

# Apple Bluetooth Low Energy MIDI Specification

Release R1

# Contents

<b>1. Introduction</b>	4
1.1 Purpose of This Specification	4
1.2 Requirements, Recommendations, and Permissions	4
1.3 Terminology	4
<b>2. Bluetooth Low Energy MIDI</b>	6
2.1 Requirements	6
2.1.1 Bluetooth Low Energy	6
2.1.2 Connection Interval	6
2.1.3 MTU Negotiation	6
2.1.4 Multiple Packet Transmissions	6
2.1.5 Apple Bluetooth Low Energy MIDI Service	7
2.2 Usage	7
2.2.1 Initial Connection and Pairing	7
2.2.2 MIDI Data Transfer	7
2.2.3 MIDI Data Encoding	8
2.2.4 MIDI Event Timestamps	11
<b>3. Revision History</b>	13

# Figures and Tables

## 2. Bluetooth Low Energy MIDI 6

Figure 2-1	Bluetooth Low Energy MIDI Packet Example (Full Events)	10
Figure 2-2	Bluetooth Low Energy MIDI Packet Example (Full Event + Running Status Event)	10
Figure 2-3	Bluetooth Low Energy MIDI Packet Example (SysEx Message - 1 of 2)	11
Figure 2-4	Bluetooth Low Energy MIDI Packet Example (SysEx Message - 2 of 2)	11
Table 2-1	Apple Bluetooth Low Energy MIDI Service UUIDs	7
Table 2-2	Apple Bluetooth Low Energy MIDI Service Characteristics	7
Table 2-3	Bluetooth Low Energy MIDI Packet Header Byte	8
Table 2-4	Bluetooth Low Energy MIDI Timestamp Byte	9
Table 2-5	Bluetooth Low Energy MIDI Event Encoding (Full)	10
Table 2-6	Bluetooth Low Energy MIDI Event Encoding (Running Status)	10
Table 2-7	Bluetooth Low Energy MIDI SysEx Message Structure	11

# 1. Introduction

## 1.1 Purpose of This Specification

This specification outlines a method for encoding and decoding MIDI data over Bluetooth Low Energy connections.

## 1.2 Requirements, Recommendations, and Permissions

The use of the phrases *must*, *must not*, *required*, *shall*, *shall not*, *should*, *should not*, *recommended*, *not recommended*, *may*, and *optional* in a statement have the following meanings:

- *must*, *shall*, or *required* means the statement is an absolute requirement.
- *must not* or *shall not* means the statement is an absolute prohibition.
- *should* or *recommended* means the full implications must be understood before choosing a different course.
- *should not* or *not recommended* means the full implications must be understood before choosing this course.
- *may* or *optional* means the statement is truly optional, and its presence or absence cannot be assumed.

## 1.3 Terminology

Throughout this specification:

- The term *device* is used to refer to an Apple iPhone, iPad, or iPod touch (typically running iOS, Apple's mobile operating system).
- The term *accessory* is used to refer to any product intended to interface with a device or product via the means described in this specification.
- The term *product* is used to refer generically to either a Mac (Apple computers that run OS X) or an aforementioned *device*.

The term 'Bluetooth Low Energy' is defined in the Bluetooth 4.0 specification and above (see <http://www.bluetooth.org>).

The term 'MIDI' is used to refer to the Musical Instrument Digital Interface as defined in the specifications published by the MIDI Manufacturers Association (see <http://www.midi.org>).

## 2. Bluetooth Low Energy MIDI

Accessories that implement support for the Apple Bluetooth Low Energy MIDI service may interact with apps that use the Core MIDI framework on:

- Apple devices running iOS 8.0 and above
- Apple computers running OS X Yosemite and above

### 2.1 Requirements

#### 2.1.1 Bluetooth Low Energy

The accessory shall comply with the requirements stated in the *Bluetooth Low Energy* chapter of the *Bluetooth Accessory Design Guidelines for Apple Products* (see <https://developer.apple.com/hardware/drivers/BluetoothDesignGuidelines.pdf>) unless those requirements are modified by requirements specific to Bluetooth Low Energy MIDI in this chapter.

#### 2.1.2 Connection Interval

The accessory shall request a connection interval of 15 ms or less. Apple recommends starting with a request for a connection interval of 11.25 ms and going to 15 ms if the connection request is rejected by the Apple product.

Intervals higher than 15 ms are unsuitable for live playback situations.

#### 2.1.3 MTU Negotiation

The accessory shall support MTU negotiation. See the *MTU Size* section in the *Bluetooth Low Energy* chapter of the *Bluetooth Accessory Design Guidelines for Apple Products* for implementation details.

#### 2.1.4 Multiple Packet Transmissions

The accessory shall support sending and receiving the maximum number of Bluetooth Low Energy packets that can fit into the connection interval. MIDI minimum bandwidth requirements may not be met otherwise.

## 2.1.5 Apple Bluetooth Low Energy MIDI Service

The accessory shall advertise support for a GATT service using the the MIDI Service UUID specified in [Table 2-1](#) (page 7) with the characteristics specified in [Table 2-2](#) (page 7).

**Table 2-1** Apple Bluetooth Low Energy MIDI Service UUIDs

Name	UUID
MIDI Service	03B80E5A-EDE8-4B33-A751-6CE34EC4C700
MIDI I/O Characteristic	7772E5DB-3868-4112-A1A9-F2669D106BF3

**Table 2-2** Apple Bluetooth Low Energy MIDI Service Characteristics

Name	Type	Security	Properties	Comment
MIDI I/O	blob	Read, Write, Notify	Pairing required	Shall require encryption. Writes must not expect a response.

### 2.1.5.1 MIDI I/O Characteristic Encryption

The MIDI I/O characteristic shall be encryption protected.

## 2.2 Usage

### 2.2.1 Initial Connection and Pairing

Apple devices that support Bluetooth Low Energy MIDI will attempt to read the MIDI I/O characteristic after establishing a connection with the accessory.

The accessory shall reject MIDI I/O characteristic read requests from an unpaired Apple device. See the *Pairing* section in the *Bluetooth Low Energy* chapter of the *Bluetooth Accessory Design Guidelines for Apple Products* for implementation details.

The accessory shall respond to the initial MIDI I/O characteristic read with a packet that has no payload.

### 2.2.2 MIDI Data Transfer

While in use, Apple devices will transfer MIDI data to and from the accessory via the MIDI I/O characteristic.

The Apple device will write to the MIDI I/O characteristic whenever it has MIDI data to send to the accessory. When the accessory has MIDI data to send to the Apple device, it shall notify the Apple device of an update to the MIDI I/O characteristic.

### 2.2.3 MIDI Data Encoding

One or more MIDI events in a MIDI data stream may be encoded into one Bluetooth Low Energy packet and sent/received via the MIDI I/O characteristic. The maximum MIDI payload for a Bluetooth Low Energy packet is the negotiated MTU minus 3 bytes (see [MTU Negotiation](#) (page 6)).

With the sole exception of MIDI System Exclusive (SysEx) events, MIDI events shall not span across Bluetooth Low Energy packets.

The MIDI timestamp information in a Bluetooth Low Energy packet shall be applied to all MIDI events contained in the Bluetooth Low Energy packet.

#### 2.2.3.1 Packet Format (non SysEx)

Bluetooth Low Energy packets containing MIDI events other than SysEx events shall always start with a Header byte (see [Header Byte](#) (page 8)), followed by a mixture of:

- Timestamp bytes (see [Timestamp Byte](#) (page 9))
- MIDI Full or Running Status events (see [MIDI Event \(non SysEx\)](#) (page 9))

#### 2.2.3.2 Header Byte

The header byte in the Bluetooth Low Energy packet shall take the following format:

**Table 2-3** Bluetooth Low Energy MIDI Packet Header Byte

Bit	Name	Notes
7	Start Bit	Shall be set to 1
6	Reserved	Shall be set to 0
5	Timestamp[12]	Bit 12 of MIDI timestamp information
4	Timestamp[11]	Bit 11 of MIDI timestamp information
3	Timestamp[10]	Bit 10 of MIDI timestamp information
2	Timestamp[9]	Bit 9 of MIDI timestamp information



Bit	Name	Notes
1	Timestamp[8]	Bit 8 of MIDI timestamp information
0	Timestamp[7]	Bit 7 of MIDI timestamp information

### 2.2.3.3 Timestamp Byte

The timestamp byte in the Bluetooth Low Energy packet shall take the following format:

**Table 2-4** Bluetooth Low Energy MIDI Timestamp Byte

Bit	Name	Notes
7	Start Bit	Shall be set to 1
6	Timestamp[6]	Bit 6 of MIDI timestamp information
5	Timestamp[5]	Bit 5 of MIDI timestamp information
4	Timestamp[4]	Bit 4 of MIDI timestamp information
3	Timestamp[3]	Bit 3 of MIDI timestamp information
2	Timestamp[2]	Bit 2 of MIDI timestamp information
1	Timestamp[1]	Bit 1 of MIDI timestamp information
0	Timestamp[0]	Bit 0 of MIDI timestamp information

The timestamp information contained in bits 5 through 0 applies to subsequent MIDI event(s).

### 2.2.3.4 MIDI Event (non SysEx)

MIDI events other than SysEx messages shall be encoded in one of two formats:

- Full
- Running Status

Full events

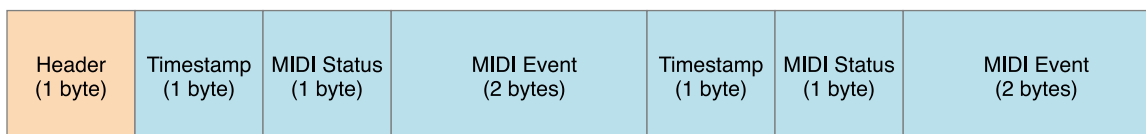
- shall be preceded by a Timestamp byte (see [Timestamp Byte](#) (page 9))
- may be followed by one or more Running Status events

A Full event is a standard MIDI event including MIDI Status.

**Table 2-5** Bluetooth Low Energy MIDI Event Encoding (Full)

Byte(s)	Name	Notes
0	MIDI Status	Most Significant Bit shall be set to 1
1-2 (optional)	MIDI Event	Not present for some MIDI messages. See MIDI specification

**Figure 2-1** Bluetooth Low Energy MIDI Packet Example (Full Events)



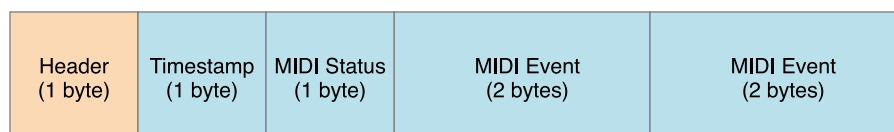
Running Status events may be used to efficiently encode additional MIDI events that are concurrent with a Full event. A Running Status event does not include the MIDI status byte. Running Status events shall meet the following criteria:

- The MIDI event that it represents is greater than 1 byte in size and is not a system message (status bytes 0x80 - 0xEF inclusive).
- The omitted status byte is the same as the most recently preceding full event's.
- The event is concurrent with the most recently preceding full event.

**Table 2-6** Bluetooth Low Energy MIDI Event Encoding (Running Status)

Byte(s)	Name	Notes
0-1	MIDI Event	See MIDI specification

**Figure 2-2** Bluetooth Low Energy MIDI Packet Example (Full Event + Running Status Event)



### 2.2.3.5 Multiple Packet Encoding (SysEx Only)

MIDI SysEx messages may span multiple Bluetooth Low Energy packets depending on the size of the SysEx message.

All SysEx messages shall take the following structure:

**Table 2-7** Bluetooth Low Energy MIDI SysEx Message Structure

Byte(s)	Name	Notes
0	Timestamp	See <a href="#">Timestamp Byte</a> (page 9)
1	SysEx Start (Status)	Shall be set to 0xF0
2 to n	SysEx Data	
n+1	Timestamp	
n+2	SysEx End (Status)	Shall be set to 0xF7

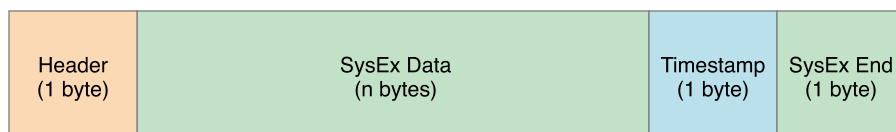
The SysEx message shall be split into one or more Bluetooth Low Energy packets. Every Bluetooth Low Energy packet shall start with a Header Byte (see [Header Byte](#) (page 8)) and be followed by a portion of the SysEx message.

For example, a SysEx message sent across 2 Bluetooth Low Energy packets will be encoded as shown:

**Figure 2-3** Bluetooth Low Energy MIDI Packet Example (SysEx Message - 1 of 2)



**Figure 2-4** Bluetooth Low Energy MIDI Packet Example (SysEx Message - 2 of 2)



## 2.2.4 MIDI Event Timestamps

The 13-bit timestamp for a MIDI event in any given Bluetooth Low Energy packet is formed from the bottom 6 bits of the Header Byte (see [Header Byte](#) (page 8)) and the bottom 7 bits of the most recently preceding Timestamp byte (See [Timestamp Byte](#) (page 9)).

Timestamps are expressed in milliseconds, implying that the maximum timestamp range is 8192 ms.

Timestamps shall be sent in monotonically increasing order.

The accessory shall

- account for overflow when Timestamp bytes within the packet wrap around the 7-bit data range.
- correlate their clock with the received timestamps for accurate event rendition.

## 3. Revision History

This table describes the changes to the Apple Bluetooth Low Energy MIDI Specification.

Date	Notes
2012-12-17	<i>Release R1</i>
	First Release



Apple Inc.  
Copyright © 2014 Apple Inc.  
All rights reserved.

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

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

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

Offline copy. Trademarks go [here](#).

Even though Apple has reviewed this document, APPLE MAKES NO WARRANTY OR REPRESENTATION, EITHER EXPRESS OR IMPLIED, WITH RESPECT TO THIS DOCUMENT, ITS QUALITY, ACCURACY, MERCHANTABILITY, OR FITNESS FOR A PARTICULAR PURPOSE. AS A RESULT, THIS DOCUMENT IS PROVIDED "AS IS," AND YOU, THE READER, ARE ASSUMING THE ENTIRE RISK AS TO ITS QUALITY AND ACCURACY.

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

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

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