br>5th generation (video)<br>30GB<br><br>iPod<br>5th generation (video)<br>60GB 80GB | |
| | *Connectivity:* Dock connector, headphone jack | |
| **2G nano** | | |
|  | *Product name:* iPod nano (2nd generation) | *Shipped:* 09/2006 |
| | *Compatibility icon:*<br>iPod nano<br>2nd generation (aluminum)<br>2GB 4GB 8GB | |
| | *Connectivity:* Dock connector, headphone jack | |
| **iPod classic, 120 GB classic, 160 GB classic** | | |
|  | *Product names:* iPod classic, iPod classic (120GB), iPod classic (160GB) | *Shipped:* 09/2007, 09/2008, 9/2009 |
| | *Compatibility icons:*<br>iPod classic<br>80GB<br><br>iPod classic<br>120GB<br><br>iPod classic<br>160GB (2007)<br><br>iPod classic<br>120GB 160GB (2009) | |
| | *Connectivity:* Dock connector, headphone jack | |

## 3G nano

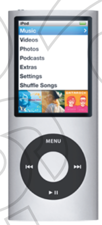
*Product name:* iPod nano (3rd generation) — *Shipped:* 09/2007

*Compatibility icon:*

iPod nano
3rd generation (video)
4GB 8GB

*Connectivity:* Dock connector, headphone jack

## 4G nano



*Product name:* iPod nano (4th generation) — *Shipped:* 09/2008

*Compatibility icon:*

iPod nano
4th generation (video)
8GB 16GB

*Connectivity:* Dock connector, microphone/headphone jack

## iPhone, iPhone 3G, iPhone 3GS

*Product names:* iPhone, iPhone 3G, iPhone 3GS — *Shipped:* 06/2007, 06/2008, 6/2009

*Compatibility icons:*

iPhone
4GB 8GB 16GB

iPhone 3G
8GB 16GB

iPhone 3GS
16GB 32GB

*Connectivity:* GSM, WiFi, Bluetooth, multi-touch display, dock connector, microphone/headphone jack

## iPod touch, 2G touch

*Product names:* iPod touch, iPod touch (2nd generation) — *Shipped:* 09/2007, 02/2008, 09/2008, 09/2009

*Compatibility icons:*

iPod touch
8GB 16GB 32GB

iPod touch
2nd generation
8GB 16GB 32GB 64GB

*Connectivity:* WiFi, Bluetooth, multi-touch display, dock connector, microphone/headphone jack

| 5G nano | | |
|---|---|---|
|  | *Product name:* iPod nano (5th generation) | *Shipped:* 09/2009 |
| | *Compatibility icon:*<br>**iPod nano**<br>5th generation (video camera)<br>8GB 16GB | |
| | *Connectivity:* Dock connector, microphone/headphone jack | |

## Organization of This Document

The specifications in this document are arranged in four chapters:

- "Protocol Features and Availability" (page 35) gives an overview of the General and accessory lingoes and their availability.
- "The Protocol Core and the General Lingo" (page 47) gives an overview of the iAP and describes the General Lingo, which all accessories must support.
- "Accessory Lingoes" (page 145) describes the various device-specific accessory lingoes that are part of the iAP and their commands.
- "The Extended Interface Protocol" (page 341) describes iAP Lingo 0x04, which allows the user interface of the iPod to be translated to other environments.

Several appendixes provide additional information for both hardware and software designers:

- "Accessory Identification" (page 445) specifies the Identify Device Preferences and Settings (IDPS) process which accessories identify themselves.
- "Transaction IDs" (page 451) describes the transaction ID parameters used by the Location lingo, the IDPS process, and multisection data transfers.
- "Multisection Data Transfers" (page 459) tells how to transfer amounts of data larger than the data receiver's maximum incoming packet size.
- "iTunes Tagging" (page 463) describes the iTunes tagging feature for HD and FM radio accessories.
- "Nike + iPod Cardio Equipment System" (page 495) describes the use of the Sports and Storage lingoes with Nike + iPod cardio equipment.
- "Historical Information" (page 517) provides specifications for past iPod models and iAP protocols.

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

## 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," "may," and "reserved" 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.

## See Also

For further information, refer to the latest revisions of these additional documents:

- *IEEE 1394a Specification*
- *USB 2.0 High Speed Specification*
- *USB Device Class Definition for Audio Devices*
- *USB Device Class Definition for Audio Data Formats*
- *USB Device Class Definition for Human Interface Devices (HID)*
- *United States RBDS Standard, NRSC-4-A*

# Protocol Features and Availability

Table 1-1 (page 35) lists the current firmware and iPhone OS versions for each iPod and iPhone model.

**Table 1-1** Current firmware and OS versions in iPod and iPhone models

| Model | Firmware version | Firmware revision date | iPhone OS version | OS revision date |
|---|---|---|---|---|
| iPod 3G[1] | 2.3 | 02/2005 | | |
| iPod mini | 1.4.1 | 01/2006 | | |
| 4G iPod | 3.1.1 | 01/2006 | | |
| 4G iPod (color display) | 1.2.1 | 01/2006 | | |
| 1G nano | 1.3.1 | 03/2007 | | |
| iPod 5G | 1.3 | 03/2008 | | |
| 2G nano | 1.1.3 | 05/2007 | | |
| iPod classic | 1.1.2 | 05/2008 | | |
| 3G nano | 1.1.3 | 07/2008 | | |
| iPod touch | | | 1.1.5 | 07/2008 |
| | | | 2.2.1 | 01/2009 |
| | | | 3.1.2 | 10/2009 |
| iPhone | | | 3.1.2 | 10/2009 |
| iPhone 3G | | | 3.1.2 | 10/2009 |
| 4G nano | 1.0.4 | 08/2009 | | |
| 120 GB classic | 2.0.3 | 09/2009 | | |
| 2G touch | | | 2.2.1 | 01/2009 |
| | | | 3.1.2 | 10/2009 |
| iPhone 3GS | | | 3.1.2 | 10/2009 |
| 160 GB classic | 2.0.3 | 09/2009 | | |
| 5G nano | 1.0.1 | 09/2009 | | |

Table 1-2 (page 36) and Table 1-3 (page 37) list the lingo protocol versions for each iPod model's most recent firmware and OS version. In these tables, "NL" indicates that the given lingo was not implemented in the specified model loaded with the specified firmware. "NV" indicates that although the lingo was implemented, its protocol version could not be read from the iPod.

**Table 1-2** Most recent iPod models, firmware, and lingo versions, Table 1

| iPod models | 3G [1] | mini | 4G | photo; 4G (color display) | 1G nano | 5G | 2G nano | classic | 3G nano | 1G touch |
|---|---|---|---|---|---|---|---|---|---|---|
| Most recent Firmware | 2.3 | 1.4.1 | 3.1.1 | 1.2.1 | 1.3.1 | 1.3 | 1.1.3 | 1.1.2 | 1.1.3 | 3.1.2 |
| Last Revision Date | 02/ 2005 | 01/ 2006 | 01/ 2006 | 01/ 2006 | 03/ 2007 | 03/ 2008 | 05/ 2007 | 05/ 2008 | 07/ 2008 | 10/ 2009 |
| Most recent lingo protocol versions | | | | | | | | | | |
| General 0x00 | NV | 1.02 | 1.02 | 1.02 | 1.05 | 1.06 | 1.06 | 1.07 | 1.07 | 1.09 |
| Microphone 0x01 | NV | NL | 1.00 | 1.00 | NL | 1.01 | 1.01 | 1.01 | 1.01 | 1.02 |
| Simple Remote 0x02 | NV | 1.00 | 1.00 | 1.00 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 |
| Display Remote 0x03 | NL | 1.01 | 1.01 | 1.01 | 1.05 | 1.05 | 1.04 | 1.05 | 1.05 | 1.05 |
| Extended Interface 0x04 | 1.02 | 1.05 | 1.05 | 1.09 | 1.11 | 1.12 | 1.10 | 1.13 | 1.13 | 1.12 |
| Accessory Power 0x05 | NL | 1.00 | 1.00 | 1.00 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 |
| USB Host Control 0x06 | NL | NL | NL | 1.00 | NL | 1.00 | NL | NL | NL | NL |
| RF Tuner 0x07 | NL | NL | NL | NL | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | NL |
| Accessory Equalizer 0x08 | NL | NL | NL | NL | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Sports 0x09 | NL | NL | NL | NL | NL | NL | NL | NL | 1.01 | NL |
| Digital Audio 0x0A | NL | NL | NL | NL | 1.01 | 1.01 | 1.02 | 1.03 | 1.03 | 1.02 |
| Storage 0x0C | NL | NL | NL | NL | NL | NL | NL | NL | 1.02 | 1.02 |
| Location 0x0E | NL | NL | NL | NL | NL | NL | NL | NL | NL | 1.00 |

[1] Supporting the 3G iPod requires special design considerations. See "Interfacing With the 3G iPod" in *iPod/iPhone Hardware Specifications*.

**Table 1-3** Most recent iPod/iPhone models, firmware, and lingo versions, Table 2

| iPod/iPhone models | iPhone | iPhone 3G | 4G nano | 120 GB classic | 2G touch | iPhone 3GS | 160 GB classic | 5G nano |
|---|---|---|---|---|---|---|---|---|
| Most recent Firmware | 3.1.2 | 3.1.2 | 1.0.4 | 2.0.1 | 3.1.2 | 3.1.2 | 2.0.3 | 1.0.1 |
| Last Revision Date | 10/2009 | 10/2009 | 08/2009 | 01/2009 | 10/2009 | 10/2009 | 09/2009 | 09/2009 |
| Most recent lingo protocol versions | | | | | | | | |
| General 0x00 | 1.09 | 1.09 | 1.08 | 1.08 | 1.09 | 1.09 | 1.08 | 1.08 |
| Microphone 0x01 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 |
| Simple Remote 0x02 | 1.02 | 1.02 | 1.04 | 1.03 | 1.02 | 1.02 | 1.03 | 1.04 |
| Display Remote 0x03 | 1.05 | 1.05 | 1.05 | 1.05 | 1.05 | 1.05 | 1.05 | 1.05 |
| Extended Interface 0x04 | 1.12 | 1.12 | 1.14 | 1.13 | 1.12 | 1.12 | 1.13 | 1.14 |
| Accessory Power 0x05 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 |
| USB Host Control 0x06 | NL | NL | NL | NL | NL | NL | NL | NL |
| RF Tuner 0x07 | NL | NL | 1.01 | 1.00 | NL | NL | 1.00 | 1.01 |
| Accessory Equalizer 0x08 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Sports 0x09 | NL | NL | 1.01 | NL | 1.01 | 1.01 | NL | 1.01 |
| Digital Audio 0x0A | 1.02 | 1.02 | 1.03 | 1.03 | 1.02 | 1.02 | 1.03 | 1.03 |
| Storage 0x0C | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 |
| Location 0x0E | 1.00 | 1.00 | NL | NL | 1.00 | 1.00 | NL | NL |

The accessory should determine what features an attached iPod supports by sending the General lingo command 0x4B, `GetiPodOptionsForLingo`. If the iPod does not support that command, the accessory must extract the lingo version number from the iPod. This protocol version information can be used to determine which features the connected iPod supports. See "Command 0x0F: RequestLingoProtocolVersion" (page 79) for information about the `RequestLingoProtocolVersion` command.

For past firmware versions, see Table F-1 (page 517). Table 1-4 (page 38) lists hardware and software features outside these protocols.

# General iPod Features

Table 1-4 (page 38) and Table 1-5 (page 39) list iPod/iPhone hardware and software features that are not part of specific lingoes. The numbers in the tables show the firmware versions in which each of these features was introduced.

**Table 1-4** Features supported by specific iPod firmware and OS versions, Table 1

| Features | Software versions | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 3G | mini | 4G | photo; 4G (color display) | nano | 5G | 2G nano | classic | 3G nano | 1G touch |
| Serial autobaud on framing errors | — | 1.4.0 | 3.1.0 | 1.1.0 | 1.0.0 | 1.0.0 | 1.0.0 | 1.0.0 | 1.0.0 | 1.1.0 |
| Display notification on unsupported iAP device attach | — | — | — | — | 1.0.0 | 1.0.0 | 1.0.0 | 1.0.0 | 1.0.0 | 1.1.0 |
| iPod detects detach for all valid $R_{ID}$ values | — | 1.4.0 | 3.1.0 | 1.2.0 | 1.0.0 | 1.0.0 | 1.0.0 | 1.0.0 | 1.0.0 | 1.1.0 |
| Authentication Version 1.00 | — | — | — | — | 1.0.0 | 1.0.0 | 1.0.0 | 1.0.0 | 1.0.0 | 1.1.0 |
| Authentication Version 2.00 | — | — | — | — | 1.2.0 | 1.2.0 | 1.0.0 | 1.0.0 | 1.0.0 | 1.1.0 |
| USB audio | — | — | — | — | 1.2.0 [1] | 1.2.0 | 1.1.2 | 1.0.0 | 1.0.0 | 1.1.0 |
| Video browsing[2] | — | — | — | — | — | 1.2.0 | — | 1.0.3 | 1.0.3 | 2.0.0 |
| iTunes tagging | — | — | — | — | — | 1.2.3 | — | 1.0.0 | 1.0.0 | 2.1.0 |
| Headphone remote[3] and mic system | — | — | — | — | — | — | — | — | — | — |
| Nike + iPod cardio equipment | — | — | — | — | — | — | — | — | 1.1.2 | — |
| Communication with iPhone OS applications | — | — | — | — | — | — | — | — | — | 3.0.0 |

**Table 1-5** Features supported by specific iPod/iPhone firmware and OS versions, Table 2

| Features | Software versions | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | iPhone | iPhone 3G | 4G nano | 120 GB classic | 2G touch | iPhone 3GS | 160 GB classic | 5G nano |
| Serial autobaud on framing errors | 2.1.0 | 2.1.0 | 1.02 | 2.0.0 | 2.1.1 | 3.0.0 | 2.0.3 | 1.0.1 |
| Display notification on unsupported iAP device attach | 2.1.0 | 2.1.0 | 1.02 | 2.0.0 | 2.1.1 | 3.0.0 | 2.0.3 | 1.0.1 |
| iPod detects detach for all valid $R_{ID}$ values | 2.1.0 | 2.1.0 | 1.02 | 2.0.0 | 2.1.1 | 3.0.0 | 2.0.3 | 1.0.1 |
| Authentication Version 1.00 | 2.1.0 | 2.1.0 | 1.02 | 2.0.0 | 2.1.1 | 3.0.0 | 2.0.3 | 1.0.1 |
| Authentication Version 2.00 | 2.1.0 | 2.1.0 | 1.02 | 2.0.0 | 2.1.1 | 3.0.0 | 2.0.3 | 1.0.1 |
| USB audio | 2.1.0 | 2.1.0 | 1.02 | 2.0.0 | 2.1.1 | 3.0.0 | 2.0.3 | 1.0.1 |
| Video browsing[2] | 2.1.0 | 2.1.0 | 1.02 | 2.0.0 | 2.1.1 | 3.0.0 | 2.0.3 | 1.0.1 |
| iTunes tagging | 2.1.0 | 2.1.0 | 1.02 | 2.0.0 | 2.1.1 | 3.0.0 | 2.0.3 | 1.0.1 |
| Headphone remote[3] and mic system | — | — | 1.02 | 2.0.0 | 2.1.1 | 3.0.0 | 2.0.3 | 1.0.1 |
| Nike + iPod cardio equipment | — | — | 1.02 | — | 2.1.1 | 3.0.0 | — | 1.0.1 |
| Communication with iPhone OS applications | 3.0.0 | 3.0.0 | — | — | 3.0.0 | 3.0.0 | — | — |

[1] Because version 1.00 of Lingo 0x0A contained a bug that was corrected in version 1.0.1, accessories should attempt Digital Audio only with iPods whose Lingo 0x0A version is higher than or equal to 1.0.1. See Table 3-218 (page 294).

[2] With iPod models that store and display video content (in addition to music), an accessory device may choose to navigate the iPod's hierarchy of stored videos. For details, see "Video Browsing" (page 358).

[3] In the headphone remote and mic system, remote control from the headphone is limited to volume +/– support.

# Accessory Power Policy

All accessories must comply with the power states of the iPod as specified in this section.

Accessories may draw 5 mA plus any current required by the Apple Authentication Coprocessor, up to the peak current drain specified in Apple's *iPod Authentication Coprocessor 2.0B Specification, Release R4*. They may draw this total current throughout the Authentication process, which begins at the rising edge of the Accessory Power line (pin 13 of the 30-pin connector) and ends 500 ms after the iPod sends the accessory an `AckDevAuthenticationStatus` command with a status of 0x00, Success (OK).

Accessories that declare Low Power during the identification process are limited to drawing 5 mA peak current from the Accessory Power line at all times except during authentication.

Accessories may register for software-controlled intermittent high power during the identification process. If the iPod sends an `AckDevAuthenticationStatus` command with a status of 0x00, they can draw up to 100 mA peak current from the Accessory Power line upon receipt of any one or more of the following iAP commands:

- Microphone lingo:
  - `iPodModeChange`: Begin audio recording mode
  - `iPodModeChange`: Begin audio playback mode
- Accessory Power lingo:
  - `BeginHighPower`
- RF Tuner lingo:
  - `SetTunerCtrl`: Turn RF tuner device power on
- General lingo (communicating with iPhone OS 3.0 applications):
  - `OpenDataSessionForProtocol`
- Location lingo:
  - `SetDevControl`: Accessory GPS radio power, Power on

Accessories must reduce their power consumption to no more than 5 mA within 1 second after all the commands that set high power are canceled by one or more of the following commands:

- Microphone lingo:
  - `iPodModeChange`: End audio recording mode
  - `iPodModeChange`: End audio playback mode
- Accessory Power lingo:
  - `EndHighPower`
- RF Tuner lingo:
  - `SetTunerCtrl`: Turn RF tuner device power off
- General lingo (communicating with iPhone OS 3.0 applications):
  - `CloseDataSession`

- Location lingo:
  - `SetDevControl`: Accessory GPS radio power, Power off

At all other times, accessories must comply with the 5 mA Low Power accessory rules.

Accessories may register for constant high power mode during the identification process if they power the iPod as a charger or battery pack using the method defined in "Supplying USB Power" in appendix "iPod Power States and Accessory Power" in *iPod/iPhone Hardware Specifications*. In this mode they may draw 100 mA continuously after the iPod sends an `AckDevAuthenticationStatus` command with a status of 0x00.

# Video Output Preferences

The iAP General lingo includes commands that let automotive head units and other accessories determine if the iPod supports video output, and if so, to control several video output preferences. All iPod models let an accessory control the video screen configuration and format. Newer iPods also let the user control the video output connection type, aspect ratio, closed caption enabling, and subtitle behavior, as shown in Table 1-6 (page 41).

**Table 1-6** Video output capabilities

| Capability | 5G iPod | iPod classic; 3G, 4G, and 5G nano | iPod touch, iPhone | 2G touch | iPhone 3G, iPhone 3GS |
|---|---|---|---|---|---|
| Widescreen signaling | No | Yes | No | | |
| Composite (interlaced) output | Yes | Yes | Yes | | |
| S-video (interlaced) output | Yes | Yes | Yes | | |
| Component (interlaced) output | No | No | Yes | No | |
| Component (progressive) output | No | Yes | No | Yes | |
| 4:3 fullscreen aspect ratio | Yes | Yes | Yes | | |
| 16:9 widescreen aspect ratio | No | Yes | Yes | | |
| Closed captioning | No | Yes | Yes | | |
| Subtitle display | No | Yes | No | | |
| Display resolution | 640 x 480 | NTSC: 720 x 480; | PAL: 720 x 576 | | |

An accessory can determine if the iPod supports video output by sending a `GetiPodOptionsForLingo` command. If the iPod does not support that command, the accessory may send a `GetiPodOptions` command. If the iPod returns an `ACK` command with a Bad Parameter status, or sends a `RetiPodOptions` command with the Video Option bit (bit 0) clear, the iPod does not support video. If the video option bit is set, the iPod at least supports video output, screen configuration, and video format preferences. The accessory can determine if the iPod supports other preferences by sending a `GetiPodPreferences` command for each preference. If the iPod returns an `ACK` command with Bad Parameter status, that preference is not supported (see "Command 0x29: GetiPodPreferences" (page 102)).

## Character Encoding

The iTunes application and all iPods and iPhones use Unicode UTF-8 encoding for tags and metadata. UTF-8 is compatible with the ASCII character set and supports other languages, including Chinese, Japanese, and Korean. It specifies unique encodings to represent all its supported character glyphs including the Roman alphabet and Han, Kanji, Kana, and Hangul characters. The UTF-8 format uses 1 to 4 bytes to represent each encoding; this means that a 5-character word can require from 5 to 20 bytes of storage. More information on Unicode and UTF-8 encoding can be found at http://www.unicode.org/.

Every accessory should decode UTF-8 characters. If the accessory is not capable of displaying certain Unicode character glyphs, a substitute glyph (such as an open square) should be displayed instead. Accessories should make provision to decode and render the curly apostrophe character (ASCII 0xD5), which occurs in all iTunes text.

## Accessory Control of the iPod touch and iPhone

Accessory developers must take into account these current limitations on the ability of accessories to control an iPod touch or iPhone.

- An accessory cannot navigate the home screen of an iPod touch or iPhone.
- An accessory cannot unlock an iPod touch or iPhone screen once it is locked.
- When the iPod touch or iPhone screen is locked, most iAP commands continue to operate, but some Simple Remote lingo commands (such as the menu, select, and arrow button controls) produce no visible effect.
- Accessories are responsible for adjusting video out settings if they are not entering or using the Extended Interface mode. If it needs to display video outside the display on an iPhone or iPod touch, the accessory should set the video out preference to On, or to Ask if it wants the user to be prompted. In Remote UI mode, the Ask preference defaults to On and no prompt appears.

## Accessory Communication With iPhone OS Applications

This section describes the communication process between accessories and the iPhone OS and specifies the iAP commands that an accessory can use to open and maintain communication with an iPhone OS application. For information about iAP command formats, see "Command Packet Formats" (page 58).

**Note:** Before it can communicate with any iPhone OS application, an accessory must be identified through the process described in "Accessory Identification" (page 445) and must authenticate itself using Authentication 2.0B, as described in "Authentication" (page 52). Using IDPS also requires enabling transaction IDs in iAP commands, as described in "Transaction IDs" (page 451).

The IDPS process lets an iPhone or iPod touch match its applications with its attached accessories, making it possible to open communication between them. Once an accessory has been identified and authenticated, the process described below can create a route for two-way data transmission between it and compatible iPhone OS applications.

The communication process between an iPhone or iPod touch accessory and an iPhone OS application requires both accessory iAP commands and application programming. The iAP side of the process is described in this section. For iPhone OS programming information, visit developer.apple.com/iphone/program.

## Setting Up a Communication Session

To communicate with an iPhone OS application, an accessory must first expose certain protocol identifiers by sending `protocolString` values to the iPod or iPhone; see Table 2-78 (page 114). This information is used to establish communication channels to the application. The accessory must also send an Apple-assigned `BundleSeedIDString` value, as shown in Table 2-79 (page 115). This string identifies the accessory's preferred application. The Bundle Seed ID string is assigned to the application developer through the iPhone Developer Program, as part of the application development process. For further information, see "Managing Devices" in *iPhone Development Guide*, available at http://developer.apple.com/iphone. The accessory sends the `BundleSeedIDString` value as part of its startup identification, as described in "Accessory Identification" (page 445).

The design and maintenance of communication protocols between accessories and applications are entirely the responsibility of the developers of these products. Apple makes no attempt to secure protocol name space or provide for communication security between accessories and applications. Protocol names must be in reverse-DNS format and must be associated with domains that are registered with the Internet Corporation for Assigned Names and Numbers (ICANN), so that Apple can rely on each protocol having a unique owner. Apple does not require a developer to be the owner of the domain name used, but will require (by self-certification) that the developer has permission to use the domain name for the protocol. For suggestions on protocol design, see "Protocol Design Hints" (page 45).

When an iPhone OS application requests access to an accessory, the iPhone or iPod touch sends it an `OpenDataSessionForProtocol` command. As a part of this notification, `sessionID` and `protocolIndex` values are sent to the accessory, so it can identify incoming iAP commands for this session. A session ID is included in all iAP data transfer commands, so that multiple sessions may run concurrently. The accessory should accept the connection with a `DevACK` response.

When the application has finished with the accessory, or the iPhone or iPod touch has determined that communication is no longer needed, a `CloseDataSession` command is sent to the accessory. The accessory must cease communication through the `sessionID` that was just closed. At this time the accessory can implement any power-saving features it may have.

## Data Flow from the iPod or iPhone

The iAP command `iPodDataTransfer` is used to communicate information to the accessory from the application and `DevDataTransfer` to communicate information to the application from the accessory. Both iAP commands contain a `sessionID` parameter to identify which channel they are traveling through. The message delivery order is first in, first out. End-to-end delivery of data is normally reliable, but not absolutely guaranteed, so developer protocols must be designed to recover from loss of data. For information about iAP transport links, see "Protocol Transport Links" in *iPod/iPhone Hardware Specifications*.

During a communication session, the following rules apply to `iPodDataTransfer` commands:

- The iPod will send an initial `iPodDataTransfer` packet when an application has placed data into the accessory's input queue.
- Upon receiving an acknowledgment of an `iPodDataTransfer` command, the iPod may immediately send a new command containing available data for any session ID.
- The accessory's acknowledgment of an `iPodDataTransfer` command with Success status (0x00) must signify that the packet has been received, it has been moved out of the accessory's lowest-level receive queue, and that the accessory is ready to receive another packet.
- The only circumstance under which an accessory may acknowledge an `iPodDataTransfer` command with a nonzero status is if no prior `OpenDataSessionForProtocol` command has established the command's session ID. In this case it must send a Bad Parameter (0x04) status, and the iPod may close the session.
- If an `iPodDataTransfer` command is acknowledged with an error status, the iPod may optionally purge its outbound packet queue of all pending `iPodDataTransfer` packets for that session ID. The iPod will not otherwise discard any data in a session.
- If an accessory's data receive queue cannot accept another packet, then the accessory must not acknowledge the `iPodDataTransfer` command until packet acceptance is restored. This may cause the iPod to retry the `iPodDataTransfer` command up to ten times. If the iPod receives no acknowledgment after the tenth retry, it may close the session.
- If a 500 ms timeout occurs before an `iPodDataTransfer` command is acknowledged, the iPod will resend the same packet with the same transaction ID.

During a communication session, the following rules apply to `DevDataTransfer` commands:

- The accessory should send a `DevDataTransfer` command whenever it has data it wants to stream to an application with an open session.
- The accessory must not send another `DevDataTransfer` packet until the previous one has been acknowledged (as successful or not) or a 500 ms timeout has expired.
- Upon receiving an acknowledgment of a `DevDataTransfer` command, the accessory may immediately send a new command containing available data for any session ID.
- If a 500 ms timeout occurs before a `DevDataTransfer` command is acknowledged, the accessory may resend the same packet with the same transaction ID.
- If the accessory receives an `iPodNotification` command for flow control, it must not send any packets (including retries of `DevDataTransfer` packets) during the specified waiting time. For information about iPod notification commands, see iPod Event Notifications (page 449).

## Matching Accessories With Applications

The iPhone or iPod touch matches applications and accessories by using the preferences and protocol names communicated by the accessory during its IDPS session. If the accessory names multiple protocols, it will be deemed compatible with an application if the application supports at least one of them. In addition, the accessory's `BundleSeedIDString` value is used to identify preferred or default applications.

A `BundleSeedIDString` is required to properly pair the accessory to its preferred or default application on the iPhone OS device. The application must be submitted to Apple as part of the accessory certification process. Apple assigns a Bundle seed ID value to the application developer, who provides this information to the accessory developer for inclusion in the accessory's firmware.

## Communication Protocol Design Hints

The owner or creator of a protocol for communication between accessories and iPhone OS applications must define the preferences that are required or optional. Each accessory and application must then negotiate their level of compatibility directly. Apple does not referee protocols, and protocol creators must ensure that their accessories and applications can verify that they support the same features. The following suggestions can help with protocol design:

- Ensure that the accessory can always resynchronize its data stream in the event of an error.
- The round-trip latency of commands may vary; do not draw inferences from propagation times. There is no guarantee of delivery timing over the communication link.
- After a connection has been established, clearly establish which end speaks first.
- Begin communication with an exchange of meta-information, such as confirmation of the protocol and version. Give both ends the opportunity to declare that they cannot proceed due to protocol incompatibilities.
- Ensure that the transaction order is clear and that both ends know their position in it. Packets within each stream are guaranteed to be ordered but not free of gaps between packets, so ensure that the stream can be resynchronized after a gap.
- Ensure that responses can always be matched to their corresponding requests. The simplest forms of reliable communication are call and response. Interleaved communication streams are more complicated and less desirable.
- Establish an unambiguous indicator of the start of each packet.
- Add security where needed, but recognize that it slows down and complicates each transaction.
- Ensure that the other end of each transaction has both received and understood the last packet.
- Ensure that each packet is received intact and error free by adding a CRC value, checksum, or the like.
- Ensure that incoming data can be cached until it can be processed.
- Try to make the protocol extensible for future needs.

## Communication iAP Commands

The General lingo commands that support iPhone OS applications communicating with accessories are listed in Table 1-7 (page 46) and documented in detail in "Lingo 0x00: General Lingo" (page 60). All commands are protocol version 1.09 and require authentication 2.0B.

**Table 1-7** Accessory communication commands

| CmdID | Name | Direction | Payload:bytes |
|---|---|---|---|
| 0x3F | `OpenDataSession-ForProtocol` | iPod to Dev | `{transID;2, sessionID;2, protocolIndex;1}` |
| 0x40 | `CloseDataSession` | iPod to Dev | `{transID;2, sessionID;2}` |
| 0x41 | `DevACK` | Dev to iPod | `{transID;2, ackStatus;1, cmdID;1}` |
| 0x42 | `DevDataTransfer` | Dev to iPod | `{transID;2, sessionID;2, data;<var>}` |
| 0x43 | `iPodDataTransfer` | iPod to Dev | `{transID;2, sessionID;2, data;<var>}` |
| 0x4A | `iPodNotification` | iPod to Dev | `{transID;2, notificationType;1, waitTime;4, overflowTransID;2}` |

**Note:** The `transID` parameters in the foregoing table are described in "Transaction IDs" (page 451).

# The Protocol Core and the General Lingo

This chapter covers the basics of the iPod Accessory Protocol (iAP), including accessory identification and authentication. It also describes the packet format used for iAP command and gives detailed descriptions of the commands included in the General lingo.

The iAP is used for both directions of a link, so every device must implement both sending and receiving capabilities. It should be possible to determine the direction (device to iPod or iPod to device) of a packet only from its contents. This means that no packet is valid for sending from both the iPod and the device.

All devices must be able to handle variable-length packets. An accessory must be able to accept a packet with extra data and ignore the unexpected bytes. At a minimum, the device must not lose sync to the packet signaling.

Most command packets generate a response, either an `ACK` command or a packet with data answering a query. Accessories should wait for the response before querying to see if the original request has been processed by the iPod. In the Display Remote lingo, for example, when an accessory sends a `GetiPodStateInfo` command it should wait for the iPod to return the corresponding `RetiPodStateInfo` (or `ACK`) command before sending a subsequent `GetPlayStatus` command.

**Note:** Unless otherwise stated in this specification, an accessory should wait 3 seconds for the iPod to respond before retrying a command. The absolute minimum for any accessory-generated retry is 500 ms for all lingoes except the Extended Interface lingo, in which the minimum is 1 second. Some special timeout rules apply to the IDPS process; see "Accessory Identification" (page 445).

## Reserved Commands and Data

From time to time an iPod or iPhone may send an attached accessory a command that is reserved and not documented in this specification, or a documented command that has reserved data in its payload. Accessories must follow these rules when handling such reserved commands or data:

- When a data field is marked "Reserved" in this specification, accessories writing to it must set it to 0 and accessories reading it must ignore its value. The only exception is byte 9 of the `RetTunerCaps` packet shown in Table 3-99 (page 226), which must be set to 0x01.
- If an accessory receives a command documented in this specification that passes reserved data, it must acknowledge successful receipt of the command, extract the data in it that is documented, and ignore the reserved data.
- If an accessory receives a command not documented in this specification, it should ignore it. Alternatively, it may return a General lingo `ACK` command with a value of 0x04 (Bad Parameter) to prevent the iPod from waiting for a timeout period to receive a reply.

# Device Signaling and Initialization

When attached, the accessory must detect the iPod and initiate the identification process. This section describes the initialization process for both the UART serial port link and the USB port link.

## Packet Signaling and Initialization Using the UART Serial Port Link

When using the UART serial port link, the identification process starts when the accessory detects accessory power. The accessory must wait at least 80 ms and then transmit a sync byte. After sending the sync byte, the accessory must wait another 20 ms before starting the IDPS identification process.

**IMPORTANT:** To identify an accessory to an attached iPod or iPhone, before authentication, new accessory designs must use the Identify Device Preferences and Settings (IDPS) process described in Appendix B, "Accessory Identification" (page 445). This process ensures their compatibility with future firmware. Existing accessory designs may continue to send the iAP General lingo command 0x13, `IdentifyDeviceLingoes`, identifying the lingoes they support and requesting immediate authentication. Accessories that need to support the 3G iPod must use the command described in "General Lingo Command 0x01: Identify (Deprecated)" (page 523).

The IDPS accessory identification process begins when the accessory sends "Command 0x38: StartIDPS" (page 108) to the attached iPod. If the iPod does not respond, the accessory may resend `StartIDPS` command as long as iPod Detect (pin 30) is low and Accessory Power (pin 13) is high; see “Hardware Interfaces” in *iPod/iPhone Hardware Specifications.* The accessory must not retry IDPS identification more often than once per second. For 3G iPod support, see “Interfacing With the 3G iPod” in *iPod/iPhone Hardware Specifications*.

If the iPod refuses the `StartIDPS` command by returning a General lingo `ACK` command with a status of 0x04 (Bad Parameter), the accessory must assume it is connected to an iPod that doesn’t support the IDPS process. In this case, the accessory must send an `IdentifyDeviceLingoes` command, requesting authentication, within 800 ms.

Table 2-1 (page 48) shows the command traffic for device identification and authentication when using the UART serial port link.

**Note:** Accessory identification and authentication may take place over any of the iPod’s transport links—UART, USB, or Bluetooth. If the process fails, the iPod displays a "Accessory not supported" message to the user.

**Table 2-1** Command traffic for UART accessory identification

| Step | Action or command | Direction | Comments |
|---|---|---|---|
| 1 | Wait 80 ms after the iPod turns on Accessory Power (pin 13 in “Hardware Interfaces” in *iPod/iPhone Hardware Specifications*) | Device | Wait for the iPod’s internal bootstrap and wakeup. If the iPod is in Sleep mode, the accessory must repeat Steps 1-5 until the iPod wakes and the accessory receives an `ACK` command. |
| 2 | Send sync byte (0xFF) | Device to iPod | Allow iPod to synchronize to the device’s baud rate. |

<table>
<tr><th>Step</th><th>Action or command</th><th>Direction</th><th>Comments</th></tr>
<tr><td>3</td><td>Wait 20 ms</td><td>Device</td><td></td></tr>
<tr><td>4</td><td>StartIDPS (0x38)</td><td>Device to iPod</td><td>The accessory sends StartIDPS to start the identification process specified in "Accessory Identification" (page 445).</td></tr>
<tr><td>5</td><td>Wait up to 1 second</td><td>Device</td><td>The device waits for the iPod to send an ACK command acknowledging receipt of StartIDPS.</td></tr>
<tr><td>6</td><td>ACK (0x02) of StartIDPS</td><td>iPod to Device</td><td>The iPod sends a status of 0x00 (OK) to acknowledge receipt of the StartIDPS command.</td></tr>
<tr><td colspan="4">If the ACK reply to StartIDPS returns a status of 0x00, the accessory proceeds to Step 7. Otherwise,<br>■ If the accessory receives no ACK command within 1 second, it may retry Step 1 at 1-second intervals as long as iPod Detect (pin 30 of the 30-pin connector) is low and Accessory Power (pin 13) is high. Accessories that don't monitor these signals (such as Bluetooth accessories or USB accessories without a 191 kΩ ID resistor) may retry without checking them.<br>■ If the accessory receives an ACK status of 0x04 (Bad Parameter), the iPod does not support IDPS. Within 800 ms the accessory must send an IdentifyDeviceLingoes command with its lingo mask set for only the General lingo, with no options, and with a Device ID of 0x0. See "Cancelling a Current Authentication Process With IdentifyDeviceLingoes" (page 83). A sample command sequence is listed in Table F-22 (page 532).<br>■ If the accessory receives any other nonzero ACK status, it must not send any more iAP commands until it has been disconnected. Upon reconnection it must restart identification at Step 1.</td></tr>
<tr><td>7</td><td>SetFIDTokenValues (0x39)</td><td>Device to iPod</td><td>The accessory sends the iPod a collection of tokens that provide information about it; see "Command 0x39: SetFIDTokenValues" (page 109).</td></tr>
<tr><td>8</td><td>RetFIDTokenValueACKs (0x3A)</td><td>iPod to Device</td><td>The iPod acknowledges receipt of the tokens sent by the SetFIDTokenValues command.</td></tr>
<tr><td>9</td><td>EndIDPS (0x3B)</td><td>Device to iPod</td><td>The accessory terminates the IDPS process, passing an accEndIDPSStatus value of 0x00 to ask the iPod to continue with authentication; see "Command 0x3B: EndIDPS" (page 119).</td></tr>
</table>

| Step | Action or command | Direction | Comments |
|---|---|---|---|
| 10 | `IDPSStatus` (0x3C) | iPod to Device | The iPod acknowledges receipt of `EndIDPS` and passes a `status` value of 0x00 to indicate that it has received all required tokens and that authentication will proceed; see "Command 0x3C: IDPSStatus" (page 120). |
| The iPod or iPhone now initiates the authentication process by sending a `GetDevAuthenticationInfo` command to the accessory, as shown in Table 2-5 (page 55). | | | |

A device must reidentify itself if it receives a "Command 0x00: RequestIdentify" (page 64) command from the iPod.

Once accessory packet transmission has begun, the maximum time between transmitted data bytes is 25 milliseconds. If the inter-character delay exceeds 25 ms, the iPod discards any packet characters already received, plus any remaining characters received received before the start of the next valid packet. The iPod may exceed the 25 ms inter-character timing requirement in its outgoing packets when under heavy system load situations.

One known limitation exists when waking an iPod from Sleep mode: the iPod UART is not available for the first few milliseconds after waking from Sleep. If an external device sends a packet to the iPod while it is asleep, the first packet will be lost. Accessories must follow the steps below to wake an iPod and ensure that the first packet is not lost:

1. Send a sync byte; this should wake the iPod.
2. Wait for 20 ms.
3. Send the command packet with sync byte.

> **Note:** Supporting the 3G iPod requires special design considerations. See “Interfacing With the 3G iPod” in *iPod/iPhone Hardware Specifications*.

## iAP Signaling and Initialization Using the USB or BT Port Link

When using iAP over USB, initialization involves the USB host detecting the attached iPod and setting its iUI configuration. Upon completion of this process, the host may send General lingo iAP commands to the iPod using the USB HID interface. USB host access to the iAP accessory lingoes is enabled only after the host has identified itself and been authenticated by the iPod. Before authentication, only a subset of the General lingo commands are available, as shown in Table 2-4 (page 54).

To use iAP over Bluetooth, the accessory must first establish an RFCOMM protocol session with the iPod. While the session is active, the host may send General lingo iAP commands to the iPod using the RFCOMM channel. Access to the iAP accessory lingoes over BT is enabled only after the accessory has identified itself and been authenticated by the iPod. Before authentication, only a subset of the General lingo commands are available, as shown in Table 2-4 (page 54).

To identify an accessory to an iPod or iPhone, using USB or BT, new accessory designs must use the Identify Device Preferences and Settings (IDPS) process described in Appendix B, "Accessory Identification" (page 445). This process ensures their compatibility with future firmware. A sample command sequence is shown in Table 2-2 (page 51). Existing accessory designs may continue to send the iAP General lingo command 0x13, `IdentifyDeviceLingoes`, identifying the lingoes they support and requesting immediate authentication.

**Table 2-2** Commands for accessory identification via USB or BT

| Step | Action or command | Direction | Comments |
|---|---|---|---|
| 1 | `StartIDPS` (0x38) | Device to iPod | The accessory sends `StartIDPS` to start the identification process specified in "Accessory Identification" (page 445). |
| 2 | Wait up to 1 second | Device | The device waits for the iPod to send an `ACK` command acknowledging receipt of `StartIDPS`. |
| 3 | `ACK` (0x02) of `StartIDPS` | iPod to Device | The iPod sends a status of 0x00 (OK) to acknowledge receipt of the `StartIDPS` command. |
| If the `ACK` reply to `StartIDPS` returns a status of 0x00, the accessory proceeds to Step 4. Otherwise,<br>■ If the accessory receives no `ACK` command within 1 second, it may retry Step 1 at 1-second intervals as long as iPod Detect (pin 30 of the 30-pin connector) is low and Accessory Power (pin 13) is high. Accessories that don't monitor these signals (such as Bluetooth accessories or USB accessories without a 191 kΩ ID resistor) may retry without checking them.<br>■ If the accessory receives an `ACK` status of 0x04 (Bad Parameter), the iPod does not support IDPS. Within 800 ms the accessory must send an `IdentifyDeviceLingoes` command with its lingo mask set for only the General lingo, with no options, and with a Device ID of 0x0. See "Cancelling a Current Authentication Process With IdentifyDeviceLingoes" (page 83). A sample command sequence is listed in Table F-23 (page 534).<br>■ If the accessory receives any other nonzero `ACK` status, it must not send any more iAP commands until it has been disconnected. Upon reconnection it must restart identification at Step 1. | | | |
| 4 | `SetFIDTokenValues` (0x39) | Device to iPod | The accessory sends the iPod a collection of tokens that provide information about it; see "Command 0x39: SetFIDTokenValues" (page 109). |
| 5 | `RetFIDTokenValueACKs` (0x3A) | iPod to Device | The iPod acknowledges receipt of the tokens sent by the `SetFIDTokenValues` command. |

| Step | Action or command | Direction | Comments |
|---|---|---|---|
| 6 | EndIDPS (0x3B) | Device to iPod | The accessory terminates the IDPS process, passing an accEndIDPSStatus value of 0x00 to ask the iPod to continue with authentication; see "Command 0x3B: EndIDPS" (page 119). |
| 7 | IDPSStatus (0x3C) | iPod to Device | The iPod acknowledges receipt of EndIDPS and passes a status value of 0x00 to indicate that it has received all required tokens and that authentication will proceed; see "Command 0x3C: IDPSStatus" (page 120). |
| The iPod or iPhone now initiates the authentication process by sending a GetDevAuthenticationInfo command to the accessory, as shown in Table 2-5 (page 55). | | | |

In addition to identifying itself at plug-in, a host may need to reidentify during an iAP session if the iPod so requests. If the host receives "Command 0x00: RequestIdentify" (page 64), it must send a StartIDPS command and repeat the IDPS and authentication processes. USB hosts do not have to reconfigure iUI when responding to the RequestIdentify command from the iPod.

**Note:** An accessory that is newly connected to a sleeping or hibernating iPod cannot expect an immediate response. If it uses wired transport, the accessory should wait for the iPod to turn on Accessory Power. If it uses Bluetooth or is unsuccessful the first time, it should retry the StartIDPS command every 1 sec until it gets a response.

# Authentication

Authentication is a mechanism used by the iPod to verify whether an attached device is an authorized accessory and by an accessory to authenticate the iPod, if desired. Certain functionality on the iPod is accessible only after a device has been authenticated as an authorized accessory. This functionality is summarized in Table 2-4 (page 54) and includes the use of any accessory lingo command over the USB or BT transport.

The limited set of General lingo commands listed in Table 2-4 (page 54) as requiring no authentication are free over USB and BT. After the device identification process, authentication may be independently initiated from either the iPod or the device. In the identify and authentication sequences, the accessory should check the ACK status for all commands. If a failure status is returned, the process has failed and should be retried and/or abandoned.

**Note:** To participate in the authentication process, an accessory device must contain an authentication coprocessor provided by Apple.

## Levels of Device Authentication

iAP supports three levels of security in the process by which an iPod may authenticate an accessory device connected to it:

- **None.** Older iPod models through the iPod mini do not support authentication. They operate freely with simple accessories that do not require authentication, but they cannot work with newer or more sophisticated accessories whose range of functionality requires authentication. For details, see “Functional Description” in *iPod/iPhone Hardware Specifications*.
- **Authentication 1.0.** Version 1.0 authentication is based on public and private keys, where each accessory has a private key and every iPod has the associated public key. The accessory authentication process is a part of the iAP General lingo (0x00) command protocol and is controlled by the iPod internal software. Devices identify themselves to the iPod as speaking specific lingoes and supporting authentication. iAP queries the device’s authentication information, sends a challenge to the device, and verifies that the device responds to the challenge correctly.
- **Authentication 2.0.** Version 2.0 authentication is based on standard X.509 Version 3 certificates. Information about this standard can be found at the IETF website: http://tools.ietf.org/html/rfc3280. Each certificate is generated and signed by a recognized certificate authority (CA) and has a unique serial number. Authentication 2.0 uses certificate classes to identify the type of accessory being authenticated, as shown in Table 2-3 (page 53).

**IMPORTANT:** Current iPod models support Authentication 1.0, as shown in "Authentication 1.0 Sample Command Sequence" (page 531), only as a legacy technology, to make them compatible with existing accessory devices. All new accessory designs must use Authentication 2.0.

**Table 2-3** iPod and iPhone authentication coprocessor classes

| iPod Class ID | iPhone Class ID | Description |
|---|---|---|
| 1 | 4 | Automotive use only; enables all authenticated features. |
| 2 | 5 | Nonautomotive use only; enables all authenticated features except the Digital Audio lingo. **Deprecated; do not use in new products.** |
| 3 | 6 | Nonautomotive use only; enables all authenticated features. |

## Authentication Requirements

Because device authentication can take a significant amount of time (up to 75 seconds for Authentication 2.0A), it is performed as a background process. The process starts when the iPod or iPhone sends a `GetDevAuthenticationInfo` command to the device. The device must respond by transmitting its entire `RetDevAuthenticationInfo` command within 1.00 seconds for Authentication 1.0 or 2.00 seconds for Authentication 2.0, including the transmission of all sections of its certificate. When the iPod or iPhone transmits a `GetDevAuthenticationSignature` command, the device must transmit its `RetDevAuthenticationSignature` response within 7.00 seconds for Authentication 1.0, 65.00 seconds for Authentication 2.0A, or 2.00 seconds for Authentication 2.0B.

All lingo-authenticated commands and features are available to accessories once the iPod has sent the device an `AckDevAuthenticationInfo` command with success status (0x00). This provisional authentication lasts until the iPod sends a `AckDevAuthenticationStatus` command indicating that authentication has finished. The lingo command availability will be revoked if the authentication process fails, the device reidentifies without authentication, the iPod sleeps or powers on, or the device is detached from the iPod. The iPod starts both a timer and a retry counter to guarantee that the authentication process will conclude.

**Table 2-4** Lingo commands requiring authentication

| Lingoes | UART port link | USB port link | BT port link |
|---|---|---|---|
| Lingo 0x00: General | No (0x00-0x19, 0x23-0x28, 0x38-0x39, 0x3B)<br>Yes (0x1A-0x1F, 0x29-0x4C[1]) | | |
| Lingo 0x01: Microphone | No (0x00–0x03)<br>Yes (0x04–0x0B) | Yes | N/A |
| Lingo 0x02: Simple Remote | No (0x00)<br>Yes (0x01–0x04) | Yes | N/A |
| Lingo 0x03: Display Remote | No (0x00–0x07; 0x1A–0x1E)<br>Yes (0x08–0x19; 0x1F–0x20) | Yes | N/A |
| Lingo 0x04: Extended Interface | No (0x0000–0x003A)<br>Yes (0x003B-0x0043) | Yes | N/A |
| Lingo 0x05: Accessory Power | No | Yes | N/A |
| Lingo 0x06: USB Host Control | Yes | N/A | N/A |
| Lingo 0x07: RF Tuner | Yes | Yes | N/A |
| Lingo 0x08: Accessory Equalizer | Yes | Yes | N/A |
| Lingo 0x09: Sports | Yes | Yes | Yes |
| Lingo 0x0A: Digital Audio | Yes | Yes | N/A |
| Lingo 0x0B: Reserved | N/A | N/A | N/A |
| Lingo 0x0C: Storage | Yes | Yes | Yes |
| Lingo 0x0D: Reserved | N/A | N/A | N/A |
| Lingo 0x0E: Location | Yes | Yes | Yes |
| Lingoes 0x0F–0x1F: Reserved | N/A | N/A | N/A |

[1] Preference commands (0x29-0x4C) require authentication on all iPods and iPhones except the 5G iPod; however, getting or setting the line-out preference class (0x03) does not require authentication. Commands 0x42 (`DevDataTransfer`) and 0x43 (`iPodDataTransfer`) are not available until authentication has finished.

## iPod Authentication of the Accessory

The process of authenticating the device is initiated by the iPod, based on the settings made in the IDPS process. The authentication options also allow a device to request authentication of an iPod, as described in "Device Authentication of iPod" (page 57).

> **IMPORTANT:** The device must send the iPod a `StartIDPS` command (or `Identify` if it must support the 3G iPod) before it tries to send any other iAP commands.

Table 2-5 (page 55) summarizes the authentication process, using Authentication 2.0. This is the authentication process that all new devices should use. Steps 4 and 5 are necessary only if the accessory is unable to use the IDPS process and is initializing using `IdentifyDeviceLingoes`.

**Table 2-5** Command traffic for accessory authentication

| Step | Action or command | Direction | Comments |
| --- | --- | --- | --- |
| 1 | `GetDevAuthenticationInfo` (0x14) | iPod to Device | The iPod requests accessory authentication information and starts its timeout timer. |
| 2 | `RetDevAuthenticationInfo` (0x15) | Device to iPod | The accessory returns its major and minor authentication version and its X.509 public certificate (see Note 1, below). |
| 3 | `AckDevAuthenticationInfo` (0x16) | iPod to Device | The iPod assembles and checks the accessory's X.509 certificate. If it does not support the authentication version, or if the certificate check fails, the iPod sends a value of 0x08 to the accessory (see Note 2, below). |
| All lingo-authenticated commands are enabled after the authentication version is validated, the lingoes requested by the device are checked against the lingoes allowed by the X.509 certificate, and the certificate has been verified (see Note 3, below). | | | |
| 4 (non-IDPS only) | `GetAccessoryInfo` (0x27) | iPod to Device | The iPod queries the accessory for information about it. |
| 5 (non-IDPS only) | `RetAccessoryInfo` (0x28) | Device to iPod | The accessory returns information about its identity and capabilities. |
| 6 | `GetDevAuthenticationSignature` (0x17) | iPod to Device | The iPod sends a 20-byte random challenge to the accessory and asks it to calculate a digital signature. |

| Step | Action or command | Direction | Comments |
|---|---|---|---|
| 7 | `RetDevAuthentication-Signature` (0x18) | Device to iPod | The accessory returns its digital signature to the iPod within 2 seconds (Authentication 2.0B) or 75 seconds (Authentication 2.0A). |
| 8 | `AckDevAuthentication-Status` (0x19) | iPod to Device | The iPod verifies the signature, using the public key contained in the accessory's X.509 certificate, and returns the status of signature verification. |

**Notes:**

1. Not more than 500 certificate bytes may be sent at once. If the X.509 certificate is larger than 500 bytes, the device must divide it into sections, each not larger than 500 bytes, for reassembly by the iPod. The iPod will send a General lingo `ACK` command for each certificate section up to, but not including, the last one. The accessory must wait for the `ACK` command before sending the next certificate section in a `RetDevAuthenticationInfo` packet.
2. The final certificate section is acknowledged by an `AckDevAuthenticationInfo` command.
3. The iPod parses the X.509 certificate into an allowed lingoes mask. It uses the mask to confirm that the device's identified lingoes are allowed by the certificate. If the device requests lingoes not allowed by the certificate, authentication fails. The iPod also verifies that the certificate is valid.

The iPod and the accessory can perform noncritical operations while background authentication is in progress. The command timeout counter and retry counter are not reset until authentication is complete or has failed.

**Note:** iPod-powered accessories are allowed to draw up to 15 mA current during the Authentication process. This time period begins when the accessory receives a `GetDevAuthenticationInfo` command from the iPod and ends 500 ms after it receives a successful `AckDevAuthenticationStatus` command.

Some lingoes requested by a device (such as the General, Accessory Equalizer, and Sports lingoes) cause the iPod to request accessory information after it sends the `AckDevAuthenticationInfo` command. Accessories should be able to handle both authentication requests and asynchronous information requests from the iPod during the authentication process.

With IDPS all iPod preferences are set before authentication. Accessories that must use `IdentifyDeviceLingoes` should set any iPod preferences that do not require authentication within 2 seconds of receiving the `ACK` reply to `IdentifyDeviceLingoes`, and set iPod preferences that require authentication within 2 seconds of receiving the `AckDevAuthenticationInfo` command.

**IMPORTANT:** If the device is disconnected during the authentication process, or if authentication does not finish for other reasons, the iPod may refuse to recognize the device for several minutes. With the IDPS process, the first command issued should be `StartIDPS`. This will clear the iPod's state and allow normal identification and authentication to occur. If the iPod does not support IDPS and the accessory's mode of use is such that it might be disconnected and then reconnected during the authentication process, then the device should send the iPod an `IdentifyDeviceLingoes` command with the No Authentication option (see Table 2-34 (page 83)) as its first command every time it is connected. This would cancel any authentication process that might already be running in the iPod from a previous device attachment.

The device may ignore `GetAccessoryInfo` commands from the iPod until it sends a second `IdentifyDeviceLingoes` command with actual lingo information.

If the iPod fails to authenticate the device at any point in the Authentication 1.0 or 2.0 process, and the retry count is exhausted, the iPod may display a"Device Not Supported"message to the user.

## Device Authentication of iPod

The accessory can initiate a process to authenticate the iPod, any time after it has been authenticated by the iPod. This process is summarized in Table 2-6 (page 57). See "General Lingo Command Summary" (page 60) for information on the individual commands.

**Note:** Device authentication of the iPod is currently supported only for Authentication 2.0.

**Table 2-6** Accessory authentication of the iPod

| Step | Action or command | Direction | Comments |
|---|---|---|---|
| 1 | `GetiPodAuthenticationInfo` (0x1A) | Device to iPod | The accessory requests information to authenticate the iPod. |
| 2 | `RetiPodAuthenticationInfo` (0x1B) | iPod to Device | The iPod returns its major and minor authentication version and its X.509 public certificate (see Note, below). |
| 3 | `AckiPodAuthenticationInfo` (0x1C) | Device to iPod | The accessory assembles and checks the iPod's X.509 certificate. If the accessory does not support the authentication version, or if the certificate check fails, it returns an error status. |
| 4 | `GetiPodAuthenticationSignature` (0x1D) | Device to iPod | The accessory sends a 20-byte random challenge to the iPod and asks it to calculate a digital signature. |
| 5 | `RetiPodAuthenticationSignature` (0x1E) | iPod to Device | The iPod returns its digital signature to the accessory within 75 seconds. The accessory verifies the signature, using the public key contained in the iPod's X.509 certificate. If verification succeeds, the accessory begins to operate. |
| 6 | `AckiPodAuthenticationStatus` (0x1F) | Device to iPod | The accessory returns the status of the digital signature comparison. |

**Note:**

1. The iPod's X.509 certificate is sent in a PKCS-7 message containing only the certificate, encoded in DER format. See the IETF document RFC 2311, "S/MIME Version 2 Message Specification" for details about using PKCS-7 messages to transfer X.509 certificates. If necessary, the iPod divides the X.509 certificate into sections, each not larger than the maximum packet size that the accessory specified during the IDPS process, for reassembly by the device. If the accessory has not specified a packet size, the iPod sends 128-byte sections. The accessory must not acknowledge any certificate sections sent by the iPod until the complete certificate has been received and verified.

# Command Packet Formats

This section describes the general format for iAP packets. Use the small packet format for payloads up to 255 bytes. Use the large packet format for payloads greater than 255 bytes.

## Small Packet Format

For command packets whose payloads are 255 bytes or less, use the small packet format. The small packet format is shown in Table 2-7 (page 58).

**Table 2-7** Small packet format

| Byte number | Value | Meaning |
|---|---|---|
| 0x00 | 0xFF | Sync byte |
| 0x01 | 0x55 | Packet start byte |
| 0x02 | 0x*NN* | Packet payload length |
| 0x03 | 0x*NN* | Lingo ID |
| 0x04 | 0x*NN* | Command ID |
| 0x05…0x*NN* | 0x*NN* | Command data |
| (last byte) | 0x*NN* | Packet payload checksum |

Note that the command ID and command data format for packets with currently unspecified lingoes may not follow the format indicated here (1 byte command ID, 0x*N* bytes command data). Also note that a packet payload length of 0x00 is not valid for the small packet format; it is reserved as a marker for the large packet format.

## Large Packet Format

For command packets whose payloads are between 256 bytes and 65535 bytes in length, use the large packet format. The large packet format is shown in Table 2-8 (page 59).

**Table 2-8** Large packet format

| Byte number | Value | Meaning |
|---|---|---|
| 0x00 | 0xFF | Sync byte |
| 0x01 | 0x55 | Packet start byte |
| 0x02 | 0x00 | Packet payload length marker |
| 0x03 | 0x*NN* | Packet payload length (bits 15:8) |
| 0x04 | 0x*NN* | Packet payload length (bits 7:0) |
| 0x05 | 0x*NN* | Lingo ID |
| 0x06 | 0x*NN* | Command ID |
| 0x07…0x*NN* | 0x*NN* | Command data |
| (last byte) | 0x*NN* | Packet payload checksum |

## Packet Details

The sync byte (0xFF) is not considered part of the packet. It is sent merely to facilitate automatic baud rate detection and correction when using a UART serial port link and, in some cases, to power on the iPod. It is not necessary to send the sync byte when using BT or USB as a link.

The packet payload length is the number of bytes in the packet, not including the sync byte, packet start byte, packet payload length byte, or packet payload checksum byte. That is, it is the length of the command ID, lingo, and command data. Thus, the packet payload data length for a `RequestIdentify` command would be 0x02. The Lingo ID specifies the broad category that the communication falls under. The Command ID is a more specific indication of the significance of the packet and is interpreted differently depending on the Lingo ID.

Unless otherwise specified, the following rules apply:

- All packet data fields larger than 8 bits are sent and received in big-endian format; that is, ordered from the most significant byte to the least significant byte.
- Device command packets that have a valid checksum but contain an invalid parameter, invalid command, or other such failure cause the iPod to respond with an ACK command containing the appropriate error status.
- A packet with an invalid checksum received by iPod is presumed to be invalid and is ignored. No ACK or other command is sent to the device in response to the invalid packet.

**Note:** Unless otherwise specified, all data units larger than bytes must be transferred in a big-endian order; that is, 32 bits should be sent as bits 31:24, followed by bits 23:16, and so forth. Similarly, 16 bits should be sent as bits 15:8, followed by bits 7:0. This includes the 16-bit large packet format payload length: the high byte of the length is sent first, followed by the low byte of the length.

The sum of all the bytes from the packet payload length (or marker, if applicable) to and including the packet payload checksum is 0x00. The checksum must be calculated appropriately, by adding the bytes together as signed 8-bit values, discarding any signed 8-bit overflow, and then negating the sum to create the signed 8-bit checksum byte. All packets received with a nonzero checksum are presumed to be corrupted and will be discarded.

# Lingo 0x00: General Lingo

The General lingo is intended for housekeeping commands and must be supported by all devices. In addition to the General lingo, external devices implement function-specific lingoes. For example, a microphone device attached to the mono microphone input of the 9-pin Audio/Remote connector on the iPod uses the Microphone lingo (0x01). The Simple Remote lingo (0x02) is used by Apple's simple in-line remote control. An external RF transmitter device uses the Accessory Power lingo (0x05).

## General Lingo Command Summary

Table 2-9 (page 60) gives a summary of all commands in the General lingo, including the command ID, the length of the associated data, the first version of the General lingo protocol in which the command is supported, and what device authentication (if any) is required to use the command.

**Table 2-9** General lingo commands

| Command | ID | Data length | Protocol version | Authentication for UART transport |
|---|---|---|---|---|
| `RequestIdentify` | 0x00 | 0x00 | All | None |
| `Identify` (**deprecated;** see "General Lingo Command 0x01: Identify" (page 523)) | 0x01 | 0x01 | All | None |
| `ACK` | 0x02 | 0x02 or 0x06 | 1.00 | None |
| `RequestRemoteUIMode` | 0x03 | 0x00 | 1.00 | None |
| `ReturnRemoteUIMode` | 0x04 | 0x01 | 1.00 | None |
| `EnterRemoteUIMode` | 0x05 | 0x00 | 1.00 | None |
| `ExitRemoteUIMode` | 0x06 | 0x00 | 1.00 | None |
| `RequestiPodName` | 0x07 | 0x00 | 1.00 | None |
| `ReturniPodName` | 0x08 | 0x*NN* | 1.00 | None |

| Command | ID | Data length | Protocol version | Authentication for UART transport |
|---|---|---|---|---|
| RequestiPodSoftwareVersion | 0x09 | 0x00 | 1.00 | None |
| ReturniPodSoftwareVersion | 0x0A | 0x03 | 1.00 | None |
| RequestiPodSerialNum | 0x0B | 0x00 | 1.00 | None |
| ReturniPodSerialNum | 0x0C | 0x*NN* | 1.00 | None |
| RequestiPodModelNum | 0x0D | 0x00 | 1.00 | None |
| ReturniPodModelNum | 0x0E | 0x*NN* | 1.00 | None |
| RequestLingoProtocolVersion | 0x0F | 0x01 | 1.00 | None |
| ReturnLingoProtocolVersion | 0x10 | 0x03 | 1.00 | None |
| Reserved | 0x11–0x12 | N/A | N/A | N/A |
| IdentifyDeviceLingoes | 0x13 | 0x0C | 1.01 | None |
| GetDevAuthenticationInfo | 0x14 | 0x00 | 1.01 | None |
| RetDevAuthenticationInfo | 0x15 | 0x*NN* | 1.01 | None |
| AckDevAuthenticationInfo | 0x16 | 0x01 | 1.01 | None |
| GetDevAuthentication-Signature | 0x17 | 0x11 or 0x15 | 1.01 | None |
| RetDevAuthentication-Signature | 0x18 | 0x*NN* | 1.01 | None |
| AckDevAuthenticationStatus | 0x19 | 0x01 | 1.01 | None |
| GetiPodAuthenticationInfo | 0x1A | 0x00 | 1.01 | Authentication 2.0 |
| RetiPodAuthenticationInfo | 0x1B | 0x*NN* | 1.01 | Authentication 2.0 |
| AckiPodAuthenticationInfo | 0x1C | 0x01 | 1.01 | Authentication 2.0 |
| GetiPodAuthentication-Signature | 0x1D | 0x*NN* | 1.01 | Authentication 2.0 |
| RetiPodAuthentication-Signature | 0x1E | 0x*NN* | 1.01 | Authentication 2.0 |
| AckiPodAuthenticationStatus | 0x1F | 0x01 | 1.01 | Authentication 2.0 |
| Reserved | 0x20–0x22 | N/A | N/A | N/A |
| NotifyiPodStateChange | 0x23 | 0x01 | 1.02 | None |
| GetiPodOptions | 0x24 | 0x00 | 1.05 | None |

| Command | ID | Data length | Protocol version | Authentication for UART transport |
|---|---|---|---|---|
| RetiPodOptions | 0x25 | 0x08 | 1.05 | None |
| Reserved | 0x26 | N/A | N/A | N/A |
| GetAccessoryInfo | 0x27 | 0x*NN* | 1.04 | None |
| RetAccessoryInfo | 0x28 | 0x*NN* | 1.04 | None |
| GetiPodPreferences | 0x29 | 0x01 | 1.05 | Yes[1] |
| RetiPodPreferences | 0x2A | 0x02 | 1.05 | Yes[1] |
| SetiPodPreferences | 0x2B | 0x03 | 1.05 | Yes[1] |
| Reserved | 0x2C–0x37 | N/A | N/A | N/A |
| StartIDPS | 0x38 | 0x00 | 1.09 | None |
| SetFIDTokenValues | 0x39 | 0x*NN* | 1.09 | None |
| RetFIDTokenValueACKs | 0x3A | 0x*NN* | 1.09 | None |
| EndIDPS | 0x3B | 0x01 | 1.09 | None |
| IDPSStatus | 0x3C | 0x01 | 1.09 | None |
| Reserved | 0x3D–0x3E | N/A | N/A | N/A |
| OpenDataSessionForProtocol | 0x3F | 0x05 | 1.09 | Authentication 2.0B |
| CloseDataSession | 0x40 | 0x04 | 1.09 | Authentication 2.0B |
| DevACK | 0x41 | 0x04 | 1.09 | Authentication 2.0B |
| DevDataTransfer | 0x42 | 0x*NN* | 1.09 | Authentication 2.0B |
| iPodDataTransfer | 0x43 | 0x*NN* | 1.09 | Authentication 2.0B |
| Reserved | 0x44–0x48 | N/A | N/A | N/A |
| SetEventNotification | 0x49 | 0x0A | 1.09 | Authentication 2.0B |
| iPodNotification | 0x4A | 0x*NN* | 1.09 | Authentication 2.0B |
| GetiPodOptionsForLingo | 0x4B | 0x01 | 1.09 | Authentication 2.0B |
| RetiPodOptionsForLingo | 0x4C | 0x09 | 1.09 | Authentication 2.0B |
| GetEventNotification | 0x4D | 0x00 | 1.09 | Authentication 2.0B |
| RetEventNotification | 0x4E | 0x08 | 1.09 | Authentication 2.0B |

| Command | ID | Data length | Protocol version | Authentication for UART transport |
|---|---|---|---|---|
| GetSupportedEvent-Notification | 0x4F | 0x00 | 1.09 | Authentication 2.0B |
| Reserved | 0x50 | N/A | N/A | N/A |
| RetSupportedEvent-Notification | 0x51 | 0x08 | 1.09 | Authentication 2.0B |
| Reserved | 0x52–0xFF | N/A | N/A | N/A |

[1] Preference commands (0x29-0x2B) require authentication on all iPods and iPhones except the 5G iPod; however, getting or setting the line-out preference class (0x03) does not require authentication.

When first connected to an iPod or iPhone, every accessory must identify itself. New accessory designs must use the Identify Device Preferences and Settings (IDPS) process described in Appendix B, "Accessory Identification" (page 445). This process ensures their compatibility with future firmware. Existing accessory designs may send the iAP General lingo command 0x13, `IdentifyDeviceLingoes`, identifying the lingoes they support. Accessories that need to support the 3G iPod must use the command described in "General Lingo Command 0x01: Identify (Deprecated)" (page 523). For details, see "Device Signaling and Initialization" (page 48).

The iPod may send a `RequestIdentify` command to the device to ask it to reidentify itself. There is currently no data defined for this command. Any command returned in response to a `RequestIdentify` packet does not need to have the extra sync bytes and delays used during the device startup process (described in "Device Signaling and Initialization" (page 48)).

The remaining General lingo commands can be used to obtain general information from the iPod. These commands allow the device to request the name, serial number, model number, and software version number of the iPod. The `RequestLingoProtocolVersion` command allows a device to query the iPod for the lingo protocol versions of all supported lingoes on the iPod. The `ACK` command is used by the iPod to report command error conditions and has an ACK pending feature to notify the requesting device how long to wait for responses to certain commands.

Accessories should send the `GetiPodOptionsForLingo` command to query the iPod for its support of specific features for each lingo. The iPod responds with a `RetiPodOptionsForLingo` command, telling the accessory exactly which options it supports for the specific lingo. With iPods that do not support `GetiPodOptionsForLingo`, an accessory can send `RequestLingoProtocolVersion` to get the lingo version; however, this method forces the accessory to infer features using the method described in "Protocol Features and Availability" (page 35).

> **Note:** Supporting the 3G iPod requires special design considerations. See “Interfacing With the 3G iPod” in *iPod/iPhone Hardware Specifications.*

## History of the General lingo protocol

Table 2-10 (page 64) lists changes introduced with each version of the General lingo protocol.

**Table 2-10** General lingo revision history

| Lingo version | Command changes | Features |
|---|---|---|
| No version | Add: 0x00, 0x01 | Request identification, identify as single lingo device |
| 1.00 | Add: 0x02, 0x07–0x10 | ACK response, request iPod name, software version, serial number, and model number; support for 38400 and 57600 baud rates |
| 1.01 | Add: 0x13–0x1F | Identify as multilingo device, Authentication 1.0 process |
| 1.02 | Add: 0x23 | Notify device of iPod state changes (Sleep/Power On/Hibernate) |
| 1.03 | None | (Internal code restructuring) |
| 1.04 | Add: 0x27, 0x28 | Get/return accessory device information, Authentication 2.0 process |
| 1.05 | Add: 0x24–0x25, 0x29–0x2B | Video browsing preferences |
| 1.06 | None | Line-out preferences, two-way Authentication 2.0 |
| 1.07 | None | Additional video preferences |
| 1.08 | None | Different timeout times for `GetDevAuthenticationInfo` and `GetDevAuthenticationSignature`. |
| 1.09 | Add: 0x38-0x3C, 0x3F-0x43, 0x4A-0x4C | Identify accessories through IDPS, communicate with iPhone OS applications, query iPod for lingo options. |

## Command 0x00: RequestIdentify

Direction: iPod to Device

The iPod sends this command to prompt accessories to reidentify themselves. If an accessory receives this command, it must respond with `StartIDPS`, as described in "Device Signaling and Initialization" (page 48). The only exception is for accessories that support the 3G iPod, which must respond with the deprecated "Command 0x01: Identify" (page 523).

**Table 2-11** `RequestIdentify` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x02 | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo. All devices must support this lingo. |

| Byte number | Value | Comment |
|---|---|---|
| 4 | 0x00 | Command: `RequestIdentify` |
| 5 | 0xFE | Checksum |

## Command 0x02: ACK

Direction: iPod to Device

The iPod sends the `ACK` command to notify the device of command completion status and errors. The `ACK` command may come in one of two forms, depending on the status being returned. For any status other than command pending, the normal ACK packet structure shown in Table 2-12 (page 65) is used.

**Table 2-12** `ACK` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x04 | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x02 | Command: `ACK` |
| 5 | 0x*NN* | Command result status. Possible values are shown in Table 2-13 (page 65). |
| 6 | 0x*NN* | The ID of the command being acknowledged |
| 7 | 0x*NN* | Checksum |

**Table 2-13** ACK command error codes

| Value | Description |
|---|---|
| 0x00 | Success (OK) |
| 0x01 | ERROR: Unknown database category |
| 0x02 | ERROR: Command failed |
| 0x03 | ERROR: Out of resources |
| 0x04 | ERROR: Bad parameter |
| 0x05 | ERROR: Unknown ID |
| 0x06 | Command Pending; see Table 2-14 (page 66) |

| Value | Description |
|---|---|
| 0x07 | ERROR: Not authenticated |
| 0x08 | ERROR: Bad authentication version |
| 0x09 | ERROR: Accessory power mode request failed |
| 0x0A | ERROR: Certificate invalid |
| 0x0B | ERROR: Certificate permissions invalid |
| 0x0C | ERROR: File is in use |
| 0x0D | ERROR: Invalid file handle |
| 0x0E | ERROR: Directory not empty |
| 0x0F | ERROR: Operation timed out |
| 0x10 | ERROR: Command unavailable in this iPod mode |
| 0x11 | ERROR: Invalid accessory resistor ID value |
| 0x12–0x14 | Reserved |
| 0x15 | ERROR: Maximum number of accessory connections already reached |
| 0x16–0xFF | Reserved |

If the status returned by the `ACK` command is Command Pending, an additional field is added to the ACK packet that represents the amount of time, in milliseconds, that a device should wait to receive the final packet indicating that the current command completed or returned an error status.

After receiving a Command Pending ACK, the device should wait for up to the specified number of milliseconds for a final ACK response. If no final ACK packet is received before the specified amount of time expires, the device should retry the command.

**Table 2-14** `ACK` packet with Command Pending status

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x08 | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x02 | Command: `ACK` |
| 5 | 0x06 | Command result status: Command Pending |
| 6 | 0x*NN* | The ID of the command being acknowledged. |

| Byte number | Value | Comment |
|---|---|---|
| 7 | 0x*NN* | Maximum amount of time to wait for pending response, in milliseconds (bits 31:24). |
| 8 | 0x*NN* | Maximum pending wait, in milliseconds (bits 23:16) |
| 9 | 0x*NN* | Maximum pending wait, in milliseconds (bits 15:8) |
| 10 | 0x*NN* | Maximum pending wait, in milliseconds (bits 7:0) |
| 11 | 0x*NN* | Checksum |

## Command 0x03: RequestRemoteUIMode

Direction: Device to iPod

The device requests the Extended Interface mode from the iPod. The iPod responds with "Command 0x04: ReturnRemoteUIMode" (page 67). This command may be used only if the accessory requests Lingo 0x04 during its identification process.

**Table 2-15** `RequestRemoteUIMode` packet

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x02 | Packet payload length |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x03 | Command ID: `RequestRemoteUIMode` |
| 5 | 0xFB | Packet payload checksum byte |

## Command 0x04: ReturnRemoteUIMode

Direction: iPod to Device

The iPod returns the current operating mode of the iPod UI. This is either Standard UI mode or Extended Interface mode. If the returned mode byte is nonzero (true), the iPod is in Extended Interface mode. This command may be used only if the accessory requests Lingo 0x04 during its identification process.

**Table 2-16** `ReturnRemoteUIMode` packet

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |

| Byte number | Value | Meaning |
|---|---|---|
| 2 | 0x03 | Packet payload length |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x04 | Command ID: `ReturnRemoteUIMode` |
| 5 | 0x*NN* | Mode byte. If nonzero (true), the iPod is in Extended Interface Mode. If zero (false), the iPod is in Standard UI mode. |
| 6 | 0x*NN* | Packet payload checksum byte |

## Command 0x05: EnterRemoteUIMode

Direction: Device to iPod

The device sends this command to the iPod to force it to enter the Extended Interface mode. If the iPod is already in the Extended Interface mode, it immediately returns a General lingo `ACK` command packet, notifying the user that the command was successful. This command may be used only if the accessory requests Lingo 0x04 during its identification process.

**Note:** This command fails if the iPod does not detect a valid $R_{ID}$ resistor. See "Accessory Detect and Identify" in *iPod/iPhone Hardware Specifications.*

If the iPod needs to switch modes, it returns a General lingo ACK Pending command packet, informing the device how long it will take the iPod to switch modes. This is followed by an ACK packet notifying the device that the iPod successfully changed modes. Devices should honor the timeout returned by the ACK pending before assuming the original command has failed.

If audio is playing when the iPod enters Extended Interface mode, the iPod will pause playback. If video is playing, the iPod will stop playback.

**Table 2-17** `EnterRemoteUIMode` packet

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x02 | Packet payload length |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x05 | Command ID: `EnterRemoteUIMode` |
| 5 | 0xF9 | Packet payload checksum byte |

## Command 0x06: ExitRemoteUIMode

Direction: Device to iPod

The device sends this command to the iPod to force it to exit the Extended Interface mode. If the iPod is already in the Standard UI mode, it immediately returns a General lingo `ACK` command packet, notifying the user that the command was successful. This command may be used only if the accessory requests Lingo 0x04 during its identification process.

If the iPod needs to switch modes, it sends a General lingo ACK Pending command packet informing the device how long it will take the iPod to switch modes. This is followed by an ACK packet notifying the device that the iPod successfully changed modes. Devices should honor the timeout returned by the ACK pending before assuming the original command has failed.

**Table 2-18** `ExitRemoteUIMode` packet

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x02 | Packet payload length |
| 3 | 0x00 | Lingo ID; General lingo |
| 4 | 0x06 | Command ID: `ExitRemoteUIMode` |
| 5 | 0xF8 | Packet payload checksum byte |

## Command 0x07: RequestiPodName

Direction: Device to iPod

Retrieves the name of the iPod. The iPod responds with a "Command 0x08: ReturniPodName" (page 70) command containing the name of the iPod as a null-terminated UTF-8 character array.

**Table 2-19** `RequestiPodName` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x02 | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x07 | Command: `RequestiPodName` |
| 5 | 0xF7 | Checksum |

## Command 0x08: ReturniPodName

Direction: iPod to Device

The iPod sends this command in response to the "Command 0x07: RequestiPodName" (page 69) message from the device. The iPod name is encoded as a null-terminated UTF-8 character array. If the iPod name has not been modified by the user, it is returned as "iPod".

**Note:** Starting with version 1.02 of the General lingo, the `ReturniPodName` command on Windows-formatted iPods returns the iTunes name of the iPod instead of the Windows volume name.

**Table 2-20** `ReturniPodName` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x*NN* | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x08 | Command: `ReturniPodName` |
| 5 | 0x*NN*... | The name of the iPod as a null-terminated UTF-8 character array. |
| (last byte) | 0x*NN* | Checksum |

## Command 0x09: RequestiPodSoftwareVersion

Direction: Device to iPod

Retrieves the software version information for the iPod. The iPod responds with a "Command 0x0A: ReturniPodSoftwareVersion" (page 71) containing the major, minor, and revision version numbers.

**Note:** This command requests the iPod software version and not the version of a particular lingo protocol.

**Table 2-21** `RequestiPodSoftwareVersion` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x02 | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |

| Byte number | Value | Comment |
|---|---|---|
| 4 | 0x09 | Command: `RequestiPodSoftwareVersion` |
| 5 | 0xF5 | Checksum |

## Command 0x0A: ReturniPodSoftwareVersion

Direction: iPod to Device

The iPod sends this command in response to the "Command 0x09: RequestiPodSoftwareVersion" (page 70) message from the device. The iPod returns each version number as an individual byte, with the major version number sent first. For example, if the major, minor, and revision bytes are returned as 0x01, 0x02, and 0x03, the iPod software version number is 1.02.03.

**Table 2-22** `ReturniPodSoftwareVersion` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x05 | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x0A | Command: `ReturniPodSoftwareVersion` |
| 5 | 0x*NN* | iPod major version number. |
| 6 | 0x*NN* | iPod minor version number. |
| 7 | 0x*NN* | iPod revision version number. |
| 8 | 0x*NN* | Checksum |

## Command 0x0B: RequestiPodSerialNum

Direction: Device to iPod

Retrieves the serial number string of the iPod. The iPod responds with a "Command 0x0C: ReturniPodSerialNum" (page 72) containing the serial number as a null-terminated UTF-8 character array.

**Table 2-23** `RequestiPodSerialNum` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |

| Byte number | Value | Comment |
|---|---|---|
| 2 | 0x02 | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x0B | Command: `RequestiPodSerialNum` |
| 5 | 0xF3 | Checksum |

## Command 0x0C: ReturniPodSerialNum

Direction: iPod to Device

The iPod sends this command in response to the "Command 0x0B: RequestiPodSerialNum" (page 71) message from the device. The iPod serial number is encoded as a null-terminated UTF-8 character array.

**Table 2-24** `ReturniPodSerialNum` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x*NN* | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x0C | Command: `ReturniPodSerialNum` |
| 5 | 0x*NN*… | The iPod serial number, as a null-terminated UTF-8 character array. |
| (last byte) | 0x*NN* | Checksum |

## Command 0x0D: RequestiPodModelNum

Direction: Device to iPod

Retrieves model information for the iPod. The iPod responds with a "Command 0x0E: ReturniPodModelNum" (page 73) containing the model number of the iPod as a 32-bit integer (model ID) and as a null-terminated UTF-8 character array. If an internal memory error occurs while the iPod is processing this command, the iPod returns an `ACK` command with the Command Failed error status. The returned model number can be used to determine what iPod hardware has been connected. See "Command 0x0E: ReturniPodModelNum" (page 73) for details.

**Table 2-25** `RequestiPodModelNum` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |

| Byte number | Value | Comment |
|---|---|---|
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x02 | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x0D | Command: `RequestiPodModelNum` |
| 5 | 0xF1 | Checksum |

## Command 0x0E: ReturniPodModelNum

Direction: iPod to Device

The iPod sends this command in response to the "Command 0x0D: RequestiPodModelNum" (page 72) message from the device. The iPod model number is encoded as 32-bit integer (model ID) and as a null-terminated UTF-8 character array.

> **WARNING:** Because firmware updates can change an iPod's functionality, you must never use the model number alone to determine its capabilities. Use "Command 0x0F: RequestLingoProtocolVersion" (page 79) instead.

The iPod model number can be used to identify the size and color of an iPod. Currently, the accessory need only examine the first five characters of the model number to make that determination.

**Table 2-26** `ReturniPodModelNum` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x*NN* | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x0E | Command: `ReturniPodModelNum` |
| 5 | 0x*NN* | iPod Model ID (bits 31:24). See Table 2-27 (page 74). |
| 6 | 0x*NN* | iPod Model ID (bits 23:16) |
| 7 | 0x*NN* | iPod Model ID (bits 15:8) |
| 8 | 0x*NN* | iPod Model ID (bits 7:0) |
| 9 … *N* | 0x*NN*… | The iPod model number as a null-terminated UTF-8 character array. See Table 2-28 (page 75) and Table 2-29 (page 76). |

| Byte number | Value | Comment |
|---|---|---|
| (last byte) | 0x*NN* | Checksum |

Table 2-27 (page 74) shows the existing iPod model IDs. Table 2-28 (page 75) and Table 2-29 (page 76) list the model number strings returned for each iPod model.

**Table 2-27** iPod model IDs

| iPod model ID | iPod hardware |
|---|---|
| 0x0003*NNNN* | 3G iPod. This is the white iPod with 4 buttons above a white click wheel. |
| 0x0004*NNNN* | iPod mini: original 4 GB model. |
| 0x0005*NNNN* | 4G iPod. This is the white iPod with a gray click wheel. |
| 0x0006*NNNN* | 4G iPod (color display) |
| 0x0007*NNNN* | 2nd generation iPod mini (models M9800 – M9807, 4 GB and 6 GB) |
| 0x000B*NNNN* | 5G iPod |
| 0x000C*NNNN* | iPod nano |
| 0x0010*NNNN* | 2G iPod nano |
| 0x0011*NNNN* | iPhone |
| 0x0013*NNNN* | iPod classic |
| 0x00130100 | iPod classic 120 GB |
| 0x0014*NNNN* | 3G iPod nano |
| 0x0015*NNNN* | iPod touch |
| 0x0017*NNNN* | 4G iPod nano |
| 0x0018*NNNN* | iPhone 3G |
| 0x0019*NNNN* | 2G touch |
| 0x001B*NNNN* | iPhone 3GS |
| 0x00130200 | iPod classic 160 GB |
| 0x001C*NNNN* | 5G iPod nano |
| 0x001D*NNNN* | 2G touch (2009) |

**Table 2-28** iPod model number strings M8948-M9974 and P8948-P9830

| iPod model ID strings | iPod hardware |
|---|---|
| M8948, P8948 | 3G iPod: 30 GB |
| M8976, P8976 | 3G iPod: 10 GB |
| M9160, P9160 | iPod mini: 4 GB silver |
| M9244, P9244 | 3G iPod: 20 GB |
| M9245, P9245 | 3G iPod: 40 GB |
| M9268, P9268 | 4G iPod: 40 GB |
| M9282, P9282, P9659, P9660, P9661, P9662 | 4G iPod: 20 GB |
| M9434, P9434 | iPod mini: 4 GB green |
| M9435, P9435 | iPod mini: 4 GB pink |
| M9436, P9436 | iPod mini: 4 GB blue |
| M9437, P9437 | iPod mini: 4 GB gold |
| M9460, M8946, P8946, P9460 | 3G iPod: 15 GB |
| M9575 | 4G iPod: 20 GB (HP-branded) |
| M9576 | 4G iPod: 40 GB (HP-branded) |
| M9585, P9585 | iPod photo: 40 GB |
| M9586, P9586 | iPod photo: 60 GB |
| M9787 | 4G iPod: 20 GB black (U2 special edition) |
| M9800, P9800 | 2nd Generation (2G) iPod mini: 4 GB silver |
| M9801, P9801 | 2G iPod mini: 6 GB silver |
| M9802, P9802 | 2G iPod mini: 4 GB blue |
| M9803, P9803 | 2G iPod mini: 6 GB blue |
| M9804, P9804 | 2G iPod mini: 4 GB pink |
| M9805, P9805 | 2G iPod mini: 6 GB pink |
| M9806, P9806 | 2G iPod mini: 4 GB green |
| M9807, P9807 | 2G iPod mini: 6 GB green |
| M9829, P9829 | 2nd generation (2G) iPod photo: 30 GB |
| M9830, P9830 | 2G iPod photo: 60 GB |

| iPod model ID strings | iPod hardware |
|---|---|
| M9872 | 2G iPod photo: 30 GB (HP-branded) |
| M9873 | 2G iPod photo: 60 GB (HP-branded) |
| M9973 | 2G iPod mini: 4 GB silver (HP-branded) |
| M9974 | 2G iPod mini: 6 GB silver (HP-branded) |

**Table 2-29** iPod model number strings MA002/PA002 and higher

| iPod model ID strings | iPod hardware |
|---|---|
| MA002, PA002, PA148, PA323, MA444, PA444 | 5G iPod: 30 GB white |
| MA003, PA003, PA150 | 5G iPod: 60 GB white |
| MA004, PA004, PA115 | iPod nano: 2 GB white |
| MA005, PA005, PA116 | iPod nano: 4 GB white |
| MA079, PA079 | 4G iPod (color display): 20 GB |
| MA080 | 4G iPod (color display): 20 GB (HP-branded) |
| MA099, PA099, PA100 | iPod nano: 2 GB black |
| MA107, PA107, PA108 | iPod nano: 4 GB black |
| MA127 | 4G iPod (color display): 20 GB black (U2 special edition) |
| MA146, PA146, PA149, MA446, PA446 | 5G iPod: 30 GB black |
| MA147, PA147, PA151 | 5G iPod: 60 GB black |
| MA215 | 4G iPod (color display): 20 GB (Harry Potter special edition) |
| MA253 | 5G iPod: 30 GB white (Harry Potter special edition) |
| MA305 | 5G iPod: 30 GB black (Harry Potter special edition) |
| MA350, PA350, PA351 | iPod nano: 1 GB white |
| MA352, PA352, PA353 | iPod nano: 1 GB black |
| MA426, PA426, PA427 | 2G iPod nano: 4 GB silver |
| MA428, PA428, PA429 | 2G iPod nano: 4 GB blue |
| MA448, PA448, PA449 | 5G iPod: 80 GB white |
| MA450, PA450, PA451 | 5G iPod: 80 GB black |
| MA452, MA664 | 5G iPod: 30 GB black (U2 special edition) |

| iPod model ID strings | iPod hardware |
|---|---|
| MA477, PA477, PA478 | 2G iPod nano: 2 GB silver |
| MA487, PA487, PA488 | 2G iPod nano: 4 GB green |
| MA489, PA489, PA490 | 2G iPod nano: 4 GB pink |
| MA497, PA497, PA498 | 2G iPod nano: 8 GB black |
| MA725, PA725 | 2G iPod nano: 4 GB red |
| MA899, PA899 | 2G iPod nano: 8 GB red |
| MA501 | iPhone: 4 GB |
| MA712 | iPhone: 8 GB |
| MB384 | iPhone: 16 GB |
| MB046 | iPhone 3G: 8 GB black |
| MB048 | iPhone 3G: 16 GB black |
| MB499 | iPhone 3G: 16 GB white |
| MB029, PB029, PB031 | iPod classic: 80 GB silver |
| MB145, PB145, PB146 | iPod classic: 160 GB silver |
| MB147, PB147, PB148 | iPod classic: 80 GB black |
| MB150, PB150, PB151 | iPod classic: 160 GB black |
| MB562, PB562, PB563, PB864 | iPod classic: 120 GB silver |
| MB565, PB565, PB566 | iPod classic: 120 GB black |
| MA978, PA978, PA979, MB245 | 3G iPod nano: 4 GB silver |
| MA980, PA980, PA981, MB247 | 3G iPod nano: 8 GB silver |
| MB249, PB249, PB250, MB251 | 3G iPod nano: 8 GB blue |
| MB253, PB253, PB254, MB255 | 3G iPod nano: 8 GB green |
| MB257, PB257, PB258, MB259 | 3G iPod nano: 8 GB red |
| MB261, PB261, PB262, MB263 | 3G iPod nano: 8 GB black |
| MB453, PB453, PB454, MB455, MB456 | 3G iPod nano: 8 GB pink |
| MA623, PA623, PA624, PA839 | 1G iPod touch: 8 GB |
| MA627, PA627, PA628 | 1G iPod touch: 16 GB |

| iPod model ID strings | iPod hardware |
|---|---|
| MB376 | 1G iPod touch: 32 GB |
| MB598, MB599 | 4G iPod nano: 8 GB silver |
| MB732, PB732, PB733 | 4G iPod nano: 8 GB blue |
| MB735, PB735, PB736 | 4G iPod nano: 8 GB pink |
| MB739, PB739, PB740 | 4G iPod nano: 8 GB purple |
| MB742, PB742, PB743 | 4G iPod nano: 8 GB orange |
| MB745, PB745, PB746 | 4G iPod nano: 8 GB green |
| MB748, PB748, PB749 | 4G iPod nano: 8 GB yellow |
| MB751, MB753, PB751 | 4G iPod nano: 8 GB red |
| MB754, PB754, PB755, PB889 | 4G iPod nano: 8 GB black |
| MB903, MB904, MB920, PB903, PB904, PB920 | 4G iPod nano: 16 GB silver |
| MB905, MB906, MB921, PB905, PB906, PB921 | 4G iPod nano: 16 GB blue |
| MB907, MB908, MB922, PB907, PB908, PB922 | 4G iPod nano: 16 GB pink |
| MB909, MB910, MB923, PB909, PB910, PB923 | 4G iPod nano: 16 GB purple |
| MB911, MB912, MB924, PB911, PB912, PB924 | 4G iPod nano: 16 GB orange |
| MB913, MB914, MB925, PB913, PB914, PB925 | 4G iPod nano: 16 GB green |
| MB915, MB916, MB926, PB915, PB916, PB926 | 4G iPod nano: 16 GB yellow |
| MB917, PB917 | 4G iPod nano: 16 GB red |
| MB918, MB919, MB927, PB918, PB919, PB927 | 4G iPod nano: 16 GB black |
| MB528, PB528, PB529 | 2G touch: 8 GB |
| MB531, PB531, PB532 | 2G touch: 16 GB |
| MB533, PB533, PB534 | 2G touch: 32 GB |
| MB715, MB735 | iPhone 3GS: 16 GB black |
| MB716, MB736 | iPhone 3GS: 16 GB white |
| MB717, MB737 | iPhone 3GS: 32 GB black |
| MB718, MB738 | iPhone 3GS: 32 GB white |
| MC008 | 2G touch (2009): 32 GB |

| iPod model ID strings | iPod hardware |
|---|---|
| MC011 | 2G touch (2009): 64 GB |
| MC027 | 5G iPod nano: 8 GB silver |
| MC031 | 5G iPod nano: 8 GB black |
| MC034 | 5G iPod nano: 8 GB purple |
| MC037 | 5G iPod nano: 8 GB blue |
| MC040 | 5G iPod nano: 8 GB green |
| MC043 | 5G iPod nano: 8 GB yellow |
| MC046 | 5G iPod nano: 8 GB orange |
| MC049 | 5G iPod nano: 8 GB red |
| MC050 | 5G iPod nano: 8 GB pink |
| MC060 | 5G iPod nano: 16 GB silver |
| MC062 | 5G iPod nano: 16 GB black |
| MC064 | 5G iPod nano: 16 GB purple |
| MC066 | 5G iPod nano: 16 GB blue |
| MC068 | 5G iPod nano: 16 GB green |
| MC070 | 5G iPod nano: 16 GB yellow |
| MC072 | 5G iPod nano: 16 GB orange |
| MC074 | 5G iPod nano: 16 GB red |
| MC075 | 5G iPod nano: 16 GB pink |

## Command 0x0F: RequestLingoProtocolVersion

Direction: Device to iPod

Retrieves version information for any of the lingoes supported by the iPod. The iPod responds with a "Command 0x10: ReturnLingoProtocolVersion" (page 80) containing the major and minor version information of the requested iPod lingo. This command has one parameter, the lingo whose version information is requested. The iPod returns an `ACK` command with a bad parameter status if an accessory calls this command with an invalid or unsupported lingo ID. When an iPod does not respond to the `GetiPodOptionsForLingo` command, the accessory may use the `RequestLingoProtocolVersion` command to determine what iAP features are available for each lingo used.

**Table 2-30** `RequestLingoProtocolVersion` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x03 | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x0F | Command: `RequestLingoProtocolVersion` |
| 5 | 0x*NN* | The lingo for which to request version information. |
| 6 | 0x*NN* | Checksum |

## Command 0x10: ReturnLingoProtocolVersion

Direction: iPod to Device

The iPod sends this command in response to the "Command 0x0F: RequestLingoProtocolVersion" (page 79) message from the device. The major and minor version information for the requested lingo are returned.

**Table 2-31** `ReturnLingoProtocolVersion` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x05 | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x10 | Command: `ReturnLingoProtocolVersion` |
| 5 | 0x*NN* | The lingo for which version information is being returned. |
| 6 | 0x*NN* | The major protocol version for the given lingo. |
| 7 | 0x*NN* | The minor protocol version for the given lingo. |
| 8 | 0x*NN* | Checksum |

## Command 0x13: IdentifyDeviceLingoes

Direction: Device to iPod

**IMPORTANT:** New accessory designs must use the Identify Device Preferences and Settings (IDPS) process described in Appendix B, "Accessory Identification" (page 445). This process ensures their compatibility with future firmware. Existing accessory designs may continue to send the `IdentifyDeviceLingoes` command, identifying the lingoes they support and requesting immediate authentication.

The device sends this command to signal its presence and to identify its supported lingoes. In response, the iPod sends an `ACK` command. Devices use the `IdentifyDeviceLingoes` command to report all supported lingoes; it must be used in place of the `Identify` (0x01) command.

The `IdentifyDeviceLingoes` command resets all device information set by a previous `Identify` command, including the authentication retry counter and any previously granted authentication access permissions. The payload of this command includes three fields: the Device Lingoes Spoken, Options, and Device ID fields.

**Note:** An accessory attached via the 30-pin connector must always monitor the Accessory Power output from the iPod (pin 13 in "Hardware Interfaces" in *iPod/iPhone Hardware Specifications*). If Accessory Power goes low, even momentarily, the accessory must stop sending iAP commands. After Accessory Power goes high, the accessory must wait at least 80 ms and then send a `StartIDPS` command, following the steps shown in Table 2-1 (page 48) (UART accessories) or Table 2-2 (page 51) (USB or BT accessories).

The `IdentifyDeviceLingoes` command disables all but free lingoes on the current port unless authentication is requested (immediate authentication is also required for Authentication 2.0). For serial ports, this means lingoes 0x00, 0x02, 0x03, and 0x05 may be used, excluding authenticated commands; the USB port will be able to use only the general lingo, 0x00 (see Table 2-4 (page 54)). Devices that register with this command can use only those lingoes that they specifically identify (see Table 2-33 (page 82)).

If any lingo identified by the `IdentifyDeviceLingoes` command can be used by only one device at a time, and that lingo is already in use by a different device, the command will fail but no command failure `ACK` command will be sent to the device. The device can verify that the `IdentifyDeviceLingoes` command has succeeded by sending a free command with valid parameters and checking the iPod's response. The iPod should respond with an `ACK` response with failure status if any lingo is already in use. An identification failure results in the device being able to use only the General lingo (0x00).

This command performs lingo conflict checking to ensure that single-instance lingoes, such as Display Remote, are used on only one port at a time. If the `IdentifyDeviceLingoes` command is acknowledged with a status of 0x15 (Maximum number of accessory connections already reached), the accessory must not send any further iAP traffic until it has been disconnected and reconnected to the iPod.

For sample command sequences in which an accessory identifies its supported lingoes, using `IdentifyDeviceLingoes`, see Sample Identification Sequences (page 334).

**Table 2-32** `IdentifyDeviceLingoes` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x0E | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |

| Byte number | Value | Comment |
|---|---|---|
| 4 | 0x13 | Command: `IdentifyDeviceLingoes` |
| 5-8 | 0x*NN* | Device Lingoes Spoken; see Table 2-33 (page 82). |
| 9-12 | 0x*NN* | Options; see Table 2-34 (page 83). |
| 13-16 | 0x*NN* | Device ID. Devices must send a unique identifier, supplied by the iPod Authentication Coprocessor, if they require authentication. If a device does not require authentication, it can send the Device ID to 0x00000000 and set the authentication option bits to 0x0. |
| 17 | 0x*NN* | Checksum |

Use the Device Lingoes Spoken field as a bit field to set each bit corresponding to the lingoes supported by the accessory. For example, if an accessory device supports both the Microphone and Simple Remote lingoes, the bit field is 0x00000007 or the low byte in binary is 00000111.

**Table 2-33** Device Lingoes Spoken bits

| Bit | Supported lingo |
|---|---|
| 0 | General lingo (must be set by all devices) |
| 1 | Microphone lingo |
| 2 | Simple Remote lingo |
| 3 | Display Remote lingo |
| 4 | Extended Interface lingo |
| 5 | Accessory Power lingo |
| 6 | USB Host Control lingo (deprecated; see "Lingo 0x06: USB Host Control Lingo" (page 525)) |
| 7 | RF Tuner lingo |
| 8 | Accessory Equalizer lingo |
| 9 | Sports lingo |
| 10 | Digital Audio lingo |
| 11 | Reserved; set to 0 |
| 12 | Storage lingo |
| 31:13 | Reserved; set to 0 |

**Note:** The Location lingo (Lingo 0x0E) is available only if the accessory has identified itself using IDPS. See "Device Signaling and Initialization" (page 48).

The bits of the Options field are defined as shown in Table 2-34 (page 83).

**Table 2-34** `IdentifyDeviceLingoes` Options bits

| Bits | Meaning |
| --- | --- |
| 1:0 | Authentication control bits. These bits have the following meanings:<br>00 = no authentication is supported or required<br>01 = defer authentication until an authenticated command is used (Authentication 1.0 only); see Note below<br>10 = authenticate immediately after identification (required for Authentication 2.0).<br>11 = reserved |
| 3:2 | Power control bits. These bits have the following meanings:<br>00 = low power only; device requires not more than 5 mA power from the iPod at any time<br>01 = intermittent high power; device requires more than 5 mA power from iPod (up to 100mA maximum) during playback operation<br>10 = reserved<br>11 = constant high power; device requires more than 5 mA power from iPod (up to 100 mA maximum) at all times. This mode must not be declared unless the accessory provides power as specified in "Supplying USB Power" in *iPod/iPhone Hardware Specifications*. |
| 31:4 | Reserved; set to 0 |

**Note:** Certain lingoes require immediate authentication. Requesting deferred authentication with the Microphone, USB Host Control, RF Tuner, Accessory Equalizer and Digital Audio lingoes results in a command failed `ACK` return from the iPod.

Devices identifying using the `IdentifyDeviceLingoes` command receive notifications when the iPod changes state. See "Command 0x23: NotifyiPodStateChange" (page 92) for more details.

**Note:** If a device uses an invalid device ID during an identification attempt, the iPod returns a bad parameter error (0x04) ACK. If the device claims a Device Lingo Spoken that is not supported by the attached iPod, the iPod returns a command failed (0x02) ACK.

## Cancelling a Current Authentication Process With IdentifyDeviceLingoes

For best success calling `IdentifyDeviceLingoes`, use the following sequence:

1. For UART-based communications, ensure that the Accessory Identify pin (pin 10) is connected to the correct resistors and that the Accessory Detect (pin 20) pin is grounded; see "Accessory Detect and Identify" in *iPod/iPhone Hardware Specifications*. Also, precede all iAP packets by an extra 0xFF autobaud synchronization byte.

2. Send `IdentifyDeviceLingoes` with the lingo mask set to only the General lingo, the option bitmask set to 0x0 (no options), and the device ID set to 0x0. This will cancel any active authentication process on the current iPod accessory port.

3. Wait up to 1 second for the iPod to send an ACK response. After the ACK response, the iPod will send the accessory a `GetAccessoryInfo` command. The accessory must respond with a `RetAccessoryInfo` command, but it must ignore the iPod's acknowledgment of that command.

4. If the iPod responds with an ACK success status within 1 second, proceed to the rest of the device initialization and authentication processes.

5. If the iPod does not respond with an ACK success status within 1 second, repeat Steps 2 and 3 as many times as desired unless the accessory supports the 3G iPod.

6. If the accessory supports the 3G iPod, stop after the third try (3 seconds total elapsed time) and assume that the device is attached to a 3G iPod.

Sample command sequences that illustrate some of these best practices are listed in Table F-22 (page 532) and Table F-23 (page 534).

## Command 0x14: GetDevAuthenticationInfo

Direction: iPod to Device

The iPod sends this command to obtain authentication information from the device. The command is sent only if the device has indicated that it supports authentication during its identification process and has passed a valid, nonzero device ID. In response, the device sends "Command 0x15: RetDevAuthenticationInfo" (page 84).

**Table 2-35** `GetDevAuthenticationInfo` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x02 | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x14 | Command: `GetDevAuthenticationInfo` |
| 5 | 0xEA | Checksum |

## Command 0x15: RetDevAuthenticationInfo

Direction: Device to iPod

The device indicates the iAP authentication version that it supports by returning this command in response to a "Command 0x14: GetDevAuthenticationInfo" (page 84) command from the iPod. The authentication version returned by this command must be consistent with the device ID sent during its identification process.

The returned packet may have either of two formats, depending on whether the authentication process is Authentication 1.0 or 2.0. See Table 2-36 (page 85) and Table 2-37 (page 85).

**Table 2-36** `RetDevAuthenticationInfo` packet, Authentication 1.0

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x04 | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x15 | Command: `RetDevAuthenticationInfo` |
| 5 | 0x*NN* | Authentication protocol major version number |
| 6 | 0x*NN* | Authentication protocol minor version number |
| 7 | 0x*NN* | Checksum |

**Table 2-37** `RetDevAuthenticationInfo` packet, Authentication 2.0

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x*NN* | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x15 | Command: `RetDevAuthenticationInfo` |
| 5 | 0x02 | Authentication major version (0x02) |
| 6 | 0x00 | Authentication minor version (0x00) |
| 7 | 0x*NN* | X.509 certificate current section index (0 = first section, 1 = second section, and so on) |
| 8 | 0x*NN* | X.509 certificate maximum section index (0 = one section total, 1 = two sections, and so on) |
| 9 | 0x*NN*... | X.509 certificate data. If the data length exceeds 500 bytes it must be broken into sections, each not more than 500 bytes. |
| (last byte) | 0x*NN* | Checksum |

**Note:** During Authentication 2.0, not more than 500 certificate bytes may be sent at once. If the X.509 certificate is larger than 500 bytes, the device must divide it into sections, each not larger than 500 bytes, for reassembly by the iPod. The iPod will send an `ACK` command for each certificate section up to, but not including, the last one. The accessory must wait for the `ACK` command before sending the next certificate section. The final certificate section is acknowledged by an `AckDevAuthenticationInfo` command.

## Command 0x16: AckDevAuthenticationInfo

Direction: iPod to Device

The iPod sends this command in response to "Command 0x15: RetDevAuthenticationInfo" (page 84). It indicates the current state of the device authentication information. If the device receives a nonzero status, the iPod does not support the device's authentication version and the device will fail authentication.

**Note:** The accessory must send certificate data in sections not larger than 500 bytes, for reassembly by the iPod, and must wait for an `ACK` command after each one. The iPod acknowledges the final certificate section with this command.

**Table 2-38** `AckDevAuthenticationInfo` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x03 | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x16 | Command: `AckDevAuthenticationInfo` |
| 5 | 0x*NN* | Status of authentication information. Possible values are:<br>0x00 = Authentication information supported<br>0x08 = Authentication information unsupported<br>0x0A = Certificate is invalid<br>0x0B = Certificate permissions are invalid |
| 6 | 0x*NN* | Checksum |

## Command 0x17: GetDevAuthenticationSignature

Direction: iPod to Device

The iPod sends this command to authenticate a device that has identified itself as requiring authentication. Authentication occurs either immediately upon identification or when the device attempts to use a restricted lingo or command. The device calculates its digital signature based on the challenge offered by the iPod and sends the results back to the iPod using "Command 0x18: RetDevAuthenticationSignature" (page 87).

The authentication retry counter is used to track the number of retries. If the returned signature cannot be verified, the iPod responds with a nonzero "Command 0x19: AckDevAuthenticationStatus" (page 88), followed immediately by another "Command 0x17: GetDevAuthenticationSignature" (page 86).

The retry counter is set to 0x01 for the first authentication attempt and incremented each time the iPod retries the `GetDevAuthenticationSignature` command. Devices using Authentication 1.0 are allowed up to four retries and a maximum of 30 seconds (up to 7.5 seconds per retry) for the authentication process. Devices using Authentication 2.0 are allowed up to two retries and a maximum of 150 seconds (up to 75 seconds per retry) for the authentication process. If a device fails to respond to the `GetDevAuthenticationSignature` command, the authentication process will fail and the device will not be able to use any of the authenticated commands.

**Table 2-39** `GetDevAuthenticationSignature` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x13 or 0x17 | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x17 | Command: `GetDevAuthenticationSignature` |
| 5–20 or 5–24 | 0x*NN*... | An offered challenge sent for the device to sign and return (16 bytes for Authentication 1.0, 20 bytes for Authentication 2.0). |
| *NN* | 0x*NN* | Authentication retry counter. The authentication process terminates after the maximum retry count or maximum timeout interval has been reached, whichever comes first. When the authentication process fails, only nonauthenticated lingoes and commands are usable. |
| (last byte) | 0x*NN* | Checksum |

## Command 0x18: RetDevAuthenticationSignature

Direction: Device to iPod

The device sends this command to the iPod in response to "Command 0x17: GetDevAuthenticationSignature" (page 86). The iPod verifies the digital signature, calculated by the device based on the offered challenge. If verification passes, the iPod authenticates the device and updates its lingo and command access permissions accordingly. The authentication status is sent to the device using "Command 0x19: AckDevAuthenticationStatus" (page 88).

**Table 2-40** `RetDevAuthenticationSignature` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x*NN* | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x18 | Command: `RetDevAuthenticationSignature` |
| 5 | 0x*NN*… | The digital signature calculated by the device, based on the offered challenge (variable length). |
| (last byte) | 0x*NN* | Checksum |

## Command 0x19: AckDevAuthenticationStatus

Direction: iPod to Device

The iPod sends this command to the device in response to the "Command 0x18: RetDevAuthenticationSignature" (page 87) command. It indicates the current device authentication state. If the device receives a nonzero status, the device has failed authentication and will only be able to use unauthenticated lingo commands.

If the device receives a zero status, the iPod has successfully authenticated the device. The device may then use the requested authenticated lingoes and commands. Optionally, the device may begin the process of authenticating the iPod, by sending "Command 0x1A: GetiPodAuthenticationInfo" (page 89).

**Table 2-41** `AckDevAuthenticationStatus` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x03 | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x19 | Command: `AckDevAuthenticationStatus` |
| 5 | 0x*NN* | Status of the authentication operation:<br>0x00 = Authentication operation passed<br>All other values = Authentication operation failed; see Table 2-13 (page 65) |
| 6 | 0x*NN* | Checksum |

## Command 0x1A: GetiPodAuthenticationInfo

Direction: Device to iPod

The device sends this command to obtain authentication information from the iPod. The device should send this command only if the device has indicated that it supports authentication during its identification process and the iPod has successfully authenticated the device. (Device authentication is successful when the device receives the "Command 0x19: AckDevAuthenticationStatus" (page 88) command with a status of 0x00). In response to `GetiPodAuthenticationInfo` the iPod sends "Command 0x1B: RetiPodAuthenticationInfo" (page 89).

**Table 2-42** `GetiPodAuthenticationInfo` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x02 | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x1A | Command: `GetiPodAuthenticationInfo` |
| 5 | 0xE4 | Checksum |

## Command 0x1B: RetiPodAuthenticationInfo

Direction: iPod to Device

The iPod returns this command in response to "Command 0x1A: GetiPodAuthenticationInfo" (page 89) from the device.

**Table 2-43** `RetiPodAuthenticationInfo` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x*NN* | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x1B | Command: `RetiPodAuthenticationInfo` |
| 5 | 0x02 | Authentication major version (0x02) |
| 6 | 0x00 | Authentication minor version (0x00) |

| Byte number | Value | Comment |
|---|---|---|
| 7 | 0x*NN*... | X.509 certificate current section index (0 = first section, 1 = second section, and so on) |
| 8 | 0x*NN* | X.509 certificate maximum section index (0 = one section total, 1 = two sections, and so on) |
| 9 | 0x*NN* | X.509 certificate data. If the data length exceeds 500 bytes it must be broken into sections, each not more than 500 bytes. |
| (last byte) | 0x*NN* | Checksum |

> **Note:** Authentication version 2.00 (major version 0x02, minor version 0x00) is the only version supported by iPods that can be authenticated by devices.

## Command 0x1C: AckiPodAuthenticationInfo

Direction: Device to iPod

The device sends this command to the iPod in response to "Command 0x1B: RetiPodAuthenticationInfo" (page 89). It indicates the current state of the iPod authentication information version. If the device sends a nonzero status, it indicates that it will not be able to authenticate the iPod due to an invalid X.509 certificate.

**Table 2-44** `AckiPodAuthenticationInfo` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x03 | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x1C | Command: `AckiPodAuthenticationInfo` |
| 5 | 0x*NN* | Status of the authentication information:<br>0x00 = authentication information valid<br>Other values = authentication information not valid |
| 6 | 0x*NN* | Checksum |

## Command 0x1D: GetiPodAuthenticationSignature

Direction: Device to iPod

The device uses this command to send an offered challenge to the iPod for digital signature. In response, the iPod returns its signed challenge to the device using "Command 0x1E: RetiPodAuthenticationSignature" (page 91). Accessories must implement the authentication retry feature described in "Command 0x17: GetDevAuthenticationSignature" (page 86), allowing the iPod two retries in 150 seconds. The retry counter must be set to 0x01 in the first `GetiPodAuthenticationSignature` command sent to the iPod and must be incremented for each subsequent attempt. Authentication must fail after either the retry count or maximum response interval have been exceeded since the first `GetiPodAuthenticationSignature` command was sent.

**Table 2-45** `GetiPodAuthenticationSignature` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x*NN* | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x1D | Command: `GetiPodAuthenticationSignature` |
| 5–24 | 0x*NN*... | An offered challenge for the iPod to sign and return (20 bytes) |
| 25 | 0x00 | Authentication retry counter. A maximum of two retries or 150 seconds, whichever happens first, should occur before the authentication process is terminated. |
| 26 | 0x*NN* | Checksum |

## Command 0x1E: RetiPodAuthenticationSignature

Direction: iPod to Device

The iPod sends this command to the device in response to "Command 0x1D: GetiPodAuthenticationSignature" (page 90). The device verifies the digital signature, calculated by the iPod based on the offered challenge, and, if verification passes, authenticates the iPod. The device sends the authentication status to the iPod using "Command 0x1F: AckiPodAuthenticationStatus" (page 92).

**Table 2-46** `RetiPodAuthenticationSignature` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x*NN* | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x1E | Command: `RetiPodAuthenticationSignature` |

| Byte number | Value | Comment |
|---|---|---|
| 5 … *N* | 0x*NN*... | The digital signature calculated by the iPod |
| (last byte) | 0x*NN* | Checksum |

## Command 0x1F: AckiPodAuthenticationStatus

Direction: Device to iPod

The device sends this command to the iPod in response to "Command 0x1E: RetiPodAuthenticationSignature" (page 91). It indicates the current iPod authentication state. The device should return a nonzero ACK for each failed authentication attempt.

**Table 2-47** `AckiPodAuthenticationStatus` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x03 | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x1F | Command: `AckiPodAuthenticationStatus` |
| 5 | 0x*NN* | Status of authentication information:<br>0x00 = authentication operation passed<br>Other values = authentication operation failed |
| 6 | 0x*NN* | Checksum |

## Command 0x23: NotifyiPodStateChange

Direction: iPod to Device

When the iPod power state is about to change, the iPod sends this notification command to devices that identify using IDPS or `IdentifyDeviceLingoes`. If the device identifies using the deprecated command `Identify`, this notification is not sent. The state change byte indicates the specific iPod state transition. If the iPod is switching from a Power On state to a Sleep state, devices must immediately reduce their power consumption below the 5 mA maximum current. When the iPod has transitioned to Hibernate state, self-powered accessories are expected to automatically reidentify themselves 80 ms after accessory power is restored.

**Table 2-48** `NotifyiPodStateChange` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x03 | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x23 | Command: `NotifyiPodStateChange` |
| 5 | 0x*NN* | `StateChg` (1 byte). The iPod state change. Possible values are:<br>0x00 = reserved.<br>0x01 = accessory power going to Hibernate state (no power) and not preserving menu selections or playback context (see “Power States” in *iPod/iPhone Hardware Specifications*).<br>0x02 = accessory power going to Hibernate state (no power) but preserving menu selections and playback context.<br>0x03 = accessory power going to Sleep state (less than 5 mA current).<br>0x04 = accessory power going to the Power On state.<br>0x05–0xFF = reserved. |
| 6 | 0x*NN* | Checksum |

**Note:** Firmware version 1.0.0 of the iPod nano reported the iPod state change incorrectly. The `StateChg` byte is decremented by 1, so that 0x00 represents a value of 0x01, 0x01 represents a value of 0x02, and so forth. All later versions of the nano firmware conform to the table above.

## Command 0x24: GetiPodOptions

Direction: Device to iPod

**IMPORTANT:** The preferred way to obtain information about the capabilities of an attached iPod is to send "Command 0x4B: GetiPodOptionsForLingo" (page 132). New accessory designs must send `GetiPodOptionsForLingo` first. If and only if an ACK command with Bad Parameter status (0x04) is returned, then the accessory may send `GetiPodOptions` instead.

The accessory device sends this command to ask the iPod to return a 64-bit field that defines the options that the iPod supports. In response, the iPod sends a `RetiPodOptions` command.

**Table 2-49** `GetiPodOptions` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |

| Byte number | Value | Comment |
|---|---|---|
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x02 | Length of packet |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x24 | Command ID: `GetiPodOptions` |
| 5 | 0xDA | Checksum |

## Command 0x25: RetiPodOptions

Direction: iPod to Device

The iPod sends this command in response to a `GetiPodOptions` command from the accessory.

**Table 2-50** `RetiPodOptions` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x0A | Length of packet |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x25 | Command ID: `RetiPodOptions` |
| 5 | 0x*NN* | Option bits (bits 63:56): Reserved |
| 6 | 0x*NN* | Option bits (bits 55:48): Reserved |
| 7 | 0x*NN* | Option bits (bits 47:40): Reserved |
| 8 | 0x*NN* | Option bits (bits 39:32): Reserved |
| 9 | 0x*NN* | Option bits (bits 31:24): Reserved |
| 10 | 0x*NN* | Option bits (bits 23:16): Reserved |
| 11 | 0x*NN* | Option bits (bits 15:8): Reserved |
| 12 | 0x*NN* | Option bits (bits 7:0):<br>Bit 1: iPod supports using `SetiPodPreferences` to control line-out usage<br>Bit 0: iPod supports video output |
| 13 | 0x*NN* | Checksum |

## Command 0x27: GetAccessoryInfo

Direction: iPod to Device

The iPod sends this command to devices that identify themselves using the `IdentifyDeviceLingoes` command to obtain certain information from the accessory. The accessory must respond with a `RetAccessoryInfo` command for the required accessory Info Types. The iPod will use the information gathered to:

- Display accessory information in the Settings:About box on the iPod
- Display a message to the user if the iPod firmware needs to be updated to support the accessory
- Display a message to the user if the iPod firmware does not support the accessory

The `GetAccessoryInfo` command sends the Accessory Info Type and the Accessory Info Type parameters to the accessory. Table 2-52 (page 96) lists the number of parameter bytes for the corresponding Accessory Info Types. The iPod requests each of the Accessory Info Types in the order in which they appear in Table 2-52 (page 96). Because the Accessory minimum supported iPod firmware version request (which sends the iPod model number as a parameter) is sent before any Accessory minimum supported lingo version requests, the accessory has the option of changing its responses to those appropriate for the iPod model.

When the `GetAccessoryInfo` command is sent with the accessory minimum supported iPod firmware version info type, the 4-byte iPod model number and the 3-byte iPod firmware version are sent as parameters. See "Command 0x0E: ReturniPodModelNum" (page 73) for the model number format and "Command 0x0A: ReturniPodSoftwareVersion" (page 71) for the firmware version format.

When the `GetAccessoryInfo` command is sent with the accessory minimum supported lingo version info type, the 1-byte lingo number for which the iPod is requesting the minimum supported version is sent as a parameter. The iPod will send the `GetAccessoryInfo` command with this Accessory Info Type for every lingo that the accessory indicates it supports.

The iPod begins sending `GetAccessoryInfo` commands as soon as an accessory identifies itself successfully via the `IdentifyDeviceLingoes` command and either enters the background authentication state or does not request authentication. If the accessory does not respond, the iPod waits 5 seconds for a response before timing out and retrying. It retries a maximum of three times.

**Table 2-51** `GetAccessoryInfo` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART transport) |
| 1 | 0x55 | Start of packet |
| 2 | 0x*NN* | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x27 | Command ID: `GetAccessoryInfo` |
| 5 | 0x*NN* | Accessory Info Type (see Table 2-52 (page 96)) |
| n... | 0x*NN*... | Accessory Info Type parameters (see Table 2-52 (page 96) for length) |

| Byte number | Value | Comment |
|---|---|---|
| (last byte) | 0x*NN* | Checksum |

**Table 2-52** Accessory Info Type values

| Value | Meaning | Bytes | Requirement |
|---|---|---|---|
| 0x00 | Accessory info capabilities | 0 | Required |
| 0x01 | Accessory name | 0 | Required |
| 0x02 | Accessory minimum supported iPod firmware version | 7 | Optional |
| 0x03 | Accessory minimum supported lingo version | 1 | Optional |
| 0x04 | Accessory firmware version | 0 | Required |
| 0x05 | Accessory hardware version | 0 | Required |
| 0x06 | Accessory manufacturer | 0 | Required |
| 0x07 | Accessory model number | 0 | Required |
| 0x08 | Accessory serial number | 0 | Optional |
| 0x09 | Accessory incoming maximum payload size | 0 | Optional |
| 0x0A-0xFF | Reserved | | |

**Table 2-53** `GetAccessoryInfo` packet with Accessory Info Type = 0x02

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART transport) |
| 1 | 0x55 | Start of packet |
| 2 | 0x0A | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x27 | Command ID: `GetAccessoryInfo` |
| 5 | 0x02 | Accessory Info Type (see Table 2-56 (page 98)) |
| 6 | 0x*NN* | iPod Model ID (bits 31:24) |
| 7 | 0x*NN* | iPod Model ID (bits 23:16) |
| 8 | 0x*NN* | iPod Model ID (bits 15:8) |
| 9 | 0x*NN* | iPod Model ID (bits 7:0) |

| Byte number | Value | Comment |
|---|---|---|
| 10 | 0x*NN* | iPod firmware major version number |
| 11 | 0x*NN* | iPod firmware minor version number |
| 12 | 0x*NN* | iPod firmware revision version number |
| 13 | 0x*NN* | Checksum |

**Table 2-54** `GetAccessoryInfo` packet with Accessory Info Type = 0x03

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART transport) |
| 1 | 0x55 | Start of packet |
| 2 | 0x04 | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x27 | Command ID: `GetAccessoryInfo` |
| 5 | 0x03 | Accessory Info Type (see Table 2-56 (page 98)) |
| 6 | 0x*NN* | Lingo ID |
| 7 | 0x*NN* | Checksum |

## Command 0x28: RetAccessoryInfo

Direction: Device to iPod

The accessory device must reply with this command to every receipt of command 0x27, `GetAccessoryInfo`, from the iPod. The data contained in the packet must be responsive to the Accessory Info Type requested by the iPod.

When the `RetAccessoryInfo` command is returning the accessory info capabilities, a bit-field is returned where every set bit represents a supported Accessory Info Type. See Table 2-51 (page 95) for a description of the Accessory Info Type; see Table 2-56 (page 98) for the meanings of its bytes.

**Table 2-55** `RetAccessoryInfo` packet with Accessory Info Type = 0x00

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART transport) |
| 1 | 0x55 | Start of packet |
| 2 | 0x07 | Length of packet payload |

| Byte number | Value | Comment |
|---|---|---|
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x28 | Command ID: `RetAccessoryInfo` |
| 5 | 0x00 | Accessory Info Type. See Table 2-56 (page 98) |
| 6 | 0x*NN* | Accessory capabilities, bits 31:24; see Table 2-57 (page 98)) |
| 7 | 0x*NN* | Accessory capabilities, bits 23:16 |
| 8 | 0x*NN* | Accessory capabilities, bits 15:8 |
| 9 | 0x*NN* | Accessory capabilities, bits 7:0 |
| 10 | 0x*NN* | Checksum |

**Table 2-56** Accessory Info Type values for RetAccessoryInfo

| Value | Meaning | Parameter bytes |
|---|---|---|
| 0x00 | Accessory info capabilities | 4 |
| 0x01 | Accessory name | 1–64 |
| 0x02 | Accessory minimum supported iPod firmware version | 7 |
| 0x03 | Accessory minimum supported lingo version | 3 |
| 0x04 | Accessory firmware version | 3 |
| 0x05 | Accessory hardware version | 3 |
| 0x06 | Accessory manufacturer | 1–64 |
| 0x07 | Accessory model number | 1–64 |
| 0x08 | Accessory serial number | 1–64 |
| 0x09 | Accessory incoming maximum payload size | 2 |
| 0x0A-0xFF | Reserved | N/A |

**Table 2-57** Accessory Capabilities bit field

| Bit | Capability supported | Accessory requirement |
|---|---|---|
| 0 | Accessory info capabilities | Required; set to 1 |
| 1 | Accessory name | Required; set to 1 |
| 2 | Accessory minimum supported iPod firmware version | Optional |

| Bit | Capability supported | Accessory requirement |
|---|---|---|
| 3 | Accessory minimum supported lingo version | Optional |
| 4 | Accessory firmware version | Required; set to 1 |
| 5 | Accessory hardware version | Required; set to 1 |
| 6 | Accessory manufacturer | Required; set to 1 |
| 7 | Accessory model number | Required; set to 1 |
| 8 | Accessory serial number | Optional |
| 9 | Accessory incoming max packet size | Optional |
| 10–31 | Reserved | N/A |

**IMPORTANT:** Accessories must provide capability information for all required items listed in Table 2-57 (page 98).

The accessory name, manufacturer, model number, and serial number are sent as UTF-8 character arrays and must be less than or equal to 64 bytes (including a null termination character). See Table 2-57 (page 98) for details. Note that even if this condition is met, the iPod may not be capable of displaying all the characters in the array in its About box.

**Table 2-58** `RetAccessoryInfo` packet with Accessory Info Type = 0x01/0x06/0x07/0x08

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART transport) |
| 1 | 0x55 | Start of packet |
| 2 | 0x*NN* | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x28 | Command ID: `RetAccessoryInfo` |
| 5 | 0x*NN* | Accessory Info Type. See Table 2-56 (page 98) |
| 6... | 0x*NN*... | Null-terminated UTF-8 character array |
| (last byte) | 0x*NN* | Checksum |

When the accessory returns the 3-byte minimum supported iPod firmware major/minor/revision version it requires, it also returns the 4-byte iPod model ID. The accessory should therefore store all the model numbers of iPods that support it, along with their corresponding minimum supported iPod firmware versions.

If an unknown or unsupported iPod model ID is sent to the accessory, the accessory should return the `RetAccessoryInfo` command with the iPod Model ID and 0xFF as the iPod firmware major/minor/revision version numbers.

**Table 2-59** `RetAccessoryInfo` packet with Accessory Info Type = 0x02

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART transport) |
| 1 | 0x55 | Start of packet |
| 2 | 0x0A | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x28 | Command ID: `RetAccessoryInfo` |
| 5 | 0x02 | Accessory Info Type. See Table 2-56 (page 98) |
| 6 | 0x*NN* | iPod Model ID (bits 31:24) |
| 7 | 0x*NN* | iPod Model ID (bits 23:16) |
| 8 | 0x*NN* | iPod Model ID (bits 15:8) |
| 9 | 0x*NN* | iPod Model ID (bits 7:0) |
| 10 | 0x*NN* | minimum supported iPod firmware major version |
| 11 | 0x*NN* | minimum supported iPod firmware minor version |
| 12 | 0x*NN* | minimum supported iPod firmware revision version |
| 13 | 0x*NN* | Checksum |

If the accessory's minimum supported iPod firmware version is higher than the iPod firmware version, and one or more of the lingo version numbers is higher than that supported by the iPod, the iPod will display a message to the user indicating that the iPod firmware should be updated.

If the accessory's minimum supported iPod firmware version is smaller than or equal to the iPod firmware version or any of the major/minor/revision numbers are 0xFF, and one or more of the lingo version numbers is higher than that supported by the iPod, the iPod will display a message to the user indicating that the iPod does not support the accessory.

**Table 2-60** `RetAccessoryInfo` packet with Accessory Info Type = 0x03

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART transport) |
| 1 | 0x55 | Start of packet |
| 2 | 0x06 | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x28 | Command ID: `RetAccessoryInfo` |

| Byte number | Value | Comment |
|---|---|---|
| 5 | 0x03 | Accessory Info Type. See Table 2-56 (page 98) |
| 6 | 0x*NN* | Lingo ID |
| 7 | 0x*NN* | Major protocol version for lingo ID |
| 8 | 0x*NN* | Minor protocol version for lingo ID |
| 9 | 0x*NN* | Checksum |

**Table 2-61** `RetAccessoryInfo` packet with Accessory Info Type = 0x04/0x05

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART transport) |
| 1 | 0x55 | Start of packet |
| 2 | 0x06 | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x28 | Command ID: `RetAccessoryInfo` |
| 5 | 0x*NN* | Accessory Info Type. See Table 2-56 (page 98) |
| 6 | 0x*NN* | Accessory major version number |
| 7 | 0x*NN* | Accessory minor version number |
| 8 | 0x*NN* | Accessory revision version number |
| 9 | 0x*NN* | Checksum |

The accessory's incoming maximum payload size indicates the maximum size of a packet from the iPod that the accessory can support. If the accessory does not return a value, the iPod assumes that the maximum payload size is 1024 bytes. The maximum payload size must be bigger or equal to 128 bytes and smaller or equal to 65536 bytes.

Only iPod packets that contain a UTF-8 character array can be larger than maximum payload size. In that case, the iPod will insert a null termination character into the UTF-8 array to force it to fit into the packet. This does not apply to commands that allow multipacket responses.

**Note:** The maximum payload size restriction does not apply to General lingo packets related to authentication.

**Table 2-62** `RetAccessoryInfo` packet with Accessory Info Type = 0x09

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART transport) |

| Byte number | Value | Comment |
|---|---|---|
| 1 | 0x55 | Start of packet |
| 2 | 0x05 | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x28 | Command ID: `RetAccessoryInfo` |
| 5 | 0x09 | Accessory Info Type. See Table 2-56 (page 98) |
| 6 | 0x*NN* | Max payload size (bits 15:8) |
| 7 | 0x*NN* | Max payload size (bits 7:0) |
| 8 | 0x*NN* | Checksum |

## Command 0x29: GetiPodPreferences

Direction: Device to iPod

The accessory device sends this command to ask the iPod to return a specific class of preferences set on it, as defined by a preference class ID. In response, the iPod sends a `RetiPodPreferences` command.

**Table 2-63** `GetiPodPreferences` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x03 | Length of packet |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x29 | Command ID: `GetiPodPreferences` |
| 5 | 0x*NN* | Preference class ID (see Table 2-64 (page 103)). Class IDs 0x00-0x02, 0x08-0x0A, and 0x0C-0x0D are available only if the iPod supports video playback; see "Video Output Preferences" (page 41). Class ID 0x03 is available only if the iPod supports line-out usage. |
| 6 | 0x*NN* | Checksum |

**Table 2-64** iPod preference class and setting IDs

| Class ID | Preference | Setting | Setting ID | Description |
|---|---|---|---|---|
| 0x00 | Video out setting | Off | 0x00 | Disables iPod video output of any kind. |
| | | On | 0x01 | Enables iPod video output based on the other video preferences (NTSC/PAL, screen configuration, etc.). |
| | | Ask user | 0x02 | If the iPod is not in extended interface mode, makes the UI ask the user to select the video output on/off setting when video playback is started. When the iPod enters extended interface mode, video output mode is automatically enabled. The accessory must not select this setting after entering extended interface mode because the UI will be locked out. |
| | | Reserved | 0x03–0xFF | |
| 0x01 | Screen configuration | Fill entire screen | 0x00 | Expand the video image to fill the entire screen without letterbox or pillarbox black bars. The "square" pixel proportions are preserved by enlarging both vertical and horizontal dimensions by the same percentage. Depending on the iPod media source and video monitor destination aspect ratios, this may result in cutting off the top and bottom or left and right edges of the image; see Note 1, below. |
| | | Fit to screen edge | 0x01 | Expand the video image to screen edge. The iPod enlarges the source media so that its top and bottom or left and right edges end at the screen edge without losing any vertical or horizontal image information. The "square" pixel vertical and horizontal proportions are preserved by being enlarged by the same percentage. Depending on the iPod media source and video monitor destination aspect ratio, this may result in adding either letterbox black bars at the top and bottom of the screen or pillarbox black bars at the left and right of the screen; see Note 2, below. |
| | | Reserved | 0x02–0xFF | |
| 0x02 | Video signal format | NTSC | 0x00 | NTSC video format and timing. |
| | | PAL | 0x01 | PAL video format and timing. |
| | | Reserved | 0x02-0xFF | |

| Class ID | Preference | Setting | Setting ID | Description |
|---|---|---|---|---|
| 0x03 | Line-out usage | Not used | 0x00 | Line-out disabled. |
| | | Used | 0x01 | Line-out enabled. |
| | | Reserved | 0x02-0xFF | |
| 0x04-0x07 | Reserved | | | |
| 0x08 | Video-out connection | None | 0x00 | No connection. |
| | | Composite | 0x01 | Composite video connection (interlaced video only). |
| | | S-video | 0x02 | S-video video connection (interlaced video only). |
| | | Component | 0x03 | Component Y/Pr/Pb video connection (interlaced or progressive scan, depending on the iPod model). |
| | | Reserved | 0x04-0xFF | |
| 0x09 | Closed captioning | Off | 0x00 | Closed caption signalling is disabled. |
| | | On | 0x01 | The iPod overlays closed caption text on the video content before outputting the video signal. The text is not present on line 21, so the video monitor cannot do any closed caption processing. **Note:** Closed captions and subtitles cannot be enabled at the same time. |
| | | Reserved | 0x02-0xFF | |
| 0x0A | Video monitor aspect ratio | 0x00 | 4:3 aspect ratio (fullscreen) | Used when the video output destination monitor has a horizontal to vertical aspect ratio of 4 to 3, such as an original television monitor format. Depending on the media source format and screen configuration preference, the media content may be displayed fullscreen or have letterbox bars. iPods that support widescreen signaling use it to send aspect ratio information to the monitor. |
| | | 0x01 | 16:9 aspect ratio (widescreen) | Used when the video output destination monitor has a horizontal to vertical aspect ratio of 16 to 9, such as the widescreen theater format. Depending on the media source format and screen configuration preference, the media content may be displayed widescreen or have pillarbox bars. iPods that support widescreen signaling use it to send aspect ratio information to the monitor. |
| | | Reserved | 0x02-0xFF | |

| Class ID | Preference | Setting | Setting ID | Description |
|---|---|---|---|---|
| 0x0B | Reserved | | | |
| 0x0C | Subtitles (see Note 3, below) | 0x00 | Subtitles off | Subtitle overlays are disabled. |
| | | 0x01 | Subtitles on | The iPod overlays subtitle text on the video content before outputting the video signal. The video monitor does not need to do any subtitle processing. **Note:** Closed captions and subtitles cannot be enabled at the same time. |
| | | Reserved | 0x02-0xFF | |
| 0x0D | Video alternate audio channel | 0x00 | Alternate audio off | The alternate audio channel is disabled. |
| | | 0x01 | Alternate audio on | The alternate audio channel is enabled. |
| | | Reserved | 0x02-0xFF | |
| 0x0E-0xFF | Reserved | | | |

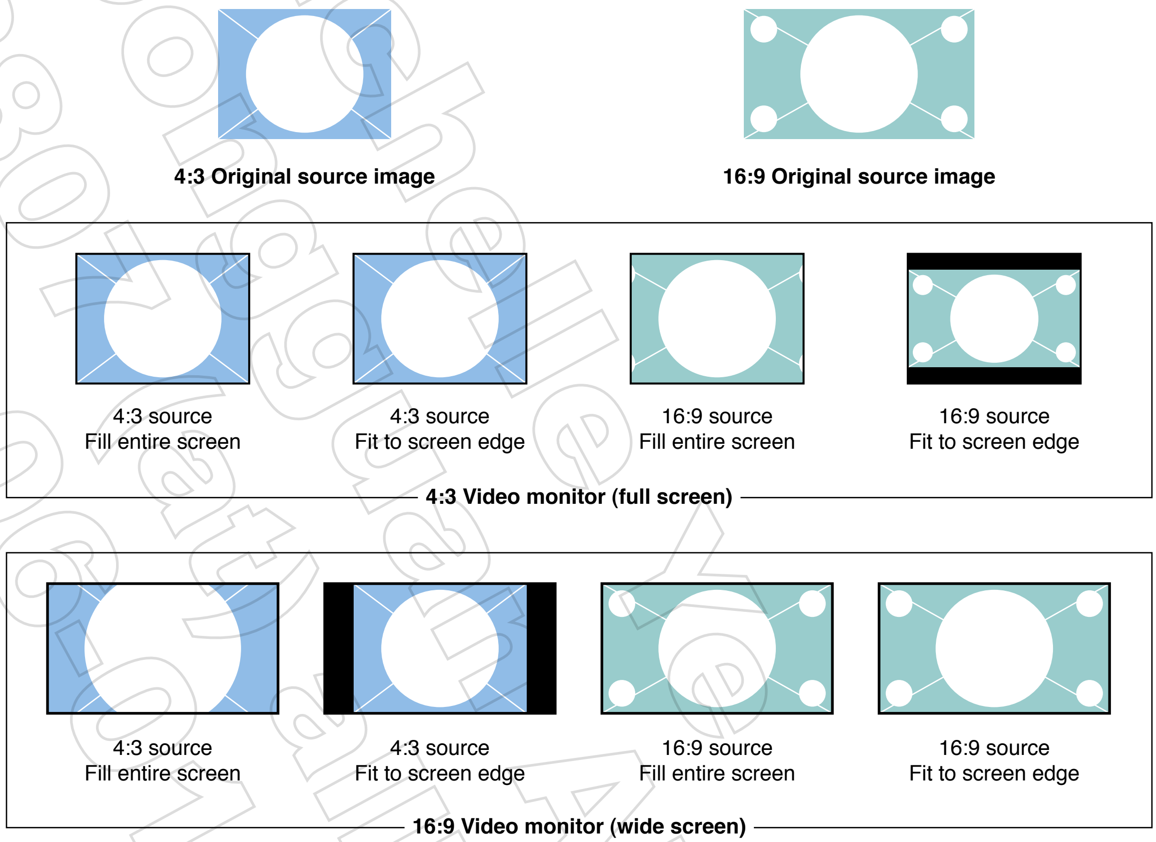
**Notes** to Table 2-64 (page 103):

1. If the source media has a 4:3 (fullscreen) aspect ratio and the destination monitor has a 16:9 (widescreen) aspect ratio, the video is enlarged to eliminate the pillarbox bars normally present on the left and right of the screen. This may result in the top and bottom edges of the video being enlarged beyond the limits of the screen and cut off. If the source media has a 16:9 (widescreen) aspect ratio and the destination monitor has a 4:3 (fullscreen) aspect ratio, the video is enlarged to eliminate the letterbox bars normally present on the top and bottom of the screen. This may result in the left and right edges of the video being enlarged beyond the limits of the screen and cut off. See Figure 2-1 (page 106).

2. If the source media has a 4:3 (fullscreen) aspect ratio and the destination monitor has a 16:9 (widescreen) aspect ratio, the video is enlarged so that the image fills the screen vertically, but it may have pillarbox black bars on the left and right edges of the screen. If the source media has a 16:9 (widescreen) aspect ratio and the destination monitor has a 4:3 (fullscreen) aspect ratio, the video is enlarged so that the image fills the screen horizontally, but it may have letterbox black bars on the top and bottom edges of the screen. See Figure 2-1 (page 106).

3. On the iPod touch, subtitle display is not a global setting; it is set for each content item.

**Figure 2-1** Screen configuration examples




**Authentication Note:** To receive video signals from the iPhone and from most iPods, and to set their preferences, an accessory must be authenticated; the only class ID that an accessory can get or set without being authenticated is 0x03 (line-out usage). For the best user experience, the iPod should be configured to the device's line out and video out preferences as soon as possible. If a device has not set its preferences, the iPod will make assumptions based on the device's Accessory Identify Resistor and declared lingoes. These assumptions may not match the device's needs, so it is strongly recommended that devices set their iPod preferences promptly. The earliest time at which a device can set its video preferences is immediately after the iPod sends it an `AckDevAuthenticationInfo` command with a value of 0x00 (success status). The 5G iPod is exempt from the authentication requirement.

## Command 0x2A: RetiPodPreferences

Direction: iPod to Device

The iPod sends this command in response to a `GetiPodPreferences` command from the accessory. In byte 5 it echoes the requested preference class ID, and in byte 6 it sends the current preference setting for that class.

**Table 2-65** `RetiPodPreferences` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x04 | Length of packet |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x2A | Command ID: `RetiPodPreferences` |
| 5 | 0x*NN* | Preference class ID (see Table 2-64 (page 103)) |
| 6 | 0x*NN* | Preference setting ID (see Table 2-64 (page 103)) |
| 7 | 0x*NN* | Checksum |

## Command 0x2B: SetiPodPreferences

Direction: Device to iPod

The accessory device sends this command to the iPod to set a specific preference. It sends the preference class ID in byte 5 and the setting ID in byte 6. If byte 7, restore on exit, is set to 0x01, then the iPod restores the original setting for this preference when the accessory is disconnected; if it is 0x00, it does not perform the restore. Other values of byte 7 are illegal.

**Note:** This command fails if the iPod does not detect a valid $R_{ID}$ resistor. See "Accessory Detect and Identify" in *iPod/iPhone Hardware Specifications.*

Although iPod options need not be used to turn on video output from the iPod, the iPod has no default settings. It will reflect the options the user has entered in its settings menu, for which the accessory should not make any assumptions. The following are recommended option-setting practices for accessory designs:

- The accessory should set the video signal format (NTSC or PAL) to ensure signal compatibility with the attached display.
- The accessory should set the video monitor aspect ratio, if possible, to ensure image compatibility with the attached display.
- The accessory should select the audio output path (line out or digital audio out) to ensure that audio will be routed appropriately with its associated video.
- The accessory should always select the Restore on Exit flag to return the iPod to its previous state when it is disconnected.

**Note:** Video preferences must be set after the authentication process has begun and after the device has received an `AckDevAuthenticationInfo` command with a value of 0x00. Attempts to set it earlier will result in an ACK command with an error status. See "Authentication Note" (page 106).

**Table 2-66** `SetiPodPreferences` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x05 | Length of packet |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x2B | Command ID: `SetiPodPreferences` |
| 5 | 0x*NN* | Preference class ID (see Table 2-64 (page 103)) |
| 6 | 0x*NN* | Preference setting ID (see Table 2-64 (page 103)) |
| 7 | 0x*NN* | Restore on exit |
| 8 | 0x*NN* | Checksum |

**Note:** The iPod line-out state is always restored, regardless of the Restore-on-Exit setting. On some iPods, the video-out state is also always restored, regardless of the Restore-on-Exit setting.

## Command 0x38: StartIDPS

Direction: Device to iPod

This command is sent by the accessory to start the Identify Device Preferences and Settings (IDPS) process. When the iPod sends a General lingo `ACK` command with a status of Success (0x00) in response to `StartIDPS`, it enters the IDPS process described in "Using IDPS" (page 445). If the accessory sends `StartIDPS` again, while the iPod is in the IDPS process, the iPod will restart the IDPS process.

If the iPod sends a General lingo `ACK` command with a status of Maximum Connections (0x15) the accessory must not continue with IDPS or any other identification process, because the iPod has already reached its maximum allowed number of accessory connections.

The accessory must start and complete the IDPS process (defined as sending `EndIDPS` successfully) within a total time of 3 seconds after the rising edge of power from the iPod or iPhone on pin 13 (Accessory Power) of the 30-pin connector. The accessory may continue the IDPS process only after it has received an `ACK` response to `StartIDPS` whose transaction ID matches that of the accessory's most recent `StartIDPS` command. Each `StartIDPS` command renders previous `StartIDPS` commands invalid, even if they are subsequently acknowledged.

After the IDPS process has finished, the iPod sends the accessory an `IDPSStatus` command. If this command indicates an unsuccessful IDPS process, the accessory can retry `StartIDPS` within the 3-second total time limit. If the IDPS process times out, the accessory won't be able to retry IDPS unless it is detached and re-attached, or the iPod sends a `RequestIdentify` command.

If the accessory is in the IDPS process and cannot complete it successfully, it must send `EndIDPS` with a status value of 0x02 before either retrying IDPS or sending `IdentifyDeviceLingoes`. If the accessory does this within 3 seconds of sending `StartIDPS`, the iPod will send an `IDPSStatus` of 0x04 and will let the accessory retry the IDPS process or send `IdentifyDeviceLingoes`. If the accessory fails to do this within 3 seconds of sending `StartIDPS`, the iPod will not let the accessory retry IDPS and will send an `IDPSStatus` of 0x05 in response to the accessory's `EndIDPS` command. After that, the iPod will accept only `IdentifyDeviceLingoes`.

If an accessory has already completed IDPS successfully, inadvertently sending a `StartIDPS` or `IdentifyDeviceLingoes` command resets its authentication and identification states. The accessory must repeat the IDPS and authentication processes.

When an iPod transitions from sleep to power on, it sends a `RequestIdentify` command to the accessory. The accessory must respond with `StartIDPS` and go through the IDPS process. After an iPod transitions from hibernation and the accessory detects accessory power, the accessory must wait at least 80 ms, send `StartIDPS`, and complete the IDPS process.

**Table 2-67** `StartIDPS` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x04 | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x38 | Command ID: `StartIDPS` |
| 5 | 0x*NN* | `transID` [bits 15:8]: Transaction ID; see "Transaction IDs" (page 451). |
| 6 | 0x*NN* | `transID` [bits 7:0] |
| 7 | 0x*NN* | Checksum |

## Command 0x39: SetFIDTokenValues

Direction: Device to iPod

During the IDPS process, the accessory uses this command to send the iPod a full ID string (FID). This string contains token-value fields that the iPod is able to parse during the accessory identification process. The iPod accepts this command only if the accessory previously initiated the IDPS process by sending a `StartIDPS` command.

The accessory may send this command multiple times with different transaction IDs, but it must put as many token-value fields as possible into each command. No command may exceed a value of 500 bytes in its length-of-packet-payload field. The accessory must wait for the iPod to respond to each `SetFIDTokenValues` command with a `RetFIDTokenValueACKs` command before sending the next. If the same token is sent multiple times, the last value will be stored. If a `SetFIDTokenValues` packet is malformed and the iPod cannot parse one or more token-value fields, the iPod will responds by sending a General lingo `ACK` command with a nonzero status.

> **Note:** The accessory must send certain token-value fields to the iPod before the accessory can send `EndIDPS` to complete the IDPS process and proceed with authentication. See Table 2-70 (page 111) for these requirements.

**Table 2-68** `SetFIDTokenValues` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x*NN* | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x39 | Command ID: `SetFIDTokenValues` |
| 5 | 0x*NN* | `transID` [bits 15:8]: Transaction ID; see "Transaction IDs" (page 451). |
| 6 | 0x*NN* | `transID` [bits 7:0] |
| 7 | 0x*NN* | `numFIDTokenValues`: The number of token-value fields the device is setting by this command. If the number of token-value fields the iPod parses from the command doesn't match this value, the iPod returns a nonzero `ACK` and accepts no token-value fields. |
| 8-0x*NN* | 0x*NN* | `FIDTokenValues`: Token-value fields containing information the device sends to the iPod before going through authentication. See Table 2-69 (page 110) for the format of each field. |
| (last byte) | 0x*NN* | Checksum |

**Table 2-69** `FIDTokenValues` field format

| Byte | Size | Name | Description |
|---|---|---|---|
| 0 | 0x01 | `length` | Length of this token-value field in bytes, not including this byte. |
| 1 | 0x01 | `InfoByteOne` | First byte of token ID; see Table 2-70 (page 111). |
| 2 | 0x01 | `InfoByteTwo` | Second byte of token ID; see Table 2-70 (page 111). |
| 3-*NN* | 0x*NN* | `data` | Data corresponding to token; see Table 2-71 (page 112) through Table 2-80 (page 115). All multibyte elements in the `data` field must be big-endian. |

**Table 2-70** FIDTokenValues tokens

| infoByteOne | infoByteTwo | Token name | Requirements | Format |
|---|---|---|---|---|
| 0 | 0 | IdentifyToken | Required; must be the first token sent. | See Table 2-71 (page 112). |
| 0 | 1 | AccCapsToken | Required | See Table 2-73 (page 113). |
| 0 | 2 | AccInfoToken | Accessory Info Types 0x01, 0x04, 0x05, 0x06, and 0x07 required; other types optional. See Table 2-76 (page 114). | See Table 2-75 (page 113). |
| 0 | 3 | iPodPreferenceToken | Recommended | See Table 2-77 (page 114). |
| 0 | 4 | SDKProtocolToken | Required for accessories that communicate with iPhone OS applications. | See Table 2-78 (page 114). |
| 0 | 5 | BundleSeedIDPref-Token | Required for accessories that communicate with iPhone OS applications. | See Table 2-79 (page 115). |
| 1 | 0 | MicrophoneCapsToken | Required if the accessory includes the Microphone lingo in its IdentifyToken value; see Table 2-71 (page 112). | See Table 2-80 (page 115). |

**Note:** The IDPS process will fail unless the iPod successfully receives all the tokens listed as required in Table 2-70 (page 111). The IdentifyToken token must be sent at the beginning of the first SetFIDTokenValues packet. For the best user experience, the accessory should also return all the recommended tokens that it supports.

The accessory will also fail the IDPS process if it tries to set a preference in the iPodPreferenceToken that requires an accessory capability not previously declared in the AccCapsToken. An example of such a failure would be to declare no line-out support in the AccCapsToken but then try to set a line-out usage preference in the iPodPreferenceToken.

Although an iPodPreferenceToken is not required, iPods do not have default settings and the accessory should make no assumptions about their preferences. During the IDPS process, the accessory should set every preference it will require. The accessory can later change iPod preferences by using the General lingo SetiPodPreferences command.

**Table 2-71** `IdentifyToken` format

| Name | Bytes | Value | Description |
|---|---|---|---|
| `length` | 1 | 0x*NN* | Length of this token-value field in bytes, not including this byte. |
| `infoByteOne` | 1 | 0x00 | First byte of token ID. |
| `infoByteTwo` | 1 | 0x00 | Second byte of token ID. |
| `numLingoes` | 1 | 0x*NN* | Number of bytes in `accessoryLingoes`. |
| `accessoryLingoes` | *NN* | <var> | One byte for each lingo the accessory supports. For example, 0x00, 0x02, and 0x04 = General lingo + Simple Remote lingo + Extended Interface lingo, with `numLingoes` set to 0x03 and `length` set to 0x0C. The General lingo (0x00) must always be included. |
| `DeviceOptions` | 4 | 0x*NNNNNNNN* | Accessory's device options; see Table 2-72 (page 112). The accessory must request immediate Authentication 2.0. |
| `DeviceID` | 4 | 0x*NNNNNNNN* | Accessory's unique identifier, supplied by its iPod Authentication Coprocessor. |

**Table 2-72** `DeviceOptions` bits in `IdentifyToken`

| Bits | Meaning |
|---|---|
| 1:0 | Authentication control bits. These bits have the following meanings:<br>00 = no authentication is supported or required<br>01 = reserved<br>10 = authenticate immediately after identification (required for Authentication 2.0).<br>11 = reserved |
| 3:2 | Power control bits. These bits have the following meanings:<br>00 = low power only; device requires not more than 5 mA power from the iPod at any time<br>01 = intermittent high power; device requires more than 5 mA power from iPod (up to 100mA maximum) during playback operation<br>10 = reserved<br>11 = constant high power; device requires more than 5 mA power from iPod (up to 100 mA maximum) at all times. This mode must not be declared unless the accessory provides power as specified in "Supplying USB Power" in *iPod/iPhone Hardware Specifications*. |
| 31:4 | Reserved; set to 0 |

**Table 2-73** `AccCapsToken` format

| Name | Bytes | Value | Description |
|---|---|---|---|
| `length` | 1 | 0x0A | Length of this token-value field in bytes, not including this byte. |
| `infoByteOne` | 1 | 0x00 | First byte of token ID. |
| `infoByteTwo` | 1 | 0x01 | Second byte of token ID. |
| `accCapsBitmask` | 8 | 0x*NNNNNNNNNNNNNNNN* | Accessory capabilities; see Table 2-74 (page 113). |

**Table 2-74** Accessory capabilities bit values

| Bit | Accessory capability |
|---|---|
| 00 | Analog line-out (accessory consumes iPod line-out) |
| 01 | Analog line-in (accessory supplies line-in to iPod) |
| 02 | Analog video-out (accessory consumes iPod video-out) |
| 03 | Reserved (set to 0) |
| 04 | USB audio (accessory consumes iPod digital audio) |
| 05-08 | Reserved (set to 0) |
| 09 | Accessory supports communication with an iPhone OS application. |
| 10 | Reserved (set to 0) |
| 11 | Accessory checks iPod volume, either by registering for Display Remote lingo notifications or by sending `GetiPodStateInfo` commands with an `infoType` of 0x04 or 0x10. |
| 12–63 | Reserved (set to 0) |

**Table 2-75** `AccInfoToken` format

| Name | Bytes | Value | Description |
|---|---|---|---|
| `length` | 1 | 0x*NN* | Length of this token-value field in bytes, not including this byte. |
| `infoByteOne` | 1 | 0x00 | First byte of token ID. |
| `infoByteTwo` | 1 | 0x02 | Second byte of token ID. |
| `accInfoType` | 1 | 0x*NN* | Accessory info type; see Table 2-76 (page 114). |
| `accInfo` | *NN* | <var> | Accessory info; see Table 2-76 (page 114). |

**Table 2-76** Accessory Info Type values

| Value | Meaning | Parameter |
|---|---|---|
| 0x00 | Reserved | |
| 0x01 | Accessory name | Null-terminated UTF-8 string (64 bytes maximum, including terminator) |
| 0x02 | Reserved | |
| 0x03 | Reserved | |
| 0x04 | Accessory firmware version | 3 bytes |
| 0x05 | Accessory hardware version | 3 bytes |
| 0x06 | Accessory manufacturer | Null-terminated UTF-8 string (64 bytes maximum, including terminator) |
| 0x07 | Accessory model number | Null-terminated UTF-8 string (64 bytes maximum, including terminator) |
| 0x08 | Accessory serial number | Null-terminated UTF-8 string (64 bytes maximum, including terminator) |
| 0x09 | Accessory incoming maximum payload size | 2 bytes |
| 0x0A–0xFF | Reserved | |

**Table 2-77** `iPodPreferenceToken` format

| Name | Bytes | Value | Description |
|---|---|---|---|
| `length` | 1 | 0x05 | Length of this token-value field in bytes, not including this byte. |
| `infoByteOne` | 1 | 0x00 | First byte of token ID. |
| `infoByteTwo` | 1 | 0x03 | Second byte of token ID. |
| `iPodPrefClass` | 1 | 0x*NN* | iPod preference class ID; see Table 2-64 (page 103). |
| `prefClassSetting` | 1 | 0x*NN* | iPod preference setting ID; see Table 2-64 (page 103). |
| `restoreOnExit` | 1 | 0x01 | Must be set to 0x01. |

**Table 2-78** `SDKProtocolToken` format

| Name | Bytes | Value | Description |
|---|---|---|---|
| `length` | 1 | 0x*NN* | Length of this token-value field in bytes, not including this byte. |
| `infoByteOne` | 1 | 0x00 | First byte of token ID. |

| Name | Bytes | Value | Description |
|---|---|---|---|
| `infoByteTwo` | 1 | 0x04 | Second byte of token ID. |
| `protocolIndex` | 1 | 0x*NN* | A unique protocol index, starting from 1. Subsequent indexes in other `SDKProtocolToken` token-value fields must increment by 1. |
| `protocolString` | *NN* | <var> | A null-terminated UTF-8 reverse-DNS string (e.g. 'com.acme.gadget'). This string will be compared (without considering case) to strings presented by applications on the iPhone or iPod touch. |

**Note:** If an accessory sends a duplicate `protocolString` or repeats a `protocolIndex` number, the last received `SDKProtocolToken` will be used; any information from a previous `SDKProtocolToken` will be overwritten.

**Table 2-79** `BundleSeedIDPrefToken` format

| Name | Bytes | Value | Description |
|---|---|---|---|
| `length` | 1 | 0x0D | Length of this token-value field in bytes, not including this byte. |
| `infoByteOne` | 1 | 0x00 | First byte of token ID. |
| `infoByteTwo` | 1 | 0x05 | Second byte of token ID. |
| `BundleSeedIDString` | 11 | <var> | A null-terminated UTF-8 string (e.g. 'A1B2C3D4E5') that identifies the vendor of a preferred application, with case sensitivity. This string is derived from the vendor's App ID assigned by Apple. |

**Table 2-80** `MicrophoneCapsToken` format

| Name | Bytes | Value | Description |
|---|---|---|---|
| `length` | 1 | 0x06 | Length of this token-value field in bytes, not including this byte. |
| `infoByteOne` | 1 | 0x01 | First byte of token ID. |
| `infoByteTwo` | 1 | 0x00 | Second byte of token ID. |
| `micCapsBitmask` | 4 | 0x*NNNNNNNN* | Microphone capabilities; see Table 2-81 (page 115). |

**Table 2-81** Microphone capabilities bits

| Bit | Meaning |
|---|---|
| 00 | Stereo line input. A value of 0 indicates the device is monophonic only. |
| 01 | Stereo or mono line input. This bit should be set only if the microphone supports stereo line input and can switch between stereo and mono modes. |

| Bit | Meaning |
|---|---|
| 02 | Recording level is present and variable. |
| 03 | Recording level limit is present. |
| 04 | Accessory supports duplex audio; it can play audio output from the iPod while it sends audio input to the iPod. |
| 31:05 | Reserved. |

## Command 0x3A: RetFIDTokenValueACKs

Direction: iPod to Device

The iPod sends this command in response to each `SetFIDTokenValues` packet from the accessory. The number of token-value fields contained in `FIDTokenValueACKs` matches exactly the number of fields the accessory sent in its `SetFIDTokenValues` command. The different statuses returned to the accessory let it determine whether to retry a failed token-value field.

**Table 2-82** `RetFIDTokenValueACKs` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | x*NN* | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x3A | Command ID: `RetFIDTokenValueACKs` |
| 5 | 0x*NN* | `transID` [bits 15:8]: Transaction ID of the `SetFIDTokenValues` packet being responded to; see "Transaction IDs" (page 451). |
| 6 | 0x*NN* | `transID` [bits 7:0] |
| 7 | 0x*NN* | `numFIDTokenValueACKs`: The number of token-value fields the iPod is acknowledging. This number matches the number the accessory sent in the `SetFIDTokenValues` command. |
| 8-0x*NN* | 0x*NN* | `FIDTokenValueACKs`: Acknowledgement values for the token-value fields sent by `SetFIDTokenValues`. See Table 2-83 (page 117) through Table 2-90 (page 119). |
| (last byte) | 0x*NN* | Checksum |

**Table 2-83** Acknowledgment format for `IdentifyToken`

| Name | Bytes | Value | Description |
|---|---|---|---|
| `length` | 1 | 0x03 | Length of this token-value field in bytes, not including this byte. |
| `infoByteOne` | 1 | 0x00 | First byte of token ID. |
| `infoByteTwo` | 1 | 0x00 | Second byte of token ID. |
| `ACKStatus` | 1 | 0x*NN* | Status of acknowledgment; see Table 2-84 (page 117). |
| `lingoIDs` | 0x*NN* | 0x*NN* | If `ACKStatus` = 4, IDs of busy lingoes; see Table 2-84 (page 117). |

**Table 2-84** Acknowledgment status codes

| Value | Description |
|---|---|
| 0 | Token-value field accepted. |
| 1 | Required token-value field failed. |
| 2 | Optional token-value field recognized, but failed; the accessory may retry, either with another `SetFIDTokenValues` command while in the IDPS process or with another iAP command that emulates the desired setting. The accessory should not allow this status return to prevent it from completing IDPS process. |
| 3 | Token not supported; the accessory must not retry with this iPod. |
| 4 | Lingoes busy. This status responds to an `IdentifyToken` that tries to register for lingoes that are busy on another port. The ID numbers of the busy lingoes are appended to the token. See `lingoIDs` in Table 2-83 (page 117). |
| 5 | Maximum connections reached. This status responds to an `IdentifyToken` if another accessory is connected and the calling accessory cannot connect to the iPod. |
| 6–255 | Reserved |

**Table 2-85** Acknowledgment format for `AccCapsToken`

| Name | Bytes | Value | Description |
|---|---|---|---|
| `length` | 1 | 0x03 | Length of this token-value field in bytes, not including this byte. |
| `infoByteOne` | 1 | 0x00 | First byte of token ID. |
| `infoByteTwo` | 1 | 0x01 | Second byte of token ID. |
| `ACKStatus` | 1 | 0x*NN* | Status of acknowledgment; see Table 2-84 (page 117). |

**Table 2-86** Acknowledgment format for `AccInfoToken`

| Name | Bytes | Value | Description |
|---|---|---|---|
| `length` | 1 | 0x04 | Length of this token-value field in bytes, not including this byte. |
| `infoByteOne` | 1 | 0x00 | First byte of token ID. |
| `infoByteTwo` | 1 | 0x02 | Second byte of token ID. |
| `ACKStatus` | 1 | 0x*NN* | Status of acknowledgment; see Table 2-84 (page 117). |
| `accInfoType` | 1 | 0x*NN* | Accessory info type in token being acknowledged. |

**Table 2-87** Acknowledgment format for `IpodPreferenceToken`

| Name | Bytes | Value | Description |
|---|---|---|---|
| `length` | 1 | 0x04 | Length of this token-value field in bytes, not including this byte. |
| `infoByteOne` | 1 | 0x00 | First byte of token ID. |
| `infoByteTwo` | 1 | 0x03 | Second byte of token ID. |
| `ACKStatus` | 1 | 0x*NN* | Status of acknowledgment; see Table 2-84 (page 117). |
| `iPodPrefClass` | 1 | 0x*NN* | iPod preference class in token being acknowledged. |

**Table 2-88** Acknowledgment format for `SDKProtocolToken`

| Name | Bytes | Value | Description |
|---|---|---|---|
| `length` | 1 | 0x04 | Length of this token-value field in bytes, not including this byte. |
| `infoByteOne` | 1 | 0x00 | First byte of token ID. |
| `infoByteTwo` | 1 | 0x04 | Second byte of token ID. |
| `ACKStatus` | 1 | 0x*NN* | Status of acknowledgment; see Table 2-84 (page 117). |
| `protocolIndex` | 1 | 0x*NN* | Protocol index in token being acknowledged. |

**Table 2-89** Acknowledgment format for `BundleSeedIDPrefToken`

| Name | Bytes | Value | Description |
|---|---|---|---|
| `length` | 1 | 0x03 | Length of this token-value field in bytes, not including this byte. |
| `infoByteOne` | 1 | 0x00 | First byte of token ID. |
| `infoByteTwo` | 1 | 0x05 | Second byte of token ID. |
| `ACKStatus` | 1 | 0x*NN* | Status of acknowledgment; see Table 2-84 (page 117). |

**Table 2-90** Acknowledgment format for `MicCapsToken`

| Name | Bytes | Value | Description |
|---|---|---|---|
| `length` | 1 | 0x03 | Length of this token-value field in bytes, not including this byte. |
| `infoByteOne` | 1 | 0x01 | First byte of token ID. |
| `infoByteTwo` | 1 | 0x00 | Second byte of token ID. |
| `ACKStatus` | 1 | 0x*NN* | Status of acknowledgment; see Table 2-84 (page 117). |

## Command 0x3B: EndIDPS

Direction: Device to iPod

This command is sent by the accessory to end the IDPS process. The iPod takes different actions depending on the value of `accIDPSStatus`.

If the accessory sends this command while the iPod is not in the IDPS process, the iPod responds with an `ACK` command that passes a nonzero status. If the iPod is in the IDPS process and the accessory sends this command with an unsupported `accEndIDPSStatus` value, the iPod remains in the IDPS process.

**Table 2-91** `EndIDPS` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x05 | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x3B | Command ID: `EndIDPS` |
| 5 | 0x*NN* | `transID` [bits 15:8]: Transaction ID; see "Transaction IDs" (page 451). |
| 6 | 0x*NN* | `transID` [bits 7:0] |
| 7 | 0x*NN* | `accEndIDPSStatus`: The accessory's IDPS status, which determines what action the iPod takes after receiving `EndIDPS`. See Table 2-92 (page 119). |
| 8 | 0x*NN* | Checksum |

**Table 2-92** `accEndIDPSStatus` values

| Value | Actions to be taken |
|---|---|
| 0 | The accessory is finished with IDPS, and asks the iPod to continue with authentication if the iPod sends a `IDPSStatus` command with success status. |

| Value | Actions to be taken |
|---|---|
| 1 | The accessory asks to reset all IDPS information it has sent to the iPod. The accessory must then send another `StartIDPS` command and successfully complete the IDPS process within the time limit specified in "Command 0x38: StartIDPS" (page 108). |
| 2 | The accessory has determined that the iPod doesn't support features the accessory needs. The accessory is abandoning the IDPS process. |
| 3–255 | Reserved |

**Note:** In the future, an accessory may be connected to an iPod that supports IDPS but doesn't recognize a specific token-value field. To handle this case, the accessory must respond to the `accIDPSStatus` value of 2. For example, if the accessory needs to set a token-value field that the attached iPod cannot parse, it may determine that it can't work with the iPod and hence must discontinue the identification process.

## Command 0x3C: IDPSStatus

Direction: iPod to Device

This command is sent by the iPod after an accessory sends `EndIDPS`. The iPod determines whether all required token-value fields were successfully sent by the accessory, and sends a `status` value that indicates whether authentication will proceed and the iPod will apply the tokens, or the accessory failed to identify itself properly.

**Note:** After receiving an EndIDPS with status 0, the iPod evaluates the set of FID tokens that the accessory sent for completeness and consistency. At this point the accessory will fail the IDPS process if it has set a preference in the `iPodPreferenceToken` that requires an accessory capability not declared in the `AccCapsToken`. An example of such an inconsistency would be to declare no line-out support in the `AccCapsToken` but also set a line-out usage preference in the `iPodPreferenceToken`.

**Table 2-93** `IDPSStatus` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x05 | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x3C | Command ID: `IDPSStatus` |
| 5 | 0x*NN* | `transID` [bits 15:8]: Transaction ID; see "Transaction IDs" (page 451). |
| 6 | 0x*NN* | `transID` [bits 7:0] |

| Byte number | Value | Comment |
|---|---|---|
| 7 | 0x*NN* | `status`: A value that indicates whether the accessory successfully identified during the IDPS sequence. Combined with the value of `accEndIDPSStatus` sent by the accessory, it determines the iPod's action. See Table 2-94 (page 121). |
| 8 | 0x*NN* | Checksum |

**Table 2-94** iPod actions in response to `accEndIDPSStatus` and IDPS status

| accEndIDPSStatus | IDPS status | Action taken by the iPod |
|---|---|---|
| 0 | 0 | The iPod received all required token-value fields; authentication will proceed. Optional token-value fields may or may not have been received, but their status will not block authentication. |
| | 1 | One or more required token-value fields were rejected by an `FIDTokenValueACK` command and were not correctly resent; IDPS fails. |
| | 2 | One or more required token-value fields were missing; IDPS fails. |
| | 3 | One or more required token-value fields were rejected by an `FIDTokenValueACK` command and were not correctly resent, plus one or more required token-value fields were missing; IDPS fails. |
| 1 | 4 | The IDPS time limit was not exceeded; the accessory may retry IDPS or send `IdentifyDeviceLingoes`. |
| | 5 | The IDPS time limit was reached; the accessory cannot retry IDPS but may send `IdentifyDeviceLingoes`. |
| 2 | 6 | The iPod will not accept any token-value fields and will not continue with authentication. The accessory may send `IdentifyDeviceLingoes` but not `StartIDPS`. |

| accEndIDPSStatus | IDPS status | Action taken by the iPod |
|---|---|---|
| 0 | 7 | IDPS fails for one or more of the following reasons:<br>■ The accessory sent an iPod Preference Token for preference class 0x03 (line-out) without indicating line-out support in the `accCapsBitmask` field of its Accessory Capabilities Token.<br>■ The accessory sent an iPod Preference Token for at least one of preference classes 0x00 (video-out), 0x01 (video-out screen configuration), 0x02 (video-out signal format), 0x08 (video-out connection), or 0x0A (video monitor aspect ratio) without indicating video-out support in the `accCapsBitmask` field of its Accessory Capabilities Token.<br>■ The accessory set any SDK Protocol Tokens, or a Preferred Bundle Seed ID, without setting bit 09 in its `AccCapsToken`.<br>■ The accessory identified for the Digital Audio Lingo in its Identify token without setting the USB Audio bit (bit 04) in its `AccCapsToken`.<br>■ The accessory identified for the Microphone Lingo in its Identify token without setting the Analog Line-In bit (bit 01) in its `AccCapsToken`. |
| *NN* | 8–255 | Reserved |

**Note:** When a failed IDPS process is retried, the iPod does not retain any successfully set token-value fields from the failed IDPS process. Accessories must send all token-value fields again.

## Command 0x3F: OpenDataSessionForProtocol

Direction: iPod to Device

The iPod sends this command to tell the accessory that a data stream has been opened between the accessory and an iPhone OS application. It sends the accessory the `sessionID` of the data stream and the `protocolIndex` to which the open session corresponds. All communications between the accessory and the application for the given `sessionID` are assumed to use the protocol specified by `protocolIndex`.

The accessory must send a `DevACK` commmand in response. A success status means the accessory can support a new open data stream. If the accessory sends a `DevACK` commmand with other than success status, the iPod informs the application that the accessory has refused the data stream connection.

**Table 2-95** `OpenDataSessionForProtocol` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x07 | Length of packet payload |

| Byte number | Value | Comment |
|---|---|---|
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x3F | Command ID: `OpenDataSessionForProtocol` |
| 5 | 0x*NN* | `transID` [bits 15:8]: Transaction ID accessory must use when acknowledging this command; see "Transaction IDs" (page 451). |
| 6 | 0x*NN* | `transID` [bits 7:0] |
| 7 | 0x*NN* | `sessionID` [bits 15:8]: Session ID for subsequent data transfer commands |
| 8 | 0x*NN* | `sessionID` [bits 7:0] |
| 9 | 0x*NN* | `protocolIndex`: Index of the protocol for which this session is being opened; see Table 2-78 (page 114). |
| 10 | 0x*NN* | Checksum |

## Command 0x40: CloseDataSession

Direction: iPod to Device

The iPod sends this command to tell the accessory that the data stream on the given `sessionID` is closing, ending communication. The accessory must send a `DevACK` response, but the data stream will remain closed regardless of the `DevACK` status. If the accessory sends any more `DevDataTransfer` packets for the closed session they will be acknowledged with an Unknown Category status (0x01). The iPod never retries a `CloseDataSession` command.

**Table 2-96** `CloseDataSession` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x06 | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x40 | Command ID: `CloseDataSession` |
| 5 | 0x*NN* | `transID` [bits 15:8]: Transaction ID accessory must use when acknowledging this command; see "Transaction IDs" (page 451). |
| 6 | 0x*NN* | `transID` [bits 7:0] |
| 7 | 0x*NN* | `sessionID` [bits 15:8]: Session ID of the session being closed |
| 8 | 0x*NN* | `sessionID` [bits 7:0] |

| Byte number | Value | Comment |
|---|---|---|
| 9 | 0x*NN* | Checksum |

## Command 0x41: DevACK

Direction: Device to iPod

The accessory sends this command to acknowledge certain iPod-generated General lingo commands.

**Table 2-97** `DevACK` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x06 | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x41 | Command ID: `DevACK` |
| 5 | 0x*NN* | `transID` [bits 15:8]: Transaction ID; see "Transaction IDs" (page 451). |
| 6 | 0x*NN* | `transID` [bits 7:0] |
| 7 | 0x*NN* | `ackStatus`: Status of command being acknowledged. See Table 2-13 (page 65). |
| 8 | 0x*NN* | `cmdID`: ID of command being acknowledged. |
| 9 | 0x*NN* | Checksum |

## Command 0x42: DevDataTransfer

Direction: Device to iPod

The accessory uses this command to send data to an iPhone OS application listening for a specific `sessionID`, as established by a prior `OpenDataSessionForProtocol` command. The iPod responds with a General lingo `ACK` command indicating whether or not the application was able to receive the data from this command.

If the accessory sends a `DevDataTransfer` command for a session that is closed or doesn't exist, the iPod acknowledges it with an Unknown Category status (0x01). If the accessory sends a `DevDataTransfer` command for a session that the iPod has opened but which the accessory has not acknowledged successfully, the iPod acknowledges it with a Command Failed status (0x02).

During a communication session, the following rules apply to `DevDataTransfer` commands:

- The accessory should send a `DevDataTransfer` command whenever it has data it wants to stream to an application with an open session.

- The accessory must not send another `DevDataTransfer` packet until the previous one has been acknowledged (as successful or not) or a 500 ms timeout has expired.
- Upon receiving a successful acknowledgment of a `DevDataTransfer` command, the accessory may immediately send a new command containing available data for any session ID.
- If a 500 ms timeout occurs before a `DevDataTransfer` command is acknowledged successfully, the accessory may resend the same packet with the same transaction ID.
- If the accessory receives an `iPodNotification` command for flow control, it must not send any packets (including retries of `DevDataTransfer` packets) during the specified waiting time.

The accessory can choose either small packet format (for packet payload lengths of 255 bytes or less) or large packet format, as defined in "Command Packet Formats" (page 58). The two `DevDataTransfer` formats are shown in Table 2-98 (page 125) and Table 2-99 (page 125).

**Table 2-98** `DevDataTransfer` small packet

| Byte number | Value | Comment |
| --- | --- | --- |
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x*NN* | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x42 | Command ID: `DevDataTransfer` |
| 5 | 0x*NN* | `transID` [bits 15:8]: Transaction ID; see "Transaction IDs" (page 451). |
| 6 | 0x*NN* | `transID` [bits 7:0] |
| 7 | 0x*NN* | `sessionID` [bits 15:8]: Session ID of the connection between the application and the accessory |
| 8 | 0x*NN* | `sessionID` [bits 7:0] |
| 9-*NN* | 0x*NN* | `data`: Data the device sends to the listening application. |
| (last byte) | 0x*NN* | Checksum |

**Table 2-99** `DevDataTransfer` large packet

| Byte number | Value | Comment |
| --- | --- | --- |
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x00 | Packet payload length marker |
| 3 | 0x*NN* | Length of packet payload [bits 15:8] |

| Byte number | Value | Comment |
|---|---|---|
| 4 | 0x*NN* | Length of packet payload [bits 7:0] |
| 5 | 0x00 | Lingo ID: General lingo |
| 6 | 0x42 | Command ID: `DevDataTransfer` |
| 7 | 0x*NN* | `transID` [bits 15:8]: Transaction ID; see "Transaction IDs" (page 451). |
| 8 | 0x*NN* | `transID` [bits 7:0] |
| 9 | 0x*NN* | `sessionID` [bits 15:8]: Session ID of the connection between the application and the accessory |
| 10 | 0x*NN* | `sessionID` [bits 7:0] |
| 11-*NN* | 0x*NN* | `data`: Data the device sends to the listening application. |
| (last byte) | 0x*NN* | Checksum |

## Command 0x43: iPodDataTransfer

Direction: iPod to Device

The iPod uses this command to send data to an accessory listening for a specific `sessionID`, as established by a prior `OpenDataSessionForProtocol` command. The accessory must respond with a `DevACK` command that passes a command ID of 0x43 and the same transaction ID as contained in the `iPodDataTransfer` packet.

> **Note:** The iPod will not send this command until accessory authentication has finished. The Authentication 2.0B process may last up to 2 seconds after accessory identification.

By default, the maximum `iPodDataTransfer` packet payload length is 1,018 bytes. The accessory can specify a different maximum length by sending an `AccInfoToken` with an `accInfoType` of 0x09. The length that can be set ranges from 128 to 65,535 bytes. Specifying less than 128 bytes will revert to 128. The packet payload length is the combined length of the lingo ID, command ID, transaction ID, session ID, and command data; the payload does not include the sync byte, packet start byte, packet payload length bytes, or packet payload checksum byte.

The iPod or iPhone may send data in either small packet format or large packet format, as defined in "Command Packet Formats" (page 58). The two `iPodDataTransfer` formats are shown in Table 2-100 (page 127) and Table 2-101 (page 127). Accessories must be prepared to receive either format unless they have specified a maximum packet payload length within the limits of the small packet format.

During a communication session, the following rules apply to `iPodDataTransfer` commands:

- The iPod will send an initial `iPodDataTransfer` packet when an application has placed data into the accessory's input queue.
- Upon receiving an acknowledgment of an `iPodDataTransfer` command, the iPod may immediately send a new command containing available data for any session ID.

- The accessory's acknowledgment of an iPodDataTransfer command with Success status (0x00) must signify that the packet has been received, it has been moved out of the accessory's lowest-level receive queue, and that the accessory is ready to receive another packet.
- The only circumstance under which an accessory may acknowledge an iPodDataTransfer command with a nonzero status is if no prior OpenDataSessionForProtocol command has established the command's session ID. In this case it must send a Bad Parameter (0x04) status, and the iPod may close the session.
- If an iPodDataTransfer command is acknowledged with an error status, the iPod may optionally purge its outbound packet queue of all pending iPodDataTransfer packets for that session ID. The iPod will not otherwise discard any data in a session.
- If an accessory's data receive queue cannot accept another packet, then the accessory must not acknowledge the iPodDataTransfer command until packet acceptance is restored. This may cause the iPod to retry the iPodDataTransfer command up to ten times. If the iPod receives no acknowledgment after the tenth retry, it may close the session.
- If a 500 ms timeout occurs before an iPodDataTransfer command is acknowledged, the iPod will resend the same packet with the same transaction ID.

**Table 2-100** iPodDataTransfer small packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x*NN* | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x43 | Command ID: iPodDataTransfer |
| 5 | 0x*NN* | transID [bits 15:8]: Transaction ID; see "Transaction IDs" (page 451). |
| 6 | 0x*NN* | transID [bits 7:0] |
| 7 | 0x*NN* | sessionID [bits 15:8]: Session ID of the connection between the application and the accessory |
| 8 | 0x*NN* | sessionID [bits 7:0] |
| 9-*NN* | 0x*NN* | data: Data the application sends to the listening accessory. |
| (last byte) | 0x*NN* | Checksum |

**Table 2-101** iPodDataTransfer large packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |

| Byte number | Value | Comment |
|---|---|---|
| 2 | 0x00 | Packet payload length marker |
| 3 | 0x*NN* | Length of packet payload [bits 15:8] |
| 4 | 0x*NN* | Length of packet payload [bits 7:0] |
| 5 | 0x00 | Lingo ID: General lingo |
| 6 | 0x43 | Command ID: `iPodDataTransfer` |
| 7 | 0x*NN* | `transID` [bits 15:8]: Transaction ID; see "Transaction IDs" (page 451). |
| 8 | 0x*NN* | `transID` [bits 7:0] |
| 9 | 0x*NN* | `sessionID` [bits 15:8]: Session ID of the connection between the application and the accessory |
| 10 | 0x*NN* | `sessionID` [bits 7:0] |
| 11-*NN* | 0x*NN* | `data`: Data the application sends to the listening accessory. |
| (last byte) | 0x*NN* | Checksum |

## Command 0x49: SetEventNotification

Direction: Device to iPod

This command enables asynchronous remote event notifications for specific iPod events, as described in iPod Event Notifications (page 449).

When the accessory identifies itself, it can check the attached iPod's notification support by sending a `GetSupportedEventNotification` command. If the iPod supports notifications, it returns a `RetSupportedEventNotification` command confirming that it supports at least Flow Control notifications (bit 2 in the 64-bit big-endian notification bitmask). If the accessory needs to send notifications of types that the attached iPod supports, it must then send this command to register for one or more of the notifications listed in Table 2-103 (page 129).

The iPod acknowledges this command with a General Lingo `ACK` command reporting Status OK (0x00).

If the accessory registers for camera notifications, the iPod also sends an `iPodNotification` command reporting its current Camera mode. The iPod may send these commands in any order.

For a suggested sequence of commands to enable iPod notifications, see iPod Event Notifications (page 449).

**Table 2-102** `SetEventNotification` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |

| Byte number | Value | Comment |
|---|---|---|
| 2 | 0x0C | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x49 | Command ID: `SetEventNotification` |
| 5 | 0x*NN* | `transID` [bits 15:8]: Transaction ID of this command. If the iPod does not support IDPS, omit this and the next byte and subtract 2 from the value of byte 2. |
| 6 | 0x*NN* | `transID` [bits 7:0] |
| 7 | 0x00 | Event notification mask (bits 63:56) |
| 8 | 0x00 | Event notification mask (bits 55:48) |
| 9 | 0x00 | Event notification mask (bits 47:40) |
| 10 | 0x00 | Event notification mask (bits 39:32) |
| 11 | 0x00 | Event notification mask (bits 31:24) |
| 12 | 0x00 | Event notification mask (bits 23:16) |
| 13 | 0x00 | Event notification mask (bits 15:8) |
| 14 | 0x*NN* | Event notification mask (bits 7:0); at least bit 2 must be set (see Table 2-103 (page 129)) |
| 15 | 0x*NN* | Checksum |

**Table 2-103** Notification bitmask bits

| Bit number | Description | Notes |
|---|---|---|
| 0-1 | Reserved; set to 0 | |
| 2 | Flow control | Must always set to 1. If and only if the accessory uses IDPS, Flow Control notifications are enabled by default. See "Accessory Identification" (page 445). |
| 3 | Radio tagging status | See "iTunes Tagging" (page 463). |
| 4 | Camera status | See "Accessory Control of the iPod 5G nano Camera" (page 161). |
| 5-63 | Reserved; set to 0 | |

## Command 0x4A: iPodNotification

Direction: iPod to Device

If an accessory has registered for notifications, using `SetEventNotification`, the iPod sends this command to the accessory every time there is a change in the state of any of the processes for which notification was requested. The notification timings and payloads are different for each of the notification types listed in Table 2-103 (page 129):

- If Flow Control notifications are enabled, the iPod sends a Flow Control notification whenever the incoming queue is full and the iPod is unable to accept more packets. When an accessory receives this notification, it must stop sending packets to the iPod/iPhone for the wait time specified by the notification packet shown in Table 2-104 (page 130). If transaction IDs are being used, the Flow Control notification also returns the transaction ID of the packet that caused the overflow. This packet was not added to the incoming data queue; hence the accessory can use the overflow transaction ID to determine which packets need to be resent after the wait time.
- If the accessory registers for Radio Tagging notifications, the iPod sends notifications when tagging information is available or when a tagging operation is initiated (either from the iPod's user interface or from the accessory via the Simple Remote lingo `RadioButtonStatus` command). The notification packet for Radio Tagging is shown in Table 2-105 (page 131).
- If the accessory registers for Camera notifications, the iPod sends a notification immediately after receiving `SetEventNotification` and subsequently whenever its Camera mode changes. It passes the state of its Camera mode using the packet format shown in Table 2-107 (page 132). Because the iPod's notification mechanism is asynchronous, the accessory may receive this packet before its `SetEventNotification` command has been acknowledged. The iPod may also send notifications to the accessory at any time as the result of changes in the Camera application's state that may be unrelated to any action taken by the accessory. For full details see "Accessory Control of the iPod 5G nano Camera" (page 161).

**Note:** The accessory must not acknowledge `iPodNotification` commands and must simply ignore any that it cannot handle. The iPod does not retry these commands.

**Table 2-104** `iPodNotification` packet for Flow Control Notifications

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x0B or 0x07 | Length of packet payload: 0x0B if the iPod supports IDPS, 0x07 otherwise. |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x4A | Command ID: `iPodNotification` |
| 5 | 0x*NN* | `transID` [bits 15:8]: Transaction ID of this command. If the iPod does not support IDPS, this and the next byte are omitted and the value of byte 2 is 0x07. |
| 6 | 0x*NN* | `transID` [bits 7:0] |
| 7 | 0x02 | Notification type: Flow Control |
| 8 | 0x*NN* | Wait time in ms (bits 31:24) |
| 9 | 0x*NN* | Wait time in ms (bits 23:16) |

| Byte number | Value | Comment |
|---|---|---|
| 10 | 0x*NN* | Wait time in ms (bits 15:8) |
| 11 | 0x*NN* | Wait time in ms (bits 7:0) |
| 12 | 0x*NN* | Overflow transaction ID (bits 15:8); Transaction ID of the packet that caused the iPod or iPhone's incoming data queue to overflow. If the iPod does not support IDPS, this and the next byte are omitted. |
| 13 | 0x*NN* | Overflow transaction ID (bits 7:0) |
| 14 | 0x*NN* | Checksum |

**Table 2-105** `iPodNotification` packet for Radio Tagging Notifications

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x09 | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x4A | Command ID: `iPodNotification` |
| 5 | 0x*NN* | `transID` [bits 15:8]: Transaction ID of this command. If the iPod does not support IDPS, omit this and the next byte and subtract 2 from the value of byte 2. |
| 6 | 0x*NN* | `transID` [bits 7:0] |
| 7 | 0x03 | Notification type: Radio Tagging |
| 8 | 0x*NN* | Tag status; see Table 2-106 (page 131). |
| 9 | 0x*NN* | Checksum |

**Table 2-106** `iPodNotification` payload for Radio Tagging notifications

| Byte value | Description |
|---|---|
| 0x00 | Tagging operation successful |
| 0x01 | Tagging operation failed |
| 0x02 | Information available for tagging (all required RT+ information has been received) |
| 0x03 | Information not available for tagging (tagging is not possible because the RT+ information has been reset due to a song change, station change, loss of signal, etc.) |
| 0x04-0xFF | Reserved |

**Table 2-107** `iPodNotification` packet for Camera notifications

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x06 | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x4A | Command ID: `iPodNotification` |
| 5 | 0x*NN* | `transID` [bits 15:8]: Transaction ID of this command. If the iPod does not support IDPS, omit this and the next byte and subtract 2 from the value of byte 2. |
| 6 | 0x*NN* | `transID` [bits 7:0] |
| 7 | 0x04 | Notification type: Camera Notifications |
| 8 | 0x*NN* | Payload; see Table 2-108 (page 132). |
| 9 | 0x*NN* | Checksum |

**Table 2-108** `iPodNotification` payload for Camera Notifications

| Byte value | Description |
|---|---|
| 0x00 | Camera App Off |
| 0x01-0x02 | Reserved |
| 0x03 | Preview |
| 0x04 | Recording |
| 0x05-0xFF | Reserved |

## Command 0x4B: GetiPodOptionsForLingo

Direction: Device to iPod

The accessory sends this command to ask the iPod to return a 64-bit field that defines the options that the iPod supports for a specific lingo, identified in `LingoID`. In response, the iPod sends a `RetiPodOptionsForLingo` command.

If the device requests options for the General lingo (0x00) and the iPod returns an `ACK` with nonzero status, then the iPod does not support `GetiPodOptionsForLingo`; the accessory should use `RequestLingoProtocolVersion` instead. If the device requests options for any other lingo and the iPod returns a nonzero `ACK`, that lingo is not listed in Table 2-110 (page 133) or is not supported by the iPod on the port being used; no `RetiPodOptionsForLingo` command will be returned.

**Table 2-109** `GetiPodOptionsForLingo` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x03 | Length of packet |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x4B | Command ID: `GetiPodOptionsForLingo` |
| 5 | 0x*NN* | `LingoID`: ID of lingo for which options are requested; see Table 2-110 (page 133). |
| 6 | 0x*NN* | Checksum |

**Table 2-110** `RetiPodOptionsForLingo` option bits

| Lingo | Lingo ID | Bit | Description |
|---|---|---|---|
| General | 0x00 | 0x00 | Line out usage |
| | | 0x01 | Video output |
| | | 0x02 | NTSC video signal format |
| | | 0x03 | PAL video signal format |
| | | 0x04 | Composite video out connection |
| | | 0x05 | S-Video video out connection |
| | | 0x06 | Component video out connection |
| | | 0x07 | Closed Captioning (video) |
| | | 0x08 | Video aspect ratio 4:3 (fullscreen) |
| | | 0x09 | Video aspect ratio 6:9 (widescreen) |
| | | 0x0A | Subtitles (video) |
| | | 0x0B | Video Alternate Audio Channel |
| | | 0x0C | Reserved |
| | | 0x0D | Communication with iPhone OS 3.x applications |
| | | 0x0E | iPod notifications |
| | | 0x0F-0x3F | Reserved |
| Microphone | 0x01 | 0x00-0x3F | Reserved |

| Lingo | Lingo ID | Bit | Description |
|---|---|---|---|
| Simple Remote | 0x02 | 0x00 | Context-specific controls |
| | | 0x01 | Audio media controls |
| | | 0x02 | Video media controls |
| | | 0x03 | Image media controls |
| | | 0x04 | Sports media controls |
| | | 0x05-0x3F | Reserved |
| Display Remote | 0x03 | 0x00 | Volume control |
| | | 0x01 | Absolute Volume control |
| | | 0x02-0x3F | Reserved |
| Extended Interface | 0x04 | 0x00 | Video browsing |
| | | 0x01 | Extended Interface enhancements |
| | | 0x02 | Nested playlists |
| | | 0x03 | Reserved |
| | | 0x04 | Supports Set Display Image |
| | | 0x05-0x3F | Reserved |
| Accessory Power | 0x05 | 0x00-0x3F | Reserved |
| RF Tuner | 0x07 | 0x00 | RDS Raw Mode support |
| | | 0x01 | HD Radio Tuning support |
| | | 0x02 | AM Radio Tuning support |
| | | 0x03-0x3F | Reserved |
| Accessory Equalizer | 0x08 | 0x00-0x3F | Reserved |
| Sports | 0x09 | 0x00 | Reserved |
| | | 0x01 | Nike + iPod Cardio Equipment |
| | | 0x02-0x3F | Reserved |
| Digital Audio | 0x0A | 0x00 | A/V Synchronization |
| | | 0x01-0x3F | Reserved |
| Storage | 0x0C | 0x00 | iTunes Tagging |

| Lingo | Lingo ID | Bit | Description |
|---|---|---|---|
| | | 0x01 | Nike + iPod Cardio Equipment |
| | | 0x02-0x3F | Reserved |
| Location | 0x0E | 0x00 | iPod accepts NMEA GPS location data |
| | | 0x01 | iPod can send location assistance data |
| | | 0x02-0x3F | Reserved |

Table 2-111 (page 135) lists a sample command flow that queries an iPod's options for most of the iAP lingoes.

**Table 2-111** Sample GetiPodOptionsForLingo and RetiPodOptionsForLingo commands

<table>
<tr><th>Step</th><th>Accessory command</th><th>iPod command</th><th>Comment</th></tr>
<tr><td>1</td><td><code>StartIDPS</code></td><td></td><td>no params</td></tr>
<tr><td>2</td><td></td><td><code>ACK</code></td><td>acknowledging 'Success (OK)' to command 'General Lingo::StartIDPS'</td></tr>
<tr><td colspan="4">If the <code>ACK</code> reply to <code>StartIDPS</code> returns a status of 0x00, the accessory proceeds to Step 3. Otherwise,<br>■ If the accessory receives no <code>ACK</code> command within 1 second, it may retry Step 1 at 1-second intervals as long as iPod Detect (pin 30 of the 30-pin connector) is low and Accessory Power (pin 13) is high. Accessories that don't monitor these signals (such as Bluetooth accessories or USB accessories without a 191 kΩ ID resistor) may retry without checking them.<br>■ If the accessory receives an <code>ACK</code> status of 0x04 (Bad Parameter), the iPod does not support IDPS. Within 800 ms the accessory must send an <code>IdentifyDeviceLingoes</code> command with its lingo mask set for only the General lingo, with no options, and with a Device ID of 0x0. See "Cancelling a Current Authentication Process With IdentifyDeviceLingoes" (page 83).<br>■ If the accessory receives any other nonzero <code>ACK</code> status, it must not send any more iAP commands until it has been disconnected. Upon reconnection it must restart identification at Step 1.</td></tr>
<tr><td>3</td><td><code>GetiPodOptions-ForLingo</code></td><td></td><td>getting options for General Lingo</td></tr>
</table>

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| 4 | | RetiPodOptions-ForLingo | returning options of 0000000000006FFF (Line out usage \| Video output \| NTSC video signal format \| PAL video signal format \| Composite video out connection \| S-Video video out connection \| Component video out connection \| Closed captioning (video) \| Video aspect ratio 4:3 (fullscreen) \| Video aspect ratio 6:9 (widescreen) \| Subtitles (video) \| Video Alternate Audio Channel \| App communication capable \| iPod notifications) for General Lingo |
| 5 | GetiPodOptions-ForLingo | | getting options for Microphone Lingo |
| 6 | | RetiPodOptions-ForLingo | returning options of 0000000000000000 for Microphone Lingo |
| 7 | GetiPodOptions-ForLingo | | getting options for Simple Remote Lingo |
| 8 | | RetiPodOptions-ForLingo | returning options of 000000000000000F (Audio media controls \| Video media controls \| Image media controls \| context-specific controls) for Simple Remote Lingo |
| 9 | GetiPodOptions-ForLingo | | getting options for Display Remote Lingo |
| 10 | | RetiPodOptions-ForLingo | returning options of 0000000000000001 (Volume control) for Display Remote Lingo |
| 11 | GetiPodOptions-ForLingo | | getting options for Extended Interface Lingo |
| 12 | | RetiPodOptions-ForLingo | returning options of 0000000000000001 (Video browsing) for Extended Interface Lingo |
| 13 | GetiPodOptions-ForLingo | | getting options for Accessory Power Lingo |
| 14 | | RetiPodOptions-ForLingo | returning options of 0000000000000000 (none) for Accessory Power Lingo |

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| 15 | GetiPodOptions-ForLingo | | getting options for Accessory Equalizer Lingo |
| 16 | | RetiPodOptions-ForLingo | returning options of 0000000000000000 (none) for Accessory Equalizer Lingo |
| 17 | GetiPodOptions-ForLingo | | getting options for Sports Lingo |
| 18 | | RetiPodOptions-ForLingo | returning options of 0000000000000002 (Nike + iPod cardio equipment) for Sports Lingo |
| 19 | GetiPodOptions-ForLingo | | getting options for Digital Audio Lingo |
| 20 | | RetiPodOptions-ForLingo | returning options of 0000000000000000 (none) for Digital Audio Lingo |
| 21 | GetiPodOptions-ForLingo | | getting options for Storage Lingo |
| 22 | | RetiPodOptions-ForLingo | returning options of 0000000000000003 (iTunes tagging \| Nike + iPod cardio equipment) for Storage Lingo |
| 23 | GetiPodOptions-ForLingo | | getting options for Location Lingo |
| 24 | | RetiPodOptions-ForLingo | returning options of 0000000000000003 (iPod accepts NMEA GPS location data \| iPod can send location assistance data) for Location Lingo |
| 25 | SetFIDTokenValues | | setting 8 FID tokens ; AccInfoToken = Acc name (iPod Accessory Name); AccInfoToken = Acc FW version (v1.2.1); AccInfoToken = Acc HW version (v1.0.0); AccInfoToken = Acc manufacturer (Apple Inc.); AccInfoToken = Acc model number (MA1390LL/A); SDKProtocolToken = 1 (com.apple.protocolMain); SDKProtocolToken = 2 (com.apple.protocolAlternative); BundleSeedIDString = 24D4XFAF43 |

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| 26 | | RetFIDTokenValueACKs | 8 ACKs for FID tokens ; AccInfoToken = (Acc name) accepted; AccInfoToken = (Acc FW version) accepted; AccInfoToken = (Acc HW version) accepted; AccInfoToken = (Acc manufacturer) accepted; AccInfoToken = (Acc model number) accepted; SDKProtocolToken = (1) accepted; SDKProtocolToken = (2) accepted; BundleSeedIDPrefToken = accepted |
| 27 | SetFIDTokenValues | | setting 1 FID tokens ; IdentifyToken = (lingoes: 0/2 \| options 0x00000006 \| device ID 0x00000200) |
| 28 | | RetFIDTokenValueACKs | 1 ACKs for FID tokens ; IdentifyToken = accepted |
| 29 | SetFIDTokenValues | | setting 1 FID tokens ; AccCapsToken = 0x0000000000000A17 |
| 30 | | RetFIDTokenValueACKs | 1 ACKs for FID tokens ; AccCapsToken = accepted |
| 31 | SetFIDTokenValues | | setting 1 FID tokens ; iPodPreferenceToken = (setting 'used' for preference class 'line out usage' with restore on exit 'selected') |
| 32 | | RetFIDTokenValueACKs | 1 ACKs for FID tokens ; iPodPreferenceToken = (line out usage) accepted |
| 33 | SetFIDTokenValues | | setting 1 FID tokens ; iPodPreferenceToken = (setting 'ask' for preference class 'video out setting' with restore on exit 'selected') |
| 34 | | RetFIDTokenValueACKs | 1 ACKs for FID tokens ; iPodPreferenceToken = (video out setting) accepted |
| 35 | SetFIDTokenValues | | setting 1 FID tokens ; iPodPreferenceToken = (setting 'widescreen' for preference class 'screen configuration' with restore on exit 'selected') |
| 36 | | RetFIDTokenValueACKs | 1 ACKs for FID tokens ; iPodPreferenceToken = (screen configuration) accepted |

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| 37 | SetFIDTokenValues | | setting 1 FID tokens ; iPodPreferenceToken = (setting 'PAL' for preference class 'video format setting' with restore on exit 'selected') |
| 38 | | RetFIDTokenValueACKs | 1 ACKs for FID tokens ; iPodPreferenceToken = (video format setting) accepted |
| 39 | SetFIDTokenValues | | setting 1 FID tokens ; iPodPreferenceToken = (setting 'component' for preference class 'video connection' with restore on exit 'selected') |
| 40 | | RetFIDTokenValueACKs | 1 ACKs for FID tokens ; iPodPreferenceToken = (video connection) accepted |
| 41 | SetFIDTokenValues | | setting 1 FID tokens ; iPodPreferenceToken = (setting '16:9' for preference class 'aspect ratio' with restore on exit 'selected') |
| 42 | | RetFIDTokenValueACKs | 1 ACKs for FID tokens ; iPodPreferenceToken = (aspect ratio) accepted |
| 43 | SetFIDTokenValues | | setting 1 FID tokens ; iPodPreferenceToken = (setting 'component' for preference class 'video connection' with restore on exit 'selected') |
| 44 | | RetFIDTokenValueACKs | 1 ACKs for FID tokens ; iPodPreferenceToken = (video connection) accepted |
| 45 | SetFIDTokenValues | | setting 1 FID tokens ; iPodPreferenceToken = (setting 'on' for preference class 'video subtitles' with restore on exit 'selected') |
| 46 | | RetFIDTokenValueACKs | 1 ACKs for FID tokens ; iPodPreferenceToken = (video subtitles) accepted |
| 47 | SetFIDTokenValues | | setting 1 FID tokens ; iPodPreferenceToken = (setting 'on' for preference class 'alternate audio channel' with restore on exit 'selected') |

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| 48 | | RetFIDTokenValueACKs | 1 ACKs for FID tokens ; iPodPreferenceToken = (alternate audio channel) accepted |
| 49 | SetFIDTokenValues | | setting 1 FID tokens ; iPodPreferenceToken = (setting 'on' for preference class 'closed captions' with restore on exit 'selected') |
| 50 | | RetFIDTokenValueACKs | 1 ACKs for FID tokens ; iPodPreferenceToken = (closed captions) accepted |
| 51 | EndIDPS | | status 'finished with IDPS; proceed to authentication' |
| 52 | | IDPSStatus | status 'ready for auth' |
| 53 | | GetDevAuthentication-Info | no params |
| 54 | RetDevAuthentication-Info | | returning auth protocol v2.0; section: 0/1; cert data: ... |
| 55 | | ACK | acknowledging 'Success (OK)' to command 'General Lingo::RetDevAuthenticationInfo' |
| 56 | RetDevAuthentication-Info | | returning auth protocol v2.0; section: 1/1; cert data: ... |
| 57 | | AckDevAuthentication-Info | acknowledging 'auth info supported' |
| 58 | | GetDevAuthentication-Signature | offering challenge '...' with retry counter 1 |
| 59 | RetDevAuthentication-Signature | | returning signature '...' |
| 60 | | AckDevAuthentication-Status | acknowledging authentication status 'Success (OK)' |

## Command 0x4C: RetiPodOptionsForLingo

Direction: iPod to Device

The iPod sends this command in response to a GetiPodOptionsForLingo command from the accessory. It returns the ID of the lingo for which options were requested in LingoID and the option bits as a 64-bit big-endian field in bytes 6-13. Table 2-110 (page 133) lists the available option bit values for various lingoes, and Table 2-111 (page 135) lists a sample command flow that queries an iPod's options for those lingoes.

**Table 2-112** `RetiPodOptionsForLingo` packet

| Byte number | Value | Comment | |
|---|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) | |
| 1 | 0x55 | Start of packet (SOP) | |
| 2 | 0x0B | Length of packet | |
| 3 | 0x00 | Lingo ID: General lingo | |
| 4 | 0x4C | Command ID: `RetiPodOptionsForLingo` | |
| 5 | 0x*NN* | `LingoID`: ID of lingo for which options were requested. | |
| 6 | 0x*NN* | Option bits (bits 63:56) | See Table 2-110 (page 133) |
| 7 | 0x*NN* | Option bits (bits 55:48) | |
| 8 | 0x*NN* | Option bits (bits 47:40) | |
| 9 | 0x*NN* | Option bits (bits 39:32) | |
| 10 | 0x*NN* | Option bits (bits 31:24) | |
| 11 | 0x*NN* | Option bits (bits 23:16) | |
| 12 | 0x*NN* | Option bits (bits 15:8) | |
| 13 | 0x*NN* | Option bits (bits 7:0) | |
| 14 | 0x*NN* | Checksum | |

## Command 0x4D: GetEventNotification

Direction: Device to iPod

The accessory sends this command to the iPod to ask for the iPod's current 64-bit big-endian notification bitmask.

**Table 2-113** `GetEventNotification` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x04 | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x4D | Command ID: `GetEventNotification` |

| Byte number | Value | Comment |
|---|---|---|
| 5 | 0x*NN* | `transID` [bits 15:8]: Transaction ID of this command. If the iPod does not support IDPS, omit this and the next byte and subtract 2 from the value of byte 2. |
| 6 | 0x*NN* | `transID` [bits 7:0] |
| 7 | 0x*NN* | Checksum |

## Command 0x4E: RetEventNotification

Direction: iPod to Device

The iPod sends this command to the accessory in response to a `GetEventNotification` command. It passes its current 64-bit big-endian notification bitmask.

**Table 2-114** `RetEventNotification` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x0C | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x4E | Command ID: `RetEventNotification` |
| 5 | 0x*NN* | `transID` [bits 15:8]: Transaction ID of this command. If the iPod does not support IDPS, omit this and the next byte and subtract 2 from the value of byte 2. |
| 6 | 0x*NN* | `transID` [bits 7:0] |
| 7 | 0x00 | Event notification mask (bits 63:56) |
| 8 | 0x00 | Event notification mask (bits 55:48) |
| 9 | 0x00 | Event notification mask (bits 47:40) |
| 10 | 0x00 | Event notification mask (bits 39:32) |
| 11 | 0x00 | Event notification mask (bits 31:24) |
| 12 | 0x00 | Event notification mask (bits 23:16) |
| 13 | 0x00 | Event notification mask (bits 15:8) |
| 14 | 0x*NN* | Event notification mask (bits 7:0); see Table 2-103 (page 129). |
| 15 | 0x*NN* | Checksum |

## Command 0x4F: GetSupportedEventNotification

Direction: Device to iPod

The accessory sends this command to the iPod to query the iPod's support for notifications. The iPod responds with a `RetSupportedEventNotification` command.

**Table 2-115** `GetSupportedEventNotification` packet

| Byte number | Value | Comment |
| --- | --- | --- |
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x04 | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x4F | Command ID: `GetSupportedEventNotification` |
| 5 | 0x*NN* | `transID` [bits 15:8]: Transaction ID of this command. If the iPod does not support IDPS, omit this and the next byte and subtract 2 from the value of byte 2. |
| 6 | 0x*NN* | `transID` [bits 7:0] |
| 7 | 0x*NN* | Checksum |

## Command 0x51: RetSupportedEventNotification

Direction: iPod to Device

The iPod sends this command to the accessory in response to a `GetSupportedEventNotification` command. It passes a 64-bit big-endian bitmask that defines the types of notifications that the iPod supports.

**Table 2-116** `RetSupportedEventNotification` packet

| Byte number | Value | Comment |
| --- | --- | --- |
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x0C | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x51 | Command ID: `RetSupportedEventNotification` |
| 5 | 0x*NN* | `transID` [bits 15:8]: Transaction ID of this command. If the iPod does not support IDPS, omit this and the next byte and subtract 2 from the value of byte 2. |
| 6 | 0x*NN* | `transID` [bits 7:0] |

| Byte number | Value | Comment |
|---|---|---|
| 7 | 0x00 | Event notification mask (bits 63:56) |
| 8 | 0x00 | Event notification mask (bits 55:48) |
| 9 | 0x00 | Event notification mask (bits 47:40) |
| 10 | 0x00 | Event notification mask (bits 39:32) |
| 11 | 0x00 | Event notification mask (bits 31:24) |
| 12 | 0x00 | Event notification mask (bits 23:16) |
| 13 | 0x00 | Event notification mask (bits 15:8) |
| 14 | 0x*NN* | Event notification mask (bits 7:0); see Table 2-103 (page 129). |
| 15 | 0x*NN* | Checksum |

# Accessory Lingoes

The iPod Accessory Protocol defines a number of different accessory lingoes. This chapter describes these lingoes and their commands.

Table 3-1 (page 145) shows the available accessory lingoes and their IDs.

**Table 3-1** iPod accessory lingoes

| Lingo | ID | Notes |
|---|---|---|
| Microphone | 0x01 | |
| Simple Remote | 0x02 | |
| Display Remote | 0x03 | |
| Extended Interface | 0x04 | See The Extended Interface Protocol (page 341). For a sample command sequence that declares the Extended Interface lingo, see Table 3-271 (page 334). |
| Accessory Power | 0x05 | |
| USB Host Control | 0x06 | Deprecated; see "Lingo 0x06: USB Host Control Lingo" (page 525). |
| RF Tuner | 0x07 | |
| Accessory Equalizer | 0x08 | |
| Sports | 0x09 | |
| Digital Audio | 0x0A | |
| Reserved | 0x0B | |
| Storage | 0x0C | |
| Reserved | 0x0D | |
| Location | 0x0E | |
| Reserved | 0x0F–0xFF | |

# Command Timings

Some iAP commands sent by the iPod take a significant time to execute, and some of these retry if the device does not acknowledge the first attempt. Timeout information and the number of times the command tries to execute are shown in Table 3-2 (page 146).

**Table 3-2** Select iPod command timings

| Lingo | Command | Timeout | Tries |
|---|---|---|---|
| Microphone (0x01) | `GetDevAck` (0x05) | 200 ms | 1 |
| | `GetDevCaps` (0x07) | 200 ms | 1 |
| | `GetDevCtrl` (0x09) | 200 ms | 1 |
| | `SetDevCtrl` (0x0B) | 200 ms | 1 |
| RF Tuner (0x07) | `GetCaps` (0x01) | 200 ms | 1 |
| | `GetCtrl` (0x03) | 200 ms | 1 |
| | `SetCtrl` (0x05) | 200 ms | 1 |
| | `GetBand` (0x06) | 200 ms | 1 |
| | `SetBand` (0x08) | 200 ms | 1 |
| | `GetFreq` (0x09) | 200 ms | 1 |
| | `SetFreq` (0x0B) | 200 ms | 1 |
| | `GetMode` (0x0C) | 200 ms | 1 |
| | `SetMode` (0x0E) | 200 ms | 1 |
| | `GetSeekRssi` (0x0F) | 200 ms | 1 |
| | `SetSeekRssi` (0x11) | 200 ms | 1 |
| | `SeekStart` (0x12) | 200 ms | 1 |
| | `GetStatus` (0x14) | 200 ms | 1 |
| | `GetStatusNotifyMask` (0x16) | 200 ms | 1 |
| | `SetStatusNotifyMask` (0x18) | 200 ms | 1 |
| | `GetRdsReadyStatus` (0x1A) | 200 ms | 1 |
| | `GetRdsData` (0x1C) | 200 ms | 1 |
| | `GetRdsNotifyMask` (0x1E) | 200 ms | 1 |

| Lingo | Command | Timeout | Tries |
|---|---|---|---|
| | `SetRdsNotifyMask` (0x20) | 200 ms | 1 |
| Accessory Equalizer (0x08) | `GetCurrentEQIndex` (0x01) | 2500 ms | 3 |
| | `SetCurrentEQIndex` (0x03) | 3000 ms | 3 |
| | `GetEQSettingCount` (0x04) | 3000 ms | 3 |
| | `GetEQIndexName` (0x06) | 3000 ms | 3 |
| Sports (0x09) | `GetDeviceCaps` (0x03) | 500 ms | 2 |
| Digital Audio (0x0A) | `GetAccSampleRateCaps` (0x02) | 3000 ms | 3 |
| Location (0x0E) | `GetDevCaps` (0x01) | 500 ms | 1 |
| | `GetDevControl` (0x03) | 500 ms | 1 |
| | `SetDevControl` (0x05) | 500 ms | 1 |
| | `GetDevData` (0x06) | 500 ms | 1 |
| | `SetDevData` (0x08) | 500 ms | 1 |

# Lingo 0x01: Microphone Lingo

The Microphone lingo enables combination microphone and speaker accessory devices to record and play back audio. Initial microphone devices supported one input mode (mono) and one sample rate (8 kHz). The increased iPod mass storage disk capacities enable the option of supporting a stereo input mode and higher audio sample rates. With these changes, iPods may be used for high-quality mobile audio recording.

**Note:** The 3G iPod, iPod mini, and first generation iPod nano do not support the microphone lingo; it is not possible to create a voice recorder for these products. The 5G iPod, 2G nano, iPod classic, and 3G nano support both stereo and monophonic microphones through the 30-pin connector. The 4G iPod only supports monophonic microphones plugged into the 9-pin audio/remote connector; it cannot record audio from a microphone connected to the 30-pin connector. See "The 9-Pin Audio/Remote Connector" in the chapter "Historical Information" in *iPod/iPhone Hardware Specifications*.

The Microphone lingo is defined such that the iPod initiates commands and the accessory device responds to these commands; that is, the iPod sends commands to the device and the device responds with data or `ACK` commands.

When the iPod detects a device speaking the Microphone lingo, it may transition into a recorder application where it can create and manage recordings. Based on the microphone device capabilities, the iPod recording application may choose to change its appearance based on the presence or absence of certain microphone features. The device should indicate its capabilities to the iPod on request. These capabilities may include:

- Stereo line input source
- Stereo/mono control
- Recording level control
- Recording level limiter

> **Note:** Accessories using Authentication 2.0 and identifying for the Microphone lingo may have audio routed to them by default, based on their resistor ID, identification method and/or iPod model. If a microphone accessory does not support line-out (i.e. it does not have a built-in speaker) and it uses IDPS for identification, its `AccCapsToken` must not confirm line-out support (see Table 2-73 (page 113)).

Microphone accessory devices can draw power from the iPod or supply power to the iPod. Accessory device power management is important as iPods transition to a smaller physical size at the same time as trying to extend battery life. An accessory using the Microphone lingo must remain in low-power mode by default. It is allowed to transition to high-power mode only if it receives an `iPodModeChange` command with a Mode value of 0x00 or 0x02 (begin audio recording or playback), as listed in Table 3-9 (page 152), and also only if it has declared the intermittent high-power option during its identification process. The accessory must return to low-power mode within 100 ms of receiving an `iPodModeChange` command with a Mode value of 0x01 or 0x03 (end audio recording or playback). Like all accessories, an accessory using the Microphone lingo must comply with the power requirements of the iPod's Sleep and Hibernate states, as specified in "iPod Power States and Accessory Power" (page 341). Accessories are informed of iPod state changes by receiving a General lingo `NotifyiPodStateChange` command.

The microphone device is responsible for keeping its power consumption below the maximum allowed limits for each iPod state; see "Accessory Power Policy" (page 39). Accessory power is completely shut off when the iPod enters the Hibernate state. On reset or power up, the accessory device must be in low power state (consuming less than 5 mA) with the amplifier off (that is, with audio input and output disabled).

Microphone state information must be retained locally by the device while uninterrupted accessory power (either high or low power) is available. If accessory power is turned off, device state information may be lost. Devices are not expected to retain state information across accessory power down cycles (Hibernate mode).

iPod playback volume level changes may require the device to support Display Remote lingo (0x03) functionality.

Table 3-3 (page 149) lists the commands available as part of the Microphone lingo.

**Note:** Legacy Microphone lingo commands 0x00–0x03 are disabled for devices using the 30-pin connector. They are superseded by "Command 0x06: iPodModeChange" (page 151), which returns an ACK. Deprecated commands 0x00–0x03 are documented in "9-Pin Audio/Remote Connector Commands" (page 520).

**Table 3-3** Microphone lingo command summary

| Command | ID | Data length | Protocol Version | Connector | Authentication Required |
|---|---|---|---|---|---|
| `BeginRecord` | 0x00 | 0x00 | All | 9-pin Audio/Remote | No |
| `EndRecord` | 0x01 | 0x00 | All | 9-pin Audio/Remote | No |
| `BeginPlayback` | 0x02 | 0x00 | All | 9-pin Audio/Remote | No |
| `EndPlayback` | 0x03 | 0x00 | All | 9-pin Audio/Remote | No |
| `ACK` | 0x04 | 0x02 | 1.01 | 30-pin | Yes |
| `GetDevAck` | 0x05 | 0x00 | 1.01 | 30-pin | Yes |
| `iPodModeChange` | 0x06 | 0x01 | 1.01 | 30-pin | Yes |
| `GetDevCaps` | 0x07 | 0x00 | 1.01 | 30-pin | Yes |
| `RetDevCaps` | 0x08 | 0x04 | 1.01 | 30-pin | Yes |
| `GetDevCtrl` | 0x09 | 0x00 | 1.01 | 30-pin | Yes |
| `RetDevCtrl` | 0x0A | 0x02 | 1.01 | 30-pin | Yes |
| `SetDevCtrl` | 0x0B | 0x02 | 1.01 | 30-pin | Yes |
| Reserved | 0x0C–0xFF | N/A | N/A | N/A | N/A |

## Command History of the Microphone Lingo

Table 3-4 (page 149) shows the history of command changes in the Microphone lingo.

**Table 3-4** Microphone lingo command history

| Lingo version | Command changes | Features |
|---|---|---|
| No version | Add: 0x00–0x03 | Microphone begin/end record/playback notification commands, 9-pin Audio/Remote connector only |
| 1.00 | None | Version number available through `RequestLingoProtocolVersion` |
| 1.01 | Add: 0x04–0x0B | ACK, mode change, capabilities, and control support (30-pin connector only) |

The commands described in the following sections are used only with the 30-pin connector. For information about 9-pin connector commands, see "9-Pin Audio/Remote Connector Commands" (page 520).

**Note:** Devices must return responses to iPod commands in the order in which the commands were received and within the specified time limits. Failing to send responses in the order commands were received or exceeding the command timeout limits could cause a communications failure and result in the device being considered not present by the iPod.

## Command 0x04: ACK

Direction: Device to iPod

The microphone device sends this command in response to a command sent from the iPod. Note that the commands 0x00–0x03 do not require an `ACK` response. The device sends an `ACK` response when a command that does not return any data has completed, a bad parameter is received, or an unsupported or invalid command is received.

**Table 3-5** `ACK` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x04 | Length of packet payload |
| 3 | 0x01 | Lingo ID: Microphone lingo |
| 4 | 0x04 | Command ID: `ACK` |
| 5 | 0x*NN* | The command result status. See Table 3-6 (page 150) for the possible values. |
| 6 | 0x*NN* | The ID of the command for which the response is being sent. |
| 7 | 0x*NN* | Checksum |

Table 3-6 (page 150) shows the possible values of the command result status byte.

**Table 3-6** Command result values

| Byte | Meaning |
|---|---|
| 0x00 | Success (OK) |
| 0x01 | Not applicable: the Microphone lingo does not use this error value. |
| 0x02 | ERROR: Command failed. Sent in response to a valid command if that command did not succeed. |
| 0x03 | ERROR: Out of resources. This indicates that an iPod internal allocation failed. |

| Byte | Meaning |
|---|---|
| 0x04 | ERROR: Bad parameter. The command or input parameters are invalid. |
| 0x05 | Not applicable: the Microphone lingo does not use this error value. |
| 0x06 | Reserved |
| 0x07 | ERROR: The device is not authenticated to use this lingo command. |
| 0x08 | ERROR: Mismatched authentication protocol version. |
| 0x09 - 0xFF | Reserved |

## Command 0x05: GetDevAck

Direction: iPod to Device

The iPod sends this command to get an `ACK` response from a microphone device. The iPod uses this command to "ping" the device and determine that it is present and ready to accept commands. In response, the device sends the `ACK` command with command status OK.

The timeout for this command is 200 ms (0.2 second). The device must respond within the allotted time; the iPod will not retry the command. If the device does not respond within the specified time, the command will fail and the device may be considered not present by the iPod.

**Table 3-7** `GetDevAck` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x02 | Length of packet payload |
| 3 | 0x01 | Lingo ID: Microphone lingo |
| 4 | 0x05 | Command ID: `GetDevAck` |
| 5 | 0xF8 | Checksum |

## Command 0x06: iPodModeChange

Direction: iPod to Device

The iPod sends this command to the microphone device when an audio recording or playback event occurs. The microphone device uses the `iPodModeChange` command to configure its inputs or outputs and power consumption level for the specified mode. In response, the device sends the `ACK` command with the command status OK. The device sends the `ACK` command when the device has completed its mode change.

The iPod does not wait to receive an `ACK` command from the device in response to the mode change. It may continue sending other commands to the device after it has sent the mode change command.

**Table 3-8** `iPodModeChange` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x03 | Length of packet payload |
| 3 | 0x01 | Lingo ID: Microphone lingo |
| 4 | 0x06 | Command ID: `iPodModeChange` |
| 5 | 0x*NN* | Mode. See Table 3-9 (page 152). |
| 6 | 0x*NN* | Checksum |

Table 3-9 (page 152) lists the possible values of the Mode byte.

**Table 3-9** Mode values

| Value | Meaning |
|---|---|
| 0x00 | Begin audio recording mode.<br>When it receives this command, the device can activate its microphone recording inputs or outputs connected to the iPod line inputs. If the device has requested the intermittent high power option using General lingo "Command 0x13: IdentifyDeviceLingoes" (page 80), it must wait until after this command is received before consuming more that 5 mA of accessory supply current. By the time the device receives this command, accessory high power is enabled and ready to use during the recording process. |
| 0x01 | End audio recording mode.<br>When it receives this command, the device can deactivate its microphone recording inputs or outputs and return to a quiescent state. If the device has requested the intermittent high power option, by using the General lingo command `IdentifyDeviceLingoes`, it may be in a high power consumption state. After receiving this command, the device must reduce its power consumption below 5 mA of accessory supply current within 100 ms. |
| 0x02 | Begin audio playback mode.<br>When it receives this command, the device can activate its speaker playback inputs or outputs connected to the iPod line outputs, if present. If the device has requested the intermittent high power option, by using the General lingo command `IdentifyDeviceLingoes`, it must wait until after this command is received before consuming more that 5 mA of accessory supply current. By the time the device receives this command, accessory high power is enabled and ready to use during the playback process. |

| Value | Meaning |
|---|---|
| 0x03 | End audio playback mode.<br>When it receives this command, the device can deactivate its speaker playback inputs or outputs and return to a quiescent state. If the device has requested the intermittent high power option using the General lingo command `IdentifyDeviceLingoes`, it may be in a high power consumption state. After receiving this command, the device must reduce its power consumption below 5 mA of accessory supply current within 100 ms. |
| 0x04–0xFF | Reserved. |

**Note:** Failure to wait for a mode change notification before increasing power consumption could result in an incompatibility with present and future iPods.

Failure to reduce power consumption within the stated time could result in an incompatibility with present and future iPods.

## Command 0x07: GetDevCaps

Direction: iPod to Device

The iPod sends this command to the microphone device to determine the features present on the device. In response, the device sends "Command 0x08: RetDevCaps" (page 153) with the payload indicating the capabilities it supports.

The timeout for this command is 200 ms (0.2 second). The device must respond within the allotted time; the iPod will not retry the command. If the device does not respond within the specified time, the command will fail and the device may be considered not present by the iPod.

**Table 3-10** `GetDevCaps` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x02 | Length of packet payload |
| 3 | 0x01 | Lingo ID: Microphone lingo |
| 4 | 0x07 | Command ID: `GetDevCaps` |
| 5 | 0xF6 | Checksum |

## Command 0x08: RetDevCaps

Direction: Device to iPod

The device sends this command in response to the command "Command 0x07: GetDevCaps" (page 153) sent by the iPod. The microphone device returns the payload indicating which capabilities it supports.

**Table 3-11** `RetDevCaps` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x06 | Length of packet payload |
| 3 | 0x01 | Lingo ID: Microphone lingo |
| 4 | 0x08 | Command ID: `RetDevCaps` |
| 5 | 0x*NN* | Device capabilities (bits 31: 24). See Table 3-12 (page 154). |
| 6 | 0x*NN* | Device capabilities (bits 23: 16) |
| 7 | 0x*NN* | Device capabilities (bits 15: 8) |
| 8 | 0x*NN* | Device capabilities (bits 7: 0) |
| 9 | 0x*NN* | Checksum |

The capabilities bit ranges correspond to the microphone control commands. The iPod should not attempt to control device features, using "Command 0x0B: SetDevCtrl" (page 156), if the associated capabilities bits are not set. Table 3-12 (page 154) lists the meaning of these bits.

**Table 3-12** Microphone capabilities bitmask

| Bit | Meaning |
|---|---|
| 00 | Stereo line input. A value of 0 indicates the device is monophonic only. |
| 01 | Stereo or mono line input. This bit should be set only if the microphone supports stereo line input and can switch between stereo and mono modes. |
| 02 | Recording level is present and variable. |
| 03 | Recording level limit is present. |
| 04 | Accessory supports duplex audio; it can play audio output from the iPod while it sends audio input to the iPod. |
| 31:05 | Reserved. |

## Command 0x09: GetDevCtrl

Direction: iPod to Device

The iPod sends this command to get the device control state for the specified control type. In response, the device sends "Command 0x0A: RetDevCtrl" (page 155) with its current control state. If this command is not supported by the device—that is, if the microphone does not have any configurable controls—it must return an ACK command with a bad parameter error status.

The timeout for this command is 200 ms (0.2 second). The device must respond within the allotted time; the iPod will not retry the command. If the device does not respond within the specified time, the command will fail and the device may be considered not present by the iPod.

**Table 3-13** `GetDevCtrl` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x03 | Length of packet payload |
| 3 | 0x01 | Lingo ID: Microphone lingo |
| 4 | 0x09 | Command ID: `GetDevCtrl` |
| 5 | 0x*NN* | The control type for which to get the state. The possible values are:<br>0x00: Reserved.<br>0x01: Stereo/mono line input.<br>0x02: Recording level control.<br>0x03: Recording level limiter control.<br>0x04–0xFF: Reserved. |
| 6 | 0x*NN* | Checksum |

## Command 0x0A: RetDevCtrl

Direction: Device to iPod

The device sends this command in response to the command "Command 0x09: GetDevCtrl" (page 154) received from the iPod. The device returns the current control state for the specified control type. Control types are supported only if the associated capabilities bits are set in the command "Command 0x08: RetDevCaps" (page 153).

**Table 3-14** `RetDevCtrl` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x04 | Length of packet payload |

| Byte number | Value | Comment |
|---|---|---|
| 3 | 0x01 | Lingo ID: Microphone lingo |
| 4 | 0x0A | Command ID: `RetDevCtrl` |
| 5 | 0x*NN* | The control type. See Table 3-15 (page 156). |
| 6 | 0x*NN* | The control data. See Table 3-15 (page 156). |
| 7 | 0x*NN* | Checksum |

Table 3-15 (page 156) lists the different control types and the data associated with them.

**Table 3-15** Control types and data

| Control type value | Control type | Control data |
|---|---|---|
| 0x00 | Reserved | Stereo capability cannot be set. |
| 0x01 | Stereo/mono line input | Possible data values are:<br>0x00 = mono<br>0x01 = stereo<br>0x02–0xFF = reserved |
| 0x02 | Recording level control | Possible data values are in a range between:<br>0x00 = mute<br>0xFF = maximum gain |
| 0x03 | Recording level limiter | Possible data values are:<br>0x00 = off<br>0x01 = on<br>0x02–0xFF = reserved |
| 0x04–0xFF | Reserved | |

## Command 0x0B: SetDevCtrl

Direction: iPod to Device

The iPod sends this command to set the device control state for the specified control type. In response, the device sends the `ACK` command with the command status. If this command is not supported by the device—that is, if the microphone does not have any configurable controls—it must return an `ACK` command with a bad parameter error status.

The timeout for this command is 200 ms (0.2 second). The device must respond within the allotted time; the iPod will not retry the command. If the device does not respond within the specified time, the command will fail and the device may be considered not present by the iPod.

**Table 3-16** `SetDevCtrl` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x04 | Length of packet payload |
| 3 | 0x01 | Lingo ID: Microphone lingo |
| 4 | 0x0B | Command ID: `SetDevCtrl` |
| 5 | 0x*NN* | The control type. The control type and data values are the same as for the `RetDevCtrl` (0x0A) command. See Table 3-15 (page 156) for more information. |
| 6 | 0x*NN* | The control data. See Table 3-15 (page 156) for more information. |
| 7 | 0x*NN* | Checksum |

# Lingo 0x02: Simple Remote Lingo

This lingo is intended for a remote device that retains no state information about the iPod. Simple commands are sent to the iPod, and no acknowledgment or state information is sent back to the device. This lingo is used by the iPod standard in-line remote control. For a sample command sequence that declares this lingo, see Table 3-272 (page 335).

## History and Applicability

System software versions 2.0 through 2.2 on the 3G iPod and versions 1.0 and 1.1 of the iPod mini support only the first five button responses (0 through 4) in the `ContextButtonStatus` command. This is called the contextual button lingo and includes only command 0x00. An extended set of commands (0x01 through 0x04) is available in the dedicated media lingoes, as shown in Table 3-17 (page 157).

**Table 3-17** Simple remote lingo command summary

| Command | ID | Direction | Packet | Lingo version | Authentication |
|---|---|---|---|---|---|
| 0x00 | `ContextButtonStatus` | Device to iPod | `buttonStatus:4` | All | No |
| 0x01 | `ACK` | iPod to Device | `cmdStatus:1, cmdID:1` | 1.01 | Yes |
| 0x02 | `ImageButtonStatus` | Device to iPod | `buttonStatus:4` | 1.01 | Yes |
| 0x03 | `VideoButtonStatus` | Device to iPod | `buttonStatus:4` | 1.01 | Yes |
| 0x04 | `AudioButtonStatus` | Device to iPod | `buttonStatus:4` | 1.01 | Yes |

| Command | ID | Direction | Packet | Lingo version | Authentication |
|---|---|---|---|---|---|
| 0x05–0x0C | Reserved | N/A | N/A | N/A | N/A |
| 0x0D | `RadioButtonStatus` | Device to iPod | `buttonStatus:1` | 1.02 | Yes |
| 0x0E | `CameraButtonStatus` | Device to iPod | `buttonStatus:1` | 1.02 | Yes |
| 0x0F–0xFF | Reserved | N/A | N/A | N/A | N/A |

Dedicated media lingoes are supported by version 1.01 of the Simple Remote lingo. By using `GetiPodOptionsForLingo` (or querying the version number, as shown in Table 3-18 (page 158) if the iPod does not support `GetiPodOptionsForLingo`), an accessory can determine the level of command support.

**Table 3-18** Simple remote lingo support versions

| Version | Support |
|---|---|
| No version | Command 0 supported, buttons 0–4 |
| No version | Command 0 supported, buttons 0–25 |
| 1.00 | Version number can be obtained |
| 1.01 | Command 0–4 supported, buttons 0–25, media controls |
| 1.02 | Bug fix for compatibility with some accessories: when a device identifies itself using the General lingo `Identify` command, the 200 ms time limit during which `ContextButtonStatus` must report that all buttons are up is removed. |

Table 3-19 (page 158) shows the history of command changes in the Simple Remote lingo:

**Table 3-19** Simple Remote lingo command history

| Lingo version | Command changes | Features |
|---|---|---|
| No version | Add: 0x00 | Context specific button status, buttons 0–4 |
| No version | None | Context-specific button status, buttons 5-25 added (4G iPod with firmware versions 3.0.0 and 3.0.1) |
| 1.00 | None | Version number available through `RequestLingoProtocol-Version` |
| 1.01 | Add: 0x01–0x04 | Image-, video-, and audio-specific media control button status |
| 1.02 | Add: 0x0D, 0x0E | All-buttons-up timeout applied to all commands, except not to `ContextButtonStatus` when that command is used with the General lingo (0x00) `Identify` command (0x01) |

## Playback Engine Playlists

The iPod **playback engine** contains a list of queued and currently playing media tracks. Its contents can be queried via the Display Remote or Extended Interface lingoes to obtain track information such as track name, artist, album, genre, etc. One way the playback engine can be loaded is for the user to traverse the iPod UI, selecting one or more media menu items (such as music or videos) and pressing the play/pause button. Another way is for an accessory to send Extended Interface lingo commands to select database categories and initiate the playback of specific selections.

The list of media tracks currently queued for playback in the iPod's playback engine is called the **Now Playing** list. The playlist consisting of all tracks for a given media type, such as audio or video, is called the **All Tracks** list.

## Using Contextual Buttons

A simple remote device sends a `ContextButtonStatus` command to provide updated status on which buttons are held down or released. The data of the packet is a number of bytes indicating which buttons are currently held down. The bytes are constructed by ORing the masks of the buttons together. To indicate all buttons are released, the device must send a full data payload consisting of 0x00. While any buttons are held down, the device must periodically send an updated `ContextButtonStatus` packet on a 30 ms to 100 ms interval.

It is not necessary to transmit any trailing bytes in which no bits are set. If this option is exercised, the length of the packet in the header must be adjusted accordingly; that is, the packet payload length must be decreased to exclude the trailing zero byte(s) that will not be transmitted.

When the user presses and holds down a button, a simple remote device must generate the button status packet immediately and repeat it every 30 to 100 ms for as long as the button is pressed. If a second button is pressed while the first button is down, the button status packet sent by the device must include status for both buttons, and this packet must be repeated every 30 to 100 ms for as long as both buttons are held down. Table 3-26 (page 168) lists the possible iPod button states.

The Next Track and Previous Track commands skip to the next or previous track. If the current track has played less than two seconds, Previous Track backs up to the beginning of the previous track. If the current track has played more than two seconds, it backs up to the beginning of the current track. These commands skip to the next or previous track even when the current track has chapters.

If the current track is an audiobook or a podcast with chapters, the Next Chapter and Previous Chapter commands skip to the next or previous chapter; otherwise they have no effect. If a track has chapters and has played more than two seconds of the current chapter, the Previous Chapter command backs up to the beginning of the current chapter; if the track has played less than two seconds, it backs up to the beginning of the previous chapter.

Some iPod button states are interpreted differently by the iPod when pressed and held down for 2 seconds or more. These are as follows:

- The Next Track button is treated as a Scan Forward button when pressed and held while a track is playing.
- The Previous Track button is treated as a Scan Backward button when pressed and held while a track is playing.
- The Play/Pause button is treated as a Power Off button when pressed and held.

- In iPods before the 4G iPod (color display), the Menu button acted as a Display Backlight On/Off button when pressed and held. Starting with the 4G iPod (color display), pressing and holding the Menu button causes a jump to the top level menu.
- If the iPod is in Browse mode, the Select button is treated as an Add Track to On-The-Go Playlist button when pressed and held.

Repeated Next Track and Previous Track commands (see Table 3-26 (page 168)), without an intervening button status packet indicating all buttons are up, are interpreted as Fast Forward and Rewind commands. For a locking Fast Forward or Rewind button, use the Begin Fast Forward or Begin Rewind commands to start the operation and a Play/Resume command to return to the play state.

The Next and Previous Album commands (see Table 3-26 (page 168)) have no effect if there is no next or previous album to go to in the Now Playing list. Similarly, the Next and Previous Chapter commands have no effect if the currently playing track does not have two or more chapters.

If the list of media tracks currently in the playback engine contains two or more different playlists (including the All Tracks playlist), the Next and Previous Playlist commands navigate these playlists. If the list of media tracks is from a single playlist, or none of the tracks are associated with a playlist, then the Next and Previous Playlist commands have no effect.

Use the following steps to wake an iPod when a simple remote button is pressed (UART serial port only):

1. Send a 0xFF sync byte.
2. Wait 20 ms.
3. Send the button status packet.
4. Wait 30 to 100 ms.
5. Repeat steps 3 and 4 for as long as any button is pressed.

Multiple button status packets cannot be sent back to back; otherwise, the repeated button status packets may be misinterpreted as being part of a corrupted packet. Repeated packets must always be separated by a gap of more than 25 ms, so the iPod knows that the new packet is not part of the previous packet (which may happen if the SYNC and SOP bytes in the first packet have been lost).

## Using Dedicated Media Buttons

The iAP contextual button protocol sends command packets with button messages that are interpreted based on the iPod user interface context. When an iPod is playing media types such as images and video, however, remote controls can become overloaded and their behavior may become confusing to the iPod user. In this case, the accessory device should use dedicated media control button commands.

The dedicated media lingoes include an `ACK` command, so devices know that a packet has been received, and dedicated button status commands for each media type currently supported by the iPod: images, slideshows, videos, and audio. Use of the dedicated media lingoes requires accessory device authentication.

Media control button status bits are organized so that the most frequently used buttons are assigned low bit positions. This reduces the button status packet sizes for frequently used buttons. Button status is maintained separately for all ports and all commands. This means that buttons can be in different states for different media control types.

**Note:** For a given port and media control type (except `ContextButtonStatus` from a device using the `Identify` command), if a command has not been received within approximately 200 ms after the last button status command, the button status will be reset to all buttons up.

## Accessory Control of the iPod 5G nano Camera

This section describes commands that let accessories control the video camera in the iPod 5G nano.

### iPod Camera Modes

The camera in the iPod 5G nano is operated by an iPod firmware application that can be on or off. In its Preview mode, the image that the camera captures is continuously displayed on the iPod's screen. Its Recording mode captures the video being previewed. The user can make each of three modes transition to other modes by means of user controls on either the iPod or its attached accessory, as shown in Table 3-20 (page 161).

**Table 3-20** iPod camera modes and transitions

| Mode | Description | Next mode | Transition control |
|---|---|---|---|
| Camera App Off | The iPod performs only non-camera functions. | Preview | iPod only |
| Preview | The iPod screen displays the image that can be captured as video. In this mode and Recording mode, the iPod's music capabilities are disabled. | Recording | iPod or accessory |
| | | Camera App Off | iPod only |
| Recording | The iPod is recording video | Preview | iPod or accessory |
| | | Camera App Off | iPod only |

If a camera accessory is designed to receive feedback from the iPod, it must register for notifications, as specified in Camera Accessory Identification (page 162). After registration, the iPod notifies the accessory of its current mode and then sends notifications whenever it changes mode.

### Camera Sessions

An iPod camera session begins when the user launches the iPod's Camera Application. The application starts in Preview mode.

When the iPod is in Preview mode the user can order it to start recording video, using either the iPod or the accessory. The iPod goes to Recording mode and records video. When the user stops recording, using either the iPod or the accessory, the iPod returns to Preview mode.

In either Preview or Recording mode the user can quit the Camera Application, using the iPod. The iPod quits the application and returns to its non-camera functionality.

The following is a typical sequence of user actions to capture a video:

1. Launch the Camera application on the iPod. This sets Preview Mode.
2. Order video recording to start, using either the iPod or the accessory.

3. Order video recording to end, using either the iPod or the accessory, or quit the Camera Application, using the iPod.

## Accessory Feedback

In some situations, the user may operate the iPod's camera functions by means of an accessory without being able to see the iPod or otherwise get feedback from it. Thus it is desirable, but not required, for camera-control accessories to provide feedback to the user about the iPod camera's modes.

A simple feedback model might be for the accessory to provide a tristate indicator, such as a LED display, with OFF, MIDDLE, and ON states. When the accessory is connected to the iPod, and while it is going through its identification and authentication process, the indicator would be OFF. Its MIDDLE and ON states would then follow the guidelines shown in Table 3-21 (page 162).

**Table 3-21** Suggested accessory feedback indications

| iPod mode | Indicator | Comments |
|---|---|---|
| Camera App Off | OFF | Default accessory feedback state |
| Preview | MIDDLE | MIDDLE state indicates Preview mode |
| Recording | ON | Indicator remains ON until the iPod notifies the accessory that it has gone to Preview or Camera App Off mode, or communication between the accessory and the iPod is interrupted. |

## Camera Accessory Identification

Every accessory that supports the iPod camera technology described in this document must identify and authenticate itself for at least the General and Simple Remote lingoes (Lingoes 0x00 and 0x02), as specified in "Accessory Identification" (page 445).

After it has received an `AckDevAuthenticationStatus` command with a status of 0x00 from the iPod (completing the authentication process), the accessory can start sending `CameraButtonStatus` commands to it. An accessory that wants feedback from the iPod may also query the iPod's notification capabilities, using `GetSupportedEventNotification` and `RetSupportedEventNotification`, then send a `SetEventNotification` command, as described in Camera Interface Commands (page 162). To get camera feedback, the `SetEventNotification` command sets bit 4 (Camera Notifications) in its bitmask. The iPod replies with an `iPodNotification` command, passing the current mode of its Camera Application. Because the user can set the iPod's camera to either Preview or Recording mode, the accessory must be prepared to configure itself to be compatible with any of the modes listed in Table 3-20 (page 161).

If it has sent a `SetEventNotification` command, the accessory must be prepared to receive `iPodNotification` commands from the iPod every time the iPod's camera state changes. The accessory may use these notifications to provide feedback to the user, as suggested in Accessory Feedback (page 162).

## Camera Interface Commands

Accessory communication with the 5G nano camera is implemented by five iAP commands, as shown in Table 3-22 (page 163).

**Table 3-22** iPod camera interface commands

| Lingo ID | Cmd ID | Cmd name | Direction | Parameters |
|---|---|---|---|---|
| 0x00 | 0x4F | `GetSupportedEvent-Notification` | Device to iPod | {`transID`:2} |
| 0x00 | 0x51 | `RetSupportedEvent-Notification` | iPod to Device | {`transID`:2, `eventNotifyMask`:8} |
| 0x00 | 0x49 | `SetEventNotification` | Device to iPod | {`transID`:2, `eventNotifyMask`:8} |
| 0x00 | 0x4A | `iPodNotification` | iPod to Device | {`transID`:2, `notificationType`:1, `payload`:1} |
| 0x02 | 0x0E | `CameraButtonStatus` | Device to iPod | {`transID`:2, `buttonStatus`:1} |

## Sample Command Sequences

This section describes two scenarios in which an accessory communicates with a 5G nano to control its camera. For further information about notification commands, see iPod Event Notifications (page 449).

### Scenario 1: Video Control On and Off by the Accessory

A typical scenario for recording video under complete accessory control includes these actions:

1. The accessory is connected and authenticates itself. Its feedback indicator is OFF (see Table 3-21 (page 162)).
2. The accessory sends `GetSupportedEventNotification` to the iPod to determine which event notifications it supports.
3. The iPod responds with `RetSupportedEventNotification`, passing a mask that reports which notifications it supports.
4. The accessory sends `SetEventNotification` to the iPod, requesting notifications for camera and flow control events.
5. The Camera Application is not yet launched, so the iPod sends the accessory an `iPodNotification` command with a payload of Camera App Off (see Table 2-108 (page 132)).
6. Using iPod controls, the user launches the Camera application, which comes up in Preview mode.
7. The iPod sends the accessory an `iPodNotification` command with a payload of Preview.
8. The accessory changes its Indicator to the Middle state.
9. The user presses the camera button on the accessory.
10. The accessory sends a `CameraButtonStatus` command to the iPod, passing 0x01.
11. The accessory sends a second “button-up” `CameraButtonStatus` command to the iPod, passing 0x00.
12. The iPod transitions to its Recording mode and sends a corresponding notification to the accessory.

13. The accessory turns On its Indicator.
14. The iPod records video...
15. The user presses the camera button on the accessory.
16. The accessory sends a `CameraButtonStatus` command to the iPod, passing 0x01.
17. The accessory sends a second “button-up” `CameraButtonStatus` command to the iPod, passing 0x00. The iPod stops recording video.
18. The iPod transitions to its Preview mode and sends a corresponding notification to the accessory.
19. The accessory changes its Indicator to the Middle state.

As a result of this sequence, the accessory has started and ended video recording, during which time the accessory’s Indicator has been On. A typical sequence of commands that implements this scenario is listed in Table 3-23 (page 164).

**Table 3-23** Sample video control commands, accessory on and off

| Step | Accessory command | iPod command | Comment |
| --- | --- | --- | --- |
| The accessory identifies itself as supporting the General and Simple Remote lingoes and performs the actions necessary to pass device authentication, as described in "Accessory Identification" (page 445). | | | |
| 1 | | `AckDevAuthentication-Status` | acknowledging authentication status 'Success (OK)' |
| 2 | `GetSupportedEvent-Notification` | | requesting supported notifications |
| 3 | | `RetSupportedEvent-Notification` | reporting that notifications for events 'flow control' and 'camera' are supported |
| 4 | `SetEventNotification` | | setting notifications for events 'flow control' and 'camera' |
| 5 | | `iPodNotification` | sending notification 'Camera Not Ready' |
| 6 | | `ACK` | acknowledging 'Success (OK)' to command 'General Lingo::SetEventNotification' |
| The user launches the Camera application, using controls on the iPod. | | | |
| 7 | | `iPodNotification` | sending notification 'Preview' |
| The user presses the Camera Action button on the accessory. | | | |
| 8 | `CameraButtonStatus` | | Camera Action |
| 9 | `CameraButtonStatus` | | button up |

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| 10 | | `ACK` | acknowledging 'Success (OK)' to command 'Simple Remote Lingo::CameraButtonStatus' |
| 11 | | `ACK` | acknowledging 'Success (OK)' to command 'Simple Remote Lingo::CameraButtonStatus' |
| 12 | | `iPodNotification` | sending notification 'Recording' |
| The user presses the Camera Action button on the accessory. | | | |
| 13 | `CameraButtonStatus` | | Camera Action |
| 14 | `CameraButtonStatus` | | button up |
| 15 | | `ACK` | acknowledging 'Success (OK)' to command 'Simple Remote Lingo::CameraButtonStatus' |
| 16 | | `ACK` | acknowledging 'Success (OK)' to command 'Simple Remote Lingo::CameraButtonStatus' |
| 17 | | `iPodNotification` | sending notification 'Preview' |

### Scenario 2: Video Control On by the iPod and Off by the Accessory

This scenario differs from Scenario 1 in that the iPod starts video recording and the accessory ends it. The following actions take place:

1. The accessory is connected and authenticates itself. Its feedback indicator is OFF (see Table 3-21 (page 162)).
2. The accessory sends `GetSupportedEventNotification` to the iPod to determine which event notifications it supports.
3. The iPod responds with `RetSupportedEventNotification`, passing a mask that reports which notifications it supports.
4. The accessory sends `SetEventNotification` to the iPod, requesting notifications for camera and flow control events.
5. The Camera Application is not yet launched, so the iPod sends the accessory an `iPodNotification` command with a payload of Camera App Off (see Table 2-108 (page 132)).
6. Using iPod controls, the user launches the Camera application, which starts in Preview mode.
7. The iPod sends the accessory an `iPodNotification` command with a payload of Preview.
8. The accessory changes its Indicator to the Middle state.
9. The user starts Recording using controls on the iPod.

10. The iPod sends the accessory an `iPodNotification` command with a payload of Recording.
11. The accessory turns On its Indicator.
12. The iPod records video...
13. The user presses the camera button on the accessory.
14. The accessory sends a `CameraButtonStatus` command to the iPod, passing 0x01.
15. The accessory sends a second “button-up” `CameraButtonStatus` command to the iPod, passing 0x00. The iPod stops recording video.
16. The iPod transitions to its Preview mode and sends a corresponding notification to the accessory.
17. The accessory changes its Indicator to the Middle state.

As a result of this sequence, the iPod has started and the accessory has ended a video recording, during which time the accessory’s Indicator has been On. A typical sequence of commands that implements this scenario is listed in Table 3-24 (page 166).

**Table 3-24** Sample video control commands, iPod on and accessory off

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| The accessory identifies itself as supporting the General and Simple Remote lingoes and performs the actions necessary to pass device authentication, as described in "Accessory Identification" (page 445). | | | |
| 1 | | `AckDevAuthentication-Status` | acknowledging authentication status 'Success (OK)' |
| 2 | `GetSupportedEvent-Notification` | | requesting supported notifications |
| 3 | | `RetSupportedEvent-Notification` | reporting that notifications for events 'flow control' and 'camera' are supported |
| 4 | `SetEventNotification` | | setting notifications for events 'flow control' and 'camera' |
| 5 | | `iPodNotification` | sending notification 'Camera Not Ready' |
| 6 | | `ACK` | acknowledging 'Success (OK)' to command 'General Lingo::SetEventNotification' |
| The user launches the Camera application, using controls on the iPod. | | | |
| 7 | | `iPodNotification` | sending notification 'Preview' |
| The user starts recording video, using controls on the iPod. | | | |
| 8 | | `iPodNotification` | sending notification 'Recording' |

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| The user presses the Camera Action button on the accessory. | | | |
| 9 | CameraButtonStatus | | Camera Action |
| 10 | CameraButtonStatus | | button up |
| 11 | | ACK | acknowledging 'Success (OK)' to command 'Simple Remote Lingo::CameraButtonStatus' |
| 12 | | ACK | acknowledging 'Success (OK)' to command 'Simple Remote Lingo::CameraButtonStatus' |
| 13 | | iPodNotification | sending notification 'Preview' |

## Command 0x00: ContextButtonStatus

Direction: Device to iPod

The device sends this command to the iPod when a button event occurs. The button status is a bitmask representing each button that is currently pressed. The device must send the button status packet repeatedly at intervals between 30 and 100 ms, while one or more buttons are pressed. When all buttons are released, the device must send a button status packet with a 0x00 payload to indicate that no buttons are pressed. The iPod does not return a packet to the device in response to this command.

**Table 3-25** `ContextButtonStatus` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x03–0x06 | Length of packet payload |
| 3 | 0x02 | Lingo ID: Simple Remote lingo |
| 4 | 0x00 | Command ID: `ContextButtonStatus` |
| 5 | 0x*NN* | Byte index 0, button states 7:0. See Table 3-26 (page 168) for a list of button states recognized by the iPod. |
| 6 | 0x*NN* | Byte index 1, button states 15:8 (optional) |
| 7 | 0x*NN* | Byte index 2, button states 23:16 (optional) |
| 8 | 0x*NN* | Byte index 3, button states 31:24 (optional) |
| (last byte) | 0x*NN* | Checksum |

Table 3-26 (page 168) lists the available buttons and their bitmasks.

**Table 3-26** Button states

| Button name | Number | Byte index | Button bitmask |
|---|---|---|---|
| Play/Pause | 0 | 0x00 | 0x01 |
| Volume Up | 1 | 0x00 | 0x02 |
| Volume Down | 2 | 0x00 | 0x04 |
| Next Track | 3 | 0x00 | 0x08 |
| Previous Track | 4 | 0x00 | 0x10 |
| Next Album | 5 | 0x00 | 0x20 |
| Previous Album | 6 | 0x00 | 0x40 |
| Stop | 7 | 0x00 | 0x80 |
| Play/Resume | 8 | 0x01 | 0x01 |
| Pause | 9 | 0x01 | 0x02 |
| Mute toggle | 10 | 0x01 | 0x04 |
| Next Chapter | 11 | 0x01 | 0x08 |
| Previous Chapter | 12 | 0x01 | 0x10 |
| Next Playlist | 13 | 0x01 | 0x20 |
| Previous Playlist | 14 | 0x01 | 0x40 |
| Shuffle Setting Advance | 15 | 0x01 | 0x80 |
| Repeat Setting Advance | 16 | 0x02 | 0x01 |
| Power On | 17 | 0x02 | 0x02 |
| Power Off | 18 | 0x02 | 0x04 |
| Backlight for 30 Seconds | 19 | 0x02 | 0x08 |
| Begin Fast Forward | 20 | 0x02 | 0x10 |
| Begin Rewind | 21 | 0x02 | 0x20 |
| Menu | 22 | 0x02 | 0x40 |
| Select | 23 | 0x02 | 0x80 |
| Up Arrow | 24 | 0x03 | 0x01 |
| Down Arrow | 25 | 0x03 | 0x02 |

| Button name | Number | Byte index | Button bitmask |
|---|---|---|---|
| Backlight Off | 26 | 0x03 | 0x04 |
| Reserved | 27-31 | 0x03 | 0xF8 |

**Notes:**

- The Begin Fast Forward and Begin Rewind states must be sent every 30 to 100 ms to assure continuous fast forward or rewind actions.
- If the user holds down the Fast Forward button (sending repeated Fast Forward states) through a track change, the new track begins playing at normal speed.
- The Menu button navigates only within iPod/Music/Video applications and does not return the user to the Home screen.

## Command 0x01: ACK

Direction: iPod to Device

The iPod sends this command in response to any command sent from the device, except command 0x00. An `ACK` response is sent when a command that does not return any data has completed, when a bad parameter is received, or when an unsupported or invalid command is received.

**Table 3-27** `ACK` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x04 | Length of packet payload |
| 3 | 0x02 | Lingo ID: Simple Remote lingo |
| 4 | 0x01 | Command ID: `ACK` |
| 5 | 0x*NN* | Status of command received (see Table 3-28 (page 169)) |
| 6 | 0x*NN* | ID of the command being acknowledged |
| 7 | 0x*NN* | Checksum |

**Table 3-28** Command status codes

| Code | Command status |
|---|---|
| 0x00 | Command OK |

| Code | Command status |
| --- | --- |
| 0x01 | Unknown track category (not applicable) |
| 0x02 | Command failed (valid command, did not succeed) |
| 0x03 | Out of resources (iPod internal allocation failed) |
| 0x04 | Bad parameter (command or input parameters invalid) |
| 0x05 | Unknown track ID (not applicable) |
| 0x06 | Command pending (`cmdPendTime` parameter returned) |
| 0x07 | Not authenticated (not authenticated) |
| 0x08 | Mismatched authentication protocol version |
| 0x09–0xFF | Reserved |

## Command 0x02: ImageButtonStatus

Direction: Device to iPod

The device sends this command to the iPod when an image-specific button event occurs. The button status is a bitmask representing each button that is currently pressed. The button status packet must be repeatedly sent by the device at intervals between 30 and 100 ms while one or more buttons are pressed. When all buttons are released, the device must send a button status packet with a 0x00 payload to indicate that no buttons are pressed. In response, the iPod will return an `ACK` packet containing the command status to the device.

**Table 3-29** `ImageButtonStatus` packet

| Byte number | Value | Comment |
| --- | --- | --- |
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x*NN* | Length of packet payload |
| 3 | 0x02 | Lingo ID: Simple Remote lingo |
| 4 | 0x02 | Command ID: `ImageButtonStatus` |
| 5 | 0x*NN* | Byte index 0, image-specific button states 7:0. See Table 3-30 (page 171) for a list of image-specific button states recognized by the iPod. |
| 6 | 0x*NN* | Byte index 1, button states 15:8 (optional) |
| 7 | 0x*NN* | Byte index 2, button states 23:16 (optional) |
| 8 | 0x*NN* | Byte index 3, button states 31:24 (optional) |

| Byte number | Value | Comment |
|---|---|---|
| (last byte) | 0x*NN* | Checksum |

**Table 3-30** Image-specific button values

| Button name | Number | Byte index | Button bitmask |
|---|---|---|---|
| Play/Pause | 0 | 0x00 | 0x01 |
| Next image | 1 | 0x00 | 0x02 |
| Previous image | 2 | 0x00 | 0x04 |
| Stop | 3 | 0x00 | 0x08 |
| Play/resume | 4 | 0x00 | 0x10 |
| Pause | 5 | 0x00 | 0x20 |
| Shuffle advance | 6 | 0x00 | 0x40 |
| Repeat advance | 7 | 0x00 | 0x80 |
| Reserved | 8-15 | 0x01 | 0xFF |
| Reserved | 16-23 | 0x02 | 0xFF |
| Reserved | 24-31 | 0x03 | 0xFF |

## Command 0x03: VideoButtonStatus

Direction: Device to iPod

The device sends this command to the iPod when a video-specific button event occurs. The button status is a bitmask representing each button that is currently pressed. The button status packet must be repeatedly sent by the device at intervals between 30 ms and 100 ms while one or more buttons are pressed. When all buttons are released, the device must send a button status packet with a 0x00 payload to indicate that no buttons are pressed. In response, the iPod will return an `ACK` packet containing the command status to the device.

**Table 3-31** `VideoButtonStatus` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x*NN* | Length of packet payload |
| 3 | 0x02 | Lingo ID: Simple Remote lingo |

| Byte number | Value | Comment |
|---|---|---|
| 4 | 0x03 | Command ID: `VideoButtonStatus` |
| 5 | 0x*NN* | Byte index 0, video-specific button states 7:0. See Table 3-32 (page 172) for a list of video-specific button states recognized by the iPod. |
| 6 | 0x*NN* | Byte index 1, button states 15:8 (optional) |
| 7 | 0x*NN* | Byte index 2, button states 23:16 (optional) |
| 8 | 0x*NN* | Byte index 3, button states 31:24 (optional) |
| (last byte) | 0x*NN* | Checksum |

**Table 3-32** Video-specific button values

| Button name | Number | Byte index | Button bitmask |
|---|---|---|---|
| Play/Pause | 0 | 0x00 | 0x01 |
| Next video | 1 | 0x00 | 0x02 |
| Previous video | 2 | 0x00 | 0x04 |
| Stop | 3 | 0x00 | 0x08 |
| Play/Resume | 4 | 0x00 | 0x10 |
| Pause | 5 | 0x00 | 0x20 |
| Begin FF | 6 | 0x00 | 0x40 |
| Begin REW | 7 | 0x00 | 0x80 |
| Next chapter | 8 | 0x01 | 0x01 |
| Previous chapter | 9 | 0x01 | 0x02 |
| Next frame | 10 | 0x01 | 0x04 |
| Previous frame | 11 | 0x01 | 0x08 |
| Reserved | 12-15 | 0x01 | 0xF0 |
| Reserved | 16-23 | 0x02 | 0xFF |
| Reserved | 24-31 | 0x03 | 0xFF |

The Next Video and Previous Video button commands skip to the next or previous video. If the current video has played less than two seconds, Previous Video backs up to the beginning of the previous video; if it has played more than two seconds, it backs up to the beginning of the current video. These commands skip to the next or previous video even when the current video has chapters. If the current video has chapters, the Next Chapter and Previous Chapter commands skip to the next or previous chapter; otherwise they have no effect. If the video has chapters and has played more than two seconds of the current chapter, the Previous Chapter command backs up to the beginning of the current chapter; if the track has played less than two seconds, it backs up to the beginning of the previous chapter.

## Command 0x04: AudioButtonStatus

Direction: Device to iPod

The device sends this command to the iPod when an audio-specific button event occurs. The button status is a bitmask representing each button that is currently pressed. The button status packet must be repeatedly sent by the device at intervals between 30 ms and 100 ms while one or more buttons are pressed. When all buttons are released, the device must send a button status packet with a 0x00 payload to indicate that no buttons are pressed. In response, the iPod will return to the device an `ACK` message containing the command status.

**Table 3-33** `AudioButtonStatus` packet

| Byte number | Value | Comment |
| --- | --- | --- |
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x*NN* | Length of packet payload |
| 3 | 0x02 | Lingo ID: Simple Remote lingo |
| 4 | 0x04 | Command ID: `AudioButtonStatus` |
| 5 | 0x*NN* | Byte index 0, audio-specific button states 7:0. See Table 3-34 (page 173) for a list of audio-specific button states recognized by the iPod. |
| 6 | 0x*NN* | Byte index 1, button states 15:8 (optional) |
| 7 | 0x*NN* | Byte index 2, button states 23:16 (optional) |
| 8 | 0x*NN* | Byte index 3, button states 31:24 (optional) |
| (last byte) | 0x*NN* | Checksum |

**Table 3-34** Audio-specific button values

| Button name | Number | Byte index | Button bitmask |
| --- | --- | --- | --- |
| Play/Pause | 0 | 0x00 | 0x01 |
| Volume Up | 1 | 0x00 | 0x02 |
| Volume Down | 2 | 0x00 | 0x04 |
| Next Track | 3 | 0x00 | 0x08 |
| Previous Track | 4 | 0x00 | 0x10 |

| Button name | Number | Byte index | Button bitmask |
|---|---|---|---|
| Next Album | 5 | 0x00 | 0x20 |
| Previous Album | 6 | 0x00 | 0x40 |
| Stop | 7 | 0x00 | 0x80 |
| Play/Resume | 8 | 0x01 | 0x01 |
| Pause | 9 | 0x01 | 0x02 |
| Mute toggle | 10 | 0x01 | 0x04 |
| Next chapter | 11 | 0x01 | 0x08 |
| Previous chapter | 12 | 0x01 | 0x10 |
| Next playlist | 13 | 0x01 | 0x20 |
| Previous playlist | 14 | 0x01 | 0x40 |
| Shuffle setting advance | 15 | 0x01 | 0x80 |
| Repeat setting advance | 16 | 0x02 | 0x01 |
| Begin FF | 17 | 0x02 | 0x02 |
| Begin REW | 18 | 0x02 | 0x04 |
| Record | 19 | 0x02 | 0x08 |
| Reserved | 20-23 | 0x02 | 0xF0 |
| Reserved | 24-31 | 0x03 | 0xFF |

The Next and Previous Track, Album, and Playlist button commands skip to the next or previous track, album, or playlist. If the current track, album, or playlist has played less than two seconds, the Previous command backs up to the beginning of the previous one; if it has played more than two seconds, it backs up to the beginning of the current one. These commands skip to the next or previous track, album, or playlist even when the current one has chapters. If the current track has chapters, the Next Chapter and Previous Chapter commands skip to the next or previous chapter; otherwise they have no effect. If the track has chapters and has played more than two seconds of the current chapter, the Previous Chapter command backs up to the beginning of the current chapter; if the track has played less than two seconds, it backs up to the beginning of the previous chapter.

## Command 0x0D: RadioButtonStatus

Direction: Device to iPod

The accessory sends this command to a 5G nano iPod to initiate a tagging action by the iPod's Radio Application. Once the accessory has authenticated itself for the Simple Remote lingo, it may send this command at any time.

Currently the only payloads for this command are the values 0x01 and 0x00 in `buttonStatus` (byte 7). Any other values will result in the iPod returning an error value of 0x04 (Bad Parameter). The accessory should repeatedly send this command with a payload of 0x01 at intervals of 30-100 ms while its Radio Tag button is held down. When the button is released it must send a payload of 0x00 to indicate that no buttons are down. The iPod responds with an `ACK` command passing success (0x00).

This command is intended to be used with the `GetSupportedEventNotification` and `SetEventNotification` commands; see iPod Event Notifications (page 449).

**Table 3-35** `RadioButtonStatus` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x05 | Length of packet payload |
| 3 | 0x02 | Lingo ID: Simple Remote lingo |
| 4 | 0x0D | Command ID: `RadioButtonStatus` |
| 5 | 0x*NN* | `transID` [bits 15:8]: Transaction ID of this command. |
| 6 | 0x*NN* | `transID` [bits 7:0] |
| 7 | 0x*NN* | `buttonStatus`: 0x01 = Radio button pushed to tag current song; 0x00 = button released. |
| 8 | 0x*NN* | Checksum |

## Command 0x0E: CameraButtonStatus

Direction: Device to iPod

The accessory sends this command to the iPod to initiate changes in the iPod's Camera mode. Once the accessory has authenticated itself for the Simple Remote lingo, it may send this command at any time.

The accessory must send `CameraButtonStatus` commands in pairs: the first command must pass 0x01 in `buttonStatus` (byte 7) and the second command must pass 0x00. If the accessory doesn't send a second command, the iPod assumes such a return after a 200 ms timeout. Each `CameraButtonStatus` command may pass only the value 0x00 or 0x01; otherwise, the iPod will acknowledge it with a Bad Parameter error status. The iPod will acknowledge each valid `CameraButtonStatus` command with a General lingo `ACK` command reporting Status OK (0x00).

This command is intended to be used with the `GetSupportedEventNotification` and `SetEventNotification` commands; see iPod Event Notifications (page 449).

Table 3-36 `CameraButtonStatus` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x05 | Length of packet payload |
| 3 | 0x02 | Lingo ID: Simple Remote lingo |
| 4 | 0x0E | Command ID: `CameraButtonStatus` |
| 5 | 0x*NN* | `transID` [bits 15:8]: Transaction ID of this command. |
| 6 | 0x*NN* | `transID` [bits 7:0] |
| 7 | 0x*NN* | `buttonStatus`: (0x01 = down, 0x00 = up) |
| 8 | 0x*NN* | Checksum |

## Lingo 0x03: Display Remote Lingo

The Display Remote lingo is for accessory devices that need to control the state of the iPod, display information about the state of the iPod on a remote display, or control the state of the iPod equalizer. The Display Remote protocol can be used by simple inline-display remotes (remotes that have single-line display and play control buttons) and more complex devices that have full multiline graphical displays to show information about the track, artist, or album; current play or pause state; track position; battery; shuffle and time.

For example, the Display Remote protocol can be used in an automotive application to show currently playing track information on the in-vehicle display while allowing the user to browse the database stored in the iPod. Such an application could let the user choose where to browse the database (on the in-vehicle display or on the iPod) and switch between Extended Interface and Display Remote modes, depending on the setting. For a sample command sequence that declares this lingo, see Table 3-272 (page 335).

By supporting multiple lingoes, an accessory can use the Display Remote lingo in combination with other lingoes to create a fully functional iPod/accessory system. Accessories can also use this lingo to control the state of the iPod equalizer. The Display Remote lingo supports serial accessories attached to the 30-pin connector.

The Display Remote command set uses a single byte command format similar to the General and Simple Remote lingoes. Devices using the Display Remote lingo can identify using the General lingo (0x0) command `IdentifyDeviceLingoes` (0x13). See "Command 0x13: IdentifyDeviceLingoes" (page 80) for more information.

**Note:** The Display Remote lingo is an authenticated lingo, with some exceptions. USB accessories must authenticate before they can use the Display Remote lingo. Serial accessories have access only to the equalizer control, battery state, and sound check state commands (commands 0x01–0x07 and 0x1A–0x1E) if they do not authenticate. Please refer to Table 3-37 (page 177) to determine which commands require authentication.

The Display Remote lingo can operate in notification (interrupt) mode, where the iPod sends event notifications to the device, or in polled (non-interrupt) mode. In polled mode, the device should send requests for state change information to the iPod.

The Display Remote commands export text as UTF-8 characters. Graphics cannot be exported. Note that Chapter count information can be retrieved only from the currently playing track.

**Table 3-37** Display Remote lingo command summary

| Command | ID | Data length | Protocol version | Requires authentication over serial link |
|---|---|---|---|---|
| `ACK` | 0x00 | 0x02 | 1.00 | No |
| `GetCurrentEQProfileIndex` | 0x01 | 0x00 | 1.00 | No |
| `RetCurrentEQProfileIndex` | 0x02 | 0x04 | 1.00 | No |
| `SetCurrentEQProfileIndex` | 0x03 | 0x05 | 1.00 | No |
| `GetNumEQProfiles` | 0x04 | 0x00 | 1.00 | No |
| `RetNumEQProfiles` | 0x05 | 0x04 | 1.00 | No |
| `GetIndexedEQProfileName` | 0x06 | 0x04 | 1.00 | No |
| `RetIndexedEQProfileName` | 0x07 | 0x*NN* | 1.00 | No |
| `SetRemoteEventNotification` | 0x08 | 0x04 | 1.02 | Yes |
| `RemoteEventNotification` | 0x09 | 0x*NN* | 1.02 | Yes |
| `GetRemoteEventStatus` | 0x0A | 0x00 | 1.02 | Yes |
| `RetRemoteEventStatus` | 0x0B | 0x04 | 1.02 | Yes |
| `GetiPodStateInfo` | 0x0C | 0x01 | 1.02 | Yes |
| `RetiPodStateInfo` | 0x0D | 0x*NN* | 1.02 | Yes |
| `SetiPodStateInfo` | 0x0E | 0x*NN* | 1.02 | Yes |
| `GetPlayStatus` | 0x0F | 0x00 | 1.02 | Yes |
| `RetPlayStatus` | 0x10 | 0x0D | 1.02 | Yes |

| Command | ID | Data length | Protocol version | Requires authentication over serial link |
|---|---|---|---|---|
| SetCurrentPlayingTrack | 0x11 | 0x04 | 1.02 | Yes |
| GetIndexedPlayingTrackInfo | 0x12 | 0x07 | 1.02 | Yes |
| RetIndexedPlayingTrackInfo | 0x13 | 0x*NN* | 1.02 | Yes |
| GetNumPlayingTracks | 0x14 | 0x00 | 1.02 | Yes |
| RetNumPlayingTracks | 0x15 | 0x04 | 1.02 | Yes |
| GetArtworkFormats | 0x16 | 0x02 | 1.04 | Yes |
| RetArtworkFormats | 0x17 | 0x*NN* | 1.04 | Yes |
| GetTrackArtworkData | 0x18 | 0x0C | 1.04 | Yes |
| RetTrackArtworkData | 0x19 | 0x*NN* | 1.04 | Yes |
| GetPowerBatteryState | 0x1A | 0x00 | 1.02 | No |
| RetPowerBatteryState | 0x1B | 0x02 | 1.02 | No |
| GetSoundCheckState | 0x1C | 0x00 | 1.02 | No |
| RetSoundCheckState | 0x1D | 0x01 | 1.02 | No |
| SetSoundCheckState | 0x1E | 0x02 | 1.02 | No |
| GetTrackArtworkTimes | 0x1F | 0x0C | 1.04 | Yes |
| RetTrackArtworkTimes | 0x20 | 0x*NN* | 1.04 | Yes |
| Reserved | 0x21–0xFF | N/A | N/A | N/A |

## Command History of the Display Remote lingo

Table 3-38 (page 178) shows the history of command changes in the Display Remote lingo:

**Table 3-38** Display Remote lingo command history

| Lingo version | Command changes | Features |
|---|---|---|
| 1.00 | Add: 0x00–0x07 | iPod Equalizer Setting save/restore control |
| 1.01 | None | BugFix: Equalizer state not restored on extended interface exit |
| 1.02 | Add: 0x08–0x15, 0x1A–0x1E | Event notifications, iPod state info, playback track info, sound check, power/battery support |

| Lingo version | Command changes | Features |
|---|---|---|
| 1.03 | None | BugFix: Fix intermittent UI hang when restoring on exit |
| 1.04 | Add: 0x16–0x19, 0x1F–0x20 | Track artwork, lyrics, track time position in seconds |
| 1.05 | None | Video browsing support added to playback commands. Chapter information can be retrieved for all tracks in the Now Playing list, not just for the currently playing track. |

## Transferring Album Art

The Display Remote lingo includes several commands that support the transfer of album artwork from an iPod to an accessory:

- `GetArtworkFormats`
- `RetArtworkFormats`
- `GetTrackArtworkTimes`
- `RetTrackArtworkTimes`
- `GetTrackArtworkData`
- `RetTrackArtworkData`

All album art image encoding is RGB-565, which can be transferred in both big- and small-endian formats. Artwork retrieval takes place in the following steps:

1. Retrieve the number of formats available for artwork on the iPod using `GetArtworkFormats`. It is not necessary to call `GetArtworkFormats` more than once per session; these values will be static while the accessory is attached to the iPod. However, there are no guarantees about the number of formats and which ones are available on a particular model or firmware version. Each `formatID` in `RetArtworkFormats` specifies both a pixel encoding, such as RGB-565 little-endian, and the image dimensions. All formats are fixed-size.

2. When the accessory wants to retrieve the artwork for a given track, it calls `GetIndexedPlayingTrackInfo` with an `infoType` of 0x08. This returns the count of artwork available for each `formatID` associated with the track. It is possible that a track may not have artwork for a particular `formatID` or that the number of images will vary by `formatID`. A given size of album artwork may be available for only one track in the database.

3. To retrieve the list of images associated with a given track and `formatID`, the accessory calls `GetTrackArtworkTimes`. This command tells the iPod to return the associated timestamp for each artwork. The timestamp indicates when the artwork should be displayed, expressed in milliseconds from the start of playback.

4. When the accessory wants to retrieve an individual piece of artwork, it sends `GetTrackArtworkData` to the iPod. This requires the accessory to specify a track, a formatID, and the timestamp of the desired image. The iPod returns the specified artwork and the accessory can display it whenever it chooses.

## Command 0x00: ACK

Direction: iPod to Device

The iPod sends this command to acknowledge the receipt of a command from the device and return the command status. The command ID field indicates the device command for which the response is being sent. The command status indicates the result of the command (success or failure).

**Table 3-39** `ACK` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x04 | Length of packet payload |
| 3 | 0x03 | Lingo ID: Display Remote lingo |
| 4 | 0x00 | Command ID: `ACK` |
| 5 | 0x*NN* | Command result status. See Table 3-40 (page 180). |
| 6 | 0x*NN* | The ID for the command being acknowledged. |
| 7 | 0x*NN* | Checksum |

Table 3-40 (page 180) lists the possible result values for the command result status field.

**Table 3-40** Command result values

| Result | Meaning |
|---|---|
| 0x00 | Success (OK) |
| 0x01 | Reserved |
| 0x02 | ERROR: Command failed |
| 0x03 | ERROR: Out of resources |
| 0x04 | ERROR: Bad parameter |
| 0x05 | ERROR: Unknown ID |
| 0x06 | Reserved |
| 0x07 | ERROR: Accessory not authenticated |
| 0x08–0xFF | Reserved |

## Command 0x01: GetCurrentEQProfileIndex

Direction: Device to iPod

The device requests the current Equalizer Profile setting index. In response, the iPod sends the "Command 0x02: RetCurrentEQProfileIndex" (page 181) packet.

**Table 3-41** `GetCurrentEQProfileIndex` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x02 | Length of packet payload |
| 3 | 0x03 | Lingo ID: Display Remote lingo |
| 4 | 0x01 | Command ID: `GetCurrentEQProfileIndex` |
| 5 | 0xFA | Checksum |

## Command 0x02: RetCurrentEQProfileIndex

Direction: iPod to Device

The iPod sends this command, returning the current Equalizer Profile setting index, in response to the "Command 0x01: GetCurrentEQProfileIndex" (page 181) packet sent by the device. An Equalizer Index of 0x0 indicates that the equalizer is disabled.

**Table 3-42** `RetCurrentEQProfileIndex` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x06 | Length of packet payload |
| 3 | 0x03 | Lingo ID: Display Remote lingo |
| 4 | 0x02 | Command ID: `RetCurrentEQProfileIndex` |
| 5 | 0x*NN* | Current Equalizer Index (bits 31:24) |
| 6 | 0x*NN* | Current Equalizer Index (bits 23:16) |
| 7 | 0x*NN* | Current Equalizer Index (bits 15:8) |
| 8 | 0x*NN* | Current Equalizer Index (bits 7:0) |

| Byte number | Value | Comment |
|---|---|---|
| 9 | 0x*NN* | Checksum |

## Command 0x03: SetCurrentEQProfileIndex

Direction: Device to iPod

The device sets the current Equalizer Profile setting index and optionally restores the original Equalizer Setting on accessory detach. The valid Equalizer Index range can be determined by sending "Command 0x04: GetNumEQProfiles" (page 183). An Equalizer Index of 0x0 tells the iPod that the equalizer should be disabled; a valid nonzero index enables the equalizer.

In response to this command, the iPod returns an `ACK` packet with the status of this command.

**Table 3-43** `SetCurrentEQProfileIndex` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x07 | Length of packet payload |
| 3 | 0x03 | Lingo ID: Display Remote lingo |
| 4 | 0x03 | Command ID: `SetCurrentEQProfileIndex` |
| 5 | 0x*NN* | Current Equalizer Index (bits 31:24) |
| 6 | 0x*NN* | Current Equalizer Index (bits 23:16) |
| 7 | 0x*NN* | Current Equalizer Index (bits 15:8) |
| 8 | 0x*NN* | Current Equalizer Index (bits 7:0) |
| 9 | 0x*NN* | `bRestoreOnExit`. Specifies whether to restore the previous Equalizer Setting on device exit or detach. See the discussion below. |
| 10 | 0x*NN* | Checksum |

The `bRestoreOnExit` Boolean byte flag determines the behavior of the iPod when the accessory device is detached from the connector. A value of 0x0 (false) indicates that the original Equalizer Setting should be discarded. A nonzero (true) value indicates that the previous Equalizer Setting should be restored when the device is detached from the iPod. Anytime the `SetCurrentEQProfileIndex` command is sent with `bRestoreOnExit` equal to false, the previous equalizer state is erased and lost. If `SetCurrentEQProfileIndex` is sent with `bRestoreOnExit` equal to true every time, the first `SetCurrentEQProfileIndex` command saves the original equalizer state; subsequent commands do not change the original saved equalizer state. On accessory detach, the original saved equalizer state is restored.

## Command 0x04: GetNumEQProfiles

Direction: Device to iPod

The device requests the number of iPod Equalizer Profile settings. In response, the iPod sends the "Command 0x05: RetNumEQProfiles" (page 183) packet.

**Table 3-44** `GetNumEQProfiles` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x02 | Length of packet payload |
| 3 | 0x03 | Lingo ID: Display Remote lingo |
| 4 | 0x04 | Command ID: `GetNumEQProfiles` |
| 5 | 0xF7 | Checksum |

## Command 0x05: RetNumEQProfiles

Direction: iPod to Device

The iPod returns the number of Equalizer Profiles in it. It sends this command in response to the "Command 0x04: GetNumEQProfiles" (page 183) packet sent by the device. The valid profile index range for iPod equalizer commands accepting a profile index is 0x0 to `profileCount-1`.

**Table 3-45** `RetNumEQProfiles` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x06 | Length of packet payload |
| 3 | 0x03 | Lingo ID: Display Remote lingo |
| 4 | 0x05 | Command ID: `RetNumEQProfiles` |
| 5 | 0x*NN* | `profileCount`. The Equalizer Profile count (bits 31:24). |
| 6 | 0x*NN* | Equalizer profile count (bits 23:16) |
| 7 | 0x*NN* | Equalizer profile count (bits 15:8) |
| 8 | 0x*NN* | Equalizer profile count (bits 7:0) |

| Byte number | Value | Comment |
|---|---|---|
| 9 | 0x*NN* | Checksum |

## Command 0x06: GetIndexedEQProfileName

Direction: Device to iPod

The device requests the iPod Equalizer Profile setting name for a given Equalizer Profile index. In response, the iPod sends the "Command 0x07: RetIndexedEQProfileName" (page 184) packet. The valid profile index range can be obtained by sending "Command 0x04: GetNumEQProfiles" (page 183).

**Table 3-46** `GetIndexedEQProfileName` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x06 | Length of packet payload |
| 3 | 0x03 | Lingo ID: Display Remote lingo |
| 4 | 0x06 | Command ID: `GetIndexedEQProfileName` |
| 5 | 0x*NN* | Equalizer profile index (bits 31:24) |
| 6 | 0x*NN* | Equalizer profile index (bits 23:16) |
| 7 | 0x*NN* | Equalizer profile index (bits 15:8) |
| 8 | 0x*NN* | Equalizer profile index (bits 7:0) |
| 9 | 0x*NN* | Checksum |

## Command 0x07: RetIndexedEQProfileName

Direction: iPod to Device

The iPod returns its Equalizer Profile setting name for the specified Equalizer Profile index in response to "Command 0x06: GetIndexedEQProfileName" (page 184). The Equalizer Profile name is returned as a variable-length, null-terminated UTF-8 character array.

**Note:** The UTF-8 Equalizer Profile name string is not limited to 255 characters. It may be sent in either small or large packet format. The following table shows the small packet format.

**Table 3-47** `RetIndexedEQProfileName` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x*NN* | Length of packet payload |
| 3 | 0x03 | Lingo ID: Display Remote lingo |
| 4 | 0x07 | Command ID: `RetIndexedEQProfileName` |
| 5 … *N* | 0x*NN*… | The Equalizer Profile name, as a null-terminated UTF-8 character array. |
| (last byte) | 0x*NN* | Checksum |

## Command 0x08: SetRemoteEventNotification

Direction: Device to iPod

The device requests that the iPod enable asynchronous remote event notification for specific iPod events. Notification for each event can be enabled by setting the associated bit in the remote event bitmask (`remEventMask`). By default, all event notifications are disabled and must be explicitly enabled using this command. In response, the iPod sends an `ACK` command indicating the command completion status. A remote event bitmask of 0x0 disables all remote event status notifications. On device detach, event notification is reset to the default disabled state.

**Table 3-48** `SetRemoteEventNotification` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x06 | Length of packet payload |
| 3 | 0x03 | Lingo ID: Display Remote lingo |
| 4 | 0x08 | Command ID: `SetRemoteEventNotification` |
| 5 | 0x*NN* | `remEventMask` (bits 31:24). See Table 3-49 (page 186) for a list of the events for which you can enable notification. |
| 6 | 0x*NN* | `remEventMask` (bits 23:16) |
| 7 | 0x*NN* | `remEventMask` (bits 15:8) |

| Byte number | Value | Comment |
|---|---|---|
| 8 | 0x*NN* | `remEventMask` (bits 7:0) |
| 9 | 0x*NN* | Checksum |

Enable notifications for the events listed in Table 3-49 (page 186) by setting the bit for each event in the remote event bitmask. A value of 1 enables the notification of the iPod state change for that event and a value of 0 disables the notification.

**Table 3-49** iPod events

| Bit number | Remote Event |
|---|---|
| 0 | Track time position in milliseconds |
| 1 | Track playback index |
| 2 | Chapter index |
| 3 | Play status (play, pause, stop, FF, and RW) |
| 4 | Mute/UI Volume |
| 5 | Power/battery |
| 6 | Equalizer setting |
| 7 | Shuffle setting |
| 8 | Repeat setting |
| 9 | Date and time setting |
| 10 | Alarm setting |
| 11 | Backlight state |
| 12 | Hold switch state |
| 13 | Sound check state |
| 14 | Audiobook speed |
| 15 | Track time position in seconds |
| 16 | Mute/UI/Absolute Volume (see Note below) |
| 31:17 | Reserved |

**Note:** When bit 16 is set in the remote event bitmask of `SetRemoteEventNotification`, `RemoteEventNotification` returns the same mute state and UI volume level as for bit 4. The absolute volume value it returns is the actual audio volume after the iPod volume limit has been applied. Its range is 0 to 255 if the iPod volume limit setting is set to maximum scale; otherwise its range is 0 to iPod volume limit. The UI volume level is scaled to cover the absolute volume range. This lets an accessory with a headphone jack comply with the iPod volume limit setting.

## Command 0x09: RemoteEventNotification

Direction: iPod to Device

The iPod sends this command asynchronously whenever an enabled event change has occurred. Use "Command 0x08: SetRemoteEventNotification" (page 185) to control which events are enabled. The notification packet formats are described in more detail below. Notifications for enabled events are sent every 500 ms, with the exception of volume change notifications, which are sent every 100 ms.

**Note:** Notifications are sent only when the iPod is in Power On mode; none are sent when the iPod is in Sleep or Hibernate mode.

This is the command packet for the `RemoteEventNotifcation` command. See Table 3-51 (page 188) to interpret the `eventNum` and `eventData` fields.

**Table 3-50** `RemoteEventNotification` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x*NN* | Length of packet payload |
| 3 | 0x03 | Lingo ID: Display Remote lingo |
| 4 | 0x09 | Command ID: `RemoteEventNotification` |
| 5 | 0x*NN* | `eventNum`. A number indicating the type of event. |
| 6 … *N* | 0x*NN* | `eventData`. Additional information about the event. This field is variable length; see Table 3-51 (page 188). |
| (last byte) | 0x*NN* | Checksum |

Table 3-51 (page 188) shows the expected payload and length for each type of event notification. For example, if an accessory receives an event notification for event 0x02 (Chapter Info) then the payload is 8 bytes long and contains the track index (bytes 0–3), the chapter count (bytes 4 and 5) and the chapter index (bytes 6 and 7). If bytes 4 and 5 are all zeros, the currently playing track does not have chapters.

Table 3-51 Event notification data

| Event number | Event | Event data | Data length in bytes |
|---|---|---|---|
| 0x00 | Track position | The new track position, in milliseconds.<br>■ Byte 0: Track Position (bits 31:24)<br>■ Byte 1: Track Position (bits 23:16)<br>■ Byte 2: Track Position (bits 15:8)<br>■ Byte 3: Track Position (bits 7:0) | 0x04 |
| 0x01 | Track index | The index of the currently playing track.<br>■ Byte 0: Track Index (bits 31:24)<br>■ Byte 1: Track Index (bits 23:16)<br>■ Byte 2: Track Index (bits 15:8)<br>■ Byte 3: Track Index (bits 7:0) | 0x04 |
| 0x02 | Chapter information | Chapter information, including the track index, chapter count, and chapter index.<br>■ Bytes 0–3 specify the currently playing track index, as follows:<br>Byte 0: Track Index (bits 31:24)<br>Byte 1: Track Index (bits 23:16)<br>Byte 2: Track Index (bits 15:8)<br>Byte 3: Track Index (bits 7:0)<br>■ Bytes 4-5 specify the chapter count of the track, as follows. A value of 0x0000 indicates that the track does not have chapters.<br>Byte 4: Chapter Count (bits 15:8)<br>Byte 5: Chapter Count (bits 7:0)<br>■ Bytes 6-7 specify the chapter index, as follows. A value of 0xFFFF indicates that the track does not have chapters.<br>Byte 6: Chapter Index (bits 15:8)<br>Byte 7: Chapter Index (bits 7:0) | 0x08 |
| 0x03 | Play status | The current play status of the iPod; that is, whether it is playing, paused, stopped, fast forwarding or rewinding. Possible values are described in Table 3-52 (page 191).<br>■ Byte 0: Play Status (bits 7:0) | 0x01 |

| Event number | Event | Event data | Data length in bytes |
| --- | --- | --- | --- |
| 0x04 | Mute/UI Volume | The current state of the mute setting and UI volume information.<br>■ Byte 0: Mute State (bits 7:0)<br>A value of 0 indicates that mute is off; a value of 1 indicates that mute is on.<br>■ Byte 1: UI Volume Level (bits 7:0)<br>A value between 0 and 255, with 0 indicating minimum volume and 255 indicating maximum volume.<br>Note that if the Mute State value is true (mute is on), the UI volume level field is not valid and is returned as 0. | 0x02 |
| 0x05 | Power/battery | Information about the power and battery status.<br>■ Byte 0: Power State (bits 7:0)<br>A value indicating the current power source and its state. See Table 3-55 (page 192) for possible values.<br>■ Byte 1: Battery Level (bits 7:0)<br>Specifies the current battery level. A value from 0 to 255, with 0 indicating a fully discharged battery and 255 indicating a battery that is fully charged.<br>If an external power status is returned, the battery level is invalid and is returned as 0. | 0x02 |
| 0x06 | Equalizer state | The current Equalizer Setting index.<br>■ Byte 0: Equalizer index (bits 31:24)<br>■ Byte 1: Equalizer index (bits 23:16)<br>■ Byte 2: Equalizer index (bits 15:8)<br>■ Byte 3: Equalizer index (bits 7:0) | 0x04 |
| 0x07 | Shuffle | The state of the shuffle setting. See Table 3-53 (page 192) for a list of possible values.<br>■ Byte 0: Shuffle State (bits 7:0) | 0x01 |
| 0x08 | Repeat | The state of the repeat setting. See Table 3-54 (page 192) for a list of possible values.<br>■ Byte 0: Repeat State (bits 7:0) | 0x01 |

| Event number | Event | Event data | Data length in bytes |
|---|---|---|---|
| 0x09 | Date/time | The current date and time.<br>■ Bytes 0–1 specify the current year. A value of 2005 represents the year 2005 A.D.<br>Byte 0: Year (bits 15:8)<br>Byte 1: Year (bits 7:0)<br>■ Byte 2: Month (bits 7:0)<br>A value between 1 and 12, where 1 = January and 12 = December.<br>■ Byte 3: Day of the month (bits 7:0)<br>A value between 1 and 31.<br>■ Byte 4: Hour (bits 7:0)<br>A value between 0 and 23, where 0 = 12:00 a.m. and 23 = 11:00 p.m.<br>■ Byte 5: Minute (bits 7:0)<br>A value between 0 and 59. | 0x06 |
| 0x0A | Alarm | Alarm information.<br>■ Byte 0: Alarm State (bits 7:0)<br>A value indicating the current state of the alarm. Possible values are:<br>0 = off<br>1 = enabled<br>2 = triggered<br>■ Byte 1: Alarm Hour (bits 7:0)<br>A value between 0 and 23, where 0 = 12:00 a.m. and 23 = 11:00 p.m.<br>■ Byte 2: Alarm Minute (bits 7:0)<br>A value between 0 and 59. | 0x03 |
| 0x0B | Backlight | The current backlight level. A value between 0 and 255, where 0 indicates the backlight is off and 255 indicates that the backlight is at full intensity.<br>■ Byte 0: Backlight Level (bits 7:0) | 0x01 |
| 0x0C | Hold switch | The current state of the hold switch. A value of 0 means the hold switch is off. A value of 1 indicates it is on.<br>■ Byte 0: Hold Switch State (bits 7:0) | 0x01 |

| Event number | Event | Event data | Data length in bytes |
|---|---|---|---|
| 0x0D | Sound check | The state of the sound check setting. A value of 0 means that sound check is off; a value of 1 indicates it is on.<br>■ Byte 0: Sound Check State (bits 7:0) | 0x01 |
| 0x0E | Audiobook | The audiobook playback speed setting. See Table 3-56 (page 193) for a list of possible values.<br>■ Byte 0: Audiobook Playback Speed Setting (bits 7:0) | 0x01 |
| 0x0F | Track position in seconds | The new track time position, in seconds.<br>■ Byte 0: Track Position (bits 15:8)<br>■ Byte 1: Track Position (bits 7:0) | 0x02 |
| 0x10 | Mute/UI/Absolute Volume | The current state of the mute setting, UI volume, and absolute volume.<br>■ Byte 0: Mute state (bits 7:0). A value of 0 indicates that muting is off; a value of 1 indicates that muting is on.<br>■ Byte 1: UI volume level (bits 7:0). A value between 0 and 255, normalized to volume limit settings. 0 indicates minimum volume and 255 indicates maximum volume.<br>■ Byte 2: Absolue volume level (bits 7:0). A value between 0 and 255, not normalized. 0 indicates minimum absolute volume and 255 indicates maximum absolute volume. If muting is on (byte 0 = 0x00), the absolute volume level is not valid and is returned as 0. | 0x02 |
| 0x11–0xFF | Reserved | N/A | N/A |

The battery and volume UI levels (but not absolute levels) are normalized across all iPod platforms so that 0 represents the minimum level and 255 represents the maximum level. The granularity of minimum to maximum range steps varies by iPod platform.

Table 3-52 (page 191) lists the possible values for the data associated with a Play Status event and their meanings.

**Table 3-52** Play status values

| Value | Meaning |
|---|---|
| 0x00 | Playback stopped |
| 0x01 | Playing (for "Command 0x0E: SetiPodStateInfo" (page 197), start or resume playback) |
| 0x02 | Playback paused |
| 0x03 | Fast forward (FF) |

| Value | Meaning |
|---|---|
| 0x04 | Fast rewind (REW) |
| 0x05 | End fast forward or rewind mode |
| 0x06–0xFF | Reserved |

**Note:** With the iPhone, incoming phone calls can pause audio playback at any time. The accessory should enable notifications for this event and act accordingly (for example, by changing an icon). It should not try to cancel the pause.

Table 3-53 (page 192) lists the possible values for the data associated with a Shuffle event.

**Table 3-53** Shuffle state

| Value | Meaning |
|---|---|
| 0x00 | Shuffle off |
| 0x01 | Shuffle tracks and songs |
| 0x02 | Shuffle albums |
| 0x03–0xFF | Reserved |

Table 3-54 (page 192) lists the possible values for the data associated with a Repeat event.

**Table 3-54** Repeat state

| Value | Meaning |
|---|---|
| 0x00 | Repeat off |
| 0x01 | Repeat one track or song |
| 0x02 | Repeat all tracks |
| 0x03–0xFF | Reserved |

Table 3-55 (page 192) lists the possible values for the data associated with a Power/Battery event and their meanings.

**Table 3-55** Power and battery state

| Value | Meaning |
|---|---|
| 0x00 | Internal battery power, low power (< 30%) |
| 0x01 | Internal battery power |

| Value | Meaning |
|---|---|
| 0x02 | External power, battery pack, no charging |
| 0x03 | External power, no charging |
| 0x04 | External power, battery charging |
| 0x05 | External power, battery charged |
| 0x06–0xFF | Reserved |

Table 3-56 (page 193) lists the possible values for the data associated with an Audiobook event and their meanings.

**Table 3-56** Audiobook playback speeds

| Value | Meaning |
|---|---|
| 0xFF | Slower (–1) |
| 0x00 | Normal |
| 0x01 | Faster (+1) |
| 0x02–0xFE | Reserved |

## Command 0x0A: GetRemoteEventStatus

Direction: Device to iPod

The device requests the status of state information that has changed on the iPod. In response, the iPod sends "Command 0x0B: RetRemoteEventStatus" (page 194), containing a bitmask of event states that changed since the last `GetRemoteEventStatus` command and clears all the remote event status bits. This command may be used to poll the iPod for certain event changes without enabling asynchronous remote event notification.

**Note:** Accessories must not poll for play status; they must use the iAP notification mechanism instead. See "Command 0x08: SetRemoteEventNotification" (page 185).

**Table 3-57** `GetRemoteEventStatus` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x02 | Length of packet payload |
| 3 | 0x03 | Lingo ID: Display Remote lingo |

| Byte number | Value | Comment |
|---|---|---|
| 4 | 0x0A | Command ID: GetRemoteEventStatus |
| 5 | 0xF1 | Checksum |

## Command 0x0B: RetRemoteEventStatus

Direction: iPod to Device

The iPod sends this command in response to "Command 0x0A: GetRemoteEventStatus" (page 193).

**Table 3-58** RetRemoteEventStatus packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x06 | Length of packet payload |
| 3 | 0x03 | Lingo ID: Display Remote lingo |
| 4 | 0x0B | Command ID: RetRemoteEventStatus |
| 5 | 0x*NN* | remEventStatus (bits 31:24). The event status that has changed. See Table 3-49 (page 186) for a list of possible events. |
| 6 | 0x*NN* | remEventStatus (bits 23:16) |
| 7 | 0x*NN* | remEventStatus (bits 15:8) |
| 8 | 0x*NN* | remEventStatus (bits 7:0) |
| 9 | 0x*NN* | Checksum |

The bits in Table 3-49 (page 186) represent the events whose status has changed on the iPod since the last GetRemoteEventStatus command was received. For example, if the returned remEventStatus field has bits 2 and 7 set, then the chapter index and shuffle states of the iPod have changed since the last GetRemoteEventStatus command was sent by the accessory. Accessories can use "Command 0x0C: GetiPodStateInfo" (page 194) to get the updated state information for those events.

## Command 0x0C: GetiPodStateInfo

Direction: Device to iPod

The device obtains iPod state information. The information type (infoType) field specifies the type of information to get. In response, the iPod sends "Command 0x0D: RetiPodStateInfo" (page 196) with the requested state information.

**Table 3-59** `GetiPodStateInfo` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x03 | Length of packet payload |
| 3 | 0x03 | Lingo ID: Display Remote lingo |
| 4 | 0x0C | Command ID: `GetiPodStateInfo` |
| 5 | 0x*NN* | `infoType` (1 byte). The type of state information for which to query the iPod. See Table 3-60 (page 195). |
| 6 | 0x*NN* | Checksum |

Table 3-60 (page 195) lists the different types of information for which you can query the iPod.

**Table 3-60** `infoType` values

| Value | Type of information |
|---|---|
| 0x00 | Track time position in milliseconds |
| 0x01 | Track playback index |
| 0x02 | Chapter information |
| 0x03 | Play status (play, pause, stop, FF, and RW) |
| 0x04 | Mute and volume information |
| 0x05 | Power and battery status |
| 0x06 | Equalizer setting |
| 0x07 | Shuffle setting |
| 0x08 | Repeat setting |
| 0x09 | Date and time |
| 0x0A | Alarm state and time |
| 0x0B | Backlight state |
| 0x0C | Hold switch state |
| 0x0E | Audiobook speed |
| 0x0F | Track time position in seconds |

| Value | Type of information |
|---|---|
| 0x10 | Mute/UI/Absolute volume |
| 0x11–0xFF | Reserved |

For example, to retrieve the iPod Equalizer Setting, an accessory could send the command shown in Table 3-61 (page 196).

**Table 3-61** `GetiPodStateInfo` packet to retrieve the iPod Equalizer Setting

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x03 | Length of packet payload |
| 3 | 0x03 | Lingo ID: Display Remote lingo |
| 4 | 0x0C | Command ID: `GetiPodStateInfo` |
| 5 | 0x06 | `infoType` = 0x06 (Equalizer setting) |
| 6 | 0xE8 | Checksum |

## Command 0x0D: RetiPodStateInfo

Direction: iPod to Device

The iPod sends this command in response to "Command 0x0C: GetiPodStateInfo" (page 194). The format of the returned state information depends on the type of information. See Table 3-51 (page 188) for a description of the data returned for each information type.

**Table 3-62** `RetiPodStateInfo` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x*NN* | Length of packet payload |
| 3 | 0x03 | Lingo ID: Display Remote lingo |
| 4 | 0x0D | Command ID: `RetiPodStateInfo` |
| 5 | 0x*NN* | `infoType` (1 byte). The type of iPod state information returned. |
| 6 … *N* | 0x*NN* | `infoData` (variable length). The iPod state information. |

| Byte number | Value | Comment |
|---|---|---|
| (last byte) | 0x*NN* | Checksum |

For example, an accessory requesting the Chapter Info of the currently playing track would receive a `RetiPodStateInfo` command packet similar to this (assuming a track index of 10, a chapter count of 8 and a current chapter index of 3):

**Table 3-63** `RetiPodStateInfo` packet for requesting chapter information

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x0B | Length of packet payload |
| 3 | 0x03 | Lingo ID: Display Remote lingo |
| 4 | 0x0D | Command ID: `RetiPodStateInfo` |
| 5 | 0x02 | `infoType` = 0x02 (Chapter Information) |
| 6 | 0x00 | `infoData` = Track Index (bits 31:24) |
| 7 | 0x00 | `infoData` = Track Index (bits 23:16) |
| 8 | 0x00 | `infoData` = Track Index (bits 15:8) |
| 9 | 0x0A | `infoData` = Track Index (bits 7:0) |
| 10 | 0x00 | `infoData` = Chapter Count (bits 15:8) |
| 11 | 0x08 | `infoData` = Chapter Count (bits 7:0) |
| 12 | 0x00 | `infoData` = Chapter Index (bits 15:8) |
| 13 | 0x03 | `infoData` = Chapter Index (bits 7:0) |
| 14 | 0xCE | Checksum |

## Command 0x0E: SetiPodStateInfo

Direction: Device to iPod

Sets the iPod state. The information type (`infoType`) field specifies the type of information to update. In response, the iPod sends an `ACK` command with the results of the operation. Some commands include a `bRestoreOnExit` parameter that optionally allows the original iPod setting to be restored on exit.

**Table 3-64** `SetiPodStateInfo` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x*NN* | Length of packet payload |
| 3 | 0x03 | Lingo ID: Display Remote lingo |
| 4 | 0x0E | Command ID: `SetiPodStateInfo` |
| 5 | 0x*NN* | `infoType` (1 byte). The type of iPod state information to set. |
| 6 … *N* | 0x*NN* | `infoData` (variable length). The data for the iPod state information to set. |
| (last byte) | 0x*NN* | Checksum |

Table 3-65 (page 198) lists the possible values of the `infoType` field and the corresponding data in the `infoData` field.

**Note:** Information types 0x09 (date/time) and 0x0B (backlight) cannot be set on the iPhone or iPod touch.

**Table 3-65** iPod state data

| Information type | | Information data | |
|---|---|---|---|
| Value | Name | Description | Length (bytes) |
| 0x00 | Track position | The new position of the track, in milliseconds.<br>■ Byte 0: Track Position (bits 31:24)<br>■ Byte 1: Track Position (bits 23:16)<br>■ Byte 2: Track Position (bits 15:8)<br>■ Byte 3: Track Position (bits 7:0) | 0x04 |
| 0x01 | Track index | The index of the track to play.<br>■ Byte 0: Track Index (bits 31:24)<br>■ Byte 1: Track Index (bits 23:16)<br>■ Byte 2: Track Index (bits 15:8)<br>■ Byte 3: Track Index (bits 7:0) | 0x04 |
| 0x02 | Chapter index | The new chapter index.<br>■ Byte 0: Chapter Index (bits 15:8)<br>■ Byte 1: Chapter Index (bits 7:0) | 0x02 |

| Information type | | Information data | |
|---|---|---|---|
| **Value** | **Name** | **Description** | **Length (bytes)** |
| 0x03 | Play status | The play status of the iPod (play, pause, stop, FF or REW). See Table 3-52 (page 191) for a list of possible values.<br>Byte 0: Play Status (bits 7:0) | 0x01 |
| 0x04 | Mute/volume | The new mute setting or volume level.<br>■ Byte 0: Mute State (bits 7:0)<br>A value of 0x00 turns mute off; a value of 0x01 turns on mute.<br>■ Byte 1: Volume Level (bits 7:0)<br>A value between 0 and 255, with 0 indicating minimum volume and 255 indicating maximum volume.<br>■ Byte 2: `bRestoreOnExit` (bits 7:0)<br>See Table 3-66 (page 202).<br>If the mute state is 0x01, the volume level field is ignored. | 0x03 |
| 0x05 | Power/battery | Reserved: Power and battery state cannot be set. | N/A |
| 0x06 | Equalizer state | The new Equalizer Setting.<br>■ Byte 0: Equalizer index (bits 31:24)<br>■ Byte 1: Equalizer index (bits 23:16)<br>■ Byte 2: Equalizer index (bits 15:8)<br>■ Byte 3: Equalizer index (bits 7:0)<br>■ Byte 4: `bRestoreOnExit` (bits 7:0)<br>See Table 3-66 (page 202). | 0x05 |
| 0x07 | Shuffle | The new state of the shuffle setting.<br>■ Byte 0: Shuffle State (bits 7:0)<br>See Table 3-53 (page 192) for a list of possible values.<br>■ Byte 1: `bRestoreOnExit` (bits 7:0)<br>See Table 3-66 (page 202). | 0x02 |
| 0x08 | Repeat | The new state of the repeat setting<br>■ Byte 0: Repeat State (bits 7:0)<br>See Table 3-54 (page 192) for a list of possible values.<br>■ Byte 1: `bRestoreOnExit` (bits 7:0)<br>See Table 3-66 (page 202). | 0x02 |

| Information type | | Information data | |
|---|---|---|---|
| **Value** | **Name** | **Description** | **Length (bytes)** |
| 0x09 | Date/time | The new date and time.<br>■ Bytes 0–1 specify the current year. A value of 2005 represents the year 2005 A.D.<br>Byte 0: Year (bits 15:8)<br>Byte 1: Year (bits 7:0)<br>■ Byte 2: Month (bits 7:0)<br>A value between 1 and 12, where 1 = January and 12 = December.<br>■ Byte 3: Day of the month (bits 7:0)<br>A value between 1 and 31.<br>■ Byte 4: Hour (bits 7:0)<br>A value between 0 and 23, where 0 = 12:00 a.m. and 23 = 11:00 p.m.<br>■ Byte 5: Minute (bits 7:0)<br>A value between 0 and 59. | 0x06 |
| 0x0A | Alarm | The alarm state and time.<br>■ Byte 0: Alarm State (bits 7:0)<br>A value of 0 turns the alarm off, while a value of 1 enables the alarm. When turning off the alarm, the Hour and Minutes bytes are ignored.<br>■ Byte 1: Alarm Hour (bits 7:0)<br>A value between 0 and 23, where 0 = 12:00 a.m. and 23 = 11:00 p.m.<br>■ Byte 2: Alarm Minute (bits 7:0)<br>A value between 0 and 59.<br>■ Byte 3: `bRestoreOnExit` (bits 7:0): See Table 3-66 (page 202). | 0x04 |
| 0x0B | Backlight | The new state of the backlight.<br>■ Byte 0: Backlight Level (bits 7:0)<br>The backlight control only supports two modes: on or off. A value of 0 turns the backlight off; any other value turns on the backlight. There is no support for dimming the iPod backlight setting.<br>■ Byte 1: `bRestoreOnExit` (bits 7:0)<br>See Table 3-66 (page 202). | 0x02 |

| Information type | | Information data | |
|---|---|---|---|
| Value | Name | Description | Length (bytes) |
| 0x0C | Hold switch | Reserved. The state of the Hold switch cannot be set. | N/A |
| 0x0D | Sound check | The new sound check state.<br>■ Byte 0: Sound Check State (bits 7:0)<br>A value of 0x00 turns sound check off; a value of 0x01 turns it on.<br>■ Byte 1: `bRestoreOnExit` (bits 7:0)<br>See Table 3-66 (page 202). | 0x02 |
| 0x0E | Audiobook speed | The audiobook playback speed.<br>■ Byte 0: Audiobook Playback Speed Setting (bits 7:0)<br>See Table 3-56 (page 193) for a list of possible values.<br>■ Byte 1: `bRestoreOnExit` (bits 7:0)<br>See Table 3-66 (page 202). | 0x01 |
| 0x0F | Track position in seconds | The current track time position, in seconds.<br>■ Byte 0: Track Time Position (bits 15:8)<br>■ Byte 1: Track Time Position (bits 7:0) | 0x02 |
| 0x10 | Mute/UI/Absolute volume | The current state of the mute setting, UI volume, and absolute volume.<br>■ Byte 0: Mute state (bits 7:0). A value of 0 indicates that muting is off; a value of 1 indicates that muting is on.<br>■ Byte 1: UI volume level (bits 7:0). A value between 0 and 255, normalized to volume limit settings. 0 indicates minimum volume and 255 indicates maximum volume. If the accessory sets this byte to 0, the iPod uses the absolute volume setting.<br>■ Byte 2: Absolute volume level (bits 7:0). A value between 0 and 255, not normalized. 0 indicates minimum absolute volume and 255 indicates maximum absolute volume. If muting is on (byte 0 = 0x00), the absolute volume level is not valid and is returned as 0.<br>■ Byte 3: `bRestoreOnExit` (bits 7:0). See Table 3-66 (page 202) for a list of values. | 0x04 |
| 0x11–0xFF | Reserved | N/A | N/A |

Table 3-66 (page 202) lists the possible values for the `bRestoreOnExit` parameter.

**Table 3-66** Restore-on-exit values

| Value | Meaning |
|---|---|
| 0x00 | Do not save the original state. |
| 0x01 | Save the original state and restore it on exit. |

For example, an accessory could send the command shown in Table 3-67 (page 202) to set the iPod alarm to 8:15 a.m. and have the setting restored upon accessory detach.

**Table 3-67** `SetiPodStateInfo` packet to set the alarm

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x07 | Length of packet payload |
| 3 | 0x03 | Lingo ID: Display Remote lingo |
| 4 | 0x0E | Command ID: `SetiPodStateInfo` |
| 5 | 0x0A | `infoType` = 0x0A (Alarm) |
| 6 | 0x01 | `infoData` = Alarm State set to On (0x01). |
| 7 | 0x08 | `infoData` = Alarm Hour set to 8. |
| 8 | 0x0F | `infoData` = Alarm Minute set to 15. |
| 9 | 0x01 | `InfoData` = `bRestoreOnExit` set to true (0x01). |
| 10 | 0xC5 | Checksum |

As another example, an accessory could send the command shown in Table 3-68 (page 202) to set the currently playing track on the iPod to track 1000.

**Table 3-68** `SetiPodStateInfo` packet for setting the current track

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x07 | Length of packet payload |
| 3 | 0x03 | Lingo ID: Display Remote lingo |
| 4 | 0x0E | Command ID: `SetiPodStateInfo` |

| Byte number | Value | Comment |
|---|---|---|
| 5 | 0x01 | `infoType` = 0x01 (Track Index) |
| 6 | 0x00 | `infoData` = Track Index (bits 31:24). Sets the playback track index to 1000. |
| 7 | 0x00 | `infoData` = Track Index (bits 23:16) |
| 8 | 0x03 | `infoData` = Track Index (bits 15:8) |
| 9 | 0xE8 | `infoData` = Track Index (bits 7:0) |
| 10 | 0xFC | Checksum |

**Note:** `SetiPodStateInfo` commands that use information types that have data fields larger than one byte must be sure to send the data in big-endian format. See the example in Table 3-68 (page 202).

## Command 0x0F: GetPlayStatus

Direction: Device to iPod

The device requests the current iPod play status information. In response, the iPod sends "Command 0x10: RetPlayStatus" (page 203) with the current play state, track index, track position, and track length.

**Table 3-69** `GetPlayStatus` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x02 | Length of packet payload |
| 3 | 0x03 | Lingo ID: Display Remote lingo |
| 4 | 0x0F | Command ID: `GetPlayStatus` |
| 5 | 0xEC | Checksum |

## Command 0x10: RetPlayStatus

Direction: iPod to Device

The iPod sends this command in response to "Command 0x0F: GetPlayStatus" (page 203) and returns the current iPod play status information. If the iPod is in a playing or paused state, the track index (`trackIndex`), track length (`trackTotMs`), and track position (`trackPosMs`) fields are valid. Otherwise, they should be ignored.

**Table 3-70** `RetPlayStatus` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x0F | Length of packet payload |
| 3 | 0x03 | Lingo ID: Display Remote lingo |
| 4 | 0x10 | Command ID: `RetPlayStatus` |
| 5 | 0x*NN* | `playState` (1 byte). The iPod playback engine state. See Table 3-52 (page 191) for a list of possible values. If the value of this field is 0x00, all of the subsequent track fields are invalid. The value 0x05 is reserved. |
| 6 | 0x*NN* | `trackIndex` (bits 31:24). Specifies the index of the currently playing track. |
| 7 | 0x*NN* | `trackIndex` (bits 23:16) |
| 8 | 0x*NN* | `trackIndex` (bits 15:8) |
| 9 | 0x*NN* | `trackIndex` (bits 7:0) |
| 10 | 0x*NN* | `trackTotMs` (bits 31:24). Specifies the total length of the track, in milliseconds. |
| 11 | 0x*NN* | `trackTotMs` (bits 23:16) |
| 12 | 0x*NN* | `trackTotMs` (bits 15:8) |
| 13 | 0x*NN* | `trackTotMs` (bits 7:0) |
| 14 | 0x*NN* | `trackPosMs` (bits 31:24). The current position of the track, in milliseconds. |
| 15 | 0x*NN* | `trackPosMs` (bits 23:16) |
| 16 | 0x*NN* | `trackPosMs` (bits 15:8) |
| 17 | 0x*NN* | `trackPosMs` (bits 7:0) |
| 18 | 0x*NN* | Checksum |

## Command 0x11: SetCurrentPlayingTrack

Direction: Device to iPod

The device sets the iPod's currently playing track to the track at the specified index. The total number of playing tracks can be obtained by sending "Command 0x14: GetNumPlayingTracks" (page 208). The playing track index is zero based, so the valid range is from 0x0 to `numPlayTracks`–1 (one less than the total count).

**Table 3-71** `SetCurrentPlayingTrack` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x06 | Length of packet payload |
| 3 | 0x03 | Lingo ID: Display Remote lingo |
| 4 | 0x11 | Command ID: `SetCurrentPlayingTrack` |
| 5 | 0x*NN* | `trackIndex` (bits 31:24). The track index to begin playing. |
| 6 | 0x*NN* | `trackIndex` (bits 23:16) |
| 7 | 0x*NN* | `trackIndex` (bits 15:8) |
| 8 | 0x*NN* | `trackIndex` (bits 7:0) |
| 9 | 0x*NN* | Checksum |

## Command 0x12: GetIndexedPlayingTrackInfo

Direction: Device to iPod

The device requests track information for the specified playing track index. The `infoType` field specifies the type of information to be returned, such as track title, artist name, album name, track genre, and track chapter information. In response, the iPod sends "Command 0x13: RetIndexedPlayingTrackInfo" (page 206) with the requested track information.

**Table 3-72** `GetIndexedPlayingTrackInfo` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x09 | Length of packet payload |
| 3 | 0x03 | Lingo ID: Display Remote lingo |
| 4 | 0x12 | Command ID: `GetIndexedPlayingTrackInfo` |
| 5 | 0x*NN* | `infoType` (1 byte). The type of track information to retrieve. See Table 3-74 (page 207) for a list of the available types of information. |
| 6 | 0x*NN* | `trackIndex` (bits 31:24). The index of the track for which to retrieve information. |
| 7 | 0x*NN* | `trackIndex` (bits 23:16) |

| Byte number | Value | Comment |
|---|---|---|
| 8 | 0x*NN* | `trackIndex` (bits 15:8) |
| 9 | 0x*NN* | `trackIndex` (bits 7:0) |
| 10 | 0x*NN* | `chapIndex` (bits 15:8). The index of the chapter for which to retrieve information. This field is valid only when `infoType` is chapter information (0x01) and the track at `trackIndex` has chapters. Set the `chapIndex` fields to 0x00 if `infoType` is not chapter information and `trackIndex` does not have chapters. |
| 11 | 0x*NN* | `chapIndex` (bits 7:0) |
| 12 | 0x*NN* | Checksum |

## Command 0x13: RetIndexedPlayingTrackInfo

Direction: iPod to Device

The iPod sends this command in response to "Command 0x12: GetIndexedPlayingTrackInfo" (page 205). It returns the requested type of information and data for the specified playing track. Data returned as strings are encoded as null-terminated UTF-8 character arrays. If the track information string does not exist, an empty null-terminated string is returned.

**Table 3-73** `RetIndexedPlayingTrackInfo` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x*NN* | Length of packet payload |
| 3 | 0x03 | Lingo ID: Display Remote lingo |
| 4 | 0x13 | Command ID: `RetIndexedPlayingTrackInfo` |
| 5 | 0x*NN* | `infoType`. The type of track information being returned. See Table 3-74 (page 207) for possible values. |
| 6 … *N* | 0x*NN* | `infoData` (variable length). The track information data. |
| (last byte) | 0x*NN* | Checksum |

Table 3-74 (page 207) shows the data returned for each type of track information.

**Table 3-74** Track information data

| Info type | Data type | Track information data | Data length |
|---|---|---|---|
| 0x00 | Track caps/info | Track capabilities and information. This contains 3 fields:<br>■ Bytes 0–3: Track Caps bitfields.<br>Specifies the capabilities of the track. These bits have the following meanings:<br>Bit 0: If equal to 1, the track is an audiobook.<br>Bit 1: If equal to 1, the track has chapters.<br>Bit 2: Set to 1 if album artwork is available, 0 otherwise<br>Bit 3: If equal to 1, the track has song lyrics.<br>Bit 6:4: Reserved<br>Bit 7: Track contains video (a video podcast, music video, movie, or TV show)<br>Bit 8: Track is currently queued to play as a video<br>Bit 31:9: Reserved<br>■ Bytes 4–7: TrackTotMs.<br>The total length of the track in milliseconds.<br>■ Bytes 8–9: ChapCount.<br>If the track has chapters, the chapter count. | 10 |
| 0x01 | Chapter time/name | Chapter time and name, having two fields:<br>■ Bytes 0–3: Chapter Time<br>The chapter time in milliseconds. A value of 0 indicates there are no chapters.<br>■ (variable length): Chapter Name<br>The chapter name, as a UTF-8 string. | 4 + Variable |
| 0x02 | Artist name | The artist name, as a UTF-8 string. | Variable |
| 0x03 | Album name | The album name, as a UTF-8 string. | Variable |
| 0x04 | Genre name | The genre name, as a UTF-8 string. | Variable |
| 0x05 | Track title | The title of the track, as a UTF-8 string. | Variable |
| 0x06 | Composer name | The composer name, as a UTF-8 string. | Variable |

| Info type | Data type | Track information data | Data length |
|---|---|---|---|
| 0x07 | Lyrics | Track lyrics data, consisting of 3 fields:<br>■ Byte 0: Packet information bits. If set, these bits have the following meanings:<br>Bit 0: If equal to 1, indicates that this is one of multiple packets.<br>Bit 1: If equal to 1, this is the last packet (applicable only if bit 0 is equal to 1).<br>Bits 7:2: Reserved; set to 0.<br>■ Bytes 1–2: Packet index (16-bit big-endian format)<br>■ Bytes 3–*NN*: Track lyrics as a UTF-8 string (see **Note** below). | Variable |
| 0x08 | Artwork count | Artwork count data.<br>The artwork count is a sequence of 4-byte records; each record consists of a 2-byte `formatID` value followed by a 2-byte count of images in that format for this track. If the track contains no format IDs, this info type will return only 1 byte containing 0x08 and no records. For information about `formatID` values, see "Command 0x17: RetArtworkFormats" (page 210). | Variable |
| 0x09–0xFF | Reserved | N/A | N/A |

**Note:** Track lyrics are formatted as a single null-terminated UTF8 string. If the lyrics string is too long to be carried within a single packet, then the string is broken into sections and carried within separate packets with distinct values for each section index. The last lyrics packet section contains the null terminator character for the full track lyrics string. Lyric sections before the last section do not include null terminators, and individual sections may not necessarily be valid UTF8 strings. Accessories must use the packet payload length to determine the length of each string section and assemble the full lyrics string by concatenating the individual substrings in order.

If `GetIndexedPlayingTrackInfo` specified a track not currently playing, a null string is returned. Lyrics for a track being played may take up to 5 seconds to return. A device may try to get the current lyrics every 0.5 seconds until either 5 seconds has elapsed or the track lyrics string has been returned.

## Command 0x14: GetNumPlayingTracks

Direction: Device to iPod

The device requests the total number of tracks playing in the iPod playback engine. The count can be used to select a different playing track or obtain information for a specific track. In response, the iPod sends "Command 0x15: RetNumPlayingTracks" (page 209).

**Table 3-75** `GetNumPlayingTracks` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x02 | Length of packet payload |
| 3 | 0x03 | Lingo ID: Display Remote lingo |
| 4 | 0x14 | Command = 0x14 (`GetNumPlayingTracks`) |
| 5 | 0xE7 | Checksum |

## Command 0x15: RetNumPlayingTracks

Direction: iPod to Device

The iPod sends this command in response to "Command 0x14: GetNumPlayingTracks" (page 208) received from the device. It returns the total number of tracks queued in the playback engine.

**Table 3-76** `RetNumPlayingTracks` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x06 | Length of packet payload |
| 3 | 0x03 | Lingo ID: Display Remote lingo |
| 4 | 0x15 | Command ID: `RetNumPlayingTracks` |
| 5 | 0x*NN* | `numPlayTracks` (bits 31:24). The total number of queued playing tracks. |
| 6 | 0x*NN* | `numPlayTracks` (bits 23:16) |
| 7 | 0x*NN* | `numPlayTracks` (bits 15:8) |
| 8 | 0x*NN* | `numPlayTracks` (bits 7:0) |
| 9 | 0x*NN* | Checksum |

## Command 0x16: GetArtworkFormats

Direction: Device to iPod

The device sends this command to obtain the list of supported artwork formats on the iPod. No parameters are sent. See "Transferring Album Art" (page 179).

**Table 3-77** `GetArtworkFormats` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x02 | Length of packet |
| 3 | 0x03 | Lingo ID: Display Remote lingo |
| 4 | 0x16 | Command ID: `GetArtworkFormats` |
| 5 | 0xE5 | Checksum |

## Command 0x17: RetArtworkFormats

Direction: iPod to Device

The iPod sends this command to the device in response to "Command 0x16: GetArtworkFormats" (page 209). Each format is described in a 7-byte record (`formatID:2`, `pixelFormat:1`, `width:2`, `height:2`). The `formatID` is used when sending `GetTrackArtworkTimes`. The device may return zero records if the iPod does not contain any artwork. See "Transferring Album Art" (page 179).

**Table 3-78** `RetArtworkFormats` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x*NN* | Length of packet |
| 3 | 0x03 | Lingo ID: Display Remote lingo |
| 4 | 0x17 | Command ID: `RetArtworkFormats` |
| *NN* | 0x*NN* | `formatID` (bits 15:8) iPod-assigned value for this format |
| *NN* | 0x*NN* | `formatID` (bits 7:0) |
| *NN* | 0x*NN* | `pixelFormat`. See Table 3-79 (page 211). |
| *NN* | 0x*NN* | `imageWidth` (bits 15:8). Number of pixels wide for each image. |
| *NN* | 0x*NN* | `imageWidth` (bits 7:0) |
| *NN* | 0x*NN* | `imageHeight` (bits 15:8). Number of pixels high for each image. |

| Byte number | Value | Comment |
|---|---|---|
| *NN* | 0x*NN* | `imageHeight` (bits 7:0) |
| Previous 7 bytes may be repeated *NN* times | | |
| *NN* | 0x*NN* | Checksum |

**Table 3-79** Display pixel format codes

| Display pixel format | Code |
|---|---|
| Reserved | 0x00 |
| Monochrome, 2 bits per pixel | 0x01 |
| RGB 565 color, little-endian, 16 bpp | 0x02 |
| RGB 565 color, big-endian, 16 bpp | 0x03 |
| Reserved | 0x04–0xFF |

## Command 0x18: GetTrackArtworkData

Direction: Device to iPod

The device sends this command to the iPod to request the artwork image bitmap data for a given `trackIndex`, `formatID`, and `artworkIndex`. See "Transferring Album Art" (page 179).

**Table 3-80** `GetTrackArtworkData` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x0C | Length of packet |
| 3 | 0x03 | Lingo ID: Display Remote lingo |
| 4 | 0x18 | Command ID: `GetTrackArtworkData` |
| 5 | 0x*NN* | `trackIndex` (bits 31:24). |
| 6 | 0x*NN* | `trackIndex` (bits 23:16) |
| 7 | 0x*NN* | `trackIndex` (bits 15:8) |
| 8 | 0x*NN* | `trackIndex` (bits 7:0) |
| 9 | 0x*NN* | `formatID` (bits 15:8) |

| Byte number | Value | Comment |
|---|---|---|
| 10 | 0x*NN* | `formatID` (bits 7:0) |
| 11 | 0x*NN* | Time offset in milliseconds (bits 31:24) |
| 12 | 0x*NN* | Time offset in milliseconds (bits 23:16) |
| 13 | 0x*NN* | Time offset in milliseconds (bits 15:8) |
| 14 | 0x*NN* | Time offset in milliseconds (bits 7:0) |
| 15 | 0x*NN* | Checksum |

## Command 0x19: RetTrackArtworkData

Direction: iPod to Device

The iPod sends this command in response to a "Command 0x18: GetTrackArtworkData" (page 211) command received from a device. Multiple `RetTrackArtworkData` commands may be necessary to transfer all the data because it will be too much to fit into a single packet. See "Transferring Album Art" (page 179).

This command returns the overall image width and height in pixels, the image row size in bytes, and the inset rectangle that contains the actual artwork content. The inset rectangle coordinates consist of two *x*,*y* pairs. Each *x* or *y* value is 2 bytes, so the total size of the inset rectangle coordinate set is 8 bytes.

The total image size in bytes is given by multiplying the row size by the image height. Padding may be inserted at the top, bottom, left, or right of the artwork to fit it to the iPod screen.

**Table 3-81** `RetTrackArtworkData` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x*NN* | Length of packet |
| 3 | 0x03 | Lingo ID: Display Remote lingo |
| 4 | 0x19 | Command ID: `RetTrackArtworkData` |
| 5 | 0x*NN* | Descriptor packet index (15:8). These fields uniquely identify each packet in the `RetTrackArtworkData` transaction. The first packet is the descriptor packet, which always starts with an index of 0x0000. |
| 6 | 0x*NN* | Descriptor packet index (7:0) |
| 7 | 0x*NN* | Display pixel format code. See Table 3-79 (page 211). |
| 8 | 0x*NN* | Image width in pixels (15:8) |

| Byte number | Value | Comment |
|---|---|---|
| 9 | 0x*NN* | Image width in pixels (7:0) |
| 10 | 0x*NN* | Image height in pixels (15:8) |
| 11 | 0x*NN* | Image height in pixels (7:0) |
| 12 | 0x*NN* | Inset rectangle, top-left point, *x* value (15:8) |
| 13 | 0x*NN* | Inset rectangle, top-left point, *x* value (7:0) |
| 14 | 0x*NN* | Inset rectangle, top-left point, *y* value (15:8) |
| 15 | 0x*NN* | Inset rectangle, top-left point, *y* value (7:0) |
| 16 | 0x*NN* | Inset rectangle, bottom-right point, *x* value (15:8) |
| 17 | 0x*NN* | Inset rectangle, bottom-right point, *x* value (7:0) |
| 18 | 0x*NN* | Inset rectangle, bottom-right point, *y* value (15:8) |
| 19 | 0x*NN* | Inset rectangle, bottom-right point, *y* value (7:0) |
| 20 | 0x*NN* | Row size in bytes (bits 31:24) |
| 21 | 0x*NN* | Row size in bytes (bits 23:16) |
| 22 | 0x*NN* | Row size in bytes (bits 15:8) |
| 23 | 0x*NN* | Row size in bytes (bits 7:0) |
| 24 | 0x*NN*... | Image pixel data (variable length) |
| *NN* | 0x*NN* | Checksum |

**Note:** In subsequent packets in the sequence (packets with a descriptor packet index greater than 0x0000), bytes 7 through 23 are omitted.

## Command 0x1A: GetPowerBatteryState

Direction: Device to iPod

The device sends this command to obtain the power and battery level state of the iPod. In response, the iPod sends "Command 0x1B: RetPowerBatteryState" (page 214) with the power and battery information.

**Table 3-82** `GetPowerBatteryState` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |

| Byte number | Value | Comment |
|---|---|---|
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x02 | Length of packet payload |
| 3 | 0x03 | Lingo ID: Display Remote lingo |
| 4 | 0x1A | Command ID: `GetPowerBatteryState` |
| 5 | 0xE1 | Checksum |

## Command 0x1B: RetPowerBatteryState

Direction: iPod to Device

The iPod sends this command in response to "Command 0x1A: GetPowerBatteryState" (page 213), returning the current iPod power state and battery level.

**Note:** If an external power status (indicated by the value of the `powerStat` field) is returned, the battery level is invalid and is 0 on return.

**Table 3-83** `RetPowerBatteryState` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x04 | Length of packet payload |
| 3 | 0x03 | Lingo ID: Display Remote lingo |
| 4 | 0x1B | Command ID: `RetPowerBatteryState` |
| 5 | 0x*NN* | `powerStat` (1 byte). The battery power state. See Table 3-55 (page 192). |
| 6 | 0x*NN* | `battLevel` (1 byte). The battery power level. This is a value between 00 (the battery is fully discharged, no power remains) and 255 (the battery is fully charged).<br>This field is valid only if `powerStat` is Internal battery (0x00 or 0x01) |
| 7 | 0x*NN* | Checksum |

## Command 0x1C: GetSoundCheckState

Direction: Device to iPod

The device requests the iPod's current sound check setting. When enabled, sound check adjusts track playback volume to the same level. In response, the iPod sends "Command 0x1D: RetSoundCheckState" (page 215) with the current sound check state.

**Table 3-84** `GetSoundCheckState` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x02 | Length of packet payload |
| 3 | 0x03 | Lingo ID: Display Remote lingo |
| 4 | 0x1C | Command ID: `GetSoundCheckState` |
| 5 | 0xDF | Checksum |

## Command 0x1D: RetSoundCheckState

Direction: iPod to Device

The iPod sends this command in response to "Command 0x1C: GetSoundCheckState" (page 214) and returns the current state of the sound check setting.

**Table 3-85** `RetSoundCheckState` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x03 | Length of packet payload |
| 3 | 0x03 | Lingo ID: Display Remote lingo |
| 4 | 0x1D | Command ID: `RetSoundCheckState` |
| 5 | 0x*NN* | `sndChkState` (1 byte). The current state of the sound check setting. A value of 0x00 indicates that sound check is off; 0x01 indicates that it is on. |
| 6 | 0x*NN* | Checksum |

## Command 0x1E: SetSoundCheckState

Direction: Device to iPod

The device sets the state of the iPod's sound check setting and optionally saves the previous sound check state to be restored on device detach. In response to this command, the iPod sends an `ACK` packet with the status of the command.

**Table 3-86** `SetSoundCheckState` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x04 | Length of packet payload |
| 3 | 0x03 | Lingo ID: Display Remote lingo |
| 4 | 0x1E | Command ID: `SetSoundCheckState` |
| 5 | 0x*NN* | `sndChkState` (1 byte). The new state of the sound check setting. A value of 0x00 turns off sound check off; 0x01 turns on sound check. |
| 6 | 0x*NN* | `bRestoreOnExit` (1 byte). Specifies whether the original sound check state is saved and restored on exit. See Table 3-66 (page 202) |
| 7 | 0x*NN* | Checksum |

## Command 0x1F: GetTrackArtworkTimes

Direction: Device to iPod

The device sends this command to the iPod to request the list of artwork time offsets for a track. A 4-byte `trackIndex` specifies which track is to be selected. A 2-byte `formatID` indicates which type of artwork is desired. The format IDs that the iPod supports can be obtained using the "Command 0x16: GetArtworkFormats" (page 209) command.

The 2-byte `artworkIndex` specifies where to begin searching for artwork. A value of 0 indicates that the iPod should start with the first available artwork.

The 2-byte `artworkCount` specifies the maximum number of times to be returned. A value of -1 (0xFFFF) indicates that all artwork times from the specified index should be returned.

**Table 3-87** `GetTrackArtworkTimes` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x0C | Length of packet |
| 3 | 0x03 | Lingo ID: Display Remote lingo |

| Byte number | Value | Comment |
|---|---|---|
| 4 | 0x1F | Command ID: `GetTrackArtworkTimes` |
| 5 | 0x*NN* | `trackIndex` (bits 31:24) |
| 6 | 0x*NN* | `trackIndex` (bits 23:16) |
| 7 | 0x*NN* | `trackIndex` (bits 15:8) |
| 8 | 0x*NN* | `trackIndex` (bits 7:0) |
| 9 | 0x*NN* | `formatID` (bits 15:8) |
| 10 | 0x*NN* | `formatID` (bits 7:0) |
| 11 | 0x*NN* | `artworkIndex` (bits 15:8) |
| 12 | 0x*NN* | `artworkIndex` (bits 7:0) |
| 13 | 0x*NN* | `artworkCount` (bits 15:8) |
| 14 | 0x*NN* | `artworkCount` (bits 7:0) |
| 15 | 0x*NN* | Checksum |

## Command 0x20: RetTrackArtworkTimes

Direction: iPod to Device

The iPod sends this command to the device in response to a "Command 0x1F: GetTrackArtworkTimes" (page 216) command. The device returns zero or more 4-byte records, one for each piece of artwork associated with the track and format specified by `GetTrackArtworkTimes`. Artwork times are expressed as offsets, in milliseconds, from the beginning of the track.

The number of records returned will be no greater than the number specified in the `GetTrackArtworkTimes` command. It may, however, be less than requested. This can happen if there are fewer pieces of artwork available than were requested, or if the iPod is unable to place the full number in a single packet. Check the number of records returned against the results of `RetIndexedPlayingTrackInfo` with `infoType` 0x08 to ensure that all artwork has been received.

**Table 3-88** `RetTrackArtworkTimes` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x*NN* | Length of packet |
| 3 | 0x03 | Lingo ID: Display Remote lingo |

| Byte number | Value | Comment |
|---|---|---|
| 4 | 0x20 | Command ID: `RetTrackArtworkTimes` |
| 5 | 0x*NN* | Time offset in milliseconds (bits 31:24) |
| 6 | 0x*NN* | Time offset in milliseconds (bits 23:16) |
| 7 | 0x*NN* | Time offset in milliseconds (bits 15:8) |
| 8 | 0x*NN* | Time offset in milliseconds (bits 7:0) |
| The preceding 4 bytes may be repeated *NN* times. | | |
| *NN* | 0x*NN* | Checksum |

## Lingo 0x04: Extended Interface Lingo

Lingo 0x04 of the iAP is specified in detail in "The Extended Interface Protocol" (page 341).

## Lingo 0x05: Accessory Power Lingo

The Accessory Power lingo is used by devices that draw up to 100 mA peak current from the iPod through pin 13 of the 30-pin connector (Accessory Detect). To use this lingo, accessories must identify themselves as intermittent high-power devices during the identification process. They may include accessories that transmit the iPod analog audio over radio frequencies, typically over an unused frequency in the FM band.

The Accessory Power lingo is intended for use in conjunction with audio playback from the iPod. The accessory must remain in its low-power state until it receives a `BeginHighPower` command, which notifies it that it may begin drawing high power. The `EndHighPower` command notifies the accessory that it must stop drawing high power and return to the low power state within 1 second of receiving the command.

Like all accessories, an accessory using the Accessory Power lingo must comply with the power requirements of the iPod's Sleep and Hibernate states, as specified in "iPod Power States and Accessory Power" (page 341). Accessories are informed of iPod state changes by receiving a General lingo `NotifyiPodStateChange` command.

**Table 3-89** Accessory Power lingo command summary

| Command | ID | Data length | Protocol version | Authentication required |
|---|---|---|---|---|
| Reserved | 0x00–0x01 | N/A | N/A | N/A |
| `BeginHighPower` | 0x02 | 0x00 | All | UART: No<br>USB: Yes |
| `EndHighPower` | 0x03 | 0x00 | All | |
| Reserved | 0x04–0xFF | N/A | N/A | N/A |

## Command History of the Accessory Power lingo

Table 3-90 (page 219) shows the history of command changes in the Accessory Power lingo:

**Table 3-90** Accessory Power lingo command history

| Lingo version | Command changes | Features |
|---|---|---|
| (0.00) | Add: 0x02–0x03 | `Begin/EndHighPower` support |
| 1.00 | None | Version number available through `RequestLingoProtocolVersion` |
| 1.01 | None | BugFix: `BeginTransmission` command sent after device inserted while iPod is playing |

## Command 0x02: BeginHighPower

Direction: iPod to Device

The iPod sends this command to notify the device that high power may be used. Upon receipt of the this command, the device may begin drawing more than 5 mA power, up to a maximum of 100 mA, if it has previously requested intermittent high power during its identification process.

**Table 3-91** `BeginHighPower` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x02 | Length of packet payload |
| 3 | 0x05 | Lingo ID: Accessory Power lingo |
| 4 | 0x02 | Command ID: `BeginHighPower` |
| 5 | 0xF7 | Checksum |

## Command 0x03: EndHighPower

Direction: iPod to Device

The iPod sends this command to notify the device to stop using accessory high power. The device must reduce its power usage to less than 5 mA within 1 second of receiving an `EndHighPower` packet.

**Note:** Failure to reduce device power consumption to below 5 mA within 1 second after receiving this notification could damage the iPod.

**Table 3-92** `EndHighPower` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x02 | Length of packet payload |
| 3 | 0x05 | Lingo ID: Accessory Power lingo |
| 4 | 0x03 | Command ID: `EndHighPower` |
| 5 | 0xF6 | Checksum |

# Lingo 0x07: RF Tuner Lingo

An external radio frequency tuner accessory can be attached to an iPod to provide radio reception. When an iPod successfully acknowledges an accessory's declaration of the RF Tuner lingo during the identification process, it makes a radio menu item available. Choosing this menu item displays the iPod tuner application. The application lets the user change the iPod's music source and control the accessory's RF band and tuner frequency.

**Note:** If an iPod contains an RF Tuner (such as the FM tuner in the 5G nano), the external tuner accessory will override it.

The RF Tuner lingo is used to pass control and state information between an iPod and an RF tuner device. Normally the iPod is the master and the accessory responds to commands from the iPod. This means that the iPod can initiate actions such as controlling tuner power, setting the tuner's band and frequency, initiating up or down frequency scans, and so on. An iPod attached to an RF tuner device also stores station frequencies and other tuner state information.

Every RF tuner device must report all of its capabilities back to the attached iPod, including support for at least one of the RF bands listed in Table 3-100 (page 227). Based on the capabilities reported by the RF tuner device, the iPod tuner application may choose to change its appearance to reflect the presence or absence of certain RF tuner features.

## RF Tuner Accessory Design

RF tuner accessory devices for iPods must meet the following requirements:

- All RF tuner lingo commands require authentication.

- An iPod can support only one RF tuner device at any time, and that device must be attached using the 30-pin connector.
- On reset or power up, the RF tuner device must be in its low power state (<5 mA) with the tuner off and any audio output disabled.
- US devices must support the Europe/US FM band (87.5–108.0 MHz), with 200 KHz channel spacing and default 75 µsec deemphasis.
- EU/US devices must support the Europe/US FM band (87.5–108.0 MHz), with 100 KHz channel spacing and selectable 50 µsec or 75 µsec deemphasis.
- JP devices must support the Japan FM band (76.0–90.0 MHz), with 100 KHz channel spacing and selectable 50 µsec or 75 µsec deemphasis.

An RF tuner device may support US, EU, and/or JP requirements.

The following options apply to RF tuner devices:

- An RF tuner device may send asynchronous notification of state changes to an attached iPod, but such notifications are not required.
- RF tuner devices are not expected to retain state information across accessory power down cycles resulting from the invocation of Hibernate mode.
- RF tuner devices may support HD radio.

## RF Tuner Power

An attached RF tuner device will be notified of iPod state changes such as transitions between Power On, Sleep, and Hibernate states. It is responsible for keeping its power consumption below the maximum allowed limits for each iPod state. For details, see "Accessory Power Policy" (page 39).

Accessory power is completely shut off during hibernation. When an iPod wakes from hibernation and the accessory detects accessory power, the accessory must wait at least 80 ms and then start the IDPS process. When an iPod transitions from sleep to power on, it sends a `RequestIdentify` command to the accessory. In either case, the accessory must reidentify and reauthenticate itself, using IDPS (or `IdentifyDeviceLingoes` if the iPod does not support IDPS).

RF Tuner accessories can register for intermittent high power during the identification process. If properly registered, they may draw up to 100 mA after receiving a `SetTunerCtrl` command specifying power-on. They must reduce their power consumption below 5 mA within 1 second of receiving a `SetTunerCtrl` command specifying power-off. Regardless of the power state specified by the iPod, all devices must comply with the iPod state changes cited above.

## RF Tuner Lingo Commands

Table 3-93 (page 222) summarizes the RF Tuner commands (lingo 0x07).

**Table 3-93** RF Tuner lingo command summary

| Command | ID | Direction | Data length | Protocol version | Authentication required |
|---|---|---|---|---|---|
| ACK | 0x00 | Dev to iPod | 4 or 8 | 1.00 | Yes |
| GetTunerCaps | 0x01 | iPod to Dev | 2 | 1.00 | Yes |
| RetTunerCaps | 0x02 | Dev to iPod | 8 | 1.00 | Yes |
| GetTunerCtrl | 0x03 | iPod to Dev | 2 | 1.00 | Yes |
| RetTunerCtrl | 0x04 | Dev to iPod | 3 | 1.00 | Yes |
| SetTunerCtrl | 0x05 | iPod to Dev | 3 | 1.00 | Yes |
| GetTunerBand | 0x06 | iPod to Dev | 2 | 1.00 | Yes |
| RetTunerBand | 0x07 | Dev to iPod | 3 | 1.00 | Yes |
| SetTunerBand | 0x08 | iPod to Dev | 3 | 1.00 | Yes |
| GetTunerFreq | 0x09 | iPod to Dev | 2 | 1.00 | Yes |
| RetTunerFreq | 0x0A | Dev to iPod | 7 | 1.00 | Yes |
| SetTunerFreq | 0x0B | iPod to Dev | 6 | 1.00 | Yes |
| GetTunerMode | 0x0C | iPod to Dev | 2 | 1.00 | Yes |
| RetTunerMode | 0x0D | Dev to iPod | 3 | 1.00 | Yes |
| SetTunerMode | 0x0E | iPod to Dev | 3 | 1.00 | Yes |
| GetTunerSeekRssi | 0x0F | iPod to Dev | 2 | 1.00 | Yes |
| RetTunerSeekRssi | 0x10 | Dev to iPod | 3 | 1.00 | Yes |
| SetTunerSeekRssi | 0x11 | iPod to Dev | 3 | 1.00 | Yes |
| TunerSeekStart | 0x12 | iPod to Dev | 3 | 1.00 | Yes |
| TunerSeekDone | 0x13 | Dev to iPod | 7 | 1.00 | Yes |
| GetTunerStatus | 0x14 | iPod to Dev | 2 | 1.00 | Yes |
| RetTunerStatus | 0x15 | Dev to iPod | 3 | 1.00 | Yes |
| GetStatusNotifyMask | 0x16 | iPod to Dev | 2 | 1.00 | Yes |
| RetStatusNotifyMask | 0x17 | Dev to iPod | 3 | 1.00 | Yes |
| SetStatusNotifyMask | 0x18 | iPod to Dev | 3 | 1.00 | Yes |
| StatusChangeNotify | 0x19 | Dev to iPod | 3 | 1.00 | Yes |

| Command | ID | Direction | Data length | Protocol version | Authentication required |
|---|---|---|---|---|---|
| GetRdsReadyStatus | 0x1A | iPod to Dev | 2 | 1.00 | Yes |
| RetRdsReadyStatus | 0x1B | Dev to iPod | 6 | 1.00 | Yes |
| GetRdsData | 0x1C | iPod to Dev | 3 | 1.00 | Yes |
| RetRdsData | 0x1D | Dev to iPod | 0x*NN* | 1.00 | Yes |
| GetRdsNotifyMask | 0x1E | iPod to Dev | 2 | 1.00 | Yes |
| RetRdsNotifyMask | 0x1F | Dev to iPod | 6 | 1.00 | Yes |
| SetRdsNotifyMask | 0x20 | iPod to Dev | 6 | 1.00 | Yes |
| RdsReadyNotify | 0x21 | Dev to iPod | 0x*NN* | 1.00 | Yes |
| Reserved | 0x22–0x24 | N/A | N/A | N/A | N/A |
| GetHDProgramServiceCount | 0x25 | iPod to Dev | 0 | 1.01 | Yes |
| RetHDProgramServiceCount | 0x26 | Dev to iPod | 1 | 1.01 | Yes |
| GetHDProgramService | 0x27 | iPod to Dev | 0 | 1.01 | Yes |
| RetHDProgramService | 0x28 | Dev to iPod | 1 | 1.01 | Yes |
| SetHDProgramService | 0x29 | iPod to Dev | 1 | 1.01 | Yes |
| GetHDDataReadyStatus | 0x2A | iPod to Dev | 0 | 1.01 | Yes |
| RetHDDataReadyStatus | 0x2B | Dev to iPod | 4 | 1.01 | Yes |
| GetHDData | 0x2C | iPod to Dev | 1 | 1.01 | Yes |
| RetHDData | 0x2D | Dev to iPod | 0x*NN* | 1.01 | Yes |
| GetHDDataNotifyMask | 0x2E | iPod to Dev | 0 | 1.01 | Yes |
| RetHDDataNotifyMask | 0x2F | Dev to iPod | 4 | 1.01 | Yes |
| SetHDDataNotifyMask | 0x30 | iPod to Dev | 4 | 1.01 | Yes |
| HDDataReadyNotify | 0x31 | Dev to iPod | 0x*NN* | 1.01 | Yes |
| Reserved | 0x32–0xFF | N/A | N/A | N/A | N/A |

## Command History of the RF Tuner Lingo

Table 3-94 (page 224) shows the history of changes to the RF Tuner lingo.

**Table 3-94** RF Tuner lingo command history

| Lingo version | Command changes | Features |
|---|---|---|
| 1.00 | Add: 0x00–0x21 | RF tuner control and support |
| 1.01 | Update: 0x02, 0x04, 0x05, 0x07, 0x0D, 0x0E, 0x12, 0x13, 0x15, 0x17, 0x18, 0x19, 0x1B, 0x1C, 0x1D, 0x1F, 0x20, and 0x21<br>Add: 0x25–0x31 | Support for HD radio, AM tuning, FM wide band |

## Command 0x00: ACK

Direction: Device to iPod

This command is sent by an RF tuner device on completion of a command received from an iPod. An `ACK` response is also sent if a bad parameter is received, an unsupported or invalid command is received, or a command that does not return any data has finished.

> **Note:** Certain bytes of the RF tuner lingo `ACK` command packet are included only if the value of `cmdStatus` is 0x06. See Table 3-95 (page 224) and Table 3-96 (page 224).

**Table 3-95** RF tuner lingo `ACK` packet with `cmdStatus` not 0x06

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x*NN* | Length of packet |
| 3 | 0x07 | Lingo ID: RF Tuner lingo |
| 4 | 0x00 | Command ID: `ACK` |
| 5 | 0x*NN* | `cmdStatus`: Status of command received (see Table 3-97 (page 225)) |
| 6 | 0x*NN* | `cmdIDOrig`: ID of the command for which the response is being sent |
| 7 | 0x*NN* | Checksum |

**Table 3-96** RF tuner lingo `ACK` packet with `cmdStatus` equal to 0x06

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |

| Byte number | Value | Comment |
|---|---|---|
| 2 | 0x*NN* | Length of packet |
| 3 | 0x07 | Lingo ID: RF Tuner lingo |
| 4 | 0x00 | Command ID: `ACK` |
| 5 | 0x06 | `cmdStatus`: Command pending |
| 6 | 0x*NN* | `cmdIDOrig`: ID of the command for which the response is being sent |
| 7 | 0x*NN* | `cmdPendTime` (bits 31:24). Total timeout in milliseconds for the pending command to complete. |
| 8 | 0x*NN* | `cmdPendTime` (bits 23:16) |
| 9 | 0x*NN* | `cmdPendTime` (bits 15:8) |
| 10 | 0x*NN* | `cmdPendTime` (bits 7:0) |
| 11 | 0x*NN* | Checksum |

**Table 3-97** RF tuner lingo `ACK` command status values

| Value | Meaning |
|---|---|
| 0x00 | Command OK |
| 0x01 | Unknown track category (not applicable) |
| 0x02 | Command failed (command valid but did not succeed) |
| 0x03 | Out of resources (iPod internal allocation failed) |
| 0x04 | Bad parameter (command or input parameters invalid) |
| 0x05 | Unknown track ID (not applicable) |
| 0x06 | Command pending (`cmdPendTime` parameter returned) |
| 0x07 | Not authenticated (iPod not authenticated) |

**Note:** A value of 0x06 is usually returned in the `cmdStatus` byte of the RF tuner `ACK` packet for commands that require more than 100 ms to complete. In this case, the `cmdPendTime` parameter is included in bytes 7–10 of the `ACK` packet. If the completion status is not returned by the total number of milliseconds specified by these bytes, the iPod will assume that a command failure has occurred and will retry the command or otherwise recover from the error. The RF tuner device should not return any response to the command after this timeout period has expired.

## Command 0x01: GetTunerCaps

Direction: iPod to Device

This command is sent by an iPod to query an attached RF tuner device's capabilities and determine what features the device supports. In response, the device must send a `RetTunerCaps` command with a payload specifying its capabilities.

**Table 3-98** `GetTunerCaps` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x02 | Length of packet |
| 3 | 0x07 | Lingo ID: RF Tuner lingo |
| 4 | 0x01 | Command ID: `GetTunerCaps` |
| 5 | 0xF6 | Checksum |

## Command 0x02: RetTunerCaps

Direction: Device to iPod

This command is sent by an RF tuner device in response to a `GetTunerCaps` command sent by an iPod. The command transmits a payload indicating which RF tuner capabilities it supports.

**Table 3-99** `RetTunerCaps` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x08 | Length of packet |
| 3 | 0x07 | Lingo ID: RF Tuner lingo |
| 4 | 0x02 | Command ID: `RetTunerCaps` |
| 5 | 0x*NN* | Tuner capabilities (bits 31:24) (See Table 3-100 (page 227)) |
| 6 | 0x*NN* | Tuner capabilities (bits 23:16) |
| 7 | 0x*NN* | Tuner capabilities (bits 15:8) |
| 8 | 0x*NN* | Tuner capabilities (bits 7:0) |

| Byte number | Value | Comment |
|---|---|---|
| 9 | 0x01 | Nonzero reserved; set to 0x01 |
| 10 | 0x00 | Reserved; set to 0x00 |
| 11 | 0x*NN* | Checksum |

**Note:** The capabilities bits returned in the `RetTunerCaps` payload (bytes 5-8) correspond to the band, control, mode, and status commands of the RF tuner lingo. The iPod will enable features or use commands only if the RF tuner device sets the associated capabilities bits when sending this command.

**Table 3-100** RF tuner device capabilities payload

| Bits | Capability |
|---|---|
| 00 | AM band, Worldwide (520-1710 KHz) capable |
| 01 | FM band, Europe/US (87.5–108.0 MHz) capable |
| 02 | FM band, Japan (76.0–90.0 MHz) capable |
| 03 | FM band, Wide (76.0-108.0 MHz) capable |
| 04 | HD Radio capable; may be set only if bit 01 is set |
| 07:05 | Reserved; set to 0 |
| 08 | Tuner power on/off control capable |
| 09 | Status change notification capable |
| 15:10 | Reserved; set to 0 |
| 17:16 | Minimum FM resolution ID bits (see Table 3-101 (page 228)) |
| 18 | Tuner seek up/down capable |
| 19 | Tuner seek RSSI threshold capable (must not be set if bit 18 is 0) |
| 20 | Force monophonic mode capable |
| 21 | Stereo blend capable |
| 22 | FM Tuner deemphasis select capable |
| 23 | AM tuner resolution 9KHz (0=10KHz only) capable |
| 24 | Radio Data System (RDS/RBDS) data capable |
| 25 | Tuner channel RSSI indication capable |
| 26 | Stereo source indicator capable |

| Bits | Capability |
|---|---|
| 27 | RDS/RDBS Raw mode capable |
| 31:28 | Reserved; set to 0 |

**Note:** Bit 04 (HD Radio capable), listed in Table 3-100 (page 227), may be set in addition to the FM band bits (00-03), but only if bit 01 is set. This bit indicates that the radio is capable of receiving HD signals on an existing Europe/US AM or FM band.

**Table 3-101** Minimum FM resolution ID bits

| ID bits | Description |
|---|---|
| 00 | 200 kHz capable |
| 01 | 100 kHz capable |
| 10 | 50 kHz capable |
| 11 | Reserved |

**Note:** The minimum FM resolution bits (bits 17-16) should report the smallest FM tuner resolution that the RF tuner device supports.

## Command 0x03: GetTunerCtrl

Direction: iPod to Device

An iPod sends this command to an RF tuner device to get the device's control state. In response, the device must send a `RetTunerCtrl` command with its current control state.

**Table 3-102** `GetTunerCtrl` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x02 | Length of packet |
| 3 | 0x07 | Lingo ID: RF Tuner lingo |
| 4 | 0x03 | Command ID: `GetTunerCtrl` |
| 5 | 0xF4 | Checksum |

## Command 0x04: RetTunerCtrl

Direction: Device to iPod

An RF tuner device uses this command to send its current device control state in response to a `GetTunerCtrl` command from an iPod. Tuner control bits may be set only if the corresponding capabilities bits have been set in a previous `RetTunerCaps` command.

**Table 3-103** `RetTunerCtrl` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x03 | Length of packet |
| 3 | 0x07 | Lingo ID: RF Tuner lingo |
| 4 | 0x04 | Command ID: `RetTunerCtrl` |
| 5 | 0x*NN* | Tuner control state (see Table 3-104 (page 229)) |
| 6 | 0x*NN* | Checksum |

**Table 3-104** Tuner control state bits

| Bit | Description |
|---|---|
| 0 | RF tuner device power is on (1) or off (0). When RF tuner device power is off, the accessory should rest in the lowest power state that still allows iAP commands to be received and processed. |
| 1 | Status change notification is enabled (1) or disabled (0). When status change notification is disabled, the iPod assumes that the device will send no asynchronous `StatusChangeNotify` commands. The iPod may poll the device for changes. |
| 2 | Reserved |
| 3 | RDS/RBDS Raw mode enabled |
| 7:4 | Reserved |

## Command 0x05: SetTunerCtrl

Direction: iPod to Device

This command is sent by an iPod to control an RF tuner device's state. In response, the device must return an `ACK` command with the command status. RF tuner state information, such as tuner frequency, band, and so on, must be preserved by the device across tuner on and off cycles, assuming accessory power is available.

When the tuner power is turned off, it must disable its audio output and reduce its power consumption to less than 5 mA. When tuner power is switched on, its power consumption may rise to the maximum declared during its identification process. If a device has specified that it requires intermittent accessory high power (up to 100 mA while on), the iPod will enable its accessory high power before sending a `SetTunerCtrl` command to turn on tuner power. The iPod accessory high power will remain on until a subsequent `SetTunerCtrl` command to turn off tuner power has finished. The accessory must reduce its power consumption below 5 mA within 1 second of receiving the command.

**Note:** The iPod `NotifyiPodStateChange` command overrides this command for iPod transitions to a low power state (Sleep or Hibernate). Even if this command has enabled RF tuner device power, the device must reduce its power consumption below 5 mA on receiving an iPod state change notification that specifies a transition to a low power state. The only iPod power state in which an RF tuner device requesting high power can consume more than 5 mA is the Power On state.

**Table 3-105** `SetTunerCtrl` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x03 | Length of packet |
| 3 | 0x07 | Lingo ID: RF Tuner lingo |
| 4 | 0x05 | Command ID: `SetTunerCtrl` |
| 5 | 0x*NN* | Tuner control bits (see Table 3-106 (page 230)) |
| 6 | 0x*NN* | Checksum |

**Table 3-106** Tuner control bits

| Bit | Description |
|---|---|
| 0 | Turn RF tuner device power on (1) or off (0). When RF tuner device power is turned off, the accessory should rest in the lowest power state that still allows iAP commands to be received and processed. |
| 1 | Enable (1) or disable (0) status change notification. When status change notification is disabled, the iPod assumes that the device will send no asynchronous `StatusChangeNotify` commands. The iPod may poll the device for changes. |
| 2 | Reserved |
| 3 | Enable RDS/RBDS Raw mode. When enabled, raw RDS/RBDS data format is used by the RDS data commands (commands 0x1A-0x21). When disabled, parsed RDS data is used by the RDS data commands. |
| 7:4 | Reserved |

## Command 0x06: GetTunerBand

Direction: iPod to Device

This command is sent by an iPod to get an RF tuner device's RF band information. The device must respond by returning a `RetTunerBand` command.

**Table 3-107** `GetTunerBand` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x02 | Length of packet |
| 3 | 0x07 | Lingo ID: RF Tuner lingo |
| 4 | 0x06 | Command ID: `GetTunerBand` |
| 5 | 0xF1 | Checksum |

## Command 0x07: RetTunerBand

Direction: Device to iPod

This command is sent by an RF tuner device to report its tuner band state in response to an iPod's `GetTunerBand` command. If the RF tuner device power is off, it should return its last active band state.

**Note:** Tuner band state information must be consistent with the device's capabilities, as previously reported by a `RetTunerCaps` command.

**Table 3-108** `RetTunerBand` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x03 | Length of packet |
| 3 | 0x07 | Lingo ID: RF Tuner lingo |
| 4 | 0x07 | Command ID: `RetTunerBand` |
| 5 | 0x*NN* | Tuner band state information (see Table 3-109 (page 232)): |
| 6 | 0x*NN* | Checksum |

**Table 3-109** Tuner band state IDs

| ID | Description |
|---|---|
| 0x00 | AM band worldwide (520-1710 KHz) |
| 0x01 | Europe/US FM band (87.5–108.0 MHz) |
| 0x02 | Japan FM band (76.0–90.0 MHz) |
| 0x03 | FM wide band (76.0-108.0 MHz) |
| 0x04–0xFF | Reserved |

## Command 0x08: SetTunerBand

Direction: iPod to Device

This command is sent by an iPod to an RF tuner device to set its tuner band. In response, the device must send the iPod an `ACK` command with the command status. The command status must be reported as command failed (command status 0x02) if RF tuner device power is not on.

**Table 3-110** `SetTunerBand` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x03 | Length of packet |
| 3 | 0x07 | Lingo ID: RF Tuner lingo |
| 4 | 0x08 | Command ID: `SetTunerBand` |
| 5 | 0x*NN* | Tuner band to be set (see Table 3-109 (page 232)) |
| 6 | 0x*NN* | Checksum |

**Note:** The tuner band setting requested by the iPod will be consistent with the RF tuner device's capabilities, as previously reported by a `RetTunerCaps` command.

## Command 0x09: GetTunerFreq

Direction: iPod to Device

This command is sent by an iPod to get an RF tuner device's current device tuner frequency and signal strength level. In response, the device must send the iPod a `RetTunerFreq` command.

**Table 3-111** `GetTunerFreq` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x02 | Length of packet |
| 3 | 0x07 | Lingo ID: RF Tuner lingo |
| 4 | 0x09 | Command ID: `GetTunerFreq` |
| 5 | 0xEE | Checksum |

## Command 0x0A: RetTunerFreq

Direction: Device to iPod

This command is sent by an RF tuner device in response to a `GetTunerFreq` or `SetTunerFreq` command received from an iPod. The tuner frequency is expressed in kilohertz: for example, 76000 for 76.0 MHz, 87500 for 87.5 MHz, or 107900 for 107.9 MHz. Valid ranges are 87500 to 107900 for the European/US FM band and 76000 to 89900 for the Japanese FM band.

If the RF tuner device's capabilities includes tuner channel RSSI indication, byte 9 of the command packet may be a number greater than zero; otherwise it must be set to 0x00. The tuner RSSI level must be normalized to a value between 0 (minimum) and 255 (maximum). If RF tuner device power is off, the last active tuner frequency and signal strength (if applicable) should be sent.

**Table 3-112** `RetTunerFreq` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x07 | Length of packet |
| 3 | 0x07 | Lingo ID: RF Tuner lingo |
| 4 | 0x0A | Command ID: `RetTunerFreq` |
| 5 | 0x*NN* | Tuner frequency in kilohertz (bits 31:24) |
| 6 | 0x*NN* | Tuner frequency (bits 23:16) |
| 7 | 0x*NN* | Tuner frequency (bits 15:8) |
| 8 | 0x*NN* | Tuner frequency (bits 7:0) |

| Byte number | Value | Comment |
|---|---|---|
| 9 | 0x*NN* | Tuner channel received signal strength (`rssiLevel`); may range from 0x00 (no signal present or RSSI indication not supported) to 0xFF (maximum RSSI signal strength). |
| 10 | 0x*NN* | Checksum |

**Note:** The tuner channel received signal strength value is valid only if the tuner RSSI bit was set in a previous `RetTunerCaps` command.

## Command 0x0B: SetTunerFreq

Direction: iPod to Device

This command is sent by an iPod to an RF tuner device to select a specific tuner frequency within the current tuner band. The tuner frequency is expressed in kilohertz; valid ranges are 87500 to 107900 for the European/US FM band and 76000 to 89900 for the Japanese FM band. In response, the device must send a `RetTunerFreq` command with the new tuner frequency and RSSI level (if the device supports RSSI). The requested frequency should be within the currently selected tuner band. The command status must be reported as command failed (command status 0x02) if RF tuner device power is not on.

**Table 3-113** `SetTunerFreq` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x06 | Length of packet |
| 3 | 0x07 | Lingo ID: RF Tuner lingo |
| 4 | 0x0B | Command ID: `SetTunerFreq` |
| 5 | 0x*NN* | Tuner frequency in kilohertz (bits 31:24) |
| 6 | 0x*NN* | Tuner frequency (bits 23:16) |
| 7 | 0x*NN* | Tuner frequency (bits 15:8) |
| 8 | 0x*NN* | Tuner frequency (bits 7:0) |
| 9 | 0x*NN* | Checksum |

## Command 0x0C: GetTunerMode

Direction: iPod to Device

This command is sent by an iPod to an RF tuner device to get the current tuner mode state from the device. In response, the device must send the iPod a `RetTunerMode` command.

**Table 3-114** `GetTunerMode` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x02 | Length of packet |
| 3 | 0x07 | Lingo ID: RF Tuner lingo |
| 4 | 0x0C | Command ID: `GetTunerMode` |
| 5 | 0xEB | Checksum |

## Command 0x0D: RetTunerMode

Direction: Device to iPod

This command is sent by a device in response to a `GetTunerMode` command received from an iPod. The tuner mode bits returned are valid only if the associated mode bits returned by a previous `RetTunerCaps` command were set. If tuner power is off, the last active tuner mode information should be returned.

**Table 3-115** `RetTunerMode` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x03 | Length of packet |
| 3 | 0x07 | Lingo ID: RF Tuner lingo |
| 4 | 0x0D | Command ID: `RetTunerMode` |
| 5 | 0x*NN* | Tuner mode status (see Table 3-116 (page 235)) |
| 6 | 0x*NN* | Checksum |

**Table 3-116** RF Tuner mode status bits

| Bits | Description |
|---|---|
| 1:0 | FM tuner resolution (see Table 3-101 (page 228)) |
| 2 | Tuner is currently seeking up or down |

| Bits | Description |
|---|---|
| 3 | Tuner is currently seeking with an RSSI minimum threshold enabled |
| 4 | Monophonic mode is forced (1) or stereo is allowed (0) |
| 5 | Stereo blend is enabled (valid only if bit 4 is 0) |
| 6 | FM Tuner deemphasis is 50 µsec (1) or 75 µsec (0) |
| 7 | AM tuner resolution (1 = 9 KHz, 0 = 10 KHz) |

## Command 0x0E: SetTunerMode

Direction: iPod to Device

This command is sent by an iPod to an RF tuner device to set the current tuner mode. In response, the device must send an RF tuner lingo `ACK` command with the command status. The command status must be reported as command failed (command status 0x02) if RF tuner device power is not on.

**Table 3-117** `SetTunerMode` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x03 | Length of packet |
| 3 | 0x07 | Lingo ID: RF Tuner lingo |
| 4 | 0x0E | Command ID: `SetTunerMode` |
| 5 | 0x*NN* | Tuner mode to be set (see Table 3-118 (page 236)) |
| 6 | 0x*NN* | Checksum |

**Table 3-118** Set RF Tuner mode bits

| Bits | Description |
|---|---|
| 1:0 | Set FM tuner resolution (see Table 3-101 (page 228)) |
| 2-3 | Reserved; set to 0 |
| 4 | Force monophonic mode (1) or allow stereo (0) |
| 5 | Enable stereo blend (valid only if bit 4 is 0); this blends the source left and right channels to improve the perceived signal quality while still retaining some stereo image separation |
| 6 | Set FM Tuner deemphasis to 50 µsec (1) or 75 µsec (0) |

| Bits | Description |
|---|---|
| 7 | Set AM tuner resolution (1 = 9 KHz, 0 = 10 KHz) |

**Note:** SetTunerMode must not be used to start tuner seeking or set the seek type. The TunerSeekStart command must be used instead.

## Command 0x0F: GetTunerSeekRssi

Direction: iPod to Device

This command is sent by an iPod to get the current tuner seek threshold value from an RF tuner device. In response, the device must send a RetTunerSeekRssi command with the seek RSSI threshold, if supported by the device. If seek RSSI is not supported, the RF tuner device must return an ACK command with failure status.

**Table 3-119** GetTunerSeekRssi packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x02 | Length of packet |
| 3 | 0x07 | Lingo ID: RF Tuner lingo |
| 4 | 0x0F | Command ID: GetTunerSeekRssi |
| 5 | 0xE8 | Checksum |

## Command 0x10: RetTunerSeekRssi

Direction: Device to iPod

This command is sent by a device in response to a GetTunerSeekRssi command received from an iPod, assuming the device supports the seek RSSI capability. Its threshold value represents the minimum signal strength that allows a tuner channel to be recognized during the seek process; it is normalized to a value between 0 (minimum) and 255 (maximum). If device power is off, the last active RSSI threshold value should be sent.

**Table 3-120** RetTunerSeekRssi packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |

| Byte number | Value | Comment |
|---|---|---|
| 2 | 0x03 | Length of packet |
| 3 | 0x07 | Lingo ID: RF Tuner lingo |
| 4 | 0x10 | Command ID: `RetTunerSeekRssi` |
| 5 | 0x*NN* | RSSI threshold for seeking action |
| 6 | 0x*NN* | Checksum |

## Command 0x11: SetTunerSeekRssi

Direction: iPod to Device

This command is sent by an iPod to an RF tuner device that supports the seek RSSI capability, to set the device's seek RSSI signal strength threshold. The threshold value is the minimum signal strength that allows a tuner channel to be recognized during the seek process; it is normalized to a range between 0 (minimum) and 255 (maximum).

**Table 3-121** `SetTunerSeekRssi` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x03 | Length of packet |
| 3 | 0x07 | Lingo ID: RF Tuner lingo |
| 4 | 0x11 | Command ID: `SetTunerSeekRssi` |
| 5 | 0x*NN* | RSSI threshold for seeking action |
| 6 | 0x*NN* | Checksum |

## Command 0x12: TunerSeekStart

Direction: iPod to Device

This command is sent by an iPod to an RF tuner device that supports the tuner seek up/down capability (as reported by a previous `RetTunerCaps` command), to initiate seeking of a specified type. The returned `ACK` command status must be reported as command failed (command status 0x02) if RF tuner device power is not on. Seeking operations that use an RSSI threshold are initiated only if the RF tuner device's seek RSSI threshold capability is also supported, as reported by the `RetTunerCaps` command.

**Table 3-122** `TunerSeekStart` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x03 | Length of packet |
| 3 | 0x07 | Lingo ID: RF Tuner lingo |
| 4 | 0x12 | Command ID: `TunerSeekStart` |
| 5 | 0x*NN* | ID of tuner seeking operation (see Table 3-123 (page 239) and Note below) |
| 6 | 0x*NN* | Checksum |

**Note:** An accessory that declares support for HD radio by setting its capability bit 04 (see Table 3-100 (page 227)) must also support HD seeks. If the accessory receives a seek code it does not support, it must return a `DevACK` command with Bad Parameter status (0x04).

**Table 3-123** Tuner seeking operations

| ID | Operation | Use RSSI threshold |
|---|---|---|
| 0x00 | No seek operation (cancel seek operation, if active) | N/A |
| 0x01 | Seek up from beginning of band | No |
| 0x02 | Seek down from end of band | No |
| 0x03 | Seek up from current frequency | No |
| 0x04 | Seek down from current frequency | No |
| 0x05 | Seek up from beginning of band | Yes |
| 0x06 | Seek down from end of band | Yes |
| 0x07 | Seek up from current frequency | Yes |
| 0x08 | Seek down from current frequency | Yes |
| 0x09 | Seek up from beginning of band for an HD signal | No |
| 0x0A | Seek down from end of band for an HD signal | No |
| 0x0B | Seek up from current frequency for an HD signal | No |
| 0x0C | Seek down from current frequency for an HD signal | No |
| 0x0D | Seek up from beginning of band for an HD signal | Yes |

| ID | Operation | Use RSSI threshold |
|---|---|---|
| 0x0E | Seek down from end of band for an HD signal | Yes |
| 0x0F | Seek up from current frequency for an HD signal | Yes |
| 0x10 | Seek down from current frequency for an HD signal | Yes |
| 0x11–0xFF | Reserved | N/A |

An analog seek operation (operation 0x01-0x08) will seek any frequency that contains a valid signal including HD signals. An HD seek operation (operation 0x09-0x10) skips channels that are not HD and stops only on channels with HD signals present. The HD seek completes when either of two conditions is satisfied:

- An HD channel that satisfies the criteria of the tuner's seek function was located within the band. This may result in moving one or more channel spacings and wrapping around one end of the band.
- No HD channel that satisfies the criteria of the tuner's seek function was located within the band, and the seek has traversed the entire band and wrapped back to the original tuner frequency.

A seek operation using an RSSI threshold completes when either of two conditions is satisfied:

- A channel was located within the band that satisfies the minimum RSSI threshold level.
- No channel was located within the band that satisfies the minimum the RSSI threshold level. The seek has traversed the entire band and wrapped back to the beginning tuner frequency without locating a valid channel. If no channel is found, it may indicate that the threshold is too high for the current radio reception area.

A seek operation using no RSSI threshold completes when either of two conditions is satisfied:

- A channel was located within the band that satisfies the criteria of the tuner's seek function. This may result in moving one or more channel spacings and wrapping around at the band ends.
- No channel was located within the band that satisfies the criteria of the tuner's seek function and the seek has traversed the entire band and wrapped back to the beginning tuner frequency without locating a valid channel.

An `ACK` command with command pending status is returned for seek operations requiring more than 100 ms to complete. It indicates the maximum time required for the device to complete the requested scan type. When the requested seek operation is completed (either successfully or unsuccessfully), the device must respond with a `TunerSeekDone` command indicating the seek operation status. If the device does not support tuner seek (with RSSI) operations or if tuner power is off, an `ACK` command with error status is returned.

When a cancel seek operation is requested and a seek operation is active, the seek operation stops at the current seek channel and the device responds with a `TunerSeekDone` command indicating the frequency and RSSI of the channel.

## Command 0x13: TunerSeekDone

Direction: Device to iPod

In response to a `TunerSeekStart` command from an iPod, an RF tuner device must send this command to the iPod after the seek operation has finished. It reports the current tuner frequency, which is assumed to be the result of the seek operation. If the device supports a tuner channel RSSI indication capability (as reported by a previous `RetTunerCaps` command), the `rssiLevel` value shows the current channel's RSSI signal strength level. If no channel was found, a tuner frequency value of 0xFFFFFFFF must be reported. The received signal strength value must be normalized to a range from 0x00 (no signal or device does not support RSSI indication) to 0xFF (maximum signal strength).

If an HD signal seek was requested, the tuner should tune to the next frequency containing HD content but it should not select an analog or HD program service. The iPod will perform the program selection operation separately. See "Command 0x28: RetHDProgramService" (page 256) and "Command 0x29: SetHDProgramService" (page 257).

**Table 3-124** `TunerSeekDone` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x07 | Length of packet |
| 3 | 0x07 | Lingo ID: RF Tuner lingo |
| 4 | 0x13 | Command ID: `TunerSeekDone` |
| 5 | 0x*NN* | Tuner frequency in kilohertz (bits 31:24) |
| 6 | 0x*NN* | Tuner frequency in kilohertz (bits 23:16) |
| 7 | 0x*NN* | Tuner frequency in kilohertz (bits 15:8) |
| 8 | 0x*NN* | Tuner frequency in kilohertz (bits 7:0) |
| 9 | 0x*NN* | Tuner channel RSSI received signal strength value |
| 10 | 0x*NN* | Checksum |

## Command 0x14: GetTunerStatus

Direction: iPod to Device

This command is sent by an iPod to an RF tuner device to get its current tuner status state; in response, the device must send a `RetTunerStatus` command. The command can be used to poll the device's status if the device does not support status change notifications. After the device's status is reported its status bits must be cleared, so that an immediate reread will return no active status.

**Table 3-125** `GetTunerStatus` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |

| Byte number | Value | Comment |
|---|---|---|
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x02 | Length of packet |
| 3 | 0x07 | Lingo ID: RF Tuner lingo |
| 4 | 0x14 | Command ID: `GetTunerStatus` |
| 5 | 0xE3 | Checksum |

## Command 0x15: RetTunerStatus

Direction: Device to iPod

This command is sent by an RF tuner device in response to a `GetTunerStatus` command received from an iPod. The tuner status bits returned are valid only if the status capability bits returned by a previous `RetTunerCaps` command were set. If the tuner power is off, the last active tuner status information should be returned.

**Table 3-126** `RetTunerStatus` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x03 | Length of packet |
| 3 | 0x07 | Lingo ID: RF Tuner lingo |
| 4 | 0x15 | Command ID: `RetTunerStatus` |
| 5 | 0x*NN* | Tuner status bits (see Table 3-127 (page 242)) |
| 6 | 0x*NN* | Checksum |

**Note:** An accessory that declares support for HD radio by setting its capability bit 04 must return valid RF tuner status bits; see Table 3-100 (page 227).

**Table 3-127** RF tuner status bits

| Bit | Description |
|---|---|
| 0 | RDS/RBDS data is received, ready to read |
| 1 | Tuner channel RSSI level has changed |
| 2 | Stereo source indicator state; 1 for a stereo signal source, 0 for monophonic |

| Bit | Description |
|---|---|
| 3 | HD signal present |
| 4 | HD digital audio present |
| 5 | HD data is received; ready to read |
| 7:6 | Reserved |

## Command 0x16: GetStatusNotifyMask

Direction: iPod to Device

This command is sent by an iPod to an RF tuner device to get the status notification mask from the device. This mask indicates which state changes will invoke a notification change command from the device. In response, the device must send the iPod a `RetStatusNotifyMask` command.

**Table 3-128** `GetStatusNotifyMask` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x02 | Length of packet |
| 3 | 0x07 | Lingo ID: RF Tuner lingo |
| 4 | 0x16 | Command ID: `GetStatusNotifyMask` |
| 5 | 0xE1 | Checksum |

## Command 0x17: RetStatusNotifyMask

Direction: Device to iPod

This command must be returned by the device in response to the `GetStatusNotifyMask` command. The status notification mask indicates which state changes will invoke a notification change command from the device. However, its bit values are valid only if the corresponding capabilities bits returned by a previous `RetTunerCaps` command were set. A mask bit value of 1 indicates that notification is enabled; a value of 0 indicates notification is disabled or not supported.

**Table 3-129** `RetStatusNotifyMask` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |

| Byte number | Value | Comment |
|---|---|---|
| 2 | 0x03 | Length of packet |
| 3 | 0x07 | Lingo ID: RF Tuner lingo |
| 4 | 0x17 | Command ID: `RetStatusNotifyMask` |
| 5 | 0x*NN* | Status notification mask (see Table 3-130 (page 244)) |
| 6 | 0x*NN* | Checksum |

**Note:** An accessory that declares support for HD radio by setting its capability bit 04 (see Table 3-100 (page 227)) must support status notifications.

**Table 3-130** Status notification mask bits

| Bit | Description |
|---|---|
| 0 | RDS/RBDS data-ready change notify enabled (ignored if `SetRdsNotifyMask` sets `rdsMask` to a value other than zero) |
| 1 | Tuner channel RSSI-level change notify enabled |
| 2 | Stereo indicator state change notify enabled |
| 3 | HD signal present notification enabled |
| 4 | HD digital audio present notification enabled |
| 5 | HD data ready notification enabled |
| 7:6 | Reserved |

## Command 0x18: SetStatusNotifyMask

Direction: iPod to Device

The iPod sends this command to an RF tuner device to set the status change notification mask. The status notification mask indicates which state changes will invoke a notification change command from the device. However, its bit values are valid only if the corresponding capabilities bits returned by a previous `RetTunerCaps` command were set. A mask bit value of 1 indicates that notification is enabled; a value of 0 indicates notification is disabled or not supported.

**Note:** For RDS/RBDS data-ready changes, the `SetRdsNotifyMask` command can override the notification status mask bit. If the `SetRdsNotifyMask` notification mask is set with a nonzero mask, then any enabled RDS/RBDS data notifications will be sent using the `RdsReadyNotify` command instead of the `StatusChangeNotify` command. For HD data ready changes, the `SetHDDataNotifyMask` command can override the HD data notification status mask bit. If the `SetHDDataNotifyMask` notification mask is set with a nonzero mask, then any enabled HD data notifications must be sent using the `HDDataReadyNotify` command instead of the `StatusChangeNotify` command.

**Table 3-131** `SetStatusNotifyMask` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x03 | Length of packet |
| 3 | 0x07 | Lingo ID: RF Tuner lingo |
| 4 | 0x18 | Command ID: `SetStatusNotifyMask` |
| 5 | 0x*NN* | Status notification mask (see Table 3-132 (page 245)) |
| 6 | 0x*NN* | Checksum |

**Table 3-132** Status notification mask setting bits

| Bit | Description |
|---|---|
| 0 | Enable RDS/RBDS data-ready change notification (ignored if `SetRdsNotifyMask` sets `rdsMask` to a value other than zero) |
| 1 | Enable tuner channel RSSI-level change notification |
| 2 | Enable stereo-indicator state change notification |
| 3 | Enable HD signal present notification |
| 4 | Enable HD digital audio present notification |
| 5 | Enable HD data ready notification |
| 7:6 | Reserved |

## Command 0x19: StatusChangeNotify

Direction: Device to iPod

This command must be sent asynchronously by an RF tuner device to an attached iPod to report each enabled status change. The iPod enables specific RF tuner status change notifications using the `SetStatusNotifyMask` command. After a notification has been sent, the status bits should be automatically cleared so they are ready to receive the next status change.

> **Note:** Tuner channel RSSI-level change and stereo-indicator state change notifications must not occur more than once every 100 ms.

**Table 3-133** `StatusChangeNotify` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x03 | Length of packet |
| 3 | 0x07 | Lingo ID: RF Tuner lingo |
| 4 | 0x19 | Command ID: `StatusChangeNotify` |
| 5 | 0x*NN* | Status change ID bits (see Table 3-134 (page 246)) |
| 6 | 0x*NN* | Checksum |

> **Note:** For RDS/RBDS data-ready changes, the `SetRdsNotifyMask` command can override the notification status mask bit. If the `SetRdsNotifyMask` notification mask is set with a nonzero mask, then any enabled RDS/RBDS data notifications will be sent using the `RdsReadyNotify` command instead of the `StatusChangeNotify` command. Similarly, for HD data-ready changes, the `SetHDDataNotifyMask` command can override the HD data notification status mask bit. If the `SetHDDataNotifyMask` notification mask is set with a nonzero mask, then any enabled HD data notifications will be sent using the `HDDataReadyNotify` command instead of the `StatusChangeNotify` command.

**Table 3-134** Status change ID bits

| Bit | Description |
|---|---|
| 0 | RDS/RBDS data-ready change (valid only if bit 0 of `statusMask` is 1 and `SetRdsNotifyMask` sets `rdsMask` to 0x0) |
| 1 | Tuner channel RSSI-level change |
| 2 | Stereo indicator state change |
| 3 | HD signal present |
| 4 | HD digital audio present |
| 5 | HD data is received; ready to read |
| 7:6 | Reserved |

## Command 0x1A: GetRdsReadyStatus

Direction: iPod to Device

This command is sent by an iPod to an RF tuner device to get the device's current RDS/RBDS data-ready status. It can be used to poll the device's RDS/RBDS data-ready status without having to enable RDS/RBDS data-ready notifications. This command is usable only if the `RetTunerCaps` capability bits report has indicated that the device supports RDS/RBDS data reception and parsing. In response, the device must send a `RetRdsReadyStatus` command.

**Table 3-135** `GetRdsReadyStatus` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x02 | Length of packet |
| 3 | 0x07 | Lingo ID: RF Tuner lingo |
| 4 | 0x1A | Command ID: `GetRdsReadyStatus` |
| 5 | 0xDD | Checksum |

## Command 0x1B: RetRdsReadyStatus

Direction: Device to iPod

This command must be sent by an RF tuner device in response to a `GetRdsReadyStatus` command received from an iPod. Its status value indicates which RDS/RBDS data values are available to be read. All status bits must remain set on the device until the iPod sends a `GetRdsData` command to read the data. If the device does not support RDS/RBDS data, it must send an `rdsReady` data-ready status of 0 to indicate that no data is ready.

**Table 3-136** `RetRdsReadyStatus` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x06 | Length of packet |
| 3 | 0x07 | Lingo ID: RF Tuner lingo |
| 4 | 0x1B | Command ID: `RetRdsReadyStatus` |
| 5 | 0x*NN* | RDS/RBDS data-ready status (bits 31:24) (see Table 3-137 (page 248) and Table 3-138 (page 248)) |

| Byte number | Value | Comment |
|---|---|---|
| 6 | 0x*NN* | RDS/RBDS data-ready status (bits 23:16) |
| 7 | 0x*NN* | RDS/RBDS data-ready status (bits 15:8) |
| 8 | 0x*NN* | RDS/RBDS data-ready status (bits 7:0) |
| 9 | 0x*NN* | Checksum |

**Table 3-137** RDS/RBDS data-ready status bits, parsed mode

| Bit | Description |
|---|---|
| 03-00 | Reserved; set to zeros |
| 04 | RadioText (RT) data-ready |
| 29-05 | Reserved; set to zeros |
| 30 | Program Service Name (PSN) data-ready |
| 31 | Reserved; set to zero |

**Table 3-138** RDS/RBDS data-ready status bits, raw mode

| Bit | Description |
|---|---|
| 04-00 | Reserved |
| 05 | RDS/RBDS group data ready |
| 31-06 | Reserved |

## Command 0x1C: GetRdsData

Direction: iPod to Device

This command is sent by an iPod to get raw or unparsed RDS/RBDS data from an RF tuner device that supports the RDS/RBDS data capability. If the device supports RDS/RBDS and has data-ready, it must send a `RetRdsData` command. If the device does not support RDS/RBDS or does not have the specified data type ready, it must return an `ACK` command with command failure status.

**Table 3-139** `GetRdsData` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |

| Byte number | Value | Comment |
|---|---|---|
| 2 | 0x03 | Length of packet |
| 3 | 0x07 | Lingo ID: RF Tuner lingo |
| 4 | 0x1C | Command ID: `GetRdsData` |
| 5 | 0x*NN* | RDS/RBDS data type (`rdsDataType`) ID (see Table 3-140 (page 249) and Table 3-141 (page 249)) |
| 6 | 0x*NN* | Checksum |

**Table 3-140** RDS/RBDS data type IDs, parsed mode

| ID Bytes | Description |
|---|---|
| 0x00–0x03 | Reserved |
| 0x04 | RadioText (RT) |
| 0x05–0x1D | Reserved |
| 0x1E | Program Service Name (PSN) |
| 0x1F–0xFF | Reserved |

**Table 3-141** RDS/RBDS data type IDs, raw mode

| ID Bytes | Description |
|---|---|
| 0x00–0x04 | Reserved |
| 0x05 | RDS/RBDS group data ready |
| 0x06–0xFF | Reserved |

## Command 0x1D: RetRdsData

Direction: Device to iPod

This command is sent by an RF tuner device that has an RDS/RBDS data group ready in response to a `GetRdsData` command received from an iPod. If the device does not support the RDS/RBDS capability or does not have the specified data type ready, it must return an `ACK` command with command failure status (command status 0x02).

**Table 3-142** `RetRdsData` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |

| Byte number | Value | Comment |
|---|---|---|
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x*NN* | Length of packet |
| 3 | 0x07 | Lingo ID: RF Tuner lingo |
| 4 | 0x1D | Command ID: `RetRdsData` |
| 5 | 0x*NN* | `rdsDataType` (see Table 3-143 (page 250)) |
| 6 | 0x*NN* | `rdsData` (see Table 3-143 (page 250)) |
| *NN* | 0x*NN* | Checksum |

**Table 3-143** `rdsDataType` bytes and `rdsData` formats

| rdsDataType bytes | Description | rdsData format |
|---|---|---|
| 0x00–0x03 | Reserved | N/A |
| 0x04 | RadioText (RT) | `charSet`:1 (see Table 3-144 (page 250)), `radioText`:64 |
| 0x05–0x1D | Reserved | N/A |
| 0x1E | Program Service Name (PSN) | `charSet`:1 (see Table 3-144 (page 250)), `progSvcName`:8 |
| 0x1F–0xFF | Reserved | N/A |

**Note:** The maximum length of a Radio Text is 64 bytes and that of a Program Service Name is 8 bytes.

**Table 3-144** `rdsData` character set IDs

| ID | Character set |
|---|---|
| 0x00 | Latin-based languages |
| 0x01 | Cyrillic- and Greek-based languages |
| 0x02 | Arabic- and Hebrew-based languages |
| 0x03–0xFF | Reserved |

When RDS/RBDS Raw mode is enabled, the data shown in Table 3-145 (page 251) is returned for the rdsDataType x05 (RDS/RBDS group data ready).

**Table 3-145** RDS/RBDS group data-ready data

| Byte | Description |
|---|---|
| 0x00-0x01 | 16 bit value for Block A of RDS/RBDS group data |
| 0x02-0x03 | 16 bit value for Block B of RDS/RBDS group data |
| 0x04-0x05 | 16 bit value for Block C of RDS/RBDS group data |
| 0x06-0x07 | 16 bit value for Block D of RDS/RBDS group data |
| 0x08 | Block errors byte (see Table 3-146 (page 251)) |

**Table 3-146** Block errors byte encoding

| Byte | Description | |
|---|---|---|
| 1:0 | Block A error bits | See Table 3-147 (page 251) |
| 3:2 | Block B error bits | |
| 5:4 | Block C error bits | |
| 7:6 | Block D error bits | |

**Table 3-147** Block error bit values

| Bits | Description |
|---|---|
| 00 | No errors |
| 01 | 1 to 2 errors; slight chance of uncorrected errors |
| 10 | 3 to 5 errors; may have uncorrected errors |
| 11 | 6 or more errors; uncorrectable block |

## Command 0x1E: GetRdsNotifyMask

Direction: iPod to Device

This command is sent by an iPod to get an RF tuner device's current RDS/RBDS data notification mask (`rdsMask`). In response, the device must send a `RetRdsNotifyMask` command with the RDS/RBDS data notification mask. This command is valid only if the RDS/RBDS data-ready capability bit was set in a previous `RetTunerCaps` command.

**Table 3-148** `GetRdsNotifyMask` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x02 | Length of packet |
| 3 | 0x07 | Lingo ID: RF Tuner lingo |
| 4 | 0x1E | Command ID: `GetRdsNotifyMask` |
| 5 | 0xD9 | Checksum |

## Command 0x1F: RetRdsNotifyMask

Direction: Device to iPod

This command is sent by an RF tuner device in response to a `GetRdsNotifyMask` command sent by an iPod. The RDS/RBDS mask (`rdsMask`) indicates which asychronous data notifications should be sent by the device when data is ready. For each data type bit, 1 means that data-ready notification is enabled and 0 means that notification is disabled. For enabled RDS/RBDS data types, the device must send `RdsReadyNotify` commands to the iPod when the associated data becomes available.

**Table 3-149** `RetRdsNotifyMask` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x06 | Length of packet |
| 3 | 0x07 | Lingo ID: RF Tuner lingo |
| 4 | 0x1F | Command ID: `RetRdsNotifyMask` |
| 5 | 0x*NN* | RDS/RBDS data change notification mask (bits 31:24) (see Table 3-150 (page 253) and Table 3-151 (page 253)) |
| 6 | 0x*NN* | RDS/RBDS data change notification mask (bits 23:16) |
| 7 | 0x*NN* | RDS/RBDS data change notification mask (bits 15:8) |
| 8 | 0x*NN* | RDS/RBDS data change notification mask (bits 7:0) |
| 9 | 0x*NN* | Checksum |

**Table 3-150** RDS/RBDS data change notification mask bits, parsed mode

| Bit | Description |
|---|---|
| 03-00 | Reserved |
| 04 | RadioText (RT) |
| 29-05 | Reserved (must be set to zeros) |
| 30 | Program Service Name (PSN) |
| 31 | Reserved (must be set to 0) |

**Table 3-151** RDS/RBDS data change notification mask bits, raw mode

| Bit | Description |
|---|---|
| 04-00 | Reserved |
| 05 | RDS/RBDS group data |
| 31-06 | Reserved |

## Command 0x20: SetRdsNotifyMask

Direction: iPod to Device

This command is sent by an iPod to an RF tuner device to set the device's RDS/RBDS data-ready notification mask (`rdsMask`). When notification bits are enabled, the device must send an `RdsReadyNotify` command with the associated RDS/RBDS data. For each RDS/RBDS data type bit, 1 enables data-ready notification and 0 disables notification.

**Note:** For RDS/RBDS data-ready changes, the `SetRdsNotifyMask` command can override the notification status mask bit. If the `SetRdsNotifyMask` notification mask is set with a nonzero mask, then any enabled RDS/RBDS data notifications will be sent using the `RdsReadyNotify` command instead of the `StatusChangeNotify` command.

**Table 3-152** `SetRdsNotifyMask` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x06 | Length of packet |
| 3 | 0x07 | Lingo ID: RF Tuner lingo |
| 4 | 0x20 | Command ID: `SetRdsNotifyMask` |

| Byte number | Value | Comment |
|---|---|---|
| 5 | 0x*NN* | RDS/RBDS data change notification mask (bits 31:24) (see Table 3-153 (page 254) and Table 3-154 (page 254)) |
| 6 | 0x*NN* | RDS/RBDS data change notification mask (bits 23:16) |
| 7 | 0x*NN* | RDS/RBDS data change notification mask (bits 15:8) |
| 8 | 0x*NN* | RDS/RBDS data change notification mask (bits 7:0) |
| 9 | 0x*NN* | Checksum |

**Table 3-153** RDS/RBDS data change notification mask setting bits, parsed mode

| Bit | Description |
|---|---|
| 03-00 | Reserved |
| 04 | RadioText (RT) |
| 29-05 | Reserved |
| 30 | Program Service Name (PSN) |
| 31 | Reserved |

**Table 3-154** RDS/RBDS data change notification mask setting bits, raw mode

| Bit | Description |
|---|---|
| 04-00 | Reserved |
| 05 | RDS/RBDS group data |
| 31-06 | Reserved |

## Command 0x21: RdsReadyNotify

Direction: Device to iPod

This command must be sent by an RF tuner device when RDS/RBDS data is ready, the associated `SetRdsNotifyMask` bit is set, and the device's capability bit from a previous `RetTunerCaps` command indicates that the device supports RDS/RBDS status notifications. After a notification command is sent, the device's associated RDS/RBDS data-ready status bit must cleared.

**Table 3-155** `RdsReadyNotify` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |

| Byte number | Value | Comment |
| --- | --- | --- |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x*NN* | Length of packet |
| 3 | 0x07 | Lingo ID: RF Tuner lingo |
| 4 | 0x21 | Command ID: `RdsReadyNotify` |
| 5 | 0x*NN* | `rdsDataType` (for RDS data types, see Table 3-143 (page 250); for HD data types, see Table 3-167 (page 261)) |
| 6 | 0x*NN* | `rdsData` (for RDS data types, see Table 3-143 (page 250); for HD data types, see Table 3-167 (page 261)) |
| *NN* | 0x*NN* | Checksum |

## Command 0x25: GetHDProgramServiceCount

Direction: iPod to Device

This command is sent by an iPod to an RF Tuner device to get the count of HD program services broadcast at the current tuner frequency. In response, the device must send a `RetHDProgramServiceCount` command with the count of HD program services available. This command is only valid if the HD capable bit was set in a previous `RetTunerCaps` command.

**Table 3-156** `GetHDProgramServiceCount` packet

| Byte number | Value | Comment |
| --- | --- | --- |
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x02 | Length of packet |
| 3 | 0x07 | Lingo ID: RF Tuner lingo |
| 4 | 0x25 | Command ID: `GetHDProgramServiceCount` |
| 5 | 0xD2 | Checksum |

## Command 0x26: RetHDProgramServiceCount

Direction: Device to iPod

This command is sent by an RF Tuner device in response to a `GetHDProgramServiceCount` command sent by an iPod. The command returns the count of HD program services broadcast at the current tuner frequency. The command returns a count of 0 if there are no HD program services available. HD programs services must be indexed from 1 to the count value, 1 being the main program service. The Analog Program Exists field indicates whether the station has analog programming or not. This command is only valid if the HD capable bit was set in a previous `RetTunerCaps` command.

**Table 3-157** `RetHDProgramServiceCount` packet

| Byte number | Value | Comment |
| --- | --- | --- |
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x04 | Length of packet |
| 3 | 0x07 | Lingo ID: RF Tuner lingo |
| 4 | 0x26 | Command ID: `RetHDProgramServiceCount` |
| 5 | 0x*NN* | HD program service count (0-8) |
| 6 | 0x*NN* | Analog Program Exists (0 = no, 1 = yes) |
| 7 | 0x*NN* | Checksum |

## Command 0x27: GetHDProgramService

Direction: iPod to Device

This command is sent by an iPod to an RF Tuner device to get the current tuned HD program service. In response, the device must send a `RetHDProgramService` command with the current HD program service. This command is only valid if the HD capable bit was set in a previous `RetTunerCaps` command.

**Table 3-158** `GetHDProgramService` packet

| Byte number | Value | Comment |
| --- | --- | --- |
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x02 | Length of packet |
| 3 | 0x07 | Lingo ID: RF Tuner lingo |
| 4 | 0x27 | Command ID: `GetHDProgramService` |
| 5 | 0xD0 | Checksum |

## Command 0x28: RetHDProgramService

Direction: Device to iPod

This command is sent by an RF Tuner device in response to a `GetHDProgramService` command sent by an iPod. The value returned is the tuned HD program service, 0 if the analog program is currently tuned, or 0xFF if audio decoding and output is currently disabled. The output may be disabled if a `SetHDProgramService` command was sent with parameter 0xFF or if the radio has just been tuned to a station's frequency. This command is only valid if the HD capable bit was set in a previous `RetTunerCaps` command.

**Table 3-159** `RetHDProgramService` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x02 | Length of packet |
| 3 | 0x07 | Lingo ID: RF Tuner lingo |
| 4 | 0x28 | Command ID: `RetHDProgramService` |
| 5 | 0x*NN* | HD program service index (0x00-0x08 or 0xFF) |
| 6 | 0x*NN* | Checksum |

## Command 0x29: SetHDProgramService

Direction: iPod to Device

This command is sent by an iPod to an RF Tuner device to tune to an HD program service. Tuning to program service 0 disables HD tuning and switches back to analog tuning, if it is available. Tuning to program service 0xFF disables all audio decoding and output. This command lets the iPod retrieve information for all available HD programs before selecting a program's audio to be decoded and presented. This command is only valid if the HD capable bit was set in a previous `RetTunerCaps` command.

Selecting an analog program on an HD digital-only station or attempting to select a nonexistent HD program constitutes an invalid program selection. In this case, the accessory should send the iPod an `ACK` command with Bad Parameter status.

**Table 3-160** `SetHDProgramService` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x02 | Length of packet |
| 3 | 0x07 | Lingo ID: RF Tuner lingo |
| 4 | 0x29 | Command ID: `SetHDProgramService` |
| 5 | 0x*NN* | HD program service index (0x00-0x08 or 0xFF) |

| Byte number | Value | Comment |
|---|---|---|
| 6 | 0x*NN* | Checksum |

## Command 0x2A: GetHDDataReadyStatus

Direction: iPod to Device

This command is sent by an iPod to an RF tuner device to get the device's current HD data-ready status. It can be used to poll the device's HD data-ready status without having to enable HD data-ready notifications. In response, the device must send a `RetHDDataReadyStatus` command. This command is only valid if the HD capable bit was set in a previous `RetTunerCaps` command.

**Note:** Only parsed mode is supported for HD Data.

**Table 3-161** `GetHDDataReadyStatus` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x02 | Length of packet |
| 3 | 0x07 | Lingo ID: RF Tuner lingo |
| 4 | 0x2A | Command ID: `GetHDDataReadyStatus` |
| 5 | 0xCD | Checksum |

## Command 0x2B: RetHDDataReadyStatus

Direction: Device to iPod

This command must be sent by an RF tuner device in response to a `GetHDDataReadyStatus` command received from an iPod. Its status value indicates which HD data values are available to be read. All status bits must remain set on the device until the iPod sends a `GetHDData` command to read the data.

**Table 3-162** `RetHDDataReadyStatus` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x06 | Length of packet |

| Byte number | Value | Comment |
|---|---|---|
| 3 | 0x07 | Lingo ID: RF Tuner lingo |
| 4 | 0x2B | Command ID: `RetHDDataReadyStatus` |
| 5 | 0x*NN* | HD data-ready status (bits 31:24) (see Table 3-163 (page 259)) |
| 6 | 0x*NN* | HD data-ready status (bits 23:16) |
| 7 | 0x*NN* | HD data-ready status (bits 15:8) |
| 8 | 0x*NN* | HD data-ready status (bits 7:0) |
| 9 | 0x*NN* | Checksum |

**Table 3-163** HD data-ready status bits

| Bit | Description |
|---|---|
| 0 | PSD data ready |
| 1 | Reserved |
| 2 | SIS Station ID number data-ready |
| 3 | SIS Station Name (short) data-ready |
| 4 | SIS Station Name (long) data-ready |
| 5 | SIS ALFN data-ready |
| 6 | SIS Station Location data-ready |
| 7 | SIS Station Message data-ready |
| 8 | SIS Slogan data-ready |
| 9 | SIS Parameter Message data-ready |
| 31:10 | Reserved |

## Command 0x2C: GetHDData

Direction: iPod to Device

This command is sent by an iPod to get HD data from an RF tuner device. If the device supports HD and has data-ready, it must send a `RetHDData` command. If the device does not support HD or does not have the specified data type ready, it must return an `ACK` command with command failure status. This command is valid only if the HD capable bit was set in a previous `RetTunerCaps` command.

**Note:** Only parsed mode is supported for HD Data.

**Table 3-164** `GetHDData` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x03 | Length of packet |
| 3 | 0x07 | Lingo ID: RF Tuner lingo |
| 4 | 0x2C | Command ID: `GetHDData` |
| 5 | 0x*NN* | HD data type; see Table 3-165 (page 260) |
| 6 | 0x*NN* | Checksum |

**Table 3-165** HD data type IDs

| Byte number | Description |
|---|---|
| 0x00 | PSD data |
| 0x01 | Reserved |
| 0x02 | SIS Station ID number data |
| 0x03 | SIS Station Name (short) data |
| 0x04 | SIS Station Name (long) data |
| 0x05 | SIS ALFN data |
| 0x06 | SIS Station Location data |
| 0x07 | SIS Station Message data |
| 0x08 | SIS Slogan |
| 0x09 | SIS Parameter Message data |
| 0x0A-0xFF | Reserved |

## Command 0x2D: RetHDData

Direction: Device to iPod

This command is sent by an RF Tuner device that has HD data ready in response to a `GetHDData` command. If the device does not have the specified data type ready, it must return an `ACK` command with command failure status (command status 0x02). On sending this command, the accessory device must keep clear its internal HD data-ready status for the data type being read until the next time data is ready.

**Table 3-166** `RetHDData` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x*NN* | Length of packet |
| 3 | 0x07 | Lingo ID: RF Tuner lingo |
| 4 | 0x2D | Command ID: `RetHDData` |
| 5 | 0x*NN* | `HDDataType` (see Table 3-167 (page 261)) |
| 6 | 0x*NN* | `HDData` |
| *NN* | 0x*NN* | Checksum |

**Table 3-167** `HDDataType` type IDs and formats

| HDDataType ID | HDData format |
|---|---|
| 0x00 | 8 Bit integer index, 8 Bit integer max index, 8 bit HD program index, ID3 Frame data (see Table 3-168 (page 262)) |
| 0x01 | N/A |
| 0x02 | 32-bit integer station ID |
| 0x03 | 8-bit character encoding type, up to 12 bytes (4 or 7 in USA) of short station name (see Table 3-169 (page 262)) |
| 0x04 | 0-56 characters station name (UTF-7) |
| 0x05 | 32-bit ALFN |
| 0x06 | 27-bit GPS latitude/longitude encoded in lower bits of 32 bit data |
| 0x07 | 8-bit character encoding type, 0-190 bytes station message (see Table 3-169 (page 262)) |
| 0x08 | 8-bit character encoding type, 2-96 bytes station slogan (see Table 3-169 (page 262)) |
| 0x09 | 6-bit index encoded in lower bits of 8 bit data, 16-bit parameter |
| 0x0A–0xFF | N/A |

**Table 3-168** PSD data format

| HDDataType ID | Description |
|---|---|
| 0x00 | Current ID3 Frame index (0 = first) |
| 0x01 | Last Index of ID3 Frame data |
| 0x02 | HD Program Index (1-8) |
| 0x03–0x*NN* | ID3 Frame data, ID3 tag version 2.3.0. The first byte of the ID3 tag's text information contains the encoding type. |

**Table 3-169** 8-bit character encoding type formats

| Encoding type ID | Description |
|---|---|
| 0x00 | ISO/IEC 8859-1:1998 |
| 0x01–0x03 | Reserved |
| 0x04 | ISO/IEC 10646-1:2000, UCS-2 (Little-endian) |
| 0x05–0xFF | Reserved |

## Command 0x2E: GetHDDataNotifyMask

Direction: iPod to Device

This command is sent by an iPod to get an RF tuner device's current HD data notification mask. In response, the device must send a `RetHDDataNotifyMask` command with the HD data notification mask. This command is valid only if the HD capability bit was set in a previous `RetTunerCaps` command.

**Table 3-170** `GetHDDataNotifyMask` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x02 | Length of packet |
| 3 | 0x07 | Lingo ID: RF Tuner lingo |
| 4 | 0x2E | Command ID: `GetHDDataNotifyMask` |
| 5 | 0xC9 | Checksum |

## Command 0x2F: RetHDDataNotifyMask

Direction: Device to iPod

This command is sent by an RF tuner device in response to a `GetHDDataNotifyMask` command sent by an iPod. The HD mask indicates which asychronous data notifications should be sent by the device when data is ready. For each data type bit, 1 means that data-ready notification is enabled and 0 means that notification is disabled. For enabled HD data types, the device must send `HDDataReadyNotify` commands to the iPod when the associated data becomes available.

**Table 3-171** `RetHDDataNotifyMask` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x06 | Length of packet |
| 3 | 0x07 | Lingo ID: RF Tuner lingo |
| 4 | 0x2F | Command ID: `RetHDDataNotifyMask` |
| 5 | 0x*NN* | HD data change notification mask (bits 31:24) (see Table 3-172 (page 263)) |
| 6 | 0x*NN* | HD data change notification mask (bits 23:16) |
| 7 | 0x*NN* | HD data change notification mask (bits 15:8) |
| 8 | 0x*NN* | HD data change notification mask (bits 7:0) |
| 9 | 0x*NN* | Checksum |

**Table 3-172** HD data change notification mask bits

| Bit | Description |
|---|---|
| 0 | PSD data ready |
| 1 | Reserved |
| 2 | SIS Station ID number data-ready |
| 3 | SIS Station Name (short) data-ready |
| 4 | SIS Station Name (long) data-ready |
| 5 | SIS ALFN data-ready |
| 6 | SIS Station Location data-ready |
| 7 | SIS Station Message data-ready |

| Bit | Description |
|---|---|
| 8 | SIS Slogan data-ready |
| 9 | SIS Parameter Message data-ready |
| 31:10 | Reserved |

## Command 0x30: SetHDDataNotifyMask

Direction: iPod to Device

This command is sent by an iPod to an RF tuner device to set the device's HD data-ready notification mask. When notification bits are enabled, the device must send an `HDDataReadyNotify` command with the associated HD data. For each HD data type bit, 1 enables data-ready notification and 0 disables notification. This command is valid only if the HD capability bit was set in a previous `RetTunerCaps` command.

**Table 3-173** `SetHDDataNotifyMask` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x06 | Length of packet |
| 3 | 0x07 | Lingo ID: RF Tuner lingo |
| 4 | 0x30 | Command ID: `SetHDDataNotifyMask` |
| 5 | 0x*NN* | HD data change notification mask (bits 31:24) (see Table 3-174 (page 264)) |
| 6 | 0x*NN* | HD data change notification mask (bits 23:16) |
| 7 | 0x*NN* | HD data change notification mask (bits 15:8) |
| 8 | 0x*NN* | HD data change notification mask (bits 7:0) |
| 9 | 0x*NN* | Checksum |

**Table 3-174** HD data change notification mask setting bits

| Bit | Description |
|---|---|
| 0 | PSD data ready |
| 1 | Reserved |
| 2 | SIS Station ID number data-ready |
| 3 | SIS Station Name (short) data-ready |

| Bit | Description |
|---|---|
| 4 | SIS Station Name (long) data-ready |
| 5 | SIS ALFN data-ready |
| 6 | SIS Station Location data-ready |
| 7 | SIS Station Message data-ready |
| 8 | SIS Slogan data-ready |
| 9 | SIS Parameter Message data-ready |
| 31:10 | Reserved |

## Command 0x31: HDDataReadyNotify

Direction: Device to iPod

This command must be sent by an RF tuner device when HD data is ready, the associated `SetHDDataNotifyMask` bit is set, and the device's capability bit from a previous `RetTunerCaps` command indicates that the device supports HD status notifications. After a notification command is sent, the device's associated HD data-ready status bit must cleared.

**Table 3-175** `HDDataReadyNotify` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x*NN* | Length of packet |
| 3 | 0x07 | Lingo ID: RF Tuner lingo |
| 4 | 0x31 | Command ID: `HDDataReadyNotify` |
| 5 | 0x*NN* | `HDDataType` (see Table 3-176 (page 265)) |
| 6–0x*NN* | 0x*NN* | HD data (see Table 3-177 (page 266)) |
| *NN* | 0x*NN* | Checksum |

**Table 3-176** HD data types

| Byte | Description |
|---|---|
| 0x00 | PSD data |
| 0x01 | Reserved |

| Byte | Description |
|---|---|
| 0x02 | SIS Station ID number data |
| 0x03 | SIS Station Name (short) data |
| 0x04 | SIS Station Name (long) data |
| 0x05 | SIS ALFN data |
| 0x06 | SIS Station Location data |
| 0x07 | SIS Station Message data |
| 0x08 | SIS Slogan data |
| 0x09 | SIS Parameter Message data |
| 0x0A–0xFF | Reserved |

**Table 3-177** HD Data Type type IDs and formats

| HD data type ID | HDData format |
|---|---|
| 0x00 | 8 Bit integer index, 8 Bit integer max index, 8 bit HD program index, ID3 Frame data (see Table 3-178 (page 266)) |
| 0x01 | N/A |
| 0x02 | 32-bit integer station ID |
| 0x03 | 8-bit character encoding type, up to 12 bytes (4 or 7 in USA) of short station name (see Table 3-179 (page 267)) |
| 0x04 | 0-56 characters station name (UTF-7) |
| 0x05 | 32-bit ALFN |
| 0x06 | 27-bit GPS latitude/longitude encoded in lower bits of 32 bit data |
| 0x07 | 8-bit character encoding type, 0-190 bytes station message (see Table 3-179 (page 267)) |
| 0x08 | 8-bit character encoding type, 2-96 bytes station slogan (see Table 3-179 (page 267)) |
| 0x09 | 6-bit index encoded in lower bits of 8 bit data, 16-bit parameter |
| 0x0A–0xFF | N/A |

**Table 3-178** PSD data format

| HDDataType ID | Description |
|---|---|
| 0x00 | Current ID3 Frame index (0 = first) |

| HDDataType ID | Description |
|---|---|
| 0x01 | Last Index of ID3 Frame data |
| 0x02 | HD Program Index (1-8) |
| 0x03–0x*NN* | ID3 Frame data, ID3 tag version 2.3.0. The first byte of the ID3 tag's text information contains the encoding type. |

**Table 3-179** 8-bit character encoding type formats

| Encoding type ID | Description |
|---|---|
| 0x00 | ISO/IEC 8859-1:1998 |
| 0x01–0x03 | Reserved |
| 0x04 | ISO/IEC 10646-1:2000, UCS-2 (Little-endian) |
| 0x05–0xFF | Reserved |

## Sample HD Command Sequences

This section presents three typical examples of using RF Tuner lingo commands with HD radio.

### Initializing HD Radio

This example sets up HD Radio using RF Tuner lingo commands.

**Table 3-180** Example of HD radio setup

| Command | Direction | Data | Comments |
|---|---|---|---|
| `GetTunerCaps` | iPod to Dev | No Data | Request RF Tuner accessory's supported capabilities. |
| `RetTunerCaps` | Dev to iPod | 0x07FC0712 | Return 32-bit field indicating the accessory's capabilities (FM band US, HD Radio, Tuner power control, status change notification, FM resolution 200 kHz, Tuner seek capable, Tuner seek RSSI threshold capable, Force monophonic mode capable, Stereo blend capable, FM Tuner deemphasis select capable, AM resolution 10 kHz, RDS/RBDS data capable, Tuner channel RSSI indication capable, Stereo source indicator capable). |
| `SetTunerCtrl` | iPod to Dev | 0x01 | Tuner power on, status change notification off, raw mode off. |
| `ACK` | Dev to iPod | 0x00 | Acknowledge `SetTunerCtrl` |

| Command | Direction | Data | Comments |
| --- | --- | --- | --- |
| SetStatusNotifyMask | iPod to Dev | 0x38 | Set status notification for HD signal present, HD digital audio present, HD data ready. |
| ACK | Dev to iPod | 0x00 | Acknowledge SetStatusNotifyMask |
| SetHDDataNotifyMask | iPod to Dev | 0x00000009 | Set HD data ready notification for Station Short Name and PSD Data. |
| ACK | Dev to iPod | 0x00 | Acknowledge SetHDDataNotifyMask |
| SetTunerMode | iPod to Dev | 0x00 | Set FM Tuner resolution 200kHz, stereo allowed, no stereo blend, FM Tuner de-emphasis 75 µsec, AM Tuner resolution 10kHz. |
| ACK | Dev to iPod | 0x00 | Acknowledge SetTunerMode |

## HD Radio Tuning and Reception

Using RF Tuner lingo commands, this example tunes to an HD radio station, collects data on it, and responds to a loss of digital audio.

**Table 3-181** Example of HD radio tuning and reception

| Command | Direction | Data | Comments |
| --- | --- | --- | --- |
| SetTunerBand | iPod to Dev | 0x01 | Set Tuner band to FM US. |
| ACK | Dev to iPod | 0x00 | Acknowledge SetTunerBand |
| SetTunerFreq | iPod to Dev | 97700 | Set FM Tuner frequency to 97.7 MHz |
| RetTunerFreq | Dev to iPod | 97700, 31 | Return FM Tuner frequency set to 97.7 MHz with RSSI level of 31. |
| SetTunerSeekRssi | iPod to Dev | 8 | Set the tuner seek RSSI threshold to 8. |
| ACK | Dev to iPod | 0x00 | Acknowledge SetTunerSeekRssi |
| TunerSeekStart | iPod to Dev | 0x0F | Start tuner seek up from current frequency while checking for RSSI threshold. |
| ACK | Dev to iPod | 0x00 | Acknowledge TunerSeekStart |
| TunerSeekDone | Dev to iPod | 106900, 30 | Tuner seek has finished with tuned frequency of 106.9 MHz and RSSI level of 30. |
| GetHDProgramService-Count | iPod to Dev | No data | Retrieve number of HD Program Services available. |

| Command | Direction | Data | Comments |
|---|---|---|---|
| RetHDProgramService-Count | Dev to iPod | 3,1 | 3 HD Program services and the analog programming are available. |
| SetHDProgramService | iPod to Dev | 1 | Start decode and playback of HD program service #1. |
| ACK | Dev to iPod | 0x00 | Acknowledge SetHDProgramService |
| Collect info on HD programs, as shown in "HD Radio Service Management" (page 270). Info collection could have been performed before tuning by using SetHDDataNotifyMask; see "Initializing HD Radio" (page 267). | | | |
| Set notification: | | | |
| SetStatusNotifyMask | iPod to Dev | 0x18 | Set status notification for HD signal present, HD digital audio present. |
| ACK | Dev to iPod | 0x00 | Acknowledge SetStatusNotifyMask |
| Retrieve HD signal and audio status: | | | |
| StatusChangeNotify | Dev to iPod | 0x18 | Status change notification: HD signal and HD audio present. |
| GetHDProgramService-Count | iPod to Dev | No data | Retrieve number of HD Program Services available. |
| RetHDProgramService-Count | Dev to iPod | 2,1 | 2 HD Program services and the analog programming are available. |
| SetHDProgramService | iPod to Dev | 1 | Start decode/playback of HD program service #1. |
| ACK | Dev to iPod | 0x00 | Acknowledge SetHDProgramService |
| Respond to loss of HD digital audio: | | | |
| StatusChangeNotify | Dev to iPod | 0x08 | Status change notification: HD Signal present, HD digital audio and data not present. |
| GetHDProgramService-Count | iPod to Dev | No data | Retrieve number of HD Program Services available. |
| RetHDProgramService-Count | Dev to iPod | 0,1 | Zero HD Program services and the analog programming are available. |
| SetHDProgramService | iPod to Dev | 0 | Start playback of analog programming. |
| ACK | Dev to iPod | 0x00 | Acknowledge SetHDProgramService |

## HD Radio Service Management

This example retrieves PSD and other data for HD radio, using RF Tuner lingo commands.

**Table 3-182** Example of getting PSD and name data

| Command | Direction | Data | Comments |
|---|---|---|---|
| `SetHDDataNotifyMask` | iPod to Dev | 0x00000009 | Set HD data ready notification for Station Short Name and PSD Data. |
| `ACK` | Dev to iPod | 0x00 | Acknowledge `SetHDDataNotifyMask` |
| `HDDataReadyNotify` | Dev to iPod | 0x03, 1, NNNN | Station Short Name received, ISO 8859-1. |
| `HDDataReadyNotify` | Dev to iPod | 0x00, 0, 1, 1, NNNN | PSD ID3 Frame data 1 of 2 received for program 1. |
| `HDDataReadyNotify` | Dev to iPod | 0x00, 1, 1, 1, NNNN | PSD ID3 Frame data 2 of 2 received for program 1. |
| `HDDataReadyNotify` | Dev to iPod | 0x00, 0, 0, 2, NNNN | PSD ID3 Frame data 1 of 1 received for program 2. |
| `GetHDDataReadyStatus` | iPod to Dev | No Data | Ask accessory to return HD data ready status. |
| `RetHDDataReadyStatus` | Dev to iPod | 0x00000009 | Station Short Name and PSD data available. |
| `GetHDData` | iPod to Dev | 0x03 | Ask accessory for Station Short Name. |
| `RetHDData` | Dev to iPod | 0x03, 1, NNNN | Station Short Name, ISO 8859-1. |
| `GetHDData` | iPod to Dev | 0x00 | Ask accessory for PSD Data. |
| `RetHDData` | Dev to iPod | 0x00, 0, 1, 1, NNNN | PSD ID3 Frame data 1 of 2 received for program 1. |
| `RetHDData` | Dev to iPod | 0x00, 1, 1, 1, NNNN | PSD ID3 Frame data 2 of 2 received for program 1. |
| `GetHDDataReadyStatus` | iPod to Dev | No Data | Ask accessory to return HD data ready status. |
| `RetHDDataReadyStatus` | Dev to iPod | 0x00000001 | PSD data available. |
| `GetHDData` | iPod to Dev | 0x00 | Ask accessory for PSD Data. |
| `RetHDData` | Dev to iPod | 0x00, 0, 0, 2, NNNN | PSD ID3 Frame data 1 of 1 received for program 2. |
| `GetHDDataReadyStatus` | iPod to Dev | No Data | Ask accessory to return HD data ready status. |
| `RetHDDataReadyStatus` | Dev to iPod | 0x00000000 | No more data available. |

# Lingo 0x08: Accessory Equalizer Lingo

iPods may be connected to accessory devices such as boom boxes or amplifiers that are capable of frequency response equalization. The Accessory Equalizer lingo, number 0x08, lets the iPod control the Equalizer Settings of the accessory device.

**Note:** The Accessory Equalizer lingo requires device authentication for all communication transports (serial or USB).

The Accessory Equalizer lingo is similar to the Display Remote Equalizer lingo, but the command direction is reversed: the iPod is the master, initiating commands to which the device responds. The iPod can query the total count of device Equalizer Settings and the UTF-8 name for each one; it can then get or set each Equalizer Setting on the accessory device.

To support this lingo, the iPod application software will add an iPod menu item for accessory equalizer selection and control.

## Equalizer Setting Requirements

To be compatible with the Accessory Equalizer lingo, an accessory device must observe these rules:

- The accessory must have an Equalizer Setting with an index of 0x00 and this must be the accessory equalizer's off/none setting.
- The Equalizer Index and Equalizer Setting count fields are 1 byte in size, limiting the setting count to a maximum of 255, including the required index 0x00 setting.
- Devices supporting this lingo must support at least two Equalizer Settings: off/none and at least one other setting. If fewer than two settings are returned by the device, the iPod will not present equalizer menu options to the user.

## Accessory Equalizer Lingo Commands

Table 3-183 (page 271) lists the commands included in the Accessory Equalizer lingo.

**Table 3-183** Accessory Equalizer lingo command summary

| Command | ID | Direction | Data length | Protocol version | Authentication required |
|---|---|---|---|---|---|
| `ACK` | 0x00 | Dev to iPod | 4 | 1.00 | Yes |
| `GetCurrentEQIndex` | 0x01 | iPod to Dev | 2 | 1.00 | Yes |
| `RetCurrentEQIndex` | 0x02 | Dev to iPod | 3 | 1.00 | Yes |
| `SetCurrentEQIndex` | 0x03 | iPod to Dev | 3 | 1.00 | Yes |
| `GetEQSettingCount` | 0x04 | iPod to Dev | 2 | 1.00 | Yes |

| Command | ID | Direction | Data length | Protocol version | Authentication required |
|---|---|---|---|---|---|
| RetEQSettingCount | 0x05 | Dev to iPod | 3 | 1.00 | Yes |
| GetEQIndexName | 0x06 | iPod to Dev | 3 | 1.00 | Yes |
| RetEQIndexName | 0x07 | Dev to iPod | 0x*NN* | 1.00 | Yes |
| Reserved | 0x08–0xFF | N/A | N/A | N/A | N/A |

## Command History of the Accessory Equalizer Lingo

Table 3-184 (page 272) shows the history of command changes in the accessory equalizer lingo:

**Table 3-184** Accessory Equalizer lingo command history

| Lingo version | Command changes | Features |
|---|---|---|
| 1.00 | Add: 0x00–0x07 | Accessory device Equalizer Index, count, and name support |

# Command 0x00: ACK

Direction: Device to iPod

This command is sent by the device in response to a command sent from the iPod. An ACK response is sent when a bad parameter is received, an unsupported/invalid command is received, or a command completed but did not return any data. See Table 3-185 (page 272).

**Table 3-185** ACK packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x04 | Length of packet |
| 3 | 0x08 | Lingo ID: Accessory Equalizer lingo |
| 4 | 0x00 | Command ID: ACK |
| 5 | 0x*NN* | Status of command received (see Table 3-28 (page 169)) |
| 6 | 0x*NN* | ID of the command for which the response is being sent |
| 7 | 0x*NN* | Checksum |

## Command 0x01: GetCurrentEQIndex

Direction: iPod to Device

This command is sent by the iPod to request the current Equalizer Setting from the device. In reponse, the device sends a `RetCurrentEQIndex` command with the current Equalizer Index.

The timeout for this command is 2500 ms (2.5 seconds). If the device does not respond within the allotted time, the iPod will retry up to three times. If the device does not respond within the specified time and retry count, the command will fail.

**Table 3-186** `GetCurrentEQIndex` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x02 | Length of packet |
| 3 | 0x08 | Lingo ID: Accessory Equalizer lingo |
| 4 | 0x01 | Command ID: `GetCurrentEQIndex` |
| 5 | 0xF5 | Checksum |

## Command 0x02: RetCurrentEQIndex

Direction: Device to iPod

This command is sent by the device in response to the `GetCurrentEQIndex` command received from the iPod. The Equalizer Index returned may range from 0 (reserved for the off/none Equalizer Setting) to 254 (the maximum possible Equalizer Index). Devices are not required to support 255 settings; they may support as few as the two minimum required settings.

**Table 3-187** `RetCurrentEQIndex` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x03 | Length of packet |
| 3 | 0x08 | Lingo ID: Accessory Equalizer lingo |
| 4 | 0x02 | Command ID: `RetCurrentEQIndex` |
| 5 | 0x*NN* | `eqIndex`: The current accessory Equalizer Index. See Table 3-188 (page 274). |
| 6 | 0x*NN* | Checksum |

**Table 3-188** Device Equalizer Setting indices

| Index | Description |
|---|---|
| 0x00 | Equalizer off/none |
| 0x01 | First Equalizer Setting |
| 0x*NN* | Last Equalizer Setting (accessory-dependent maximum index) |

## Command 0x03: SetCurrentEQIndex

Direction: iPod to Device

This command is sent by the iPod to select an accessory Equalizer Index from the supported range. The valid range is from 0 to one less than the Equalizer Setting count returned by the `RetEQSettingCount` command. See Table 3-188 (page 274).

**Note:** Accessories may receive duplicate `SetCurrentEQIndex` commands at any time and must handle them correctly.

The timeout for this command is 3000 ms (3.0 seconds). If the device does not respond within the allotted time, the iPod will retry up to three times. If the device does not respond within the specified time and retry count, the command will fail.

**Table 3-189** `SetCurrentEQIndex` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x03 | Length of packet |
| 3 | 0x08 | Lingo ID: Accessory Equalizer lingo |
| 4 | 0x03 | Command ID: `SetCurrentEQIndex` |
| 5 | 0x*NN* | `eqIndex`: the selected accessory Equalizer Index |
| 6 | 0x*NN* | Checksum |

## Command 0x04: GetEQSettingCount

Direction: iPod to Device

This command is sent by the iPod to determine how many Equalizer Settings the device supports. In response, the device sends a `RetEQSettingCount` command with the count of Equalizer Settings supported.

The timeout for this command is 3000 ms (3.0 seconds). If the device does not respond within the allotted time, the iPod will retry up to three times. If the device does not respond within the specified time and retry count, the command will fail.

**Table 3-190** `GetEQSettingCount` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x02 | Length of packet |
| 3 | 0x08 | Lingo ID: Accessory Equalizer lingo |
| 4 | 0x04 | Command ID: `GetEQSettingCount` |
| 5 | 0xF2 | Checksum |

## Command 0x05: RetEQSettingCount

Direction: Device to iPod

This command is sent by the device in response to a `GetEQSettingCount` command from the iPod. To support the Accessory Equalizer lingo, a device must report a minimum count of 0x02 (equalizer off/none plus one other setting) and may support a maximum count of 0xFF (equalizer off/none plus 254 other settings).

**Table 3-191** `RetEQSettingCount` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x03 | Length of packet |
| 3 | 0x08 | Lingo ID: Accessory Equalizer lingo |
| 4 | 0x05 | Command ID: `RetEQSettingCount` |
| 5 | 0x*NN* | `eqCount`: the count of accessory equalizer indices. See Table 3-192 (page 275). |
| 6 | 0x*NN* | Checksum |

**Table 3-192** `RetEQSettingCount` parameter values

| Range | Comment |
|---|---|
| 0x00–0x01 | Invalid equalizer count (minimum count is 0x02) |

| Range | Comment |
|---|---|
| 0x02–0xFF | Valid equalizer count range |

## Command 0x06: GetEQIndexName

Direction: iPod to Device

This command is sent by the iPod to obtain the name string associated with a specified Equalizer Index. In response, the device sends a `RetEQIndexName` command with the same Equalizer Index and the associated Equalizer Setting name string.

The timeout for this command is 3000 ms (3.0 seconds). If the device does not respond within the allotted time, the iPod will retry up to three times. If the device does not respond within the specified time and retry count, the command will fail.

**Table 3-193** `GetEQIndexName` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x03 | Length of packet |
| 3 | 0x08 | Lingo ID: Accessory Equalizer lingo |
| 4 | 0x06 | Command ID: `GetEQIndexName` |
| 5 | 0x*NN* | `eqIndex`: the selected accessory Equalizer Index |
| 6 | 0x*NN* | Checksum |

## Command 0x07: RetEQIndexName

Direction: Device to iPod

This command is sent by the device in response to a `GetEQIndexName` command received from the iPod. The `eqIndex` byte is the same index that was sent by the `GetEQIndexName` command. The `eqName` string is a null-terminated UTF-8 character array. The array length must not exceed 32 characters plus a null terminator character. This length limit minimizes truncation of the Equalizer Setting name when it is displayed in the iPod accessory Equalizer Settings menu.

**Table 3-194** `RetEQIndexName` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |

| Byte number | Value | Comment |
|---|---|---|
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x*NN* | Length of packet |
| 3 | 0x08 | Lingo ID: Accessory Equalizer lingo |
| 4 | 0x07 | Command ID: `RetEQIndexName` |
| 5 | 0x*NN* | `eqIndex`: the selected accessory Equalizer Index |
| 6-*NN* | 0x*NN*... | The accessory equalizer name, as a null-terminated UTF-8 character array |
| (last byte) | 0x*NN* | Checksum |

# Lingo 0x09: Sports Lingo

The Sports lingo enables gym cardio equipment to communicate with an iPod to track a user's workout while the user continues to use the iPod for other purposes. The Sports lingo version of the iPod must be 1.01 or later to support these accessories. For information about determining the lingo version, see "Determining iPod Support for Cardio Equipment" (page 495).

All Sports lingo commands require authentication level 2.0.

## Sports Lingo commands

Table 3-195 (page 277) summarizes the Sports commands (lingo 0x09).

**Table 3-195** Sports lingo command summary

| Command | ID | Direction | Data length | Protocol version |
|---|---|---|---|---|
| `DeviceACK` | 0x00 | Dev to iPod | 0x02 | 1.01 |
| `GetDeviceVersion` | 0x01 | iPod to Dev | 0x00 | 1.01 |
| `RetDeviceVersion` | 0x02 | Dev to iPod | 0x02 | 1.01 |
| `GetDeviceCaps` | 0x03 | iPod to Dev | 0x00 | 1.01 |
| `RetDeviceCaps` | 0x04 | Dev to iPod | 0x03 | 1.01 |
| Reserved | 0x05-0x7F | N/A | | |
| `iPodACK` | 0x80 | iPod to Dev | 0x02 | 1.01 |
| Reserved | 0x81-0x82 | N/A | | |
| `GetiPodCaps` | 0x83 | Dev to iPod | 0x00 | 1.01 |

| Command | ID | Direction | Data length | Protocol version |
|---|---|---|---|---|
| `RetiPodCaps` | 0x84 | iPod to Dev | 0x03 | 1.01 |
| `GetUserIndex` | 0x85 | Dev to iPod | 0x00 | 1.01 |
| `RetUserIndex` | 0x86 | iPod to Dev | 0x01 | 1.01 |
| Reserved | 0x87 | N/A | | |
| `GetUserData` | 0x88 | Dev to iPod | 0x01 | 1.01 |
| `RetUserData` | 0x89 | iPod to Dev | 0x*NN* | 1.01 |
| `SetUserData` | 0x8A | Dev to iPod | 0x*NN* | 1.01 |
| Reserved | 0x8B-0xFF | N/A | | |

## Command History of the Sports Lingo

Table 3-196 (page 278) shows the history of changes to the Sports lingo.

**Table 3-196** Sports lingo command history

| Lingo version | Command changes | Features |
|---|---|---|
| 1.01 | Add: 0x00–0x04, 0x80, 0x83-0x86, 0x88-0x8A | Cardio equipment accessory support |

## Command 0x00: DeviceACK

Direction: Device to iPod

This command is sent by the device in response to a command sent from the iPod. An ACK response must be sent for any of the following conditions:

- A bad parameter is received
- An unsupported/invalid command is received
- A command that does not return any data has completed

**Table 3-197** `DeviceACK` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of Packet (SOP) |
| 2 | 0x04 | Length of Packet |

| Byte number | Value | Comment |
|---|---|---|
| 3 | 0x09 | Lingo ID: Sports |
| 4 | 0x00 | Command ID: DeviceACK |
| 5 | 0x*NN* | ackStatus of command; see Table 3-198 (page 279) for details |
| 6 | 0x*NN* | ID of command being acknowledged |
| 7 | 0x*NN* | Checksum |

Table 3-198 (page 279) presents the possible values for the ackStatus byte.

**Table 3-198** ackStatus details

| ackStatus | Description |
|---|---|
| 0x00 | Success |
| 0x01 | N/A (reserved) |
| 0x02 | Command failed |
| 0x03 | Out of resources |
| 0x04 | Bad parameter |
| 0x05 | N/A (reserved) |
| 0x06 | N/A (reserved) |
| 0x07 | Not authenticated |
| 0x08-0xFF | Reserved |

## Command 0x01: GetDeviceVersion

Direction: iPod to Device

This command is sent by iPod to obtain the sports device lingo protocol version. In response, the device will send the RetDeviceVersion command with its major and minor protocol version numbers. Devices may query the iPod's Sports Lingo protocol version using the General Lingo RequestLingoProtocolVersion command.

**Table 3-199** GetDeviceVersion packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of Packet (SOP) |

| Byte number | Value | Comment |
|---|---|---|
| 2 | 0x02 | Length of Packet |
| 3 | 0x09 | Lingo ID: Sports |
| 4 | 0x01 | Command ID: `GetDeviceVersion` |
| 5 | 0xF4 | Checksum |

## Command 0x02: RetDeviceVersion

Direction: Device to iPod

This command must be returned by the device in response to each `GetDeviceVersion` command received from the iPod. The device returns the maximum lingo version that it supports. The first byte is the major version number (tens/ones digits left of the decimal point) and the second byte is the minor version number (tenths/hundreths digits right of the decimal point). The iPod will support all device lingo versions up to and including its own current lingo version.

**Table 3-200** `RetDeviceVersion` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of Packet (SOP) |
| 2 | 0x04 | Length of Packet |
| 3 | 0x09 | Lingo ID: Sports |
| 4 | 0x02 | Command ID: `RetDeviceVersion` |
| 5 | 0x*NN* | Major Sports lingo protocol version supported by device (currently 0x01) |
| 6 | 0x*NN* | Minor Sports lingo protocol version supported by device (currently 0x01) |
| 7 | 0x*NN* | Checksum |

## Command 0x03: GetDeviceCaps

Direction: iPod to Device

This command is sent by the iPod to get the sports device capabilities and determine the features present on the device. In response, the device will send the `GetDeviceCaps` command with the payload indicating the capabilities supported.

**Table 3-201** `GetDeviceCaps` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of Packet (SOP) |
| 2 | 0x02 | Length of Packet |
| 3 | 0x09 | Lingo ID: Sports |
| 4 | 0x03 | Command ID: `GetDeviceCaps` |
| 5 | 0xF2 | Checksum |

## Command 0x04: RetDeviceCaps

Direction: Device to iPod

This command must be sent by the device in response to each `GetDeviceCaps` command sent by the iPod. The sports device returns the payload indicating which of the capabilities it supports. When a capability bit is set, it means that the associated command is supported by the device. Conversely, if a capability bit is clear, it means that the associated commands are not supported by the device.

**Table 3-202** `RetDeviceCaps` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of Packet (SOP) |
| 2 | 0x05 | Length of Packet |
| 3 | 0x09 | Lingo ID: Sports |
| 4 | 0x04 | Command ID: `GetDeviceCaps` |
| 5 | 0x*NN* | `capsMask` (bits15:8) |
| 6 | 0x00 | `capsMask` (bits7:0) |
| 7 | 0x00 | Reserved (set equal to 0x00) |
| 8 | 0x*NN* | Checksum |

Table 3-203 (page 282) presents the possible values for the `capsMask` bits.

**Table 3-203** `RetDeviceCaps capsMask` details

| capsMask | Description |
|---|---|
| bits 0-8 | Reserved (set to 0) |
| bit 9 | Accessory supports (1) or does not support (0) Sports lingo commands 0x80 through 0x8A |
| bits 10-15 | Reserved (set to 0) |

## Command 0x80: iPodACK

Direction: iPod to Device

This command is sent by the iPod in response to a command sent from the device. An ACK response is sent when a bad parameter is received, an unsupported/invalid command is received, or a command that does not return any data has completed.

**Table 3-204** `iPodACK` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of Packet (SOP) |
| 2 | 0x04 | Length of Packet |
| 3 | 0x09 | Lingo ID: Sports |
| 4 | 0x80 | Command ID: `iPodACK` |
| 5 | 0x*NN* | ackStatus of Command |
| 6 | 0x*NN* | ID of Command being acknowledged |
| 7 | 0x*NN* | Checksum |

Table 3-205 (page 282) presents the possible values for the `iPodACK` byte.

**Table 3-205** `iPodACK ackStatus` details

| ackStatus | Description |
|---|---|
| 0x00 | Success |
| 0x01 | N/A (reserved) |
| 0x02 | Command failed |
| 0x03 | Out of resources |
| 0x04 | Bad parameter |

| ackStatus | Description |
|---|---|
| 0x05-0xFF | N/A (reserved) |

## Command 0x83: GetiPodCaps

Direction: Device to iPod

This command may be sent by the device to get the iPod capabilities and determine if required features are present. In response, the iPod will send the `RetiPodCaps` command with the payload indicating the capabilities supported.

**Note:** The `GetiPodCaps` command must be sent before the device may use any commands that rely upon iPod support for gym cardio equipment features, such as `GetUserIndex`.

**Table 3-206** `GetiPodCaps` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of Packet (SOP) |
| 2 | 0x02 | Length of Packet |
| 3 | 0x09 | Lingo ID: Sports |
| 4 | 0x83 | Command ID: `GetiPodCaps` |
| 5 | 0x72 | Checksum |

## Command 0x84: RetiPodCaps

Direction: iPod to Device

This command is sent by the iPod in response to the `GetiPodCaps` command sent by the device. The iPod returns the payload indicating which of the capabilities it supports. The user count is valid only if the iPod user data capability bit is set.

**Table 3-207** `RetiPodCaps` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of Packet (SOP) |
| 2 | 0x05 | Length of Packet |

| Byte number | Value | Comment |
|---|---|---|
| 3 | 0x09 | Lingo ID: Sports |
| 4 | 0x84 | Command ID: `RetiPodCaps` |
| 5 | 0x00 | `capsMask` (bits15:8) |
| 6 | 0x*NN* | `capsMask` (bits7:0) |
| 7 | 0x*NN* | `userCount` number of user data profiles on iPod |
| 8 | 0x*NN* | Checksum |

Table 3-208 (page 284) presents the possible values for the `capsMask` bits.

**Table 3-208** `RetiPodCaps` `capsMask` details

| capsMask | Description |
|---|---|
| bit 0 | Cardio equipment is supported (1) or is not supported (0). |
| bit 1 | User data is supported (1) or is not supported (0). The `userCount` value is valid if and only if this capability bit is set. |
| bit2-15 | Reserved (set to 0) |

## Command 0x85: GetUserIndex

Direction: Device to iPod

This command may be sent by the device to obtain the current user index selection from the iPod. In response, the iPod will return the `RetUserIndex` command with the current user index.

**Note:** This command must not be sent unless the device has already sent a `GetiPodCaps` command and received a `RetiPodCaps` command indicating user data support capability. If the iPod does not support user data, it will return an `iPodACK` with a bad parameter status.

**Table 3-209** `GetUserIndex` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of Packet (SOP) |
| 2 | 0x02 | Length of Packet |
| 3 | 0x09 | Lingo ID: Sports |
| 4 | 0x85 | Command ID: `GetUserIndex` |

| Byte number | Value | Comment |
| --- | --- | --- |
| 5 | 0x70 | Checksum |

## Command 0x86: RetUserIndex

Direction: iPod to Device

This command is sent by the iPod in response to the `GetUserIndex` command received from the device. The current user index is returned (the first user has index 0). The total user count present on the iPod is obtained using the `GetiPodCaps` command.

**Table 3-210** `RetUserIndex` packet

| Byte number | Value | Comment |
| --- | --- | --- |
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of Packet (SOP) |
| 2 | 0x03 | Length of Packet |
| 3 | 0x09 | Lingo ID: Sports |
| 4 | 0x86 | Command ID: `RetUserIndex` |
| 5 | 0x*NN* | `userIndex` (0 to `userCount`-1) (see Note below) |
| 6 | 0x*NN* | Checksum |

**Note:** The `userIndex` value 0 is reserved by iPod for the default/unknown user profile. An iPod that does not support multiple user profiles but does support user data will offer only `userIndex` 0.

## Command 0x88: GetUserData

Direction: Device to iPod

This command may be sent by the device to obtain the current user's data. In response, the iPod will return the `RetUserData` command with the specified `userDataType`. If the iPod does not support this command or the `userDataType` is not valid, iPod will return an `iPodACK` with a bad parameter status.

**Note:** This command must not be sent unless the device has already sent a `GetiPodCaps` command and received a `RetiPodCaps` command indicating user data support capability. If the iPod does not support user data, it will return an `iPodACK` with a bad parameter status.

**Table 3-211** `GetUserData` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of Packet (SOP) |
| 2 | 0x03 | Length of Packet |
| 3 | 0x09 | Lingo ID: Sports |
| 4 | 0x88 | Command ID: `GetUserData` |
| 5 | 0x*NN* | `userDataType` |
| 6 | 0x*NN* | Checksum |

Table 3-212 (page 286) presents the possible values for the `userDataType` byte.

**Table 3-212** `GetUserData` `userDataType` details

| userDataType | Description |
|---|---|
| 0x00 | Preferred Unit System |
| 0x01 | Name |
| 0x02 | Gender |
| 0x03 | Weight |
| 0x04 | Age |
| 0x05 | Workout Recording Preference |
| 0x06-0xFF | Reserved |

## Command 0x89: RetUserData

Direction: iPod to Device

This command is sent by the iPod in response to the `GetUserData` command received from the device. The iPod returns the requested user data for the specified data type.

**Table 3-213** `RetUserData` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of Packet (SOP) |
| 2 | 0x*NN* | Length of Packet |
| 3 | 0x09 | Lingo ID: Sports |
| 4 | 0x89 | Command ID: `RetUserData` |
| 5 | 0x*NN* | `userDataType` |
| 6...N | 0x*NN* | `userData` (variable length) |
| (last byte) | 0x*NN* | Checksum |

Table 3-214 (page 287) presents the possible values for the `userDataType` byte and `userData` field values.

**Table 3-214** `RetUserData` `userDataType` details

| userDataType | userData |
|---|---|
| 0x00 | Preferred unit system (1 byte):<br>0x00 = No information<br>0x01 = Imperial units (lbs/miles)<br>0x02 = Metric units (kg/km)<br>0x03-0xFF = Reserved |
| 0x01 | Name (variable length, 128 bytes max, null-terminated UTF-8 string) |
| 0x02 | Gender (1 byte):<br>0x00 = No information<br>0x01 = Female<br>0x02 = Male<br>0x03-0xFF = Reserved |
| 0x03 | Weight in tenths of a kg (2 bytes, MSB first):<br>0x0000 = No information<br>0x0001 = 0.1 kg<br>0x0200 = 51.2 kg<br>0x1388 = 500.0 kg (maximum weight limit)<br>0x1389-0xFFFF = Reserved |

| userDataType | userData |
|---|---|
| 0x04 | Age in years (1 byte):<br>0x00 = No information<br>0x20 = 32 years old<br>0xC8 = 200 years old (maximum age limit)<br>0xC9-0xFF = Reserved |
| 0x05 | Workout recording preference (1 byte):<br>0x00 = No information<br>0x01 = Never record workout data<br>0x02 = Ask if workout should be recorded<br>0x03 = Always record workout data<br>0x04-0xFF = Reserved |
| 0x06-0xFF | Reserved |

## Command 0x8A: SetUserData

This command may be sent by the device to set the current user's data. In response, the iPod will send the `iPodACK` command with the status of the operation. If the iPod does not support this command or the `userDataType` or `userData` is not valid, an `iPodACK` with a bad parameter status is returned.

> **Note:** This command must not be sent unless the device has already sent a `GetiPodCaps` command and received a `RetiPodCaps` command indicating user data support capability. If the iPod does not support user data, it will return an `iPodACK` with a bad parameter status.

**Table 3-215** `SetUserData` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of Packet (SOP) |
| 2 | 0x*NN* | Length of Packet |
| 3 | 0x09 | Lingo ID: Sports |
| 4 | 0x8A | Command ID: `SetUserData` |
| 5 | 0x*NN* | `userDataType` |
| 6...N | 0x*NN* | `userData` (variable length) |
| (last byte) | 0x*NN* | Checksum |

Table 3-216 (page 289) presents the possible values for the `userDataType` byte and `userData` field values.

**Table 3-216** `SetUserData` `userDataType` details

| userDataType | userData |
|---|---|
| 0x00 | Preferred unit system (1 byte):<br>0x00 = No information<br>0x01 = Imperial units (lbs/miles)<br>0x02 = Metric units (kg/km)<br>0x03-0xFF = Reserved |
| 0x01 | Setting not allowed |
| 0x02 | Gender (1 byte):<br>0x00 = No information<br>0x01 = Female<br>0x02 = Male<br>0x03-0xFF = Reserved |
| 0x03 | Weight in tenths of a kg (2 bytes, MSB first):<br>0x0000 = No information<br>0x0001 = 0.1 kg<br>0x0200 = 51.2 kg<br>0x1388 = 500.0 kg (maximum weight limit)<br>0x1389-0xFFFF = Reserved |
| 0x04 | Age in years (1 byte):<br>0x00 = No information<br>0x20 = 32 years old<br>0xC8 = 200 years old (maximum age limit)<br>0xC9-0xFF = Reserved |
| 0x05 | Setting not allowed |
| 0x06-0xFF | Reserved |

# Lingo 0x0A: Digital Audio Lingo

The Digital Audio lingo supports iAP commands, using either USB or UART transport, that let the iPod transfer digital audio to an accessory. The iPod uses these lingo commands to retrieve a list of supported sample rates from the accessory and to inform the accessory of the iPod's current sample rate, Sound Check value, and track volume adjustment value (which is set using iTunes). After these interchanges, the iPod performs audio sample rate conversion internally and transfers digital audio to the accessory device at one of the device's supported audio data sample rates. For a sample command sequence that declares this lingo, see Table 3-273 (page 337).

**Note:** The iPod models that contain version 1.00 of the Digital Audio lingo do not correctly support digital audio. An accessory should check the attached iPod's version of the Digital Audio lingo and use digital audio only if the version number is greater than 1.00. See Table 1-2 (page 36) and Table 1-3 (page 37) for lists of affected iPod models.

## Accessory Authentication

Every accessory device that supports the Digital Audio lingo must authenticate itself with a connected iPod as soon as the iPod recognizes the device; deferred authentication is not permitted. This means that the accessory's IDPS process must specify authentication immediately after identification in its `IdentifyToken` (see Table 2-72 (page 112)). With iPods that do not support IDPS, the accessory must send an `IdentifyDeviceLingoes` command with the authentication control bits in its `options` field set to $10_b$ (Authenticate immediately after identification). See Table 2-34 (page 83) for details.

**Note:** The General lingo `Identify` command cannot be used to identify an accessory device for any purpose if the device supports the Digital Audio lingo.

When the accessory identifies itself as supporting the Digital Audio lingo, authentication can happen in the background and the iPod can proceed to transfer digital audio as if authentication were successful.

The Digital Audio lingo ID is 0x0A. All its commands are transferred in small packet format and all require authentication. They are listed in Table 3-217 (page 290).

**Table 3-217** Digital Audio lingo command summary

| ID | Command | Data length | Protocol version | Authentication required |
|---|---|---|---|---|
| 0x00 | `AccAck` | 0x04 | 1.00 | Yes |
| 0x01 | `iPodAck` | 0x04 | 1.00 | Yes |
| 0x02 | `GetAccSampleRateCaps` | 0x02 | 1.00 | Yes |
| 0x03 | `RetAccSampleRateCaps` | *NN* | 1.00 | Yes |
| 0x04 | `NewiPodTrackInfo` | 0x0E | 1.00 | Yes |
| 0x05 | `SetVideoDelay` | 0x06 | 1.03 | Yes |
| 0x06–0xFF | `Reserved` | N/A | N/A | N/A |

## USB Audio Transport

Digital audio on the iPod supports USB Audio 1.0, with the addition that it will transfer digital audio on a High-Speed USB 2.0 bus as well as on a Full-Speed USB 1.1 bus. During transport, the accessory is the USB host, the iPod is the USB device, and PCM data is synchronized with the 1 ms USB start-of-frame (SOF) packets. More information about USB and its standards is available at `http://www.usb.org`.

**Note:** The iPod USB isochronous audio data endpoint descriptor `bmAttributes` field erroneously returns the Synchronization Type field (D3:2) as b00 (no synchronization) instead of the correct value, b11 (synchronous). The iPod supports synchronous data transfers, so USB host devices must override these attribute bits. The erroneous b00 value is retained for backwards compatibility with older iPod accessories.

**Note:** Any accessory that outputs digital audio obtained from an iPod must implement copy protection in its output stream; for example, by setting Serial Copy Management System (SCMS) bits to 10.

When receiving digital audio over a USB audio streaming interface, the accessory may buffer data to achieve consistent audio playback. Since buffering introduces latency, it is suggested that this latency be kept below 200 ms to ensure timely response to user input. Apple may enforce this suggestion in the future.

### Digital Audio and Extended Interface Mode

Digital Audio lingo version 1.01 requires the iPod to be in Extended Interface mode before USB audio can be transferred. With versions 1.02 and later, USB audio can be transferred in any mode.

### Audio/Video Synchronization for Digital Audio

Digital Audio lingo versions 1.03 and above allow synchronization between iPod video and the sound for that video that is being transmitted as digital audio. The video may either appear on the iPod's display or be transmitted through the analog video output. For synchronization to occur, the accessory must use the `SetVideoDelay` command to send a fixed time (in milliseconds) that the iPod will add as a delay to its own video. The delay should be equal to the audio latency of the accessory; it corresponds to the difference between the time that digital audio data appears on the digital audio transport (USB) and the time the corresponding analog audio is sent to the speakers. The accessory must resend the `SetVideoDelay` command whenever its audio latency changes, for example at sample rate changes.

### Line Level Output and Digital Audio Transport

Line level output and digital audio transport are mutually exclusive. All iPod audio is sent to the LINE-OUT pins of the 30-pin connector until digital audio transport is enabled, at which point the iPod's audio output is redirected to the USB audio streaming interface. When digital audio transport is disabled, iPod audio is again sent to the LINE-OUT pins (see Table 3-1 (page 145)).

When disabling digital audio transport, the iPod does not automatically enter the playback Pause state, but instead continues in its current Play or Pause state. The only difference is that the output mode changes to LINE-OUT. If appropriate, the accessory should set the iPod to Pause when disabling digital audio.

## Enabling and Disabling USB Audio

Digital audio is enabled and LINE-OUT audio is disabled when:

- Version 1.01: The accessory selects a nonzero-bandwidth alternate USB audio streaming interface and enters Extended Interface mode.
- Version 1.02: The accessory replies to a `GetAccSampleRateCaps` command with a list of valid sample rates.

Digital audio is disabled and LINE-OUT audio is enabled when:

- Version 1.01: The accessory selects a zero-bandwidth alternate USB audio streaming interface, reidentifies itself without supporting the Digital Audio lingo, or disconnects from the USB Audio Configuration (that is, it disconnects the USB cable).
- Version 1.02: The accessory either reidentifies itself without supporting the Digital Audio lingo or disconnects from the USB Audio Configuration (that is, it disconnects the USB cable).

To enable USB audio, an iPod and its attached accessory must perform the following steps, in the order listed, after the user has connected the iPod to the accessory:

1. The iPod's USB enumeration lists two configurations: 1 = Mass Storage, 2 = USB Audio and HID device.
2. The device sends the USB standard request `Set_Configuration` to select configuration 2.
3. The accessory completes the IDPS identification process, declaring the General lingo and the Digital Audio lingo, plus the Extended Interface lingo if the iPod does not support Digital Audio lingo version 1.02. With iPods that do not support IDPS, the `IdentifyDeviceLingoes` command may be used. The iPod authenticates the device for the requested lingoes.
4. The device selects a nonzero-bandwidth alternate USB audio streaming interface on the iPod.
5. The device tells the iPod to enter Extended Interface Mode using the General lingo `EnterRemoteUIMode` command (not required for Digital Audio lingo version 1.02). If an audio track is playing, playback will pause. If a video track is playing, playback will stop.
6. The device places the iPod in the Play state.
7. The iPod sends a `NewiPodTrackInfo` command to the device.
8. The device acknowledges the `NewiPodTrackInfo` command using the `AccAck` command.
9. The device configures its playback DAC to the iPod's sample rate.
10. The device sends a USB audio `SET_CUR` request for the `SAMPLING_FREQ_CONTROL` control, passing a sample rate equal to the value sent by the `NewiPodTrackInfo` command.
11. The device requests digital audio packets from the isochronous USB pipe.

**Note:** Step 2 is slightly different if a 191 kΩ resistor is used as the identify resistor (see "Accessory Detect and Identify" in *iPod/iPhone Hardware Specifications*). In this case, the iPod will present the USB audio and HID device configuration as the first configuration, and the accessory will be required to select configuration 1 through the `Set_Configuration` USB standard request.

An example of the Digital Audio identification process is shown in Table 3-273 (page 337).

**Note:** With Digital Audio lingo version 1.01, switching from the zero bandwidth alternate USB audio streaming interface to the nonzero bandwidth interface without first exiting and entering Extended Interface Mode can prevent a `NewiPodTrackInfo` command from being sent from the iPod when a track change occurs. The accessory must not select the zero-bandwidth alternate interface on the iPod, even when changing sample rates, unless it is also exiting Extended Interface Mode.

With Digital Audio lingo version 1.01, reenabling digital audio after an accessory has disabled it requires the following actions:

1. Enable the nonzero-bandwidth alternate USB audio streaming interface on the iPod.
2. Enter Extended Interface Mode using the General lingo `EnterRemoteUIMode`. This will pause iPod playback.
3. Place the iPod in the Play state.
4. Receive a `NewiPodTrackInfo` command from the iPod.
5. Acknowledge the `NewiPodTrackInfo` command using the `AccAck` command.
6. Configure the accessory's playback DAC to the iPod's sample rate.
7. Send a USB audio `SET_CUR` request for the `SAMPLING_FREQ_CONTROL` control, passing a sample rate equal to the value sent by the `NewiPodTrackInfo` command.
8. Request digital audio packets from the isochronous USB pipe.

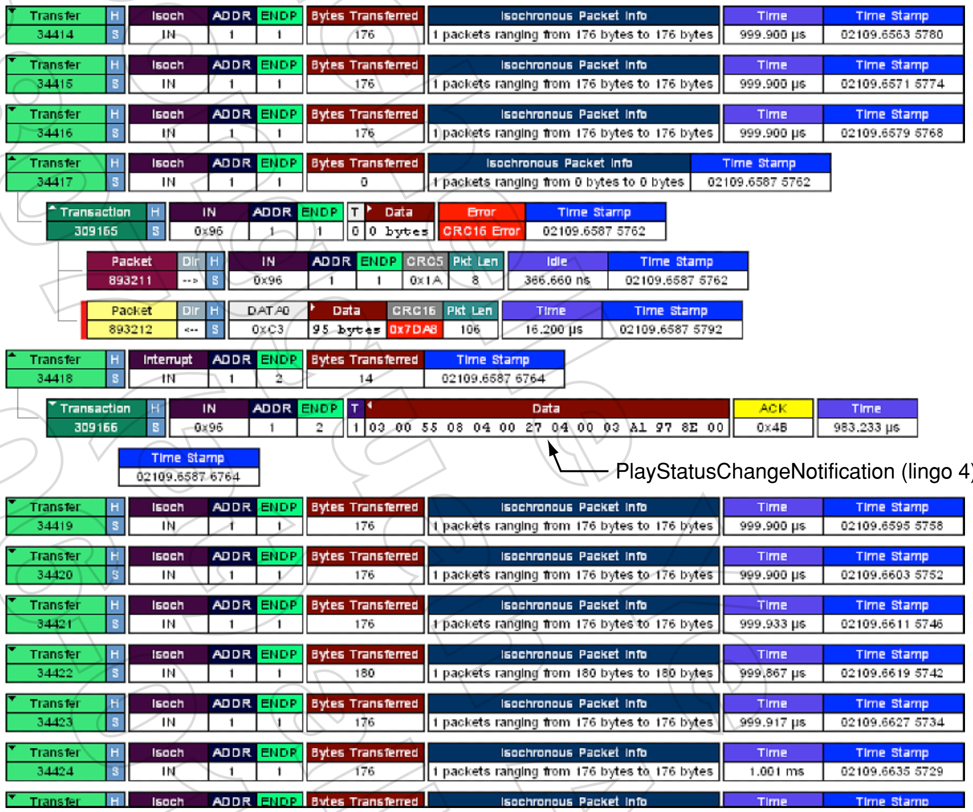
If the accessory requests digital audio data from the isochronous USB pipe before digital audio is enabled or before the correct digital sample rate has been negotiated, the iPod will return isochronous packets filled with zeros. The iPod will also return packets filled with zeros if authentication fails.

## USB Audio Errors on Older iPods

On first-generation nano and 5G iPods, USB Audio data from the iPod will occasionally contain 16-bit cyclic redundancy check (CRC16) errors. If iAP commands are sent from the iPod to a USB host while USB audio is enabled, there is a possibility that the USB audio DATA0 packet immediately preceding the iAP command will contain a CRC16 error. This error occurs infrequently; however, enabling iPod notifications over USB (such as the Lingo 0x04 `PlayStatusChangeNotification` command, which is sent every 500 ms when enabled) greatly increases the possibility that a CRC16 error will occur.

To resolve this problem, the USB host must be able to recover immediately from a CRC16 error in the payload of the isochronous USB audio data. Figure 3-1 (page 294) illustrates a typical recovery sequence.

**Figure 3-1** A USB host recovers from a CRC16 error




## Command History of the Digital Audio Lingo

Table 3-218 (page 294) shows the history of command changes in the Digital Audio lingo:

**Table 3-218** Digital Audio lingo command history

| Lingo version | Command changes | Features |
|---|---|---|
| 1.00 | Add: 0x00–0x04 | Digital audio sample rate and track information support |
| 1.01 | None | The `NewiPodTrackInfo` command is resent until it is acknowledged by the USB host with an `AccAck` command. Also corrected a bug where `NewiPodTrackInfo` was not being sent before every track; for this reason, accessories should not use Digital Audio with iPods that support only Digital Audio lingo version 1.00. |
| 1.02 | None | The Digital Audio lingo no longer requires the iPod to be in Extended Interface mode. |
| 1.03 | Add 0x05 | Added `SetVideoDelay` to allow digital audio to synchronize with video playback. |

## Command 0x00: AccAck

Direction: Device to iPod

The accessory sends the `AccAck` command to acknowledge the receipt of a command from the iPod and returns the command status (see Table 3-220 (page 295)). An `AccAck` command should be sent only for commands whose documentation specifies that an `AccAck` command is needed.

**Table 3-219** `AccAck` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART transport) |
| 1 | 0x55 | Start of packet |
| 2 | 0x04 | Length of packet payload |
| 3 | 0x0A | Lingo ID: Digital audio lingo |
| 4 | 0x00 | Command ID: `AccAck` |
| 5 | 0x*NN* | Command status. See Table 3-220 (page 295) |
| 6 | 0x*NN* | The ID for the command being acknowledged |
| 7 | 0x*NN* | Checksum |

**Table 3-220** `AccAck` status values

| status | Meaning |
|---|---|
| 0x00 | Success (OK) |
| 0x01 | Reserved |
| 0x02 | ERROR: Command failed |
| 0x03 | ERROR: Out of resources |
| 0x04 | ERROR: Bad parameter |
| 0x05 | ERROR: Unknown ID |
| 0x06 | Reserved |
| 0x07 | ERROR: Accessory not authenticated |
| 0x08–0xFF | Reserved |

## Command 0x01: iPodAck

Direction: iPod to Device

The iPod sends the `iPodAck` command when it receives an invalid or unsupported command or a bad parameter. The command status returns are the same as those used for the `AccAck` command (see Table 3-220 (page 295)).

**Table 3-221** `iPodAck` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART transport) |
| 1 | 0x55 | Start of packet |
| 2 | 0x04 | Length of packet payload |
| 3 | 0x0A | Lingo ID: Digital audio lingo |
| 4 | 0x01 | Command ID: `iPodAck` |
| 5 | 0x*NN* | Command status. See Table 3-220 (page 295) |
| 6 | 0x*NN* | The ID for the command being acknowledged |
| 7 | 0x*NN* | Checksum |

## Command 0x02: GetAccSampleRateCaps

Direction: iPod to Device

The iPod uses this command to request the list of supported sample rates from the accessory. The iPod sends it after the accessory indicates its support of the Digital Audio lingo during its identification process. The accessory responds to this command using the `RetAccSampleRateCaps` command.

After the iPod sends a `GetAccSampleRateCaps` command, it waits up to 3 seconds for a `RetAccSampleRateCaps` command from the accessory before timing out. If a timeout occurs, the iPod resends the command. It will resend the command up to three times if necessary, and if all three attempts fail, the iPod will then respond to any digital audio request with zeros.

If the iPod receives a `RetAccSampleRateCaps` command with invalid parameters, it sends the appropriate command status using an `iPodAck` command (see Table 3-220 (page 295)). At this point the accessory should send a `RetAccSampleRateCaps` with correct parameters. The iPod allows up to three retries if necessary, and if all three attempts fail, the iPod then responds to any digital audio request with zeros.

**Table 3-222** `GetAccSampleRateCaps` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART transport) |

| Byte number | Value | Comment |
|---|---|---|
| 1 | 0x55 | Start of packet |
| 2 | 0x02 | Length of packet payload |
| 3 | 0x0A | Lingo ID: Digital audio lingo |
| 4 | 0x02 | Command ID: `GetAccSampleRateCaps` |
| 5 | 0xF2 | Checksum |

## Command 0x03: RetAccSampleRateCaps

Direction: Device to iPod

An accessory sends the `RetAccSampleRateCaps` command in response to a `GetAccSampleRateCaps` command from an iPod.

The accessory returns the list of sample rates it supports with this command. The sample rates must be taken from the list of iPod supported sample rates shown in Table 3-224 (page 298). Any audio encoded at an unsupported sample rate is resampled internally by the iPod to conform to a supported sample rate. In general, audio quality will be better when no resampling is performed; therefore accessories should support as many values listed in Table 3-224 (page 298) as possible.

**Note:** At a minimum, every accessory must support the sample rates 32 KHz, 44.1 KHz, and 48 KHz.

A `RetAccSampleRateCaps` command with sample rates not listed in Table 3-224 (page 298), or missing any of the required sample rates, is invalid. If the iPod receives such a command, it sends the accessory an `iPodAck` command with a negative acknowledgment as the command status.

**Table 3-223** `RetAccSampleRateCaps` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART transport) |
| 1 | 0x55 | Start of packet |
| 2 | 2+4n | Length of packet payload |
| 3 | 0x0A | Lingo ID: Digital audio lingo |
| 4 | 0x03 | Command ID: `RetAccSampleRateCaps` |
| 5 ... (5+4n-1) | 0x*NNNNNNNN* | A list of *n* sample rates (32-bit big-endian format) supported by the accessory. The sample rates must be taken from Table 3-224 (page 298). |
| 5+4n | 0x*NN* | Checksum |

**Table 3-224** Digital audio sample rates supported by iPods (in Hertz)

| Decimal | Hexadecimal | Required/Optional |
|---|---|---|
| 8000 | 0x00001F40 | Optional |
| 11025 | 0x00002B11 | Optional |
| 12000 | 0x00002EE0 | Optional |
| 16000 | 0x00003E80 | Optional |
| 22050 | 0x00005622 | Optional |
| 24000 | 0x00005DC0 | Optional |
| 32000 | 0x00007D00 | Optional |
| 44100 | 0x0000AC44 | Required |
| 48000 | 0x0000BB80 | Required |

## Command 0x04: NewiPodTrackInfo

Direction: iPod to Device

The iPod sends the `NewiPodTrackInfo` command before the first audio track begins playing. It sends the command again whenever it starts playing a track with different sample rate, sound check, or track volume parameters. In response to this command, accessories should prepare themselves to receive audio data with the new parameters.

The accessory must acknowledge this command, using the `AccAck` command, but the iPod does not wait for this acknowledgment before allowing digital audio to be transferred to the accessory.

The sample rate sent to the accessory is taken from the list of sample rates returned to the iPod by the `RetAccSampleRateCaps` command. If the accessory supports the sample rate of the current audio track, then it is sent as the current sample rate. If the accessory does not support the sample rate, the iPod resamples the audio data to a supported sample rate in real time and sends this new supported sample rate as the current sample rate.

The Sound Check value and track volume adjustment value are the corresponding values set by iTunes, rounded to the nearest integer. The values represent gain (in decibels) and may be positive or negative. Note that if the Sound Check option in the iPod is disabled, the `NewiPodTrackInfo` command always sends 0 as the new Sound Check value.

When the iPod sends a `NewiPodTrackInfo` command, it waits up to 500 ms for the `AccAck` command before timing out. If a timeout occurs or if the `AccAck` returns an error as the command status, the iPod sends the command again.

**IMPORTANT:** The `NewiPodTrackInfo` command should not be used as a general mechanism to detect track changes. Use appropriate commands from the Display Remote or Extended Interface lingoes instead.

**Table 3-225** `NewiPodTrackInfo` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART transport) |
| 1 | 0x55 | Start of packet |
| 2 | 0x0E | Length of packet payload |
| 3 | 0x0A | Lingo ID: Digital audio lingo |
| 4 | 0x04 | Command ID: `NewiPodTrackInfo` |
| 5 | 0x*NN* | New sample rate, bits 31:24 |
| 6 | 0x*NN* | New sample rate, bits 23:16 |
| 7 | 0x*NN* | New sample rate, bits 15:8 |
| 8 | 0x*NN* | New sample rate, bits 7:0 |
| 9 | *0xNN* | New Sound Check value, bits 31:24 |
| 10 | *0xNN* | New Sound Check value, bits 23:16 |
| 11 | *0xNN* | New Sound Check value, bits 15:8 |
| 12 | *0xNN* | New Sound Check value, bits 7:0 |
| 13 | *0xNN* | New track volume adjustment, bits 31:24 |
| 14 | *0xNN* | New track volume adjustment, bits 23:16 |
| 15 | *0xNN* | New track volume adjustment, bits 15:8 |
| 16 | *0xNN* | New track volume adjustment, bits 7:0 |
| 17 | 0x*NN* | Checksum |

## Command 0x05: SetVideoDelay

Direction: Device to iPod

The device sends this command to inform the iPod of a new delay (in milliseconds) that must be applied to iPod video to synchronize it with the the audio for the currently playing video. See "Audio/Video Synchronization for Digital Audio" (page 291). The iPod responds to `SetVideoDelay` with a an "iPodAck" (page 296) command.

**Table 3-226** `SetVideoDelay` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART transport) |
| 1 | 0x55 | Start of packet |
| 2 | 0x06 | Length of packet payload |
| 3 | 0x0A | Lingo ID: Digital audio lingo |
| 4 | 0x05 | Command ID: `SetVideoDelay` |
| 5 | 0x*NN* | Video delay in milliseconds, bits 31:24 |
| 6 | 0x*NN* | Video delay in milliseconds, bits 23:16 |
| 7 | 0x*NN* | Video delay in milliseconds, bits 15:8 |
| 8 | 0x*NN* | Video delay in milliseconds, bits 7:0 |
| 9 | 0x*NN* | Checksum |

# Lingo 0x0C: Storage Lingo

The iAP Storage lingo, Lingo 0x0C, lets an accessory device store files on an attached iPod as if it were a hard drive. Use of the Storage lingo requires accessory authentication.

## Command History of the Storage Lingo

Table 3-227 (page 300) shows the history of command changes in the Storage lingo:

**Table 3-227** Storage lingo command history

| Lingo version | Command changes | Features |
|---|---|---|
| 1.01 | Add: 0x00-0x02, 0x04, 0x07-08, 0x10-0x12 | Support for iTunes Tagging. |
| 1.02 | Add:0x80-0x82. Add options to 0x12 | Add support for Sports lingo. |

## Command Summary

Table 3-228 (page 301) lists the Storage lingo commands.

**Table 3-228** Storage lingo commands

| CmdID | Name | Direction | Payload:bytes |
|---|---|---|---|
| 0x00 | iPodACK | iPod to Dev | [ackStatus:1, cmdID:1, handle:1, (transactionID:2)] |
| 0x01 | GetiPodCaps | Dev to iPod | [None] |
| 0x02 | RetiPodCaps | iPod to Dev | [totalSpace:8, maxFileSize:4, maxWriteSize:2, Reserved:6, majorVersion:1, minorVersion:1] |
| 0x03 | Reserved | | |
| 0x04 | RetiPodFileHandle | iPod to Dev | [handle:1] |
| 0x05-0x06 | Reserved | | |
| 0x07 | WriteiPodFileData | Dev to iPod | [offset:4, handle:1, data:<var>] |
| 0x08 | CloseiPodFile | Dev to iPod | [handle:1] |
| 0x09-0x0F | Reserved | | |
| 0x10 | GetiPodFreeSpace | Dev to iPod | [None] |
| 0x11 | RetiPodFreeSpace | iPod to Dev | [freeSpace:8] |
| 0x12 | OpeniPodFeatureFile | Dev to iPod | [feature: 0x*NN*] |
| 0x13-0x7F | Reserved | | |
| 0x80 | DeviceACK | Dev to iPod | [ackStatus:1, cmdID:1, handle:1 |
| 0x81 | GetDeviceCaps | iPod to Dev | [feature: 0x*NN*] |
| 0x82 | RetDeviceCaps | Dev to iPod | [feature: 0x*NN*] |
| 0x83-0xFF | Reserved | | |

The following is the typical sequence of commands used to store data on an iPod:

1. Complete the device identification and authentication processes, as specified in "Device Signaling and Initialization" (page 48), making sure to identify the accessory as supporting the Storage lingo.

2. Send GetiPodCaps and receive RetiPodCaps, which returns the maximum write size.

3. Send OpeniPodFeatureFile and receive RetiPodFileHandle. The returned file handle points to a specific area in the iPod's file system. Currently the only accessible area is /iPod_Control/Device/Accessories/Tags/, used by the Radio Tagging System (see "iTunes Tagging" (page 463)).

4. Send one or more WriteiPodFileData commands with the data to be stored. Receive an iPodACK command for each one.

5. Send `CloseiPodFile` when finished writing all the data. Alternately, all files are automatically closed when the accessory detaches.

**Note:** The accessory should use "Command 0x10: GetiPodFreeSpace" (page 307) to verify that there is adequate free space available on the iPod's drive before attempting to open or write data to a file. If there is less than 5 MB available, then calls to `OpeniPodFeatureFile` or `WriteiPodFileData` may fail for lack of memory. The recommended practice is to check the free space before opening or writing data, and to handle any out-of-memory ACK commands by retaining the data in internal storage and displaying an "iPod Full" message on the accessory's display.

## Command 0x00: iPodACK

Direction: iPod to Device

The iPod sends this command to acknowledge the receipt of a Storage lingo command from the accessory.

**Table 3-229** Storage `iPodACK` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x05 | Length of packet |
| 3 | 0x0C | Lingo ID: Storage lingo |
| 4 | 0x00 | Command ID: `iPodACK` |
| 5 | 0x*NN* | Command result status. See Table 3-230 (page 302). |
| 6 | 0x*NN* | The ID for the command being acknowledged. |
| 7 | 0x*NN* | The file handle for the command (0xFF if not applicable.) |
| 8 | 0x*NN* | Checksum |

**Table 3-230** iPodACK responses

| Value | Description |
|---|---|
| 0x00 | Success |
| 0x01 | N/A (reserved) |
| 0x02 | Command failed |
| 0x03 | Out of resources |
| 0x04 | Bad parameter |

| Value | Description |
|---|---|
| 0x05 | Unknown ID |
| 0x06 | N/A (reserved) |
| 0x07 | Not authenticated |
| 0x08 | Bad authentication version |
| 0x09 | N/A (reserved) |
| 0x0A | N/A (reserved) |
| 0x0B | N/A (reserved) |
| 0x0C | N/A (reserved) |
| 0x0D | Invalid file handle |
| 0x0E-0xFF | Reserved |

## Command 0x01: GetiPodCaps

Direction: Device to iPod

The accessory asks the iPod to return its storage capabilities. The iPod replies with `RetiPodCaps`.

**Table 3-231** `GetiPodCaps` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x02 | Length of packet |
| 3 | 0x0C | Lingo ID: Storage lingo |
| 4 | 0x01 | Command ID: `GetiPodCaps` |
| 5 | 0xF1 | Checksum |

## Command 0x02: RetiPodCaps

Direction: iPod to Device

The iPod tells the accessory about the iPod's storage capabilities:

- `totalSpace` is the amount of storage on the iPod in bytes, including space currently in use.

- `maxFileSize` is the largest possible size, in bytes, of any file on the iPod.
- `maxWriteSize` is the largest amount of data, in bytes, that can be written to the iPod in a single `WriteiPodFileData` command.
- `majorVersion` and `minorVersion` are the version number of the Storage lingo protocol implemented by the device.

**Table 3-232** `RetiPodCaps` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x18 | Length of packet |
| 3 | 0x0C | Lingo ID: Storage lingo |
| 4 | 0x02 | Command ID: `RetiPodCaps` |
| 5 | 0x*NN* | `totalSpace` (bits 63:56). The total amount of storage space on the iPod in bytes, including space currently in use. |
| 6 | 0x*NN* | `totalSpace` (bits 55:48) |
| 7 | 0x*NN* | `totalSpace` (bits 47:40) |
| 8 | 0x*NN* | `totalSpace` (bits 39:32) |
| 9 | 0x*NN* | `totalSpace` (bits 31:24) |
| 10 | 0x*NN* | `totalSpace` (bits 23:16) |
| 11 | 0x*NN* | `totalSpace` (bits 15:8) |
| 12 | 0x*NN* | `totalSpace` (bits 7:0) |
| 13 | 0x*NN* | `maxFileSize` (bits 31:24). The size in bytes of the largest possible file on the iPod. |
| 14 | 0x*NN* | `maxFileSize` (bits 23:16) |
| 15 | 0x*NN* | `maxFileSize` (bits 15:8) |
| 16 | 0x*NN* | `maxFileSize` (bits 7:0) |
| 17 | 0x*NN* | `maxWriteSize` (bits 15:8). The size in bytes of the largest possible amount of data than can be sent to the iPod with `WriteiPodFile`. |
| 18 | 0x*NN* | `maxWriteSize` (bits 7:0) |
| 19 | 0x*NN* | Reserved. |
| 20 | 0x*NN* | Reserved. |

| Byte number | Value | Comment |
|---|---|---|
| 21 | 0x*NN* | Reserved. |
| 22 | 0x*NN* | Reserved. |
| 23 | 0x*NN* | Reserved. |
| 24 | 0x*NN* | Reserved. |
| 25 | 0x*NN* | `majorVersion` (1 byte). The major version number. |
| 26 | 0x*NN* | `minorVersion` (1 byte). The minor version number. |
| 27 | 0x*NN* | Checksum |

## Command 0x04: RetiPodFileHandle

Direction: iPod to Device

The iPod returns a unique 8-bit handle to identify the file.

The value of `handle` is a session-specific identifier that represents a file. This is similar to a Unix file descriptor. The handle is valid until either the accessory is detached or the accessory sends a `CloseiPodFile` command with this handle.

**Table 3-233** `RetiPodFileHandle` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x03 | Length of packet |
| 3 | 0x0C | Lingo ID: Storage lingo |
| 4 | 0x04 | Command ID: `RetiPodFileHandle` |
| 5 | 0x*NN* | `handle` (1 byte) |
| 6 | 0x*NN* | Checksum |

## Command 0x07: WriteiPodFileData

Direction: Device to iPod

The accessory writes a block of data to a file starting at the offset passed with this command. The file must have been previously opened for writing; failure is reported as a bad parameter (see Table 3-230 (page 302)). If the file was not previously opened for writing, or the handle is invalid (invalid handle error), or the writeSize exceeds the iPod's capabilities (bad parameter error), then the operation will fail. If the caller attempts to write too much data, the state of the file will be undefined; some or none of the data may have been added to the file.

All data must be written sequentially, but write actions may occur across multiple WriteiPodFileData commands. The amount of data transferred must also be within the bounds set by the iPod's capabilities. If any of these criteria are not met, the iPod will return an iPodACK command with a failure message.

When a WriteiPodFileData command fails, the state of the file is left unknown. The accessory must close the file and then create a new file to write the data.

WriteiPodFileData passes the following parameters:

- offset is the offset (in bytes) into the file at which to begin writing.
- handle is a unique file identifier.
- data is the data to be written to the file.

**Table 3-234** WriteiPodFileData packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x*NN* | Length of packet |
| 3 | 0x0C | Lingo ID: Storage lingo |
| 4 | 0x07 | Command ID: WriteiPodFileData |
| 5 | 0x*NN* | offset (bits 31:24). The offset into the file at which to begin writing, in bytes. |
| 6 | 0x*NN* | offset (bits 23:16) |
| 7 | 0x*NN* | offset (bits 15:8) |
| 8 | 0x*NN* | offset (bits 7:0) |
| 9 | 0x*NN* | handle (1 byte). |
| 10...N | 0x*NN* | data (variable length). The file data. |
| (last byte) | 0x*NN* | Checksum |

## Command 0x08: CloseiPodFile

Direction: Device to iPod

This command closes a file and releases its handle. The handle is invalid for further use after this call, and the iPod may assign the handle later to represent a different file. An iPodACK command is sent on success or failure. Parameter handle is a unique file identifier.

**Table 3-235** `CloseiPodFile` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x03 | Length of packet |
| 3 | 0x0C | Lingo ID: Storage lingo |
| 4 | 0x08 | Command ID: `CloseiPodFile` |
| 5 | 0x*NN* | `handle` (1 byte). |
| 6 | 0x*NN* | Checksum |

## Command 0x10: GetiPodFreeSpace

Direction: Device to iPod

The accessory asks the iPod to return the amount of free space on its storage system. The iPod replies with `RetiPodFreeSpace`.

**Table 3-236** `GetiPodFreeSpace` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x02 | Length of packet |
| 3 | 0x0C | Lingo ID: Storage lingo |
| 4 | 0x10 | Command ID: `GetiPodFreeSpace` |
| 5 | 0xE2 | Checksum |

## Command 0x11: RetiPodFreeSpace

Direction: iPod to Device

The iPod tells the accessory the current amount of free space (in bytes) in its storage system.

**Table 3-237** `RetiPodFreeSpace` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x0A | Length of packet |
| 3 | 0x0C | Lingo ID: Storage lingo |
| 4 | 0x11 | Command ID: `RetiPodFreeSpace` |
| 5 | 0x*NN* | `freeSpace` (bits 63:56). The amount of the iPod's free space. |
| 6 | 0x*NN* | `freeSpace` (bits 55:48) |
| 7 | 0x*NN* | `freeSpace` (bits 47:40) |
| 8 | 0x*NN* | `freeSpace` (bits 39:32) |
| 9 | 0x*NN* | `freeSpace` (bits 31:24) |
| 10 | 0x*NN* | `freeSpace` (bits 23:16) |
| 11 | 0x*NN* | `freeSpace` (bits 15:8) |
| 12 | 0x*NN* | `freeSpace` (bits 7:0) |
| 13 | 0x*NN* | Checksum |

## Command 0x12: OpeniPodFeatureFile

Direction: Device to iPod

The accessory uses the `OpeniPodFeatureFile` command to open a feature file on the iPod. Table 3-238 (page 308) presents the format of the `OpeniPodFeatureFile` command packet.

In response, the iPod returns the `iPodACK` command with the operation status and, if the command succeeded, the feature file handle. If the feature type is not supported or the feature parameters are not valid, an `iPodACK` with bad parameter error status is returned. with an invalid file handle.

**Table 3-238** `OpeniPodFeatureFile` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of Packet (SOP) |
| 2 | 0xNN | Length of Packet |
| 3 | 0x0C | Lingo ID: Storage |

| Byte number | Value | Comment |
| --- | --- | --- |
| 4 | 0x12 | Command ID: OpeniPodFeatureFile |
| 5 | 0xNN | featureType |
| 6 | 0xNN | fileOptionsMask (bits 31:24) |
| 7 | 0xNN | fileOptionsMask (bits 23:16) |
| 8 | 0xNN | fileOptionsMask (bits 15:8) |
| 9 | 0xNN | fileOptionsMask (bits 7:0) |
| 10...N | 0xNN | `fileData` (maximum 128 bytes) data to be appended at close. `fileOptionsMask` bit 0 must be set if this field is nonzero length. |
| (last byte) | 0xNN | Checksum |

Table 3-239 (page 309) lists the current possible `featureType` values for the `OpeniPodFeatureFile` command packet.

**Table 3-239** featureType values

| featureType | Description |
| --- | --- |
| 0x00 | Reserved |
| 0x01 | Radio tagging (no `fileOptionsMask` or `fileData` can be passed) |
| 0x02 | Cardio equipment workout |
| 0x03-0xFF | Reserved |

Table 3-240 (page 309) lists the current possible `fileOptionsMask` values for the `OpeniPodFeatureFile` command.

**Table 3-240** fileOptionsMask values

| fileOptionsMask | Description |
| --- | --- |
| bit 0 | 1 = On feature file close or device detach, append the `fileData` binary file data bytes to the file. Note that `fileData` must be nonzero length if this bit is set.<br>0 = Do not append any bytes to the file. `fileData` must be zero length if this bit is zero. |
| bit 1 | 1 = On file close or device detach, append the XML <ipodInfo> element to the file (includes <openTime>, <closeTime>, <model>, <softwareVersion>, and <serialNumber>). This option is applied before the bit 0 option.<br>0 = Do not write <ipodInfo> element to file.<br>This option must be set when the XML Signature (bit 3) option is set = 1. |

| fileOptionsMask | Description |
|---|---|
| bit 2 | Reserved (must be 0). |
| bit 3 | 1 = On file close or device detach, insert an XML <Signature> element to the file. This option is applied after bit 0 and bit 1 options.<br>0 = Do not insert an XML <Signature> element.<br>When this option bit is set, the <ipodInfo> option (bit 1) must be set = 1. |
| bits 4-31 | Reserved (must be 0). |

## Command 0x80: DeviceACK

Direction: Device to iPod

The accessory must send the `DeviceACK` command to acknowledge the receipt of a Storage lingo command from the iPod. The accessory must respond with bad parameter status whenever a Storage lingo command in the range 0x83 to 0xFF is received from the iPod.

Table 3-241 (page 310) shows the format of the `DeviceACK` command packet.

**Table 3-241** `DeviceACK` packet

| Byte number | Value | |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x05 | Length of packet |
| 3 | 0x0C | Lingo ID: Storage |
| 4 | 0x80 | Command ID: `DeviceACK` |
| 5 | 0xNN | `ackStatus` of command |
| 6 | 0xNN | ID of Command being acknowledged |
| 7 | 0xFF | File Handle for Command (set to 0xFF for not applicable) |
| 8 | 0xNN | Checksum |

Table 3-242 (page 310) presents the possible values for the `ackStatus` byte.

**Table 3-242** ackStatus values

| ackStatus | Description |
|---|---|
| 0x00 | Success |

| ackStatus | Description |
|---|---|
| 0x01 | N/A (reserved) |
| 0x02 | Command failed |
| 0x03 | Out of resources |
| 0x04 | Bad parameter |
| 0x05-0xFF | Reserved |

## Command 0x81: GetDeviceCaps

Direction: iPod to Device

The `GetDeviceCaps` command may be sent by the iPod to ask the device to return its storage capabilities (if any). Table 3-243 (page 311) presents the format of the `GetDeviceCaps` command packet.The device replies with `RetDeviceCaps`.

**Table 3-243** `GetDeviceCaps` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of Packet (SOP) |
| 2 | 0x02 | Length of Packet |
| 3 | 0x0C | Lingo ID: Storage |
| 4 | 0x81 | Command ID: GetDeviceCaps |
| 5 | 0x71 | Checksum |

## Command 0x82: RetDeviceCaps

Direction: Device to iPod

The accessory must send the `RetDeviceCaps` command in response to a `GetDeviceCaps` command from the iPod to determine the storage capabilities supported by the device. Table 3-244 (page 311) presents the format of the `RetDeviceCaps` command packet.

**Table 3-244** `RetDeviceCaps` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of Packet (SOP) |

| Byte number | Value | Comment |
|---|---|---|
| 2 | 0x18 | Length of Packet |
| 3 | 0x0C | Lingo ID: Storage |
| 4 | 0x82 | Command ID: `RetDeviceCaps` |
| 5 - 23 | 0x00 | Reserved (must be 0x00) |
| 24 | 0xFF | Reserved (must be 0xFF) |
| 25 | 0xNN | Major Storage lingo protocol version supported by device (currently 0x01) |
| 26 | 0xNN | Minor Storage lingo protocol version supported by device (currently 0x02) |
| 27 | 0xNN | Checksum |

# Lingo 0x0E: Location Lingo

The National Marine Electronics Association (NMEA) has established a standard interface for transferring global positioning system (GPS) information. The NMEA *0183 Interface Standard,* Version 3.01 (released 2002/01), gives complete details about the sentence formats and contents.

The iAP Location lingo provides a mechanism by which NMEA sentences and other types of location information can be sent from accessories to attached iPods or iPhones. Thus the Location lingo lets an accessory that generates raw location data send the data to an iPod that collects, interprets, and displays it. Currently, only the iPhone OS 3.0 supports the Location lingo.

**Note:** Accessories that include GPS receivers must support the Location lingo in addition to any other lingoes they support.

## Location Data Requirements

Accessories that generate NMEA GPS location sentences must support at least the GPGGA sentence type, as defined in the *0183 Interface Standard*. The iPod also accepts the GPRMC sentence type; if the accessory supports it, the accessory must provide it to the iPod when using the Location lingo. The accessory may support additional NMEA sentence types, either standard or proprietary, and future iPod models may also support more sentence types.

For maximum quality of the user experience, accessories that generate NMEA GPS location sentences must enable filtering and pass to the iPod only sentence types that are in the filter list.

## Accessory Power Using the Location Lingo

Attached accessories that support the Location lingo are notified of iPod state changes, such as transitions between Power On and Hibernate. The accessory must keep its power consumption below the maximum allowed limits for each iPod state; see "iPod Power States and Accessory Power" (page 341). Accessory power will be off when the iPod hibernates; when the iPod wakes, the accessory must identify and authenticate itself, using the IDPS process specified in "Device Signaling and Initialization" (page 48).

Accessories that support the Location lingo may register for intermittent high power during their identification process. If so registered, they may draw up to 100 mA after receiving a `SetDevControl` command specifying GPS radio power on (see Table 3-258 (page 324)). Accessories must reduce their power consumption below 5 mA within 1 second of receiving a `SetDevControl` command specifying GPS radio power off. Regardless of the state of power set by the Location lingo, accessories must comply with iPod state changes as detailed in "iPod Power States and Accessory Power" (page 341).

## Command Summary

Certain prerequisites must be met for an iPhone OS 3.0 accessory to use the Location lingo:

- The accessory must identify itself through the Identify Device Preferences and Settings (IDPS) process, as specified in "Accessory Identification" (page 445).
- To send and receive Location lingo and IDPS commands, the accessory must be able to generate and interpret transaction IDs, as described in "Transaction IDs" (page 451), throughout the communication session.
- The accessory must perform Authentication 2.0, as described in "Authentication" (page 52). Location lingo commands are usable after the accessory enters the background authentication state.

> **Note:** With iPods that support wireless iAP over Bluetooth, an accessory need not be physically attached to an iPod to send it location information.

The iPod determines accessory capabilities by sending the Location lingo `GetDevCaps` command. A type parameter in this command specifies the type of capabilities queried. Capabilities type 0x00 requests the types of location services that the accessory supports and types 0x01–0x3F request details about the specific location services. Location capabilities include the following:

- Accessory general capabilties
- NMEA GPS location information (sentence filtering and GPGGA sentence generation are required).
- Location assistance information
- Asynchronous location notification control
- Capabilties specific to each location information type

Location lingo commands are extensible; new features, capabilities, and parameters may be added to future lingo versions. Lingo extensions will be made backward compatible so that existing implementations will continue to work. Accessory implementations must comply with the following rules to be compatible with future lingo versions:

- For all command responses, check for a packet length greater than or equal to the expected length. Do not check for an exact payload length, because this will fail after extensions are made. If the packet length is greater than expected, ignore any additional data.
- When reading lingo bitfield parameters, clear unrecognized bits to 0 before testing for feature bits.
- For other parameters, do range checks on their values and return a `DevACK` command with a bad parameter status (0x04) if a parameter is out of range.

> **Note:** iPods and accessories that support the Location lingo must initialize their control states to empty or disabled when the iPod-accessory connection is first established. Initializing the control state is effectively the same as receiving `SetDevControl` commands for all `locType` values, with `ctlData` set to 0x0 for each. This will ensure that for all `locType` values, notifications are disabled by default and accessories are in a low power state. One or more control states may be changed later, depending on the iPod's or accessory's capabilities and usage requirements.

Table 3-245 (page 314) lists the Location lingo commands.

**Table 3-245** Location lingo commands

| ID | Name | Direction | Parameters |
|---|---|---|---|
| 0x00 | `DevACK` | Dev to iPod | `{transID;2, cmdStatus;1, cmdIDOrig;1}` |
| 0x01 | `GetDevCaps` | iPod to Dev | `{transID;2, locType;1}` |
| 0x02 | `RetDevCaps` | Dev to iPod | `{transID;2, locType;1, capsData;<var>}` |
| 0x03 | `GetDevControl` | iPod to Dev | `{transID;2, locType;1}` |
| 0x04 | `RetDevControl` | Dev to iPod | `{transID;2, locType;1, ctlData;<var>}` |
| 0x05 | `SetDevControl` | iPod to Dev | `{transID;2, locType;1, ctlData;<var>}` |
| 0x06 | `GetDevData` | iPod to Dev | `{transID;2, locType;1, dataType;1}` |
| 0x07 | `RetDevData` | Dev to iPod | `{transID;2, locType;1, dataType;1, sectCur;2, sectMax;2, locData;<var>}` |
| 0x08 | `SetDevData` | iPod to Dev | `{transID;2, locType;1, dataType;1, sectCur;2, sectMax;2, locData;<var>}` |
| 0x09 | `AsyncDevData` | Dev to iPod | `{transID;2, locType;1, dataType;1, sectCur;2, sectMax;2, locData;<var>}` |
| 0x0A–0x7F | Reserved | | |
| 0x80 | `iPodACK` | iPod to Dev | `{transID;2, cmdStatus;1, cmdIDOrig;1}` |
| 0x81–0xFF | Reserved | | |

## A Typical Location Data Session

Table 3-246 (page 315) shows a typical exchange of commands by which an iPod may obtain location data from an accessory. The first time such session could take place would be after the iPod had acknowledged successful completion of the accessory identification process by sending `IDPSStatus` (see Accessory Identification (page 445)) and had begun the process of authenticating the accessory, as specified in "Authentication" (page 52).

**Table 3-246** Sample command interchange

| Step | Command | `locType` | `dataType` | Direction | Comments |
|---|---|---|---|---|---|
| 1 | `GetDevCaps` | 0x00 | | iPod to Dev | The iPod queries the accessory's system capabilities. |
| 2 | `RetDevCaps` | 0x00 | | Dev to iPod | The accessory returns its system capabilities. |
| 3 | `GetDevCaps` | 0x01 | | iPod to Dev | The iPod queries the accessory's NMEA GPS location capabilities. |
| 4 | `RetDevCaps` | 0x01 | | Dev to iPod | The accessory returns its NMEA GPS location capabilities. |
| 5 | `GetDevCaps` | 0x02 | | iPod to Dev | The iPod queries the accessory's location assistance capabilities. |
| 6 | `RetDevCaps` | 0x02 | | Dev to iPod | The accessory returns its location assistance capabilities. |
| 7 | `GetDevControl` | 0x00 | | iPod to Dev | The iPod queries the accessory's system control state. |
| 8 | `RetDevControl` | 0x00 | | Dev to iPod | The accessory returns its system control state. |
| 9 | `GetDevControl` | 0x01 | | iPod to Dev | The iPod queries the accessory's NMEA GPS location control state. |
| 10 | `RetDevControl` | 0x01 | | Dev to iPod | The accessory returns its NMEA GPS location control state. |
| 11 | `SetDevControl` | 0x00 | | iPod to Dev | The iPod sets the accessory's system control state for `locType` = 0x00 in accordance with the capabilities and controls sent to it by previous `RetDevCaps` and `RetDevControl` commands. |
| 12 | `DevACK` | | | Dev to iPod | The accessory acknowledges receipt of `SetDevControl`. |
| 13 | `SetDevData` | 0x01 | 0x00 | iPod to Dev | The iPod sets the NMEA sentence filter list string. |

| Step | Command | locType | dataType | Direction | Comments |
|---|---|---|---|---|---|
| 14 | DevACK | | | Dev to iPod | The accessory acknowledges receipt of SetDevData. |
| 15 | SetDevControl | 0x01 | | iPod to Dev | The iPod sets the accessory's system control state for locType = 0x01 in accordance with the capabilities and controls sent to it by previous RetDevCaps and RetDevControl commands. |
| 16 | DevACK | | | Dev to iPod | The accessory acknowledges receipt of SetDevControl. |
| 17 | GetDevData | 0x02 | 0x03 | iPod to Dev | The iPod requests the satellite ephemeris maximum refresh interval. |
| 18 | RetDevData | 0x02 | 0x03 | Dev to iPod | The accessory returns the satellite ephemeris maximum refresh interval. |
| 19 | GetDevData | 0x02 | 0x04 | iPod to Dev | The iPod requests the satellite ephemeris recommended refresh interval. |
| 20 | RetDevData | 0x02 | 0x04 | Dev to iPod | The accessory returns the satellite ephemeris recommended refresh interval. |
| 21 | AsyncDevData | 0x02 | 0x05 | Dev to iPod | The accessory sends a request for current GPS time of the system. |
| 22 | iPodACK | | | iPod to Dev | The iPod acknowledges receipt of the GPS time request. |
| 23 | AsyncDevData | 0x02 | 0x02 | Dev to iPod | The accessory sends an ephemeris URL to request an update to its ephemeris data. |
| 24 | iPodACK | | | iPod to Dev | The iPod acknowledges receipt of the satellite ephemeris data URL string. |
| 25 | SetDevData | 0x02 | 0x05 | iPod to Dev | The iPod sets the current GPS time of the accessory. |
| 26 | DevACK | | | Dev to iPod | The accessory acknowledges receipt of SetDevData. |
| 27 | SetDevData | 0x02 | 0x00 | iPod to Dev | The iPod sets the current location data on the accessory for use in looking up the satellite position within the ephemeris. |
| 28 | DevACK | | | Dev to iPod | The accessory acknowledges receipt of SetDevData. |

| Step | Command | locType | dataType | Direction | Comments |
|---|---|---|---|---|---|
| 29 | SetDevData | 0x02 | 0x01 | iPod to Dev | The iPod sets the accessory's ephemeris with data downloaded from the URL provided in Step 23. |
| 30 | DevACK | | | Dev to iPod | The accessory acknowledges receipt of SetDevData. |
| If multisection data, repeat Steps 29–30 as needed. See "Multisection Data Transfers" (page 459). | | | | | |
| 31 | AsyncDevData | 0x01 | 0x80 | Dev to iPod | The accessory begins sending location data to the iPod. |
| 32 | iPodACK | | | iPod to Dev | The iPod acknowledges receipt of AsyncDevData. |
| If multisection data, repeat Steps 31–32 as needed. See "Multisection Data Transfers" (page 459). | | | | | |

## Command 0x00: DevACK

Direction: Accessory to iPod

This command is sent by the accessory in response to a command sent from the iPod. It has two forms:

- The Section form is sent if the command from the iPod is part of a multisection data transfer. This form of the command is discussed in "Multisection DevACK Command" (page 460).
- The Default form, shown in Table 3-247 (page 317), is sent under these conditions:
  - When a bad parameter is received, an unsupported or invalid command is received, or a command that does not return any data has completed.
  - To indicate completion of a multisection data transfer, as described in "Multisection Data Transfers" (page 459).

**Table 3-247** Default DevACK packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x06 | Length of packet payload |
| 3 | 0x0E | Lingo ID: Location lingo |
| 4 | 0x00 | Command ID: DevACK |
| 5 | 0x*NN* | transID [bits 15:8]: Transaction ID of command being acknowledged; see "Transaction IDs" (page 451) |

| Byte number | Value | Comment |
|---|---|---|
| 6 | 0x*NN* | `transID` [bits 7:0] |
| 7 | 0x*NN* | `ackStatus`: Status return; possible values are listed in Table 3-248 (page 318) |
| 8 | 0x*NN* | `cmdIDOrig`: Original command ID for which this response is being sent. |
| 9 | 0x*NN* | Checksum |

**Table 3-248** Valid Location lingo ackStatus values

| Value | Meaning |
|---|---|
| 0x00 | Command OK |
| 0x02 | Command failed (valid command but did not succeed) |
| 0x03 | Out of resources (iPod internal allocation failed) |
| 0x04 | Bad parameter (invalid command or input parameters) |
| 0x06 | Reserved |
| 0x0F | Command timeout |
| 0x13 | Section of multisection data transfer received successfully (see "Multisection Data Transfers" (page 459)) |

## Command 0x01: GetDevCaps

Direction: iPod to Accessory

This command is sent by the iPod to get the accessory's capabilities. In response, the accessory sends a `RetDevCaps` command with the same `transactionID`, the capability type, and the requested capability data. If a specified `locType` is not supported, a `DevACK` must be returned with the bad parameter (0x04) status. Accessory support for capability type 0x00 (system caps) is mandatory; other capability types are optional. The iPod requests the system caps from the accessory to determine its lingo version, system capabilities, and the other location types supported by the accessory. The accessory must send a corresponding `RetDevCaps` within 500 ms in response to the `GetDevCaps` command from the iPod.

**Table 3-249** GetDevCaps packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x05 | Length of packet payload |
| 3 | 0x0E | Lingo ID: Location lingo |

| Byte number | Value | Comment |
|---|---|---|
| 4 | 0x01 | Command ID: `GetDevCaps` |
| 5 | 0x*NN* | `transID` [bits 15:8]: Transaction ID; see "Transaction IDs" (page 451) |
| 6 | 0x*NN* | `transID` [bits 7:0] |
| 7 | 0x*NN* | `locType`: The capability type; see Table 3-250 (page 319). |
| 8 | 0x*NN* | Checksum |

**Table 3-250** Values for locType

| Value | Meaning |
|---|---|
| 0x00 | System capabilities; see Table 3-252 (page 320). |
| 0x01 | NMEA GPS location capabilities; see Table 3-253 (page 321). |
| 0x02 | Location assistance capabilities; see Table 3-254 (page 321). |
| 0x03–0x3F | Reserved |
| 0x40–0xFF | Invalid |

## Command 0x02: RetDevCaps

Direction: Accessory to iPod

The accessory sends this command in response to a `GetDevCaps` command from the iPod, returning the transaction ID and the requested capabilities type. It informs the iPod of its capabilities in `capsData`. If an accessory does not support a particular capability type, it must return a `DevACK` command with a bad parameter (0x04) status.

The `capsData` fields may be extended in the future as new features are added to the Location lingo. iPods receiving this command check for a minimum packet payload length (rather than an exact payload length) and parse only the supported fields, ignoring any additional data that may be appended.

**Table 3-251** RetDevCaps packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x*NN* | Length of packet payload |
| 3 | 0x0E | Lingo ID: Location lingo |
| 4 | 0x02 | Command ID: `RetDevCaps` |

| Byte number | Value | Comment |
|---|---|---|
| 5 | 0x*NN* | `transID` [bits 15:8]: Transaction ID; see "Transaction IDs" (page 451) |
| 6 | 0x*NN* | `transID` [bits 7:0] |
| 7 | 0x*NN* | `locType`: The capability type; see Table 3-250 (page 319). |
| 8–*NN* | 0x*NN* | `capsData`: Capabilities data; see Table 3-252 (page 320), Table 3-253 (page 321), and Table 3-254 (page 321). The contents and length of this parameter depend on the value of `locType`. |
| *NN*+1 | 0x*NN* | Checksum |

**Table 3-252** System capabilities values (locType = 0x00)

| Name | Size in bytes | Bits | Meaning |
|---|---|---|---|
| `devVerMajor` | 1 | Bits 7:0 | Location lingo major version supported by the accessory |
| `devVerMinor` | 1 | Bits 7:0 | Location lingo minor version supported by the accessory |
| `sysCapsMask` | 8 | System capabilities (big-endian): | |
| | | Bit 00 | 1 = Power management control support; iPod-powered accessories must set this bit to allow power control by the iPod. |
| | | Bit 01 | Reserved; set to 0. |
| | | Bit 02 | 1 = Asynchronous location notification support |
| | | Bits 63:03 | Reserved; set to 0. |
| `locCapsMask` | 8 | Location type support (big-endian): | |
| | | Bit 00 | 1 = System support; must be set to 1. |
| | | Bit 01 | 1 = NMEA GPS location support (see **Note** below) |
| | | Bit 02 | 1 = Location assistance support; either this bit or bit 01 must be set |
| | | Bits 63:03 | Reserved; set to 0. |

**Note:** Accessories that generate NMEA GPS location sentences must support at least the GPGGA sentence type. The iPod also accepts the GPRMC sentence type; if the accessory supports it, the accessory must provide it to the iPod when using the Location lingo. The accessory may support additional NMEA sentence types, either standard or proprietary. Sentences must be generated at intervals compliant with the NMEA *0183 Interface Standard,* unless overridden by system controls or NMEA sentence filtering.

**Table 3-253** NMEA GPS location capabilities values (locType = 0x01)

| Name | Size in bytes | Bits | Meaning |
|---|---|---|---|
| `nmeaGpsCaps` | 8 | Bit 00 (big-endian) | Must be set to 1 to indicate NMEA GPS sentence filtering supported; the accessory must support a minimum filter list string length of 128 bytes. |
| | | Bits 63:01 | Reserved; set to 0. |

**Table 3-254** Location assistance capabilities values (locType = 0x02)

| Name | Size in bytes | Bits | Meaning |
|---|---|---|---|
| `locAsstData` | 8 | Location assistance data types supported; the accessory's most recent `RetDevCaps` command must set the `sysCapsMask` capability bit 01 if one or more of the following bits are set (see Table 3-252 (page 320)): | |
| | | Bit 00 (big-endian) | Reserved; set to 0. |
| | | Bit 01 | Satellite ephemeris data required, for faster location fix. This bit must be set if bit 02 is set. |
| | | Bit 02 | Satellite ephemeris data URL string (RFC 1738 compliant). This bit must be set if bit 01 is set. The accessory must supply a Web URL string for the iPod to use to download ephemeris data and must accept that data when it is set by the iPod (see Command 0x06: GetDevData (page 325) and Command 0x08: SetDevData (page 328)). |
| | | Bit 03 | Satellite position ephemeris data maximum refresh interval. If the accessory's long-term ephemeris degrades over time, this indicates the maximum amount of time during which downloaded data will be valid. |
| | | Bit 04 | Satellite position ephemeris data recommended refresh interval. If the accessory's long term ephemeris degrades over time, this indicates the recommended amount of time before a new download is needed. |
| | | Bits 63:05 | Reserved; set to 0. |

## Command 0x03: GetDevControl

Direction: iPod to Accessory

This command is sent by the iPod to get the accessory's control state. In response, the accessory must send a `RetDevControl` command within 500 ms, passing the same transaction ID and location type plus the accessory's control state information. A control type is supported only if the accessory's most recent `RetDevCaps` command set the `locCapsMask` capability bit. If the accessory receives an unsupported control type, it must return a `DevACK` command with a bad parameter (0x04) status.

**Table 3-255** GetDevControl packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x05 | Length of packet payload |
| 3 | 0x0E | Lingo ID: Location lingo |
| 4 | 0x03 | Command ID: `GetDevControl` |
| 5 | *NN* | `transID` [bits 15:8]: Transaction ID; see "Transaction IDs" (page 451) |
| 6 | *NN* | `transID` [bits 7:0] |
| 7 | *NN* | `locType`: The location control type; see Table 3-250 (page 319). |
| 8 | *NN* | Checksum |

## Command 0x04: RetDevControl

Direction: Accessory to iPod

This command is sent by the accessory in response to a `GetDevControl` command received from the iPod. The transaction ID and control type received from `GetDevControl` must be returned with this command, along with the accessory's current control state of the specified control type. System control support is required for every accessory.

**Note:** The `RetDevControl` `ctlData` fields may be extended in the future as new features are added. iPods receiving this command check for a minimum packet payload length (rather than an exact payload length) and parse only the supported fields, ignoring any unrecognized additional data that may be appended.

**Table 3-256** RetDevControl packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |

| Byte number | Value | Comment |
|---|---|---|
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x0D | Length of packet payload |
| 3 | 0x0E | Lingo ID: Location lingo |
| 4 | 0x04 | Command ID: `RetDevControl` |
| 5 | 0x*NN* | `transID` [bits 15:8]: Transaction ID; see "Transaction IDs" (page 451) |
| 6 | 0x*NN* | `transID` [bits 7:0] |
| 7 | 0x*NN* | `locType`: The location control type; see Table 3-250 (page 319). |
| 8–15 | 0x*NNNNNNNNNNNNNNNN* | `ctlData`: System control data, depending on the value of `locType`; see Table 3-258 (page 324). |
| 16 | 0x*NN* | Checksum |

## Command 0x05: SetDevControl

Direction: iPod to Accessory

This command is sent by the iPod to set the accessory's control state. In response, the accessory must send a `DevACK` command within 500 ms, passing the same transaction ID and the status of the operation. Control types are valid only if the accessory's most recent `RetDevCaps` command set the associated `RetDevCaps` `locCapsMask` location type bits. If the iPod tries to set reserved or unsupported control types or data, the accessory must return a `DevACK` command with the bad parameter (0x04) status.

Accessories that support the Location lingo may register for intermittent high power during their identification process. If so registered, they may draw up to 100 mA after receiving this command with a `ctlData` value specifying GPS radio power on; see Table 3-258 (page 324). Accessories must reduce their power consumption below 5 mA within 1 second of receiving this command with a `ctlData` value specifying GPS radio power off. Regardless of the state of power set by the Location lingo, accessories must comply with iPod state changes as detailed in "iPod Power States and Accessory Power" (page 341).

> **Note:** The `SetDevControl` `ctlData` fields may be extended in the future as new features are added. iPods implementing the Location lingo check for a minimum packet payload length (rather than an exact payload length) and parse only the supported fields, ignoring any unrecognized additional data that may be appended.

**Table 3-257** SetDevControl packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |

| Byte number | Value | Comment |
|---|---|---|
| 2 | 0x0D | Length of packet payload |
| 3 | 0x0E | Lingo ID: Location lingo |
| 4 | 0x05 | Command ID: `SetDevControl` |
| 5 | 0x*NN* | `transID` [bits 15:8]: Transaction ID; see "Transaction IDs" (page 451) |
| 6 | 0x*NN* | `transID` [bits 7:0] |
| 7 | 0x*NN* | `locType`: The location control type; see Table 3-250 (page 319). |
| 8–15 | 0x*NNNNNNNNNNNNNNNN* | `ctlData`: The accessory controls to be set; see Table 3-258 (page 324). |
| 16 | 0x*NN* | Checksum |

**Table 3-258** ctlData values

| `locType` | Name | Bits | Meaning |
|---|---|---|---|
| 0x00 | `sysCtl` | System control data: | |
| | | Bits 01:00 | Accessory GPS radio power and notify control state: |
| | | | 00: Power off; the accessory must turn its GPS radio power off when this control state is set. If the accessory is using iPod power, it must reduce its current consumption to 5 mA or less within 1 second of receiving `SetDevControl`. |
| | | | 01–10: Reserved |
| | | | 11: Power on; the accessory must turn its GPS radio power on when this control state is set. If the accessory is using iPod power, it may draw up to 100 mA after receiving `SetDevControl`. |
| | | Bit 02 | 1 = Asynchronous location notifications enabled, 0 = notifications disabled. |
| | | Bits 63:03 | Reserved; set to 0. |
| 0x01 | `nmeaGpsCtrl` | Bit 00 | When set to 1, NMEA GPS sentence filtering is enabled. When set to 0, NMEA GPS filtering is disabled; if asynchronous location notifications are enabled, all sentences must be passed to the iPod. |
| | | Bits 63:01 | Reserved; set to 0. |
| 0x02–0x3F | Reserved | | |

| locType | Name | Bits | Meaning |
|---|---|---|---|
| 0x40–0xFF | Invalid | | |

## Command 0x06: GetDevData

Direction: iPod to Accessory

This command is sent by the iPod to get location data of a specific type from the accessory. In response, the accessory sends a `RetDevData` command with the same transaction ID, location type, and the requested location data information. The accessory must send the corresponding `RetDevData` command within 500 ms after receiving a `GetDevData` command from the iPod. In the case of multi-section responses, accessories must send each subsequent section within 500 ms of sending the previous section.

**Table 3-259** GetDevData packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x06 | Length of packet payload |
| 3 | 0x0E | Lingo ID: Location lingo |
| 4 | 0x06 | Command ID: `GetDevData` |
| 5 | 0x*NN* | `transID` [bits 15:8]: Transaction ID; see "Transaction IDs" (page 451) |
| 6 | 0x*NN* | `transID` [bits 7:0] |
| 7 | 0x*NN* | `locType`: The capability type; see Table 3-250 (page 319). |
| 8 | 0x*NN* | `dataType`: Location data type; See Table 3-260 (page 325). |
| 9 | 0x*NN* | Checksum |

**Table 3-260** GetDevData dataType values

| locType | Name | Data type | Meaning |
|---|---|---|---|
| 0x00–0x01 | Reserved | | |
| 0x02 | `locAsstData` | Location assistance data; this data is available only if the accessory's most recent `RetDevCaps` command set the `locCapsMask` capability bit 01. The specific location data types are valid only if the associated `RetDevCaps` `locAssistance` bits were also set. | |
| | | 0x00–0x02 | Reserved |

| locType | Name | Data type | Meaning |
|---|---|---|---|
| | | 0x03 | Satellite ephemeris data maximum required refresh interval. If the accessory's long-term ephemeris degrades over time, this indicates the maximum amount of time during which downloaded data will be valid. |
| | | 0x04 | Satellite ephemeris data recommended refresh interval. If the accessory's long-term ephemeris degrades over time, this indicates the recommended amount of time before a new download is needed. |
| | | 0x05–0xFF | Reserved |
| 0x03–0x3F | Reserved | | |
| 0x40–0xFF | Invalid | | |

## Command 0x07: RetDevData

Direction: Accessory to iPod

This command is sent by the accessory in response to a `GetDevData` command received from the iPod, returning its transaction ID, `locType`, and `dataType`, indicating the data type requested. The `locData` field is variable in length, based on the location data types listed in Table 3-260 (page 325). The iPod acknowledges `RetDevData` with an `iPodACK` command.

The iPod has a maximum input data payload size of 500 bytes including the transaction ID. If the `locData` value sent by the accessory exceeds this size, it must be split into multiple sections as described in Multisection Data Transfers (page 459).

**Table 3-261** RetDevData packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x*NN* | Length of packet payload |
| 3 | 0x0E | Lingo ID: Location lingo |
| 4 | 0x07 | Command ID: `RetDevData` |
| 5 | 0x*NN* | `transID` [bits 15:8]: Transaction ID; see "Transaction IDs" (page 451) |
| 6 | 0x*NN* | `transID` [bits 7:0] |
| 7 | 0x*NN* | `locType`: The capability type; see Table 3-262 (page 327). |

| Byte number | Value | Comment |
|---|---|---|
| 8 | 0x*NN* | `dataType`: Location data type; see Table 3-262 (page 327). |
| 9 | 0x*NN* | `sectCur` [bits 15:8]: Current payload section index (0x0000 = first or only section) |
| 10 | 0x*NN* | `sectCur` [bits 7:0] |
| 11 | 0x*NN* | `sectMax` [bits 15:8]: Maximum payload section index (0x0000 = only section, 0x*NNNN* = maximum or last section) |
| 12 | 0x*NN* | `sectMax` [bits 7:0] |
| 13 | 0x*NN* | `totSize` [bits 31:24]: Total size of `locData` in bytes. If multiple `RetDevData` packets are sent, the `totSize` field is included only in the first packet (`sectCur` = 0x0000). |
| 14 | 0x*NN* | `totSize` [bits 23:16] |
| 15 | 0x*NN* | `totSize` [bits 15:8] |
| 16 | 0x*NN* | `totSize` [bits 7:0] |
| 13–*NN* or 17–*NN* | <*var*> | `locData`: See Table 3-262 (page 327). |
| (last byte) | 0x*NN* | Checksum |

**Table 3-262** RetDevData locData values

| `locType` | Name | Meaning |
|---|---|---|
| 0x00–0x01 | Reserved | |
| 0x02 | `locAsstData` | Location assistance data: see Table 3-263 (page 327). This data type is valid only if the accessory's most recent `RetDevCaps` command set the `sysCapsMask` capability bit 01. |
| 0x03–0x3F | Reserved | |
| 0x40–0xFF | Invalid | |

**Table 3-263** locAsstData values (locType = 0x02) for RetDevData

| `dataType` | Bytes | Field | Bytes | Subfield | Bytes | Value |
|---|---|---|---|---|---|---|
| 0x00–0x02 | Reserved. | | | | | |
| 0x03 | 4 | Satellite position ephemeris data maximum refresh interval, in milliseconds. Ephemeris data must be refreshed at least as often as this interval. This field must be sent in a single packet (`sectCur` = 0x0000 and `sectMax` = 0x0000). | | | | |

| dataType | Bytes | Field | Bytes | Subfield | Bytes | Value |
|---|---|---|---|---|---|---|
| 0x04 | 4 | Satellite position ephemeris data recommended refresh interval, in milliseconds. Ephemeris data should be refreshed at least as often as this interval. This field must be sent in a single packet (sectCur = 0x0000 and sectMax = 0x0000). Its value must be less than or equal to the maximum refresh interval (dataType 0x03). | | | | |
| 0x05–0x3F | Reserved. | | | | | |
| 0x40–0xFF | Invalid. | | | | | |

## Command 0x08: SetDevData

Direction: iPod to Accessory

This command is sent by the iPod to set location data on the accessory. In response, the accessory must return a DevACK command within 500 ms with the received transaction ID and the status of this operation. This time limit applies to both single and multisection responses. The dataType field represents the data type to be set; only certain data types, listed in Table 3-265 (page 329), can be set. The locData field is variable in length, based on the location data types listed in Table 3-267 (page 330).

The accessory should return its maximum payload size in its IDPS accInfo token; see Table 2-76 (page 114). If the accessory does not specify a maximum payload size, the iPod assumes a default size of 1024 bytes. If the locData value to be sent by the iPod exceeds this size, it will be split into multiple sections as described in Multisection Data Transfers (page 459).

**Table 3-264** SetDevData packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x*NN* | Length of packet payload |
| 3 | 0x0E | Lingo ID: Location lingo |
| 4 | 0x08 | Command ID: SetDevData |
| 5 | 0x*NN* | transID [bits 15:8]: Transaction ID; see "Transaction IDs" (page 451) |
| 6 | 0x*NN* | transID [bits 7:0] |
| 7 | 0x*NN* | locType: The capability type; see Table 3-265 (page 329). |
| 8 | 0x*NN* | dataType: the data types that can be set are listed in Table 3-265 (page 329). |
| 9 | 0x*NN* | sectCur [bits 15:8]: Current payload section index (0x0000 = first or only section) |
| 10 | 0x*NN* | sectCur [bits 7:0] |

| Byte number | Value | Comment |
|---|---|---|
| 11 | 0x*NN* | `sectMax` [bits 15:8]: Maximum payload section index (0x0000 = only section, 0x*NNNN* = maximum or last section) |
| 12 | 0x*NN* | `sectMax` [bits 7:0] |
| 13 | 0x*NN* | `totSize` [bits 31:24]: Total size of `locData` in bytes. If multiple `SetDevData` packets are sent, the `totSize` field is included only in the first packet (`sectCur` = 0x0000). |
| 14 | 0x*NN* | `totSize` [bits 23:16] |
| 15 | 0x*NN* | `totSize` [bits 15:8] |
| 16 | 0x*NN* | `totSize` [bits 7:0] |
| 13–*NN* or 17–*NN* | <*var*> | `locData`: see Table 3-267 (page 330). |
| (last byte) | 0x*NN* | Checksum |

**Table 3-265** Data types settable by SetDevData

| `locType` | `dataType` | Description |
|---|---|---|
| 0x01 | 0x00 | NMEA sentence filter list string; see Table 3-266 (page 329). |
| 0x02 | 0x00 | Current point location data; see Table 3-267 (page 330). |
| 0x02 | 0x01 | Satellite ephemeris data; see Table 3-267 (page 330). |
| 0x02 | 0x05 | Current GPS time on accessory; see Table 3-267 (page 330). |

**Table 3-266** nmeaGpsLocData values (locType = 0x01)

| `dataType` | Value |
|---|---|
| 0x00 | NMEA sentence filter list string, a comma-delimited set of NMEA standard and/or proprietary uppercase acronyms for sentence types. The accessory must support a filter string of at least 128 bytes. Depending on the string length, the iPod may split this command into multiple sections. Only the last section will include the string null terminator.<br>An example sentence list string could be `GPGGA,GPRMC`, specifying the two sentence types to be enabled. The accessory must not send sentence types not in the filter list. A string consisting of only the null terminator disables the sending of all NMEA sentences by the accessory. |
| 0x01–0xFF | Reserved |

**Table 3-267** locAsstData values (locType = 0x02) for SetDevData

| dataType | Bytes | Field | Bytes | Subfield | Bytes | Value |
|---|---|---|---|---|---|---|
| 0x00 | 16 | Current point location data; must be sent as a single packet (`sectCur` = 0x0000 and `sectMax` = 0x0000). See **Note,** below. | | | | |
| | | `locWeek` | 2 | | | GPS Week number. The 13 least significant bits comprise a modulo-8192 representation of the current GPS Week number, as defined by IS-GPS-200 PIRN-002, Section 30.3.3.1.1.1. The GPS Week Number count began at UTC midnight Saturday-Sunday January 5-6, 1980. Since then the count has been broadcast as part of the GPS message and has incremented by 1 each UTC Saturday-to-Sunday transition. The GPS Week number will roll over in the year 2137. The week containing Tuesday, April 28, 2009 is GPS Week 1,529. |
| | | `locTime` | 4 | | | GPS Time of Week. The 30 least significant bits represent the time when the location point was determined. This is measured as milliseconds in the week from the last UTC Saturday-to-Sunday transition, a number between 0 and 604,800,000. |
| | | `locPoint` | 8 | | | Current location point in millionths of a degree latitude and longitude |
| | | | | `latDegArc` | 4 | Signed 32-bit latitude: 0x00000000 = ±0° (Equator), 0x055D4A80 = +90° (maximum north), 0xFAA2B580 = –90° (maximum south). |
| | | | | `lonDegArc` | 4 | Signed 32-bit longitude: 0x00000000 = ±0° (Greenwich meridian), 0x0ABA9500 = +180.000000° (maximum east), 0xF5456B01 = –179.999999° (maximum west). |
| | | `locAccuracy` | 2 | | | Location accuracy radius |
| | | | | `locRadius` | 2 | Point location accuracy radius in meters; a smaller radius number means a more accurate point location |
| 0x01 | *<var>* | `ephData` | *<var>* | | | Satellite ephemeris data. This data does not have a standard format and is not parsed by the Location lingo. |
| 0x02–0x04 | Reserved. | | | | | |
| 0x05 | 6 | The iPod's current GPS time. | | | | |

| dataType | Bytes | Field | Bytes | Subfield | Bytes | Value |
|---|---|---|---|---|---|---|
| | | locWeek | 2 | | | GPS Week number. The 13 least significant bits comprise a modulo-8192 representation of the iPod's current GPS Week number, as defined by IS-GPS-200 PIRN-002, Section 30.3.3.1.1.1. The GPS Week Number count began at UTC midnight Saturday-Sunday January 5-6, 1980. Since then the count has been broadcast as part of the GPS message and has incremented by 1 each UTC Saturday-to-Sunday transition. The GPS Week number will roll over in the year 2137. The week containing Tuesday, April 28, 2009 is GPS Week 1,529. |
| | | locTime | 4 | | | GPS Time of Week. The 30 least significant bits represent the iPod's current GPS time. This is measured as milliseconds in the week from the last UTC Saturday-to-Sunday transition, a number between 0 and 604,800,000. |
| 0x06–0x3F | Reserved. | | | | | |
| 0x40–0xFF | Invalid. | | | | | |

**Note:** The iPod pushes system GPS time and point location data to the accessory, to be used in conjunction with ephemeris data. The GPS time of the iPod's point location data may be significantly behind system time, because it represents the last location lock that the iPod was able to achieve. When calculating its reference into ephemeris data, the accessory should consider both the system time and the point location time to validate the iPod's data.

The iPod pushes system time to the accessory when launching location services or in response to accessory inquiries. Once ephemeris data has been requested the iPod continues to push point location data asynchronously, as the data accuracy changes. It also delivers updated ephemeris data periodically, as available, after the accessory makes its initial request.

## Command 0x09: AsyncDevData

Direction: Accessory to iPod

This command is sent by the accessory to notify the iPod that location data is available. It is valid only if the accessory supports asynchronous notifications (see Table 3-258 (page 324)) and the notification category has been enabled by a `SetDevControl` command. The `dataType` field represents the data type being sent; the currently valid types are listed in Table 3-269 (page 333). The `locData` field is variable in length, depending on the data being sent.

No iAP command may exceed a value of 500 bytes in its length-of-packet-payload field. If the `locData` value sent by the accessory exceeds this size, it must be split into multiple sections with the same transaction ID, as described in Multisection Data Transfers (page 459). The iPod acknowledges each `AsyncDevData` packet with an `iPodACK` command.

The accessory may send an `AsyncDevData` command with a `dataType` of 0x02 or 0x05 any time Accessory Power is high (pin 13 of the 30-pin connector), regardless of the iPod's control state as set by `SetDevControl`. The iPod responds immediately with an `iPodACK` command, but the data requested will not be sent until iPod location services are actually engaged by an application. The accessory must respond to other iAP commands while waiting for a response. The URL must not be sent to the iPod more often than the maximum ephemeris refresh interval established by the accessory via `RetDevData`, and in any case not more often than once every 5 minutes.

**Table 3-268** AsyncDevData packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x*NN* | Length of packet payload |
| 3 | 0x0E | Lingo ID: Location lingo |
| 4 | 0x09 | Command ID: `AsyncDevData` |
| 5 | 0x*NN* | `transID` [bits 15:8]: Transaction ID; see "Transaction IDs" (page 451) |
| 6 | 0x*NN* | `transID` [bits 7:0] |
| 7 | 0x*NN* | `locType`: The capability type; see Table 3-269 (page 333). |
| 8 | 0x*NN* | `dataType`: Location data type; see Table 3-269 (page 333). |
| 9 | 0x*NN* | `sectCur` [bits 15:8]: Current payload section index (0x0000 = first or only section) |
| 10 | 0x*NN* | `sectCur` [bits 7:0] |
| 11 | 0x*NN* | `sectMax` [bits 15:8]: Maximum payload section index (0x0000 = only section, 0x*NNNN* = maximum or last section) |
| 12 | 0x*NN* | `sectMax` [bits 7:0] |
| 13 | 0x*NN* | `totSize` [bits 31:24]: Total size of `locData` in bytes. If multiple `AsyncDevData` packets are sent, the `totSize` field is included only in the first packet (`sectCur` = 0x0000). See Multisection Data Transfers (page 459). |
| 14 | 0x*NN* | `totSize` [bits 23:16] |
| 15 | 0x*NN* | `totSize` [bits 15:8] |
| 16 | 0x*NN* | `totSize` [bits 7:0] |
| 13–*NN* or 17–*NN* | <*var*> | `locData`: Data sent by `AsyncDevData`; see Table 3-269 (page 333). |
| (last byte) | 0x*NN* | Checksum |

**Table 3-269** locData values that can be sent by AsyncDevData

| locType | dataType | locData **value** |
|---|---|---|
| 0x01 | 0x80 | String of NMEA 0183 compliant sentences. Each sentence must be sent as a full NMEA 0183 compliant sentence including the `$GP`, `$P`, or `!P` prefix, the `*NN` checksum, and the `<CR><LF>` suffix. |
| 0x02 | 0x02 | Null-terminated URL string (RFC 1738 compliant) to a web site for satellite ephemeris data (such as `http://www.yourcompany.com/long-term-ephemeris`). This must be a full URL, including `http://`. Only http and https transfer protocols are currently supported. |
| 0x02 | 0x05 | Request for current system time in GPS time (GPS Week number and milliseconds offset into the week; see Table 3-267 (page 330)). |

## Command 0x80: iPodACK

Direction: iPod to Accessory

This command is sent by the iPod in response to a command sent from the accessory. It has two forms:

- The Default form, shown in Table 3-270 (page 333), is sent under these conditions:
  - When a bad parameter is received, an unsupported or invalid command is received, or a command that does not return any data has completed.
  - To indicate completion of a multisection data transfer, as described in "Multisection Data Transfers" (page 459).
- The Section form is sent if the command from the accessory is part of a multisection data transfer. This form of the command is discussed in "Multisection iPodACK Command" (page 460).

**Table 3-270** Default iPodACK packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x06 | Length of packet payload |
| 3 | 0x0E | Lingo ID: Location lingo |
| 4 | 0x80 | Command ID: `iPodACK` |
| 5 | 0x*NN* | `transID` [bits 15:8]: Transaction ID of command being acknowledged; see "Transaction IDs" (page 451) |
| 6 | 0x*NN* | `transID` [bits 7:0] |
| 7 | 0x*NN* | `ackStatus`: Status return; possible values are listed in Table 3-248 (page 318) |

| Byte number | Value | Comment |
| --- | --- | --- |
| 8 | 0x*NN* | `cmdIDOrig`: Original command ID for which this response is being sent. |
| 9 | 0x*NN* | Checksum |

# Sample Identification Sequences

This section provides the following commented listings of sample command sequences in which an accessory identifies itself to an iPod or iPhone:

- Table 3-271 (page 334) lists sample commands for an accessory that supports the General and Extended Interface lingoes. For Extended Interface command details, see "The Extended Interface Protocol" (page 341).
- Table 3-272 (page 335) lists sample commands for an accessory that supports the General, Simple Remote, and Display Remote lingoes.
- Table 3-273 (page 337) lists sample commands for an accessory that supports the General, Simple Remote, Display Remote, and Digital Audio lingoes.

**Table 3-271** Identification of lingoes 0x00+0x04

<table>
<tr><th>Step</th><th>Accessory command</th><th>iPod command</th><th>Comment</th></tr>
<tr><td>1</td><td><code>StartIDPS</code></td><td></td><td>no params</td></tr>
<tr><td>2</td><td></td><td><code>ACK</code></td><td>acknowledging 'Success (OK)' to command 'General Lingo::StartIDPS'</td></tr>
<tr><td colspan="4">If the <code>ACK</code> reply to <code>StartIDPS</code> returns a status of 0x00, the accessory proceeds to Step 3. Otherwise,<br>■ If the accessory receives no <code>ACK</code> command within 1 second, it may retry Step 1 at 1-second intervals as long as iPod Detect (pin 30 of the 30-pin connector) is low and Accessory Power (pin 13) is high. Accessories that don't monitor these signals (such as Bluetooth accessories or USB accessories without a 191 kΩ ID resistor) may retry without checking them.<br>■ If the accessory receives an <code>ACK</code> status of 0x04 (Bad Parameter), the iPod does not support IDPS. Within 800 ms the accessory must send an <code>IdentifyDeviceLingoes</code> command with its lingo mask set for only the General lingo, with no options, and with a Device ID of 0x0. See "Cancelling a Current Authentication Process With IdentifyDeviceLingoes" (page 83). A sample command sequence is listed in Table F-24 (page 535).<br>■ If the accessory receives any other nonzero <code>ACK</code> status, it must not send any more iAP commands until it has been disconnected. Upon reconnection it must restart identification at Step 1.</td></tr>
</table>

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| 3 | SetFIDTokenValues | | setting 11 FID tokens ; IdentifyToken = (lingoes: 0/4 \| options 0x00000002 \| device ID 0x00000200); AccCapsToken = 0x0000000000000205; AccInfoToken = Acc name (Apple); AccInfoToken = Acc FW version (v9.8.7); AccInfoToken = Acc HW version (v1.2.3); AccInfoToken = Acc manufacturer (Apple Inc.); AccInfoToken = Acc model number (ModelNumber-XYZ); SDKProtocolToken = 1 (com.Apple.ProtocolMain); SDKProtocolToken = 2 (com.Apple.ProtocolAlt); iPodPreferenceToken = (setting 'off' for preference class 'video out setting' with restore on exit 'not selected'); iPodPreferenceToken = (setting 'used' for preference class 'line out usage' with restore on exit 'not selected') |
| 4 | | RetFIDTokenValueACKs | 11 ACKs for FID tokens ; IdentifyToken = accepted; AccCapsToken = accepted; AccInfoToken = (Acc name) accepted; AccInfoToken = (Acc FW version) accepted; AccInfoToken = (Acc HW version) accepted; AccInfoToken = (Acc manufacturer) accepted; AccInfoToken = (Acc model number) accepted; SDKProtocolToken = (1) accepted; SDKProtocolToken = (2) accepted; iPodPreferenceToken = (video out setting) accepted; iPodPreferenceToken = (line out usage) accepted |
| 5 | EndIDPS | | status 'finished with IDPS; proceed to authentication' |
| 6 | | IDPSStatus | status 'ready for auth' |
| 7 | | GetDevAuthentication-Info | no params |

**Table 3-272** Identification of lingoes 0x00+0x02+0x03

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| 1 | StartIDPS | | no params |

<table>
<tr><th>Step</th><th>Accessory command</th><th>iPod command</th><th>Comment</th></tr>
<tr><td>2</td><td></td><td>`ACK`</td><td>acknowledging 'Success (OK)' to command 'General Lingo::StartIDPS'</td></tr>
<tr><td colspan="4">If the `ACK` reply to `StartIDPS` returns a status of 0x00, the accessory proceeds to Step 3. Otherwise,
<ul>
<li>If the accessory receives no `ACK` command within 1 second, it may retry Step 1 at 1-second intervals as long as iPod Detect (pin 30 of the 30-pin connector) is low and Accessory Power (pin 13) is high. Accessories that don’t monitor these signals (such as Bluetooth accessories or USB accessories without a 191 kΩ ID resistor) may retry without checking them.</li>
<li>If the accessory receives an `ACK` status of 0x04 (Bad Parameter), the iPod does not support IDPS. Within 800 ms the accessory must send an `IdentifyDeviceLingoes` command with its lingo mask set for only the General lingo, with no options, and with a Device ID of 0x0. See "Cancelling a Current Authentication Process With IdentifyDeviceLingoes" (page 83). A sample command sequence is listed in Table F-25 (page 539).</li>
<li>If the accessory receives any other nonzero `ACK` status, it must not send any more iAP commands until it has been disconnected. Upon reconnection it must restart identification at Step 1.</li>
</ul></td></tr>
<tr><td>3</td><td>`SetFIDTokenValues`</td><td></td><td>setting 11 FID tokens ; IdentifyToken = (lingoes: 0/2/3 | options 0x00000002 | device ID 0x00000200); AccCapsToken = 0x0000000000000205; AccInfoToken = Acc name (Apple); AccInfoToken = Acc FW version (v9.8.7); AccInfoToken = Acc HW version (v1.2.3); AccInfoToken = Acc manufacturer (Apple Inc.); AccInfoToken = Acc model number (ModelNumber-XYZ); SDKProtocolToken = 1 (com.Apple.ProtocolMain); SDKProtocolToken = 2 (com.Apple.ProtocolAlt); iPodPreferenceToken = (setting 'off' for preference class 'video out setting' with restore on exit 'not selected'); iPodPreferenceToken = (setting 'used' for preference class 'line out usage' with restore on exit 'not selected')</td></tr>
</table>

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| 4 | | RetFIDTokenValueACKs | 11 ACKs for FID tokens ; IdentifyToken = accepted; AccCapsToken = accepted; AccInfoToken = (Acc name) accepted; AccInfoToken = (Acc FW version) accepted; AccInfoToken = (Acc HW version) accepted; AccInfoToken = (Acc manufacturer) accepted; AccInfoToken = (Acc model number) accepted; SDKProtocolToken = (1) accepted; SDKProtocolToken = (2) accepted; iPodPreferenceToken = (video out setting) accepted; iPodPreferenceToken = (line out usage) accepted |
| 5 | EndIDPS | | status 'finished with IDPS; proceed to authentication' |
| 6 | | IDPSStatus | status 'ready for auth' |
| 7 | | GetDevAuthenticationInfo | no params |

**Table 3-273** Identification of lingoes 0x00+0x02+0x03+0x0A

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| 1 | StartIDPS | | no params |
| 2 | | ACK | acknowledging 'Success (OK)' to command 'General Lingo::StartIDPS' |

If the ACK reply to StartIDPS returns a status of 0x00, the accessory proceeds to Step 3. Otherwise,

- If the accessory receives no ACK command within 1 second, it may retry Step 1 at 1-second intervals as long as iPod Detect (pin 30 of the 30-pin connector) is low and Accessory Power (pin 13) is high. Accessories that don't monitor these signals (such as Bluetooth accessories or USB accessories without a 191 kΩ ID resistor) may retry without checking them.
- If the accessory receives an ACK status of 0x04 (Bad Parameter), the iPod does not support IDPS. Within 800 ms the accessory must send an IdentifyDeviceLingoes command with its lingo mask set for only the General lingo, with no options, and with a Device ID of 0x0. See "Cancelling a Current Authentication Process With IdentifyDeviceLingoes" (page 83). A sample command sequence is listed in Table F-26 (page 542).
- If the accessory receives any other nonzero ACK status, it must not send any more iAP commands until it has been disconnected. Upon reconnection it must restart identification at Step 1.

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| 3 | SetFIDTokenValues | | setting 11 FID tokens ; IdentifyToken = (lingoes: 0/2/3/10 \| options 0x00000002 \| device ID 0x00000200); AccCapsToken = 0x0000000000000215; AccInfoToken = Acc name (Apple); AccInfoToken = Acc FW version (v9.8.7); AccInfoToken = Acc HW version (v1.2.3); AccInfoToken = Acc manufacturer (Apple Inc.); AccInfoToken = Acc model number (ModelNumber-XYZ); SDKProtocolToken = 1 (com.Apple.ProtocolMain); SDKProtocolToken = 2 (com.Apple.ProtocolAlt); iPodPreferenceToken = (setting 'off' for preference class 'video out setting' with restore on exit 'not selected'); iPodPreferenceToken = (setting 'used' for preference class 'line out usage' with restore on exit 'not selected') |
| 4 | | RetFIDTokenValueACKs | 11 ACKs for FID tokens ; IdentifyToken = accepted; AccCapsToken = accepted; AccInfoToken = (Acc name) accepted; AccInfoToken = (Acc FW version) accepted; AccInfoToken = (Acc HW version) accepted; AccInfoToken = (Acc manufacturer) accepted; AccInfoToken = (Acc model number) accepted; SDKProtocolToken = (1) accepted; SDKProtocolToken = (2) accepted; iPodPreferenceToken = (video out setting) accepted; iPodPreferenceToken = (line out usage) accepted |
| 5 | EndIDPS | | status 'finished with IDPS; proceed to authentication' |
| 6 | | IDPSStatus | status 'ready for auth' |
| 7 | | GetDevAuthenticationInfo | no params |
| 8 | RetDevAuthenticationInfo | | returns authentication version and X.509 certificate data |

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| 9 | | AckDevAuthentication-Info | acknowledging 'auth info supported' |
| 10 | | GetAccSampleRateCaps | no params |
| 11 | | GetDevAuthentication-Signature | sends authentication challenge |
| 12 | RetAccSampleRateCaps | | returning sample rates '8000 \| 11025 \| 12000 \| 16000 \| 22050 \| 24000 \| 32000 \| 44100 \| 48000' |
| 13 | RetDevAuthentication-Signature | | returns digital signature in response to authentication challenge |
| 14 | | NewiPodTrackInfo | sample rate 44100; Sound Check value 0; track volume adjustment 0 |
| 15 | AccAck | | acknowledging 'NewiPodTrackInfo' |
| 16 | | AckDevAuthentication-Status | acknowledging authentication status 'Success (OK)' |
| 17 | | NewiPodTrackInfo | sample rate 44100; Sound Check value 0; track volume adjustment 0 |
| 18 | AccAck | | acknowledging 'NewiPodTrackInfo' |
| 19 | | NewiPodTrackInfo | sample rate 44100; Sound Check value 0; track volume adjustment 0 |
| 20 | AccAck | | acknowledging 'NewiPodTrackInfo' |

# The Extended Interface Protocol

The iPod Extended Interface protocol allows the user interface of the iPod to be translated to other environments; for example, a vehicle entertainment system such as a dashboard radio, large-screen display, or steering wheel mounted remote control. This document specifies command packets that allow access to the iPod database and device management over serial or USB connections. This interface has the following advantages:

- It allows file-system and database-format independence for the interfacing body.
- It allows the interfacing body to remain ignorant of the encoders and decoders used to process digital audio information.

The minimum iPod System Software versions supported by this specification are:

- Version 2.0 of the third generation (3G) iPod.
- Version 3.0 of the fourth generation (4G) iPod.
- Version 1.0 of the iPod mini, 4G iPod (color display), iPod nano, fifth-generation iPod (5G), second-generation iPod nano, iPod classic, and iPod 3G nano.
- Version 1.1 of the iPhone and the iPod touch.
- Version 2.0.0 of the iPhone 3G.

**Note:** 32- and 16-bit quantities are sent in big-endian form, as the bit breakdowns in this specification show.

## Major iPod Operating Modes

For the purpose of this document, the iPod can be considered to operate in two major modes: Standard UI mode and Extended Interface mode. In addition there is the Sleep state, which can overlay the major modes in specific circumstances. For more information on iPod power states, see *iPod/iPhone Hardware Specifications*.

Standard UI Mode is the user interface mode that allows the iPod to be driven by its front panel display and buttons. Alternatively, the iPod may be placed in Extended Interface mode and controlled by an accessory device, using the Extended Interface protocol and its lingo (Lingo 0x04) as described in this document. The present chapter briefly summarizes the iPod Extended Interface and Sleep modes.

**Note:** The iPhone and iPhone 3G do not have a Sleep state.

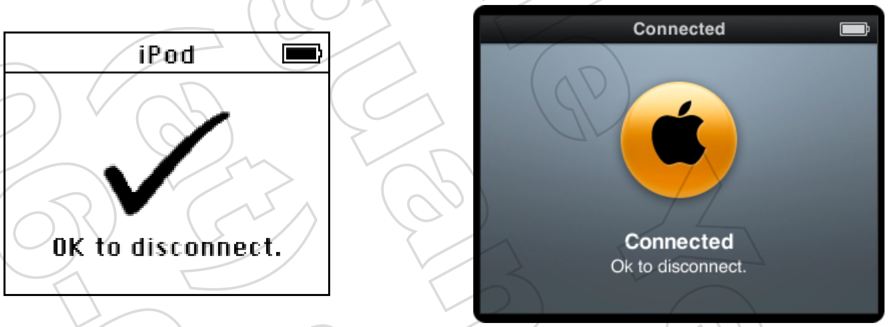
Accessories should query the iPod for the Extended Interface protocol version number, by sending the General lingo command `GetLingoProtocolVersion`, to determine which Extended Interface features are supported by the iPod. The Extended Interface protocol version number is incremented with the addition of new command IDs or with bug fixes to existing iPod features.

## Extended Interface Mode

The iPod transitions into the Extended Interface mode when a device is connected to it and issues an `EnterRemoteUIMode` command. The transition to Extended Interface mode is described in "Accessory Identification and Authentication" (page 344).

If the iPod is playing an audio track during this transition, the playback is automatically paused; video tracks are stopped. By default, the iPod's display changes to an “OK to disconnect” screen such as those shown in Figure 4-1 (page 342).

**Figure 4-1** Typical “OK to disconnect” screens




The Extended Interface protocol allows accessories to replace the checkmark graphic with a downloaded image set through "Command 0x0032: SetDisplayImage" (page 416). Removing power from the iPod while a connection remains results in the iPod going into a Sleep state after two minutes of inactivity. The keys and wheel on the front of the iPod are disabled when in Extended Interface mode.

The iPod transitions back to Standard UI mode when any of the following occurs:

- The device issues an `ExitRemoteUIMode` command.
- The device reidentifies itself, using the `StartIDPS` command (see "Device Signaling and Initialization" (page 48)).
- The device is disconnected from the iPod.

If the iPod is playing a track during this transition, the playback is automatically paused. Any iPod settings with the restore on exit feature set are restored when the iPod is disconnected.

## Sleep State

The iPod screen, playback, and most major parts of the iPod are off while the iPod is in the Sleep state. The iPod transitions from Extended Interface mode to the Sleep state when power is detached and playback is idle. A two minute period of inactivity is required before the iPod transitions into the Sleep state. When power is restored, the iPod returns to the Extended Interface mode.

An iPod will not sleep while it remains attached to an active USB host. The USB host must switch off its host controller to force an iPod in Extended Interface mode into the Sleep state. If the iPod is not currently in Extended Interface mode, playback must be paused before the host controller is turned off. In Extended

Interface mode, there is no need to pause iPod playback before turning off the host controller because this action generates a disconnect event that causes the iPod to exit the Extended Interface mode and allows the iPod to transition into the Sleep state. Attaching USB power to an iPod in Sleep state will wake it up.

Refer to the *iPod/iPhone Hardware Specifications* for information about transitions to the Sleep state from Standard UI mode.

# Packet Formats

The Extended Interface packet format is compatible with the packet formats described in "Command Packet Formats" (page 58). The primary difference between the two is the use of a 16-bit command ID field in Lingo 0x04 packets versus an 8-bit command ID field in other packet-based lingoes. Depending on the length of the packet, either the small packet format (payloads of 252 bytes or less) or the large packet format (253–65532 byte payloads) will be used.

**Note:** The Extended Interface start of packet (SOP) byte has the same value as the start of packet byte used in other iAP packets.

## Small Packet Format

For packets whose payloads are 252 bytes or less, use the small packet format. The small packet format is shown in Table 4-1 (page 343).

**Table 4-1** Small packet format

| Byte number | Value | Meaning |
|---|---|---|
| 0x00 | 0xFF | Sync byte (required only for UART serial) |
| 0x01 | 0x55 | Start of packet |
| 0x02 | 0xNN | Packet payload length |
| 0x03 | 0x04 | Lingo ID: Extended Interface lingo |
| 0x04 | 0xNN | Command ID (bits 15:8) |
| 0x05 | 0xNN | Command ID (bits 7:0) |
| 0x06…0xNN | 0xNN | Packet command data (0–252 bytes) |
| (last byte) | 0xNN | Packet payload checksum byte |

## Large Packet Format

For packets whose payloads are between 253 bytes and 65532 bytes in length, use the large packet format. The large packet format is shown in Table 4-2 (page 344).

**Table 4-2** Large packet format

| Byte number | Value | Meaning |
|---|---|---|
| 0x00 | 0xFF | Sync byte (required only for UART serial) |
| 0x01 | 0x55 | Start of packet |
| 0x02 | 0x00 | Packet payload length marker |
| 0x03 | 0xNN | Packet payload length (bits 15:0) |
| 0x04 | 0xNN | Packet payload length (bits 7:0) |
| 0x05 | 0x04 | Lingo ID: Extended Interface lingo |
| 0x06 | 0xNN | Command ID (bits 15:8) |
| 0x07 | 0xNN | Command ID (bits 7:0) |
| 0x08…0xNN | 0xNN | Packet command data (0–65532 bytes) |
| (last byte) | 0xNN | Packet payload checksum byte |

## Packet Details

The sync byte (0xFF) is not considered part of the packet. It is sent merely to facilitate automatic baud rate detection and correction when communicating over the UART serial port link. The sync byte is required only when communicating over the UART serial port link. It must not be sent when communicating over the USB port link. The packet payload length is the number of bytes in the packet not including the sync byte, packet start byte, packet payload length byte or bytes, or packet payload checksum. That is, it is the length of the lingo ID, the command ID, and the command data, if any. The lingo ID specifies the category this communication falls under; in this case, it is the iPod Extended Interface (0x04). The command ID is a 16-bit value, as compared with 8-bit command ID used by many other lingoes, that gives a specific indication of the packet's purpose.

The sum of all the bytes from the packet payload length (or length marker, if applicable) through the packet payload checksum is 0. The checksum must be calculated appropriately, by adding the bytes together as signed 8-bit values, discarding any signed 8-bit overflow, and negating the sum to create the signed 8-bit checksum byte.

# Accessory Identification and Authentication

When attached, an accessory must detect the iPod and then identify and authenticate itself, as described in "Device Signaling and Initialization" (page 48). To do this, the accessory must send a `StartIDPS` command to begin the Identify Device Preferences and Settings (IDPS) process.

As part of its identification and authentication, the accessory should query the iPod's support for Extended Interface mode by sending a `GetiPodOptionsForLingo` command for Lingo 0x04. The 64-bit field in the `RetiPodOptionsForLingo` reply declares which Extended Interface features the iPod supports, as listed in Table 4-3 (page 345).

**Table 4-3** `RetiPodOptionsForLingo` option bits for Lingo 0x04

| Bit | Description |
|---|---|
| 0x00 | Video browsing |
| 0x01 | Remote UI enhancements |
| 0x02 | Nested playlists |
| 0x03 | Reserved |
| 0x04 | Supports Set Display Image |
| 0x05-0x3F | Reserved |

A simplified sequence of iAP General lingo commands for accessory identification and authentication is shown in Table 4-4 (page 345). These commands identify the accessory, determine which options the attached iPod supports, set the accessory's preferences in the iPod, and authenticate the accessory.

**Table 4-4** Simplified IDPS and authentication command sequence

<table>
<tr><th>Step</th><th>Accessory command</th><th>iPod command</th><th>Comment</th></tr>
<tr><td>1</td><td><code>StartIDPS</code></td><td></td><td>no params</td></tr>
<tr><td>2</td><td></td><td><code>ACK</code></td><td>acknowledging 'Success (OK)' to command 'General Lingo::StartIDPS'</td></tr>
<tr><td colspan="4">If the <code>ACK</code> reply to <code>StartIDPS</code> returns a status of 0x00, the accessory proceeds to Step 3. Otherwise,<br>■ If the accessory receives no <code>ACK</code> command within 1 second, it may retry Step 1 at 1-second intervals as long as iPod Detect (pin 30 of the 30-pin connector) is low and Accessory Power (pin 13) is high. Accessories that don't monitor these signals (such as Bluetooth accessories or USB accessories without a 191 kΩ ID resistor) may retry without checking them.<br>■ If the accessory receives an <code>ACK</code> status of 0x04 (Bad Parameter), the iPod does not support IDPS. Within 800 ms the accessory must send an <code>IdentifyDeviceLingoes</code> command with its lingo mask set for only the General lingo, with no options, and with a Device ID of 0x0.<br>■ If the accessory receives any other nonzero <code>ACK</code> status, it must not send any more iAP commands until it has been disconnected. Upon reconnection it must restart identification at Step 1.</td></tr>
<tr><td>3</td><td><code>GetiPodOptions-ForLingo</code></td><td></td><td>getting options for General Lingo</td></tr>
<tr><td>4</td><td></td><td><code>RetiPodOptions-ForLingo</code></td><td>returning options for General Lingo</td></tr>
</table>

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| 5 | `GetiPodOptions-ForLingo` | | getting options for Extended Interface Lingo |
| 6 | | `RetiPodOptions-ForLingo` | returning options for Extended Interface Lingo |
| 7 | `SetFIDTokenValues` | | setting full ID (FID) tokens that identify accessory preferences |
| 8 | | `RetFIDTokenValueACKs` | acknowledging FID tokens that identify accessory preferences |
| Repeat Steps 7 and 8 until all required accessory preferences have been set and acknowledged | | | |
| 9 | `EndIDPS` | | status 'finished with IDPS; proceed to authentication' |
| 10 | | `IDPSStatus` | status 'ready for auth' |
| 11 | | `GetDevAuthentication-Info` | no params |
| 12 | `RetDevAuthentication-Info` | | returning auth protocol v2.0; section: 0/1; cert data: ... |
| 13 | | `ACK` | acknowledging 'Success (OK)' to command 'General Lingo::RetDevAuthenticationInfo' |
| 14 | `RetDevAuthentication-Info` | | returning auth protocol v2.0; section: 1/1; cert data: ... |
| 15 | | `AckDevAuthentication-Info` | acknowledging 'auth info supported' |
| 16 | `EnterRemoteUIMode` | | entering Extended Interface mode |
| 17 | | `ACK` | acknowledging 'Command Pending' to command 'General Lingo::EnterRemoteUIMode' |
| 18 | | `ACK` | acknowledging 'Success (OK)' to command 'General Lingo::EnterRemoteUIMode' |
| 19 | | `GetDevAuthentication-Signature` | offering challenge '...' with retry counter 1 |
| 20 | `RetDevAuthentication-Signature` | | returning signature '...' |
| 21 | | `AckDevAuthentication-Status` | acknowledging authentication status 'Success (OK)' |

**Note:** The process of device identification is different for accessories that must support the 3G iPod. See "Interfacing With the 3G iPod" in *iPod/iPhone Hardware Specifications.*

## Command Transports

To establish reliable communication over UART transport, it may be necessary to repeat the device identification sequence multiple times. There can be problems when the iPod tries to synchronize with the device's baud rate, resulting in packet loss. Repeating the device identification sequence until it is successful ensures that iPod identifies the device correctly. This problem does not occur with USB transport.

Devices using a UART serial port link should send an extra sync byte before a command packet in order to wake up a sleeping iPod. This recommendation does not apply while the iPod is in Extended Interface mode because iPods do not sleep in this mode as long as external power is supplied by an accessory device. If the device allows the iPod to transition to Sleep state by removing external power, it should send extra sync bytes when waking up the iPod. For further information about supported transport protocol links, see *iPod/iPhone Hardware Specifications.*

## Entering Extended Interface Mode

The iPod does not automatically enter into Extended Interface mode; the device must explicitly switch into and out of the Extended Interface mode. To confirm that the iPod has gone into Extended Interface mode, the device sends it the Lingo 0x04 command `GetPlayStatus`. Receiving a valid `ReturnPlayStatus` command tells the device that the iPod has entered Extended Interface mode and Lingo 0x04 commands can be used. The iPod will return Lingo 0x04 `ACK` commands with a bad parameter status if the device is not communicating properly with the iPod in Extended Interface mode.

Accessories may send Extended Interface command packets only after they have successfully identified and switched into Extended Interface mode. Accessories must still obey the other inter-packet and inter-command timing issues specified in "Command Timings" (page 146).

## Using the Extended Interface Protocol

There are four General lingo (Lingo 0x00) commands that allow devices to determine what mode the iPod is in and to switch between the two major modes, Standard UI and Extended Interface. These commands were implemented to allow a device to switch between modes without having to unplug the device. Multilingo devices must use these commands to switch into and out of the Extended Interface mode.

**Note:** Multilingo devices that support the Extended Interface do not automatically switch into the Extended Interface mode after the identification process completes. These devices must use the General lingo mode switching commands to explicitly switch into Extended Interface mode.

Figure 4-4 (page 362) lists the General lingo command codes for querying, entering, and exiting the Extended Interface protocol.

**Table 4-5** General lingo commands for switching modes

| Command ID | General lingo command | Protocol version | Requires authentication | |
|---|---|---|---|---|
| | | | UART serial port link | USB port link |
| 0x03 | RequestRemoteUIMode | 1.00 | No | Yes |
| 0x04 | ReturnRemoteUIMode | 1.00 | No | Yes |
| 0x05 | EnterRemoteUIMode | 1.00 | No | Yes |
| 0x06 | ExitRemoteUIMode | 1.00 | No | Yes |

Two logical entities need to be managed while browsing and playing content in Extended Interface mode: the content Database Engine and the Playback Engine. The following sections describe those engines and give an example of command traffic between a device in Extended Interface mode and an iPod.

Table 4-10 (page 368) lists the complete set of iPod Extended Interface command IDs, noting which are relevant to the Database and Playback Engines, as well as which the protocol versions in which those commands were introduced. Unless otherwise noted, all subsequent protocol versions will support existing commands.

## The Playback Engine

The Playback Engine is active when the iPod is in a playback state, such as play, fast forward, and rewind. It has a special play list, called the Now Playing playlist, that is used to determine what track or content item will be played next. The `PlayCurrentSelection` command is commonly used to transfer the currently selected database items to the Now Playing playlist and start the player at a specified item within that list. The `SelectDBRecord` and `SelectSortDBRecord` commands, with a track or audiobook category and a valid index, also transfer selected database items to the Now Playing playlist. Changes to the database selection before or after these commands have no effect on the current playback.

### Playback Behavior

An iPod's behavior when it receives a `PlayCurrentSelection` packet may depend on the shuffle setting, the repeat setting, and on the kind of tracks in a playlist. Consider a playlist with the following tracks:

Track A
Track B
Track C
Track D
Track E

If repeat is off and shuffle mode has been turned on, using `SetShuffle`, a `PlayCurrentSelection` packet with an index of –1 causes the playlist to be shuffled randomly and sent to the Playback Engine. Play starts at the first track of the new order. For example, the playlist may be sent to the Playback Engine in this order:

Track D
Track A

Track B
Track E
Track C

Playback starts at Track D, proceeds to Track A, and so on.

If repeat is off and shuffle mode is off, a `PlayCurrentSelection` packet with an index of 0x00000000 causes the playlist to be sent to the Playback Engine in the current playlist order, with play starting at the first track. Using the foregoing example, the playlist is sent to the Playback Engine in its original order:

Track A
Track B
Track C
Track D
Track E

Playback starts at Track A, proceeds to Track B, and so on.

If both repeat and shuffle mode are on, a `PlayCurrentSelection` packet with an index of 0 or greater causes the playlist to be shuffled randomly but with the first track set to the selected index. For example, with an index of 4, the playlist may be sent to the Playback Engine in the following order and play starts with Track E. If repeat is set to One, track E will repeat; if it is set to All, the entire playlist will repeat.

Track E
Track B
Track A
Track D
Track C

**Note:** The index numbers of tracks in the Playback Engine are always arranged in the current playlist order, starting with 0.

If repeat and shuffle mode are both off, a `PlayCurrentSelection` packet with an index of 0 or greater causes the playlist to be sent to the Playback Engine in the current playlist order but with the first track set to the passed index. With an index of 2, using the current example, the playlist is sent to the Playback Engine in this order but play starts at Track C, proceeds to Track D, and so on:

Track A
Track B
Track C
Track D
Track E

On clickwheel iPods (without touch screens) certain sequences of playback requests can result in an empty playlist. For example, consider the following sequence of packets:

```
SetShuffle(on)
ResetDBSelection()
SelectDBRecord(playlist)
PlayCurrentSelection(-1)
```

If the selected playlist contains only tracks that have the Skip When Shuffle attribute (for example, a playlist of audiobooks) then the playlist that is copied to the Playback Engine will be empty and no tracks will play. If `PlayCurrentSelection(0)` were sent for the last packet instead of `PlayCurrentSelection(-1)`, the track with index 0 would play but no other tracks would play after it finished.

In all the foregoing scenarios, the iPod returns a successful `ACK(0)` packet to the accessory. The accessory should not assume that any tracks are playing, but should use `GetPlayStatus` to verify that playback has started.

**Note:** Commands in other lingoes may change the iPod's playback status, including its player state, track position, and track index. Examples include the Simple Remote lingo command `ContextButtonStatus` and the Display Remote lingo command `SetCurrentPlayingTrack`. Accessories should request notifications (via `SetPlayStatusChangeNotification`) or repeatedly send `GetPlayStatus` to coordinate itself with the iPod's playback status.

## The Database Engine

The Database Engine is always accessible when the unit is awake. It can be manipulated remotely and allows groups of content items to be selected, independently of the Playback Engine. This allows the user to listen to an existing track or playlist while checking the iPod database for another selection. Once a different database selection is made, the user selection (the track or content playlist) is sent to the Playback Engine. The commands such as `ResetDBSelection` and `GetNumberCategorizedDBRecords` are examples of commands that are used to manipulate the Database Engine. You can identify database commands from playback commands by the string "DB" or "Database" embedded in the command name.

### Database Category Hierarchies

The database engine uses **categories** to classify music, videos and other records stored in the database. Possible categories are playlist, genre, media kind, artist, album, track, composer, audiobook, and podcast. A list of records can be assembled, based on the various selected categories, to create a user list of records (a playlist).

The database categories have a hierarchy by which records are sorted and retrieved. This category hierarchy has an impact on the order in which records must be selected. For example, if a low category, such as album, is selected first, followed by a higher relative category such as genre, the album selection is invalidated and is ignored. When creating a new set of database selections, the device must begin by resetting all database selections, using the `ResetDBSelection` or `ResetDBSelectionHierarchy` commands, and selecting the desired database categories from highest to lowest relative category. The category hierarchy, from highest to lowest (excluding podcasts), is shown in Table 4-6 (page 350).

**Table 4-6** Database category hierarchy (excluding podcasts)

| Category | Notes |
|---|---|
| All (highest level) | This is the state after a `ResetDBSelection` or `ResetDBSelectionHierarchy` command. No database categories are selected. If the `GetNumberCategorizedDBRecords` command is sent while in this state, it returns the total number of records for the requested category. |

| Category | Notes |
|---|---|
| Playlist | When the `SelectDBRecord` command selects a playlist, all lower database category selections (genre or media kind, artist or composer, album, and track or audiobook) are invalidated. |
| Genre or Media Kind | When the `SelectDBRecord` command selects a genre, all lower database category selections (artist or composer, album, and track) are invalidated. |
| Artist or Composer | When the `SelectDBRecord` command selects an artist or composer, all album and track category selections are invalidated. |
| Album | When the `SelectDBRecord` command selects an album, all track category selections are invalidated. |
| Track or Audiobook (lowest level) | When the `SelectDBRecord` command selects a track (music or video) or an audiobook, it is automatically transferred from the Database Engine to the Playback Engine. |

There is a parallel hierarchy for podcasts. When the podcast category is selected, all track or audiobook selections are invalidated. If other categories (such as Artist) are then selected after the podcast category, the list of podcasts returned by `GetNumberCategorizedDBRecords` and `RetrieveCategorizedDBRecords` is affected. This behavior parallels that of playlists with multiple categories selected.

The default sort order for podcasts is alphabetical. For episode tracks, the order is reverse chronological; that is, the most recent one is first.

**Table 4-7** Database category hierarchy for podcasts

| Category | Notes |
|---|---|
| All (highest level) | This is the state after a `ResetDBSelection` or `ResetDBSelectionHierarchy` command. No database categories are selected. If the `GetNumberCategorizedDBRecords` command is sent while in this state, it returns the total number of records for the requested category. |
| Podcast | When the `SelectDBRecord` command selects a podcast, all lower database category selections are invalidated. |
| Episode Track (lowest level) | When used in the context of podcasts, episode is synonymous with track. When the `SelectDBRecord` command selects an episode track, it is automatically transferred from the Database Engine to the Playback Engine. |

## Database Category Counts

The record count for a given database category is established either when the `GetNumberCategorizedDBRecords` command, or when the `SelectDBRecord` command is processed for that category. Depending on the previous database state and the order in which the categories are selected, the category record counts returned by the `GetNumberCategorizedDBRecords` command may be different.

After all database selections have been reset using the `ResetDBSelection` command, sending the `GetNumberCategorizedDBRecords` command for any category retrieves the total number of records matching that category in the entire iPod database. In contrast, if one or more categories are already selected, the `GetNumberCategorizedDBRecords` command returns the number of records that match the both the specified category, as well as any already selected categories. As an example, assume an iPod has the following four tracks in its database:

| Genre | Artist | Album | Track |
|---|---|---|---|
| Electronica/Dance | Dirty Vegas | Essential Mix | Days Go By |
| R&B | Radiance | Pick 'n Choose | All Night |
| Hip-Hop/Rap | Coolio | It Takes A Thief | Fantastic Voyage |
| Electronica/Dance | New Order | Power, Corruption & Lies | Blue Monday |

Imagine the following command sequence:

1. The database is reset using `ResetDBSelection`. All record counts are cleared.
2. The track record count returned by `GetNumberCategorizedDBRecords` is four, the total number in the database.
3. The genre Electronica/Dance is selected. The track record count returned by `GetNumberCategorizedDBRecords` is two. Two records match the Electronica/Dance genre category: the tracks by Dirty Vegas and New Order.
4. The artist Dirty Vegas is selected. Because the genre category is still selected, the track record count returned by `GetNumberCategorizedDBRecords` is one. One record matches both the Electronica/Dance genre category and the Dirty Vegas artist category: the track "Days Go By."

Note that in this example, each time a category is selected the track count is invalidated because it is in a lower category than the category selected. See "Database Category Hierarchies" (page 350) for details about the effects a category selection has on other category selections.

Retrieving the record count of a higher category does not cause the current selection to be invalidated. However, selecting one of the results of that count does cause an invalidation. For example, using the same iPod database, a different command sequence produces different results:

1. The database is reset using `ResetDBSelection`.
2. The artist Dirty Vegas is selected. The Track record count returned by `GetNumberCategorizedDBRecords` for the Artist category is one, as there is only one track matching the Dirty Vegas artist category: the track "Days Go By."
3. The Genre record count is requested using `GetNumberCategorizedDBRecords`; this also returns a record count of one. Had the database included multiple Dirty Vegas songs from the same genre, then the returned Genre record count would still have been one. Had the database included Dirty Vegas songs from multiple different genres, however, the returned Genre record count would have been greater than one.

4. The Electronica/Dance genre is selected, which results in the Dirty Vegas selection being invalidated. If the `GetNumberCategorizedDBRecords` command is used to obtain the record count for the Artist category, it returns two, the expected total number of artists matching the Electronica/Dance genre (Dirty Vegas and New Order).

## The All Tracks and On-The-Go Playlists

The iPod has two playlists that developers should be aware of: the All Tracks and On-The-Go playlists. The All Tracks playlist contains every track in the current hierarchy (either audio or video) that is stored on the iPod and always resides at index 0x00 in the Playlist category. The On-The-Go playlist is always stored at the last index in the audio playlist category and the user controls whether it contains playlist data. It is not supported under video browsing.

To populate the On-The-Go playlist, a user must select an audio track, artist, or album by locating the item in the iPod menu hierarchy and holding the select button down for several seconds. The track, album, or artist name will blink for a few seconds indicating that the track or tracks have been added to the On-The-Go playlist. Once the tracks have been added to the On-The-Go playlist, the user may clear the playlist through the playlist menu.

Accessories can use the following steps to determine whether there are any tracks available in the On-The-Go playlist:

1. Call `ResetDBSelection()`
2. Call `GetNumberCategorizedDatabaseRecords(playlists)`. This returns the number of playlists available on the iPod (the playlist count).
3. Call `SelectDBRecord(playlists, playlistCount - 1)`. This selects the On-The-Go playlist which is always the last entry in the playlist list.
4. Once the On-The-Go playlist is selected, the accessory can query the database for the number of available records using the `GetNumberCategorizedDBRecords` call with the category Tracks.

Accessories can use the following steps to select and play all the tracks on the iPod:

1. Call `ResetDBSelection()`
2. Call `GetNumberCategorizedDatabaseRecords(playlists)`. This returns the number of playlists available on the iPod.
3. Call `SelectDBRecord(playlists, 0)`. This selects the All Tracks playlist.
4. Call `PlayCurrentSelection()`.

## Nested Playlists

Version 1.13 and later of the iPod Extended Interface protocol supports nested playlists. A playlist can contain either tracks or one or more other playlists, but not both. The number of playlist nesting levels is unlimited.

When navigating playlists using the iPod's Playlist category, nested playlists are flattened and their contents are presented in the highest level playlist that contains them. For example, if playlist Adam contains two nested playlists, Bob and Carol, then the Playlist category displays three playlists: Adam, Bob, and Carol. The contents of playlists Bob and Carol are their tracks. The contents of playlist Adam is the concatenation of the tracks in playlists Bob and Carol.

The iPod provides a Nested Playlist category to traverse playlists with their nesting hierarchy in place. In the foregoing example, only playlist Adam would be returned when traversing the Nested Playlist category after a `ResetDBSelection` command. Selecting playlist Adam would expose nested playlists Bob and Carol. Selecting Bob or Carol would expose no further nested playlists. A typical command sequence for traversing the hierarchy looks like this:

1. Call `ResetDBSelection`; all record counts are cleared.
2. Call `GetNumberCategorizedDBRecords`; a `NestedPlaylist` count of 1 is returned.
3. Call `SelectDBRecord`; select a `NestedPlaylist` index of 0 (playlist Adam).
4. Call `GetNumberCategorizedDBRecords`; a `NestedPlaylist` count of 2 is returned.
5. Call `SelectDBRecord`; select a `NestedPlaylist` index of 1 (playlist Carol).
6. Call `GetNumberCategorizedDBRecords`; a `NestedPlaylist` count of 0 is returned.

When the count of nested playlists returned by `GetNumberCategorizedDBRecords` is 0, the current playlist has no nested playlists. At this point the accessory should query the iPod for the number and names of the tracks in that playlist.

Calling `SelectDBRecord` with a `NestedPlaylist` index of –1 traverses the hierarchy upward to the next parent playlist. If the current playlist has no parent playlist, passing index –1 has no effect.

### Unexpected Database Changes

Wireless iTunes store access, rentals, Genius playlists, On-The-Go playlists, and other media features present opportunities for the iPod's database contents to change without synchronizing to the iTunes database on a host computer. Category counts, category lists, track counts, tracks, and other media information may change at any time, including during Extended Interface sessions. Playback engine counts and contents may also change as media are added to or removed from the iPod.

Accessories must not expect the media information and content to remain the same throughout an Extended Interface session. Accessories must verify media information immediately before use to ensure that the data has not changed, especially when media information is cached locally on the accessory. Even then, the database or playback engine state may change without the iPod informing the accessory. Accessories using the Extended Interface must be programmed to recover from command errors and failures received unexpectedly from the iPod, by retrying commands or by reidentifying themselves and entering Extended Interface mode again.

## Transferring Album Art

The extended interface lingo includes several commands that support the transfer of album artwork from an iPod to an accessory:

- `GetArtworkFormats`
- `RetArtworkFormats`
- `GetTrackArtworkTimes`
- `RetTrackArtworkTimes`
- `GetTrackArtworkData`
- `RetTrackArtworkData`

All album art image encoding is currently RGB-565, which can be transferred in both big- and little-endian formats. Artwork retrieval takes place in the following steps:

1. Retrieve the number of formats available for artwork on the iPod using `GetArtworkFormats`. It is not necessary to call `GetArtworkFormats` more than once per session; these values will be static while the accessory is attached to the iPod. However, there are no guarantees about the number of formats and which ones are available on a particular model or firmware version. Each `formatID` in `RetArtworkFormats` specifies both a pixel encoding, such as RGB-565 little-endian, and the image dimensions. All formats are fixed-size.

2. When the accessory wants to retrieve the artwork for a given track, it calls `GetIndexedPlayingTrackInfo` with an `infoType` of 7. This returns the count of artwork available for each `formatID` associated with the track. It is possible that a track may not have artwork for a particular `formatID` or that the number of images will vary by `formatID`. A given size of album artwork may be available for only one track in the database.

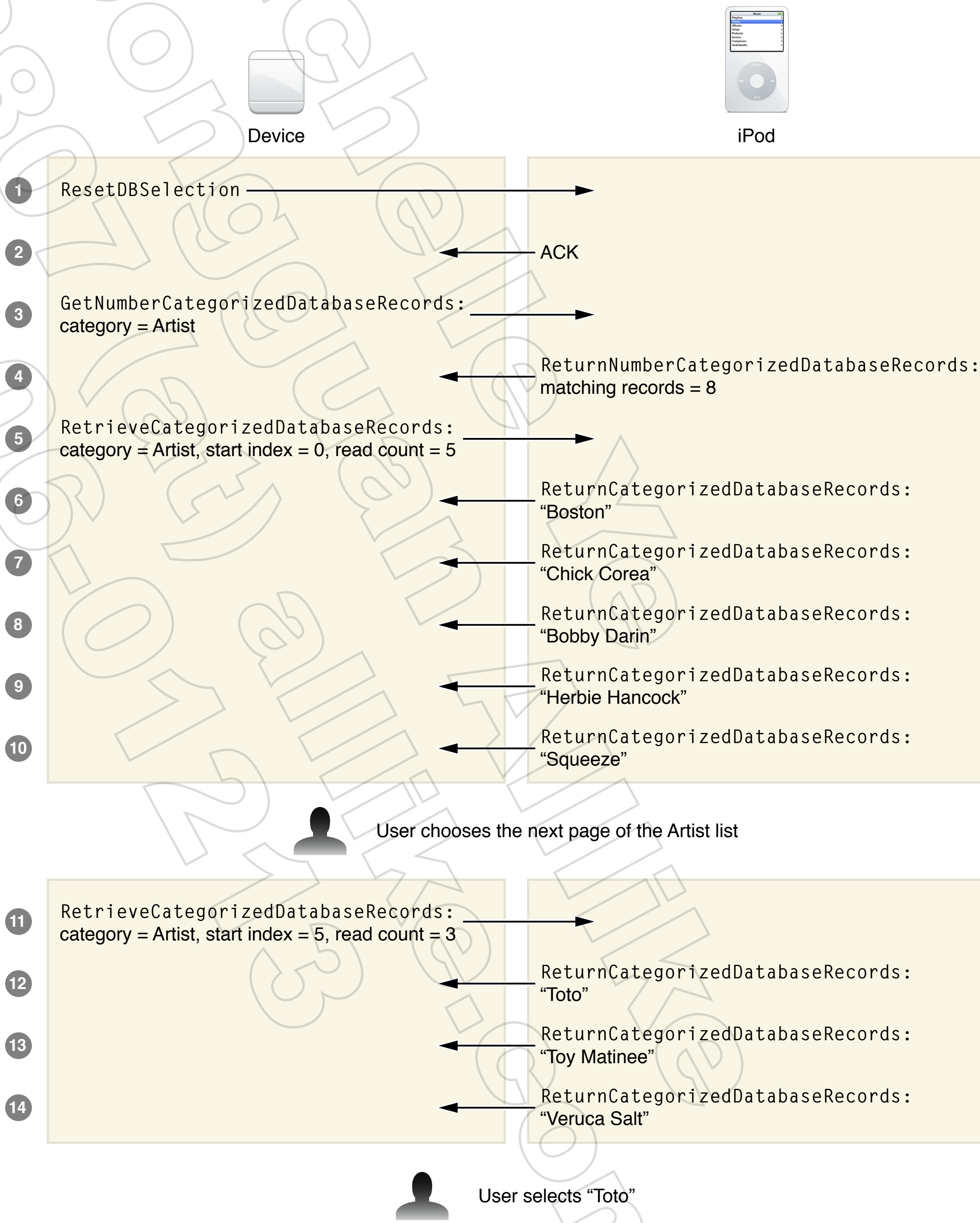
3. To retrieve the list of images associated with a given track and `formatID`, the accessory calls `GetTrackArtworkTimes`. This command tells the iPod to return the associated timestamp for each artwork. The timestamp indicates when the artwork should be displayed, expressed in milliseconds from the start of playback.

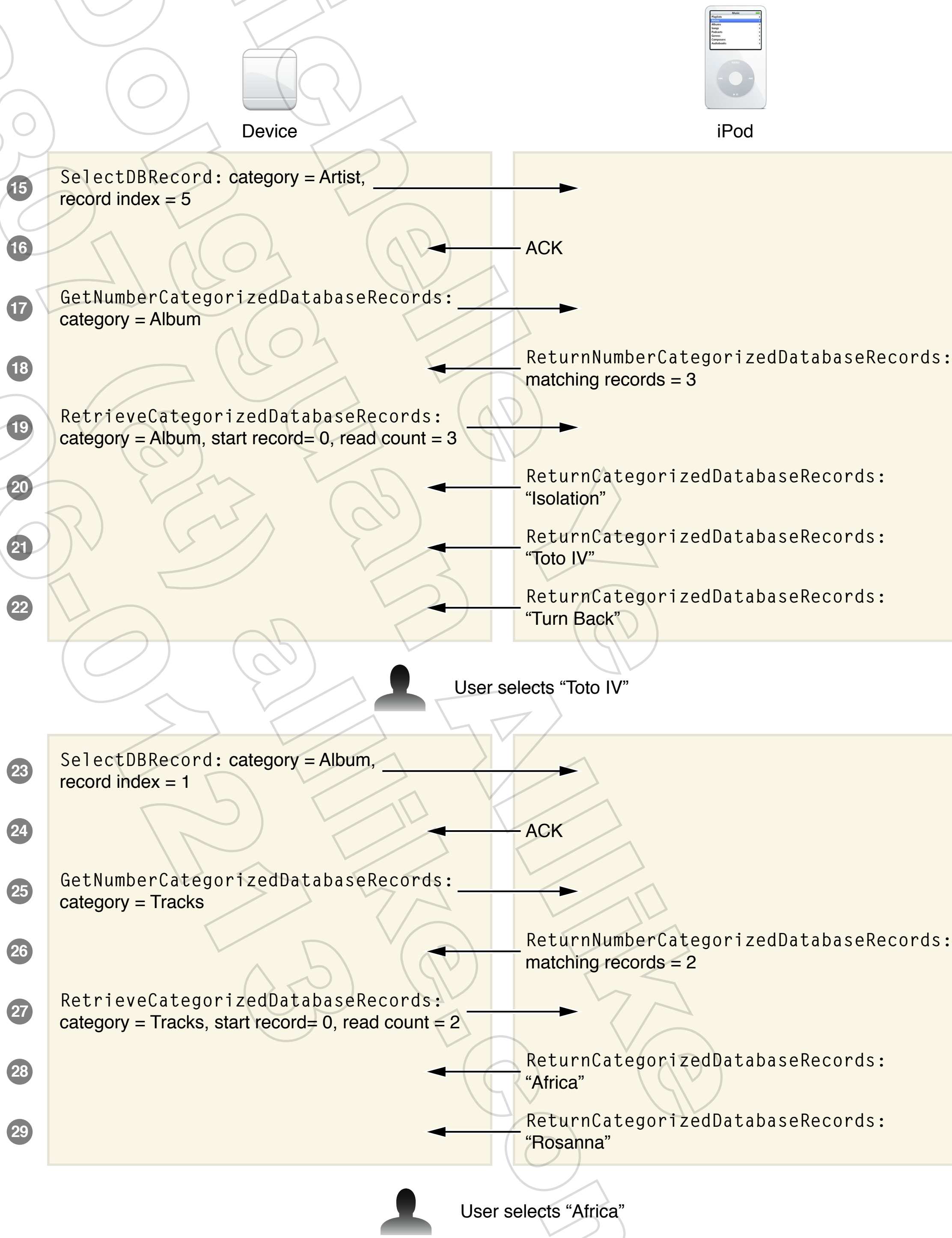
4. When the accessory wants to retrieve an individual piece of artwork, it sends `GetTrackArtworkData` to the iPod. This requires the accessory to specify a track, a formatID, and the timestamp of the desired image. The iPod returns the specified artwork and the accessory can display it whenever it chooses.

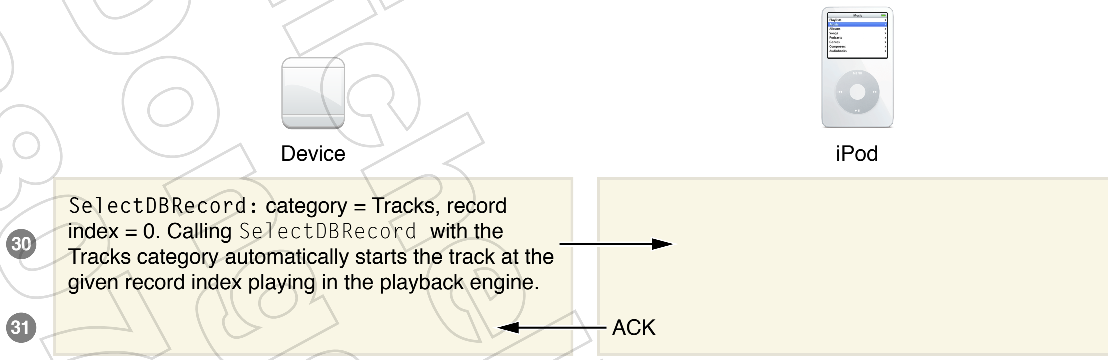
## Using the Extended Interface Protocol: An Example

The following example of command traffic shows a conversation that might occur if the interfacing device has a paged menu of 5 choices; that is, a menu capable of displaying up to 5 options for the user to choose from.

**Figure 4-2** An example interaction between an Extended Interface device and an iPod




Device
iPod
15 SelectDBRecord: category = Artist, record index = 5
16 ACK
17 GetNumberCategorizedDatabaseRecords: category = Album
18 ReturnNumberCategorizedDatabaseRecords: matching records = 3
19 RetrieveCategorizedDatabaseRecords: category = Album, start record= 0, read count = 3
20 ReturnCategorizedDatabaseRecords: “Isolation”
21 ReturnCategorizedDatabaseRecords: “Toto IV”
22 ReturnCategorizedDatabaseRecords: “Turn Back”
User selects “Toto IV”
23 SelectDBRecord: category = Album, record index = 1
24 ACK
25 GetNumberCategorizedDatabaseRecords: category = Tracks
26 ReturnNumberCategorizedDatabaseRecords: matching records = 2
27 RetrieveCategorizedDatabaseRecords: category = Tracks, start record= 0, read count = 2
28 ReturnCategorizedDatabaseRecords: “Africa”
29 ReturnCategorizedDatabaseRecords: “Rosanna”
User selects “Africa”




## Video Browsing

With iPod models that store and display video content (in addition to music), an accessory device may choose to navigate the iPod's hierarchy of stored videos. To do this, the accessory must use the command `ResetDBSelectionHierarchy` to switch from navigating music tracks to navigating video tracks.

### Video Playlists

A video playlist is a collection of tracks, created in iTunes, that contains one or more tracks playable as video. In contrast, an audio-only playlist does not contain any tracks playable as video. Video playlists may contain video-only tracks (such as movies) or tracks playable as either video or audio (such as video podcasts or music videos). Audio-only tracks are not visible and not playable when the iPod is navigating the video hierarchy.

### Video Navigation User Interface

Video track selection follows the iPod user interface rules as closely as possible and behaves in the same way as audio track selection. In the video hierarchy, the menu item Genre is used to indicate media kind. The list of media kinds is dynamic and may be updated in the future to add, modify, or remove entries.

Once a media kind has been selected, the existing Artist, Album, and Song or Track categories may be used to further narrow the selection. For some media kinds, such as movies, a category may contain a single entry. In such cases, the accessory may choose to bypass this menu level. For example, with TV shows the Season menu on the iPod is omitted if all the stored episodes are from the same season. Accessory designs that provide a video browsing user interface are encouraged to duplicate this behavior.

Video podcasts and music videos appear in both the music and video hierarchies. Other video tracks, such as movies and TV shows, appear only in the video hierarchy. Note that video playlists may contain audio-only tracks.

The Artist and Album categories do not apply to every media kind. For example, movies do not use these categories at the current time. When a category does not apply, the iPod returns a count of 1 and displays a localized version of the word "All." The accessory may choose to bypass this menu level when displaying it to the user, as described above.

## Navigating Video Playlists

The `ResetDBSelectionHierarchy` command with the video hierarchy type (0x02) selects the video hierarchy and invalidates all previous video database selections, such as `ResetDBSelection` in the audio-only hierarchy. As with the audio hierarchy, a video playlist record index of 0x00 designates the all video tracks playlist. If there are no video tracks on an iPod, the all video tracks playlist will still be present, with a record count of 0. In contrast to the audio hierarchy, there is no On-The-Go (OTG) playlist in the video hierarchy.

After a `ResetDBSelectionHierarchy` command is sent to select the video hierarchy, all video playlists become visible. The video playlist count can be obtained using the `GetNumberCategorizedDBRecords` command with the playlist category (0x01). The video playlist records can be obtained using the `RetrieveCategorizedDatabaseRecords` command. A specific video playlist can be selected using the `SelectDBRecord` command.

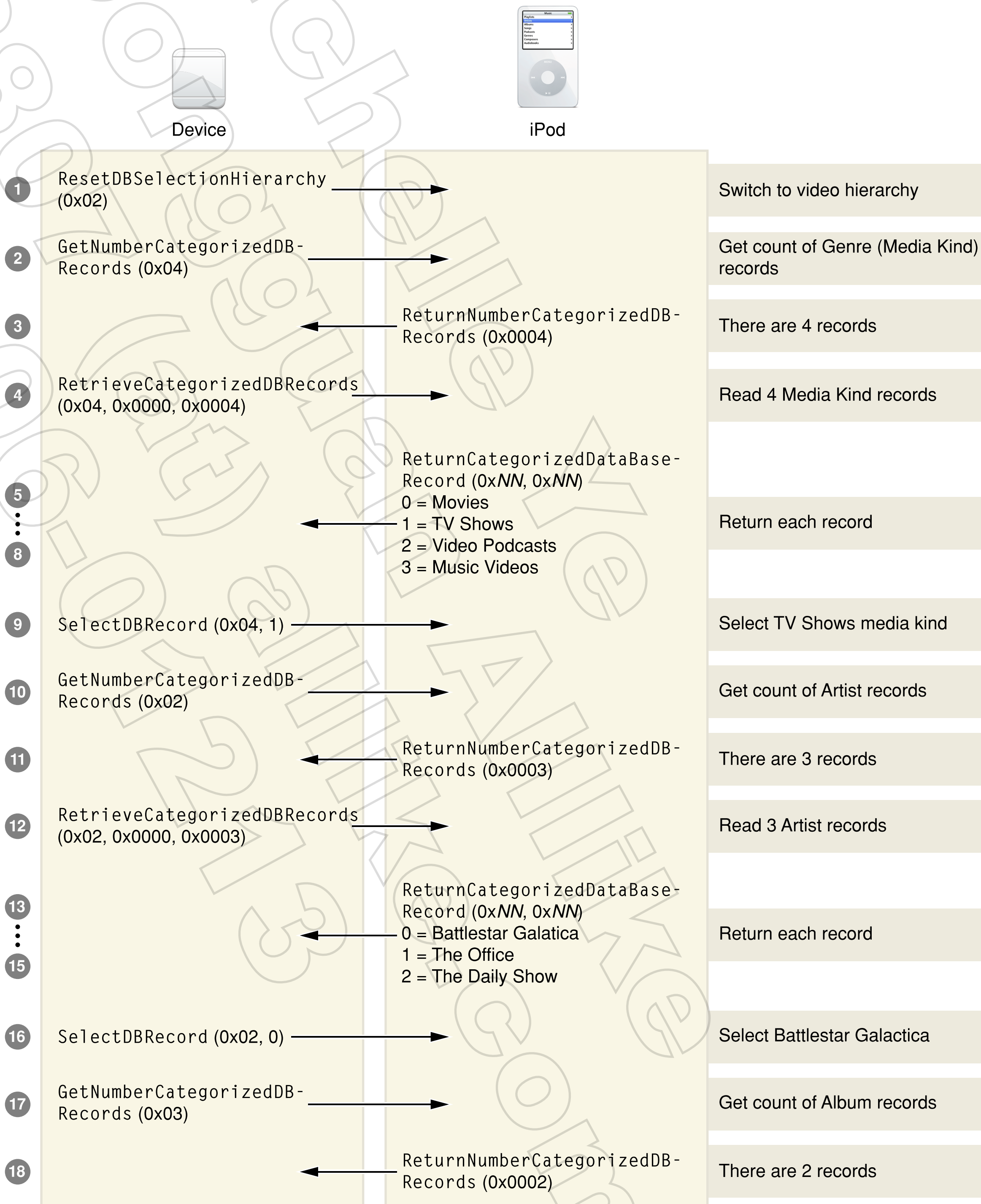
**Compatibility Note:** 5G iPods with firmware version 1.2.1 and earlier (before 11/2007) require that 1 be added to the `recIndex` values for music video artists. These iPods also do not filter out audio-only tracks while navigating the video hierarchy.

## Video Selection Examples

Figure 4-3 (page 360) diagrams a typical interchange that might take place between an accessory and an iPod as the user of the accessory navigates to a TV show stored on an iPod.

TV shows and video podcasts use both the Artist and Album categories. Music videos return “All” as the only Album entry. Movies return “All” for both Artist and Album categories. However, this behavior may change in future versions of the iPod firmware. Accessories must treat these categories as dynamic.

**Figure 4-3** Navigating to a TV show: example of interactions between a device and an iPod



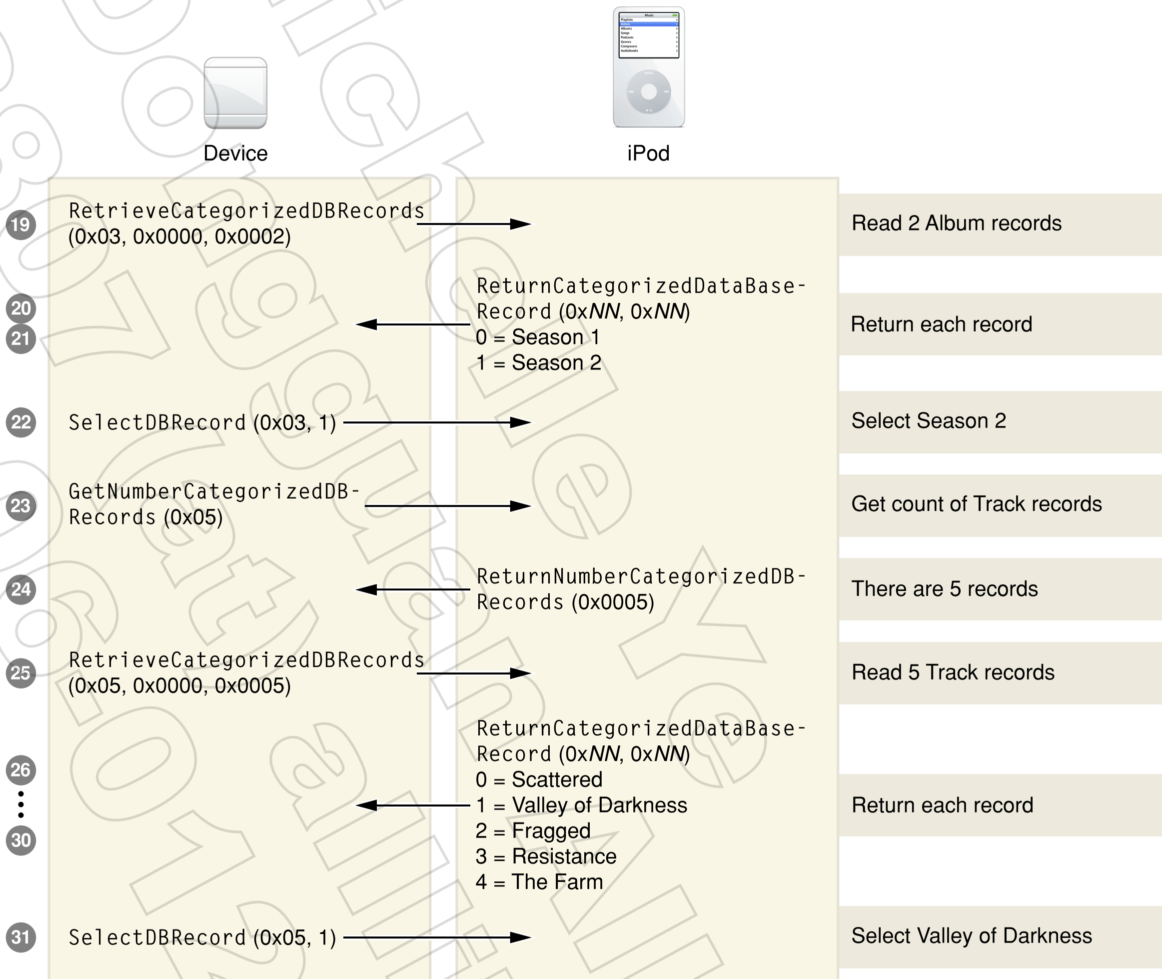
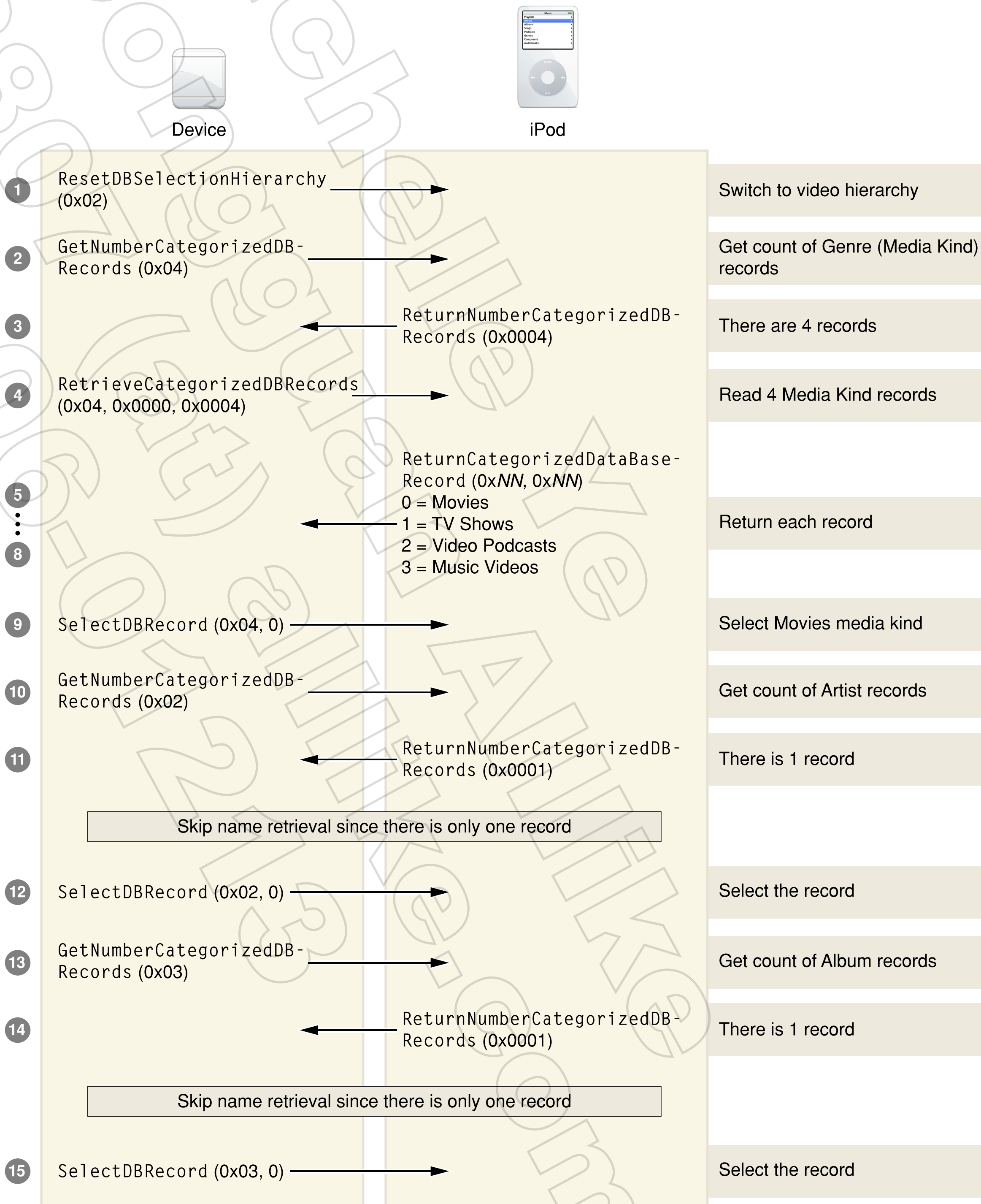
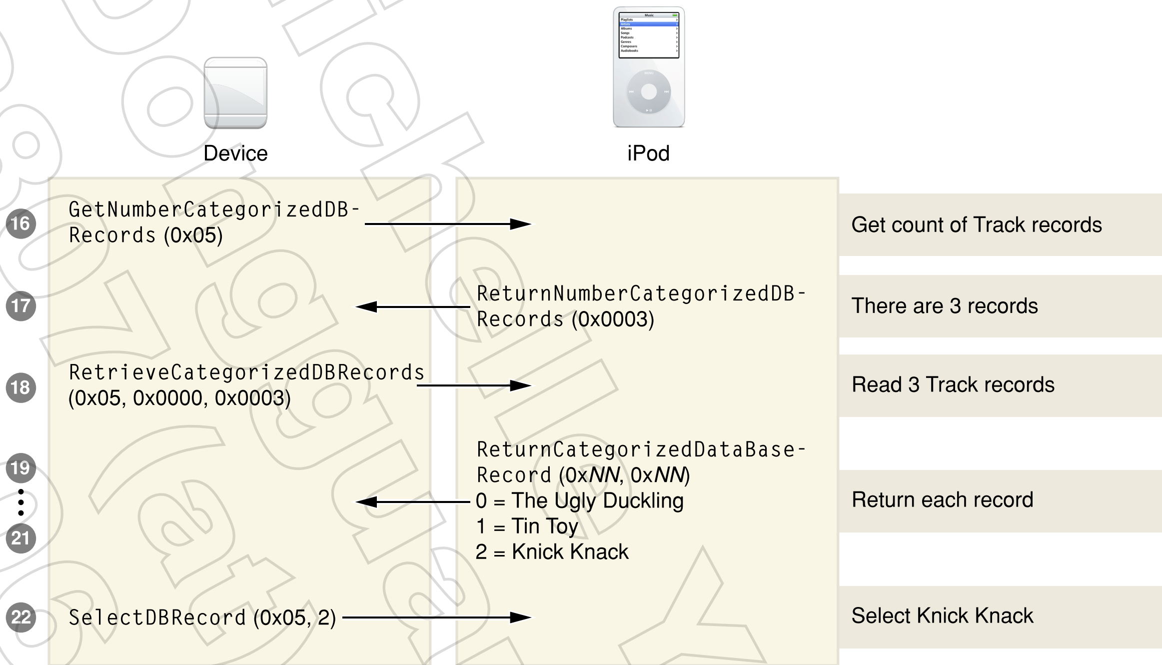



Figure 4-4 (page 362) diagrams the same kind of process with a movie. Note that in the case of the movie, the hierarchy search drops through two levels because those levels each contain only one record.

**Figure 4-4** Navigating to a movie: example of interactions between a device and an iPod






In video browsing, categorized DB records can be retrieved in any order, following essentially the same rules as navigating audio categories. It is not necessary to select the media kind. Table 4-8 (page 363) illustrates the process of selecting a playlist that contains video material.

**Table 4-8** Selecting playlists containing video

| Step | Action or command | Direction | Comments |
|---|---|---|---|
| 1 | Pass 0x02 (video) in `ResetDBSelectionHierarchy` | Device to iPod | Switch to video hierarchy. |
| 2 | Pass 0x01 (playlist) in `GetNumberCategorizedDBRecords` | Device to iPod | Get count of playlists containing video. Any playlist that has at least one video track will be counted. |
| 3 | Receive 0x05 from `ReturnNumberCategorizedDBRecords` | iPod to Device | There are 5 records. |
| 4 | Pass (0x01,0x0000,0x0005) in `RetrieveCategorizedDatabaseRecords` | Device to iPod | Get 5 video playlists starting with index 0. |
| 5–9 | Receive data from `ReturnCategorizedDataBaseRecord` | iPod to Device | Return 5 record strings from the database. |
| 10 | Pass (0x01, 0x0001) in `SelectDBRecord` | Device to iPod | Select video playlist index 1. Only video tracks will be displayed. |

Following the steps shown above, the video track selection process can follow steps 16 to 22 shown in Navigating to a movie: example of interactions between a device and an iPod (page 363).

## Sample Extended Interface Session

Table 4-9 (page 364) shows a typical sequence of Extended Interface commands. This command sequence explores the iPod's database and then returns information about a specific track.

**Table 4-9** Typical extended interface commands

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| The device identifies itself, is authenticated by iPod, and enters extended interface mode. | | | |
| 1 | `GetDBiTunesInfo(0x00)` | | Device requests database UID from iPod. The UID is used by the device to determine if this iPod database has been attached before. |
| 2 | | `RetDBiTunesInfo` | The iPod returns database UID. The device checks the UID to see if it has a match to previously cached DB contents. |
| 3 | `GetDBiTunesInfo(0x01)` | | The device requests database last sync date/time. |
| 4 | | `RetDBiTunesInfo` | The iPod returns database last sync date/time. If DB has been cached by the device, the date/time is checked to see if the DB has been synced since the last time. |
| 5 | `GetDBiTunesInfo(0x02)` | | The device requests database total audio track count. |
| 6 | | `RetDBiTunesInfo` | The iPod returns database total audio track count. If DB has been cached by the device, the audio track count is checked to see if the DB has changed since the contents were cached. A count of 0 (no tracks are present) can be used to gray out or remove audio options in the accessory's user interface. |
| 7 | `GetDBiTunesInfo(0x03)` | | The device requests database total video track count. |

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| 8 | | `RetDBiTunesInfo` | The iPod returns database total video track count. If DB has been cached by the device, the video track count is checked to see if the DB has changed since the contents were cached. A count of 0 (no tracks are present) can be used to gray out or remove video options in the accessory's user interface. |
| 9 | `GetDBiTunesInfo(0x04)` | | The device requests database total audiobook track count. |
| 10 | | `RetDBiTunesInfo` | The iPod returns database total audiobook track count. If DB has been cached by the device, the audiobook track count is checked to see if the DB has changed since the contents were cached. |
| 11 | `ResetDBSelection` | | The device resets database selection before getting the total track count. |
| 12 | | `ACK` | The iPod acknowledges the `ResetDBSelection` command. |
| 13 | `GetNumberCategorized-DBRecords(0x05)` | | The device gets the database track count. |
| 14 | | `RetNumberCategorized-DBRecords` | The iPod returns the database track count. |
| 15 | `GetDBTrackInfo(0, trackCount, infoMask)` | | The device requests track information for all audio tracks. The infoMask tells iPod what types of information should be returned for each track. |
| 16 | | `RetDBTrackInfo(N, infoType, trackInfo)` | The iPod returns track index N information of type `infoType`. |
| ... | | | |
| 17 | | `RetDBTrackInfo(N, infoType+t, trackInfo)` | The iPod returns track index N information of type `infoType+t`. |
| 18 | | `RetDBTrackInfo(N+1, infoType, trackInfo)` | The iPod returns track index N+1 information of type `infoType`. |
| ... | | | |

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| 19 | | `RetDBTrackInfo(N+1, infoType+t, trackInfo)` | The iPod returns track index N+1 information of type `infoType+t`. |
| ... | | | |
| 20 | | `RetDBTrackInfo(N+n, infoType, trackInfo)` | The iPod returns track index N+n information of type `infoType`. |
| ... | | | |
| 21 | | `RetDBTrackInfo(N+n, infoType+t, trackInfo)` | The iPod returns track index N+n information of type `infoType+t`. |
| 22 | `GetNumPlayingTracks` | | The device gets the playing track count. |
| 23 | | `RetNumPlayingTracks` | The iPod returns the playing track count. |
| 24 | `GetPBTrackInfo(0, trackCount, infoMask)` | | The device requests track information for all audio tracks. The infoMask tells iPod what types of information should be returned for each track. |
| 25 | | `RetPBTrackInfo(N, infoType, trackInfo)` | The iPod returns track index N information of type `infoType`. |
| ... | | | |
| 26 | | `RetPBTrackInfo(N, infoType+t, trackInfo)` | The iPod returns track index N information of type `infoType+t`. |
| 27 | | `RetPBTrackInfo(N+1, infoType, trackInfo)` | The iPod returns track index N+1 information of type `infoType`. |
| ... | | | |
| 28 | | `RetPBTrackInfo(N+1, infoType+t, trackInfo)` | The iPod returns track index N+1 information of type `infoType+t`. |
| ... | | | |
| 29 | | `RetPBTrackInfo(N+n, infoType, trackInfo)` | The iPod returns track index N+n information of type `infoType`. |
| ... | | | |

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| 30 | | `RetPBTrackInfo(N+n, infoType+t, trackInfo)` | The iPod returns track index N+n information of type `infoType+t`. |
| 31 | `GetUIDTrackInfo(trackUID, infoMask)` | | The device requests track information for the specified track UID (the track UID was obtained via the `GetDBTrackInfo` or `GetPBTrackInfo` commands). The infoMask tells the iPod what types of information should be returned for the track. |
| 32 | | `RetUIDTrackInfo(UID, infoType, trackInfo)` | The iPod returns track UID information of type `infoType`. |
| ... | | | |
| 33 | | `RetUIDTrackInfo(UID, infoType+t, trackInfo)` | The iPod returns track UID information of type `infoType+t`. |

# Command Packets

This section describes the individual iPod Extended Interface (Lingo 0x04) command packets.

Unless otherwise specified, the following rules apply:

- All packet data fields larger than 8 bits are sent and received in big-endian format; that is, ordered from the most significant byte to the least significant byte.
- Device command packets that have a valid checksum but contain an invalid parameter, invalid command, or other such failure cause the iPod to respond with an ACK command containing the appropriate error status.
- A packet with an invalid checksum received by iPod is presumed to be invalid and is ignored. No ACK or other command is sent to the device in response to the invalid packet.
- All UTF-8 strings returned from the iPod are null-terminated.
- All commands require authentication before they can be used over the USB port link. Some commands require authentication when used over a serial link; see Table 4-10 (page 368) for a list.

## Command Code Summary

Table 4-10 (page 368) lists the valid command codes for the Extended Interface protocol.

**Table 4-10** Extended Interface lingo command summary

| Command ID | Command | Target engine | Introduced in protocol version | Requires authentication over serial link |
|---|---|---|---|---|
| 0x0000 | Reserved | N/A | N/A | N/A |
| 0x0001 | ACK | N/A | 1.00 | No |
| 0x0002 | GetCurrentPlaying-TrackChapterInfo | Playback Engine | 1.06 | No |
| 0x0003 | ReturnCurrentPlaying-TrackChapterInfo | Playback Engine | 1.06 | No |
| 0x0004 | SetCurrentPlaying-TrackChapter | Playback Engine | 1.06 | No |
| 0x0005 | GetCurrentPlaying-TrackChapterPlayStatus | Playback Engine | 1.06 | No |
| 0x0006 | ReturnCurrentPlaying-TrackChapterPlayStatus | Playback Engine | 1.06 | No |
| 0x0007 | GetCurrentPlaying-TrackChapterName | Playback Engine | 1.06 | No |
| 0x0008 | ReturnCurrentPlaying-TrackChapterName | Playback Engine | 1.06 | No |
| 0x0009 | GetAudiobookSpeed | N/A | 1.06 | No |
| 0x000A | ReturnAudiobookSpeed | N/A | 1.06 | No |
| 0x000B | SetAudiobookSpeed | N/A | 1.06 | No |
| 0x000C | GetIndexedPlaying-TrackInfo | Playback Engine | 1.08 | No |
| 0x000D | ReturnIndexedPlaying-TrackInfo | N/A | 1.08 | No |
| 0x000E | GetArtworkFormats | Playback Engine | 1.10 | No |
| 0x000F | RetArtworkFormats | Playback Engine | 1.10 | No |
| 0x0010 | GetTrackArtworkData | Playback Engine | 1.10 | No |
| 0x0011 | RetTrackArtworkData | Playback Engine | 1.10 | No |
| 0x0012 | RequestProtocolVersion | See "Deprecated Extended Interface Commands" (page 528). | | |

| Command ID | Command | Target engine | Introduced in protocol version | Requires authentication over serial link |
|---|---|---|---|---|
| 0x0013 | ReturnProtocolVersion | See "Deprecated Extended Interface Commands" (page 528). | | |
| 0x0014 | RequestiPodName | See "Deprecated Extended Interface Commands" (page 528). | | |
| 0x0015 | ReturniPodName | See "Deprecated Extended Interface Commands" (page 528). | | |
| 0x0016 | ResetDBSelection | Database Engine | 1.00 | No |
| 0x0017 | SelectDBRecord | Database Engine<br>As an optimization, selecting a single track or audiobook automatically passes it to the player. | 1.00 | No |
| 0x0018 | GetNumberCategorized-DBRecords | Database Engine | 1.00 | No |
| 0x0019 | ReturnNumber-CategorizedDBRecords | N/A | 1.00 | No |
| 0x001A | RetrieveCategorized-DatabaseRecords | Database Engine | 1.00 | No |
| 0x001B | ReturnCategorized-DatabaseRecord | N/A | 1.00 | No |
| 0x001C | GetPlayStatus | Playback Engine | 1.00 | No |
| 0x001D | ReturnPlayStatus | N/A | 1.00 | No |
| 0x001E | GetCurrentPlaying-TrackIndex | Playback Engine | 1.00 | No |
| 0x001F | ReturnCurrentPlaying-TrackIndex | N/A | 1.00 | No |
| 0x0020 | GetIndexedPlaying-TrackTitle | Playback Engine | 1.00 | No |
| 0x0021 | ReturnIndexedPlaying-TrackTitle | N/A | 1.00 | No |
| 0x0022 | GetIndexedPlaying-TrackArtistName | Playback Engine | 1.00 | No |

| Command ID | Command | Target engine | Introduced in protocol version | Requires authentication over serial link |
|---|---|---|---|---|
| 0x0023 | ReturnIndexedPlaying-TrackArtistName | N/A | 1.00 | No |
| 0x0024 | GetIndexedPlaying-TrackAlbumName | Playback Engine | 1.00 | No |
| 0x0025 | ReturnIndexedPlaying-TrackAlbumName | N/A | 1.00 | No |
| 0x0026 | SetPlayStatusChange-Notification | Playback Engine | 1.00 | No |
| 0x0027 | PlayStatusChange-Notification | N/A | 1.00 | No |
| 0x0028 | PlayCurrentSelection | Database and Playback Engines.<br>This command copies items from the database to the Playback Engine. | 1.00 | No |
| 0x0029 | PlayControl | Playback Engine | 1.00 | No |
| 0x002A | GetTrackArtworkTimes | Playback Engine | 1.10 | No |
| 0x002B | RetTrackArtworkTimes | Playback Engine | 1.10 | No |
| 0x002C | GetShuffle | N/A | 1.00 | No |
| 0x002D | ReturnShuffle | N/A | 1.00 | No |
| 0x002E | SetShuffle | N/A | 1.00 | No |
| 0x002F | GetRepeat | N/A | 1.00 | No |
| 0x0030 | ReturnRepeat | N/A | 1.00 | No |
| 0x0031 | SetRepeat | N/A | 1.00 | No |
| 0x0032 | SetDisplayImage | N/A | 1.01 | No |
| 0x0033 | GetMonoDisplay-ImageLimits | N/A | 1.01 | No |
| 0x0034 | ReturnMonoDisplay-ImageLimits | N/A | 1.01 | No |
| 0x0035 | GetNumPlayingTracks | Playback Engine | 1.01 | No |
| 0x0036 | ReturnNumPlayingTracks | N/A | 1.01 | No |

| Command ID | Command | Target engine | Introduced in protocol version | Requires authentication over serial link |
|---|---|---|---|---|
| 0x0037 | SetCurrentPlayingTrack | Playback Engine | 1.01 | No |
| 0x0038 | SelectSortDBRecord | Database Engine<br>As an optimization, selecting a single track or audiobook automatically passes it to the player. | 1.01 | No |
| 0x0039 | GetColorDisplay-ImageLimits | N/A | 1.09 | No |
| 0x003A | ReturnColorDisplay-ImageLimits | N/A | 1.09 | No |
| 0x003B | ResetDBSelection-Hierarchy | Database Engine | 1.11 | Yes |
| 0x003C | GetDBiTunesInfo | Database Engine | 1.13 | Yes |
| 0x003D | RetDBiTunesInfo | Database Engine | 1.13 | Yes |
| 0x003E | GetUIDTrackInfo | Database Engine | 1.13 | Yes |
| 0x003F | RetUIDTrackInfo | Database Engine | 1.13 | Yes |
| 0x0040 | GetDBTrackInfo | Database Engine | 1.13 | Yes |
| 0x0041 | RetDBTrackInfo | Database Engine | 1.13 | Yes |
| 0x0042 | GetPBTrackInfo | Playback Engine | 1.13 | Yes |
| 0x0043 | RetPBTrackInfo | Playback Engine | 1.13 | Yes |
| 0x0044 – 0xFFFF | Reserved | N/A | N/A | N/A |

## Command 0x0001: ACK

Direction: iPod to Device

The iPod sends this command to acknowledge the receipt of a command and return the command status. The command ID field indicates the device command for which the response is being sent. The command status indicates the results of the command (success or failure).

**Table 4-11** `ACK` command

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x06 | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x01 | Command ID (bits 7:0) |
| 6 | 0x*NN* | Command result status. Possible values are:<br>■ 0x00 = Success (OK)<br>■ 0x01 = ERROR: Unknown database category<br>■ 0x02 = ERROR: Command failed<br>■ 0x03 = ERROR: Out of resources<br>■ 0x04 = ERROR: Bad parameter<br>■ 0x05 = ERROR: Unknown ID<br>■ 0x06 = Reserved<br>■ 0x07 = Accessory not authenticated<br>■ 0x08 – 0xFF = Reserved |
| 7 | 0x*NN* | The ID of the command being acknowledged (bits 15:8). |
| 8 | 0x*NN* | The ID of the command being acknowledged (bits 7:0). |
| 9 | 0x*NN* | Packet payload checksum byte |

## Command 0x0002: GetCurrentPlayingTrackChapterInfo

Direction: Device to iPod

Applies To: Playback Engine

Requests the chapter information of the currently playing track. In response, the iPod sends a "Command 0x0003: ReturnCurrentPlayingTrackChapterInfo" (page 373) command to the device.

**Note:** The returned track index is valid only when there is a currently playing or paused track.

**Table 4-12** `GetCurrentPlayingTrackChapterInfo` command

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x03 | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x02 | Command ID (bits 7:0) |
| 6 | 0xF7 | Packet payload checksum byte |

## Command 0x0003: ReturnCurrentPlayingTrackChapterInfo

Direction: iPod to Device

Returns the chapter information of the currently playing track. The iPod sends this command in response to the "Command 0x0002: GetCurrentPlayingTrackChapterInfo" (page 372) command from the device. The track chapter information includes the currently playing track's chapter index, as well as the total number of chapters in the track. The track chapter and the total number of chapters are 32-bit signed integers. The chapter index of the first chapter is always 0x00000000. If the track does not have chapter information, a chapter index of –1 (0xFFFFFFFF) and a chapter count of 0 (0x00000000) are returned.

**Table 4-13** `ReturnCurrentPlayingTrackChapterInfo` command

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x0B | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x03 | Command ID (bits 7:0) |
| 6 | 0x*NN* | Current chapter index (bits 31:24) |
| 7 | 0x*NN* | Current chapter index (bits 23:16) |
| 8 | 0x*NN* | Current chapter index (bits 15:8) |

| Byte number | Value | Meaning |
|---|---|---|
| 9 | 0x*NN* | Current chapter index (bits 7:0) |
| 10 | 0x*NN* | Chapter count (bits 31:24) |
| 11 | 0x*NN* | Chapter count (bits 23:16) |
| 12 | 0x*NN* | Chapter count (bits 15:8) |
| 13 | 0x*NN* | Chapter count (bits 7:0) |
| 14 | 0x*NN* | Packet payload checksum byte |

## Command 0x0004: SetCurrentPlayingTrackChapter

Direction: Device to iPod

Applies To: Playback Engine

Sets the currently playing track chapter. You can send the "Command 0x0002: GetCurrentPlayingTrackChapterInfo" (page 372) command to get the chapter count and the index of the currently playing chapter in the current track. In response to the `SetCurrentPlayingTrackChapter` command, the iPod sends an ACK command with the command status.

> **Note:** This command should be used only when the iPod is in a playing or paused state. The command fails if the iPod is stopped or if the track does not contain chapter information.

**Table 4-14** `SetCurrentPlayingTrackChapter` command

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x07 | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x04 | Command ID (bits 7:0) |
| 6 | 0x*NN* | Chapter index (bits 31:24) |
| 7 | 0x*NN* | Chapter index (bits 23:16) |
| 8 | 0x*NN* | Chapter index (bits 15:8) |
| 9 | 0x*NN* | Chapter index (bits 7:0) |

| Byte number | Value | Meaning |
|---|---|---|
| 10 | 0x*NN* | Packet payload checksum byte |

## Command 0x0005: GetCurrentPlayingTrackChapterPlayStatus

Direction: Device to iPod

Applies To: Playback Engine

Requests the chapter playtime status of the currently playing track. The status includes the chapter length and the time elapsed within that chapter. In response to a valid command, the iPod sends a "Command 0x0006: ReturnCurrentPlayingTrackChapterPlayStatus" (page 375) command to the device.

> **Note:** If the packet length or chapter index is invalid—for instance, if the track does not contain chapter information—the iPod responds with an ACK command including the specific error status.

**Table 4-15** `GetCurrentPlayingTrackChapterPlayStatus` command

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x07 | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x05 | Command ID (bits 7:0) |
| 6 | 0x*NN* | Currently playing chapter index (bits 31:24) |
| 7 | 0x*NN* | Currently playing chapter index (bits 23:16) |
| 8 | 0x*NN* | Currently playing chapter index (bits 15:8) |
| 9 | 0x*NN* | Currently playing chapter index (bits 7:0) |
| 10 | 0x*NN* | Packet payload checksum byte |

## Command 0x0006: ReturnCurrentPlayingTrackChapterPlayStatus

Direction: iPod to Device

Returns the play status of the currently playing track chapter. The iPod sends this command in response to the "Command 0x0005: GetCurrentPlayingTrackChapterPlayStatus" (page 375) command from the device. The returned information includes the chapter length and elapsed time, in milliseconds. If there is no currently playing chapter, the chapter length and elapsed time are zero.

**Table 4-16** `ReturnCurrentPlayingTrackChapterPlayStatus` command

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x0B | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x06 | Command ID (bits 7:0) |
| 6 | 0x*NN* | Chapter length in milliseconds (bits 31:24) |
| 7 | 0x*NN* | Chapter length in milliseconds (bits 23:16) |
| 8 | 0x*NN* | Chapter length in milliseconds (bits 15:8) |
| 9 | 0x*NN* | Chapter length in milliseconds (bits 7:0) |
| 10 | 0x*NN* | Elapsed time in chapter, in milliseconds (bits 31:24) |
| 11 | 0x*NN* | Elapsed time in chapter, in milliseconds (bits 23:16) |
| 12 | 0x*NN* | Elapsed time in chapter, in milliseconds (bits 15:8) |
| 13 | 0x*NN* | Elapsed time in chapter, in milliseconds (bits 7:0) |
| 14 | 0x*NN* | Packet payload checksum byte |

## Command 0x0007: GetCurrentPlayingTrackChapterName

Direction: Device to iPod

Applies To: Playback Engine

Requests a chapter name in the currently playing track. In response to a valid command, the iPod sends a "Command 0x0008: ReturnCurrentPlayingTrackChapterName" (page 377) command to the device.

**Note:** If the received packet length or track index is invalid—for instance, if the track does not have chapter information or is not a part of the Audiobook category—the iPod responds with an ACK command including the specific error status.

**Table 4-17** `GetCurrentPlayingTrackChapterName` command

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x07 | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x07 | Command ID (bits 7:0) |
| 6 | 0x*NN* | Chapter index (bits 31:24) |
| 7 | 0x*NN* | Chapter index (bits 23:16) |
| 8 | 0x*NN* | Chapter index (bits 15:8) |
| 9 | 0x*NN* | Chapter index (bits 7:0) |
| 10 | 0x*NN* | Packet payload checksum byte |

## Command 0x0008: ReturnCurrentPlayingTrackChapterName

Direction: iPod to Device

Returns a chapter name in the currently playing track. The iPod sends this command in response to a valid "Command 0x0007: GetCurrentPlayingTrackChapterName" (page 376) command from the device. The chapter name is encoded as a null-terminated UTF-8 character array.

**Note:** The chapter name string is not limited to 252 characters; it may be sent in small or large packet format depending on the string length. The small packet format is shown.

**Table 4-18** `ReturnCurrentPlayingTrackChapterName` command

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x*NN* | Packet payload length |

| Byte number | Value | Meaning |
|---|---|---|
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x08 | Command ID (bits 7:0) |
| 6…*N* | 0x*NN* | Chapter name as UTF-8 character array |
| (last byte) | 0x*NN* | Packet payload checksum byte |

## Command 0x0009: GetAudiobookSpeed

Direction: Device to iPod

Requests the current iPod audiobook speed state. The iPod responds with the "Command 0x000A: ReturnAudiobookSpeed" (page 378) command indicating the current audiobook speed.

**Table 4-19** `GetAudiobookSpeed` command

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x03 | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x09 | Command ID (bits 7:0) |
| 6 | 0xF0 | Packet payload checksum byte |

## Command 0x000A: ReturnAudiobookSpeed

Direction: iPod to Device

Returns the current audiobook speed setting. The iPod sends this command in response to the "Command 0x0009: GetAudiobookSpeed" (page 378) command from the device.

**Table 4-20** `ReturnAudiobookSpeed` command

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |

| Byte number | Value | Meaning |
|---|---|---|
| 2 | 0x04 | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x0A | Command ID (bits 7:0) |
| 6 | 0x*NN* | Audiobook speed status code. See Table 4-21 (page 379). |
| 7 | 0x*NN* | Packet payload checksum byte |

Table 4-21 (page 379) shows the possible audiobook speed states returned by this command.

**Table 4-21** Audiobook speed states

| Value | Meaning |
|---|---|
| 0xFF | Slower (–1) |
| 0x00 | Normal |
| 0x01 | Faster (+1) |
| 0x02 – 0xFE | Reserved |

## Command 0x000B: SetAudiobookSpeed

Direction: Device to iPod

Sets the speed of audiobook playback. The iPod audiobook speed states are listed in Table 4-21 (page 379). This command has two modes: one to set the speed of the currently playing audiobook and a second to set the audiobook speed for all audiobooks.

Byte number 7 is an optional byte; devices must not send this byte if they want to set the speed only of the currently playing audiobook. If devices want to set the global audiobook speed setting then they must use byte number 7. This is the Restore on Exit byte; a nonzero value restores the original audiobook speed setting when the accessory is detached. If this byte is zero, the audiobook speed setting set by the accessory is saved and persists after the accessory is detached from the iPod. See Table 4-23 (page 380) for the packet format used when including the Restore on Exit byte.

In response to this command, the iPod sends an ACK command with the command status.

**Note:** Accessory developers are encouraged to always use the Restore on Exit byte with a nonzero value, to restore any of the user's iPod settings that were modified by the accessory.

**Table 4-22** `SetAudiobookSpeed` command to set the speed of the currently playing audiobook

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x04 | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x0B | Command ID (bits 7:0) |
| 6 | 0x*NN* | New audiobook speed code. See Table 4-21 (page 379). |
| 7 | 0x*NN* | Packet payload checksum byte |

Table 4-23 (page 380) shows a command to set the global audiobook speed for all audiobooks and optionally restore the setting on accessory detach.

**Table 4-23** `SetAudiobookSpeed` command to set the global audiobook speed

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x05 | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x0B | Command ID (bits 7:0) |
| 6 | 0x*NN* | Global audiobook speed code. See Table 4-21 (page 379). |
| 7 | 0x*NN* | Restore on Exit byte. If 1, the original setting is restored on detach; if 0, the new setting persists after accessory detach. |
| 8 | 0x*NN* | Packet payload checksum byte |

## Command 0x000C: GetIndexedPlayingTrackInfo

Direction: Device to iPod

Applies To: Playback Engine

Gets track information for the track at the specified index. The track info type field specifies the type of information to be returned, such as current song lyrics, podcast name, episode date, and episode description. In response, the iPod sends the "Command 0x000D: ReturnIndexedPlayingTrackInfo" (page 382) command with the requested track information. If the information type is invalid or does not apply to the selected track, the iPod returns an ACK with an error status.

A device can determine the number of tracks in the list of tracks queued to play on the iPod by sending a "GetNumPlayingTracks" (page 423) command and receiving a "ReturnNumPlayingTracks" (page 424) command in reply.

**Table 4-24** `GetIndexedPlayingTrackInfo` command

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x0A | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x0C | Command ID (bits 7:0) |
| 6 | 0x*NN* | Track info type. See Table 4-25 (page 381). |
| 7 | 0x*NN* | Track index (bits 31:24) |
| 8 | 0x*NN* | Track index (bits 23:16) |
| 9 | 0x*NN* | Track index (bits 15:8) |
| 10 | 0x*NN* | Track index (bits 7:0) |
| 11 | 0x*NN* | Chapter index (bits 15:8) |
| 12 | 0x*NN* | Chapter index (bits 7:0) |
| (last byte) | 0x*NN* | Packet payload checksum byte |

Table 4-25 (page 381) shows the types of information you can obtain for a track.

**Table 4-25** Track information type

| Info Type | Code |
|---|---|
| 0x00 | Track Capabilities and Information |
| 0x01 | Podcast Name |
| 0x02 | Track Release Date |

| Info Type | Code |
|---|---|
| 0x03 | Track Description |
| 0x04 | Track Song Lyrics |
| 0x05 | Track Genre |
| 0x06 | Track Composer |
| 0x07 | Track Artwork Count |

**Note:** Requesting the lyrics of a track not currently being played will result in a null string being returned. Lyrics for a track being played may take up to 5 seconds to return. Use `SetPlayStatusChangeNotification` to be notified when the lyrics for the currently playing track become available.

## Command 0x000D: ReturnIndexedPlayingTrackInfo

Direction: iPod to Device

Returns the requested track information type and data. The iPod sends this command in response to the "Command 0x000C: GetIndexedPlayingTrackInfo" (page 380) command. Table 4-28 (page 384) lists the available information types and their data.

Data returned as strings are encoded as null-terminated UTF-8 character arrays. If the track information string does not exist, a null UTF-8 string is returned. If the track has no release date, then the returned release date has all bytes zeros. Track song lyrics and the track description are sent in a large or small packet format with an incrementing packet index field, spanning multiple packets if needed.

Table 4-26 (page 382) shows the packet format for the `ReturnIndexedPlayingTrackInfo` command sent in response to a request for information types 0x00 to 0x02.

**Table 4-26** `ReturnIndexedPlayingTrackInfo` command for info types 0x00-0x02 and 0x05-0x07

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte |
| 1 | 0x55 | Start of packet |
| 2 | 0x*NN* | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x0D | Command ID (bits 7:0) |
| 6 | 0x*NN* | Track info type. See Table 4-28 (page 384). |

| Byte number | Value | Meaning |
|---|---|---|
| 7 … *N* | 0x*NN* | Track information. The data format is specific to the track info type. See Table 4-28 (page 384). |
| (last byte) | 0x*NN* | Packet payload checksum byte |

Table 4-27 (page 383) shows the packet format for the `ReturnIndexedPlayingTrackInfo` command sent in response to a request for information types 0x03 to 0x04. The small packet format is not shown.

**Table 4-27** `ReturnIndexedPlayingTrackInfo` command for info types 0x03-0x04

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte |
| 1 | 0x55 | Start of packet |
| 2 | 0x00 | Packet payload marker (large format) |
| 3 | 0x*NN* | Large packet payload length (bits 15:8) |
| 4 | 0x*NN* | Large packet payload length (bits 7:0) |
| 5 | 0x04 | Lingo ID (Extended Interface lingo) |
| 6 | 0x00 | Command ID (bits 15:8) |
| 7 | 0x0D | Command ID (bits 7:0) |
| 8 | 0x*NN* | Track info type. See Table 4-28 (page 384). |
| 9 | 0x*NN* | Packet information bits. If set, these bits have the following meanings:<br>■ Bit 31:2 Reserved<br>■ Bit 1: This is the last packet. Applicable only if bit 0 is set.<br>■ Bit 0: Indicates that there are multiple packets. |
| 10 | 0x*NN* | Packet Index (bits 15:8) |
| 11 | 0x*NN* | Packet Index (bits 7:0) |
| 12 … *N* | 0x*NN* | Track information as a UTF-8 string. |
| (last byte) | 0x*NN* | Packet payload checksum byte |

Table 4-28 (page 384) shows the available track information types and the format of the data returned for each type.

**Table 4-28** Track info types and return data

| Info Type | Code | Data Format |
|---|---|---|
| 0x00 | Track Capabilities and Information | A 10-byte data. See Table 4-29 (page 384). |
| 0x01 | Podcast Name | UTF-8 string |
| 0x02 | Track Release Date | An 8-byte data. See Table 4-30 (page 385) |
| 0x03 | Track Description | UTF-8 string |
| 0x04 | Track Song Lyrics | UTF-8 string |
| 0x05 | Track Genre | UTF-8 string |
| 0x06 | Track Composer | UTF-8 string |
| 0x07 | Track Artwork Count | Artwork count data. The artwork count is a sequence of 4-byte records; each record consists of a 2-byte format ID value followed by a 2-byte count of images in that format for this track. For more information about formatID and chapter index values, see commands 0x000E-0x0011 and 0x002A-0x002B. |
| 0x08-0xFF | Reserved | N/A |

Table 4-29 (page 384) shows the data returned for the Track Capabilities and Information type.

**Table 4-29** Track Capabilities and Information encoding

| Byte number | Code |
|---|---|
| 0x00-0x03 | Track Capability bits. If set, these bits have the following meanings:<br>■ Bit 31:9: Reserved<br>■ Bit 8: Track is currently queued to play as a video<br>■ Bit 7: Track contains video (a video podcast, music video, movie, or TV show)<br>■ Bit 6: Track has description<br>■ Bit 5: Track has release date<br>■ Bit 4: Track is a podcast episode<br>■ Bit 3: Track has song lyrics<br>■ Bit 2: Track has album artwork<br>■ Bit 1: Track has chapters<br>■ Bit 0: Track is audiobook |
| 0x04 | Total track length, in milliseconds (bits 31:24) |
| 0x05 | Total track length, in milliseconds (bits 23:16) |

| Byte number | Code |
|---|---|
| 0x06 | Total track length, in milliseconds (bits 15:8) |
| 0x07 | Total track length, in milliseconds (bits 7:0) |
| 0x08 | Chapter count (bits 15:8) |
| 0x09 | Chapter count (bits 7:0) |

Table 4-30 (page 385) shows the data returned for the Track Release Date type.

**Table 4-30** Track Release Date encoding

| Byte number | Code |
|---|---|
| 0x00 | Seconds (0-59) |
| 0x01 | Minutes (0-59) |
| 0x02 | Hours (0-23) |
| 0x03 | Day of the month (1-31) |
| 0x04 | Month (1–12) |
| 0x05 | Year (bits 15:8). For example, 2006 signifies the year 2006 AD. |
| 0x06 | Year (bits 7:0). |
| 0x07 | Weekday (0-6, where 0 = Sunday and 6 = Saturday) |

## Command 0x000E: GetArtworkFormats

Direction: Device to iPod

Applies To: Playback Engine

The device sends this command to obtain the list of supported artwork formats on the iPod. No parameters are sent. See "Transferring Album Art" (page 354).

**Table 4-31** `GetArtworkFormats` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x03 | Length of packet |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |

| Byte number | Value | Comment |
|---|---|---|
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x0E | Command ID (bits 7:0) |
| 6 | 0xEB | Checksum |

## Command 0x000F: RetArtworkFormats

Direction: iPod to Device

Applies To: Playback Engine

The iPod sends this command to the device, giving it the list of supported artwork formats. Each format is described in a 7-byte record (formatID:2, pixelFormat:1, width:2, height:2). The `formatID` is used when sending `GetTrackArtworkTimes`. The device may return zero records. See "Transferring Album Art" (page 354).

**Table 4-32** `RetArtworkFormats` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x*NN* | Length of packet |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x0F | Command ID (bits 7:0) |
| *NN* | 0x*NN* | formatID (15:8) iPod-assigned value for this format |
| *NN* | 0x*NN* | formatID (7:0) |
| *NN* | 0x*NN* | pixelFormat. Same as from `SetDisplayImage` |
| *NN* | 0x*NN* | imageWidth (15:8). Number of pixels wide for each image. |
| *NN* | 0x*NN* | imageWidth (7:0) |
| *NN* | 0x*NN* | imageHeight (15:8). Number of pixels high for each image. |
| *NN* | 0x*NN* | imageHeight (7:0) |
| Previous 7 bytes may be repeated *NN* times | | |
| (last byte) | 0x*NN* | Checksum |

## Command 0x0010: GetTrackArtworkData

Direction: Device to iPod

Applies To: Playback Engine

The device sends this command to the iPod to request data for a given `trackIndex`, `formatID`, and `artworkIndex`. See "Transferring Album Art" (page 354). The time offset from track start is the value returned by "GetTrackArtworkTimes" (page 409).

**Table 4-33** `GetTrackArtworkData` packet

| Byte number | Value | Comment |
| --- | --- | --- |
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x0D | Length of packet |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x10 | Command ID (bits 7:0) |
| 6 | 0x*NN* | trackIndex (31:24). |
| 7 | 0x*NN* | trackIndex (23:16) |
| 8 | 0x*NN* | trackIndex (15:8) |
| 9 | 0x*NN* | trackIndex (7:0) |
| 10 | 0x*NN* | formatID (15:8) |
| 11 | 0x*NN* | formatID (7:0) |
| 12 | 0x*NN* | time offset from track start, in ms (31:24) |
| 13 | 0x*NN* | time offset from track start, in ms (23:16) |
| 14 | 0x*NN* | time offset from track start, in ms (15:8) |
| 15 | 0x*NN* | time offset from track start, in ms (7:0) |
| 16 | 0x*NN* | Checksum |

## Command 0x0011: RetTrackArtworkData

Direction: iPod to Device

Applies To: Playback Engine

The iPod sends the requested artwork to the accessory. Multiple `RetTrackArtworkData` commands may be necessary to transfer all the data because it will be too much to fit into a single packet. See "Transferring Album Art" (page 354).

This command uses nearly the same format as the `SetDisplayImage` command (command 0x0032). The only difference is the addition of 2 coordinates; they define an inset rectangle that describes any padding that may have been added to the image. The coordinates consist of two x,y pairs. Each x or y value is 2 bytes, so the total size of the coordinate set is 8 bytes.

**Table 4-34** `RetTrackArtworkData` packet

| Byte number | Value | Comment |
| --- | --- | --- |
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x*NN* | Length of packet |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x11 | Command ID (bits 7:0) |
| 6 | 0x00 | Descriptor packet index (15:8). These fields uniquely identify each packet in the `RetTrackArtworkData` transaction. The first command is the descriptor packet, which always starts with an index of 0x0000. |
| 7 | 0x00 | Descriptor packet index (7:0) |
| 8 | 0x*NN* | Display pixel format code. |
| 9 | 0x*NN* | Image width in pixels (15:8) |
| 10 | 0x*NN* | Image width in pixels (7:0) |
| 11 | 0x*NN* | Image height in pixels (15:8) |
| 12 | 0x*NN* | Image height in pixels (7:0) |
| 13 | 0x*NN* | Inset rectangle, top-left point, x value (15:8) |
| 14 | 0x*NN* | Inset rectangle, top-left point, x value (7:0) |
| 15 | 0x*NN* | Inset rectangle, top-left point, y value (15:8) |
| 16 | 0x*NN* | Inset rectangle, top-left point, y value (7:0) |
| 17 | 0x*NN* | Inset rectangle, bottom-right point, x value (15:8) |
| 18 | 0x*NN* | Inset rectangle, bottom-right point, x value (7:0) |
| 19 | 0x*NN* | Inset rectangle, bottom-right point, y value (15:8) |
| 20 | 0x*NN* | Inset rectangle, bottom-right point, y value (7:0) |

| Byte number | Value | Comment |
|---|---|---|
| 21 | 0x*NN* | Row size in bytes (31:24) |
| 22 | 0x*NN* | Row size in bytes (23:16) |
| 23 | 0x*NN* | Row size in bytes (15:8) |
| 24 | 0x*NN* | Row size in bytes (7:0) |
| 25-*NN* | 0x*NN*... | Image pixel data (variable length) |
| (last byte) | 0x*NN* | Checksum |

In subsequent packets in the sequence, bytes 8 through 24 are omitted.

## Command 0x0016: ResetDBSelection

Direction: Device to iPod

Applies To: Database Engine

Resets the current database selection to an empty state, invalidates the category entry count (sets the count to 0) for all categories except the playlist category, and sets the database hierarchy to the audio hierarchy (even if it is currently in the video hierarchy). This is analogous to pressing the Menu button repeatedly to get to the topmost iPod HMI menu. Any previously selected database items are deselected. The command has no effect on the Playback Engine. In response, the iPod sends an ACK command with the command status.

Once the accessory has reset the database selection, it must initialize the category count before it can select database records. Please refer to "Command 0x0018: GetNumberCategorizedDBRecords" (page 392) and "Command 0x0017: SelectDBRecord" (page 390) for details.

**Note:** Starting with protocol version 1.07, the `ResetDBSelection` command clears the sort order.

**Table 4-35** `ResetDBSelection` command

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x03 | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x16 | Command ID (bits 7:0) |

| Byte number | Value | Meaning |
|---|---|---|
| 6 | 0xE3 | Packet payload checksum byte |

## Command 0x0017: SelectDBRecord

Direction: Device to iPod

Applies To: Database Engine. Selecting a single track automatically passes it to the Playback Engine.

Selects one or more records in the Database Engine, based on a category relative index. For example, selecting category two (artist) and record index one results in a list of selected tracks (or database records) from the second artist in the artist list. Table 4-37 (page 391) lists the available database categories.

**Note:** With the iPhone and iPod touch, selecting a specific track in a playlist containing only skip-when-shuffle tracks causes the entire playlist to be shuffled and passed to the Playback Engine. With other iPods, passing a valid track index with `SelectDBRecord` and a playlist containing only skip-when-shuffle tracks causes a single track to be passed to the Playback Engine. Use the `GetNumPlayingTracks` command to query the number of songs in the Playback Engine before using any other Playback Engine commands to alter playback.

Selections are additive and limited by the category hierarchy; see "Database Category Hierarchies" (page 350) for more information about category hierarchies. Subsequent selections are made based on the subset of records resulting from the previous selections and not from the entire database. Note that the selection of a single record automatically passes it to the Playback Engine and starts its playback. Record indices consist of a 32-bit signed integer. To select database records with a specific sort order, use "Command 0x0038: SelectSortDBRecord" (page 425).

`SelectDBRecord` may be called only after a category count has been initialized through a call to "Command 0x0018: GetNumberCategorizedDBRecords" (page 392). Without a valid category count, the `SelectDBRecord` call cannot select a database record and the result of calling it will be undefined. Accessories that make use of "Command 0x0016: ResetDBSelection" (page 389) must always initialize the category count before selecting a new database record using `SelectDBRecord`.

Accessories should pay close attention to the ACK returned by the `SelectDBRecord` command. Ignoring errors may cause unexpected behavior.

To undo a database selection, send the `SelectDBRecord` command with the current category selected in the Database Engine and a record index of –1 (0xFFFFFFFF). This has the same effect as pressing the iPod Menu button once and moves the database selection up to the next highest menu level. For example, if a device selected artist number three and then album number one, it could use the `SelectDBRecord(Album, -1)` command to return to the database selection of artist number three. If multiple database selections have been made, devices can use any of the previously used categories to return to the next highest database selection. If the category used in one of these `SelectDBRecord` commands has not been used in a previous database selection then the command is treated as a no-op.

Sending a `SelectDBRecord` command with the Track or Audiobook category and a record index of –1 is invalid, because the previous database selection made with the Track category and a valid index passes the database selection to the Playback Engine. Sending a `SelectDBRecord(Track, -1)` command returns a parameter error. The iPod also returns a bad parameter error ACK when devices send the `SelectDBRecord` command with an invalid category type, or with the Track category and an index greater than the total number of tracks available on the iPod.

> **Note:** Selecting a podcast always selects from the main podcast library regardless of the current category context of the iPod.

To immediately go to the topmost iPod menu level and reset all database selections, send the `ResetDBSelection` command to the iPod.

**Table 4-36** `SelectDBRecord` command

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x08 | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x17 | Command ID (bits 7:0) |
| 6 | 0x*NN* | Database category type. See Table 4-37 (page 391). |
| 7 | 0x*NN* | Database record index (bits 31:24) |
| 8 | 0x*NN* | Database record index (bits 23:16) |
| 9 | 0x*NN* | Database record index (bits 15:8) |
| 10 | 0x*NN* | Database record index (bits 7:0) |
| 11 | 0x*NN* | Packet payload checksum byte |

Table 4-37 (page 391) lists the valid database categories.

**Table 4-37** Database category types for commands

| Category | Code | Protocol version |
|---|---|---|
| Reserved | 0x00 | N/A |
| Playlist | 0x01 | 1.00 |
| Artist | 0x02 | 1.00 |
| Album | 0x03 | 1.00 |
| Genre | 0x04 | 1.00 |
| Track | 0x05 | 1.00 |
| Composer | 0x06 | 1.00 |

| Category | Code | Protocol version |
|---|---|---|
| Audiobook | 0x07 | 1.06 |
| Podcast | 0x08 | 1.08 |
| Nested playlist | 0x09 | 1.13 |
| Reserved | 0x0A – 0xFF | N/A |

## Command 0x0018: GetNumberCategorizedDBRecords

Direction: Device to iPod

Applies To: Database Engine

Retrieves the number of records in a particular database category. For example, a device can get the number of artists or albums present in the database. The category types are described in Table 4-37 (page 391). The iPod responds with a "Command 0x0019: ReturnNumberCategorizedDBRecords" (page 393) command indicating the number of records present for this category.

`GetNumberCategorizedDBRecords` must be called to initialize the category count before selecting a database record using "Command 0x0017: SelectDBRecord" (page 390) or "Command 0x0038: SelectSortDBRecord" (page 425) commands. A category's record count can change based on the prior categories selected and the database hierarchy. The accessory is expected to call `GetNumberCategorizedDBRecords` in order to get the valid range of category entries before selecting a record in that category.

**Note:** The record count returned by this command depends on the database state before this command is sent. If the database has been reset using "Command 0x0016: ResetDBSelection" (page 389), this command returns the total number of records for a given category. However, if this command is sent after one or more categories are selected, the record count is the subset of records that are members of all the categories selected prior to this command.

**Table 4-38** `GetNumberCategorizedDBRecords` command

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x04 | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x18 | Command ID (bits 7:0) |
| 6 | 0x*NN* | Database category type. See Table 4-37 (page 391). |

| Byte number | Value | Meaning |
|---|---|---|
| 7 | 0x*NN* | Packet payload checksum byte |

## Command 0x0019: ReturnNumberCategorizedDBRecords

Direction: iPod to Device

Returns the number of database records matching the specified database category. The iPod sends this command in response to the "Command 0x0018: GetNumberCategorizedDBRecords" (page 392) command from the device. Individual records can then be extracted by sending "Command 0x001A: RetrieveCategorizedDatabaseRecords" (page 393) to the iPod.

If no matching database records are found, a record count of zero is returned. Category types are described in Table 4-37 (page 391).

After selecting the podcast category, the number of artist, album, composer, genre, and audiobook records is always zero.

**Table 4-39** `ReturnNumberCategorizedDBRecords` command

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x07 | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x19 | Command ID (bits 7:0) |
| 6 | 0x*NN* | Database record count (bits 31:24) |
| 7 | 0x*NN* | Database record count (bits 23:16) |
| 8 | 0x*NN* | Database record count (bits 15:8) |
| 9 | 0x*NN* | Database record count (bits 7:0) |
| 10 | 0x*NN* | Packet payload checksum byte |

## Command 0x001A: RetrieveCategorizedDatabaseRecords

Direction: Device to iPod

Applies To: Database Engine

Retrieves one or more database records from the iPod, typically based on the results from the "Command 0x0018: GetNumberCategorizedDBRecords" (page 392) query. The database category types are described in Table 4-37 (page 391).

This command specifies the starting record index and the number of records to retrieve (the record count). This allows a device to retrieve an individual record or the entire set of records for a category. The record start index and record count consist of 32-bit signed integers. To retrieve all records from a given starting record index, set the record count to –1 (0xFFFFFFFF).

The iPod responds to this command with a separate "Command 0x001B: ReturnCategorizedDatabaseRecord" (page 394) command for each record matching the specified criteria (category and record index range).

**Table 4-40** `RetrieveCategorizedDatabaseRecords` command

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x0C | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x1A | Command ID (bits 7:0) |
| 6 | 0x*NN* | Database category type. See Table 4-37 (page 391). |
| 7 | 0x*NN* | Database record start index (bits 31:24) |
| 8 | 0x*NN* | Database record start index (bits 23:16) |
| 9 | 0x*NN* | Database record start index (bits 15:8) |
| 10 | 0x*NN* | Database record start index (bits 7:0) |
| 11 | 0x*NN* | Database record read count (bits 31:24) |
| 12 | 0x*NN* | Database record read count (bits 23:16) |
| 13 | 0x*NN* | Database record read count (bits 15:8) |
| 14 | 0x*NN* | Database record read count (bits 7:0) |
| 15 | 0x*NN* | Packet payload checksum byte |

## Command 0x001B: ReturnCategorizedDatabaseRecord

Direction: iPod to Device

Contains information for a single database record. The iPod sends one or more of these commands in response to the "Command 0x001A: RetrieveCategorizedDatabaseRecords" (page 393) command from the device. The category record index is included to allow the device to determine which record has been sent. The record data is sent as a null-terminated UTF-8 encoded data array.

**Note:** The database record string is not limited to 252 characters; it may be sent in small or large packet format, depending on the record size. The small packet format is shown.

**Table 4-41** `ReturnCategorizedDatabaseRecord` command

| Byte number | Value | Meaning |
| --- | --- | --- |
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x*NN* | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x1B | Command ID (bits 7:0) |
| 6 | 0x*NN* | Database record category index (bits 31:24) |
| 7 | 0x*NN* | Database record category index (bits 23:16) |
| 8 | 0x*NN* | Database record category index (bits 15:8) |
| 9 | 0x*NN* | Database record category index (bits 7:0) |
| 10…*N* | 0x*NN* | Database record as a UTF-8 character array. |
| (last byte) | 0x*NN* | Packet payload checksum byte |

## Command 0x001C: GetPlayStatus

Direction: Device to iPod

Applies To: Playback Engine

Requests the current iPod playback status, allowing the device to display feedback to the user. In response, the iPod sends a "Command 0x001D: ReturnPlayStatus" (page 396) command with the current playback status.

**Note:** An accessory must not call `GetPlayStatus` more often than once a second. Instead of polling for the play status with this command, the accessory should request notifications from the iPod using `SetPlayStatusChangeNotification`.

**Table 4-42** `GetPlayStatus` command

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x03 | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x1C | Command ID (bits 7:0) |
| 6 | 0xDD | Packet payload checksum byte |

## Command 0x001D: ReturnPlayStatus

Direction: iPod to Device

Returns the current iPod playback status. The iPod sends this command in response to the "Command 0x001C: GetPlayStatus" (page 395) command from the device. The information returned includes the current track length, track position, and player state.

**Note:** The track length and track position fields are valid only if the player state is Playing or Paused. For other player states, these fields must be ignored.

**Table 4-43** `ReturnPlayStatus` command

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x0C | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x1D | Command ID (bits 7:0) |
| 6 | 0x*NN* | Track length in milliseconds (bits 31:24) |

| Byte number | Value | Meaning |
|---|---|---|
| 7 | 0x*NN* | Track length in milliseconds (bits 23:16) |
| 8 | 0x*NN* | Track length in milliseconds (bits 15:8) |
| 9 | 0x*NN* | Track length in milliseconds (bits 7:0) |
| 10 | 0x*NN* | Track position in milliseconds (bits 31:24) |
| 11 | 0x*NN* | Track position in milliseconds (bits 23:16) |
| 12 | 0x*NN* | Track position in milliseconds (bits 15:8) |
| 13 | 0x*NN* | Track position in milliseconds (bits 7:0) |
| 14 | 0x*NN* | Player state. Possible values are:<br>■ 0x00 = Stopped<br>■ 0x01 = Playing<br>■ 0x02 = Paused<br>■ 0x03 – 0xFE = Reserved<br>■ 0xFF = Error |
| 15 | 0x*NN* | Packet payload checksum byte |

## Command 0x001E: GetCurrentPlayingTrackIndex

Direction: Device to iPod

Applies To: Playback Engine

Requests the Playback Engine index of the currently playing track. In response, the iPod sends a "Command 0x001F: ReturnCurrentPlayingTrackIndex" (page 398) command to the device.

**Note:** The track index returned is valid only if there is currently a track playing or paused.

**Table 4-44** `GetCurrentPlayingTrackIndex` command

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x03 | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |

| Byte number | Value | Meaning |
|---|---|---|
| 5 | 0x1E | Command ID (bits 7:0) |
| 6 | 0xDB | Packet payload checksum byte |

## Command 0x001F: ReturnCurrentPlayingTrackIndex

Direction: iPod to Device

Returns the Playback Engine index of the current playing track in response to the "Command 0x001E: GetCurrentPlayingTrackIndex" (page 397) command from the device. The track index is a 32-bit signed integer. If there is no track currently playing or paused, an index of –1 (0xFFFFFFFF) is returned.

**Table 4-45** `ReturnCurrentPlayingTrackIndex` command

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x07 | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x1F | Command ID (bits 7:0) |
| 6 | 0x*NN* | Playback track index (bits 31:24) |
| 7 | 0x*NN* | Playback track index (bits 23:16) |
| 8 | 0x*NN* | Playback track index (bits 15:8) |
| 9 | 0x*NN* | Playback track index (bits 7:0) |
| 10 | 0x*NN* | Packet payload checksum byte |

## Command 0x0020: GetIndexedPlayingTrackTitle

Direction: Device to iPod

Applies To: Playback Engine

Requests the title name of the indexed playing track from the iPod. In response to a valid command, the iPod sends a "Command 0x0021: ReturnIndexedPlayingTrackTitle" (page 399) command to the device.

**Note:** If the packet length or playing track index is invalid, the iPod responds with an ACK command including the specific error status.

**Table 4-46** `GetIndexedPlayingTrackTitle` command

| Byte number | Value | Meaning |
| --- | --- | --- |
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x07 | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x20 | Command ID (bits 7:0) |
| 6 | 0x*NN* | Playback track index (bits 31:24) |
| 7 | 0x*NN* | Playback track index (bits 23:16) |
| 8 | 0x*NN* | Playback track index (bits 15:8) |
| 9 | 0x*NN* | Playback track index (bits 7:0) |
| 10 | 0x*NN* | Packet payload checksum byte |

## Command 0x0021: ReturnIndexedPlayingTrackTitle

Direction: iPod to Device

Returns the title of the indexed playing track in response to a valid "Command 0x0020: GetIndexedPlayingTrackTitle" (page 398) command from the device. The track title is encoded as a null-terminated UTF-8 character array.

**Note:** The track title string is not limited to 252 characters; it may be sent in small or large packet format, depending on the string length. The small packet format is shown.

**Table 4-47** `ReturnIndexedPlayingTrackTitle` command

| Byte number | Value | Meaning |
| --- | --- | --- |
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x*NN* | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |

| Byte number | Value | Meaning |
|---|---|---|
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x21 | Command ID (bits 7:0) |
| 6…*N* | 0x*NN* | Track title as a UTF-8 character array |
| (last byte) | 0x*NN* | Packet payload checksum byte |

## Command 0x0022: GetIndexedPlayingTrackArtistName

Direction: Device to iPod

Applies To: Playback Engine

Requests the name of the artist of the indexed playing track. In response to a valid command, the iPod sends a "Command 0x0023: ReturnIndexedPlayingTrackArtistName" (page 401) command to the device.

**Note:** If the packet length or playing track index is invalid, the iPod responds with an ACK command including the specific error status.

**Table 4-48** `GetIndexedPlayingTrackArtistName` command

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x07 | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x22 | Command ID (bits 7:0) |
| 6 | 0x*NN* | Playback track index (bits 31:24) |
| 7 | 0x*NN* | Playback track index (bits 23:16) |
| 8 | 0x*NN* | Playback track index (bits 15:8) |
| 9 | 0x*NN* | Playback track index (bits 7:0) |
| 10 | 0x*NN* | Packet payload checksum byte |

## Command 0x0023: ReturnIndexedPlayingTrackArtistName

Direction: iPod to Device

Returns the artist name of the indexed playing track in response to a valid "Command 0x0022: GetIndexedPlayingTrackArtistName" (page 400) command from the device. The track artist name is encoded as a null-terminated UTF-8 character array.

**Note:** The artist name string is not limited to 252 characters; it may be sent in small or large packet format, depending on the string length. The small packet format is shown.

**Table 4-49** `ReturnIndexedPlayingTrackArtistName` command

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x*NN* | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x23 | Command ID (bits 7:0) |
| 6…*N* | 0x*NN* | Artist name as UTF-8 character array |
| (last byte) | 0x*NN* | Packet payload checksum byte |

## Command 0x0024: GetIndexedPlayingTrackAlbumName

Direction: Device to iPod

Applies To: Playback Engine

Requests the album name of the indexed playing track. In response to a valid command, the iPod sends a "Command 0x0025: ReturnIndexedPlayingTrackAlbumName" (page 402) command to the device.

**Note:** If the received packet length or playing track index is invalid, the iPod responds with an ACK command including the specific error status.

**Table 4-50** `GetIndexedPlayingTrackAlbumName` command

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |

| Byte number | Value | Meaning |
|---|---|---|
| 2 | 0x07 | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x24 | Command ID (bits 7:0) |
| 6 | 0x*NN* | Playback track index (bits 31:24) |
| 7 | 0x*NN* | Playback track index (bits 23:16) |
| 8 | 0x*NN* | Playback track index (bits 15:8) |
| 9 | 0x*NN* | Playback track index (bits 7:0) |
| 10 | 0x*NN* | Packet payload checksum byte |

## Command 0x0025: ReturnIndexedPlayingTrackAlbumName

Direction: iPod to Device

Returns the album name of the indexed playing track in response to a valid "Command 0x0024: GetIndexedPlayingTrackAlbumName" (page 401) command from the device. The track album name is encoded as a null-terminated UTF-8 character array.

**Note:** The album name string is not limited to 252 characters; it may be sent in small or large packet format, depending on the string length. The small packet format is shown.

**Table 4-51** `ReturnIndexedPlayingTrackAlbumName` command

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x*NN* | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x25 | Command ID (bits 7:0) |
| 6…*N* | 0x*NN* | Album name as a UTF-8 character array |
| (last byte) | 0x*NN* | Packet payload checksum byte |

## Command 0x0026: SetPlayStatusChangeNotification

Direction: Device to iPod

Applies To: Playback Engine

This command is sent by the device to control the status change event types sent by the iPod.

There are two forms of the command. The one-byte form accepts a single Boolean to enable or disable all notifications for play state, track index, track time position, FFW/REW seek stop, and chapter index changes (`StatusChangeNotification` types 0x00-0x05). The packet for this form of the command is shown in Table 4-52 (page 403). When the value of byte 6 is set to 0x00, all notifications are disabled, whether set by the one-byte or four-byte form of the command.

The four-byte form expands the status notification control into individual bits for each type of status. The packet for this form of the command is shown in Table 4-53 (page 403). Bytes 6 through 9 are a fixed-length bitmask of events to be enabled or disabled, where 1 = enable, 0 = disable.

If any notifications are enabled, their notification conditions are tested approximately every 500 milliseconds. When the conditions change, notifications are sent to the device.

> **Note:** Status change notifications are not sent when the iPod leaves the power-on state. This means that no notifications are sent while the iPod remains in either the sleep or hibernate states. When the iPod returns to the power-on state, status notifications resume with their previous settings.

**Table 4-52** One-byte `SetPlayStatusChangeNotification` command

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x04 | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x26 | Command ID (bits 7:0) |
| 6 | 0x*NN* | Enable/disable notifications; see Table 4-54 (page 404). |
| 7 | 0x*NN* | Packet payload checksum byte |

**Table 4-53** Four-byte `SetPlayStatusChangeNotification` command

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |

| Byte number | Value | Meaning |
|---|---|---|
| 2 | 0x07 | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x26 | Command ID (bits 7:0) |
| 6 | 0x00 | Notification event mask (bits 31:24) |
| 7 | 0x00 | Notification event mask (bits 23:16) |
| 8 | 0x*NN* | Notification event mask (bits 15:8); see Table 4-55 (page 404) |
| 9 | 0x*NN* | Notification event mask (bits 7:0); see Table 4-55 (page 404) |
| 10 | 0x*NN* | Packet payload checksum byte |

**Table 4-54** One-byte status change event values

| Value | Description |
|---|---|
| 0x00 | Disable all status event notifications |
| 0x01 | Enable play status notifications for basic play state, track index, track time position, FFW/REW seek stop, and chapter index changes (`StatusChangeNotification` types 0x00-0x05). |
| 0x02-0xFF | Reserved |

**Table 4-55** Four-byte status change event mask bits

| Bit | Description |
|---|---|
| 00 | Basic play state changes (stop, FFW seek stop, or REW seek stop, using status notification types 0x00, 0x02, or 0x03). |
| 01 | Extended play state changes (playback stop, FFW seek start, REW seek start, playback started, FFW/REW seek stop, or playback pause using status notification type 0x06). Uses `PlayControl` command control codes as the play status codes; see Table 4-60 (page 408). |
| 02 | Track index |
| 03 | Track time offset (ms) |
| 04 | Track time offset (sec) |
| 05 | Chapter index |
| 06 | Chapter time offset (ms) |
| 07 | Chapter time offset (sec) |

| Bit | Description |
|---|---|
| 08 | Track unique identifier |
| 09 | Track media type (audio/video) |
| 10 | Track lyrics ready (if the track has lyrics) |
| 11-31 | Reserved |

## Command 0x0027: PlayStatusChangeNotification

Direction: iPod to Device

This command is sent by the iPod to notify the device about extended interface status changes. The types of status notifications sent to the device are controlled by the "SetPlayStatusChangeNotification" (page 403) command.

**Note:** Status change notifications are not sent when the iPod leaves the power-on state. This means that no notifications are sent while the iPod remains in either the sleep or hibernate states. When the iPod returns to the power-on state, status notifications resume with their previous settings.

**Table 4-56** `PlayStatusChangeNotification` command

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x*NN* | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x27 | Command ID (bits 7:0) |
| 6-0x*NN* | 0x*NN* | New play status. See Table 4-57 (page 405). |
| (last byte) | 0x*NN* | Packet payload checksum byte |

**Table 4-57** Play status change notification codes

| Status change | Parameters | Description |
|---|---|---|
| Playback stopped | {0x00} | |
| Track index | {0x01, `trackIndex`; 4} | `trackIndex` = playback engine track index |
| Playback FFW seek stop | {0x02} | |

| Status change | Parameters | Description |
|---|---|---|
| Playback REW seek stop | {0x03} | |
| Track time offset | {0x04, `trackOffsetMs`; 4} | `trackOffsetMs` = track time offset in milliseconds |
| Chapter index | {0x05, `chapIndex`; 4} | `chapIndex` = chapter index |
| Playback status extended | {0x06, `playState`; 1} | `playState` = playback state:<br>0x00-0x01 = Reserved<br>0x02 = Stopped<br>0x03-0x04 = Reserved<br>0x05 = FFW seek started<br>0x06 = REW seek started<br>0x07 = FFW/REW seek stopped<br>0x08-0x09 = Reserved<br>0x0A = Playing<br>0x0B = Paused<br>0x0C-0xFF = Reserved |
| Track time offset | {0x07, `trackOffsetSec`; 4} | `trackOffsetSec` = track time offset in seconds |
| Chapter time offset (ms) | {0x08, `chapTimeMs`; 4} | `chapTimeMs` = chapter time offset in milliseconds |
| Chapter time offset (sec) | {0x09, `chapTimeSec`; 4} | `chapTimeSec` = chapter time offset in seconds |
| Track unique identifier | {0x0A, `trackUID`; 8} | `trackUID` = track unique identifier |
| Track playback mode | {0x0B, `playMode`; 1} | `playMode` = playback mode of current playing track (see Note, below):<br>0x00 = Audio track<br>0x01 = Video track<br>0x02-0xFF = Reserved |
| Track lyrics ready | {0x0C} | Lyrics for the currently playing track are available for download |
| Reserved | {0x0D-0xFF} | |

**Note:** The playback mode when a track is playing may depend on the database hierarchy that was current when the track was selected. Hybrid video/audio tracks (such as music videos or video podcasts) are queued as audio tracks if selected in the audio DB hierarchy, or queued as video tracks if selected in the video DB hierarchy.

## Command 0x0028: PlayCurrentSelection

Direction: Device to iPod

Applies To: Playback and Database Engines. This command copies items from the database engine to the Playback Engine.

Requests playback of the currently selected track or list of tracks. The currently selected tracks are placed in the Now Playing playlist, where they are optionally shuffled (if the shuffle feature is enabled). Finally, the specified track record index is passed to the player to play. Note that if the track index is –1 (0xFFFFFFFF), the first track after the shuffle is complete is played first. If a track index of *n* is sent, the *n*th track of the selected tracks is played first, regardless of where it is located in the Now Playing playlist after the shuffle is performed (assuming that shuffle is on). In response, the iPod sends an ACK command indicating the status of the command.

**Note:** If the shuffle feature is enabled, any track that has the Skip When Shuffle attribute will be excluded from the Now Playing playlist unless its track record index is passed by this command, in which case it will play. With a playlist that contains only skip-when-shuffle tracks, the next action depends on the iPod model. With the iPhone and iPod touch, the next track will be shuffled and played; with other iPods, no further tracks will play.

**Table 4-58** `PlayCurrentSelection` command

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x07 | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x28 | Command ID (bits 7:0) |
| 6 | 0x*NN* | Selection track record index (bits 31:24) |
| 7 | 0x*NN* | Selection track record index (bits 23:16) |
| 8 | 0x*NN* | Selection track record index (bits 15:8) |
| 9 | 0x*NN* | Selection track record index (bits 7:0) |
| 10 | 0x*NN* | Packet payload checksum byte |

## Command 0x0029: PlayControl

Direction: Device to iPod

Applies To: Playback Engine

This command is sent by the device to control the media playback state of the iPod. If the iPod is already in the requested state, the command has no effect and returns successfully. If the iPod does not enter the requested state successfully, an error status is returned. In response, theiPod sends an `ACK` command with the play control status.

> **Note:** The iPod models before the 2G nano (09/2006) always return a successful status. Starting with the 2G nano, iPods return the actual play control status. This means that a next or previous track command will return an error if no media is playing.

**Table 4-59** `PlayControl` command

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x04 | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x29 | Command ID (bits 7:0) |
| 6 | 0x*NN* | Play control command code. See Table 4-60 (page 408). |
| 7 | 0x*NN* | Packet payload checksum byte |

Table 4-60 (page 408) shows the iPod play states the device can set.

**Table 4-60** Play control command codes

| Command | Code | Protocol | Comments |
|---|---|---|---|
| Reserved | 0x00 | Reserved | |
| Toggle Play/Pause | 0x01 | 1.00 | |
| Stop | 0x02 | 1.00 | |
| Next Track | 0x03 | 1.00 | These commands skip to the next or previous track. If the current track has played less than two seconds, Previous Track backs up to the beginning of the previous track. If the current track has played more than two seconds, it backs up to the beginning of the current track. These commands skip to the next or previous track even when the current track has chapters. To control audiobook playing by chapters, use the Next (0x08) and Previous (0x09) commands. |
| Previous Track | 0x04 | 1.00 | |
| Start FF | 0x05 | 1.00 | |

| Command | Code | Protocol | Comments |
| --- | --- | --- | --- |
| Start Rew | 0x06 | 1.00 | |
| End FF/Rew | 0x07 | 1.00 | |
| Next | 0x08 | 1.06 | If the current track is an audiobook or a podcast with chapters, these commands skip to the next or previous chapter; **see Note below.** Otherwise they act like Next Track (0x03) and Previous Track (0x04). |
| Previous | 0x09 | 1.06 | |
| Play | 0x0A | 1.13 | |
| Pause | 0x0B | 1.13 | |
| Next Chapter | 0x0C | 1.14 | If the current track is an audiobook or a podcast with chapters, these commands skip to the next or previous chapter; otherwise they have no effect. |
| Previous Chapter | 0x0D | 1.14 | |
| Reserved | 0x0E – 0xFF | N/A | |

**Note:** If a track has chapters, the Next code (0x08) will advance to the beginning of the next chapter. If the track is playing its last chapter or has no chapters, the Next code will advance to the beginning of the next track. If a track has chapters and is more than two seconds into the current chapter, the Previous code (0x09) will back up to the beginning of the current chapter. If it is less than two seconds into the current chapter, the Previous code will back up to the beginning of the previous chapter. If the track has no chapters, the Previous code will back up to the beginning of the previous track.

## Command: 0x002A: GetTrackArtworkTimes

Direction: Device to iPod

Applies To: Playback Engine

The device sends this command to the iPod to request the list of artwork time locations for a track. A 4-byte `trackIndex` specifies which track from the Playback Engine is to be selected. A 2-byte `formatID` indicates which type of artwork is desired. See "Transferring Album Art" (page 354).

The 2-byte `artworkIndex` specifies at which index to begin searching for artwork. A value of 0 indicates that the iPod should start with the first available artwork.

The 2-byte `artworkCount` specifies the maximum number of times (artwork locations) to be returned. A value of –1 (0xFFFF) indicates that there is no preferred limit. Note that podcasts may have a large number of associated images.

**Table 4-61** `GetTrackArtworkTimes` packet

| Byte number | Value | Comment |
| --- | --- | --- |
| 0 | 0xFF | Sync byte (required only for UART serial) |

| Byte number | Value | Comment |
|---|---|---|
| 1 | 0x55 | Start of packet |
| 2 | 0x0D | Length of packet |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x2A | Command ID (bits 7:0) |
| 6 | 0x*NN* | trackIndex (31:24) |
| 7 | 0x*NN* | trackIndex (23:16) |
| 8 | 0x*NN* | trackIndex (15:8) |
| 9 | 0x*NN* | trackIndex (7:0) |
| 10 | 0x*NN* | formatID (15:8) |
| 11 | 0x*NN* | formatID (7:0) |
| 12 | 0x*NN* | artworkIndex (15:8) |
| 13 | 0x*NN* | artworkIndex (7:0) |
| 14 | 0x*NN* | artworkCount (15:8) |
| 15 | 0x*NN* | artworkCount (7:0) |
| 16 | 0x*NN* | Checksum |

## Command: 0x002B: RetTrackArtworkTimes

Direction: iPod to Device

Applies To: Playback Engine

The iPod sends this command to the device to return the list of artwork times for a given track. The iPod returns zero or more 4-byte times, one for each piece of artwork associated with the track and format specified by `GetTrackArtworkTimes`. See "Transferring Album Art" (page 354).

The number of records returned will be no greater than the number specified in the `GetTrackArtworkTimes` command. It may, however, be less than requested. This can happen if there are fewer pieces of artwork available than were requested, or if the iPod is unable to place the full number in a single packet. Check the number of records returned against the results of `ReturnIndexedPlayingTrackInfo` with `infoType` 8 to ensure that all artwork has been received.

**Table 4-62** `RetTrackArtworkTimes` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x*NN* | Length of packet |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x2B | Command ID (bits 7:0) |
| 6 | 0x*NN* | time offset from track start in ms (31:24) |
| 7 | 0x*NN* | time offset from track start in ms (23:16) |
| 8 | 0x*NN* | time offset from track start in ms (15:8) |
| 9 | 0x*NN* | time offset from track start in ms (7:0) |
| Preceding 4 bytes may be repeated *NN* times | | |
| (last byte) | 0x*NN* | Checksum |

## Command 0x002C: GetShuffle

Direction: Device to iPod

Requests the current state of the iPod shuffle setting. The iPod responds with the "Command 0x002D: ReturnShuffle" (page 412) command.

**Table 4-63** `GetShuffle` command

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x03 | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x2C | Command ID (bits 7:0) |
| 6 | 0xCD | Packet payload checksum byte |

## Command 0x002D: ReturnShuffle

Direction: iPod to Device

Returns the current state of the shuffle setting. The iPod sends this command in response to the "Command 0x002C: GetShuffle" (page 411) command from the device.

**Table 4-64** `ReturnShuffle` command

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x04 | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x2D | Command ID (bits 7:0) |
| 6 | 0x*NN* | Shuffle mode. See Table 4-65 (page 412). |
| 7 | 0x*NN* | Packet payload checksum byte |

Table 4-65 (page 412) lists the possible values of the shuffle mode.

**Table 4-65** Shuffle modes

| Value | Meaning |
|---|---|
| 0x00 | Shuffle off |
| 0x01 | Shuffle tracks |
| 0x02 | Shuffle albums |
| 0x03 – 0xFF | Reserved |

## Command 0x002E: SetShuffle

Direction: Device to iPod

Sets the iPod shuffle mode. The iPod shuffle modes are listed in Table 4-65 (page 412). In response, the iPod sends an ACK command with the command status.

This command has an optional byte, byte 0x07, called the Restore on Exit byte. This byte can be used to restore the original shuffle setting in use when the accessory was attached to the iPod. A nonzero value restores the original shuffle setting of the iPod when the accessory is detached. If this byte is zero, the shuffle setting set by the accessory overwrites the original setting and persists after the accessory is detached from the iPod.

Accessory engineers should note that the shuffle mode affects items only in the Playback Engine. The shuffle setting does not affect the order of tracks in the database engine, so calling "Command 0x001A: RetrieveCategorizedDatabaseRecords" (page 393) on a database selection with the shuffle mode set returns a list of unshuffled tracks. To get the shuffled playlist, an accessory must query the Playback Engine by calling "Command 0x0020: GetIndexedPlayingTrackTitle" (page 398).

Shuffling tracks does not affect the track index, just the track at that index. If an unshuffled track at playback index 1 is shuffled, a new track is placed into index 1. The playback indexes themselves are not shuffled.

When shuffle mode is enabled, tracks that are marked “skip when shuffling” are filtered from the database selection. This affects all audiobooks and all tracks that the user has marked in iTunes. It also affects all podcasts unless their default “skip when shuffling” markings have been deliberately removed. To apply the filter to the Playback Engine, the accessory must send "Command 0x0017: SelectDBRecord" (page 390) or "Command 0x0028: PlayCurrentSelection" (page 407) after enabling shuffle mode.

**Note:** Accessory developers are encouraged to always use the Restore on Exit byte with a nonzero value to restore any settings modified by the accessory upon detach.

Table 4-66 (page 413) shows a command to set the shuffle setting and optionally restore it on accessory detach.

**Table 4-66** `SetShuffle` command with Restore on Exit byte

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x05 | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x2E | Command ID (bits 7:0) |
| 6 | 0x*NN* | New shuffle mode. See Table 4-65 (page 412). |
| 7 | 0x*NN* | Restore on Exit byte. If 1, the original setting is restored on detach; if 0, the new setting persists after accessory detach. |
| 8 | 0x*NN* | Packet payload checksum byte |

Table 4-67 (page 414) shows a command to make the shuffle setting persistent after the accessory detach.

**Table 4-67** SetShuffle command

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x04 | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x2E | Command ID (bits 7:0) |
| 6 | 0x*NN* | New shuffle mode. See Table 4-65 (page 412). |
| 7 | 0x*NN* | Packet payload checksum byte |

## Command 0x002F: GetRepeat

Direction: Device to iPod

Requests the track repeat state of the iPod. In response, the iPod sends a " Command 0x0030: ReturnRepeat" (page 414) command to the device.

**Table 4-68** GetRepeat command

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x03 | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x2F | Command ID (bits 7:0) |
| 6 | 0xCA | Packet payload checksum byte |

## Command 0x0030: ReturnRepeat

Direction: iPodto Device

Returns the current iPod track repeat state to the device. The iPod sends this command in response to the "Command 0x002F: GetRepeat" (page 414) command.

**Table 4-69** `ReturnRepeat` command

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x04 | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x30 | Command ID (bits 7:0) |
| 6 | 0x*NN* | Repeat state. See Table 4-70 (page 415). |
| 7 | 0x*NN* | Packet payload checksum byte |

Table 4-70 (page 415) lists the possible values of the repeat state field.

**Table 4-70** Repeat state values

| Value | Meaning |
|---|---|
| 0x00 | Repeat off |
| 0x01 | Repeat one track |
| 0x02 | Repeat all tracks |
| 0x03 – 0xFF | Reserved |

## Command 0x0031: SetRepeat

Direction: Device to iPod

Sets the repeat state of the iPod. The iPod track repeat modes are listed in Table 4-70 (page 415). In response, the iPod sends an ACK command with the command status.

This command has an optional byte, byte 0x07, called the Restore on Exit byte. This byte can be used to restore the original repeat setting in use when the accessory was attached to the iPod. A nonzero value restores the original repeat setting of the iPod when the accessory is detached. If this byte is zero, the repeat setting set by the accessory overwrites the original setting and persists after the accessory is detached from the iPod.

> **Note:** Accessory developers are encouraged to always use the Restore on Exit byte with a nonzero value to restore any settings modified by the accessory upon detach.

Table 4-71 (page 416) shows a command to set the repeat setting and optionally restore it on accessory detach.

**Table 4-71** `SetRepeat` command with Restore on Exit byte

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x05 | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x31 | Command ID (bits 7:0) |
| 6 | 0x*NN* | New repeat state. See Table 4-70 (page 415). |
| 7 | 0x*NN* | Restore on Exit byte. If 1, the original setting is restored on detach; if 0, the new setting persists after accessory detach. |
| 8 | 0x*NN* | Packet payload checksum byte |

Table 4-72 (page 416) shows a command to make the repeat setting persistent after the accessory detach.

**Table 4-72** `SetRepeat` command

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x04 | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x31 | Command ID (bits 7:0) |
| 6 | 0x*NN* | New repeat state. See Table 4-70 (page 415). |
| 7 | 0x*NN* | Packet payload checksum byte |

## Command 0x0032: SetDisplayImage

Direction: Device to iPod

Sets a bitmap image that is shown on the iPod display when it is connected to the device. The intent is to allow third party branding when the iPod is communicating with an external device. An image downloaded using this mechanism replaces the default checkmark bitmap image that is displayed when iPod is connected to an external device. The new bitmap is retained in RAM for as long as the iPod remains powered. After a system reset or Sleep state, the new bitmap is lost and the checkmark image restored as the default when the iPod next enters Extended Interface mode after power-up.

Before setting a monochrome display image, the device can send the "Command 0x0033: GetMonoDisplayImageLimits" (page 422) command to obtain the current iPod display width, height and pixel format. The monochrome display information returned in the "Command 0x0034: ReturnMonoDisplayImageLimits" (page 422) command can be useful to the device in deciding which type of display image format is suitable for downloading to the iPod.

On iPods with color displays, devices can send the "Command 0x0039: GetColorDisplayImageLimits" (page 427) command to obtain the iPod color display width, height, and pixel formats. The color display information is returned in the "Command 0x003A: ReturnColorDisplayImageLimits" (page 428) command.

To set a display image, the device must successfully send `SetDisplayImage` descriptor and data commands to the iPod. The `SetDisplayImage` descriptor command (packet index 0x0000) must be sent first, as it gives the iPod a description of the image to be downloaded. This command is shown in Table 4-73 (page 417)). The image descriptor command includes image pixel format, image width and height, and display row size (stride) in bytes. Optionally, the descriptor command may also contain the beginning data of the display image, as long as it remains within the maximum length limits of the packet.

Following the descriptor command, the `SetDisplayImage` data commands (packet index 0x0001 – 0x*NNNN*) must be sent using sequential packet indices until the entire image has been sent to the iPod.

**Note:** The `SetDisplayImage` command payload length is limited to 500 bytes. This packet length limit and the size and format of the display image generally determine the minimum number of packets that are required to set a display image.

**Note:** Starting with the second generation iPod nano with version 1.1.2 firmware, using the `SetDisplayImage` command is limited to once every 15 seconds over USB transport. The iPod classic and iPod 3G nano apply a different restriction to both USB and UART transports: calls made to `SetDisplayImage` after the first 15 seconds will return a successful `ACK` command, but the bitmap will not be displayed on the iPod's screen. Hence, use of the `SetDisplayImage` command should be limited to drawing bitmap images only immediately after entering Extended mode. The iPod touch accepts the `SetDisplayImage` command but will not draw it on the iPod's screen.

Table 4-73 (page 417) shows the format of a descriptor command. This example assumes the display image descriptor data exceeds the small packet payload capacity; a large packet format is shown.

**Table 4-73** `SetDisplayImage` descriptor command (packet index = 0x0000)

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x00 | Packet payload marker (large format) |
| 3 | 0x*NN* | Large packet payload length (bits 15:8) |
| 4 | 0x*NN* | Large packet payload length (bits 7:0) |

| Byte number | Value | Meaning |
|---|---|---|
| 5 | 0x04 | Lingo ID: Extended Interface lingo |
| 6 | 0x00 | Command ID (bits 15:8) |
| 7 | 0x32 | Command ID (bits 7:0) |
| 8 | 0x00 | Descriptor command index (bits 15:8). These fields uniquely identify each packet in the `SetDisplayImage` transaction. The first command is the Descriptor command and always starts with an index of 0x0000. |
| 9 | 0x00 | Descriptor command index (bits 7:0) |
| 10 | 0x*NN* | Display pixel format code. See Table 4-75 (page 420). |
| 11 | 0x*NN* | Image width in pixels (bits 15:8). The number of pixels, from left to right, per row. |
| 12 | 0x*NN* | Image width in pixels (bits 7:0) |
| 13 | 0x*NN* | Image height in pixels (bits 15:8). The number of rows, from top to bottom, in the image. |
| 14 | 0x*NN* | Image height in pixels (bits 7:0) |
| 15 | 0x*NN* | Row size (stride) in bytes (bits 31:24). The number of bytes representing one row of pixels. Each row is zero-padded to end on a 32-bit boundary. The cumulative size, in bytes, of the image data, transferred across all packets in this transaction is effectively `(Row Size * Image Height)`. |
| 16 | 0x*NN* | Row size (stride) in bytes (bits 23:16) |
| 17 | 0x*NN* | Row size (stride) in bytes (bits 15:8) |
| 18 | 0x*NN* | Row size (stride) in bytes (bits 7:0) |
| 19 – *N* | 0x*NN* | Display image pixel data |
| (last byte) | 0x*NN* | Packet payload checksum byte |

**Note:** Table 4-74 (page 418) shows the format of a data command. This example assumes the display image data exceeds the small packet payload capacity; a large packet format is shown.

**Table 4-74** `SetDisplayImage` data packet (packet index = 0x0001 – 0xNNNN)

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x00 | Packet payload marker (large format) |

| Byte number | Value | Meaning |
|---|---|---|
| 3 | 0x*NN* | Large packet payload length (bits 15:8) |
| 4 | 0x*NN* | Large packet payload length (bits 7:0) |
| 5 | 0x04 | Lingo ID: Extended Interface lingo |
| 6 | 0x00 | Command ID (bits 15:8) |
| 7 | 0x32 | Command ID (bits 7:0) |
| 8 | 0x*NN* | Descriptor command index (bits 15:8). These fields uniquely identify each packet in the `SetDisplayImage` transaction. The first command is the descriptor command, shown in Table 4-73 (page 417). The remaining `n-1` commands are simply data packets, where `n` is determined by the size of the image. |
| 9 | 0x*NN* | Descriptor packet index (bits 7:0) |
| 10 – *N* | 0x*NN* | Display image pixel data |
| (last byte) | 0x*NN* | Packet payload checksum byte |

**Note:** A known issue causes `SetDisplayImage` data packet lengths less than 11 bytes to return a bad parameter error (0x04) ACK on 3G iPods.

The iPod display is oriented as a rectangular grid of pixels. In the horizontal direction (x-coordinate), the pixel columns are numbered, left to right, from 0 to Cmax. In the vertical direction (y-coordinate), the pixel rows are numbered, top to bottom, from 0 to Rmax. Therefore, an (x,y) coordinate of (0,0) represents the upper-leftmost pixel on the display and (Cmax,Rmax) represents the lower-rightmost pixel on the display. A portion of the iPod display pixel layout is shown below, where x is the column number, y is the row number, and (Cmax,Rmax) represents the maximum row and column numbers.

| Pixel layout | *x* | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| *y* | 0,0 | 1,0 | 2,0 | 3,0 | 4,0 | 5,0 | 6,0 | 7,0 | … | Cmax,0 |
| | 0,1 | 1,1 | 2,1 | 3,1 | 4,1 | 5,1 | 6,1 | 7,1 | … | Cmax,1 |
| | 0,2 | 1,2 | 2,2 | 3,2 | 4,2 | 5,2 | 6,2 | 7,2 | … | Cmax,2 |
| | 0,3 | 1,3 | 2,3 | 3,3 | 4,3 | 5,3 | 6,3 | 7,3 | … | Cmax,3 |
| | 0,4 | 1,4 | 2,4 | 3,4 | 4,4 | 5,4 | 6,4 | 7,4 | … | Cmax,4 |
| | 0,5 | 1,5 | 2,5 | 3,5 | 4,5 | 5,5 | 6,5 | 7,5 | … | Cmax,5 |
| | 0,6 | 1,6 | 2,6 | 3,6 | 4,6 | 5,6 | 6,6 | 7,6 | … | Cmax,6 |
| | 0,7 | 1,7 | 2,7 | 3,7 | 4,7 | 5,7 | 6,7 | 7,7 | … | Cmax,7 |
| | … | … | … | … | … | … | … | … | … | … |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0, Rmax | 1, Rmax | 2, Rmax | 3, Rmax | 4, Rmax | 5, Rmax | 6, Rmax | 7, Rmax | … | Cmax,Rmax |

The iPod display pixel formats are shown in Table 4-75 (page 420).

**Table 4-75** Display pixel format codes

| Display pixel format | Code | Protocol version |
|---|---|---|
| Reserved | 0x00 | N/A |
| Monochrome, 2 bits per pixel | 0x01 | 1.01 |
| RGB 565 color, little-endian, 16 bpp | 0x02 | 1.09 |
| RGB 565 color, big-endian, 16 bpp | 0x03 | 1.09 |
| Reserved | 0x04 – 0xFF | N/A |

iPods with color screens support all three image formats. All other iPods support only display pixel format 0x01 (monochrome, 2 bpp).

## Display Pixel Format 0x01

Display pixel format 0x01 (monochrome, 2 bits per pixel) is the pixel format supported by all iPods. Each pixel consists of 2 bits that control the pixel intensity. The pixel intensities and associated binary codes are listed in Table 4-76 (page 420).

**Table 4-76** 2 bpp monochrome pixel intensities

| Pixel Intensity | Binary Code |
|---|---|
| Pixel off (not visible) | 00b |
| Pixel on 25% (light grey) | 01b |
| Pixel on 50% (dark grey) | 10b |
| Pixel on 100% (black) | 11b |

Each byte of image data contains four packed pixels. The pixel ordering within bytes and the byte ordering within 32 bits is shown below.

| Image Data Byte 0x0000 | | | | | | | |
|---|---|---|---|---|---|---|---|
| Pixel 0 | | Pixel 1 | | Pixel 2 | | Pixel 3 | |
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

| Image Data Byte 0x0001 | | | | | | | |
|---|---|---|---|---|---|---|---|
| Pixel 4 | | Pixel 5 | | Pixel 6 | | Pixel 7 | |
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

| Image Data Byte 0x0002 | | | | | | | |
|---|---|---|---|---|---|---|---|
| Pixel 8 | | Pixel 9 | | Pixel 10 | | Pixel 11 | |
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

| Image Data Byte 0x0003 | | | | | | | |
|---|---|---|---|---|---|---|---|
| Pixel 12 | | Pixel 13 | | Pixel 14 | | Pixel 15 | |
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

| Image Data Byte 0x*NNNN* | | | | | | | |
|---|---|---|---|---|---|---|---|
| Pixel N | | Pixel N+1 | | Pixel N+2 | | Pixel N+3 | |
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

## Display Pixel Formats 0x02 and 0x03

Display pixel format 0x02 (RGB 565, little-endian) and display pixel format 0x03 (RGB 565, big-endian) are available for use in all iPods with color screens. Each pixel consists of 16 bits that control the pixel intensity for the colors red, green, and blue.

It takes two bytes to represent a single pixel. Red is represented by 5 bits, green is represented by 6 bits, and blue by the final 5 bits. A 32-bit sequence represents 2 pixels. The pixel ordering within bytes and the byte ordering within 32 bits for display format 0x02 (RGB 565, little-endian) is shown below.

| Image Data Byte 0x0000 | | | | | | | |
|---|---|---|---|---|---|---|---|
| Pixel 0, lower 3 bits of green | | | Pixel 0, all 5 bits of blue | | | | |
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

| Image Data Byte 0x0001 | | | | | | | |
|---|---|---|---|---|---|---|---|
| Pixel 0, all 5 bits of red | | | | | Pixel 0, upper 3 bits of green | | |
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

| Image Data Byte 0x0002 | | | | | | | |
|---|---|---|---|---|---|---|---|
| Pixel 1, lower 3 bits of green | | | Pixel 1, all 5 bits of blue | | | | |
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

| Image Data Byte 0x0003 | | | | | | | |
|---|---|---|---|---|---|---|---|
| Pixel 1, all 5 bits of red | | | | | Pixel 1, upper 3 bits of green | | |
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

The format for display pixel format 0x03 (RGB 565, big-endian, 16 bpp) is almost identical, with the exception that bytes 0 and 1 are swapped and bytes 2 and 3 are swapped.

## Command 0x0033: GetMonoDisplayImageLimits

Direction: Device to iPod

Requests the limiting characteristics of the monochrome image that can be sent to the iPod for display while it is connected to the device. It can be used to determine the display pixel format and maximum width and height of a monochrome image to be set using the "Command 0x0032: SetDisplayImage" (page 416) command. In response, the iPod sends a "Command 0x0034: ReturnMonoDisplayImageLimits" (page 422) command to the device with the requested display information. The `GetMonoDisplayImageLimits` command is supported by iPods with either monochrome or color displays. To obtain color display image limits, use "Command 0x0039: GetColorDisplayImageLimits" (page 427).

**Table 4-77** `GetMonoDisplayImageLimits` command

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x03 | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x33 | Command ID (bits 7:0) |
| 6 | 0xC6 | Packet payload checksum byte |

## Command 0x0034: ReturnMonoDisplayImageLimits

Direction: iPod to Device

Returns the limiting characteristics of the monochrome image that can be sent to the iPod for display while it is connected to the device. The iPod sends this command in response to the "Command 0x0033: GetMonoDisplayImageLimits" (page 422) command. Monochrome display characteristics include maximum image width and height and the display pixel format.

**Table 4-78** `ReturnMonoDisplayImageLimits` command

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x*NN* | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x34 | Command ID (bits 7:0) |
| 6 | 0x*NN* | Maximum image width in pixels (bits 15:8) |
| 7 | 0x*NN* | Maximum image width in pixels (bits 7:0) |
| 8 | 0x*NN* | Maximum image height in pixels (bits 15:8) |
| 9 | 0x*NN* | Maximum image height in pixels (bits 7:0) |
| 10 | 0x*NN* | Display pixel format (see Table 4-75 (page 420)). |
| 11 | 0x*NN* | Packet payload checksum byte |

## Command 0x0035: GetNumPlayingTracks

Direction: Device to iPod

Applies To: Playback Engine

Requests the number of tracks in the list of tracks queued to play on the iPod. In response, the iPod sends a "Command 0x0036: ReturnNumPlayingTracks" (page 424) command with the count of tracks queued to play.

**Table 4-79** `GetNumPlayingTracks` command

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x03 | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |

| Byte number | Value | Meaning |
|---|---|---|
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x35 | Command ID (bits 7:0) |
| 6 | 0xC4 | Packet payload checksum byte |

## Command 0x0036: ReturnNumPlayingTracks

Direction: iPod to Device

Returns the number of tracks in the actual list of tracks queued to play, including the currently playing track (if any). The iPod sends this command in response to the "Command 0x0035: GetNumPlayingTracks" (page 423) command.

**Table 4-80** `ReturnNumPlayingTracks` command

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x07 | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x36 | Command ID (bits 7:0) |
| 6 | 0x*NN* | Number of tracks playing (bits 31:24) |
| 7 | 0x*NN* | Number of tracks playing (bits 23:16) |
| 8 | 0x*NN* | Number of tracks playing (bits 15:8) |
| 9 | 0x*NN* | Number of tracks playing (bits 7:0) |
| 10 | 0x*NN* | Packet payload checksum byte |

## Command 0x0037: SetCurrentPlayingTrack

Direction: Device to iPod

Applies To: Playback Engine

Sets the index of the track to play in the Now Playing playlist on the iPod. The index that is specified here is obtained by sending the "Command 0x0035: GetNumPlayingTracks" (page 423) and "Command 0x001E: GetCurrentPlayingTrackIndex" (page 397) commands to obtain the number of playing tracks and the current playing track index, respectively. In response, the iPod sends an ACK command indicating the status of the command.

**Note:** This command is usable only when the iPod is in a playing or paused state. If the iPod is stopped, this command fails. If this command is sent with the current playing track index, the iPod pauses playback momentarily and then resumes. If the current playing track has index 1 and this command passes index 1, playback does not restart from the beginning.

**Table 4-81** `SetCurrentPlayingTrack` command

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x07 | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x37 | Command ID (bits 7:0) |
| 6 | 0x*NN* | New current playing track index (bits 31:24) |
| 7 | 0x*NN* | New current playing track index (bits 23:16) |
| 8 | 0x*NN* | New current playing track index (bits 15:8) |
| 9 | 0x*NN* | New current playing track index (bits 7:0) |
| 10 | 0x*NN* | Packet payload checksum byte |

## Command 0x0038: SelectSortDBRecord

Direction: Device to iPod

Applies To: Database Engine

Selects one or more records in the iPod database, based on a category-relative index. For example, selecting category 2 (Artist), record index 1, and sort order 3 (Album) results in a list of selected tracks (records) from the second artist in the artist list, sorted by album name. Selections are additive and limited by the category hierarchy; see "Database Category Hierarchies" (page 350). Subsequent selections are made based on the subset of records resulting from previous selections and not from the entire database. The database category types are shown in Table 4-37 (page 391). The sort order options and codes are shown in Table 4-83 (page 426).

**Table 4-82** `SelectSortDBRecord` command

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x09 | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x38 | Command ID (bits 7:0) |
| 6 | 0x*NN* | Database category type. See Table 4-37 (page 391). |
| 7 | 0x*NN* | Category record index (bits 31:24) |
| 8 | 0x*NN* | Category record index (bits 23:16) |
| 9 | 0x*NN* | Category record index (bits 15:8) |
| 10 | 0x*NN* | Category record index (bits 7:0) |
| 11 | 0x*NN* | Database sort type. See Table 4-83 (page 426). |
| 12 | 0x*NN* | Packet payload checksum byte |

Table 4-83 (page 426) shows the possible sort orders.

**Table 4-83** Database sort order options

| Sort Order | Code | Protocol version |
|---|---|---|
| Sort by genre | 0x00 | 1.00 |
| Sort by artist | 0x01 | 1.00 |
| Sort by composer | 0x02 | 1.00 |
| Sort by album | 0x03 | 1.00 |
| Sort by name | 0x04 | 1.00 |
| Reserved | 0x05 | N/A |
| Sort by release date | 0x06 | 1.08 |
| Sort by series (video only) | 0x07 | 1.12 |
| Sort by season (video only) | 0x08 | 1.12 |
| Sort by episode (video only) | 0x09 | 1.12 |

| Sort Order | Code | Protocol version |
|---|---|---|
| Reserved | 0x0A – 0xFE | N/A |
| Use default sort type | 0xFF | 1.00 |

The default order of song and audiobook tracks on the iPod is alphabetical by artist, then alphabetical by that artist's albums, then ordered according to the order of the tracks on the album. For podcasts, the default order of episode tracks is reverse chronological—that is, the newest ones are first—then alphabetical by podcast name.

The `SelectSortDBRecord` command can be used to sort all the song and audiobook tracks on the iPod alphabetically as follows:

1. "Command 0x0016: ResetDBSelection" (page 389)
2. "Command 0x0018: GetNumberCategorizedDBRecords" (page 392) for the Playlist category.
3. `SelectSortDBRecord` based on the Playlist category, using a record index of 0 to select the All Tracks playlist and the sort by name (0x04) sort order.
4. `GetNumberCategorizedDBRecords` for the Track category.
5. "Command 0x001A: RetrieveCategorizedDatabaseRecords" (page 393) based on the Track category, using a start index of 0 and an end index of the number of records returned by the call to `GetNumberCategorizedDBRecords` in step 4.

The sort order of artist names ignores certain articles such that the artist "The Doors" is sorted under the letter 'D' and not 'T'; this matches the behavior of iTunes. The sort order is different depending on the language setting used in the iPod. The list of ignored articles may change in the future without notice.

The `SelectDBRecord` command may also be used to select a database record with the default sort order.

**Note:** The sort order field is ignored for the Audiobook category. Audiobooks are automatically sorted by track title. The sort order for podcast tracks defaults to release date, with the newest track coming first.

## Command 0x0039: GetColorDisplayImageLimits

Direction: Device to iPod

Requests the limiting characteristics of the color image that can be sent to the iPod for display while it is connected to the device. It can be used to determine the display pixel format and maximum width and height of a color image to be set using the "Command 0x0032: SetDisplayImage" (page 416) command. In response, the iPod sends a "Command 0x003A: ReturnColorDisplayImageLimits" (page 428) command to the device with the requested display information. This command is supported only by iPods with color displays.

**Table 4-84** `GetColorDisplayImageLimits` command

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x03 | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x39 | Command ID (bits 7:0) |
| 6 | 0xC0 | Packet payload checksum byte |

## Command 0x003A: ReturnColorDisplayImageLimits

Direction: iPod to Device

Returns the limiting characteristics of the color image that can be sent to the iPod for display while it is connected to the device. The iPod sends this command in response to the "Command 0x0039: GetColorDisplayImageLimits" (page 427) command. Display characteristics include maximum image width and height and the display pixel format.

> **Note:** If the iPod supports multiple display image formats, a five byte block of additional image width, height, and pixel format information is appended to the payload for each supported display format. The list of supported color display image formats returned by the iPod may change in future software versions. Devices must be able to parse a variable length list of supported color display formats to search for compatible formats.

**Table 4-85** `ReturnColorDisplayImageLimits` command

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x*NN* | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x3A | Command ID (bits 7:0) |
| 6 | 0x*NN* | Maximum image width in pixels (bits 15:8) |
| 7 | 0x*NN* | Maximum image width in pixels (bits 7:0) |

| Byte number | Value | Meaning |
|---|---|---|
| 8 | 0x*NN* | Maximum image height in pixels (bits 15:8) |
| 9 | 0x*NN* | Maximum image height in pixels (bits 7:0) |
| 10 | 0x*NN* | Display pixel format (see Table 4-75 (page 420)). |
| 11 - *N* | 0x*NN* | Optional display image width, height, and pixel format for the second to nth supported display formats, if present. |
| (last byte) | 0x*NN* | Packet payload checksum byte |

## Command 0x003B: ResetDBSelectionHierarchy

Direction: Device to iPod

Applies To: Database Engine

This command carries a single byte in its payload (byte 6). A hierarchy selection value of 0x01 means that the accessory wants to navigate the audio hierarchy; a hierarchy selection value of 0x02 means that the accessory wants to navigate the video hierarchy.

**Note:** If the device sends a `ResetDBSelectionHierarchy` command while selecting the audio hierarchy, the database resets itself to the audio hierarchy and any video database selections are invalidated. Video selections already passed to the Playback Engine are unaffected.

**Table 4-86** `ResetDBSelectionHierarchy` command

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x04 | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x3B | Command ID (bits 7:0) |
| 6 | 0x01 or 0x02 | Hierarchy selection |
| 7 | 0x*NN* | Packet payload checksum byte |

**Note:** The iPod will return an error if a device attempts to enable an unsupported hierarchy, such as a video hierarchy on an iPod model that does not support video.

## Command 0x003C: GetDBiTunesInfo

Direction: Dev to iPod

Applies to Database Engine.

This command is sent by the device to get the specified iPod iTunes database metadata information. In response, the iPod sends a `RetDBiTunesInfo` command with the requested metadata.

**Note:** This DB metadata information is updated when the iPod enters remote UI mode. This ensures that the information is updated following an iTunes sync event.

**Table 4-87** `GetDBiTunesInfo` command

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x04 | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x3C | Command ID (bits 7:0) |
| 6 | 0x*NN* | iTunes database metadata type (see Table 4-88 (page 430)) |
| 7 | 0x*NN* | Packet payload checksum byte |

Table 4-88 (page 430) shows the iTunes database metadata type codes.

**Table 4-88** iTunes database metadata types

| Type code | Description |
|---|---|
| 0x00 | Database UID unique to an iPod and assigned by iTunes. This ID does not change when the iPod is synced with iTunes nor when the iPod's content is changed. It is not the same as the track UID returned by `GetDBTrackInfo` or `GetPBTrackInfo` and used by `GetUIDTrackInfo`. |
| 0x01 | Last sync date/time to iTunes on computer; updated when the iPod is synced with iTunes even if no content has been added or deleted. |
| 0x02 | Total audio track count (including audio podcasts and audiobooks) |

| Type code | Description |
|---|---|
| 0x03 | Total video track count (including movies, TV series, and video podcasts) |
| 0x04 | Total audiobook count |
| 0x05 | Total photo count |
| 0x06-0xFF | Reserved |

## Command 0x003D: RetDBiTunesInfo

Direction: iPod to Dev

Applies to Database Engine.

This command is returned by the iPod in response to a `GetDBiTunesInfo` command received from the device. If the requested iTunes metadata information type is not within the valid range, an `ACK` command with a bad parameter status is returned.

**Table 4-89** `RetDBiTunesInfo` command

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x*NN* | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x3D | Command ID (bits 7:0) |
| 6 | 0x*NN* | iTunes database metadata type (see Table 4-88 (page 430)) |
| 7... | ... | iTunes database metadata information (see Table 4-90 (page 431)) |
| (last byte) | 0x*NN* | Packet payload checksum byte |

Table 4-90 (page 431) shows the iTunes database metadata information formats.

**Table 4-90** iTunes database metadata information formats

| Type code | Bytes | Description |
|---|---|---|
| 0x00 | 8 | iTunes database unique 64-bit identifier |
| 0x01 | 7 | Last sync date/time (see Table 4-91 (page 432)) |

| Type code | Bytes | Description |
|---|---|---|
| 0x02 | 4 | Total audio track count |
| 0x03 | 4 | Total video track count |
| 0x04 | 4 | Total audiobook count |
| 0x05 | 4 | Total photo count |
| 0x06-0xFF | Reserved | |

**Table 4-91** Date/time format

| Byte | Description | Values |
|---|---|---|
| 0 | Seconds | 00 - 59 |
| 1 | Minute | 00 - 59 |
| 2 | Hour | 00 = 12am, 23 = 11pm |
| 3 | Day | 01 = 1st, 31 = 31st |
| 4 | Month | 01 = Jan, 12 = Dec |
| 5-6 | Year | 2007 = year 2007 |

## Command 0x003E: GetUIDTrackInfo

Direction: Dev to iPod

Applies to Database Engine.

This command is sent by the device to get one or more types of track information using the track's iPod-unique identifier. In response, the iPod returns separate `RetUIDTrackInfo` commands for each type of track information requested. The track information mask is variable length; it is not necessary to transmit any trailing bytes in which no bits are set. If the track information mask contains any unrecognized track information type bits, a single `ACK` command is returned with a bad parameter status.

> **Note:** The device's input buffer must be of sufficient size to accept all requested track information response packets without errors. The requested packets may be sent to the device in rapid succession, without any pauses or interruptions.

**Table 4-92** `GetUIDTrackInfo` command

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |

| Byte number | Value | Meaning |
|---|---|---|
| 2 | 0x*NN* | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x3E | Command ID (bits 7:0) |
| 6–13 | 0x*NNNNNNNNNNNNNNNN* | Unique track identifier; a device can obtain this value by sending a GetDBTrackInfo (page 437) or GetPBTrackInfo (page 439) command with bit 7 of byte 14 set to 1. |
| 14... | ... | Track information type bitmask (see Table 4-93 (page 433)); do not set bit 7. |
| (last byte) | 0x*NN* | Packet payload checksum byte |

Table 4-93 (page 433) lists the track information type bitmask bits.

**Table 4-93** Track information type bits

| Bit | Description |
|---|---|
| 0 | Capabilities (media kind, skip when shuffle, has artwork, has bookmark, has lyrics, is audiobook, etc.) |
| 1 | Track name |
| 2 | Artist name |
| 3 | Album name |
| 4 | Genre name |
| 5 | Composer name |
| 6 | Total track time duration |
| 7 | Unique track identifier |
| 8 | Chapter count |
| 9 | Chapter times |
| 10 | Chapter names |
| 11 | Lyrics of the song currently playing in the Playback Engine |
| 12 | Description |
| 13 | Album track index |
| 14 | Disc set album index |

| Bit | Description |
|---|---|
| 15 | Play count |
| 16 | Skip count |
| 17 | Podcast release date |
| 18 | Last played date/time |
| 19 | Year (release date) |
| 20 | Star rating |
| 21 | Series name |
| 22 | Season number |
| 23 | Track volume adjust |
| 24 | Track EQ preset |
| 25 | Track sample rate |
| 26 | Bookmark offset |
| 27 | Start/stop time offset |
| 28... | Reserved |

**Note:** Requesting the lyrics of a track not currently being played will result in a null string being returned. Lyrics for a track being played may take up to 5 seconds to return. Use `SetPlayStatusChangeNotification` to be notified when the lyrics for the currently playing track become available.

## Command 0x003F: RetUIDTrackInfo

Direction: iPod to Dev

Applies to Database Engine.

This command is sent by the iPod in response to a `GetUIDTrackInfo` command received from the device. Multiple responses may be sent for each type of track information requested (e.g., chapter names).

**Note:** The device's input buffer must be of sufficient size to accept all requested track information response packets without errors. The requested packets may be sent to the device in rapid succession, without any pauses or interruptions.

**Table 4-94** `RetUIDTrackInfo` command

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x*NN* | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x3F | Command ID (bits 7:0) |
| 6–13 | 0x*NNNNNNNNNNNNNNNN* | Unique track identifier |
| 14 | 0x*NN* | Track information type (bit position number) |
| 15... | ... | Track information data (see Table 4-95 (page 435)) |
| (last byte) | 0x*NN* | Packet payload checksum byte |

Table 4-95 (page 435) shows the track information data formats.

**Table 4-95** Track information data formats

| Type | Description | Bytes | Format |
|---|---|---|---|
| 0 | Capabilities | 4 | See Table 4-96 (page 437) |
| 1 | Track name | *NN* | Null-terminated UTF8 string |
| 2 | Artist name | *NN* | Null-terminated UTF8 string |
| 3 | Album name | *NN* | Null-terminated UTF8 string |
| 4 | Genre name | *NN* | Null-terminated UTF8 string |
| 5 | Composer name | *NN* | Null-terminated UTF8 string |
| 6 | Total track duration | 4 | Milliseconds |
| 7 | iTunes unique track ID | 8 | An 8-byte UID that uniquely identifies an iPod track. This track UID is different from the iTunes database UID returned by `RetDBiTunesInfo`. |
| 8 | Chapter count | 2 | Chapter count (0 = no chapters) |

| Type | Description | Bytes | Format |
|---|---|---|---|
| 9 | Chapter times | 2,4 | 2 bytes chapter index (0 = first chapter) followed by 4 bytes chapter offset in milliseconds from beginning of track. A separate index/offset pair is appended for each track chapter. If a track has no chapters, no data is returned. |
| 10 | Chapter names | 2,*NN* | 2 bytes chapter index (0 = first chapter) followed by the chapter name as null-terminated UTF8 string. A separate index/name pair is appended for each track chapter. If a track has no chapters, no data is returned. |
| 11 | Lyrics of the song currently playing in the Playback Engine | 2,2,*NN* | 2 bytes current track lyrics section index (0 = first section, 0x*NNNN* = last section index), followed by 2 bytes maximum track lyrics section index (0 = only 1 section, 0x*NNNN* = maximum section index), followed by some or all of the track lyrics string. The track lyrics as a whole consists of a single null-terminated UTF8 string. If the lyrics string is too long to be carried in a single packet, then the string is broken into sections and carried in separate packets, with different values for each section index. The last lyrics packet section contains the null terminator character for the full string. Lyrics sections before the last section do not include null terminators and may not be valid UTF8 strings. Accessories must use the packet payload length to determine the length of the track lyrics string and assemble it by concatenating its substrings in order. Requesting the lyrics of a track not currently being played will result in a null string being returned. |
| 12 | Description | *NN* | Null-terminated UTF8 string |
| 13 | Album track index | 2 | index number |
| 14 | Disc set album index | 2 | index number |
| 15 | Play count | 4 | Track play count (0 = track not played) |
| 16 | Skip count | 4 | Track skip count (0 = track not skipped) |
| 17 | Podcast release date | 7 | Date/time (see Table 4-91 (page 432)) |
| 18 | Last played date/time | 7 | Date/time (see Table 4-91 (page 432)); all zeroes if the track has never been played. |
| 19 | Year (release date) | 2 | Year in which track was released |
| 20 | Star rating | 1 | Star rating of track; 00 = No stars, 20 = 1 star, 40 = 2 stars, 60 = 3 stars, 80 = 4 stars, 100 = 5 stars. |
| 21 | Series name | *NN* | Null-terminated UTF8 string |
| 22 | Season number | 2 | Season number (1 = First season) |
| 23 | Track volume adjust | 1 | Track volume attenuation/amplification adjustment (0x9C = –100%, 0x00 = no adjust, 0x64 = +100%) |

| Type | Description | Bytes | Format |
|---|---|---|---|
| 24 | Track EQ preset | 2 | Track equalizer preset index |
| 25 | Data rate | 4 | Track bit rate (kilobits per second) |
| 26 | Bookmark offset | 4 | Bookmark offset from start of track in milliseconds |
| 27 | Start/stop time offset | 4,4 | 4 bytes start time followed by 4 bytes stop time in milliseconds |
| 28... | Reserved | | |

**Table 4-96** Capabilities bits

| Bit | Description |
|---|---|
| 00 | 1 = Is audiobook |
| 01 | 1 = Has chapters |
| 02 | 1 = Has artwork |
| 03 | 1 = Has lyrics |
| 04 | 1 = Is podcast episode |
| 05 | 1 = Has release date |
| 06 | 1 = Has description |
| 07 | 1 = Is video |
| 08 | 1 = Is queued as video (in the Playback Engine only, not in the database) |
| 31:09 | Reserved |

## Command 0x0040: GetDBTrackInfo

Direction: Dev to iPod

Applies to Database Engine.

This command is sent by the device to get the specified iPod database track information types for the specified track index range. In response, the iPod returns separate `RetDBTrackInfo` packets for each type of track information requested. The starting track index is based on the current database track selection(s). A track count of 0xFFFFFFFF (–1) returns the track information for all iPod tracks from the starting DB track index. The track information mask is variable length; it is not necessary to transmit any trailing bytes in which no track information bits are set. If the track index, count, or information mask contains any invalid data, a single `ACK` command is returned with a bad parameter status.

**Note:** The device's input buffer must be of sufficient size to accept all requested track information response packets without errors. The requested packets may be sent to the device in rapid succession, without any pauses or interruptions.

**Table 4-97** `GetDBTrackInfo` command

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x*NN* | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x40 | Command ID (bits 7:0) |
| 6–9 | 0x*NNNNNNNN* | Track database start index |
| 10–13 | 0x*NNNNNNNN* | Track count (from track start index) |
| 14... | ... | Track information type bitmask (see Table 4-93 (page 433)) |
| (last byte) | 0x*NN* | Packet payload checksum byte |

**Note:** Requesting the lyrics of a track not currently being played will result in a null string being returned. Lyrics for a track being played may take up to 5 seconds to return. Use `SetPlayStatusChangeNotification` to be notified when the lyrics for the currently playing track become available.

## Command 0x0041: RetDBTrackInfo

Direction: iPod to Dev

Applies to Database Engine.

This command is sent by the iPod in response to a `GetDBTrackInfo` command received from the device. Multiple responses may be sent for each type of track information requested (e.g., chapter names).

**Note:** The device's input buffer must be of sufficient size to accept all requested track information response packets without errors. The requested packets may be sent to the device in rapid succession, without any pauses or interruptions.

**Table 4-98** `RetDBTrackInfo` command

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x*NN* | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x41 | Command ID (bits 7:0) |
| 6–9 | 0x*NNNNNNNN* | Track database index |
| 10 | 0x*NN* | Track information type (bit position number) |
| 11... | ... | Track information data (see Table 4-95 (page 435)) |
| (last byte) | 0x*NN* | Packet payload checksum byte |

## Command 0x0042: GetPBTrackInfo

Direction: Dev to iPod

Applies to Playback Engine.

This command is sent by the device to get the specified iPod playing track information types for the specified track index range. In response, the iPod returns separate `RetPBTrackInfo` packets for each type of track information requested. A track count of 0xFFFFFFFF (–1) returns the track information for all iPod tracks from the starting PB track index. The track information mask is variable length; it is not necessary to transmit any trailing bytes in which no track information bits are set. If the track index, count, or information mask contains any invalid data, a single `ACK` command is returned with a bad parameter status.

**Note:** The device's input buffer must be of sufficient size to accept all requested track information response packets without errors. The requested packets may be sent to the device in rapid succession, without any pauses or interruptions.

**Table 4-99** `GetPBTrackInfo` command

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |

| Byte number | Value | Meaning |
|---|---|---|
| 1 | 0x55 | Start of packet |
| 2 | 0x*NN* | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x42 | Command ID (bits 7:0) |
| 6–9 | 0x*NNNNNNNN* | Track playing start index |
| 10–13 | 0x*NNNNNNNN* | Track count (from track start index) |
| 14... | ... | Track information type bitmask (see Table 4-93 (page 433)) |
| (last byte) | 0x*NN* | Packet payload checksum byte |

**Note:** Requesting the lyrics of a track not currently being played will result in a null string being returned. Lyrics for a track being played may take up to 5 seconds to return. Use `SetPlayStatusChangeNotification` to be notified when the lyrics for the currently playing track become available.

## Command 0x0043: RetPBTrackInfo

Direction: iPod to Dev

Applies to Playback Engine.

This command is sent by the iPod in response to a `GetPBTrackInfo` command received from the device. Multiple responses may be sent for each type of track information requested (e.g., chapter names).

**Note:** The device's input buffer must be of sufficient size to accept all requested track information response packets without errors. The requested packets may be sent to the device in rapid succession, without any pauses or interruptions.

**Table 4-100** `RetPBTrackInfo` command

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x*NN* | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |

| Byte number | Value | Meaning |
|---|---|---|
| 5 | 0x43 | Command ID (bits 7:0) |
| 6–9 | 0x*NNNNNNNN* | Track playback index |
| 10 | 0x*NN* | Track information type (bit position number) |
| 11... | ... | Track information data (see Table 4-95 (page 435)) |
| (last byte) | 0x*NN* | Packet payload checksum byte |

## Known Issues

- iPods may take up to 20 seconds to detect that the remote device has been detached from the 30-pin connector. This depends on the firmware version and whether or not power is being supplied to the iPod.
- External devices such as simple remote controls may still be active, even when the iPod has entered Extended Interface mode operation. Users should be discouraged from attaching any devices to the iPod while it is in Extended Interface mode.
- iPod mini version 1.4 and 4G iPod version 3.1 do not return audiobook chapter names. They return an empty string instead.

## Protocol History

The following is a history of the changes made to the iPod Extended Interface protocol.

**Table 4-101** History of the iPod Extended Interface protocol

| Version | Changes |
|---|---|
| **Version 1.14** | Added status change control extensions to `SetPlayStatusChangeNotification` and `PlayStatusChangeNotification`. |
| | Added new support for Next Chapter and Previous Chapter in the `PlayControl` command. |
| **Version 1.13** | Added support for nested playlists. |
| | Added Play and Pause control codes to command 0x0029. |
| | Added new commands 0x003C through 0x0043. |
| **Version 1.12** | Improved video browsing support for `SelectDBRecord(-1)`. |
| **Version 1.11** | This version adds `ResetDBSelectionHierarchy` command to enable video browsing. |

| Version | Changes |
| --- | --- |
| | New feature: video browsing. |
| | Chapter information can be retrieved for all tracks in the Now Playing list, not just for the currently playing track. |
| **Version 1.10** | This version adds commands 0x000E through 0x0011 and 0x002A through 0x002B. |
| | New features:<br>Code restructured to improve performance. |
| | Added indexed playing track genre and composer info. |
| | Added playing track artwork support. |
| | Bug fixes:<br>Return track description and lyrics info if present. |
| | Notify track changes even when playback is paused. |
| **Version 1.09** | This version adds support for color images, podcast chapters, and fixes a few bugs: |
| | `SetDisplayImage` supports color images on color iPods. |
| | A bug that caused `SelectDBRecord` to fail if there were no podcasts on the iPod is fixed. |
| | A bug that caused `SelectDBRecord` and `SelectSortDBRecord` to reverse track order after a podcast was selected is fixed. |
| | `PlayStatusChange` notifications support podcast chapters. |
| | `SetCurrentPlayingChapter` now accepts a chapter index for podcasts. |
| | Added new commands `GetColorDisplayImageLimits` and `ReturnColorDisplay-ImageLimits` to obtain information about color display images. |
| **Version 1.08** | This version adds support for the Podcast category, chapter names, and indexed playing track information. It also includes a bug fix for `SetDisplayImage`. |
| **Version 1.07** | This version adds the restore on exit feature to the set shuffle, set repeat, and set audiobook speed setting commands. It also fixes a few bugs in the database engine management commands. |
| | `ResetDBSelection` clears the database sort order. |
| | `SelectDBRecord` with an invalid index returns a command error. |
| | Audiobook speed restore on exit with optional flag. |
| | Shuffle setting restore on exit with optional flag. |
| | Repeat setting restore on exit with optional flag. |

| Version | Changes |
| --- | --- |
| **Version 1.06** | This version adds several new lingo 0x04 commands to allow remote accessories to control audiobook playback. Please refer to lingo 0x04 commands 0x0002 through 0x000B for details. The following Extended Interface commands have been modified to support audiobook playback: |
| | `SelectDBRecord` |
| | `GetNumberCategorizedDBRecords` |
| | `ReturnNumberCategorizedDBRecords` |
| | `RetrieveCategorizedDatabaseRecords` |
| | `ReturnCategorizedDatabaseRecord` |
| | `PlayStatusChangeNotification` |
| | `PlayControl` |
| | `SelectSortDBRecord`. The sort order field is ignored for the case of an audiobook, as audiobooks are automatically sorted by name. |
| **Version 1.05** | This version adds several new lingo 0x00 commands and minor fixes to version 1.04. The changes include: |
| | Fixed a problem where iPod Accessory Protocol commands on the 30-pin connector did not wake up unpowered, sleeping iPods. |
| | Fixed the `SelectDBRecord` routine to play tracks from a stopped play state. |
| | Fixed `RetrieveCategorizedDBRecords` to retrieve all records from the start index when passed a count of -1. |
| | Fixed long record names resulting in large packets causing the iPod to reboot. |
| | Added missing begin and end FF or REW notification messages. |
| **Version 1.04** | This version adds some minor fixes to Version 1.03. The changes include: |
| | Fixed a problem where devices were intermittently not detected when the 30-pin connector was plugged in to the iPod. |
| | Optimized the iPod `ReturnPlayStatus` response to the `GetPlayStatus` message from the device. Command response is much faster. |
| **Version 1.03** | This version is the functional equivalent of protocol version 1.02 (1.03 is equal to 1.02). It is only reported on the iPod mini in software version 1.1. All of the changes reported for version 1.02 are applicable for 1.03 and no more. |
| **Version 1.02** | This version was released in the third generation (3G) iPod system software 2.2. The changes include: |

| Version | Changes |
|---|---|
| | Fixed a problem where the user's On-The-Go playlist was erased when the Extended Interface serial protocol was initialized. |
| | Fixed a problem where a playing iPod was stopped and playing state lost when the Extended Interface mode was initialized. |
| | Fixed a problem where the strings returned from the iPod were truncated if there were multibyte characters present. |
| | Fixed a problem where an iPod playing a track in Extended Interface mode would continue playing the same track, unpaused, when it was disconnected and reverted to the iPod UI mode. |
| | Fixed a problem where an iPod in Extended Interface mode failed to go into Sleep mode when power was removed from it. |
| | Fixed a problem where an iPod with a set alarm would honor the alarm while in Extended Interface mode or soon after disconnection. |
| | Fixed a problem where the pause indicator was shown when playback was stopped during Extended Interface mode. |
| **Version 1.01** | This version was released in the iPod mini version 1.0 system software with bug fixes and protocol improvements during February 2004. The changes include: |
| | Added the commands: `SelectSortDBRecord`, `SetCurrentPlayingTrack`, `GetNumPlayingTracks`, `GetMonoDisplayImageLimits` and `SetDisplayImage`. |
| | Changed the default sort order of returned or listed database items to match that of the iPod UI. |
| | Fixed a transmit problem where large packets being sent by the iPod would pause, mid-packet, until the beginning of another packet was received by the iPod. |
| | Fixed a problem where the iPod play/pause button remained active when the Extended Interface protocol was in control of the iPod. |
| **Version 1.0** | This is the base protocol released in October 2003 in system software version 2.1 of the 3G iPod. |

# Accessory Identification

When it is connected to an iPod or iPhone, an accessory must identify itself using the Identify Device Preferences and Settings (IDPS) process described in this appendix.

**IMPORTANT:** The IDPS process is required for new iPod and iPhone accessory designs, to ensure their compatibility with future firmware. Existing accessory designs may continue to send the iAP General lingo command 0x13, `IdentifyDeviceLingoes`, identifying the lingoes they support and requesting immediate authentication. Note that IDPS requires accessory Authentication 2.0, as specified in "Authentication" (page 52), and the use of transaction IDs throughout each communication session, as specified in "Transaction IDs" (page 451).

## Using IDPS

The IDPS process begins when an accessory sends a `StartIDPS` command to an iPod (see "Command 0x38: StartIDPS" (page 108)). If the two are newly connected, it must be the first command the accessory sends. If the iPod refuses `StartIDPS` by returning a General lingo `ACK` command with a status of 0x04 (Bad Parameter), the accessory must assume it is connected to an iPod that doesn't support the IDPS process. In this case, the accessory must send the iPod an `IdentifyDeviceLingoes` command within 800 ms, requesting authentication.

**IMPORTANT:** If the accessory has access to Accessory Power through the 30-pin connector, it must always monitor that output from the iPod (pin 13). If Accessory Power goes low, even momentarily, the accessory must restart the IDPS process after it goes high. After Accessory Power goes high the accessory must wait at least 80 ms before starting the IDPS process or sending any other iAP commands.

During the IDPS process, the iPod accepts only the following General lingo commands from the accessory:

- 0x4B, `GetiPodOptionsForLingo` to determine the options the iPod supports for a specific lingo
- 0x39, `SetFIDTokenValues` to identify the accessory to the iPod
- 0x3B, `EndIDPS` to end the IDPS process

**IMPORTANT:** After an iPod or iPhone has successfully acknowledged an accessory's `StartIDPS` command, all subsequent iAP command packets must include transaction IDs, regardless of lingo, as specified in "Transaction IDs" (page 451).

The IDPS process lets the iPod receive preference information from the accessory during the initial handshake sequence. Unlike the process using `IdentifyDeviceLingoes`, the audio/video routing and other iPod settings are established before authentication begins. Once the IDPS process begins, the iPod will not enable preferences such as line-out and video-out by default; therefore it is up to the accessory to explicitly enable all desired preferences. During the IDPS process, the iPod identifies connected accessories as uniquely as possible.

# IDPS Commands

The General lingo IDPS commands that support accessory identification are listed below and documented in detail in the sections that follow. All commands are protocol version 1.09 and require authentication 2.0.

**Table A-1** IDPS General lingo commands

| CmdID | Name | Direction | Payload:bytes |
|---|---|---|---|
| 0x38 | `StartIDPS` | Dev to iPod | `{transID;2}` |
| 0x39 | `SetFIDTokenValues` | Dev to iPod | `{transID;2, numFIDTokenValues;1, FIDTokenValues;<var>}` |
| 0x3A | `RetFIDTokenValueACKs` | iPod to Dev | `{transID;2, numFIDTokenValueACKs;1, FIDTokenValueACKs;<var>}` |
| 0x3B | `EndIDPS` | Dev to iPod | `{transID;2, accIDPSStatus;1}` |
| 0x3C | `IDPSStatus` | iPod to Dev | `{transID;2, status;1}` |

**Note:** The `transID` parameters in the foregoing table are described in "Transaction IDs" (page 451).

For details of these commands, see "The Protocol Core and the General Lingo" (page 47).

# Sample IDPS Command Sequences

This section lists two typical command sequences using IDPS:

- Table A-2 (page 446) illustrates the basic IDPS command sequence.
- Table A-3 (page 447) illustrates an IDPS command sequence followed by authentication and accessory support for Digital Audio (Lingo 0x0A).

**Table A-2** IDPS process up to authentication

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| 1 | `StartIDPS` | | no params |
| 2 | | `ACK` | acknowledging 'Success (OK)' to command 'General Lingo::StartIDPS' |

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| 3 | SetFIDTokenValues | | setting 11 FID tokens ; IdentifyToken = (lingoes: 0/2/3/4\|options 0x00000002\|device ID 0x00000200); AccCapsToken = 0x0000000000000205; AccInfoToken = Acc name (Test-Accessory); AccInfoToken = Acc FW version (v1.1.1); AccInfoToken = Acc HW version (v2.2.2); AccInfoToken = Acc manufacturer (Apple; Inc.); AccInfoToken = Acc model number (Test-Model); SDKProtocolToken = 1 (com.Apple.ProtocolMain); SDKProtocolToken = 2 (com.Apple.ProtocolAlt); iPodPreferenceToken = (setting 'off' for preference class 'video out setting' with restore on exit 'not selected'); iPodPreferenceToken = (setting 'used' for preference class 'line out usage' with restore on exit 'not selected') |
| 4 | | RetFIDTokenValueACKs | 11 ACKs for FID tokens ; IdentifyToken = accepted; AccCapsToken = accepted; AccInfoToken = (Acc name) accepted; AccInfoToken = (Acc FW version) accepted; AccInfoToken = (Acc HW version) accepted; AccInfoToken = (Acc manufacturer) accepted; AccInfoToken = (Acc model number) accepted; SDKProtocolToken = (1) accepted; SDKProtocolToken = (2) accepted; iPodPreferenceToken = (video out setting) accepted; iPodPreferenceToken = (line out usage) accepted |
| 5 | EndIDPS | | status 'finished with IDPS; proceed to authentication' |
| 6 | | IDPSStatus | status 'ready for auth' |
| 7 | | GetDevAuthentication-Info | no params |

**Table A-3** IDPS process with authentication and Digital Audio lingo

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| 1 | StartIDPS | | no params |
| 2 | | ACK | acknowledging 'Success (OK)' to command 'General Lingo::StartIDPS' |

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| 3 | SetFIDTokenValues | | setting 11 FID tokens ; IdentifyToken = (lingoes: 0/2/3/4/10\|options 0x00000002\|device ID 0x00000200); AccCapsToken = 0x0000000000000215; AccInfoToken = Acc name (Test-Accessory); AccInfoToken = Acc FW version (v1.1.1); AccInfoToken = Acc HW version (v2.2.2); AccInfoToken = Acc manufacturer (Apple; Inc.); AccInfoToken = Acc model number (Test-Model); SDKProtocolToken = 1 (com.Apple.ProtocolMain); SDKProtocolToken = 2 (com.Apple.ProtocolAlt); iPodPreferenceToken = (setting 'off' for preference class 'video out setting' with restore on exit 'not selected'); iPodPreferenceToken = (setting 'used' for preference class 'line out usage' with restore on exit 'not selected') |
| 4 | | RetFIDTokenValueACKs | 11 ACKs for FID tokens ; IdentifyToken = accepted; AccCapsToken = accepted; AccInfoToken = (Acc name) accepted; AccInfoToken = (Acc FW version) accepted; AccInfoToken = (Acc HW version) accepted; AccInfoToken = (Acc manufacturer) accepted; AccInfoToken = (Acc model number) accepted; SDKProtocolToken = (1) accepted; SDKProtocolToken = (2) accepted; iPodPreferenceToken = (video out setting) accepted; iPodPreferenceToken = (line out usage) accepted |
| 5 | EndIDPS | | status 'finished with IDPS; proceed to authentication' |
| 6 | | IDPSStatus | status 'ready for auth' |
| 7 | | GetDevAuthentication-Info | no params |
| 8 | RetDevAuthentication-Info | | returning version of authentication 2.0 and X.509 certificate; see Table 2-37 (page 85) |
| 9 | | AckDevAuthentication-Info | acknowledging 'auth info supported' |
| 10 | | GetAccSampleRateCaps | no params |
| 11 | | GetDevAuthentication-Signature | offering challenge for the accessory to sign and return; see Table 2-39 (page 87) |

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| 12 | RetAccSampleRateCaps | | returning sample rates '8000\|11025\|12000\|16000\|22050\|24000\|32000\|44100\|48000' |
| 13 | RetDevAuthentication-Signature | | returning digital signature; see Table 2-40 (page 88) |
| 14 | | NewiPodTrackInfo | sample rate 44100; Sound Check value 0; track volume adjustment 0 |
| 15 | AccAck | | acknowledging 'NewiPodTrackInfo' |
| 16 | | AckDevAuthentication-Status | acknowledging authentication status 'Success (OK)' |
| 17 | | NewiPodTrackInfo | sample rate 44100; Sound Check value 0; track volume adjustment 0 |
| 18 | AccAck | | acknowledging 'NewiPodTrackInfo' |
| 19 | | NewiPodTrackInfo | sample rate 44100; Sound Check value 0; track volume adjustment 0 |
| 20 | AccAck | | acknowledging 'NewiPodTrackInfo' |

# iPod Event Notifications

Notifications of one type, Flow Control, are enabled by default if the accessory uses IDPS. Accessories that use IdentifyDeviceLingoes must enable Flow Control notifications explicitly. Receiving Flow Control notifications lets accessories cope with situations where the iPod's incoming queue is full and it is unable to accept more packets.

To work reliably with all past and future iPods, an accessory should first send a GetSupportedEventNotification command to check which notification types the iPod supports. The iPod can respond in one of two ways:

- The iPod can return an ACK command with a Bad Parameter error. This means that the iPod does not support the GetSupportedEventNotification command. The accessory must then send a SetEventNotification command that sets only the FlowControl bit. The iPod may respond in one of two ways:
  - If the iPod responds with a successful ACK command, it means that the iPod supports Flow Control notifications and the accessory should be prepared to handle them.
  - If the iPod responds with an ACK command that passes a Bad Parameter error, it means that iPod does not support notifications.
- The iPod can return a RetSupportedEventNotification command with a notification bitmask indicating which notifications it supports. The accessory must then send a SetEventNotification command, passing the FlowControl bit plus any other bits chosen from the returned bitmask.

# Transaction IDs

Once an accessory has started the IDPS process, beginning with and including the `StartIDPS` command, the accessory must include 16-bit transaction ID parameters in every iAP packet. This appendix specifies the rules that must be followed when creating or interpreting the values of these parameters.

## Using Transaction IDs

The purpose of transaction IDs is to uniquely associate iAP commands with their responses, regardless of the order in which commands and their responses may be transmitted.

> **Note:** Transaction ID fields are part of the packet payload and must be counted when specifying the data lengths of iAP commands.

### Generating and Returning Transaction IDs

An attached accessory's responsibility for handling transaction IDs can be summarized by the following rules:

- Every time the accessory responds to a command from the iPod or iPhone that contains a transaction ID, it must include that ID in its response.
- To generate transaction IDs for the commands it sends, the accessory must initialize a 16-bit counter to 0x0000 every time it is connected to an iPod or iPhone. It must then use the counter value as the transaction ID for every command it sends and increment the counter afterward. The counter may roll over to 0x0000 after it reaches 0xFFFF.
- If the accessory receives no response to a command that it has sent, it may send another command with the same payload, but the transaction ID must be different.
- The accessory must ignore any response from the iPod or iPhone whose transaction ID does not match that of a previous command it has sent.
- The iPod or iPhone will ignore any response from the accessory whose transaction ID does not match that of a previous command it has sent.

> **Note:** The iPod or iPhone does not increment transaction ID values during authentication. The Accessory must continue to respond to iPod commands with the transaction ID included in the iPod's command.

### Enabling and Disabling Transaction ID Support

Accessories must enable their support for transaction IDs according to the following rules:

- Support for transaction IDs must be enabled upon the rising edge of power from the iPod or iPhone on pin 13 (Accessory Power) of the 30-pin connector (see *iPod/iPhone Hardware Specifications*).
- Support for transaction IDs must be enabled before the acessory sends a `StartIDPS` command.

The accessory must continue to enable its transaction ID support for all iAP commands until it encounters one of the following situations:

- Support for transaction IDs must be disabled upon receipt of a General lingo `ACK` command without a transaction ID. Such commands have a payload length value (byte 2) of either 0x04 or 0x08.
- Support for transaction IDs must be disabled upon receipt of a `RequestIdentify` command.
- Support for transaction IDs must be disabled before sending an `IdentifyDeviceLingoes` command.

**Note:** When responding to an accessory's command containing a transaction ID, an iPod with older firmware that does not support transaction IDs will send an `ACK` command with a Bad Parameter status (0x04) and no transaction ID.

## iPod Acknowledgment of Transaction ID Commands

To support commands with transaction IDs, the General lingo `ACK` command has been expanded to four formats, listed in Table B-1 (page 452). The new command details are presented in "Command 0x02: General Lingo ACK" (page 452).

**Table B-1** Forms of the General lingo `ACK` command

| Transaction ID | Command pending | Payload length | Authentication required |
|---|---|---|---|
| Yes | No | 0x06 | Authentication 2.0B |
| Yes | Yes | 0x0A | Authentication 2.0B |
| No | Yes | 0x08 | None |
| No | No | 0x04 | None |

# Command 0x02: General Lingo ACK

Direction: iPod to Device

The iPod sends a General lingo `ACK` command to an attached accessory to acknowledge receipt of a General lingo command and advise it of the command's completion status and errors. The General lingo `ACK` command has these forms:

- If the command being acknowledged sent a transaction ID, the `ACK` packet has the format shown in Table B-2 (page 453). Accessories must manage transaction IDs as specified in "Transaction IDs" (page 451).

- If the acknowledgment status value being returned is 0x06 (Command Pending), the ACK packet has the format shown in Table B-4 (page 454) (or Table B-5 (page 455) if acknowledging a command without a transaction ID).
- If none of the foregoing is the case, the ACK packet has the format shown in Table B-6 (page 455).

It is the responsibility of the accessory developer to recognize which ACK format will be returned for each General lingo command sent by the accessory and to parse it correctly.

**Table B-2** General lingo ACK packet with transaction ID

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x06 | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x02 | Command ID: ACK |
| 5 | 0x*NN* | transID [bits 15:8]: Transaction ID; see "Transaction IDs" (page 451) |
| 6 | 0x*NN* | transID [bits 7:0] |
| 7 | 0x*NN* | ackStatus: Status of command received. See Table B-3 (page 453). |
| 8 | 0x*NN* | origCmdID: ID of command received. |
| 9 | 0x*NN* | Checksum |

**Table B-3** ACK command error codes

| Value | Description |
|---|---|
| 0x00 | Success (OK) |
| 0x01 | ERROR: Unknown database category |
| 0x02 | ERROR: Command failed |
| 0x03 | ERROR: Out of resources |
| 0x04 | ERROR: Bad parameter |
| 0x05 | ERROR: Unknown ID |
| 0x06 | Command Pending; see Table B-5 (page 455) |
| 0x07 | ERROR: Not authenticated |
| 0x08 | ERROR: Bad authentication version |

| Value | Description |
|---|---|
| 0x09 | ERROR: Accessory power mode request failed |
| 0x0A | ERROR: Certificate invalid |
| 0x0B | ERROR: Certificate permissions invalid |
| 0x0C | ERROR: File is in use |
| 0x0D | ERROR: Invalid file handle |
| 0x0F | ERROR: Operation timed out |
| 0x10 | ERROR: Command unavailable in this iPod mode |
| 0x11 | ERROR: Invalid accessory resistor ID value |
| 0x12 | ERROR: Accessory not grounded |
| 0x13 | Multisection data section received successfully; see "Multisection Data Transfers" (page 459) |
| 0x14–0xFF | Reserved |

If the status returned by the `ACK` command is Command Pending, an additional field is added to the `ACK` packet that represents the amount of time, in milliseconds, that an accessory must wait to receive the final packet indicating that the current command completed or returned one of the error codes listed in Table B-3 (page 453).

After receiving a Command Pending `ACK`, the device must wait for up to the specified number of milliseconds for a final `ACK` response. If no final `ACK` packet is received before the specified amount of time expires, the device should retry the command.

**Table B-4** General lingo `ACK` packet with transaction ID and Command Pending status

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x0A | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x02 | Command: `ACK` |
| 5 | 0x*NN* | `transID` [bits 15:8]: Transaction ID; see "Transaction IDs" (page 451) |
| 6 | 0x*NN* | `transID` [bits 7:0] |
| 7 | 0x06 | Command result status: Command Pending |
| 8 | 0x*NN* | The ID of the command being acknowledged. |

| Byte number | Value | Comment |
|---|---|---|
| 9 | 0x*NN* | Maximum amount of time to wait for pending response, in milliseconds (bits 31:24). |
| 10 | 0x*NN* | Maximum pending wait, in milliseconds (bits 23:16) |
| 11 | 0x*NN* | Maximum pending wait, in milliseconds (bits 15:8) |
| 12 | 0x*NN* | Maximum pending wait, in milliseconds (bits 7:0) |
| 13 | 0x*NN* | Checksum |

**Table B-5** General lingo `ACK` packet with Command Pending status

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x08 | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x02 | Command: `ACK` |
| 5 | 0x06 | Command result status: Command Pending |
| 6 | 0x*NN* | The ID of the command being acknowledged. |
| 7 | 0x*NN* | Maximum amount of time to wait for pending response, in milliseconds (bits 31:24). |
| 8 | 0x*NN* | Maximum pending wait, in milliseconds (bits 23:16) |
| 9 | 0x*NN* | Maximum pending wait, in milliseconds (bits 15:8) |
| 10 | 0x*NN* | Maximum pending wait, in milliseconds (bits 7:0) |
| 11 | 0x*NN* | Checksum |

**Table B-6** Default General lingo `ACK` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x04 | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x02 | Command: `ACK` |

| Byte number | Value | Comment |
|---|---|---|
| 5 | 0x*NN* | Command result status. Possible values are shown in Table B-3 (page 453). |
| 6 | 0x*NN* | The ID of the command being acknowledged |
| 7 | 0x*NN* | Checksum |

# Examples of Transaction IDs

Table B-7 (page 456) through Table B-10 (page 458) illustrate the use of transaction IDs in some typical iAP command flows.

**Table B-7** Example of IDPS and authentication

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| 1 | `StartIDPS` | | Transaction ID = 0x0001 (accessory counter starts counting). |
| 2 | | `ACK` | Transaction ID = 0x0001; response to Step 1 |
| 3 | `SetFIDTokenValues` | | Transaction ID = 0x0002. |
| 4 | | `RetFIDTokenValueACKs` | Transaction ID = 0x0002; assume some token value was not acknowledged. |
| 5 | `SetFIDTokenValues` | | Transaction ID = 0x0003; retry command with a different transaction ID |
| 6 | | `RetFIDTokenValueACKs` | Transaction ID = 0x0003; response to Step 5. |
| 7 | `EndIDPS` | | Transaction ID = 0x0004. |
| 8 | | `IDPSStatus` | Transaction ID = 0x0004; response to Step 7 |
| 9 | | `GetDevAuthentication-Info` | Transaction ID = 0x0001; first command initiated by the iPod (iPod counter starts counting). |
| 10 | `RetDevAuthentication-Info` | | Transaction ID = 0x0001; response to Step 9. |
| 11 | | `AckDevAuthentication-Info` | Transaction ID = 0x0001; response to Step 10. |

**Table B-8** Example of entering Remote UI mode

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| 1 | StartIDPS | | Transaction ID = 0x0001 (accessory counter starts counting). |
| 2 | | ACK | Transaction ID = 0x0001; response to Step 1 |
| 3 | SetFIDTokenValues | | Transaction ID = 0x0002. |
| 4 | | RetFIDTokenValueACKs | Transaction ID = 0x0002; response to Step 3. |
| 5 | EndIDPS | | Transaction ID = 0x0003. |
| 6 | | IDPSStatus | Transaction ID = 0x0003; response to Step 5. |
| Enter background authentication state; see "Authentication" (page 52). | | | |
| 7 | EnterRemoteUIMode | | Transaction ID = 0x0004. |
| 8 | | ACK | Transaction ID = 0x0004; response to Step 7: command pending. |
| 9 | | ACK | Transaction ID = 0x0004; sent after the iPod has entered Remote UI mode. Note that the same transaction ID value is used. |

**Table B-9** Example of getting track artwork data

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| 1 | StartIDPS | | Transaction ID = 0x0001 (accessory counter starts counting). |
| 2 | | ACK | Transaction ID = 0x0001; response to Step 1 |
| 3 | SetFIDTokenValues | | Transaction ID = 0x0002. |
| 4 | | RetFIDTokenValueACKs | Transaction ID = 0x0002; response to Step 3. |
| 5 | EndIDPS | | Transaction ID = 0x0003. |
| 6 | | IDPSStatus | Transaction ID = 0x0003; response to Step 5. |
| Enter background authentication state; see "Authentication" (page 52). | | | |
| 7 | GetTrackArtworkData | | Transaction ID = 0x0004. |

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| 8 | | RetTrackArtworkData | Transaction ID = 0x0004; Response is divided into multiple packets with the same transaction ID. |
| 9 | | RetTrackArtworkData | Transaction ID = 0x0004. |
| 10 | | RetTrackArtworkData | Transaction ID = 0x0004; Last packet returning artwork data. |

**Table B-10** Example of sending notifications

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| 1 | StartIDPS | | Transaction ID = 0x0001 (accessory counter starts counting). |
| 2 | | ACK | Transaction ID = 0x0001; response to Step 1 |
| 3 | SetFIDTokenValues | | Transaction ID = 0x0002. |
| 4 | | RetFIDTokenValueACKs | Transaction ID = 0x0002; response to Step 3. |
| 5 | EndIDPS | | Transaction ID = 0x0003. |
| 6 | | IDPSStatus | Transaction ID = 0x0003; response to Step 5. |
| 7 | | iPodNotification | Transaction ID = 0x0001; first command initiated by the iPod (iPod counter starts counting). |
| 8 | | iPodNotification | Transaction ID = 0x0002; second command initiated by the iPod. |
| 9 | RdsReadyNotify | | Transaction ID = 0x0004; next accessory transaction ID. |
| 10 | RdsReadyNotify | | Transaction ID = 0x0005. |

# Multisection Data Transfers

Three Location lingo commands may need to transfer amounts of data larger than the data receiver's maximum incoming packet size: `RetDevData`, `SetDevData`, and `AsyncDevData`. This appendix specifies how large amounts of data are transferred in sections, using multiple packets of the same command.

## Multisection Transfer Process

The packets of commands that can transfer data in multiple sections contain two 16-bit parameters that uniquely identify transferred data sections:

- Parameter `sectCur` is the index number of the data section in that packet. The first packet has index 0x0000.
- Parameter `sectMax` is the index number of the last data section

When a data transfer fits into a single packet, both `sectCur` and `sectMax` must be set to 0x0000. When a command transfers data in multiple sections, the transaction ID of the command that requested the transfer must be used for all response sections and the `sectCur` value of each serial packet must increment by 0x0001. For optimal data throughput, data sections must be the maximum size permitted by the receiver, less any command header overhead. The last data section may be smaller than the maximum size if the total data transfer size is not a multiple of the section size.

An accessory may either send or receive multisection data. When the accessory sends multisection data to an iPod, using `RetDevData` or `AsyncDevData`, it must wait after each packet for the iPod to reply with an `iPodACK` command, as detailed in Multisection iPodACK Command (page 460). When the iPod sends multisection data to an accessory, using `SetDevData`, the accessory must reply with a `DevACK` command after each packet, as detailed in Multisection DevACK Command (page 460).

Regardless of whether the accessory is sender or receiver, the acknowledgment command must have the same transaction ID as the data transfer command. When acknowledging any packet before the last one, the acknowledgment must also return the packet's `sectCur` value plus an `ackStatus` of Section Received OK (0x13) if the section was transferred successfully. When the last section has been received successfully, the receiver must send an `ackStatus` of Command OK (0x00), without a `sectCur` value, to indicate that the entire data transfer has finished.

If an error occurs during a multisection transfer, the receiver must send an acknowledgment with a nonzero `ackStatus` other than 0x13. This means the transfer has failed. The sender must stop sending data sections with the same transaction ID. If the receiver does not acknowledge a multisection packet within 400 ms, the transfer has also failed; the sender must send the receiver an acknowledgment with the transfer's transaction ID and a Command Timeout (0x0F) status. When a transfer fails, the sender can try to send the same data again, starting from the beginning, with a different transaction ID.

# Multisection iPodACK Command

Direction: iPod to Accessory

An `iPodACK` command is sent by the iPod in response to each multisection data transfer packet sent by `RetDevData` or `AsyncDevData`. The iPod may send either of two forms of the `iPodACK` packet:

- When any section before the last section has been received successfully, the iPod sends the packet shown in Table C-1 (page 460). The accessory may send a new packet immediately.
- When the last section has been received successfully, the iPod sends the packet shown in Table 3-270 (page 333) with `ackStatus` = 0x00, indicating that the multisection data transfer is complete. See Command 0x80: iPodACK (page 333) for details of this form of the `iPodACK` command. The iPod also sends an acknowledgment of this form, with a nonzero `ackStatus`, when an error has occurred in receiving any packet.

**Table C-1** Multisection iPodACK packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x08 | Length of packet payload |
| 3 | 0x0E | Lingo ID: Location lingo |
| 4 | 0x80 | Command ID: `iPodACK` |
| 5 | 0x*NN* | `transID` [bits 15:8]: Transaction ID of command being acknowledged; see "Transaction IDs" (page 451) |
| 6 | 0x*NN* | `transID` [bits 7:0] |
| 7 | 0x13 | `ackStatus`: Section received successfully |
| 8 | 0x*NN* | `cmdIDOrig`: Original command ID for which this response is being sent. |
| 9 | 0x*NN* | `sectCur` [Bits 15:8]: Section index for which this response is being sent. |
| 10 | 0x*NN* | `sectCur` [Bits 7:0] |
| 11 | 0x*NN* | Checksum |

# Multisection DevACK Command

Direction: Accessory to iPod

The accessory must send a `DevACK` command in response to each multisection data transfer packet sent by the iPod via `SetDevData`. The accessory may send either of two forms of the `DevACK` packet:

- When it has successfully received any section before the last section, the accessory must send the packet shown in Table C-2 (page 461). The iPod will send a new packet immediately.
- When it has successfully received the last section, the accessory must send the packet shown in Table 3-247 (page 317) with `ackStatus` = 0x00, indicating that the multisection data transfer is complete. See Command 0x00: DevACK (page 317) for details of this form of the `DevACK` command. The accessory must also send an acknowledgment of this form, with a nonzero `ackStatus`, whenever it has detected an error in receiving any packet.

**Table C-2** Multisection DevACK packet

| Byte number | Value | Comment |
| --- | --- | --- |
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x08 | Length of packet payload |
| 3 | 0x0E | Lingo ID: Location lingo |
| 4 | 0x00 | Command ID: `DevACK` |
| 5 | 0x*NN* | `transID` [bits 15:8]: Transaction ID of command being acknowledged; see "Transaction IDs" (page 451) |
| 6 | 0x*NN* | `transID` [bits 7:0] |
| 7 | 0x13 | `ackStatus`: Section received successfully |
| 8 | 0x08 | `cmdIDOrig`: ID of command (`SetDevData`) for which this response is being sent. |
| 9 | 0x*NN* | `sectCur` [Bits 15:8]: Section index for which this response is being sent. |
| 10 | 0x*NN* | `sectCur` [Bits 7:0] |
| 11 | 0x*NN* | Checksum |

# iTunes Tagging

This appendix explains the iTunes tagging feature and specifies the requirements for an HD or FM radio accessory to support it.

## The iTunes Tagging Experience

To experience the capabilities of the iTunes tagging feature, an iPod user typically goes through the following steps:

1. While listening to broadcast music on an HD or FM radio accessory, the user hears a song and decides to tag it for future review or purchase by pressing a special button or other user interface element.
2. The radio accessory, equipped with a tag button or equivalent software action, stores metadata for the currently playing song. The user tags the song without needing to know anything about it or its originating station. The song information is stored in the radio accessory until an iPod is connected to it.
3. When an iPod is connected to it, the radio transfers the tagged song information to the iPod. The iPod stores the data until the iPod is synched with iTunes.
4. When the iPod is connected to the user's computer, iTunes imports the tag data, analyzes it, and presents it to the user in the form of a tagged playlist. iTunes displays the song title, artist, album and other information for each tagged song.
5. Using iTunes, the user may save, review or delete any item in the tagged playlist and may easily purchase any of the listed songs through the iTunes store.

## Tagging Feature Components

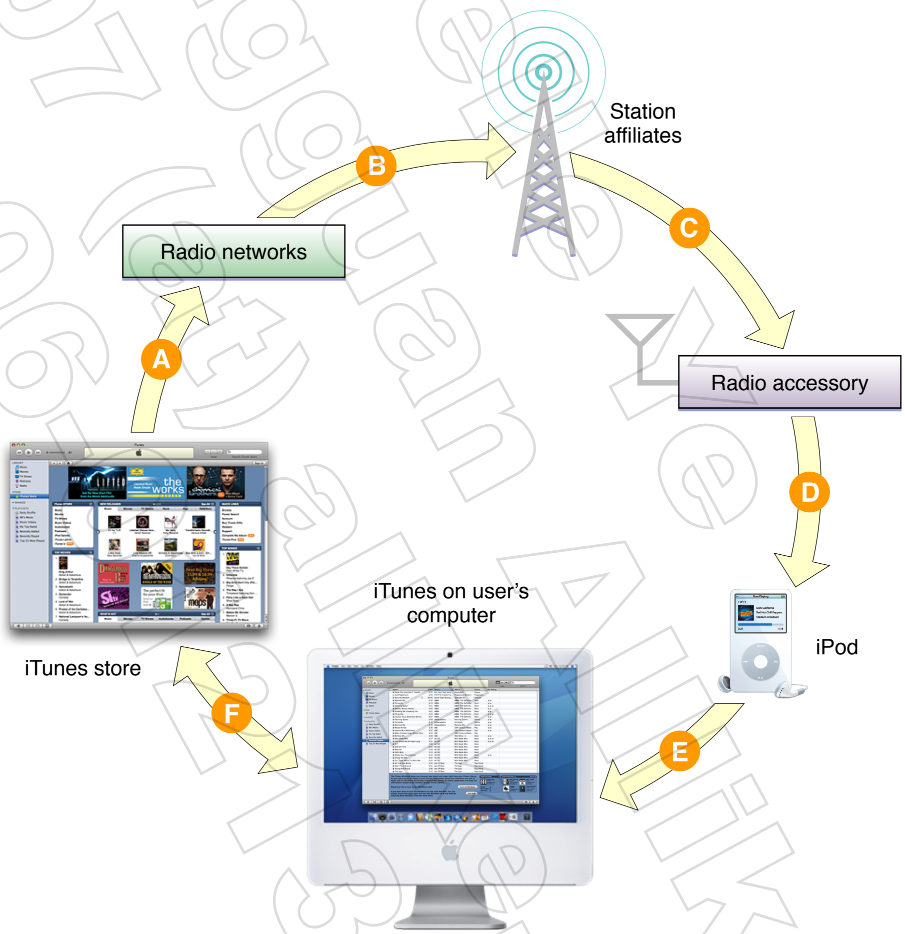
To implement the user experience described in the previous section, the iTunes tagging feature includes the following major components:

- The **iTunes store** creates and publishes unique identifiers for media available in its catalog, and allows users of accessories that support radio tagging for iTunes to purchase tagged songs.
- **Radio networks and station affiliates** receive iTunes store data and broadcast it along with program music and other content.
- **HD or FM radio accessories for the iPod** are designed to enable the tagging feature. These radio receivers may be portable, used in the home or in a car.
- An **iPod** is a media player used to transfer tags from iPod accessories to iTunes.

- The **iTunes application** is a desktop media player for managing media content, including newly-discovered music via the iTunes tagging feature.

The data flows among the components of the iTunes tagging feature listed above are diagrammed in Figure D-1 (page 464).

**Figure D-1** iTunes tagging feature data flows




| Data flow | Description |
| --- | --- |
| A | An enterprise partner feed from Apple contains `iTunesSongID`s, track names, artists, and album names for the contents of the iTunes store. |
| B | Network data is sent to the station affiliates, including Apple-supplied data. |
| C | Affiliates broadcast metadata with each song, containing the song's `iTunesSongID`, track name, and artist name. |
| D | The radio accessory writes XML tag data to a file on an attached iPod, using the iAP Storage lingo; the iPod signs the file. |

| Data flow | Description |
|---|---|
| E | iTunes verifies and uploads the iPod's tag files and presents a tagged music playlist to the user. |
| F | The user clicks a "Buy" button next to the tagged music and downloads the music from the iTunes Store. |

# Radio Accessory Requirements

Radio accessories that support the iTunes tagging feature described in this specification must perform the following actions:

- Authenticate themselves to the attached iPod. This requires that the accessory contain an authentication coprocessor supplied by Apple. For technical details, see Apple's *iPod Authentication Coprocessor 2.0B Specification*.
- Conform to the user interface requirements described in "Accessory User Interface" (page 482).
- Provide static storage capacity for at least 50 tags, and provide enough RAM to cache two tags in cases of tag ambiguity (see "Resolving Tag Ambiguity" (page 476)). Accessories should store tags in a data structure and only generate XML when writing files to the iPod. Tag data may be stored internally in any format convenient to the accessory.
- Generate tag data from the radio broadcast's metadata. Accessories supporting iTunes Tagging must populate every XML field for which metadata is received.
- Generate files from the tag data and write these files to the attached iPod. The files must be XML-formatted **plists,** as specified in "Tag Data Writing Process" (page 477). The plist fields in these files are specified in "Data Transfer to the iPod" (page 479), and the iAP commands used to write a file to the iPod are defined in "Lingo 0x0C: Storage Lingo" (page 300).

## HD Radio Tagging

In addition to their audio content, HD radio broadcasts contain Program Service Data (PSD) and Station Information Service (SIS) data. The HD radio accessory must capture these data streams and write their information to plist fields as shown in Table D-8 (page 479). The accessory must populate every plist field for which it receives data from the radio broadcast, including program service data (PSD) and station information services (SIS).

**Note:** Mac OS X plist files are UTF-8 encoded; the PSD data sent by HD radio broadcasters is ISO-8859-1 encoded. The radio accessory must convert the IS0-8859-1 data to UTF-8 before writing the plist file to the iPod. If the plist file contains ISO-8859-1 characters in the range 0x80 to 0xFF, iTunes cannot parse the file properly and the tag will be lost. The XML markup delimiters &, <, and > must be written as `&`, `<`, and `>`—otherwise iTunes cannot open the file.

# FM Radio Tagging

FM radio uses the RDS/RBDS subcarrier system to broadcast data, in addition to its audio content. For information about RBDS, see the *United States RBDS Standard, NRSC-4-A*, available at www.nrscstandards.org. FM tagging data is broadcast inside two ODAs (Open Data Applications): a RadioText Plus (RT+) ODA and a private iTunes Tagging ODA.

The FM radio accessory must capture the data streams from both these ODAs and write their information to plist files, as described in "Capturing and Storing Tag Data" (page 477). During this process, the accessory must populate every plist field listed in Table D-8 (page 479) for which it receives metadata from the radio broadcast. For an FM tag to be usable, its plist entry must provide valid data for at least the `Title` and `Artist` fields.

## The RT+ ODA

RadioText Plus (RT+) is a technology that tags RDS RadioText (RT) messages so specific content can be retrieved from them. RT+ tags are transmitted in RDS broadcasts as an ODA with an Application ID (AID) of 0x4BD7. You can download the RT+ specification at www.rds.org.uk/rds98/pdf/R06_040_1.pdf.

Each RT+ tag contains three elements:

- The RT content type
- The position inside the RT message of the first character of content to be retrieved
- The length of the content to be retrieved.

The RT+ content types used for iTunes FM radio tagging are listed in Table D-1 (page 466). The corresponding plist fields sent to the iPod are described in Table D-8 (page 479).

**Table D-1** RT+ content types

| RT+ type | iTunes plist field |
|---|---|
| `ITEM.TITLE` | `Name` |
| `ITEM.ARTIST` | `Artist` |
| `ITEM.ALBUM` | `Album` |
| `ITEM.GENRE` | `Genre` |
| `STATIONNAME.SHORT, STATIONNAME.LONG` | `StationCallLetters` |
| `INFO.URL` | `PodcastFeedURL` |

| RT+ type | iTunes plist field |
|---|---|
| PROGRAMME.HOMEPAGE | StationURL |
| PROGRAMME.SUBCHANNEL | ProgramNumber |

## The iTunes Tagging ODA

The iTunes ODA used for FM broadcasts encodes tag information as **elements.** Currently 6 element types are defined and another 10 are reserved for future use, as shown in Table D-2 (page 467).

**Table D-2** FM tag element types

| ID type | Description |
|---|---|
| 0x0 | Event Control |
| 0x1 | iTunes Song ID |
| 0x2 | iTunes Artist ID |
| 0x3 | Reserved |
| 0x4 | Industry ID |
| 0x5 | iTunes Storefront |
| 0x6 | Extended ID |
| 0x7-0xF | Reserved |

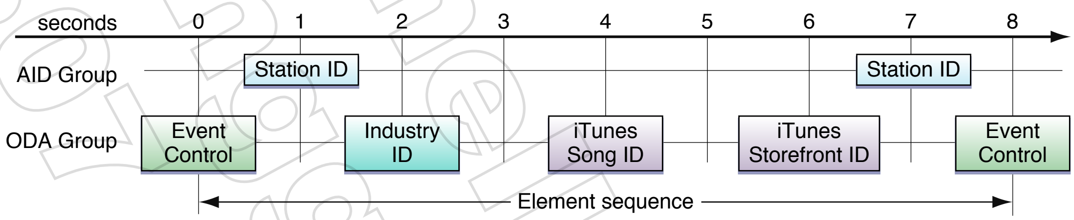
All currently defined FM tag elements carry 32 bits of data and are transmitted using a single ODA application group. If necessary, future versions of the iTunes FM tagging protocol may accommodate larger data types by chaining several ODA groups together.

FM tag elements are normally encrypted before transmission. Because the transmission must be decrypted by the receiver, it is keyed to a composite of values contained in the RDS data. This process is described in "FM Tag Decryption" (page 471).

A complete iTunes tagging transmission normally consists of several element types in an **element sequence.** The elements in the sequence are transmitted at a relatively low rate (about one element every 2 seconds), so the RDS bandwidth consumed by iTunes tagging is relatively small. When a complete sequence of elements has been transmitted the process repeats itself. Figure D-2 (page 468) shows the transmission timeline of a typical element sequence. In this example, the sequence consists of 4 element types and a complete transmission of the sequence occurs every 8 seconds.

**Note:** To assure that tag data is always available, the maximum recommended time between transmissions is 10 seconds.

**Figure D-2** iTunes tagging element sequence



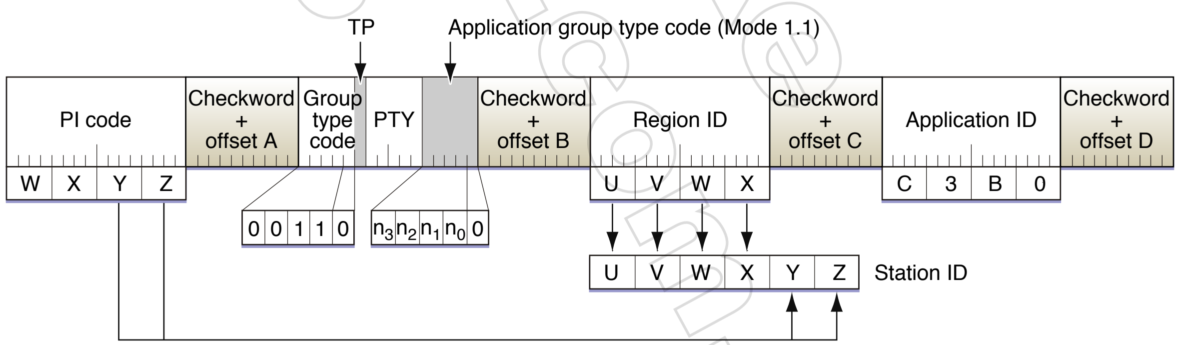

## Use of the RDS Group Type 3A

Because the RT+ and FM iTunes tagging data are contained in ODAs, they use the RDS group type 3A, also called the AID (Application ID) Group type. This RDS group type includes 16 message bits for use by each ODA (block C) and indicates the application group type (if any) used for transmission of additional ODA data. Tag data is transmitted in mode 1.1, meaning that the broadcaster allocates an available type A group for transmission of iTunes tag element data. RDS 3A group messages with Application ID 0xC3B0 indicate which RDS group type will be used to carry the iTunes tagging information. The accessory must parse group type 3A messages and save the application group type code (n3-n0), because this indicates the ODA group type on which tag data will be broadcast.

**Note:** The accessory must parse and save the application group type code for each iTunes-specific type 3A message, because the type code for subsequent iTunes data may change during the broadcast.

The recommended transmission rate for the iTunes tag 3A group is once every 7 seconds, with a maximum repeat delay of once every 10 seconds. Upon tuning to a new frequency, a tagging-enabled FM receiver waits for the reception of a 3A group containing the assigned Application ID number; this indicates that the broadcast includes iTunes tag data. The RDS 3A group structure for iTunes tagging is shown in Figure D-3 (page 468).

**Figure D-3** RDS 3A group for iTunes tagging




The Region ID code shown in Figure D-3 (page 468) combines the extended country code (see Annex N of the RBDS specification) and the upper byte of the PI (Program Identification) code: the upper byte "UV" of the Region ID carries the extended country code and the lower byte "WX" mirrors the upper byte of the PI code. The receiver must combine the 16-bit Region ID with the lower byte of the PI code to form a 24-bit Station ID, a guaranteed unique identifier of a particular radio station. The 24-bit Station ID has the byte order UVWXYZ, as shown in the diagram.

**Note:** It is possible that the upper byte of the PI code may not exactly mirror the lower byte of the Region ID. For this reason, a receiver must construct the Station ID exactly as specified above. Always use the bytes transmitted in Region ID; ignore the upper byte of the PI code.

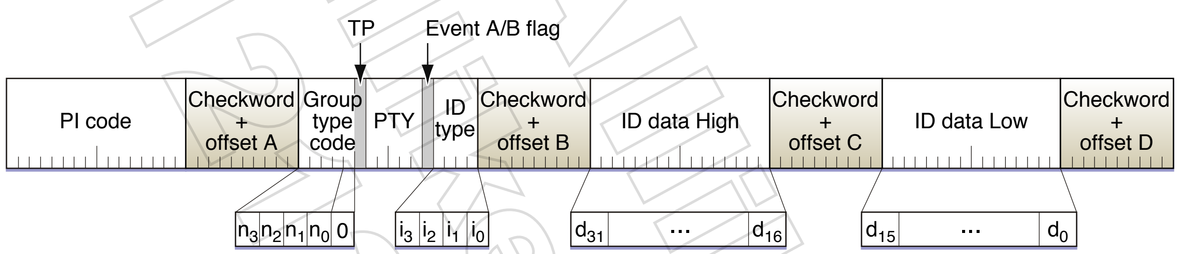
The Station ID is intended for use in affiliate programs. Because affiliate programs normally involve an online merchant, that merchant or an appropriate third party maintains a table translating the Station ID into a more traditional Affiliate ID. For example, a range of Station ID codes may map to a single group identifier for the purposes of an affiliate program.

## Tagging Application Group

The iTunes tag element data is transmitted using an RDS type A application group (also called an ODA Group), as shown in Figure D-4 (page 469). The Group Type Code (n3-n0) of this message should correspond to that broadcst as the application group type code, which was part of the Group 3A message with AID 0xC3B0.

Figure D-4 (page 469) depicts the data before encryption at the transmitter and following successful decryption at the receiver. The encryption process scrambles the ID Type (bits i3 to i0) as well as the ID data (bits d31 to d16 and d15 to d0). The remaining data (PI code, group type code, TP flag, PTY and Event A/B flag) are always transmitted in the clear.

**Figure D-4** RDS application group for iTunes tagging




The ID Type indicates the specific type of element data carried by an instance of the ODA group. There are 16 possible element types of which 6 are currently defined (see Table D-2 (page 467)). The unassigned elements are available for future use. Types 00000 and 1111 are reserved as special-purpose control elements; all other types are available for content identification codes. Data received with an unassigned element type must be written to an `UnknownData` field in the plist sent to the iPod; see "Handling Unknown Metadata Types" (page 475).

The ID data field carries the actual data associated with an element. For all currently-defined numeric identifiers (iTunes Song, iTunes Artist, iTunes Storefront, Extended ID and Industry ID) these bits are interpreted as 32-bit unsigned integer values. The Event Control element uses an alternate definition of the data bits, as detailed in "FM Tagging Event Control" (page 470). The Event A/B flag is a toggle bit that changes state each time the broadcast content changes. This tells the receiver that it should clear any temporary buffers associated with element data in preparation for reception of a new set of data. In a typical music broadcast, the Event A/B flag toggles at the transition from one song to the next, at the transition from music to non-music content (advertisement break) and at the transition from non-music content back to music. Even if there are no elements associated with a particular piece of content, the A/B flag still toggles at the start of that content to mark the end of previously identified content. In such a situation, an element sequence consisting only of the Event Control element is transmitted as a carrier for the A/B flag.

## Normal Mode and Test Mode

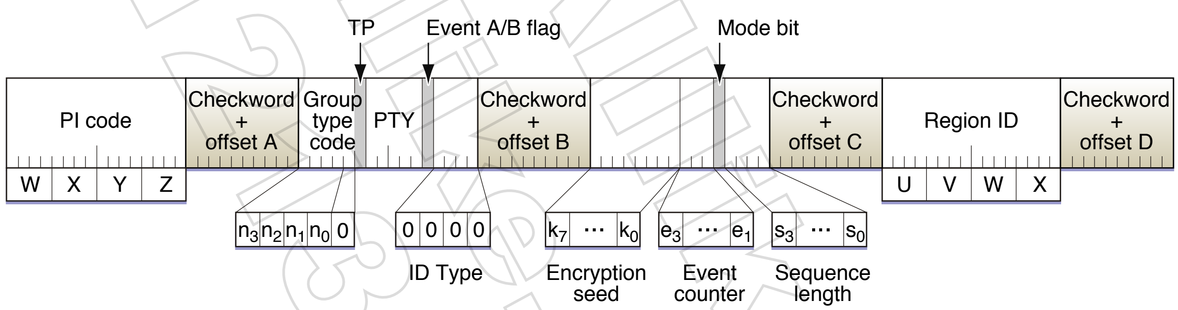
Two modes of operation are defined for the RDS transmission of iTunes tag data: **normal mode** and **test mode.** The Region ID section of Group Type Code 3A messages with AID 0xC3B0 indicate what mode is being used for broadcast. In normal mode the message bits of the AID group carry a 16-bit Region ID and encryption/decryption is enabled. In test mode the message bits are set to zero (0x0000) and encryption/decryption is disabled. Tagging-enabled FM receivers must support both operating modes. In test mode, the Station ID is constructed using Region ID and the PI code lower byte as carried by the Event Control element (See "FM Tagging Event Control" (page 470)). In test mode it is not possible to construct a Station ID from the 3A group because the Region ID is set to zero.

## FM Tagging Event Control

**Event Control** is a special-purpose element used to indicate a change in the content being broadcast as well as to indicate the overall status of the iTunes tag transmission.

The **event counter** is a 4-bit count that is incremented each time the on-air content changes. After the count reaches 15 it wraps back to 0. The 3 most significant bits of the count (bits e3-e1) are carried in the Event Control element, shown in Figure D-5 (page 470). The least significant bit of the counter (bit e0) is carried in every element type and is called the Event A/B Flag.

**Figure D-5** Event Control element




When set to 1, the mode bit shown in Figure D-5 (page 470) indicates that the event currently being broadcast has been successfully mapped to at least one type of content identifier and that identifiers are being transmitted as part of the element sequence. If no mapping exists for the current event, the mode bit is set to 0. The Sequence length bits (bits s3-s0) indicate the number of element types included in the element sequence for the current event. A value of 0000 indicates that the sequence consists only of the Event Control element. The decryption seed (bits k7-k0) is a one-byte value used to seed the decryption system discussed in "FM Tag Decryption" (page 471). The 16-bit Region ID value transmitted in block C of the AID group is also transmitted as block D of the Event Control element.

**Note:** The decryption seed must be read from every Event Control message because it may change during the broadcast.

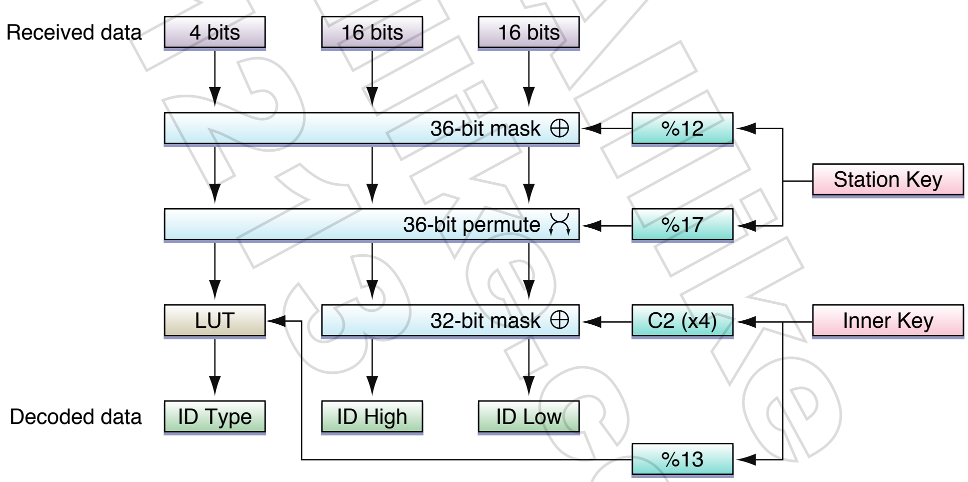
In normal mode, this retransmission lets a receiver quickly verify that Region ID has been received error-free and that element data is being decoded correctly. Retransmission is particularly valuable because the Region ID (as a component of the Station ID) is used as part of the dencryption process. In test mode, the Region ID is transmitted only as part of the Event Control element. Retransmission is of less value in test mode because encryption/decryption is disabled.

## FM Tag Decryption

During the transmission of FM tag elements, 36 bits of raw data are passed into an encryption process, including the 4-bit element type ID and 32 bits of element data (ID High and ID Low). The encryption algorithm is keyed by two values generated from RDS data: the Station Key and the Inner Key. The Station Key is the algebraic sum of all three bytes of the Station ID: `StationKey = YZ + UV + WX`. The Inner Key is the linear combination (XOR) of three byte values: the 8 least significant bits of the Station Key, a byte formed from Sequence Length (upper nibble) and Event Counter (lower nibble), and the one-byte Encryption Seed carried by the Event Control element: `InnerKey = (StationKey & 0xFF) ^ ((SequenceLength << 4) | EventCounter) ^ EncryptionSeed`.

The decryption process for FM iTunes tagging elements is diagrammed in Figure D-6 (page 471) and is described below.

**Figure D-6** Element decryption process




To decode the received data, it is first necessary to generate the station key, which is the algebraic sum of all three bytes of the Station ID. (`StationKey = YZ + UV + WX`). The three input bytes and the result are treated as unsigned integers. The Station ID bytes can be recovered from the AID group.

Upon reception of an ODA group, the 36 bits of coded tag data are passed into the decryption process. The first stage of decoding applies 1 of 12 predefined outer masks to the full 36 bits of received data using a linear mixing (XOR) operation. The 12 predefined masks are listed in Table D-3 (page 472). The mask used is selected as the modulus (integer remainder) of the Station Key divided by 12 (`MaskRow = StationKey % 12`).

**Table D-3** Outer mask lookup table

| Row | Bits 35-32 | Bits 31-16 | Bits 15-0 |
|---|---|---|---|
| 0 | D | D5D0 | E3E1 |
| 1 | 2 | 6073 | 04B4 |
| 2 | C | 5C59 | 80D5 |
| 3 | E | 9C6E | 78D0 |
| 4 | 3 | 9E48 | 2754 |
| 5 | 4 | 062E | 9DB7 |
| 6 | B | 2924 | 4436 |
| 7 | 6 | F308 | 3628 |
| 8 | 9 | 9DE8 | 27A4 |
| 9 | 5 | 1C71 | CEA0 |
| 10 | 8 | B5C7 | C134 |
| 11 | 7 | 679C | 30BD |

The second stage of decoding applies 1 of 17 predefined permute operations to the full 36 bits of received data. The permutation operation reorders the data at the bit level. The 17 permutation operations are shown in Table D-4 (page 472) and Table D-5 (page 473). The operation used is selected as the modulus of the station key divided by 17 (`PermuteRow = StationKey % 17`).

**Table D-4** Permutation lookup table, upper bits

| Bits | 35 | 34 | 33 | 32 | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 7 | 11 | 4 | 35 | 3 | 5 | 26 | 2 | 21 | 32 | 6 | 20 | 17 | 0 | 14 | 27 | 9 | 15 |
| 1 | 13 | 29 | 28 | 12 | 19 | 33 | 32 | 15 | 24 | 27 | 2 | 9 | 4 | 34 | 17 | 8 | 16 | 22 |
| 2 | 25 | 9 | 24 | 13 | 18 | 11 | 5 | 32 | 22 | 17 | 35 | 16 | 2 | 29 | 6 | 15 | 1 | 19 |
| 3 | 16 | 20 | 2 | 0 | 28 | 14 | 6 | 25 | 12 | 8 | 7 | 1 | 32 | 24 | 4 | 19 | 33 | 9 |
| 4 | 10 | 8 | 20 | 7 | 16 | 28 | 33 | 21 | 35 | 1 | 15 | 12 | 25 | 17 | 11 | 22 | 18 | 23 |
| 5 | 15 | 17 | 16 | 19 | 7 | 3 | 30 | 8 | 28 | 12 | 29 | 34 | 11 | 18 | 25 | 13 | 2 | 31 |
| 6 | 21 | 31 | 11 | 6 | 34 | 13 | 0 | 33 | 17 | 9 | 26 | 10 | 14 | 7 | 2 | 18 | 22 | 20 |
| 7 | 4 | 22 | 9 | 15 | 14 | 12 | 1 | 6 | 7 | 21 | 33 | 19 | 35 | 11 | 16 | 29 | 10 | 5 |
| 8 | 0 | 4 | 35 | 18 | 6 | 7 | 24 | 23 | 11 | 34 | 32 | 3 | 1 | 31 | 22 | 16 | 8 | 30 |

| Bits | 35 | 34 | 33 | 32 | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9 | 18 | 2 | 15 | 20 | 5 | 22 | 3 | 19 | 4 | 25 | 31 | 26 | 0 | 28 | 13 | 7 | 29 | 1 |
| 10 | 3 | 0 | 5 | 9 | 17 | 1 | 8 | 18 | 13 | 31 | 4 | 15 | 6 | 12 | 20 | 14 | 23 | 25 |
| 11 | 9 | 6 | 1 | 33 | 30 | 32 | 21 | 29 | 19 | 13 | 0 | 22 | 10 | 5 | 7 | 2 | 14 | 12 |
| 12 | 28 | 24 | 26 | 34 | 33 | 18 | 14 | 5 | 25 | 15 | 10 | 0 | 9 | 32 | 19 | 31 | 17 | 13 |
| 13 | 31 | 5 | 13 | 14 | 0 | 35 | 17 | 12 | 30 | 29 | 22 | 18 | 24 | 25 | 1 | 21 | 4 | 26 |
| 14 | 22 | 32 | 23 | 24 | 15 | 16 | 35 | 11 | 6 | 33 | 18 | 14 | 28 | 21 | 29 | 0 | 27 | 34 |
| 15 | 2 | 30 | 0 | 4 | 13 | 15 | 18 | 9 | 8 | 20 | 28 | 32 | 21 | 10 | 31 | 6 | 11 | 35 |
| 16 | 19 | 33 | 10 | 2 | 27 | 17 | 22 | 7 | 16 | 3 | 21 | 5 | 30 | 20 | 24 | 35 | 32 | 14 |

**Table D-5** Permutation lookup table, lower bits

| Bits | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 8 | 23 | 29 | 30 | 22 | 19 | 16 | 25 | 24 | 10 | 1 | 33 | 12 | 28 | 34 | 18 | 13 | 31 |
| 1 | 18 | 10 | 31 | 11 | 26 | 3 | 35 | 6 | 25 | 23 | 5 | 0 | 1 | 30 | 7 | 20 | 14 | 21 |
| 2 | 10 | 8 | 30 | 27 | 23 | 7 | 31 | 12 | 33 | 3 | 0 | 34 | 20 | 21 | 26 | 14 | 28 | 4 |
| 3 | 5 | 3 | 34 | 31 | 35 | 30 | 21 | 26 | 22 | 15 | 13 | 29 | 18 | 10 | 11 | 23 | 17 | 27 |
| 4 | 13 | 14 | 2 | 24 | 30 | 29 | 34 | 19 | 26 | 31 | 32 | 4 | 3 | 27 | 9 | 0 | 5 | 6 |
| 5 | 20 | 6 | 24 | 26 | 10 | 1 | 0 | 23 | 27 | 21 | 4 | 22 | 14 | 5 | 35 | 33 | 32 | 9 |
| 6 | 1 | 24 | 28 | 4 | 32 | 5 | 15 | 8 | 23 | 29 | 12 | 25 | 30 | 3 | 27 | 19 | 16 | 35 |
| 7 | 32 | 27 | 20 | 3 | 34 | 31 | 18 | 13 | 30 | 0 | 23 | 28 | 24 | 2 | 25 | 17 | 26 | 8 |
| 8 | 21 | 2 | 26 | 29 | 12 | 9 | 20 | 17 | 13 | 33 | 25 | 5 | 10 | 14 | 15 | 28 | 27 | 19 |
| 9 | 27 | 11 | 16 | 8 | 6 | 17 | 24 | 32 | 35 | 9 | 34 | 30 | 21 | 23 | 14 | 12 | 10 | 33 |
| 10 | 33 | 19 | 27 | 7 | 2 | 21 | 30 | 28 | 34 | 24 | 10 | 16 | 26 | 22 | 29 | 35 | 11 | 32 |
| 11 | 34 | 31 | 11 | 23 | 20 | 25 | 8 | 27 | 3 | 4 | 15 | 17 | 28 | 26 | 18 | 16 | 35 | 24 |
| 12 | 35 | 4 | 21 | 6 | 7 | 23 | 29 | 20 | 8 | 30 | 2 | 3 | 27 | 1 | 16 | 11 | 22 | 12 |
| 13 | 2 | 33 | 7 | 19 | 16 | 20 | 28 | 3 | 32 | 6 | 8 | 27 | 23 | 34 | 10 | 15 | 9 | 11 |
| 14 | 3 | 26 | 19 | 1 | 31 | 2 | 4 | 5 | 20 | 17 | 30 | 13 | 9 | 12 | 8 | 10 | 7 | 25 |
| 15 | 26 | 17 | 5 | 12 | 29 | 16 | 27 | 24 | 19 | 34 | 22 | 23 | 25 | 33 | 1 | 7 | 3 | 14 |
| 16 | 23 | 1 | 8 | 25 | 4 | 26 | 13 | 15 | 31 | 18 | 29 | 12 | 6 | 11 | 0 | 9 | 34 | 28 |

> **Note:** At this stage the outer layer of the encryption system has been reversed and it is now possible to read data from the control elements (upper 4 bits set to 0000 or 1111). The reception and parsing of an event control element (type 0000) is required before the remaining ID oriented elements can be decoded.

The third stage decodes the ID type by passing the upper 4 data bits through a predefined lookup table. It then decodes the ID high and ID low bits by applying an algorithmically-generated inner mask to the lower 32 data bits. The ID lookup is shown in Table D-6 (page 474). The lookup used is selected as the modulus of the inner key divided by 13 (`IDlookupRow = InnerKey % 13`). The upper 4 data bits select the table column and the decoded ID Type is the cell value at the selected row and column.

**Table D-6** Element type lookup table

| ID | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 6 | 7 | 2 | 9 | 8 | 11 | 4 | 3 | 10 | 13 | 14 | 1 | 12 | 5 | 15 |
| 1 | 0 | 3 | 10 | 4 | 5 | 6 | 7 | 11 | 2 | 12 | 9 | 1 | 13 | 14 | 8 | 15 |
| 2 | 0 | 9 | 3 | 11 | 6 | 7 | 4 | 1 | 14 | 13 | 12 | 5 | 8 | 2 | 10 | 15 |
| 3 | 0 | 14 | 1 | 9 | 13 | 4 | 12 | 6 | 10 | 11 | 3 | 8 | 2 | 5 | 7 | 15 |
| 4 | 0 | 7 | 14 | 8 | 3 | 10 | 2 | 12 | 13 | 1 | 5 | 4 | 11 | 9 | 6 | 15 |
| 5 | 0 | 13 | 11 | 12 | 1 | 14 | 5 | 8 | 4 | 3 | 6 | 10 | 9 | 7 | 2 | 15 |
| 6 | 0 | 11 | 4 | 13 | 14 | 2 | 9 | 3 | 7 | 8 | 1 | 6 | 5 | 10 | 12 | 15 |
| 7 | 0 | 2 | 9 | 7 | 10 | 12 | 14 | 13 | 5 | 4 | 8 | 3 | 6 | 1 | 11 | 15 |
| 8 | 0 | 8 | 13 | 6 | 2 | 9 | 10 | 5 | 11 | 14 | 4 | 12 | 7 | 3 | 1 | 15 |
| 9 | 0 | 4 | 12 | 1 | 11 | 13 | 8 | 10 | 9 | 5 | 2 | 7 | 14 | 6 | 3 | 15 |
| 10 | 0 | 5 | 8 | 14 | 7 | 1 | 3 | 9 | 12 | 6 | 11 | 2 | 10 | 4 | 13 | 15 |
| 11 | 0 | 10 | 6 | 5 | 12 | 11 | 13 | 2 | 1 | 7 | 14 | 9 | 3 | 8 | 4 | 15 |
| 12 | 0 | 12 | 5 | 10 | 8 | 3 | 1 | 14 | 6 | 2 | 7 | 13 | 4 | 11 | 9 | 15 |

> **Note:** At this point the inner layer of the encryption process for the element type has been reversed and all element types are fully decoded. Decryption of the data bits is accomplished by passing them through the polynomial shown in Listing D-1 (page 475).

To decode ID-oriented elements, it is necessary to generate the inner key. The inner key is a linear mixing (XOR) of three byte values: the 8 least significant bits of the station key, a byte formed from the sequence lLength (upper nibble) and event counter (lower nibble) and the encryption seed value, all carried by the event control element (`InnerKey = (StationKey & 0xFF) ^ ((SequenceLength << 4) | EventCounter) ^ EncryptionSeed`).

The inner mask is a pseudo-random bit pattern output from a linear feedback shift register seeded by the Inner Key. The Baicheva C2 algorithm is used as the generator polynomial. Four calls are made to the random number generator, each of which produce 8 bits of data. The seed value of the first call is the inner key. The result of the first call becomes the upper 8 bits of the inner mask. The result of the first call also becomes the seed value of the second call, and so on. The result of the fourth call becomes the lower 8 bits of the inner mask.

A code listing for the pseudo-random number generator is shown in Listing D-1 (page 475). To build the 32-bit inner mask, four calls are made to the `IDI_C2` function. The initial call passes in the seed value as the parameter `M`. Passing the output of a call (the return value) in as the seed value of a subsequent call produces the required pseudo-random sequence. Each call produces 8 of the 32 inner mask bits.

**Listing D-1** Pseudo-random number generator

```
int IDI_C2( int M )
{
 int S = 0x0000;

 for ( int i = 0x0080; i > 0; i >>= 1 )
 {
  if ( (i & M) != 0 )
  {
   S = ((( S << 1 ) ^ 0x0100 ) & 0x01FF );
  }
  else
  {
   S = (( S << 1 ) & 0x01FF );
  }

  if ( (S & 0x0100) != 0 )
  {
   S = (( S ^ 0x012F ) & 0x01FF );
  }
 }

 return S;
}
```

A reference implementation of the decryption process, in generic source code, is available from Apple upon request.

## Handling Unknown Metadata Types

Accessories must support features announced after their product releases by supporting the `UnknownData` plist field. This field is used to pass to iTunes unrecognized data types in the broadcast metadata; iTunes parses the data in the `UnknownData` field and handles it appropriately. In HD broadcasts, unknown metadata may occur in the PSD's Unique File Identifier Data (UFID) fields; in FM broadcasts, it may be passed by the iTunes ODA. On encountering unrecognized ID types in a broadcast, iTunes Tagging accessories must encode the entire unknown data field (the complete UFID in the case of HD and the whole iTunes ODA in the case of FM) in `base64` format (64 bytes) and write it to the iPod as `UnknownData`.

The current HD radio UFID data ID types are listed in Table D-7 (page 476). The current FM tag element types are listed in Table D-2 (page 467).

**Table D-7** HD UFID data ID types

| ID type | Description |
|---|---|
| 0x3031 or "01" | `iTunesSongID` |
| 0x3032–0x3033 or "02"–"03" | Reserved |
| 0x3034 or "04" | `iTunesAffiliateID` |
| 0x3035 or "05" | `iTunesStorefrontID` |
| 0x3036 or "06" | The contents of the `stationURL` field is a `PodcastFeedURL`, not a station URL. |

**Note:** The data in the HD radio UFID Identifier field is encoded in conformance with specification ISO-8859-1 and is represented as strings. Refer to iBiquity Document 2174 for more information about parsing the HD UFID data field.

## Resolving Tag Ambiguity

A broadcast tag is deemed ambiguous if the tag button is pressed within 10 seconds before or after a change in the program metadata. In an HD broadcast, a program metadata change is indicated by a Program Service Data (PSD) change; in an FM broadcast, it is indicated by the Event A/B flag. This ambiguity period exists because program metadata changes do not occur exactly on song boundaries, but within 10 seconds before or after that boundary. If the button is pressed less than 10 seconds before the program metadata changes and the new program metadata data is not yet valid, the receiver should generate a nonambiguous tag for the previous data. If a nonambiguous tag is followed by an ambiguous tag of the next song, the result should be two nonambiguous tags. The accessory's UI should not tell the user that a tag is ambiguous.

The accessory must flag ambiguous tags using the `ambiguousTag` plist field. The iTunes application will present a user interface dialog to resolve the ambiguity once the tags have been imported. Accessories should not try to resolve tag ambiguity through their own user interface. Accessories must identify each twin of the ambiguous pair and save this information as a part of the tag data in RAM. Accessories must also identify which twin was active at the time of the tag button press by setting the `ButtonPressed` plist field.

To support tag ambiguity, accessories must store both the current and previous sets of tag data in RAM and update both as program metadata changes occur. A timestamp or timer can be used to mark when either the program metadata changes or the tag button is pressed. The previous and current tags should be stored (when no iPod is connected) or written to the iPod with the `ambiguousTag` plist field set to 1 if these two events occur within 10 seconds of each other.

If the tag button is pressed within 10 seconds **before** a program change:

- The accessory timestamps the button press, or starts a 10 second timer when the tag button is pressed, and sets the `ButtonPressed` byte in the current tag data.
- If a program change occurs within the 10 seconds, the tag data in the current slot is moved to the previous slot and the broadcast tag data fills the current slot. The accessory sets the `ambiguousTag` fields for both tags to 1 and writes both tags to the iPod in a single file.

If the tag button is pressed within 10 seconds **after** a program change:

- The accessory timestamps the program change event, or starts a 10 second timer when the program change occurs, and updates the tag data in the current and previous slots.
- If the tag button is pressed within 10 seconds of the program change, the accessory sets the `ButtonPressed` byte in the current tag data, sets the `ambiguousTag` fields for both tags to 1, and writes both tags to the iPod in a single file.

> **Note:** Accessories must resolve tag ambiguity (if it exists) before saving tags or writing them to the iPod. This adds a 10 second delay to the file writing process.

# Capturing and Storing Tag Data

The process of capturing and storing tag data from an HD or FM broadcast occurs in two steps:

1. When the user presses the tag button while listening to the radio accessory, the accessory stores tag data internally.
2. When the user attaches an iPod to the radio accessory the stored tag data is written to the iPod's memory.

> **Note:** Tag data must be written to the iPod whenever the iPod is attached, regardless of what mode the accessory may be in. The user must never have to tell the accessory to write tag data nor have to change the accessory's mode to permit tag data to be written.

## Tag Data Writing Process

Each tagged track file written to an iPod consists of an extensible XML dictionary of key-value pairs, formatted as a Mac OS X Core Foundation property list (**plist**). This format is widely used in Mac OS X and can be easily generated and parsed on other platforms. The format is documented at developer.apple.com/documentation/CoreFoundation/Conceptual/CFPropertyLists/index.html. The plist document type definition (DTD) is available at www.apple.com/DTDs/PropertyList-1.0.dtd. Listings of typical of plist files can be found in "Sample Tag Files" (page 488).

After authenticating itself to the attached iPod and using `GetiPodOptionsForLingo` to determine that the iPod supports the iTunes Tagging option, an accessory typically uses the following command sequence to write a plist file to the iPod. For details of these commands, see "Lingo 0x0C: Storage Lingo" (page 300). For a sample sequence of actual commands, see Table D-11 (page 484).

| Radio accessory | Attached iPod |
|---|---|
| `GetiPodCaps` | |
| | `RetiPodCaps` |
| `GetiPodFreeSpace` | |

| Radio accessory | Attached iPod |
| --- | --- |
| | RetiPodFreeSpace |
| OpeniPodFeatureFile | |
| | RetiPodFileHandle |
| WriteiPodFileData (as many times as needed) | |
| | iPodACK for each WriteiPodFileData command |
| CloseiPodFile | |
| | iPodACK of CloseiPodFileData |

The accessory starts by sending a GetiPodCaps command to retrieve the iPod's storage lingo capabilities. The iPod responds with the RetiPodCaps command, which contains the following data:

- totalSpace: the amount of free storage on the iPod.
- maxFileSize: the largest possible size of a file on the iPod.
- maxWriteSize: the largest amount of data that can be written to the iPod in a single WriteiPodFileData command.
- majorVersion and minorVersion: the version number of the Storage lingo protocol (currently 1.1).

Accessories are required to honor the iPod's maxWriteSize limitation; they must never send a WriteiPodFileData command with a data payload larger than the iPod's maxWriteSize value.

The accessory should also check the iPod's free space before creating a file, to ensure that there is enough free space to write the file. A tag takes approximately 1 KB of data space, so the accessory should verify that the iPod has 1 KB of free space for each tag is intends to write. See "Note" (page 302). The accessory should also warn the user through its user interface when the iPod does not have enough free space; see "Accessory User Interface" (page 482) for details.

To create a file on the iPod, the accessory sends an OpeniPodFeatureFile command. This command returns a file handle that is used to write data and to close the file. The accessory must send a WriteiPodFileData command to write data to the open file. The size of the WriteiPodFileData payload is determined by the iPod's maxWriteSize; it may take several WriteiPodFileData commands to write an entire file. The iPod responds to each WriteiPodFileData command with an iPodACK command containing the status of the last write. Accessories must verify that each individual write succeeded before sending the next WriteiPodFileData command.

Only one tagging file may be opened at a time. Each time a tagging file is opened, a new file is created in /iPod_Control/Device/Accessories/Tags/ on the iPod (this location may change in future releases). You can look at the files in this directory to confirm that the data you wrote using WriteiPodFileData was transferred correctly.

The accessory should close the file using the `CloseiPodFile` command as soon as all the plist data has been written to the iPod. The accessory should verify that the iPod closed the file properly by checking the status of the `iPodACK` command sent in response to the `CloseiPodFile` command. Accessories should never delete tag data stored locally until the `CloseiPodFile` acknowledgment status has been verified.

## Data Transfer to the iPod

Table D-8 (page 479) shows the plist fields an accessory writes to an iPod. The writing process must follow these rules:

- All fields of integer type must be expressed in decimal numbers. Hexadecimal and other non-decimal numbers may not be used.
- Strings in the `Name`, `Artist`, `Album`, `Genre`, and `StationURL` fields must not be truncated; if 64 bytes are received, all 64 must be written. The `StationURL` field may contain 128 bytes.

**Table D-8** Plist fields written to the iPod

| Name | Type | Description | HD Source | FM Source |
|---|---|---|---|---|
| `MajorVersion` | integer | The major revision level of the file format. This number increments by 1 if there are changes or additions that break compatibility with all prior versions. The current major revision level is 1. | Accessory | Accessory |
| `MinorVersion` | integer | The minor revision level of the file format. This number increments by 1 if there are changes or additions that preserve compatibility with prior versions that have the same major revision level. The current minor revision level is 1. | Accessory | Accessory |
| `ManufacturerID` | positive integer (decimal format) | Manufacturer IDs are assigned by Apple's Made For iPod program (see note, below). | Accessory | Accessory |
| `ManufacturerName` | string | The manufacturer-assigned user-visible name for the manufacturer. | Accessory | Accessory |
| `DeviceName` | string | The manufacturer-assigned user-visible name for the device. | Accessory | Accessory |
| `MarkedTracks` | array | An array of one or more dictionaries, specifying the data for each tagged track. | Accessory | Accessory |
| `AmbiguousTag` | integer | 1 to mark an ambiguous track; 0 otherwise. | Accessory | Accessory |
| `ButtonPressed` | integer | 1 to designate which twin in an ambiguous pair was active when the tag button was pressed; 0 otherwise. | Accessory | Accessory |

| Name | Type | Description | HD Source | FM Source |
|---|---|---|---|---|
| `Name` | string | The name of the track. | HD PSD | RDS: RT+ |
| `Artist` | string | The name of the artist. | HD PSD | RDS: RT+ |
| `Album` | string | The name of the album. | HD PSD | RDS: RT+ |
| `Genre` | string | HD: The program type. The receiver must write this field as received, without decoding. It can contain ID3 codes, 2-digit genre strings, or both.<br>RDS: If present, the genre data can be extracted from the RT+ ITEM.GENRE class. | HD PSD | RDS: RT+ |
| `iTunesSongID` | integer | The iTunes song identifier. | HD PSD | RDS: iTunes ODA |
| `iTunesStorefrontID` | integer | The iTunes storefront identifier. | HD PSD | RDS: iTunes ODA |
| `StationFrequency` | string | The station's frequency, expressed only by digits and an optional decimal point. | HD HOST | Accessory |
| `StationCallLetters` | string | HD: The call letters for the station, written exactly as received. Call letters may be up to 12 characters long if the Universal Short Station Name is broadcast.<br>RDS: Station call lLetters can be extracted from the RDS PI field or through the RT+ STATIONNAME.SHORT and STATIONNAME.LONG classes. | HD SIS | RDS: PI or RT+ |
| `TimeStamp` | date | HD: The date and time at which the tagged track was broadcast, in ASCII timestamp format (e.g., 2008-04-16T00:35:42Z). The time zone must be UTC; iTunes converts it into local time. The `TimeStamp` plist field should be written only if the receiver has received valid, GPS-locked time information over the air and has created a valid timestamp based on it. Receivers using TI DRI352 baseband processor firmware prior to version 17 or NXP SAF355X baseband processor firmware prior to Version 2.1.2.1 should never write this field, because only newer baseband processor versions process the timestamp information correctly. Contact iBiquity for further details.<br>RDS: Group 4A messages | HD SIS | RDS: Group 4A |

| Name | Type | Description | HD Source | FM Source |
|---|---|---|---|---|
| PodcastFeedURL | integer | HD: A value of 1 if the StationURL points to a podcast, 0 otherwise.<br>RDS: If INFO.URL is filled, the broadcast should be marked as having an associated podcast. | HD PSD | RDS: RT+ |
| StationURL | string | HD: The URL of the station, or of a podcast if PodcastFeedURL is 1.<br>RDS: PROGRAMME.HOMEPAGE | HD PSD | RDS: RT+ |
| ProgramNumber | integer | HD: The station's multicast channel in the range 1 to 8, where 1 indicates the main program.<br>RDS: PROGRAMME.SUBCHANNEL | HD HOST | RDS: RT+ |
| iTunesAffiliateID | string | The iTunes affiliate ID, as broadcast. | HD PSD | N/A |
| iTunesStationID | string | The iTunes station ID, as broadcast. | N/A | RDS: iTunes ODA |
| UnknownData | data | HD: A field used to pass unknown UFID data to iTunes.<br>RDS: A field used to pass unknown iTunes Tagging ODA data types to iTunes.<br>See "Handling Unknown Metadata Types" (page 475)). | HD PSD (UFID data) | RDS: iTunes ODA |

**Note:** To obtain a ManufacturerID, a partner must submit a product plan to Apple's Made For iPod program. Once the product plan is approved, Apple will respond with a ManufacturerID assigned to that plan. Every separate product (i.e., every SKU) must have a unique ManufacturerID. The plist file must contain the ManufacturerID as a positive integer in decimal format for iTunes to interpret it correctly.

The radio accessory normally writes a tag to the iPod each time the user presses the tag button. However, the tag should not be written if tag ambiguity exists and has not been resolved (see "Resolving Tag Ambiguity" (page 476)). The opening, writing, and closing of the file should happen in one continuous action to insure that no tag information is lost. Accessories should not keep files open any longer than absolutely necessary. Do not append tags to open files; write a new file to the iPod each time the user presses the tag button. The accessory design must allow tagging while data is being written to the iPod.

The accessory must create a file for each tag saved when the iPod is connected and the tag is not ambiguous. The accessory must write ambiguous tags to the same file when the iPod is connected and the tags are ambiguous. The accessory must write all tags stored locally to one file the next time an iPod is connected, including all ambiguous tags.

**Note:** The `Artist` and `Name` strings are required to store a tag; the `iTunesSongID` integer is desirable but not required.

An accessory must never write a tag more than once. If the user presses the tag button multiple times during the same song, the accessory must write the tag to the iPod after the first button press and then filter out redundant tags by setting a flag to indicate that the broadcast tag data has been written to the iPod.

The accessory must store tags internally when no iPod is connected. If the accessory runs out of storage space, it must prompt the user to connect an iPod. When tags are stored locally, the accessory must write all tag data to a single file the next time an iPod is docked. The `MajorVersion`, `MinorVersion`, `ManufacturerName`, `ManufacturerID`, and `MarkedTracks` fields need to be written only once per file when writing multiple tags to a single file. The rest of the tag data is written in a tag array with each tag designated by the `<dict>` key. "Sample Tag Files" (page 488) shows an example of multiple tags in a single file.

Before it deletes any tag stored locally, the accessory must verify that the iPod has sent an `iPodACK` command in response to each `WriteiPodFileData` command and the `CloseiPodFile` command. The accessory must notify the user that the tags were successfully written to the iPod.

## Accessory User Interface

Table D-9 (page 482) lists the user interface elements that must be used for the tagging feature in a radio accessory. The table shows three sections: Required UI, Optional UI, and UI not allowed. Table D-10 (page 483) lists user interface messages that may appear on the accessory's display.

**Table D-9** Tagging feature user interface implementation

| Action | | Implementation | |
|---|---|---|---|
| | | **Speaker** | **Head unit** |
| Required UI | Indicate tag available | Button (LED) illuminates | Button or logo/type appears |
| | | Logo/type appears (LCD) | Button color or logo/type changes |
| | Indicate tag captured | Button LED blinks | Button blinks |
| | | Button LED changes color | Button changes color |
| | | Logo/type blinks (LCD) | Graphic |
| | | Message on LCD | Message on screen |
| | | Audible feedback | Audible feedback |
| | Indicate accessory memory full | Message (LCD) | Message |
| | | Audible feedback | Audible feedback |
| | | | Graphic |

| Action | | Implementation | |
|---|---|---|---|
| | | **Speaker** | **Head unit** |
| | Indicate iPod memory full | Message (LCD) | Message |
| | | Audible feedback | Audible feedback |
| Optional UI | Indicate write to iPod | Button LED blinks twice | Button blinks twice |
| | | Message on LCD | Message on screen |
| | | Audible feedback | Audible feedback |
| | Indicate tag not captured | LED color changes | Button color changes |
| | | Message on LCD | Message on screen |
| | | Audible feedback | Audible feedback |
| | Tags remaining | Message on LCD | Message on screen |
| UI not allowed | Resolving tag ambiguity | | |
| | Choosing whether or not to write tags to the iPod | | |

**Table D-10** Tagging feature UI text messages

| Condition | Message |
|---|---|
| Capturing tags | "Tag available" |
| | "Tag stored" |
| | "Tag stored. XX remaining." |
| Accessory memory full | "Memory full. Connect iPod." |
| | "Connect iPod to transfer tags." |
| iPod memory full | "iPod full. Tags cannot be stored." |
| Write to iPod | "Tags transferred to iPod." |
| | "Tags saved to iPod. XX remaining." |

**Note:** These message texts are preliminary and are provided for guidance only. The specific texts to be displayed are expected to change as the tagging feature user interface is further defined.

The accessory should not have a UI function that deletes individual tags; this is done by iTunes. A function to delete all tags is acceptable as a way to restore the accessory to its factory settings.

## Tag Button Text

The button on the radio accessory used to tag a song should bear the word “Tag.” The word “Tag” should be presented in a manner consistent with the text on the device’s other buttons (the same font, weight, capitalization, color, illumination, and so on).

# Sample Command Sequence

Table D-11 (page 484) shows a sample sequence of commands that implements radio tagging in an accessory.

**Table D-11** Radio tagging command sequence

<table>
<tr><th>Step</th><th>Accessory command</th><th>iPod command</th><th>Comment</th></tr>
<tr><td>1</td><td><code>StartIDPS</code></td><td></td><td>no params</td></tr>
<tr><td>2</td><td></td><td><code>ACK</code></td><td>acknowledging 'Success (OK)' to command 'General Lingo::StartIDPS'</td></tr>
<tr><td colspan="4">If the <code>ACK</code> reply to <code>StartIDPS</code> returns a status of 0x00, the accessory proceeds to Step 3. Otherwise,<br>■ If the accessory receives no <code>ACK</code> command within 1 second, it may retry Step 1 at 1-second intervals as long as iPod Detect (pin 30 of the 30-pin connector) is low and Accessory Power (pin 13) is high. Accessories that don’t monitor these signals (such as Bluetooth accessories or USB accessories without a 191 kΩ ID resistor) may retry without checking them.<br>■ If the accessory receives an <code>ACK</code> status of 0x04 (Bad Parameter), the iPod does not support IDPS. Within 800 ms the accessory must send an <code>IdentifyDeviceLingoes</code> command with its lingo mask set for only the General lingo, with no options, and with a Device ID of 0x0. See "Cancelling a Current Authentication Process With IdentifyDeviceLingoes" (page 83). A sample command sequence is listed in Table F-27 (page 545).<br>■ If the accessory receives any other nonzero <code>ACK</code> status, it must not send any more iAP commands until it has been disconnected. Upon reconnection it must restart identification at Step 1.</td></tr>
<tr><td>3</td><td><code>GetiPodOptions-ForLingo</code></td><td></td><td>getting options for General Lingo</td></tr>
<tr><td>4</td><td></td><td><code>RetiPodOptions-ForLingo</code></td><td>returning options of 000000000003F3FF (Line out usage | Video output | NTSC video signal format | PAL video signal format | Composite video out connection | S-Video video out connection | Component video out connection | Closed captioning (video) | Video aspect ratio 4:3 (fullscreen) | Video aspect ratio 6:9 (widescreen) | reserved | app communication capable | iPod notifications) for General Lingo</td></tr>
</table>

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| 5 | GetiPodOptions-ForLingo | | getting options for Storage Lingo |
| 6 | | RetiPodOptions-ForLingo | returning options of 0000000000000003 (iTunes tagging \| Nike + iPod cardio equipment) for Storage Lingo |
| 7 | SetFIDTokenValues | | setting 8 FID tokens ; IdentifyToken = (lingoes: 0/12 \| options 0x00000002 \| device ID 0x00000200); AccCapsToken = 0x0000000000000805; AccInfoToken = Acc name (Radio); AccInfoToken = Acc FW version (v1.0.1); AccInfoToken = Acc HW version (v1.0.0); AccInfoToken = Acc manufacturer (Radio Manufacturer); AccInfoToken = Acc model number (M78901LL/Z); iPodPreferenceToken = (setting 'used' for preference class 'line out usage' with restore on exit 'selected') |
| 8 | | RetFIDTokenValueACKs | 8 ACKs for FID tokens ; IdentifyToken = accepted; AccCapsToken = accepted; AccInfoToken = (Acc name) accepted; AccInfoToken = (Acc FW version) accepted; AccInfoToken = (Acc HW version) accepted; AccInfoToken = (Acc manufacturer) accepted; AccInfoToken = (Acc model number) accepted; iPodPreferenceToken = (line out usage) accepted |
| 9 | EndIDPS | | status 'finished with IDPS; proceed to authentication' |
| 10 | | IDPSStatus | status 'ready for auth' |
| 11 | | GetDevAuthentication-Info | no params |
| 12 | RetDevAuthentication-Info | | returning auth protocol v2.0; current section index: 0; maximum section index: 1; cert data ... |
| 13 | | ACK | acknowledging 'Success (OK)' to command 'General Lingo::RetDevAuthenticationInfo' |
| 14 | RetDevAuthentication-Info | | returning auth protocol v2.0; current section index: 1; maximum section index: 1; cert data ... |

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| 15 | | AckDevAuthentication-Info | acknowledging 'auth info supported' |
| 16 | | GetDevAuthentication-Signature | offering challenge ... |
| 17 | RetDevAuthentication-Signature | | returning signature ... |
| 18 | | AckDevAuthentication-Status | acknowledging authentication status 'Success (OK)' |
| 19 | GetiPodCaps | | no params |
| 20 | | RetiPodCaps | returning 'total space 2147483648; max file size 1073741824; max write size 500; v1.02' |
| 21 | GetiPodFreeSpace | | no params |
| 22 | | RetiPodFreeSpace | returning 130023424 bytes |
| 23 | OpeniPodFeatureFile | | opening feature type 'Radio Tagging' |
| 24 | | RetiPodFileHandle | returning file handle 0 |
| 25 | WriteiPodFileData | | writing 184 bytes at offset 0 and handle 0: <?xml version=""1.0" encoding=""UTF-8""?> <!DOCTYPE plist PUBLIC ""-//Apple Inc//DTD PLIST 1.0//EN" "http://www.apple.com/DTDs/PropertyList-1.0.dtd""> <plist version=""1.0""> <dict> |
| 26 | | iPodAck | acknowledging 'Success' to command 'Storage Lingo::WriteiPodFileData' with file handle 0 |
| 27 | WriteiPodFileData | | writing 290 bytes at offset 185 and handle 0: <key>DeviceName</key> <string>IES2</string> <key>MajorVersion</key> <integer>1</integer> <key>MinorVersion</key> <integer>0</integer> <key>ManufacturerID</key> <integer>17</integer> <key>ManufacturerName</key> <string>Polk Audio</string> <key>MarkedTracks</key> <array> <dict> |

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| 28 | | `iPodAck` | acknowledging 'Success' to command 'Storage Lingo::WriteiPodFileData' with file handle 0 |
| 29 | `WriteiPodFileData` | | writing 472 bytes at offset 476 and handle 0: <key>Name</key> <string>The Rising</string> <key>Artist</key> <string>Bruce Springsteen</string> <key>Album</key> <string>The Rising</string> <key>StationURL</key> <string>http://www.hdradio.com </string> <key>iTunesSongID</key> <integer>192903160</integer> <key>StationCallLetters</key> <string>IHDR</string> <key>StationFrequency</key> <string>88.1 FM</string> <key>StreamID</key> <string>2</string> <key>ProgramType</key> <string>Classic Rock</string> |
| 30 | | `iPodAck` | acknowledging 'Success' to command 'Storage Lingo::WriteiPodFileData' with file handle 0 |
| 31 | `WriteiPodFileData` | | writing 210 bytes at offset 949 and handle 0: <key>TimeStamp</key> <date>2009-06-01T09:45:57Z </date> <key>iTunesStorefrontID</key> <integer>143441</integer> <key>iTunesPlaylistID</key> <integer>192901525</integer> </dict> </array> </dict> </plist> |
| 32 | | `iPodAck` | acknowledging 'Success' to command 'Storage Lingo::WriteiPodFileData' with file handle 0 |
| 33 | `CloseiPodFile` | | closing file with handle 0 |
| 34 | | `iPodAck` | acknowledging 'Success' to command 'Storage Lingo::CloseiPodFile' with file handle 0 |

# Sample Tag Files

This section lists sample plist files that might be generated by both HD radio tagging and FM radio tagging.

## HD Radio Samples

The following is a sample HD radio plist-formatted tag file showing a header and one stored tag:

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE plist PUBLIC "-//Apple Inc//DTD PLIST 1.0//EN"
"http://www.apple.com/DTDs/PropertyList-1.0.dtd">
<plist version="1.0">
<dict>
    <key>MajorVersion</key>
    <integer>1</integer>
    <key>MinorVersion</key>
    <integer>1</integer>
    <key>ManufacturerID</key>
    <integer>17</integer>
    <key>ManufacturerName</key>
    <string>Acme</string>
    <key>DeviceName</key>
    <string>AC-HDR100</string>
    <key>MarkedTracks</key>
    <array>
        <dict>
            <key>Name</key>
            <string>Times Like These</string>
            <key>Artist</key>
            <string>Foo Fighters</string>
            <key>Album</key>
            <string>One by One</string>
            <key>iTunesSongID</key>
            <integer>6906304</integer>
            <key>iTunesStorefrontID</key>
            <integer>143441</integer>
            <key>StationFrequency</key>
            <string>104.9</string>
            <key>StationCallLetters</key>
            <string>KCNL</string>
            <key>PodcastFeedURL</key>
            <string>0</string>
            <key>StationURL</key>
            <string>http://www.channel1049.com</string>
            <key>Genre</key>
            <string>(20) Alternative</string>
            <key>TimeStamp</key>
            <date>2007-04-16T00:35:42Z</date>
            <key>ProgramNumber</key>
            <integer>1</integer>
            <key>iTunesAffiliateID</key>
            <string>00-12uR34oIcpQ</string>
            <key>UnknownData</key>
            <data>MDcwNDEyMzQwMTAyMTEwNDA4MTJhYjU2Z2g=</data>
```

```
        </dict>
    </array>
</dict>
</plist>
```

The following is a sample HD radio plist-formatted tag file showing how ambiguous tags are saved to an iPod:

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE plist PUBLIC "-//Apple Inc//DTD PLIST 1.0//EN"
"http://www.apple.com/DTDs/PropertyList-1.0.dtd">
<plist version="1.0">
<dict>
    <key>MajorVersion</key>
    <integer>1</integer>
    <key>MinorVersion</key>
    <integer>1</integer>
    <key>ManufacturerID</key>
    <integer>17</integer>
    <key>ManufacturerName</key>
    <string>Acme</string>
    <key>DeviceName</key>
    <string>AC-HDR100</string>
    <key>MarkedTracks</key>
    <array>
        <dict>
            <key>AmbiguousTag</key>
            <integer>1</integer>
            <key>ButtonPressed</key>
            <integer>1</integer>
            <key>Name</key>
            <string>Times Like These</string>
            <key>Artist</key>
            <string>Foo Fighters</string>
            <key>Album</key>
            <string>One by One</string>
            <key>iTunesSongID</key>
            <integer>6906304</integer>
            <key>iTunesStorefrontID</key>
            <integer>143441</integer>
            <key>StationFrequency</key>
            <string>104.9</string>
            <key>StationCallLetters</key>
            <string>KCNL</string>
            <key>PodcastFeedURL</key>
            <string>0</string>
            <key>StationURL</key>
            <string>http://www.channel1049.com</string>
            <key>Genre</key>
            <string>(20) Alternative</string>
            <key>TimeStamp</key>
            <date>2007-04-16T00:35:42Z</date>
            <key>ProgramNumber</key>
            <key>ProgramNumber</key>
            <integer>1</integer>
            <key>iTunesAffiliateID</key>
            <string>00-12uR34oIcpQ</string>
        </dict>
        <dict>
```

```
            <key>AmbiguousTag</key>
            <integer>1</integer>
            <key>ButtonPressed</key>
            <integer>0</integer>
            <key>Name</key>
            <string>Vertigo</string>
            <key>Artist</key>
            <string>U2</string>
            <key>Album</key>
            <string>How to Dismantle an Atomic Bomb</string>
            <key>iTunesSongID</key>
            <integer>29600235</integer>
            <key>iTunesStorefrontID</key>
            <integer>143441</integer>
            <key>StationFrequency</key>
            <string>104.9</string>
            <key>StationCallLetters</key>
            <string>KCNL</string>
            <key>PodcastFeedURL</key>
            <string>0</string>
            <key>StationURL</key>
            <string>http://www.channel1049.com</string>
            <key>Genre</key>
            <string>(17) Rock</string>
            <key>TimeStamp</key>
            <date>2007-04-16T00:35:45Z</date>
            <key>ProgramNumber</key>
            <integer>1</integer>
            <key>iTunesAffiliateID</key>
            <string>00-12uR34oIcpQ</string>
        </dict>
    </array>
</dict>
</plist>
```


The following is a sample HD radio plist-formatted tag file showing how an accessory that has multiple tags stored locally writes those tags to an iPod:


```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE plist PUBLIC "-//Apple Inc//DTD PLIST 1.0//EN"
"http://www.apple.com/DTDs/PropertyList-1.0.dtd">
<plist version="1.0">
<dict>
    <key>MajorVersion</key>
    <integer>1</integer>
    <key>MinorVersion</key>
    <integer>1</integer>
    <key>ManufacturerID</key>
    <integer>17</integer>
    <key>ManufacturerName</key>
    <string>Acme</string>
    <key>DeviceName</key>
    <string>AC-HDR100</string>
    <key>MarkedTracks</key>
    <array>
        <dict>
            <key>Name</key>
            <string>Times Like These</string>
```

```
        <key>Artist</key>
        <string>Foo Fighters</string>
        <key>Album</key>
        <string>One by One</string>
        <key>iTunesSongID</key>
        <integer>6906304</integer>
        <key>iTunesStorefrontID</key>
        <integer>143441</integer>
        <key>StationFrequency</key>
        <string>104.9</string>
        <key>StationCallLetters</key>
        <string>KCNL</string>
        <key>PodcastFeedURL</key>
        <string>0</string>
        <key>StationURL</key>
        <string>http://www.channel1049.com</string>
        <key>Genre</key>
        <string>(20) Alternative</string>
        <key>TimeStamp</key>
        <date>2007-04-16T00:35:42Z</date>
        <key>ProgramNumber</key>
        <integer>1</integer>
        <key>iTunesAffiliateID</key>
        <string>00-12uR34oIcpQ</string>
    </dict>
    <dict>
        <key>Name</key>
        <string>Vertigo</string>
        <key>Artist</key>
        <string>U2</string>
        <key>Album</key>
        <string>How to Dismantle an Atomic Bomb</string>
        <key>iTunesSongID</key>
        <integer>29600235</integer>
        <key>iTunesStorefrontID</key>
        <integer>143441</integer>
        <key>StationFrequency</key>
        <string>104.9</string>
        <key>StationCallLetters</key>
        <string>KCNL</string>
        <key>PodcastFeedURL</key>
        <string>0</string>
        <key>StationURL</key>
        <string>http://www.channel1049.com</string>
        <key>Genre</key>
        <string>(17) Rock</string>
        <key>TimeStamp</key>
        <date>2007-04-16T00:43:45Z</date>
        <integer>1</integer>
        <key>ProgramNumber</key>
        <integer>1</integer>
        <key>iTunesAffiliateID</key>
        <string>00-12uR34oIcpQ</string>
    </dict>
    <dict>
        <key>Name</key>
        <string>Ball and Chain</string>
        <key>Artist</key>
```

```
            <string>Social Distortion</string>
            <key>Album</key>
            <string>Social Distortion</string>
            <key>iTunesSongID</key>
            <integer>197986000</integer>
            <key>iTunesStorefrontID</key>
            <integer>143441</integer>
            <key>StationFrequency</key>
            <string>104.9</string>
            <key>StationCallLetters</key>
            <string>KCNL</string>
            <key>PodcastFeedURL</key>
            <string>0</string>
            <key>StationURL</key>
            <string>http://www.channel1049.com</string>
            <key>Genre</key>
            <string>(17) Rock</string>
            <key>TimeStamp</key>
            <date>2007-04-16T00:48:45Z</date>
            <key>ProgramNumber</key>
            <integer>1</integer>
            <key>iTunesAffiliateID</key>
            <string>00-12uR34oIcpQ</string>
        </dict>
    </array>
</dict>
</plist>
```

## FM Radio Sample

The following is a sample FM radio plist-formatted tag file showing a header and one stored tag:

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE plist PUBLIC "-//Apple Inc//DTD PLIST 1.0//EN" "http://www.apple.com/DTDs/PropertyList-1.0.dtd">
<plist version="1.0">
<dict>
   <key>MajorVersion</key>
   <integer>1</integer>
   <key>MinorVersion</key>
   <integer>1</integer>
   <key>ManufacturerID</key>
   <integer>17</integer>
   <key>ManufacturerName</key>
   <string>Acme</string>
   <key>DeviceName</key>
   <string>AC-HDR100</string>
   <key>MarkedTracks</key>
   <array>
       <dict>
           <key>Name</key>
           <string>Times Like These</string>
           <key>Artist</key>
           <string>Foo Fighters</string>
           <key>Album</key>
           <string>One by One</string>
           <key>iTunesSongID</key>
```

```
            <integer>6906304</integer>
            <key>iTunesStorefrontID</key>
            <integer>143441</integer>
            <key>StationFrequency</key>
            <string>104.9</string>
            <key>StationCallLetters</key>
            <string>KCNL</string>
            <key>StationURL</key>
            <string>http://www.channel1049.com</string>
            <key>Genre</key>
            <string>(20) Alternative</string>
            <key>TimeStamp</key>
            <date>2007-04-16T00:35:42Z</date>
            <key>ProgramNumber</key>
            <integer>1</integer>
            <key>iTunesStationID</key>
            <string>10491557</string>
            <key>UnknownData</key>
            <data>MDcwNDEyMzQwMTAyMTEwNDA4MTJhYjU2Z2g=</data>
        </dict>
    </array>
</dict>
</plist>
```

# Nike + iPod Cardio Equipment System

The Nike + iPod cardio equipment feature lets an iPod user record workout data gathered by an attached sports or exercise device, while at the same time enjoying entertainment from the iPod.

An iPod can support only one such device at any time, and that device must be attached using the 30-pin connector. Currently the 2nd generation iPod touch and the 3rd and 4th generation iPod nanos support this system.

## Using Nike + iPod Cardio Equipment

To use the capabilities of the Nike + iPod cardio equipment feature, an iPod user typically does the following:

1. The user connects a compatible iPod to a compatible piece of cardio equipment, makes an entertainment selection, and selects either QuickStart or a specific workout type.
2. The cardio equipment downloads user preferences and other information from the iPod.
3. If there is enough space on the iPod to store the workout data, the cardio equipment displays the message "Recording workout to iPod." It opens a file and records data in real time.
4. The cardio equipment prompts the user to accept the weight setting retrieved from the iPod or change it, in which case it stores the new weight on the iPod.
5. When the workout ends, the cardio equipment closes the file on the iPod and displays a closing message with a workout summary. It confirms that the workout has been recorded and tells the user how to view the results.
6. The user connects the iPod to a computer and iTunes uploads the workout files to `nikeplus.com`, where the user can view the results.

## Cardio Equipment Design

This section specifies the requirements for cardio equipment that works with the Nike + iPod system.

### Determining iPod Support for Cardio Equipment

To use the Nike + iPod feature, the cardio equipment must first determine that the connected iPod supports the required minimum lingo versions shown in Table E-1 (page 496).

**Table E-1** Lingo version support

| Lingo | Minimum Required Protocol Version |
|---|---|
| 0x09: Sports | v1.01 |
| 0x0C: Storage | v1.02 |

If the minimum required protocol versions are supported by the connected iPod, the cardio equipment must next identify itself as supporting those lingoes; see "Identification Procedure" (page 496).

The final step is for the cardio equipment to query the Sports lingo capabilities of the iPod with a `GetiPodOptionsForLingo` command and then parse the resulting `RetiPodOptionsForLingo` command for the Nike + iPod Cardio Equipment bit (0x01); see "Command 0x4C: RetiPodOptionsForLingo" (page 140).

**Note:** All Sports lingo commands require authentication. The cardio equipment must not send the `GetiPodOptionsForLingo` command until after the authentication process has begun. See "iPod Authentication of Device" (page 55) for further information.

## Identification Procedure

The cardio equipment must perform an identification procedure by which it discovers the capabilities of the connected iPod. If it attempts to identify for a lingo not supported by the attached iPod, the identification fails and the iPod displays an error message.

The following identification procedure is recommended:

1. Send a `StartIDPS` command. If the iPod responds with an `ACK` command passing 0x04 (Bad Parameter), the accessory must send `IdentifyDeviceLingoes` instead, with `deviceID`=0x0000 and identifying only the General lingo with no options.
2. Query the iPod for the version numbers of all necessary lingoes.
3. Based on the responses to the query, form appropriate FID values, declare them for the required lingoes, and request authentication if necessary.
4. End the IDPS process by sending `EndIDPS`.

### Sample Identification Processes

This section presents two sample identification sequences for a cardio equipment accessory. In both cases the sequences begin with the accessory sending a `StartIDPS` command. However, in both cases the iPod does not support IDPS, so the accessory reverts to sending `IdentifyDeviceLingoes`. For examples of identification sequences in which IDPS is supported, see "Sample Identification Sequences" (page 334).

For a first example, consider a piece of cardio equipment that is intended to offer simple iPod playback control (play/pause, next/previous track, etc.), display information about the currently playing track, and log workout data to the iPod. To achieve these goals, the cardio equipment needs access to four iAP lingoes:

- Simple Remote

- Display Remote
- Sports
- Storage

The example in Table E-2 (page 497) shows the command traffic exchanged between the cardio equipment and an iPod Classic running software v1.1.1.

**Table E-2** Sample identification process 1

| cardio equipment | iPod Classic (v1.1.1) |
| --- | --- |
| `StartIDPS` | |
| | `ACK( StartIDPS, 0x04 = Bad Parameter)` |
| `IdentifyDeviceLingoes (Lingoes: 0x0001, Options: 0x00, DeviceID: 0x0000)` | |
| | `ACK( IdentifyDeviceLingoes, Success)` |
| `RequestLingoProtocolVersion(0x02)` | |
| | `ReturnLingoProtocolVersion(0x02, v1.02)` |
| `RequestLingoProtocolVersion(0x03)` | |
| | `ReturnLingoProtocolVersion(0x03, v1.05)` |
| `RequestLingoProtocolVersion(0x09)` | |
| | `ACK( RequestLingoProtocolVersion, Bad Parameter)` (This iPod does not support the Sports lingo.) |
| `RequestLingoProtocolVersion (0x0C)` | |
| | `ReturnLingoProtocolVersion(0x0C, v1.01)` (This iPod does not support the required version of the Storage lingo.) |
| `IdentifyDeviceLingoes(Lingoes:0x000D, Options:0x02, DeviceID:0x0200)` | |
| | `ACK( IdentifyDeviceLingoes, Success)` |
| | `GetDeviceAuthenticationInfo()` |

In this first example, the cardio equipment determines that the attached iPod does not support the proper versions of the Sports and Storage lingoes and thus does not attempt to identify for those lingoes. Display Remote and Simple Remote are both supported, and the cardio equipment properly identifies and authenticates for those lingoes.

A more successful example is shown in Table E-3 (page 498). It lists the command traffic exchanged between the cardio equipment and a 3G iPod nano updated to support the Nike + iPod feature.

**Table E-3** Sample identification process 2

| Cardio equipment | 3G iPod nano (version 1.1.2) |
|---|---|
| `StartIDPS` | |
| | `ACK( StartIDPS, 0x04 = Bad Parameter)` |
| `IdentifyDeviceLingoes (Lingoes:0x0001, Options:0x00, DeviceID:0x0000)` | |
| | `ACK(IdentifyDeviceLingoes, Success)` |
| `RequestLingoProtocolVersion(0x02)` | |
| | `ReturnLingoProtocolVersion(0x02, v1.02)` |
| `RequestLingoProtocolVersion(0x03)` | |
| | `ReturnLingoProtocolVersion(0x03, v1.05)` |
| `RequestLingoProtocolVersion(0x09)` | |
| | `ReturnLingoProtocolVersion(0x09, v1.01)` |
| `RequestLingoProtocolVersion(0x0C)` | |
| | `ReturnLingoProtocolVersion(0x0C, v1.02)` |
| `IdentifyDeviceLingoes(Lingoes:0x120D, Options:0x02, DeviceID: 0x0200)` | |
| | `ACK(IdentifyDeviceLingoes, Success)` |
| | `GetDeviceAuthenticationInfo()` |

In this second example, the iPod supports the proper minimum protocol versions for each of the necessary lingoes. The cardio equipment identifies for all of those lingoes and operation proceeds normally.

## Declaring Cardio Equipment Support to the iPod

In the future, the iPod may change its user interface elements when attached to Nike + iPod cardio equipment. Hence, the cardio equipment must declare its support of the Nike + iPod feature. This is also necessary so that the iPod can differentiate between types of Sports lingo devices (e.g. between a Nike + iPod Sports Kit Receiver and a stair climber).

The cardio equipment declares itself as such by supporting the Sports lingo `GetDeviceCaps` command and replying to it with a `RetDeviceCaps` command with `capsMask` bit 9 = 1, indicating to the iPod that the cardio equipment supports the required commands.

## Accessing User Data

Nike + iPod compatible cardio equipment can access certain user data stored on an iPod. See "Sports Lingo commands" (page 277) for detailed information on the commands available for retrieving and/or setting the available user data fields.

Proper use of this user data requires that the cardio equipment must:

1. Always get/set data for the current `userIndex`. It is assumed that the iPod is already configured for the correct `userIndex`.
2. Write `userData` fields back to the iPod if, and only if, the user entered new or updated information via the cardio equipment user interface. For example, if the cardio equipment uses a default value for weight during a workout, that weight must not be written back to the `userData` on the iPod.
3. Never display the name field for `userIndex` = 0. That value is reserved for the default new or unknown user; consequently, the associated name field is invalid. The `userData` name fields for other `userIndex` values should be valid.

## Recording Workout Data

Workout data is stored on the iPod as a UTF-8 encoded, XML-formatted file. The cardio equipment is responsible for writing the data directly to the iPod's file system via the Storage lingo. Appropriate XML elements are written to the file in real time as the workout proceeds.

### Writing Workout Data

After successfully providing valid device authentication information to the attached iPod, the cardio equipment typically uses the following command sequence to write the workout data file to the iPod. For details of these commands, see "Lingo 0x09: Sports Lingo" (page 277) and "Lingo 0x0C: Storage Lingo" (page 300).

**Table E-4** Writing workout data to the iPod

| Cardio equipment | iPod (with Nike + iPod feature support) |
| --- | --- |
| `SportsLingo: GetiPodCaps()` | |
| | `SportsLingo: RetiPodCaps()` |
| `StorageLingo: GetiPodCaps()` | |
| | `StorageLingo: RetiPodCaps()` |
| `OpeniPodFeatureFile( featureType:0x02, optionsMask:0x000B, fileData:"</gymData>")` | |
| | `RetiPodFileHandle()` |
| `WriteiPodFileData()` as many times as needed | |

| Cardio equipment | iPod (with Nike + iPod feature support) |
|---|---|
| | `iPodACK(WriteiPodFileData, status)` for each `WriteiPodFileData` command |
| `CloseiPodFile()` | |
| | `iPodACK(CloseiPodFile, ackStatus)` |

The cardio equipment starts by sending a `GetiPodCaps` command to retrieve the Sports lingo capabilities of the iPod. The iPod responds with a `RetiPodCaps` command.

If the iPod indicates that it supports the Nike + iPod feature, the cardio equipment next sends a `GetiPodCaps` command to determine the Storage lingo capabilities of the iPod. The iPod responds with a `RetiPodCaps` command containing the following data:

- `totalSpace`: the amount of storage on the iPod, including space currently in use
- `maxFileSize`: the largest possible size of a file on the iPod
- `maxWriteSize`: the largest amount of data that can be written to the iPod in a single `WriteiPodFileData` command
- `majorVersion` and `minorVersion`: the version number of the Storage lingo protocol (currently 1.02)

The cardio equipment is required to honor the `maxWriteSize` limitation of the iPod; it must never send a `WriteiPodFileData` command with a data payload larger than that `maxWriteSize` value.

To create a cardio workout file on the iPod, the cardio equipment sends an `OpeniPodFeatureFile` command with `feature` = 0x02, `options` = 0x000B, and `fileData` equal to the UTF-8 representation of the string necessary to close the root element: “</gymData>” or 0x3C 0x2F 0x67 0x79 0x6D 0x44 0x61 0x72 0x61 0x3E. On receiving this command, the iPod performs the following steps:

1. Creates a new workout file in `/iPod_Control/Device/Trainer/Workouts/Empeds/`*USERNAME*`/latest/` (where *USERNAME* is the name of the current `userIndex`)
2. Sends a `RetiPodFileHandle` command with a handle to the new file

Next, the cardio equipment must use a series of `WriteiPodFileData` commands to write the following elements to the file:

the XML version header line
root element opening tag: <gymData>
<vers>
<equipmentInfo>
<userInfo>
<template> (optional)
<interval> with <event> “start” or “continue” and initial values for all child elements

See “XML Element Formats” (page 502) for details about valid XML elements.

As the workout progresses, the cardio equipment is required to write <interval> XML elements on a real-time basis at least every 10 seconds. Certain child elements of <interval> (the <incline> element, for example) are required only if their value has changed since the previous <interval> element .

**Note:** All <interval> elements written to file must be complete and closed. Because a user can detach the iPod at any time during the process, <interval> elements must not be broken across multiple `WriteiPodFileData` commands.

At the end of the workout, the cardio equipment must write the <workoutSummary> element to the file and then send the `CloseiPodFile` command. Upon receiving the `CloseiPodFile` command, the iPod performs the following actions (assuming the proper option bits were set in `OpeniPodFeatureFile`):

1. Append the <ipodInfo> XML element to file.
2. Write the specified `fileData` to close the root element.
3. Close the XML file.
4. Compute and insert an XML <Signature> element in to file.
5. Send an `iPodACK` command acknowledging success.

While performing these steps, the iPod is unresponsive to further iAP commands. Signature calculation requires many seconds for long workouts. The cardio equipment must wait for the `CloseiPodFile` command to fully complete before sending any new iAP commands. The `CloseiPodFile` command is complete when the iPod returns an `iPodACK` with any status other than command pending (0x06).

## Workout Events

Events that occur as part of a normal workout must be tracked and recorded to the XML file as part of the <event> child element of <interval>. There are five event types to be recorded:

- **start:** the first <interval> of a new workout
- **continue:** the first <interval> of a workout already in progress
- **pause:** when a user pauses the active workout
- **resume:** when a user resumes the workout
- **end:** the final <interval> of a completed workout

Workout time must not elapse between a pause event and a resume event; the <sec> children of both the pause and the resume <interval> elements must be identical. Continue events are used to mark a file that was opened after the workout has already started; some amount of <interval> data from the beginning of the workout is not present in the file.

## File System Full

The iPod will determine whether or not enough disk space is available to record and sign the workout data. When the iPod file system no longer contains enough free space, the iPod will respond with `iPodACK` = (0x03) (out of resources) to any `OpeniPodFeatureFile` or `WriteiPodFileData` commands. If this occurs during an `OpeniPodFeatureFile` command, the cardio equipment must notify the user that the iPod is full and that the workout will not be recorded.

If an "out of resources" `iPodACK` is received in response to a `WriteiPodFileData`, the cardio equipment must close the current workout file without writing an end <interval> or <workoutSummary> and must alert the user that the iPod is full and that the workout is no longer being recorded.

## File Writing Error Recovery

Cardio equipment accessories must properly handle unexpected failures during the file writing process. In the event of a failure while writing data to the iPod (as indicated by lack of an `ackStatus=Success` in response to `WriteiPodFileData`), the cardio equipment should first retry the operation. If the operation fails twice, the current workout file must be closed and the cardio equipment must attempt to open a new workout file.

## Recording a Workout Already in Progress

When opening a new workout data file mid-workout, the standard procedure for creating a new workout file must be followed. The difference between a standard workout file and one started in the middle of a workout is that the first <interval> element will have a nonzero <sec> value and an <event> continue (instead of start) value. It is the responsibility of the end consumer of the data (such as `nikeplus.com`) to recognize a workout file that started mid-workout and act appropriately.

# XML Element Formats

All file data must be well-formed and valid XML. Character entities are not currently supported by the iPod. All special characters (&, <, >) used as element data content must be encapsulated as part of a CDATA section. For human readability, it is recommended that each element close tag be followed by a newline character (0x0A). XML elements are required to appear in the order shown in the table with two exceptions:

- The <userInfo> element may appear at any point in the file.
- The <template> element may appear multiple times and at any point in the file.

All <interval> elements must be written in chronological order (ascending <sec> values). All distances must be recorded to 0.01 km resolution. All kilocalorie values must be recorded to 0.01 kCal resolution. In situations where the user is not moving and the workout speed is essentially zero, the <pace> element should be set to 0 instead of to infinity.

**Table E-5** XML element usage

| Element | Format | Example | Tread-mill | Ellip-tical | Stepper | Bike | Other |
|---|---|---|---|---|---|---|---|
| **Header** | | | | | | | |

| Element | Format | Example | Tread-mill | Ellip-tical | Stepper | Bike | Other |
|---|---|---|---|---|---|---|---|
| XML Header | | <?xml version="1.0" encoding="UTF-8"?> | Req | Req | Req | Req | Req |
| Root Element Open | | <gymData> | Req | Req | Req | Req | Req |
| File Format Version | integer | <vers>1</vers> | Req | Req | Req | Req | Req |
| **Equipment Info** | | | | | | | |
| | | <equipmentInfo> | Req | Req | Req | Req | Req |
| Manufacturer ID | integer (hex format) | <manufacturerID> 0123ABCD </manufacturerID> (see Note below) | Req | Req | Req | Req | Req |
| Manufacturer Name | string | <manufacturerName> Partner A </manufacturerName> | Req | Req | Req | Req | Req |
| Equipment Type | string enum: Treadmill, Elliptical, Stepper, Bike, or Other | <type>Treadmill </type> | Req | Req | Req | Req | Req |
| Equipment Model | string | <model> ExerPro 5000 </model> | Req | Req | Req | Req | Req |
| Equipment Serial No. | string | <serialNumber> XYZ012345TG88 </serialNumber> | Opt | Opt | Opt | Opt | Opt |
| Gym Name | string | <gymName> GloboGym </gymName> | Opt | Opt | Opt | Opt | Opt |
| Gym Location | string | <gymLocation> Cupertino, CA </gymLocation> | Opt | Opt | Opt | Opt | Opt |
| | | </equipmentInfo> | Req | Req | Req | Req | Req |
| **User Info** | | | | | | | |
| | | <userInfo> | Req | Req | Req | Req | Req |
| User Name | string | <name>Jane Doe </name> | Opt | Opt | Opt | Opt | Opt |

| Element | Format | Example | Tread-mill | Ellip-tical | Stepper | Bike | Other |
|---|---|---|---|---|---|---|---|
| Weight | float kilograms | <kg>53.5</kg> | Req | Req | Req | Opt | Opt |
| Gender | string enum: female or male | <gender>female </gender> | Opt | Opt | Opt | Opt | Opt |
| | | </userInfo> | Req | Req | Req | Opt | Opt |
| **Workout Template** | | | | | | | |
| | | <template> | Opt | Opt | Opt | Opt | Opt |
| Template Name | string | <templateName>Hills </templateName> | Opt | Opt | Opt | Opt | Opt |
| Caloric Goal | float kilocalories | <kCal>200.00</kCal> | Opt | Opt | Opt | Opt | Opt |
| Time Goal | integer seconds | <sec>900</sec> | Opt | Opt | Opt | Opt | Opt |
| Distance Goal | float kilometers | <km>10.00</km> | Opt | Opt | N/A | Opt | Opt |
| | float floors | <floors>30.0</floors> | N/A | N/A | Opt | N/A | Opt |
| Speed Goal | integer seconds per kilometer | <pace>450</pace> | Opt | N/A | N/A | N/A | Opt |
| | integer steps/strides per minute | <spm>40</spm> | N/A | Opt | Opt | N/A | Opt |
| | integer revolutions per minute | <rpm>60</rpm> | N/A | N/A | N/A | Opt | Opt |
| Heart Rate Goal | integer beats per minute | <bpm>140</bpm> | Opt | Opt | N/A | Opt | Opt |
| | | </template> | Opt | Opt | Opt | Opt | Opt |
| **Interval Data** (written at least every 10 seconds) | | | | | | | |
| | | <interval> | Req | Req | Req | Req | Req |
| Event Type | string enum: start, continue, pause, resume, or end | <event>pause </event> | Opt | Opt | Opt | Opt | Opt |
| Current Elapsed Time | integer seconds | <sec>1200</sec> | Req | Req | Req | Req | Req |
| Current Calories | float kilocalories | <kCal>230.12</kCal> | Req | Req | Req | Req | Req |

| Element | Format | Example | Tread-mill | Ellip-tical | Stepper | Bike | Other |
|---|---|---|---|---|---|---|---|
| Current Distance | float kilometers | <km>3.25</km> | Req | Req | N/A | Req | Opt |
| | float floors | <floors>11.0</floors> | N/A | N/A | Req | N/A | Opt |
| Current Speed | integer seconds per kilometer | <pace>430</pace> | Req | N/A | N/A | N/A | Opt |
| | integer steps/strides per minute | <spm>40</spm> | N/A | Req | Req | N/A | Opt |
| | integer revolutions per minute | <rpm>55</rpm> | N/A | N/A | N/A | Req | Opt |
| Current Heart Rate | integer beats per minute | <bpm>101</bpm> | Opt | Opt | Opt | Opt | Opt |
| Incline | float percent | <incline>10.1 </incline> | Required only if value has changed | | | | |
| Resistance/Effort | integer level | <level>3</level> | Required only if value has changed | | | | |
| | | </interval> | Req | Req | Req | Req | Req |
| **Workout Summary** | | | | | | | |
| | | <workoutSummary> | Req | Req | Req | Req | Req |
| Total Elapsed Time | integer seconds | <sec>2450</sec> | Req | Req | Req | Req | Req |
| Total Calories | float kilocalories | <kCal>342.34</kCal> | Req | Req | Req | Req | Req |
| Total Distance | float kilometers | <km>10.15</km> | Req | Req | N/A | Req | Opt |
| | float floors | <floors>11.0</floors> | N/A | N/A | Req | N/A | Opt |
| Average Speed | integer seconds per kilometer | <pace>430</pace> | Req | N/A | N/A | N/A | Opt |
| | integer steps/strides per minute | <spm>40</spm> | N/A | Req | Req | N/A | Opt |
| | integer revolutions per minute | <rpm>55</rpm> | N/A | N/A | N/A | Req | Opt |
| Average Heart Rate | integer beats per minute | <bpm>140</bpm> | Opt | Opt | Opt | Opt | Opt |

| Element | Format | Example | Tread-mill | Ellip-tical | Stepper | Bike | Other |
|---|---|---|---|---|---|---|---|
| | | </workoutSummary> | Req | Req | Req | Req | Req |
| **iPod Info** | | | | | | | |
| | | <ipodInfo> | Written by iPod | | | | |
| File Open Date/Time | date/time format w/ offset | <openTime> 2007-12-17T 17:15:17-08:00 </openTime> | Written by iPod | | | | |
| File Close Date/Time | date/time format w/ offset | <closeTime> 2007-12-17T 17:56:07-08:00 </closeTime> | Written by iPod | | | | |
| iPod Model | string | <model>MA980 </model> | Written by iPod | | | | |
| iPod Software Version | string | <softwareVersion> 1.1.2 </softwareVersion> | Written by iPod | | | | |
| iPod Serial No. | string | <serialNumber> 4H802998TVS </serialNumber> | Written by iPod | | | | |
| | | </ipodInfo> | Written by iPod | | | | |
| **XML Signature** | | | | | | | |
| iPod signature | | <Signature >same as run data</Signature> | Written by iPod | | | | |
| **Root Close** | | | | | | | |
| | | </gymData> | Written by iPod | | | | |

**Note:** To obtain a <manufacturerID> number, a partner must submit a product plan to Apple's Made For iPod program. Once the product plan is approved, Apple will assign the partner an ID for all the partner's Nike + iPod products.

## User Interface Requirements

This section sets forth the requirements for the cardio equipment's user interface. An example of a typical user interface process, from the perspective of the cardio equipment, is shown in Figure E-1 (page 509).

## The iPod Does Not Support Nike + iPod

The cardio equipment must determine whether the attached iPod supports the Nike + iPod feature; see "Determining iPod Support for Cardio Equipment" (page 495). If the attached iPod does not support the Nike + iPod feature, then the cardio equipment must display this information to the user. See Table E-6 (page 508) for the approved UI string.

## Deciding to Record a Workout to the iPod

The cardio equipment must first check the iPod for the user's Workout Recording Preference, using the Sports lingo. If the user's recording preference is set to Never then the workout must not be recorded. If the user's preference is set to Always, Ask, or Not Set, then the cardio equipment must present an option to the user. There are two approved forms for this option:

- Recommended: allow user to opt out. Default to recording the workout, but present an option for the user to cancel the recording.
- Allowed: present a dialog prompting the user to choose whether or not they would like the workout to be recorded.

## The iPod is Full

In the event that the cardio equipment is unable to record a workout to the iPod because of insufficient disk space, the cardio equipment must present a message to the user alerting them to this problem. See Table E-6 (page 508) for the approved UI string. Note that this problem may occur either when trying to open a workout file or mid-workout, if the iPod's file system becomes full.

## User Weight

Workouts are displayed at `nikeplus.com` using a metric known as Cardio Miles. Cardio Miles are a conversion from workout calories to equivalent running miles. The key metric recorded in most cardio equipment workouts is the calories burned. To accurately calculate calories burned, the user must be required to enter a weight value.

Because a user's weight may change over time, the equipment must always present the user with an opportunity to enter or adjust the weight value. The enter-weight UI on the cardio equipment must start with the weight value retrieved from iPod via the `GetUserData` command. It is acceptable for the cardio equipment UI to automatically accept the displayed weight if the user fails to enter or adjust the weight after a length of time has passed.

If the user enters a weight different from that retrieved from the iPod, the cardio equipment must write the new weight value back to iPod via the `SetUserData` command.

## Recording Indicator

Cardio equipment must always present a visible indicator to the user that the workout is being successfully recorded to iPod. This indicator must be present as soon as the workout recording begins and then disappear when the workout recording ends (either because the workout is finished or the iPod has been detached from the equipment).

Whenever the user pauses a workout, the recording indicator must flash on and off until the workout either resumes normally or is terminated.

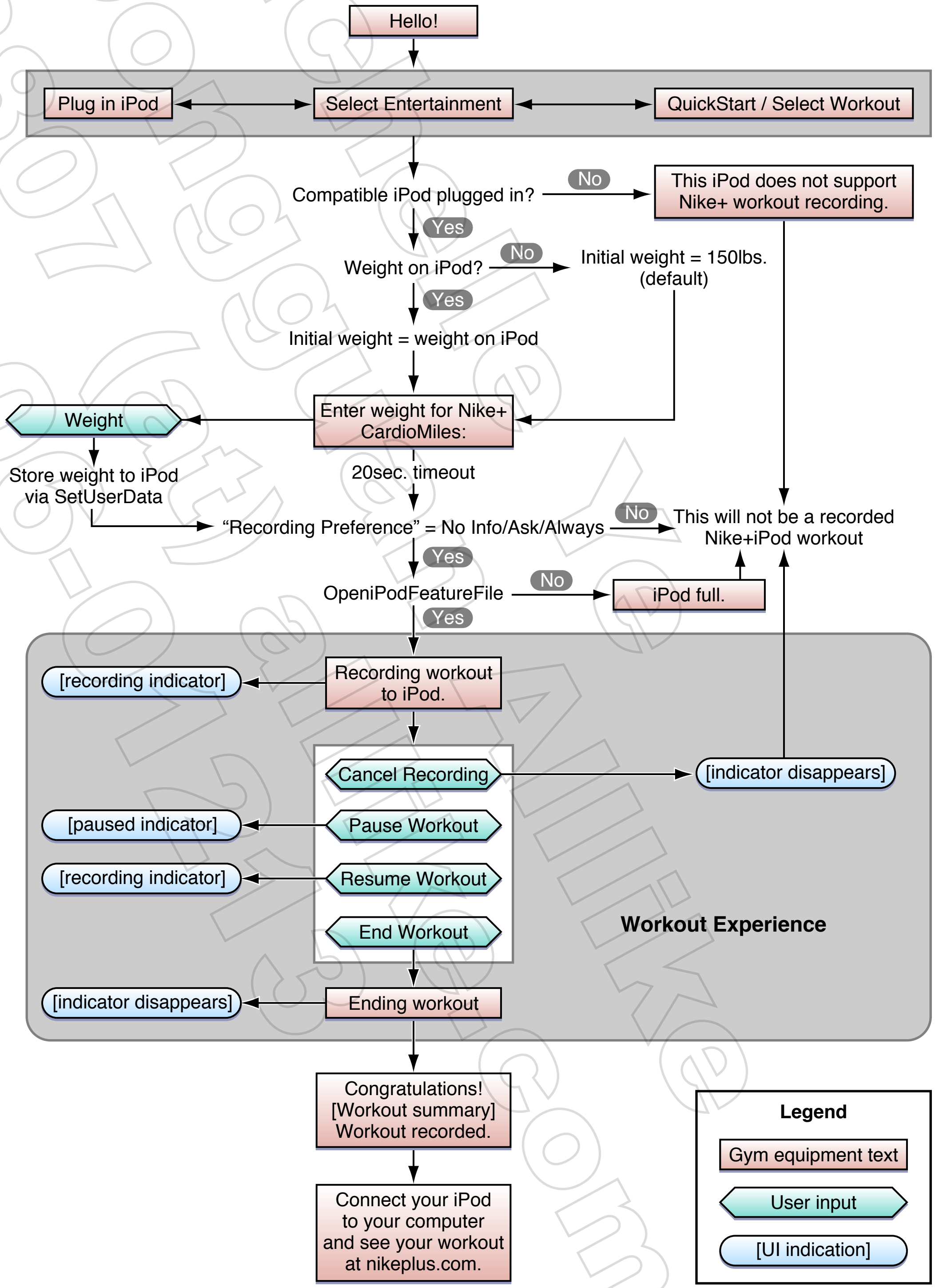
## Workout Completed

At the end of a workout, the cardio equipment must present two messages to the user. The first is a congratulatory message stating that the workout has been successfully recorded and showing a summary of the workout data. The second message gives brief instruction on how to view the user's workout statistics at the `nikeplus.com` website. Table E-6 (page 508) lists all the approved UI strings for display by Nike + iPod cardio equipment.

**Table E-6** Approved user interface messages

| Event | Approved UI string | Short UI string |
| --- | --- | --- |
| iPod Does Not Support the Nike + iPod System | This iPod does not support Nike+ workout recording. | This iPod does not support workout recording. |
| The iPod is full | This iPod is full. | iPod full. |
| Workout summary | Congratulations!<br><Workout summary><br>Workout recorded. | Congratulations!<br><Workout summary><br>Workout recorded. |
| Upload instructions | Connect your iPod to your computer to see your workout at nikeplus.com. | See your workout at nikeplus.com. |

**Figure E-1** Sample user experience flow chart



# Sample Command Sequence

Table E-7 (page 510) shows a sample sequence of IDPS commands that implements the Nike + iPod cardio equipment system in an accessory.

**Table E-7** Cardio equipment command sequence using IDPS

<table>
<tr><th>Step</th><th>Accessory command</th><th>iPod command</th><th>Comment</th></tr>
<tr><td>1</td><td><code>StartIDPS</code></td><td></td><td>no params</td></tr>
<tr><td>2</td><td></td><td><code>ACK</code></td><td>acknowledging 'Success (OK)' to command 'General Lingo::StartIDPS'</td></tr>
<tr><td colspan="4">If the <code>ACK</code> reply to <code>StartIDPS</code> returns a status of 0x00, the accessory proceeds to Step 3. Otherwise,<ul><li>If the accessory receives no <code>ACK</code> command within 1 second, it may retry Step 1 at 1-second intervals as long as iPod Detect (pin 30 of the 30-pin connector) is low and Accessory Power (pin 13) is high. Accessories that don’t monitor these signals (such as Bluetooth accessories or USB accessories without a 191 kΩ ID resistor) may retry without checking them.</li><li>If the accessory receives an <code>ACK</code> status of 0x04 (Bad Parameter), the iPod does not support IDPS. Within 800 ms the accessory must send an <code>IdentifyDeviceLingoes</code> command with its lingo mask set for only the General lingo, with no options, and with a Device ID of 0x0. See "Cancelling a Current Authentication Process With IdentifyDeviceLingoes" (page 83). A sample command sequence is listed in Table F-28 (page 548).</li><li>If the accessory receives any other nonzero <code>ACK</code> status, it must not send any more iAP commands until it has been disconnected. Upon reconnection it must restart identification at Step 1.</li></ul></td></tr>
<tr><td>3</td><td><code>GetiPodOptions-ForLingo</code></td><td></td><td>getting options for General Lingo</td></tr>
<tr><td>4</td><td></td><td><code>RetiPodOptions-ForLingo</code></td><td>returning options of 000000000003F3FF (Line out usage | Video output | NTSC video signal format | PAL video signal format | Composite video out connection | S-Video video out connection | Component video out connection | Closed captioning (video) | Video aspect ratio 4:3 (fullscreen) | Video aspect ratio 6:9 (widescreen) | reserved | app communication capable | iPod notifications) for General Lingo</td></tr>
<tr><td>5</td><td><code>GetiPodOptions-ForLingo</code></td><td></td><td>getting options for Sports Lingo</td></tr>
<tr><td>6</td><td></td><td><code>RetiPodOptions-ForLingo</code></td><td>returning options of 0000000000000002 (Nike + iPod cardio equipment) for Sports Lingo</td></tr>
</table>

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| 7 | `GetiPodOptions-ForLingo` | | getting options for Storage Lingo |
| 8 | | `RetiPodOptions-ForLingo` | returning options of 0000000000000003 (iTunes tagging \| Nike + iPod cardio equipment) for Storage Lingo |
| 9 | `SetFIDTokenValues` | | setting 12 FID tokens ; IdentifyToken = (lingoes: 0/9/12 \| options 0x00000002 \| device ID 0x00000200); AccCapsToken = 0x0000000000000805; AccInfoToken = Acc name (FitBicycle 2010); AccInfoToken = Acc FW version (v1.0.1); AccInfoToken = Acc HW version (v1.0.0); AccInfoToken = Acc manufacturer (Apple); AccInfoToken = Acc model number (MA1234LL/A); iPodPreferenceToken = (setting 'used' for preference class 'line out usage' with restore on exit 'selected'); iPodPreferenceToken = (setting 'on' for preference class 'video out setting' with restore on exit 'selected'); iPodPreferenceToken = (setting 'fullscreen' for preference class 'screen configuration' with restore on exit 'selected'); iPodPreferenceToken = (setting 'NTSC' for preference class 'video format setting' with restore on exit 'selected'); iPodPreferenceToken = (setting 'component' for preference class 'video connection' with restore on exit 'selected') |
| 10 | | `RetFIDTokenValueACKs` | 12 ACKs for FID tokens ; IdentifyToken = accepted; AccCapsToken = accepted; AccInfoToken = (Acc name) accepted; AccInfoToken = (Acc FW version) accepted; AccInfoToken = (Acc HW version) accepted; AccInfoToken = (Acc manufacturer) accepted; AccInfoToken = (Acc model number) accepted; iPodPreferenceToken = (line out usage) accepted; iPodPreferenceToken = (video out setting) accepted; iPodPreferenceToken = (screen configuration) accepted; iPodPreferenceToken = (video format setting) accepted; iPodPreferenceToken = (video connection) accepted |

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| 11 | EndIDPS | | status 'finished with IDPS; proceed to authentication' |
| 12 | | IDPSStatus | status 'ready for auth' |
| 13 | | GetDevAuthentication-Info | no params |
| 14 | RetDevAuthentication-Info | | returning auth protocol v2.0; current section index: 0; maximum section index: 1; cert data ... |
| 15 | | ACK | acknowledging 'Success (OK)' to command 'General Lingo::RetDevAuthenticationInfo' |
| 16 | RetDevAuthentication-Info | | returning auth protocol v2.0; current section index: 1; maximum section index: 1; cert data ... |
| 17 | | AckDevAuthentication-Info | acknowledging 'auth info supported' |
| 18 | | GetDeviceCaps | no params |
| 19 | | GetDevAuthentication-Signature | offering challenge '...' with retry counter 1 |
| 20 | RetDevAuthentication-Signature | | returning signature '...' |
| 21 | | AckDevAuthentication-Status | acknowledging authentication status 'Success (OK)' |
| 22 | | GetDeviceCaps | requesting accessory Sports lingo capabilities; no params |
| 23 | | GetDeviceCaps | requesting accessory Storage lingo capabilities; no params |
| 24 | RetDeviceCaps | | returning 'Gym equipment command support' |
| 25 | RetDeviceCaps | | returning 'file system type 'none'; lingo v1.02' |
| 26 | GetiPodCaps | | requesting iPod Sports lingo capabilities; no params |
| 27 | | RetiPodCaps | returning 'Gym equipment support \| User data support' with userCount of 1 |

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| 28 | GetiPodCaps | | requesting iPod Storage lingo capabilities; no params |
| 29 | | RetiPodCaps | returning 'total space 2147483648; max file size 1073741824; max write size 500; v1.02' |
| 30 | GetUserData | | requesting 'Gender' |
| 31 | | RetUserData | returning 'No information' for data type 'Gender' |
| 32 | GetUserData | | requesting 'Age' |
| 33 | | RetUserData | returning '26 years' for data type 'Age' |
| 34 | GetUserData | | requesting 'Name' |
| 35 | | RetUserData | returning 'NewUser' for data type 'Name' |
| 36 | GetUserData | | requesting 'Weight' |
| 37 | | RetUserData | returning '92.0 kg' for data type 'Weight' |
| 38 | OpeniPodFeatureFile | | opening feature type 'Gym Equipment Workout' with options mask 'file data \| ipodInfo \| XML signature' and file data:</gymData>; |
| 39 | | iPodAck | acknowledging 'Success' to command 'Storage Lingo::OpeniPodFeatureFile' with file handle 0 |
| 40 | WriteiPodFileData | | writing 39 bytes at offset 0 and handle 0: <?xml version=""1.0"" encoding=""UTF-8""?> |
| 41 | | iPodAck | acknowledging 'Success' to command 'Storage Lingo::WriteiPodFileData' with file handle 0 |
| 42 | WriteiPodFileData | | writing 10 bytes at offset 39 and handle 0: <gymData>; |
| 43 | | iPodAck | acknowledging 'Success' to command 'Storage Lingo::WriteiPodFileData' with file handle 0 |
| 44 | WriteiPodFileData | | writing 15 bytes at offset 49 and handle 0: <vers>1</vers>; |

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| 45 | | iPodAck | acknowledging 'Success' to command 'Storage Lingo::WriteiPodFileData' with file handle 0 |
| 46 | WriteiPodFileData | | writing 166 bytes at offset 64 and handle 0: <equipmentInfo> < manufacturerID>123A3A27 </manufacturerID> < manufacturerName>Scotty </manufacturerName> < type>Bike</type> < model>Bike for Scotty</model> </equipmentInfo> |
| 47 | | iPodAck | acknowledging 'Success' to command 'Storage Lingo::WriteiPodFileData' with file handle 0 |
| 48 | WriteiPodFileData | | writing 36 bytes at offset 230 and handle 0: <userInfo> < kg>90</kg> </userInfo> |
| 49 | | iPodAck | acknowledging 'Success' to command 'Storage Lingo::WriteiPodFileData' with file handle 0 |
| 50 | WriteiPodFileData | | writing 74 bytes at offset 266 and handle 0: <template> < templateName>Goal </templateName> < kCal>500</kCal> </template> |
| 51 | | iPodAck | acknowledging 'Success' to command 'Storage Lingo::WriteiPodFileData' with file handle 0 |
| 52 | WriteiPodFileData | | writing 121 bytes at offset 340 and handle 0: <interval> < event>start</event> < sec>0</sec> < kCal>0</kCal> < km>0</km> < rpm>0</rpm> < bpm>0</bpm> < level>1</level> </interval> |
| 53 | | iPodAck | acknowledging 'Success' to command 'Storage Lingo::WriteiPodFileData' with file handle 0 |
| 54 | WriteiPodFileData | | writing 88 bytes at offset 461 and handle 0: <interval> < sec>10</sec> < kCal>0</kCal> < km>2</km> < rpm>74</rpm> < bpm>96</bpm> </interval> |

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| 55 | | iPodAck | acknowledging 'Success' to command 'Storage Lingo::WriteiPodFileData' with file handle 0 |
| 56 | WriteiPodFileData | | writing 90 bytes at offset 549 and handle 0: <interval> < sec>20</sec> < kCal>2</kCal> < km>10</km> < rpm>98</rpm> < bpm>163</bpm> </interval> |
| 57 | | iPodAck | acknowledging 'Success' to command 'Storage Lingo::WriteiPodFileData' with file handle 0 |
| 58 | WriteiPodFileData | | writing 126 bytes at offset 639 and handle 0: <interval> < event>end</event> < sec>30</sec> < kCal>500</kCal> < km>17</km> < rpm>87</rpm> < bpm>172</bpm> < level>2</level> </interval> |
| 59 | | iPodAck | acknowledging 'Success' to command 'Storage Lingo::WriteiPodFileData' with file handle 0 |
| 60 | WriteiPodFileData | | writing 104 bytes at offset 765 and handle 0: <workoutSummary> < sec>30</sec> < kCal>500</kCal> < km>17</km> < rpm>89</rpm> < bpm>167</bpm> </workoutSummary> |
| 61 | | iPodAck | acknowledging 'Success' to command 'Storage Lingo::WriteiPodFileData' with file handle 0 |
| 62 | CloseiPodFile | | closing file with handle 0 |
| 63 | | iPodAck | acknowledging 'Success' to command 'Storage Lingo::CloseiPodFile' with file handle 0 |

# Historical Information

This appendix memorializes the specifications of past iPod models and iAP protocols. It is included in this specification to provide guidance for developers who need to design accessories compatible with these past technologies.

## Past Protocol Features

Table F-1 (page 517) and Table F-2 (page 519) list the past protocol versions for each lingo and the firmware releases in which they were available.

In the following tables, "NL" indicates that the given lingo was not implemented in the specified model loaded with the specified firmware. "NV" indicates that although the lingo was implemented, its protocol version could not be read from the iPod. Footnotes are listed below each table.

**Table F-1** Past iPod models, firmware, and lingo versions, table 1

| Model | Firmware | | Lingoes | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Version | Date | 0x00 | 0x01 | 0x02 | 0x03 | 0x04 | 0x05 | 0x06 | 0x07 | 0x08 | 0x0A | 0x0C |
| 3G [1] | 2.0.0 | 04/03 | NV | NL | NV | NL | NL | NL | NL | NL | NL | NL | NL |
| | 2.1.0 | 10/03 | NV | NV | NV | NL | 1.00 | NL | NL | NL | NL | NL | NL |
| | 2.2.0 | 02/04 | NV | NV | NV | NL | 1.02 | NL | NL | NL | NL | NL | NL |
| mini | 1.0.0 | 02/04 | NV | NL | NV | NL | 1.01 | NL | NL | NL | NL | NL | NL |
| | 1.1.0 | 03/04 | NV | NL | NV | NL | 1.03 | NL | NL | NL | NL | NL | NL |
| | 1.2.0 | 11/04 | 1.00 | NL | 1.00 | NL | 1.05 | 1.00 | NL | NL | NL | NL | NL |
| | 1.3.0 | 02/05 | 1.00 | NL | 1.00 | NL | 1.05 | 1.00 | NL | NL | NL | NL | NL |
| | 1.4.0 | 06/05 | 1.02 | NL | 1.00 | 1.01 | 1.05 | 1.00 | NL | NL | NL | NL | NL |
| 4G | 3.0.0 | 07/04 | NV | NV | NV | NL | 1.04 | NV | NL | NL | NL | NL | NL |
| | 3.0.1 | 08/04 | NV | NV | NV | NL | 1.04 | NV | NL | NL | NL | NL | NL |
| | 3.0.2 | 11/04 | 1.00 | 1.00 | 1.00 | NL | 1.05 | 1.00 | NL | NL | NL | NL | NL |
| | 3.1.0 | 06/05 | 1.02 | 1.00 | 1.00 | 1.01 | 1.05 | 1.00 | NL | NL | NL | NL | NL |

| Model | Firmware | | Lingoes | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Version | Date | 0x00 | 0x01 | 0x02 | 0x03 | 0x04 | 0x05 | 0x06 | 0x07 | 0x08 | 0x0A | 0x0C |
| 4G (color display) | 1.0.0 | 10/04 | 1.00 | 1.00 | 1.00 | NL | 1.05 | 1.00 | NL | NL | NL | NL | NL |
| | 1.1.0 | 03/05 | 1.01 | 1.00 | 1.00 | 1.00 | 1.06 | 1.00 | NL | NL | NL | NL | NL |
| | 1.2.0 | 06/05 | 1.02 | 1.00 | 1.00 | 1.01 | 1.06 | 1.00 | NL | NL | NL | NL | NL |
| nano | 1.0.0 | 09/05 | 1.02 | NL | 1.00 | 1.02 | 1.07 | 1.00 | NL | 1.00 | 1.00 | NL | NL |
| | 1.1.0 | 01/06 | 1.03 | NL | 1.00 | 1.03 | 1.09 | 1.00 | NL | 1.00 | 1.00 | NL | NL |
| | 1.1.1 | 03/06 | 1.03 | NL | 1.00 | 1.03 | 1.09 | 1.00 | NL | 1.00 | 1.00 | NL | NL |
| | 1.2.0 | 06/06 | 1.04 | NL | 1.02 | 1.04 | 1.10 | 1.01 | NL | 1.00 | 1.00 | 1.00 [2] | NL |
| | 1.3 | 10/06 | 1.05 | NL | 1.02 | 1.05 | 1.11 | 1.01 | NL | 1.00 | 1.00 | 1.01 | NL |
| 5G | 1.0.0 | 10/05 | 1.03 | 1.01 | 1.01 | 1.03 | 1.08 | 1.00 | 1.00 | 1.00 | 1.00 | NL | NL |
| | 1.1.0 | 01/06 | 1.03 | 1.01 | 1.01 | 1.03 | 1.09 | 1.00 | 1.00 | 1.00 | 1.00 | NL | NL |
| | 1.1.1 | 03/06 | 1.03 | 1.01 | 1.01 | 1.03 | 1.09 | 1.00 | 1.00 | 1.00 | 1.00 | NL | NL |
| | 1.1.2 | 06/06 | 1.03 | 1.01 | 1.01 | 1.03 | 1.09 | 1.00 | 1.00 | 1.00 | 1.00 | NL | NL |
| | 1.2.0 | 09/06 | 1.05 | 1.01 | 1.02 | 1.05 | 1.11 | 1.01 | 1.00 | 1.00 | 1.00 | 1.01 | NL |
| | 1.2.1 | 11/06 | 1.05 | 1.01 | 1.02 | 1.05 | 1.11 | 1.01 | 1.00 | 1.00 | 1.00 | 1.01 | NL |
| | 1.2.3 | 11/07 | 1.06 | 1.01 | 1.02 | 1.05 | 1.12 | 1.01 | 1.00 | 1.00 | 1.00 | 1.01 | 1.01 |
| 2G nano | 1.0.0 | 09/06 | 1.04 | 1.01 | 1.02 | 1.04 | 1.10 | 1.01 | NL | 1.00 | 1.00 | 1.00 [2] | NL |
| | 1.0.1 | 09/06 | 1.04 | 1.01 | 1.02 | 1.04 | 1.10 | 1.01 | NL | 1.00 | 1.00 | 1.00 [2] | NL |
| | 1.0.2 | 09/06 | 1.04 | 1.01 | 1.02 | 1.04 | 1.10 | 1.01 | NL | 1.00 | 1.00 | 1.00 [2] | NL |
| | 1.1 | 10/06 | 1.04 | 1.01 | 1.02 | 1.04 | 1.10 | 1.01 | NL | 1.00 | 1.00 | 1.00 [2] | NL |
| | 1.1.1 | 10/06 | 1.04 | 1.01 | 1.02 | 1.04 | 1.10 | 1.01 | NL | 1.00 | 1.00 | 1.00 [2] | NL |
| | 1.1.2 | 02/07 | 1.04 | 1.01 | 1.02 | 1.04 | 1.10 | 1.01 | NL | 1.00 | 1.00 | 1.02 | NL |
| classic | 1.0 | 09/07 | 1.07 | 1.01 | 1.02 | 1.05 | 1.12 | 1.01 | NL | 1.00 | 1.00 | 1.03 | 1.01 |
| | 1.0.1 | 09/07 | 1.07 | 1.01 | 1.02 | 1.05 | 1.12 | 1.01 | NL | 1.00 | 1.00 | 1.03 | 1.01 |
| | 1.0.2 | 10/07 | 1.07 | 1.01 | 1.02 | 1.05 | 1.12 | 1.01 | NL | 1.00 | 1.00 | 1.03 | 1.01 |
| | 1.0.3 | 11/07 | 1.07 | 1.01 | 1.02 | 1.05 | 1.13 | 1.01 | NL | 1.00 | 1.00 | 1.03 | 1.01 |
| | 1.1.1 | 02/08 | 1.07 | 1.01 | 1.02 | 1.05 | 1.13 | 1.01 | NL | 1.00 | 1.00 | 1.03 | 1.01 |

| Model | Firmware | | Lingoes | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Version | Date | 0x00 | 0x01 | 0x02 | 0x03 | 0x04 | 0x05 | 0x06 | 0x07 | 0x08 | 0x0A | 0x0C |
| | 1.1.2 | 05/08 | 1.07 | 1.01 | 1.02 | 1.05 | 1.13 | 1.01 | NL | 1.00 | 1.00 | 1.03 | 1.02 |
| 3G nano | 1.0 | 09/07 | 1.07 | 1.01 | 1.02 | 1.05 | 1.12 | 1.01 | NL | 1.00 | 1.00 | 1.03 | 1.01 |
| | 1.0.1 | 09/07 | 1.07 | 1.01 | 1.02 | 1.05 | 1.12 | 1.01 | NL | 1.00 | 1.00 | 1.03 | 1.01 |
| | 1.0.2 | 10/07 | 1.07 | 1.01 | 1.02 | 1.05 | 1.12 | 1.01 | NL | 1.00 | 1.00 | 1.03 | 1.01 |
| | 1.0.3 | 11/07 | 1.07 | 1.01 | 1.02 | 1.05 | 1.13 | 1.01 | NL | 1.00 | 1.00 | 1.03 | 1.01 |
| | 1.1 | 01/08 | 1.07 | 1.01 | 1.02 | 1.05 | 1.13 | 1.01 | NL | 1.00 | 1.00 | 1.03 | 1.01 |
| | 1.1.2 | 05/08 | 1.07 | 1.01 | 1.02 | 1.05 | 1.13 | 1.01 | NL | 1.00 | 1.00 | 1.03 | 1.02 |

[1] Supporting the 3G iPod requires special design considerations. See "Interfacing With the 3G iPod" in *iPod/iPhone Hardware Specifications*.

[2] Because version 1.00 of Lingo 0x0A contained a bug that was corrected in version 1.01, accessories should attempt Digital Audio only with iPods whose Lingo 0x0A version is higher than or equal to 1.01. See Table 3-218 (page 294).

**Table F-2** Past iPod models, firmware, and lingo versions, table 2

| Model | Firmware | | Lingoes | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Vers. | Date | 0x00 | 0x01 | 0x02 | 0x03 | 0x04 | 0x05 | 0x07 | 0x08 | 0x09 | 0x0A | 0x0C | 0x0E |
| iPhone | 1.1 | 09/07 | 1.07 | NL | 1.02 | 1.05 | 1.12 | 1.01 | NL | 1.00 | NL | 1.02 | NL | NL |
| | 1.1.1 | 09/07 | 1.07 | NL | 1.02 | 1.05 | 1.12 | 1.01 | NL | 1.00 | NL | 1.02 | NL | NL |
| | 1.1.2 | 11/07 | 1.07 | NL | 1.02 | 1.05 | 1.12 | 1.01 | NL | 1.00 | NL | 1.02 | NL | NL |
| | 1.1.3 | 01/08 | 1.07 | NL | 1.02 | 1.05 | 1.12 | 1.01 | NL | 1.00 | NL | 1.02 | NL | NL |
| | 1.1.4 | 02/08 | 1.07 | NL | 1.02 | 1.05 | 1.12 | 1.01 | NL | 1.00 | NL | 1.02 | NL | NL |
| | 1.1.5 | 07/08 | 1.07 | NL | 1.02 | 1.05 | 1.12 | 1.01 | NL | 1.00 | NL | 1.02 | NL | NL |
| | 2.0 | 07/08 | 1.07 | NL | 1.02 | 1.05 | 1.12 | 1.01 | NL | 1.00 | NL | 1.02 | NL | NL |
| | 2.0.1 | 08/08 | 1.07 | NL | 1.02 | 1.05 | 1.12 | 1.01 | NL | 1.00 | NL | 1.02 | NL | NL |
| | 2.1.0 | 09/08 | 1.07 | NL | 1.02 | 1.05 | 1.12 | 1.01 | NL | 1.00 | NL | 1.02 | 1.02 | NL |
| | 2.2.1 | 01/09 | 1.08 | 1.02 | 1.02 | 1.05 | 1.12 | 1.01 | NL | 1.00 | NL | 1.02 | 1.02 | NL |
| | 3.0.0 | 06/09 | 1.09 | 1.02 | 1.02 | 1.05 | 1.12 | 1.01 | NL | 1.00 | 1.01 | 1.02 | 1.02 | 1.00 |
| 1G touch | 1.1 | 09/07 | 1.07 | NL | 1.02 | 1.05 | 1.12 | 1.01 | NL | 1.00 | NL | 1.02 | NL | NL |

| Model | Firmware | | Lingoes | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Vers. | Date | 0x00 | 0x01 | 0x02 | 0x03 | 0x04 | 0x05 | 0x07 | 0x08 | 0x09 | 0x0A | 0x0C | 0x0E |
| | 1.1.1 | 09/07 | 1.07 | NL | 1.02 | 1.05 | 1.12 | 1.01 | NL | 1.00 | NL | 1.02 | NL | NL |
| | 1.1.2 | 11/07 | 1.07 | NL | 1.02 | 1.05 | 1.12 | 1.01 | NL | 1.00 | NL | 1.02 | NL | NL |
| | 1.1.3 | 01/08 | 1.07 | NL | 1.02 | 1.05 | 1.12 | 1.01 | NL | 1.00 | NL | 1.02 | NL | NL |
| | 1.1.4 | 02/08 | 1.07 | NL | 1.02 | 1.05 | 1.12 | 1.01 | NL | 1.00 | NL | 1.02 | NL | NL |
| | 1.1.5 | 07/08 | 1.07 | NL | 1.02 | 1.05 | 1.12 | 1.01 | NL | 1.00 | NL | 1.02 | NL | NL |
| | 2.0 | 07/08 | 1.07 | NL | 1.02 | 1.05 | 1.12 | 1.01 | NL | 1.00 | NL | 1.02 | NL | NL |
| | 2.0.1 | 08/08 | 1.07 | NL | 1.02 | 1.05 | 1.12 | 1.01 | NL | 1.00 | NL | 1.02 | NL | NL |
| | 2.1.0 | 09/08 | 1.08 | NL | 1.02 | 1.05 | 1.12 | 1.01 | NL | 1.00 | NL | 1.02 | 1.02 | NL |
| | 3.0.0 | 06/09 | 1.09 | 1.02 | 1.02 | 1.05 | 1.12 | 1.01 | NL | 1.00 | 1.01 | 1.02 | 1.02 | 1.00 |
| iPhone 3G | 2.1.0 | 09/08 | 1.08 | 1.02 | 1.02 | 1.05 | 1.12 | 1.01 | NL | 1.00 | NL | 1.02 | 1.02 | NL |
| | 2.2.1 | 01/09 | 1.08 | 1.02 | 1.02 | 1.05 | 1.12 | 1.01 | NL | 1.00 | NL | 1.02 | 1.02 | NL |
| | 3.0.0 | 06/09 | 1.09 | 1.02 | 1.02 | 1.05 | 1.12 | 1.01 | NL | 1.00 | 1.01 | 1.02 | 1.02 | 1.00 |
| 4G nano | 1.0.2 | 09/08 | 1.08 | 1.02 | 1.03 | 1.05 | 1.14 | 1.01 | 1.01 | 1.00 | 1.01 | 1.03 | 1.02 | NL |
| | 1.0.3 | 01/09 | 1.08 | 1.02 | 1.04 | 1.05 | 1.14 | 1.01 | 1.01 | 1.00 | 1.01 | 1.03 | 1.02 | NL |
| 120 GB classic | 2.0.0 | 09/08 | 1.08 | 1.02 | 1.02 | 1.05 | 1.13 | 1.01 | 1.00 | 1.00 | NL | 1.03 | 1.02 | NL |
| | 2.0.1 | 01/09 | 1.08 | 1.02 | 1.03 | 1.05 | 1.13 | 1.01 | 1.00 | 1.00 | NL | 1.03 | 1.02 | NL |
| 2G touch | 2.1.1 | 09/08 | 1.08 | 1.02 | 1.02 | 1.05 | 1.12 | 1.01 | NL | 1.00 | 1.01 | 1.02 | 1.02 | NL |
| | 2.2.1 | 01/09 | 1.08 | 1.02 | 1.02 | 1.05 | 1.12 | 1.01 | NL | 1.01 | NL | 1.02 | 1.02 | NL |
| | 3.0.0 | 06/09 | 1.09 | 1.02 | 1.02 | 1.05 | 1.12 | 1.01 | NL | 1.00 | 1.01 | 1.02 | 1.02 | 1.00 |
| iPhone 3GS | 3.0.0 | 06/09 | 1.09 | 1.02 | 1.02 | 1.05 | 1.12 | 1.01 | NL | 1.00 | 1.01 | 1.02 | 1.02 | 1.00 |

# 9-Pin Audio/Remote Connector Commands

The commands documented in this section apply only to the 9-pin Audio/Remote connector. For the top connector microphone only, the iPod sends a `BeginRecord` command when recording is about to begin. The device microphone bias, if applicable, should already be present. iPod sends an `EndRecord` command when recording is completed. The device may remove microphone bias, if applicable, after the `EndRecord` command is received.

The iPod sends a `BeginPlayback` command when playback is about to begin. The device may then turn on its speaker amplifier, if present. Upon receipt of an `EndPlayback` command, the device must turn off its speaker amplifier. For all Microphone lingo commands sent by the iPod, no device response is expected.

## Command 0x00: BeginRecord

Direction: iPod to Device

The iPod sends this command to notify the device that audio recording has started. The device does not return a packet to the iPod in response to this command. See "Command 0x06: iPodModeChange" (page 151) for more details.

**Table F-3** `BeginRecord` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x02 | Length of packet payload |
| 3 | 0x01 | Lingo ID: Microphone lingo |
| 4 | 0x00 | Command ID: `BeginRecord` |
| 5 | 0xFD | Checksum |

## Command 0x01: EndRecord

Direction: iPod to Device

The iPod sends this command to notify the device that audio recording has ended. The device does not return a packet to the iPod in response to this command. See "Command 0x06: iPodModeChange" (page 151) for more details.

**Table F-4** `EndRecord` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x02 | Length of packet payload |
| 3 | 0x01 | Lingo ID: Microphone lingo |
| 4 | 0x01 | Command ID: `EndRecord` |
| 5 | 0xFC | Checksum |

## Command 0x02: BeginPlayback

Direction: iPod to Device

The iPod sends this command to notify the device that audio playback has started. The device does not return a packet to the iPod in response to this command. See "Command 0x06: iPodModeChange" (page 151) for more details.

**Table F-5** BeginPlayback packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x02 | Length of packet payload |
| 3 | 0x01 | Lingo ID: Microphone lingo |
| 4 | 0x02 | Command ID: BeginPlayback |
| 5 | 0xFB | Checksum |

## Command 0x03: EndPlayback

Direction: iPod to Device

The iPod sends this command to notify the device that audio playback has ended. The device does not return a packet to the iPod in response to this command. See "Command 0x06: iPodModeChange" (page 151) for more details.

**Table F-6** EndPlayback packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x02 | Length of packet payload |
| 3 | 0x01 | Lingo ID: Microphone lingo |
| 4 | 0x03 | Command ID: EndPlayback |
| 5 | 0xFA | Checksum |

# General Lingo Command 0x01: Identify (Deprecated)

Direction: Device to iPod

**This command is deprecated.** It should be used only by accessories that need to support the 3G iPod. Supporting the 3G iPod requires other special design considerations; see “Interfacing With the 3G iPod” in *iPod/iPhone Hardware Specifications.*

Accessories that use this command send it to notify the iPod that an accessory has been attached and to register the lingo it supports. Accessories should identify at boot time and any time they receive "Command 0x00: RequestIdentify" (page 64) from the iPod. The iPod does not send an `ACK` command in response.

**Note:** The `Identify` command should be used only over the UART serial port link.

Accessories should follow the identification guidelines in "Packet Signaling and Initialization Using the UART Serial Port Link" (page 48) and "iAP Signaling and Initialization Using the USB Port Link" (page 50) to guarantee they have established communication with the iPod when using this command. Accessory devices that support more than one lingo (not including the General lingo) or that plan to use the USB transport should use the IDPS process.

The `Identify` command disables all but free lingoes on the current port. For serial ports, this means lingoes 0x00, 0x02, 0x03, and 0x05 may be used, excluding authenticated commands; the USB port will be able to use only the general lingo, 0x00 (see Table 2-4 (page 54)). Devices that register with this command can use only the General lingo (0x00) commands plus those of the specific lingo that they identified, with a few exceptions. All devices may use the Simple Remote lingo (0x02) `ContextButtonStatus` command (0x00). If the identified lingo is the Extended Interface lingo (0x04), the device may also use the Display Remote lingo (0x03) commands if that lingo is not already being used by another device.

If the lingo identified by the `Identify` command can be used by only one device at a time, and that lingo is already in use by a different device, the command will fail but no command failure `ACK` command will be sent to the device. The device can verify that the `Identify` command has succeeded by sending a free command with valid parameters and checking the iPod’s response. The iPod will respond with an `ACK` response with failure status if the lingo is already in use.

This command performs lingo conflict checking to ensure that single-instance lingoes, such as Display Remote, are used on only one port at a time.

**Table F-7** `Identify` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x03 | Length of packet payload |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x01 | Command: `Identify` |

| Byte number | Value | Comment |
|---|---|---|
| 5 | 0x0N | Supported lingo. For example, if the device supports the Simple Remote lingo, this byte should be 0x02. |
| 6 | 0x*NN* | Checksum |

The `Identify` command has facilities for devices to draw more than 5 mA power from the iPod. The `Identify` command sent by such a device contains the supported lingo and the optional power bitfields described in Table F-9 (page 524). These bits define the power requirements of the device. Table F-8 (page 524) shows the format of an `Identify` command for a high-power device.

**Table F-8** `Identify` packet for high-power devices

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x06 | Packet payload length |
| 3 | 0x00 | Lingo ID: General lingo |
| 4 | 0x01 | Command: `Identify` |
| 5 | 0x05 | Supported lingo: Accessory Power lingo |
| 6 | 0x00 | Reserved: set to 0x00 |
| 7 | 0x02 | Number of valid bits in the power option flag |
| 8 | 0x0N | Option flag bits. See Table F-9 (page 524). |
| 9 | 0x*NN* | Checksum |

The option flag byte consists of bitfields. At this time, the most significant 6 bits of the option flags are reserved and should be zero. Bit 1 is defined for Apple use only and must be zero. Bit 0 should be 1 if the device requires more than 5 mA at any time. This may be the case if it is powered by the iPod.

**Table F-9** Power option bits

| Bit | Description |
|---|---|
| 0 | Power consumption requirements. Possible values are:<br>0 = device requires 5 mA or less power from iPod at all times<br>1 = device requires more than 5 mA power from iPod (up to 100mA maximum) during playback operation |
| 1 | Reserved. This bit must be set to 0 by external devices. |
| 2–7 | Reserved. Set to 0. |

# Lingo 0x06: USB Host Control Lingo

**Note: This lingo is deprecated; do not use it in new products.**

When an accessory is attached to an iPod, the iPod ordinarily acts as the USB device and the accessory acts as the USB host. The USB Host Control lingo lets the accessory switch roles with the iPod, becoming the USB device to the iPod's host. The USB Host Control lingo also automatically launches the Photo Import application on the iPod.

When an accessory identifies itself as using this lingo, the roles are switched automatically. If authentication fails or if the accessory is detached from the iPod, the iPod reverts to being the USB device.

**Note:** This lingo may be used only over the serial port link, not over the USB port link.

The accessory developer may choose to build a self-powered accessory that communicates with the iPod over USB or may choose to build a USB dongle similar to the Apple iPod Camera Connector.

Table F-10 (page 525) summarizes the USB Host Control commands.

**Table F-10** USB Host Control lingo command summary

| Command | ID | Direction | Data length | Protocol version | Authentication required |
|---|---|---|---|---|---|
| `ACK` (command/status) | 0x00 | Dev to iPod | 4 | 1.00 | Yes |
| `GetUSBPowerState` | 0x01 | iPod to Dev | 2 | 1.00 | Yes |
| `RetUSBPowerState` | 0x02 | Dev to iPod | 3 | 1.00 | Yes |
| `SetUSBPowerState` | 0x03 | iPod to Dev | 3 | 1.00 | Yes |
| Reserved | 0x04–0xFF | N/A | N/A | N/A | N/A |

Selected Host Control lingo command timeout information and the number of times the command tries to execute are shown in Table F-11 (page 525).

**Table F-11** Select Host Control command timings

| Lingo | Command | Timeout | Tries |
|---|---|---|---|
| USB Host Control (0x06) | `GetUsbPowerState` (0x01) | 500 ms | 1 |
| | `SetUsbPowerState` (0x03) | 500 ms | 1 |

## Command History of the USB Host Control Lingo

Table F-12 (page 526) shows the history of changes to the USB Host Control lingo.

**Table F-12** USB Host Control lingo command history

| Lingo version | Command changes | Features |
|---|---|---|
| 1.00 | Add: 0x00–0x03 | USB power state support |

# Command 0x00: ACK

Direction: Device to iPod

This command is sent by the device in response to a command received from the iPod. It reports the original command number and the status of the command.

**Table F-13** `ACK` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x04 | Length of packet |
| 3 | 0x06 | Lingo ID: USB Host Control lingo |
| 4 | 0x00 | Command ID: `ACK` |
| 5 | 0x*NN* | Command status (see Table 3-28 (page 169)) |
| 6 | 0x*NN* | ID of the command being acknowledged |
| 7 | 0x*NN* | Checksum |

# Command 0x01: GetUSBPowerState

Direction: iPod to Device

This command is sent by the iPod to obtain the device's current USB power state. In response, the device must send a `RetUSBPowerState` command with the current USB power setting.

**Table F-14** `GetUSBPowerState` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x02 | Length of packet |
| 3 | 0x06 | Lingo ID: USB Host Control lingo |

| Byte number | Value | Comment |
|---|---|---|
| 4 | 0x01 | Command ID: `GetUSBPowerState` |
| 5 | 0xF7 | Checksum |

## Command 0x02: RetUSBPowerState

Direction: Device to iPod

This command is sent by the device in response to a `GetUSBPowerState` command received from the iPod. It returns the current state of the USB power supply.

**Table F-15** `RetUSBPowerState` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x03 | Length of packet |
| 3 | 0x06 | Lingo ID: USB Host Control lingo |
| 4 | 0x02 | Command ID: `RetUSBPowerState` |
| 5 | 0x*NN* | Current power state (zero for off, nonzero for on) |
| 6 | 0x*NN* | Checksum |

## Command 0x03: SetUSBPowerState

Direction: iPod to Device

This command is sent by the iPod to set the device's USB power state. The device must set the USB power state and respond with an `ACK` command indicating command completion.

**Table F-16** `SetUSBPowerState` packet

| Byte number | Value | Comment |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet (SOP) |
| 2 | 0x03 | Length of packet |
| 3 | 0x06 | Lingo ID: USB Host Control lingo |
| 4 | 0x03 | Command ID: `SetUSBPowerState` |

| Byte number | Value | Comment |
| --- | --- | --- |
| 5 | 0x*NN* | Power state to be set (zero for off, nonzero for on) |
| 6 | 0x*NN* | Checksum |

# Deprecated Extended Interface Commands

The commands in this section have been replaced by commands in the iAP General lingo (Lingo 0x00).

## Command 0x0012: RequestProtocolVersion

Direction: Device to iPod

**Note:** This command is deprecated except for use by accessories supporting 3G iPods. Use the General lingo (0x00) command 0x0F, `RequestLingoProtocolVersion`, instead.

Requests the version of the running protocol from the iPod. The iPod responds with a "Command 0x0013: ReturnProtocolVersion" (page 528) command.

**Note:** This command requests the Extended Interface protocol version, not the iPod software version.

**Table F-17** `RequestProtocolVersion` command

| Byte number | Value | Meaning |
| --- | --- | --- |
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x03 | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x12 | Command ID (bits 7:0) |
| 6 | 0xE7 | Packet payload checksum byte |

## Command 0x0013: ReturnProtocolVersion

Direction: iPod to Device

**Note:** This command is deprecated except for use by accessories supporting 3G iPods. Use the General lingo (0x00) command 0x10, `ReturnLingoProtocolVersion`, instead.

Returns the iPod Extended Interface protocol version number. The iPod sends this command in response to the "Command 0x0012: RequestProtocolVersion" (page 528) command from the device. The major version number specifies the protocol version digits to the left of the decimal point; the minor version number specifies the digits to the right of the decimal point. For example, a major version number of 0x01 and a minor version number of 0x08 represents an Extended Interface protocol version of 1.08. This protocol information is also available through the General lingo (lingo 0x00) command `RequestLingoProtocolVersion` when passing lingo 0x04 as the lingo parameter.

**Note:** This command returns the Extended Interface protocol version, not the iPod software version.

**Table F-18** `ReturnProtocolVersion` command

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x05 | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x13 | Command ID (bits 7:0) |
| 6 | 0x*NN* | Protocol major version number |
| 7 | 0x*NN* | Protocol minor version number |
| 8 | 0x*NN* | Packet payload checksum byte |

## Command 0x0014: RequestiPodName

Direction: Device to iPod

**Note:** This command is deprecated except for use by accessories supporting 3G iPods. Use the General lingo (0x00) command 0x07, `RequestiPodName`, instead.

Returns the name of the user's iPod or "iPod" if the iPod name is undefined. This allows the iPod name to be shown in the human-machine interface (HMI) of the interfacing body. The iPod responds with the "Command 0x0015: ReturniPodName" (page 530) command containing the iPod name text string.

**Table F-19** `RequestiPodName` command

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x03 | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x14 | Command ID (bits 7:0) |
| 6 | 0xE5 | Packet payload checksum byte |

## Command 0x0015: ReturniPodName

Direction: iPod to Device

> **Note:** This command is deprecated except for use by accessories supporting 3G iPods. Use the General lingo (0x00) command 0x08, `ReturniPodName`, instead.

The iPod sends this command in response to the "Command 0x0014: RequestiPodName" (page 529) command from the device. The iPod name is encoded as a null-terminated UTF-8 character array. The iPod name string is not limited to 252 characters; it may be sent in small or large packet format. The small packet format is shown.

> **Note:** Starting with version 1.07 of the Extended Interface lingo, the `ReturniPodName` command on Windows-formatted iPods returns the iTunes name of the iPod instead of the Windows volume name.

**Table F-20** `ReturniPodName` command

| Byte number | Value | Meaning |
|---|---|---|
| 0 | 0xFF | Sync byte (required only for UART serial) |
| 1 | 0x55 | Start of packet |
| 2 | 0x*NN* | Packet payload length |
| 3 | 0x04 | Lingo ID: Extended Interface lingo |
| 4 | 0x00 | Command ID (bits 15:8) |
| 5 | 0x15 | Command ID (bits 7:0) |
| 6…*N* | 0x*NN* | iPod name as UTF-8 character array |

| Byte number | Value | Meaning |
|---|---|---|
| (last byte) | 0x*NN* | Packet payload checksum byte |

# Authentication 1.0 Sample Command Sequence

For legacy purposes, Table F-21 (page 531) shows the process implemented by some existing devices, using authentication 1.0. This process is not supported for new device designs.

**Table F-21** Legacy accessory authentication

| Step | Action or command | Direction | Comments |
|---|---|---|---|
| 1 | `IdentifyDeviceLingoes` (0x13) | Device to iPod | The accessory identifies itself, lists its supported lingoes, and requests authentication. It can request immediate authentication or it can defer authentication until it tries to use restricted lingoes or commands. |
| 2 | `ACK` (0x02) | iPod to Device | The iPod acknowledges receipt of `IdentifyDeviceLingoes`. |
| 5 | `GetDevAuthenticationInfo` (0x14) | iPod to Device | The iPod requests accessory authentication information and starts its timeout timer. |
| 6 | `RetDevAuthenticationInfo` (0x15) | Device to iPod | The accessory returns its major and minor authentication version. |
| 7 | `AckDevAuthenticationInfo` (0x16) | iPod to Device | The iPod returns the status of its check of the authentication version. If it does not support the authentication version, the iPod sends a value of 0x08 to the accessory. |
| The iPod lingoes and commands are enabled after the authentication version is validated. | | | |
| 8 | `GetAccessoryInfo` (0x27) | iPod to Device | The iPod queries the accessory for information about it. |
| 9 | `RetAccessoryInfo` (0x28) | Device to iPod | The accessory returns information about its identity and capabilities. |
| 10 | `GetDevAuthenticationSignature` (0x17) | iPod to Device | The iPod sends a 16-byte random challenge to the accessory and asks it to calculate a digital signature. |
| 11 | `RetDevAuthenticationSignature` (0x18) | Device to iPod | The accessory returns its digital signature to the iPod within 7.5 seconds. |
| 12 | `AckDevAuthenticationStatus` (0x19) | iPod to Device | The iPod verifies the signature by deriving a public key from the Device ID and returns the status of signature verification. |

# Accessory Identification With Non-IDPS iPods

Some models of iPods and iPhones do not support IDPS. Every accessory must always start its identification process by sending `StartIDPS`; if the iPod's `ACK` response passes a `status` value of 0x04 (Bad Parameter), the accessory may revert to an identification process using `IdentifyDeviceLingoes`.

> **Note:** The accessory must send `IdentifyDeviceLingoes` within 800 ms of receiving the iPod's `ACK` response.

The sample command listings in this section illustrate various forms of the identification process using `IdentifyDeviceLingoes`:

- Table F-22 (page 532) shows the basic process for accessories that communicate using the UART port link.
- Table F-23 (page 534) shows the basic process for accessories that communicate using USB or Bluetooth.
- Table F-24 (page 535) lists sample commands for an accessory that supports the General and Extended Interface lingoes. For Extended Interface command details, see "The Extended Interface Protocol" (page 341).
- Table F-25 (page 539) lists sample commands for an accessory that supports the General, Simple Remote, and Display Remote lingoes.
- Table F-26 (page 542) lists sample commands for an accessory that supports the General, Simple Remote, Display Remote, and Digital Audio lingoes.
- Table F-27 (page 545) shows a sample sequence of commands that implements radio tagging in an accessory. See "iTunes Tagging" (page 463).
- Table F-28 (page 548) shows a sample sequence of commands that implements the Nike + iPod cardio equipment system in an accessory. See "Nike + iPod Cardio Equipment System" (page 495).

**Table F-22** UART accessory identification with non-IDPS iPods

| Step | Action or command | Direction | Comments |
|---|---|---|---|
| 1 | Wait 80 ms after the iPod turns on Accessory Power (pin 13 in "Hardware Interfaces" in *iPod/iPhone Hardware Specifications*) | Device | Wait for the iPod's internal bootstrap and wakeup. If the iPod is in Sleep mode, the accessory must repeat Steps 1-5 until the iPod wakes and the accessory receives an `ACK` command. |
| 2 | Send sync byte (0xFF) | Device to iPod | Allow iPod to synchronize to the device's baud rate. |
| 3 | Wait 20 ms | Device | |
| 4 | `StartIDPS` (0x38) | Device to iPod | The accessory sends `StartIDPS` to start the identification process specified in "Accessory Identification" (page 445). |

| Step | Action or command | Direction | Comments |
|---|---|---|---|
| 5 | Wait up to 1 second | Device | The device waits for the iPod to send an ACK command acknowledging receipt of StartIDPS. |
| 6 | ACK (0x02) of StartIDPS | iPod to Device | The iPod sends a status of 0x04 (Bad Parameter) to indicate that it does not support IDPS; see Table 2-1 (page 48), Step 6. |
| 7 | IdentifyDevice-Lingoes (0x13) | Device to iPod | The accessory sends IdentifyDevice-Lingoes with the lingo mask set to only the General lingo, the option bit mask set to 0x0, and the Device ID set to 0x0. This cancels any active authentication process, as detailed in "Cancelling a Current Authentication Process With IdentifyDeviceLingoes" (page 83). |
| 8 | Wait up to 1 second | Device | The device waits for the iPod to send an ACK command acknowledging receipt of IdentifyDeviceLingoes. |
| 9 | ACK (0x02) of IdentifyDevice-Lingoes | iPod to Device | The iPod sends a status of 0x00 (OK) to acknowledge receipt of the empty IdentifyDeviceLingoes command. |
| If the iPod does not send an ACK command within 1 second, it may be a 3G iPod. In this case, if the accessory needs to support the 3G iPod and it is using UART communication, in may retry Step A up to 3 times, for a total elapsed time of 3 seconds. If the accessory does not receive an ACK command after the third try, it may either quit or send an Identify command to achieve limited use of iAP. See General Lingo Command 0x01: Identify (Deprecated) (page 523) and "Interfacing With the 3G iPod" in *iPod/iPhone Hardware Specifications*. | | | |
| 10 | GetAccessoryInfo (0x27) | iPod to Device | The iPod queries the accessory for information about it. |
| 11 | RetAccessoryInfo (0x28) | Device to iPod | The accessory returns an empty string. Because the device immediately sends a second IdentifyDeviceLingoes command (Step 9), the iPod may acknowledge the RetAccessoryInfo command with an ACK command indicating an error status. The device must ignore this acknowledgment. |
| 12 | IdentifyDevice-Lingoes (0x13) | Device to iPod | The accessory sends a second IdentifyDeviceLingoes command, specifying which lingoes it supports and requesting immediate authentication (see "Authentication" (page 52)). |

| Step | Action or command | Direction | Comments |
|---|---|---|---|
| 13 | ACK (0x02) of IdentifyDevice-Lingoes | iPod to Device | The iPod acknowledges receipt of the second IdentifyDeviceLingoes command. |
| The iPod or iPhone now initiates the authentication process by sending a GetDevAuthenticationInfo command to the accessory, as shown in Table 2-5 (page 55). | | | |

**Table F-23** USB or BT accessory identification with non-IDPS iPods

| Step | Action or command | Direction | Comments |
|---|---|---|---|
| 1 | StartIDPS (0x38) | Device to iPod | The accessory sends StartIDPS to start the identification process specified in "Accessory Identification" (page 445). |
| 2 | Wait up to 1 second | Device | The device waits for the iPod to send an ACK command acknowledging receipt of StartIDPS. |
| 3 | ACK (0x02) of StartIDPS | iPod to Device | The iPod sends a status of 0x04 (Bad Parameter) to indicate that it does not support IDPS; see Table 2-2 (page 51), Step 3. |
| 4 | IdentifyDevice-Lingoes (0x13) | Device to iPod | The accessory sends IdentifyDeviceLingoes with the lingo mask set to only the General lingo, the option bit mask set to 0x0, and the Device ID set to 0x0. This cancels any active authentication process, as detailed in "Cancelling a Current Authentication Process With IdentifyDeviceLingoes" (page 83). |
| 5 | Wait up to 1 second | Device | The device waits for the iPod to send an ACK command acknowledging receipt of IdentifyDeviceLingoes. |
| 6 | ACK (0x02) of IdentifyDevice-Lingoes | iPod to Device | The iPod sends a status of 0x00 (OK) to acknowledge receipt of the empty IdentifyDeviceLingoes command. |
| 7 | GetAccessoryInfo (0x27) | iPod to Device | The iPod queries the accessory for information about it. |
| 8 | RetAccessoryInfo (0x28) | Device to iPod | The accessory returns an empty string. Because the device immediately sends a second IdentifyDeviceLingoes command (Step 9), the iPod may acknowledge the RetAccessoryInfo command with an ACK command indicating an error status. The device must ignore this acknowledgment. |

| Step | Action or command | Direction | Comments |
|---|---|---|---|
| 9 | IdentifyDevice-Lingoes (0x13) | Device to iPod | The accessory sends a second IdentifyDevice-Lingoes command, specifying which lingoes it supports and requesting immediate authentication (see "Authentication" (page 52)). |
| 10 | ACK (0x02) of IdentifyDevice-Lingoes | iPod to Device | The iPod acknowledges receipt of the second IdentifyDeviceLingoes command. |
| The iPod or iPhone now initiates the authentication process by sending a GetDevAuthenticationInfo command to the accessory, as shown in Table 2-5 (page 55). | | | |

**Table F-24** Non-IDPS identification of lingoes 0x00+0x04

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| Steps A–D cancel any current authentication process; see "Cancelling a Current Authentication Process With IdentifyDeviceLingoes" (page 83). Step B also detects if the attached iPod is a 3G iPod. | | | |
| A | IdentifyDevice-Lingoes | | identifying lingo 'General'; options none; device ID 0x00000000 |
| The accessory waits up to 1 second for the iPod to respond. | | | |
| B | | ACK | acknowledging 'Success (OK)' to command 'General Lingo::IdentifyDeviceLingoes' |
| If the iPod does not send an ACK command within 1 second, it may be a 3G iPod. In this case, if the accessory needs to support the 3G iPod and it is using UART communication, in may retry Step A up to 3 times, for a total elapsed time of 3 seconds. If the accessory does not receive an ACK command after the third try, it may either quit or send an Identify command to achieve limited use of iAP. See General Lingo Command 0x01: Identify (Deprecated) (page 523) and "Interfacing With the 3G iPod" in *iPod/iPhone Hardware Specifications*. | | | |
| C | | GetAccessoryInfo | no params |
| D | RetAccessoryInfo | | returning an empty string |
| The accessory is now assured that it can successfully identify its lingoes to the attached iPod or iPhone. | | | |
| 1 | IdentifyDevice-Lingoes | | identifying lingoes 'General\|Extended Interface'; options 'auth:immediate; power:low; device ID 0x00000200 |
| 2 | | ACK | acknowledging 'Success (OK)' to command 'General Lingo::IdentifyDeviceLingoes' |
| 3 | | GetDevAuthentication-Info | no params |

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| 4 | RetDevAuthentication-Info | | returning auth protocol v2.0; section: 0/1; |
| 5 | | ACK | acknowledging 'Success (OK)' to command 'General Lingo::RetDevAuthenticationInfo' |
| 6 | RetDevAuthentication-Info | | returning auth protocol v2.0; section: 1/1; |
| 7 | | AckDevAuthentication-Info | acknowledging 'auth info supported' |
| 8 | | GetAccessoryInfo | requesting 'Acc info capabilities' |
| 9 | | GetDevAuthentication-Signature | offering challenge |
| 10 | RetAccessoryInfo | | returning 'Acc info capabilities\|Acc name\|Acc FW version\|Acc HW version\|Acc manufacturer\|Acc model number\|Acc serial number\|Acc incoming max packet size' in response to 'Acc info capabilities' |
| 11 | | GetAccessoryInfo | requesting 'Acc name' |
| 12 | RetDevAuthentication-Signature | | returning signature |
| 13 | RetAccessoryInfo | | returning 'Apple' in response to 'Acc name' |
| 14 | | AckDevAuthentication-Status | acknowledging authentication status 'Success (OK)' |
| 15 | | GetAccessoryInfo | requesting 'Acc FW version' |
| 16 | RetAccessoryInfo | | returning 'v9.8.7' in response to 'Acc FW version' |
| 17 | | GetAccessoryInfo | requesting 'Acc HW version' |
| 18 | RetAccessoryInfo | | returning 'v1.2.3' in response to 'Acc HW version' |
| 19 | | GetAccessoryInfo | requesting 'Acc manufacturer' |
| 20 | RetAccessoryInfo | | returning 'Apple Inc.' in response to 'Acc manufacturer' |
| 21 | | GetAccessoryInfo | requesting 'Acc model number' |

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| 22 | RetAccessoryInfo | | returning 'ModelNumber-XYZ' in response to 'Acc model number' |
| 23 | | GetAccessoryInfo | requesting 'Acc serial number' |
| 24 | RetAccessoryInfo | | returning 'SerialNumber-1234' in response to 'Acc serial number' |
| 25 | | GetAccessoryInfo | requesting 'Acc incoming max packet size' |
| 26 | RetAccessoryInfo | | returning '1024 bytes' in response to 'Acc incoming max packet size' |
| 27 | EnterRemoteUIMode | | no params |
| 28 | | ACK | acknowledging 'Command Pending (max wait time: 3000 ms)' to command 'General Lingo::EnterRemoteUIMode' |
| 29 | | ACK | acknowledging 'Success (OK)' to command 'General Lingo::EnterRemoteUIMode' |
| 30 | RequestRemoteUIMode | | no params |
| 31 | | ReturnRemoteUIMode | returning 'Extended Interface Mode' |
| 32 | ResetDBSelection | | no params |
| 33 | | ACK | acknowledging 'Success (OK)' to command 'Extended Interface Lingo::ResetDBSelection' |
| 34 | GetNumberCategorized-DBRecords | | for category 'Playlist' |
| 35 | | ReturnNumber-CategorizedDBRecords | returning 'record count 22' |
| 36 | RetrieveCategorized-DatabaseRecords | | requesting 'category Playlist\|record start index 0\|record read count 4' |
| 37 | | ReturnCategorized-DatabaseRecord | returning 'record category index 0\|MyiPhone |
| 38 | | ReturnCategorized-DatabaseRecord | returning 'record category index 1\|Purchased |
| 39 | | ReturnCategorized-DatabaseRecord | returning 'record category index 2\|Against Doctor's Orders |

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| 40 | | ReturnCategorized-DatabaseRecord | returning 'record category index 3\|Always In Your Mind |
| 41 | SelectDBRecord | | selecting 'type Playlist\|record index 3 |
| 42 | | ACK | acknowledging 'Success (OK)' to command 'Extended Interface Lingo::SelectDBRecord' |
| 43 | PlayCurrentSelection | | playing selection track index 0 |
| 44 | | ACK | acknowledging 'Success (OK)' to command 'Extended Interface Lingo::PlayCurrentSelection' |
| 45 | SetPlayStatusChange-Notification | | setting 'basic play state changes\|track index' |
| 46 | | ACK | acknowledging 'Success (OK)' to command 'Extended Interface Lingo::SetPlayStatusChangeNotification' |
| 47 | PlayControl | | sending 'Toggle Play/Pause' |
| 48 | | ACK | acknowledging 'Success (OK)' to command 'Extended Interface Lingo::PlayControl' |
| 49 | PlayControl | | sending 'Next Track' |
| 50 | | ACK | acknowledging 'Success (OK)' to command 'Extended Interface Lingo::PlayControl' |
| 51 | | PlayStatusChange-Notification | notifying new play status 'playback track changed' (new track record index 1) |
| 52 | PlayControl | | sending 'Toggle Play/Pause' |
| 53 | | ACK | acknowledging 'Success (OK)' to command 'Extended Interface Lingo::PlayControl' |
| 54 | SetCurrentPlaying-Track | | setting currently playing track to 3 |
| 55 | | ACK | acknowledging 'Success (OK)' to command 'Extended Interface Lingo::SetCurrentPlayingTrack' |
| 56 | | PlayStatusChange-Notification | notifying new play status 'playback track changed' (new track record index 3) |

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| 57 | GetPlayStatus | | no params |
| 58 | | ReturnPlayStatus | returning 'Playing\|track length 155506 ms\|track position 15637 ms' |
| 59 | GetIndexedPlaying-TrackTitle | | requesting title name for track index 3 |
| 60 | | ReturnIndexedPlaying-TrackTitle | returning Auld Lang Syne |
| 61 | GetIndexedPlaying-TrackArtistName | | requesting artist name for track index 3 |
| 62 | | ReturnIndexedPlaying-TrackArtistName | returning Straight No Chaser |
| 63 | GetIndexedPlaying-TrackAlbumName | | requesting album name for track index 3 |
| 64 | | ReturnIndexedPlaying-TrackAlbumName | returning Holiday Spirits (Bonus Track Version) |
| 65 | ExitRemoteUIMode | | no params |
| 66 | | ACK | acknowledging 'Command Pending (max wait time: 3000 ms)' to command 'General Lingo::ExitRemoteUIMode' |
| 67 | | ACK | acknowledging 'Success (OK)' to command 'General Lingo::ExitRemoteUIMode' |

**Table F-25** Non-IDPS identification of lingoes 0x00+0x02+0x03

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| Steps A–D cancel any current authentication process; see "Cancelling a Current Authentication Process With IdentifyDeviceLingoes" (page 83). Step B also detects if the attached iPod is a 3G iPod. | | | |
| A | IdentifyDevice-Lingoes | | identifying lingo 'General'; options none; device ID 0x00000000 |
| The accessory waits up to 1 second for the iPod to respond. | | | |
| B | | ACK | acknowledging 'Success (OK)' to command 'General Lingo::IdentifyDeviceLingoes' |

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| If the iPod does not send an ACK command within 1 second, it may be a 3G iPod. In this case, if the accessory needs to support the 3G iPod and it is using UART communication, in may retry Step A up to 3 times, for a total elapsed time of 3 seconds. If the accessory does not receive an ACK command after the third try, it may either quit or send an Identify command to achieve limited use of iAP. See General Lingo Command 0x01: Identify (Deprecated) (page 523) and "Interfacing With the 3G iPod" in *iPod/iPhone Hardware Specifications*. | | | |
| C | | GetAccessoryInfo | no params |
| D | RetAccessoryInfo | | returning an empty string |
| The accessory is now assured that it can successfully identify its lingoes to the attached iPod or iPhone. | | | |
| 1 | IdentifyDevice-Lingoes | | identifying lingoes 'General\|Simple Remote\|Display Remote'; options 'auth:immediate; power:low; device ID 0x00000200 |
| 2 | | ACK | acknowledging 'Success (OK)' to command 'General Lingo::IdentifyDeviceLingoes' |
| 3 | | GetDevAuthentication-Info | no params |
| 4 | RetDevAuthentication-Info | | returning auth protocol v2.0; section: 0/1; |
| 5 | | ACK | acknowledging 'Success (OK)' to command 'General Lingo::RetDevAuthenticationInfo' |
| 6 | RetDevAuthentication-Info | | returning auth protocol v2.0; section: 1/1; |
| 7 | | AckDevAuthentication-Info | acknowledging 'auth info supported' |
| 8 | | GetAccessoryInfo | requesting 'Acc info capabilities' |
| 9 | | GetDevAuthentication-Signature | offering challenge |
| 10 | RetAccessoryInfo | | returning 'Acc info capabilities\|Acc name\|Acc FW version\|Acc HW version\|Acc manufacturer\|Acc model number\|Acc serial number\|Acc incoming max packet size' in response to 'Acc info capabilities' |
| 11 | | GetAccessoryInfo | requesting 'Acc name' |

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| 12 | RetDevAuthentication-Signature | | returning signature |
| 13 | RetAccessoryInfo | | returning 'Apple' in response to 'Acc name' |
| 14 | | AckDevAuthentication-Status | acknowledging authentication status 'Success (OK)' |
| 15 | | GetAccessoryInfo | requesting 'Acc FW version' |
| 16 | RetAccessoryInfo | | returning 'v9.8.7' in response to 'Acc FW version' |
| 17 | | GetAccessoryInfo | requesting 'Acc HW version' |
| 18 | RetAccessoryInfo | | returning 'v1.2.3' in response to 'Acc HW version' |
| 19 | | GetAccessoryInfo | requesting 'Acc manufacturer' |
| 20 | RetAccessoryInfo | | returning 'Apple Inc.' in response to 'Acc manufacturer' |
| 21 | | GetAccessoryInfo | requesting 'Acc model number' |
| 22 | RetAccessoryInfo | | returning 'ModelNumber-XYZ' in response to 'Acc model number' |
| 23 | | GetAccessoryInfo | requesting 'Acc serial number' |
| 24 | RetAccessoryInfo | | returning 'SerialNumber-1234' in response to 'Acc serial number' |
| 25 | | GetAccessoryInfo | requesting 'Acc incoming max packet size' |
| 26 | RetAccessoryInfo | | returning '1024 bytes' in response to 'Acc incoming max packet size' |
| 27 | SetRemoteEvent-Notification | | setting 'Track playback index\|Play status' |
| 28 | | ACK | acknowledging 'Success (OK)' to command 'Display Remote Lingo::SetRemoteEventNotification' |
| 29 | GetIndexedPlaying-TrackInfo | | getting info type 'Track title' for track index 0 and chapter index 0 |
| 30 | | RetIndexedPlaying-TrackInfo | returning 'Always In Your Mind' for info type 'Track title' |

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| 31 | GetPlayStatus | | no params |
| 32 | | RetPlayStatus | returning 'Playback paused\|index 3\|length 155506 ms\|position 84933 ms' |
| 33 | ContextButtonStatus | | sending status 'Play/Pause' |
| 34 | ContextButtonStatus | | sending status 'All buttons up' |
| 35 | | RemoteEvent-Notification | reporting status 'Playing' for parameter 'Play status' |
| 36 | GetPlayStatus | | no params |
| 37 | | RetPlayStatus | returning 'Playing\|index 3\|length 155506 ms\|position 91644 ms' |
| 38 | ContextButtonStatus | | sending status 'Next Track' |
| 39 | ContextButtonStatus | | sending status 'All buttons up' |
| 40 | | RemoteEvent-Notification | reporting status 'index 4' for parameter 'Track playback index' |
| 41 | SetCurrentPlaying-Track | | setting index 0 |
| 42 | | ACK | acknowledging 'Success (OK)' to command 'Display Remote Lingo::SetCurrentPlayingTrack' |
| 43 | | RemoteEvent-Notification | reporting status 'index 0' for parameter 'Track playback index' |
| 44 | GetIndexedPlaying-TrackInfo | | getting info type 'Track title' for track index 0 and chapter index 0 |
| 45 | | RetIndexedPlaying-TrackInfo | returning 'Always In Your Mind' for info type 'Track title' |

**Table F-26** Non-IDPS identification of lingoes 0x00+0x02+0x03+0x0A

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| Steps A–D cancel any current authentication process; see "Cancelling a Current Authentication Process With IdentifyDeviceLingoes" (page 83). Step B also detects if the attached iPod is a 3G iPod. | | | |
| A | IdentifyDevice-Lingoes | | identifying lingo 'General'; options none; device ID 0x00000000 |
| The accessory waits up to 1 second for the iPod to respond. | | | |

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| B | | ACK | acknowledging 'Success (OK)' to command 'General Lingo::IdentifyDeviceLingoes' |
| If the iPod does not send an ACK command within 1 second, it may be a 3G iPod. In this case, if the accessory needs to support the 3G iPod and it is using UART communication, in may retry Step A up to 3 times, for a total elapsed time of 3 seconds. If the accessory does not receive an ACK command after the third try, it may either quit or send an Identify command to achieve limited use of iAP. See General Lingo Command 0x01: Identify (Deprecated) (page 523) and "Interfacing With the 3G iPod" in *iPod/iPhone Hardware Specifications*. | | | |
| C | | GetAccessoryInfo | no params |
| D | RetAccessoryInfo | | returning an empty string |
| The accessory is now assured that it can successfully identify its lingoes to the attached iPod or iPhone. | | | |
| 1 | IdentifyDevice-Lingoes | | identifying lingoes 'General\| Simple Remote\| Display Remote\| Digital Audio'; options 'auth:immediate; power:low; device ID 0x00000200 |
| 2 | | ACK | acknowledging 'Success (OK)' to command 'General Lingo::IdentifyDeviceLingoes' |
| 3 | | GetDevAuthentication-Info | no params |
| 4 | RetDevAuthentication-Info | | returning auth protocol v2.0; section: 0/1; |
| 5 | | ACK | acknowledging 'Success (OK)' to command 'General Lingo::RetDevAuthenticationInfo' |
| 6 | RetDevAuthentication-Info | | returning auth protocol v2.0; section: 1/1; |
| 7 | | AckDevAuthentication-Info | acknowledging 'auth info supported' |
| 8 | | GetAccSampleRateCaps | no params |
| 9 | | GetAccessoryInfo | requesting 'Acc info capabilities' |
| 10 | | GetDevAuthentication-Signature | offering challenge |
| 11 | RetAccSampleRateCaps | | returning sample rates '8000\| 11025\| 12000\| 16000\| 22050\| 24000\| 32000\| 44100\| 48000' |

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| 12 | RetAccessoryInfo | | returning 'Acc info capabilities\| Acc name\| Acc FW version\| Acc HW version\| Acc manufacturer\| Acc model number\| Acc serial number\| Acc incoming max packet size' in response to 'Acc info capabilities' |
| 13 | RetDevAuthentication-Signature | | returning signature |
| 14 | | GetAccessoryInfo | requesting 'Acc name' |
| 15 | RetAccessoryInfo | | returning 'Apple' in response to 'Acc name' |
| 16 | | NewiPodTrackInfo | sample rate 44100; Sound Check value 0; track volume adjustment 0 |
| 17 | AccAck | | acknowledging 'Success (OK)' to command 'Digital Audio Lingo::NewiPodTrackInfo' |
| 18 | | AckDevAuthentication-Status | acknowledging authentication status 'Success (OK)' |
| 19 | | GetAccessoryInfo | requesting 'Acc FW version' |
| 20 | RetAccessoryInfo | | returning 'v9.8.7' in response to 'Acc FW version' |
| 21 | | GetAccessoryInfo | requesting 'Acc HW version' |
| 22 | RetAccessoryInfo | | returning 'v1.2.3' in response to 'Acc HW version' |
| 23 | | GetAccessoryInfo | requesting 'Acc manufacturer' |
| 24 | RetAccessoryInfo | | returning 'Apple Inc.' in response to 'Acc manufacturer' |
| 25 | | GetAccessoryInfo | requesting 'Acc model number' |
| 26 | RetAccessoryInfo | | returning 'ModelNumber-XYZ' in response to 'Acc model number' |
| 27 | | GetAccessoryInfo | requesting 'Acc serial number' |
| 28 | RetAccessoryInfo | | returning 'SerialNumber-1234' in response to 'Acc serial number' |
| 29 | | GetAccessoryInfo | requesting 'Acc incoming max packet size' |

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| 30 | RetAccessoryInfo | | returning '1024 bytes' in response to 'Acc incoming max packet size' |

**Table F-27** Non-IDPS radio tagging command sequence

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| Steps A–D cancel any current authentication process; see "Cancelling a Current Authentication Process With IdentifyDeviceLingoes" (page 83). Step B also detects if the attached iPod is a 3G iPod. | | | |
| A | IdentifyDevice-Lingoes | | identifying lingo 'General'; options none; device ID 0x00000000 |
| The accessory waits up to 1 second for the iPod to respond. | | | |
| B | | ACK | acknowledging 'Success (OK)' to command 'General Lingo::IdentifyDeviceLingoes' |
| If the iPod does not send an ACK command within 1 second, it may be a 3G iPod. In this case, if the accessory needs to support the 3G iPod and it is using UART communication, in may retry Step A up to 3 times, for a total elapsed time of 3 seconds. If the accessory does not receive an ACK command after the third try, it may either quit or send an Identify command to achieve limited use of iAP. See General Lingo Command 0x01: Identify (Deprecated) (page 523) and "Interfacing With the 3G iPod" in *iPod/iPhone Hardware Specifications*. | | | |
| C | | GetAccessoryInfo | no params |
| D | RetAccessoryInfo | | returning an empty string |
| The accessory is now assured that it can successfully identify its lingoes to the attached iPod or iPhone. | | | |
| 1 | IdentifyDevice-Lingoes | | identifying lingoes 'General'; options 'auth:none; power:low'; device ID 0x00000000 |
| 2 | | ACK | acknowledging 'Success (OK)' to command 'General Lingo::IdentifyDeviceLingoes' |
| 3 | GetiPodOptions | | no params |
| 4 | | RetiPodOptions | returning 'video output\|line out' |
| 5 | RequestLingoProtocol-Version | | requesting General Lingo version |
| 6 | | ReturnLingoProtocol-Version | returning General Lingo v1.09 |
| 7 | RequestLingoProtocol-Version | | requesting Storage Lingo version |

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| 8 | | ReturnLingoProtocol-Version | returning Storage Lingo v1.02 |
| 9 | IdentifyDevice-Lingoes | | identifying lingoes 'General\|Storage'; options 'auth:immediate; power:low'; device ID 0x00000200 |
| 10 | | ACK | acknowledging 'Success (OK)' to command 'General Lingo::IdentifyDeviceLingoes' |
| 11 | | GetDevAuthentication-Info | no params |
| 12 | RetDevAuthentication-Info | | returning auth protocol v2.0; section: 0/1; cert data: ... |
| 13 | | ACK | acknowledging 'Success (OK)' to command 'General Lingo::RetDevAuthenticationInfo' |
| 14 | RetDevAuthentication-Info | | returning auth protocol v2.0; section: 1/1; cert data: ... |
| 15 | | AckDevAuthentication-Info | acknowledging 'auth info supported' |
| 16 | | GetAccessoryInfo | requesting 'Acc info capabilities' |
| 17 | | GetDevAuthentication-Signature | offering challenge '...' with retry counter 1 |
| 18 | RetDevAuthentication-Signature | | returning signature '...' |
| 19 | | AckDevAuthentication-Status | acknowledging authentication status 'Success (OK)' |
| 20 | RetAccessoryInfo | | returning 'Acc info capabilities\|Acc name\|Acc FW version\|Acc HW version\|Acc manufacturer\|Acc model number\|Acc incoming max packet size' in response to 'Acc info capabilities' |
| 21 | | GetAccessoryInfo | requesting 'Acc name' |
| 22 | RetAccessoryInfo | | returning 'Radio' in response to 'Acc name' |
| 23 | | GetAccessoryInfo | requesting 'Acc FW version' |

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| 24 | RetAccessoryInfo | | returning 'v1.0.0' in response to 'Acc FW version' |
| 25 | | GetAccessoryInfo | requesting 'Acc HW version' |
| 26 | RetAccessoryInfo | | returning 'v1.0.0' in response to 'Acc HW version' |
| 27 | | GetAccessoryInfo | requesting 'Acc manufacturer' |
| 28 | RetAccessoryInfo | | returning 'Radio Manufacturer' in response to 'Acc manufacturer' |
| 29 | | GetAccessoryInfo | requesting 'Acc model number' |
| 30 | RetAccessoryInfo | | returning 'M78901LL/Z' in response to 'Acc model number' |
| 31 | | GetAccessoryInfo | requesting 'Acc incoming max packet size' |
| 32 | RetAccessoryInfo | | returning '2048 bytes' in response to 'Acc incoming max packet size' |
| 33 | GetiPodCaps | | no params |
| 34 | | RetiPodCaps | returning 'total space 2147483648; max file size 1073741824; max write size 500; v1.02' |
| 35 | GetiPodFreeSpace | | no params |
| 36 | | RetiPodFreeSpace | returning 130023424 bytes |
| 37 | OpeniPodFeatureFile | | opening feature type 'Radio Tagging' |
| 38 | | RetiPodFileHandle | returning file handle 0 |
| 39 | | iPodAck | acknowledging 'Success' to command 'Storage Lingo::WriteiPodFileData' with file handle 0 |
| 40 | CloseiPodFile | | closing file with handle 0 |
| 41 | | iPodAck | acknowledging 'Success' to command 'Storage Lingo::CloseiPodFile' with file handle 0 |

**Table F-28** Non-IDPS cardio equipment command sequence

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| Steps A–D cancel any current authentication process; see "Cancelling a Current Authentication Process With IdentifyDeviceLingoes" (page 83). Step B also detects if the attached iPod is a 3G iPod. | | | |
| A | IdentifyDevice-Lingoes | | identifying lingo 'General'; options none; device ID 0x00000000 |
| The accessory waits up to 1 second for the iPod to respond. | | | |
| B | | ACK | acknowledging 'Success (OK)' to command 'General Lingo::IdentifyDeviceLingoes' |
| If the iPod does not send an ACK command within 1 second, it may be a 3G iPod. In this case, if the accessory needs to support the 3G iPod and it is using UART communication, in may retry Step A up to 3 times, for a total elapsed time of 3 seconds. If the accessory does not receive an ACK command after the third try, it may either quit or send an Identify command to achieve limited use of iAP. See General Lingo Command 0x01: Identify (Deprecated) (page 523) and "Interfacing With the 3G iPod" in *iPod/iPhone Hardware Specifications.* | | | |
| C | | GetAccessoryInfo | no params |
| D | RetAccessoryInfo | | returning an empty string |
| The accessory is now assured that it can successfully identify its lingoes to the attached iPod or iPhone. | | | |
| 1 | IdentifyDevice-Lingoes | | identifying lingoes 'General'; options 'auth:none; power:low'; device ID 0x00000000 |
| 2 | | ACK | acknowledging 'Success (OK)' to command 'General Lingo::IdentifyDeviceLingoes' |
| 3 | GetiPodOptions | | no params |
| 4 | | RetiPodOptions | returning 'video output\|line out' |
| 5 | RequestLingoProtocol-Version | | requesting General Lingo version |
| 6 | | ReturnLingoProtocol-Version | returning General Lingo v1.09 |
| 7 | RequestLingoProtocol-Version | | requesting Sports Lingo version |
| 8 | | ReturnLingoProtocol-Version | returning Sports Lingo v1.01 |
| 9 | RequestLingoProtocol-Version | | requesting Storage Lingo version |

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| 10 | | ReturnLingoProtocolVersion | returning Storage Lingo v1.02 |
| 11 | IdentifyDeviceLingoes | | identifying lingoes 'General\|Sports\|Storage'; options 'auth:immediate; power:low'; device ID 0x00000200 |
| 12 | | ACK | acknowledging 'Success (OK)' to command 'General Lingo::IdentifyDeviceLingoes' |
| 13 | | GetDevAuthenticationInfo | no params |
| 14 | RetDevAuthenticationInfo | | returning auth protocol v2.0; section: 0/1; cert data: ... |
| 15 | | ACK | acknowledging 'Success (OK)' to command 'General Lingo::RetDevAuthenticationInfo' |
| 16 | RetDevAuthenticationInfo | | returning auth protocol v2.0; section: 1/1; cert data: ... |
| 17 | | AckDevAuthenticationInfo | acknowledging 'auth info supported' |
| 18 | | GetDeviceCaps | no params |
| 19 | | GetAccessoryInfo | requesting 'Acc info capabilities' |
| 20 | | GetDevAuthenticationSignature | offering challenge '...' with retry counter 1 |
| 21 | RetDevAuthenticationSignature | | returning signature '...' |
| 22 | | AckDevAuthenticationStatus | acknowledging authentication status 'Success (OK)' |
| 23 | | GetDeviceCaps | no params |
| 24 | RetDeviceCaps | | returning 'Gym equipment command support' with max 0 node filters |
| 25 | | GetDeviceCaps | no params |
| 26 | RetDeviceCaps | | returning 'total space 0; max file size 0; max write size 0; read-only; no subdirs; random writes allowed; max file count 0; max name length 0; file system type Reserved; v1.02' |

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| 27 | RetAccessoryInfo | | returning 'Acc info capabilities\| Acc name\| Acc FW version\| Acc HW version\| Acc manufacturer\| Acc model number\| Acc incoming max packet size' in response to 'Acc info capabilities' |
| 28 | | GetAccessoryInfo | requesting 'Acc name' |
| 29 | RetAccessoryInfo | | returning 'Bike' in response to 'Acc name' |
| 30 | | GetAccessoryInfo | requesting 'Acc FW version' |
| 31 | RetAccessoryInfo | | returning 'v1.0.0' in response to 'Acc FW version' |
| 32 | | GetAccessoryInfo | requesting 'Acc HW version' |
| 33 | RetAccessoryInfo | | returning 'v1.0.0' in response to 'Acc HW version' |
| 34 | | GetAccessoryInfo | requesting 'Acc manufacturer' |
| 35 | RetAccessoryInfo | | returning 'Bike Manufacturer' in response to 'Acc manufacturer' |
| 36 | | GetAccessoryInfo | requesting 'Acc model number' |
| 37 | RetAccessoryInfo | | returning 'M78901LL/Z' in response to 'Acc model number' |
| 38 | | GetAccessoryInfo | requesting 'Acc incoming max packet size' |
| 39 | RetAccessoryInfo | | returning '2048 bytes' in response to 'Acc incoming max packet size' |
| 40 | GetiPodCaps | | no params |
| 41 | | RetiPodCaps | returning 'Gym equipment support\| User data support' with userCount of 1 |
| 42 | GetiPodCaps | | no params |
| 43 | | RetiPodCaps | returning 'total space 2147483648; max file size 1073741824; max write size 500; read-only; no subdirs; random writes allowed; max file count 10000; max name length 200; file system type HFS+; v1.02' |
| 44 | GetUserIndex | | no params |

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| 45 | | RetUserIndex | returning userIndex of 0 |
| 46 | GetUserData | | requesting 'Preferred unit system' |
| 47 | | RetUserData | returning 'No information' for data type 'Preferred unit system' |
| 48 | GetUserData | | requesting 'Name' |
| 49 | | RetUserData | returning 'NewUser' for data type 'Name' |
| 50 | GetUserData | | requesting 'Gender' |
| 51 | | RetUserData | returning 'No information' for data type 'Gender' |
| 52 | GetUserData | | requesting 'Weight' |
| 53 | | RetUserData | returning '92.0 kg' for data type 'Weight' |
| 54 | GetUserData | | requesting 'Age' |
| 55 | | RetUserData | returning '26 years' for data type 'Age' |
| 56 | GetUserData | | requesting 'Recording preference' |
| 57 | | RetUserData | returning 'No information' for data type 'Recording preference' |
| 58 | OpeniPodFeatureFile | | opening feature type 'Gym Equipment Workout' with options mask 'file data\| ipodInfo\| XML signature' and file data:</gymData>; |
| 59 | | RetiPodFileHandle | returning file handle 0 |
| 60 | WriteiPodFileData | | writing 293 bytes at offset 0 and handle 0: <?xml version=""1.0"" encoding=""UTF-8""?>"; <gymData>; <vers>1</vers>; <equipmentInfo>; <manufacturerID>00000001 </manufacturerID>; <manufacturerName>Bike Manufacturer </manufacturerName>; <type>Bike</type>; <model>M78901LL/Z </model>; <serialNumber> UV1234567890-SN </serialNumber>; </equipmentInfo>; |

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| 61 | | `iPodAck` | acknowledging 'Success' to command 'Storage Lingo:: WriteiPodFileData' with file handle 0 |
| 62 | `WriteiPodFileData` | | writing 125 bytes at offset 240 and handle 0: <userInfo><kg> 92.0</kg></userInfo>; <template>; <templateName>Athletic Challenge</templateName>; <sec>60</sec>; </template>; |
| 63 | | `iPodAck` | acknowledging 'Success' to command 'Storage Lingo:: WriteiPodFileData' with file handle 0 |
| 64 | `WriteiPodFileData` | | writing 125 bytes at offset 366 and handle 0: <interval>; <event>start</event>; <sec>0</sec>; <kCal>0</kCal>; <km>0.00</km>; <rpm>26</rpm>; <level>1</level>; </interval>; |
| 65 | | `iPodAck` | acknowledging 'Success' to command 'Storage Lingo:: WriteiPodFileData' with file handle 0 |
| 66 | `WriteiPodFileData` | | writing 86 bytes at offset 392 and handle 0: <interval>; <sec>10</sec>; <kCal>0</kCal>; <km>0.02</km>; <rpm>64</rpm>; </interval>; |
| 67 | | `iPodAck` | acknowledging 'Success' to command 'Storage Lingo:: WriteiPodFileData' with file handle 0 |
| 68 | `WriteiPodFileData` | | writing 87 bytes at offset 479 and handle 0: <interval>; <sec>20</sec>; <kCal>12</kCal>; <km>0.7</km>; <rpm>189</rpm>; </interval>; |
| 69 | | `iPodAck` | acknowledging 'Success' to command 'Storage Lingo::WriteiPodFileData' with file handle 0 |
| 70 | `WriteiPodFileData` | | writing 107 bytes at offset 567 and handle 0: <interval>; <event>end</event>; <sec>21</sec>; <kCal>13</kCal>; <km>0.8</km>; <rpm>170</rpm>; </interval>; |

| Step | Accessory command | iPod command | Comment |
|---|---|---|---|
| 71 | | `iPodAck` | acknowledging 'Success' to command 'Storage Lingo:: WriteiPodFileData' with file handle 0 |
| 72 | `WriteiPodFileData` | | writing 99 bytes at offset 675 and handle 0: <workoutSummary>; <sec>21</sec>; <kCal>13</kCal>; <km>0.8</km>; <rpm>170</rpm>; </workoutSummary>; |
| 73 | | `iPodAck` | acknowledging 'Success' to command 'Storage Lingo:: WriteiPodFileData' with file handle 0 |
| 74 | `CloseiPodFile` | | closing file with handle 0 |
| 75 | | `iPodAck` | acknowledging 'Success' to command 'Storage Lingo:: CloseiPodFile' with file handle 0 |

# Glossary

**accessory** A third-party device licensed under the Made for iPod or Works With iPhone program. *See* **device.**

**authentication** A mechanism used by an iPod to verify whether an attached device is an authorized accessory and by an accessory to authenticate the iPod, 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.

**device** An external electronic component connected to the iPod using the 30-pin connector or Bluetooth.

**FID** A Full ID string, used by IDPS to send token-value fields that the iPod is able to parse during the accessory identification process.

**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 the iPod or from the iPod 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.

**IDPS** Identify Device Preferences and Settings, the identification process required for an accessory to communicate with an iPod or iPhone. See "Accessory Identification" (page 445).

**iUI (iPod USB Interface)** A configuration of the iPod when attached as a device over USB. This configuration allows the iPod 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 a device. There is a General lingo that must be supported by all devices. Other lingoes are designed for use by specific devices, such as simple remote controls and microphones.

**link** The logical connection between an external device and the iPod 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.

**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 iPods 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 iPod. 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 iPod 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 interface on a device. For instance, the HID interface on the iPod 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, the iPod 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 *iPod Accessory Protocol Interface Specification*.

| Date | Notes |
|---|---|
| 2009-10-22 | *Revision R38:* |
| | Added section "Reserved Commands and Data" (page 47). |
| | Added information for the 5G nano, the 2G touch (2009), and the iPod classic 160 GB. |
| | Added commands 0x49-0x4A, 0x4D-0x4F, and 0x51 to the General lingo to support Event Notifications; see Table 2-9 (page 60). Also added explanatory section "iPod Event Notifications" (page 449). |
| | Added commands 0x0D and 0x0E to the Simple Remote lingo to support button actions for 5G nano Radio Tagging and Camera accessories; see Table 3-17 (page 157). |
| | Added section "Accessory Control of the iPod 5G nano Camera" (page 161). |
| | Added commands 0x25-0x31 to the RF Tuner lingo, and added features to other commands, to support HD radio; see Table 3-93 (page 222). |
| | Incorporated numerous updates and corrections. |
| 2009-09-09 | *Revision R37:* |
| | Exported the following chapters and appendixes to new book *iPod/iPhone Hardware Specifications*, Release R1: “Hardware Interfaces,” “Functional Description,” “Protocol Transport Links,” “iPod Power States and Accessory Power,” “Headphone Remote and Mic System,” “Interfacing With the 3G iPod,” “Sample Accessory Circuits,” “Power Guidelines,” and “FireWire to USB Reference Design.” |
| | Exported appendix “Headset and FireWire-to-USB Power Converter Certification” to new book *iPod/iPhone Accessory Testing and Certification Specification*, Release R1. |
| | Imported entire contents of discontinued book *iPod Extended Interface Specification*, Release R25, into "The Extended Interface Protocol" (page 341). |
| | Imported some content from discontinued book *iPhone Accessory Interface Specification*, Release R9. |
| | Reformatted content to new layout and typography. |

| Date | Notes |
| --- | --- |
| 2009-06-23 | *Revision R36:* |
| | Added information about the iPhone 3GS. |
| | Added new appendix "Accessory Identification" (page 445). *This identification process is required in all new accessory designs.* Moved command examples using `IdentifyDeviceLingoes` to "Accessory Identification With Non-IDPS iPods" (page 532) in Appendix M, "Historical Information." |
| | In Chapter 3, added new section "Accessory Communication With iPhone OS Applications" (page 42); deleted section "iPod Games" and updated section "Accessory Control of the iPod touch and iPhone" (page 42). |
| | Added commands 0x38-0x3C, 0x3F-0x43, and 0x4A-0x4C to the General lingo; see Table 2-9 (page 60). |
| | Added new section "Accessory Power Policy" (page 39). |
| | Added new section "Lingo 0x0E: Location Lingo" (page 312). |
| | Added sample command sequences for iTunes tagging (Table D-11 (page 484)) and cardio equipment (Table E-7 (page 510)). |
| | Added new appendix "Transaction IDs" (page 451). |
| | Added new appendix "Multisection Data Transfers" (page 459). |
| | Added new section "Avoiding an iPhone OS Warning When a Self-Powered Accessory Is Off." |
| | Added caution about latching connectors to "30-Pin Connector." |
| | Changed button press detection parameters in "iPod/iPhone Headphone/Microphone Jack." |
| | Added information about PKCS-7 transport of certificate data to "Device Authentication of iPod" (page 57). |
| | Added warning about the iPod touch and iPhone Off state to "Power States." |
| | Updated signal level information in "UART Serial Port Link." |
| | Added new section "Examples of Transaction IDs" (page 456). |
| | Added new section Sample Identification Sequences Using IdentifyDeviceLingoes (page 334). |
| 2009-03-17 | *Revision R35:* |
| | Added Table I-1 (page 30) to identify iPod/iPhone models. |
| | Revised "iPhone headphone/microphone schematic" to show iPod/iPhone differences. |

| Date | Notes |
|---|---|
| | Revised section “Line Level Input” in Chapter 2. |
| | Updated Table 1-3 (page 37) to show current firmware versions. |
| | Added display resolution data to Table 1-6 (page 41). |
| | Updated and revised accessory identification and authentication in Table 2-1 (page 48) and Table F-21 (page 531). |
| | Added new `ACK` error codes to Table 2-13 (page 65). |
| | Added copy protection requirement to "USB Audio Transport" (page 291). |
| | Revised section “Button Detection Circuitry” in Appendix C. |
| 2009-01-05 | *Revision R34:* |
| | Added definitions of legal agreement terminology ("Specification Terms" (page 34)). |
| | Added new appendix “Accessory Certification.” |
| | Added FM radio tagging information to "iTunes Tagging" (page 463). |
| | Added new section "Lingo 0x09: Sports Lingo" (page 277). |
| | Added new appendix "Nike + iPod Cardio Equipment System" (page 495). |
| | Added new appendix “Headphone Remote and Mic System.” |
| | Added new commands 0x80-0x82 and new options for command 0x12 in "Lingo 0x0C: Storage Lingo" (page 300). |
| | Documented new models: the 4G iPod nano, 120 GB classic, and 2G iPod touch. |
| | Added section "Accessory Communication with the iPod touch and iPhone" (page 42). |
| | Added hardware details of the iPhone audio connection (“iPod/iPhone Headphone/Microphone Jack”). |
| | Clarified USB power requirements in “USB 2.0.” |
| | Added section “Magnetic Sensitivity of the iPod.” |
| | Defined recommended procedure for determining iPod capabilities in "Command 0x13: IdentifyDeviceLingoes" (page 80). |
| | Added section "Playback Engine Playlists" (page 159). |
| | Clarified behavior of Next and Previous buttons in "Using Contextual Buttons" (page 159). |
| | Clarified mute event in Table 3-51 (page 188). |

| Date | Notes |
|---|---|
| | Deprecated "Lingo 0x06: USB Host Control Lingo" (page 525). |
| | Deprecated "General Lingo Command 0x01: Identify" (page 523)). |
| | Removed from Chapter 5 obsolete description of testing for the General lingo over the UART serial port link. |
| 2008-06-26 | *Revision R33:* |
| | Added section "Command Timings" (page 146). |
| | Revised audiobook playback speeds in Table 3-56 (page 193). |
| | Added accessory requirements to Table 2-57 (page 98). |
| | Changed names of levels of authentication from V1 and V2 to authentication 1.0 and 2.0. |
| | Changed name of RF Transmitter lingo (0x05) to Accessory Power lingo. |
| | Added section “Supplying USB Power” to Appendix A. |
| | Changed "Data Transfer to the iPod" (page 479) in Appendix B to show all radio tagging plist fields required. |
| | Added section “Powering the 3G iPod” to Appendix C. |
| | Added Note about lyrics strings to Table 3-74 (page 207). |
| | Revised “Typical diode bridge circuit for an AC adapter” in Appendix E. |
| | Fixed typo in Table F-2 in Appendix F. |
| 2008-05-07 | *Revision R32:* |
| | Added new appendix, “FireWire to USB Reference Design.” |
| | Revised documentation of sleep states in Chapter 2, Appendix A, and elsewhere. |
| | Added section "Video Output Preferences" (page 41) and expanded Table 2-64 (page 103). |
| | Updated the current firmware versions in Table 1-2 (page 36). |
| | Made several updates to Appendix B, “iTunes Tagging.” |
| | Made numerous other updates, corrections, and clarifications throughout the document. |
| 2007-12-12 | *Revision R31:* |
| | Moved past firmware version documentation, description of the 9-pin Audio/Remote connector, FireWire specifications, and other noncurrent material to new appendix, "Historical Information" (page 517). |

| Date | Notes |
|---|---|
| | Documented November 2007 firmware for the 5G, classic, 3G nano, and touch iPod models. |
| | Made minor correction to "Configuration and interface descriptors for iPods with USB audio." |
| | Simplified document structure. |
| 2007-10-02 | *Revision R30:* |
| | Added "Lingo 0x0C: Storage Lingo" (page 300) to Chapter 6. |
| | Added new Appendix B, "iTunes Tagging" (page 463). |
| 2007-09-05 | *Revision R29:* |
| | Added documentation for the iPod classic, iPod 3G nano, and iPod touch. |
| | Added documentation for component video outputs. |
| | Added new command, `SetVideoDelay`, to the Digital Audio lingo. |
| | Deprecated the FireWire interface on the 30-pin connector. |
| | Added new preference IDs to `GetiPodPreferences`. |
| | Added design guidelines for third-party developers of AC adapter accessories for the iPod touch ("Power Guidelines"). |
| | Added design guidelines for third-party developers of carrying cases for iPod touch ("iPod touch Carrying Case Design"). |
| 2007-06-29 | *Revision R28:* |
| | Revised pin connections in 30-pin to FireWire cable ("30-pin to FireWire cable"). |
| | Updated model listings to include iPhone and new iPod models (Table 2-29 (page 76)) |
| | Updated requirements for artwork count data (Table 3-74 (page 207)) |
| | Added caution about sending signals to the iPod UART when its serial receive block is off. |
| | Documented X.509 certificate classes (Table 2-3 (page 53)) |
| | Added line-out usage controls (Table 2-64 (page 103)) |
| | Added section "USB Audio Errors on Older iPods" (page 151) |
| | Added authentication requirement to General lingo commands 0x1A-0x1F |
| | Deprecated Level V1 authentication for new designs (see "iPod Authentication of Device" (page 55)) |

| Date | Notes |
|---|---|
| | Deprecated "Command 0x01: Identify" (page 523) |
| 2007-02-06 | *Revision R27:* |
| | Added section “Minimizing Crosstalk and Noise.” |
| | Added new information to Table 1-2 (page 36). |
| | Removed autobaud on parity errors from Table 1-4 (page 38). |
| | Clarified UART communication rates in “UART Serial Port Link.” |
| | Removed Manufacturer String and Product String from “Choosing an iPod USB Configuration.” |
| | Added example of using iAP over USB in “Transferring IdentifyDeviceLingoes and ACK commands over USB using iAP.” |
| | Distinguished behavior of audio and video playback when iPod enters Extended Interface mode in "Command 0x05: EnterRemoteUIMode" (page 68). |
| | Added example of using Display Remote Protocol in "Lingo 0x03: Display Remote Lingo" (page 176). |
| | Clarified usage of `NewiPodTrackInfo` command in "Command 0x04: NewiPodTrackInfo" (page 298). |
| | Added new appendix, “Interfacing With the 3G iPod.” |
| | Added new appendix, “Sample Accessory Circuits.” |
| | Added temperature range to “UART Serial Port Link.” |
| 2006-11-03 | Added new information to Tables 3-1 and 5-26. |
| 2006-10-17 | *Revision R26:* |
| | Added new information to the note after Table 2-2. |
| | Updated Table 2-3. |
| | Added note to section “Line Level Output.” |
| | Added new section “Headphone Jack on Video-Capable iPods.” |
| | Added new iPod models and software versions. |
| 2006-09-12 | *Revision R25:* |
| | Added iPod options and preferences commands (0x24-0x25 and 0x29-0x2B) to General lingo. |
| | Added USB Host Control lingo (0x06). |

| Date | Notes |
|---|---|
| | Added RF Tuner lingo (0x07). |
| | Updated list of model ID strings (Table 2-28 (page 75) and Table 2-29 (page 76)). |
| | Corrected `RetTrackArtworkData` packet listing (Table 3-81 (page 212)). |
| 2006-06-19 | *Revision R24:* |
| | Added Accessory Equalizer lingo, number 0x08. |
| | Added USB Digital Audio lingo, number 0x0A. |
| | Added Authentication level V2 (X.509 certification) to General Lingo (0x00). |
| | Added Album Art commands (0x16-0x19 and 0x1F-0x20) to Display Remote Lingo (0x03). |
| | Added GetAccessoryInfo (0x27) and RetAccessoryInfo (0x28) commands to the General lingo (0x00). |
| | Added Dedicated Media commands (0x00-0x04) to the Simple Remote lingo (0x02). |
| | Added timeout and retry information to various command descriptions. |
| | Moved documentation of Extended Interface commands (0x03-0x06, General lingo) from the *iPod Extended Interface Specification*. |
| | Revised model and feature tables in Chapter 3. |
| | Added and updated lingo history tables in Chapter 6. |
| 2006-02-10 | *Revision R23:* |
| | Pages 17 and 27: Changed audio output power specification to 25 mW. |
| | Page 87: A simple remote device must send a data payload when all buttons are released; 200 ms timeout removed. |
| | Corrected Table 1-2 (page 36). |
| | Note, page 17: Specified Technical Note TN001i by name. |
| 2006-01-05 | *Revision R22:* |
| | General update and reorganization of content. |
| | Added information on iPod power states. |
| | Added "D+ and D- connections for a 500 mA USB power brick" and "iPod equivalent input circuits." |
| 2005-10-12 | Updated functional descriptions. |

| Date | Notes |
|---|---|
| | Added new microphone lingo commands. |
| | Additional information about hibernate mode. |
| | Bug fixes for volume control and others. |
| 2005-09-07 | Added support for USB/iUI, authentication and additions to the new Display Remote lingo (0x03) |
| 2005-03-21 | Added Equalizer Control lingo support and commands. |
| 2004-11-12 | Added general lingo commands, bug fixes and pinouts for the iPod photo release |
| 2004-08-03 | Reserved the 28k pulldown resistor |
| 2004-07-21 | Added lingo command packet examples. |
| | Corrected doc properties. |
| | Added minor clarifications. |
| | Added new accessory detect image. |
| | Updated content based on internal review. |
| 2004-05-17 | Incorporated review feedback |
| 2004-04-20 | Update simple remote, doc reformat |
| 2004-01-14 | Minor clarifications |
| 2003-08-12 | 5mA access power note |
| 2003-08-04 | New serial, add bottom serial |
| 2003-07-22 | Picture to show Remote Data lines |
| 2003-07-07 | License agreement |
| 2003-04-15 | Remote protocols added |
| 2003-04-02 | Car Charger Detect added |
| 2003-02-04 | Accessory Detect Resistor Change |
| 2003-01-09 | Rx, Tx Clarification |
| 2002-12-04 | Initial Release. |