

PortMidi

2.2.x

Generated by Doxygen 1.7.4

Fri Dec 30 2011 03:33:28



# Contents

<b>1</b>	<b>Module Index</b>	<b>1</b>
1.1	Modules . . . . .	1
<b>2</b>	<b>Data Structure Index</b>	<b>3</b>
2.1	Data Structures . . . . .	3
<b>3</b>	<b>Module Documentation</b>	<b>5</b>
3.1	Input/Output Devices Handling . . . . .	5
3.1.1	Function Documentation . . . . .	5
3.1.1.1	Pm_GetDeviceInfo . . . . .	5
3.1.1.2	Pm_OpenInput . . . . .	6
3.2	Events and Filters Handling . . . . .	7
3.2.1	Define Documentation . . . . .	9
3.2.1.1	PM_FILT_REALTIME . . . . .	9
3.2.1.2	Pm_Message . . . . .	9
3.2.2	Function Documentation . . . . .	9
3.2.2.1	Pm_Abort . . . . .	9
3.2.2.2	Pm_Close . . . . .	9
3.2.2.3	Pm_SetChannelMask . . . . .	10
3.2.2.4	Pm_Synchronize . . . . .	10
3.3	Reading and Writing Midi Messages . . . . .	10
3.3.1	Function Documentation . . . . .	11
3.3.1.1	Pm_Read . . . . .	11
3.3.1.2	Pm_Write . . . . .	11
3.3.1.3	Pm_WriteShort . . . . .	12

<b>4</b>	<b>Data Structure Documentation</b>	<b>13</b>
4.1	PmDeviceInfo Struct Reference . . . . .	13
4.1.1	Detailed Description . . . . .	13
4.1.2	Field Documentation . . . . .	13
4.1.2.1	interf . . . . .	13
4.1.2.2	name . . . . .	14
4.2	PmEvent Struct Reference . . . . .	14
4.2.1	Detailed Description . . . . .	14

# Chapter 1

## Module Index

### 1.1 Modules

Here is a list of all modules:

Input/Output Devices Handling . . . . .	<a href="#">5</a>
Events and Filters Handling . . . . .	<a href="#">7</a>
Reading and Writing Midi Messages . . . . .	<a href="#">10</a>



## Chapter 2

# Data Structure Index

### 2.1 Data Structures

Here are the data structures with brief descriptions:

<a href="#">PmDeviceInfo</a> . . . . .	13
<a href="#">PmEvent</a> (All midi data comes in the form of <a href="#">PmEvent</a> structures ) . . . . .	14





## Chapter 3

# Module Documentation

### 3.1 Input/Output Devices Handling

#### Functions

- PMEXPORT const [PmDeviceInfo](#) \* [Pm\\_GetDeviceInfo](#) (PmDeviceID id)  
*[Pm\\_GetDeviceInfo\(\)](#) returns a pointer to a [PmDeviceInfo](#) structure referring to the device specified by id.*
- PMEXPORT PmError [Pm\\_OpenInput](#) (PortMidiStream \*\*stream, PmDeviceID inputDevice, void \*inputDriverInfo, int32\_t bufferSize, PmTimeProcPtr time\_proc, void \*time\_info)  
*[Pm\\_OpenInput\(\)](#) and [Pm\\_OpenOutput\(\)](#) open devices.*
- PMEXPORT PmError **[Pm\\_OpenOutput](#)** (PortMidiStream \*\*stream, PmDeviceID outputDevice, void \*outputDriverInfo, int32\_t bufferSize, PmTimeProcPtr time\_proc, void \*time\_info, int32\_t latency)

#### 3.1.1 Function Documentation

##### 3.1.1.1 PMEXPORT const PmDeviceInfo\* Pm\_GetDeviceInfo ( PmDeviceID id )

[Pm\\_GetDeviceInfo\(\)](#) returns a pointer to a [PmDeviceInfo](#) structure referring to the device specified by id.

If id is out of range the function returns NULL.

The returned structure is owned by the PortMidi implementation and must not be manipulated or freed. The pointer is guaranteed to be valid between calls to [Pm\\_Initialize\(\)](#) and [Pm\\_Terminate\(\)](#).

Definition at line 183 of file portmidi.c.

```
3.1.1.2 PMEXPORT PmError Pm_OpenInput ( PortMidiStream ** stream, PmDeviceID
      inputDevice, void * inputDriverInfo, int32_t bufferSize, PmTimeProcPtr time_proc, void
      * time_info )
```

[Pm\\_OpenInput\(\)](#) and [Pm\\_OpenOutput\(\)](#) open devices.

*stream* is the address of a `PortMidiStream` pointer which will receive a pointer to the newly opened stream.

*inputDevice* is the id of the device used for input (see `PmDeviceID` above).

*inputDriverInfo* is a pointer to an optional driver specific data structure containing additional information for device setup or handle processing. *inputDriverInfo* is never required for correct operation. If not used *inputDriverInfo* should be `NULL`.

*outputDevice* is the id of the device used for output (see `PmDeviceID` above).

*outputDriverInfo* is a pointer to an optional driver specific data structure containing additional information for device setup or handle processing. *outputDriverInfo* is never required for correct operation. If not used *outputDriverInfo* should be `NULL`.

For input, the *bufferSize* specifies the number of input events to be buffered waiting to be read using [Pm\\_Read\(\)](#). For output, *bufferSize* specifies the number of output events to be buffered waiting for output. (In some cases -- see below -- `PortMidi` does not buffer output at all and merely passes data to a lower-level API, in which case *bufferSize* is ignored.)

*latency* is the delay in milliseconds applied to timestamps to determine when the output should actually occur. (If *latency* is  $< 0$ , 0 is assumed.) If *latency* is zero, timestamps are ignored and all output is delivered immediately. If *latency* is greater than zero, output is delayed until the message timestamp plus the *latency*. (NOTE: the time is measured relative to the time source indicated by *time\_proc*. Timestamps are absolute, not relative delays or offsets.) In some cases, `PortMidi` can obtain better timing than your application by passing timestamps along to the device driver or hardware. *Latency* may also help you to synchronize midi data to audio data by matching midi latency to the audio buffer latency.

*time\_proc* is a pointer to a procedure that returns time in milliseconds. It may be `NULL`, in which case a default millisecond timebase (`PortTime`) is used. If the application wants to use `PortTime`, it should start the timer (call `Pt_Start`) before calling `Pm_OpenInput` or `Pm_OpenOutput`. If the application tries to start the timer *after* `Pm_OpenInput` or `Pm_OpenOutput`, it may get a `ptAlreadyStarted` error from `Pt_Start`, and the application's preferred time resolution and callback function will be ignored. *time\_proc* result values are appended to incoming MIDI data, and *time\_proc* times are used to schedule outgoing MIDI data (when *latency* is non-zero).

*time\_info* is a pointer passed to *time\_proc*.

Example: If I provide a timestamp of 5000, *latency* is 1, and *time\_proc* returns 4990, then the desired output time will be when *time\_proc* returns  $\text{timestamp} + \text{latency} = 5001$ . This will be  $5001 - 4990 = 11\text{ms}$  from now.

return value: Upon success `Pm_Open()` returns `PmNoError` and places a pointer to a valid `PortMidiStream` in the *stream* argument. If a call to `Pm_Open()` fails a nonzero error code is returned (see `PmError` above) and the value of *port* is invalid.

Any stream that is successfully opened should eventually be closed by calling [Pm\\_Close\(\)](#).

Definition at line 669 of file portmidi.c.

References [PM\\_FILT\\_ACTIVE](#).

## 3.2 Events and Filters Handling

### Data Structures

- struct [PmEvent](#)

*All midi data comes in the form of [PmEvent](#) structures.*

### Defines

- #define [PM\\_FILT\\_ACTIVE](#) (1 << 0x0E)  
*filter active sensing messages (0xFE):*
- #define [PM\\_FILT\\_SYSEX](#) (1 << 0x00)  
*filter system exclusive messages (0xF0):*
- #define [PM\\_FILT\\_CLOCK](#) (1 << 0x08)  
*filter MIDI clock message (0xF8)*
- #define [PM\\_FILT\\_PLAY](#) ((1 << 0x0A) | (1 << 0x0C) | (1 << 0x0B))  
*filter play messages (start 0xFA, stop 0xFC, continue 0xFB)*
- #define [PM\\_FILT\\_TICK](#) (1 << 0x09)  
*filter tick messages (0xF9)*
- #define [PM\\_FILT\\_FD](#) (1 << 0x0D)  
*filter undefined FD messages*
- #define [PM\\_FILT\\_UNDEFINED](#) [PM\\_FILT\\_FD](#)  
*filter undefined real-time messages*
- #define [PM\\_FILT\\_RESET](#) (1 << 0x0F)  
*filter reset messages (0xFF)*
- #define [PM\\_FILT\\_REALTIME](#)  
*filter all real-time messages*
- #define [PM\\_FILT\\_NOTE](#) ((1 << 0x19) | (1 << 0x18))  
*filter note-on and note-off (0x90-0x9F and 0x80-0x8F)*
- #define [PM\\_FILT\\_CHANNEL\\_AFTERTOUCH](#) (1 << 0x1D)  
*filter channel aftertouch (most midi controllers use this) (0xD0-0xDF)*
- #define [PM\\_FILT\\_POLY\\_AFTERTOUCH](#) (1 << 0x1A)  
*per-note aftertouch (0xA0-0xAF)*
- #define [PM\\_FILT\\_AFTERTOUCH](#) ([PM\\_FILT\\_CHANNEL\\_AFTERTOUCH](#) | [PM\\_FILT\\_POLY\\_AFTERTOUCH](#))  
*filter both channel and poly aftertouch*
- #define [PM\\_FILT\\_PROGRAM](#) (1 << 0x1C)

- Program changes (0xC0-0xCF)*
  - #define **PM\_FILT\_CONTROL** (1 << 0x1B)
  - Control Changes (CC's) (0xB0-0xBF)*
  - #define **PM\_FILT\_PITCHBEND** (1 << 0x1E)
  - Pitch Bender (0xE0-0xEF)*
  - #define **PM\_FILT\_MTC** (1 << 0x01)
  - MIDI Time Code (0xF1)*
  - #define **PM\_FILT\_SONG\_POSITION** (1 << 0x02)
  - Song Position (0xF2)*
  - #define **PM\_FILT\_SONG\_SELECT** (1 << 0x03)
  - Song Select (0xF3)*
  - #define **PM\_FILT\_TUNE** (1 << 0x06)
  - Tuning request (0xF6)*
  - #define **PM\_FILT\_SYSTEMCOMMON** (PM\_FILT\_MTC | PM\_FILT\_SONG\_POSITION | PM\_FILT\_SONG\_SELECT | PM\_FILT\_TUNE)
  - All System Common messages (mtc, song position, song select, tune request)*
  - #define **Pm\_Channel**(channel) (1 << (channel))
  - #define **Pm\_Message**(status, data1, data2)
  - Pm\_Message()** encodes a short Midi message into a 32-bit word.*
  - #define **Pm\_MessageStatus**(msg) ((msg) & 0xFF)
  - #define **Pm\_MessageData1**(msg) (((msg) >> 8) & 0xFF)
  - #define **Pm\_MessageData2**(msg) (((msg) >> 16) & 0xFF)

## Typedefs

- typedef int32\_t **PmMessage**  
see [PmEvent](#)

## Functions

- PMEXPORT PmError **Pm\_SetFilter** (PortMidiStream \*stream, int32\_t filters)
- PMEXPORT PmError **Pm\_SetChannelMask** (PortMidiStream \*stream, int mask)
- Pm\_SetChannelMask()** filters incoming messages based on channel.*
- PMEXPORT PmError **Pm\_Abort** (PortMidiStream \*stream)
- Pm\_Abort()** terminates outgoing messages immediately The caller should immediately close the output port; this call may result in transmission of a partial midi message.*
- PMEXPORT PmError **Pm\_Close** (PortMidiStream \*stream)
- Pm\_Close()** closes a midi stream, flushing any pending buffers.*
- PmError **Pm\_Synchronize** (PortMidiStream \*stream)
- Pm\_Synchronize()** instructs PortMidi to (re)synchronize to the time\_proc passed when the stream was opened.*

### 3.2.1 Define Documentation

#### 3.2.1.1 #define PM\_FILT\_REALTIME

**Value:**

```
(PM_FILT_ACTIVE | PM_FILT_SYSEX | PM_FILT_CLOCK | \
 PM_FILT_PLAY | PM_FILT_UNDEFINED | PM_FILT_RESET | PM_FILT_TICK)
```

filter all real-time messages

Definition at line 406 of file portmidi.h.

#### 3.2.1.2 #define Pm\_Message( status, data1, data2 )

**Value:**

```
((((data2) << 16) & 0xFF0000) | \
 ((data1) << 8) & 0xFF00) | \
 ((status) & 0xFF))
```

[Pm\\_Message\(\)](#) encodes a short Midi message into a 32-bit word.

If data1 and/or data2 are not present, use zero.

Pm\_MessageStatus(), Pm\_MessageData1(), and Pm\_MessageData2() extract fields from a 32-bit midi message.

Definition at line 504 of file portmidi.h.

### 3.2.2 Function Documentation

#### 3.2.2.1 PMEXPORT PmError Pm\_Abort ( PortMidiStream \* stream )

[Pm\\_Abort\(\)](#) terminates outgoing messages immediately The caller should immediately close the output port; this call may result in transmission of a partial midi message.

There is no abort for Midi input because the user can simply ignore messages in the buffer and close an input device at any time.

Definition at line 906 of file portmidi.c.

#### 3.2.2.2 PMEXPORT PmError Pm\_Close ( PortMidiStream \* stream )

[Pm\\_Close\(\)](#) closes a midi stream, flushing any pending buffers.

(PortMidi attempts to close open streams when the application exits -- this is particularly difficult under Windows.)

Definition at line 860 of file portmidi.c.

### 3.2.2.3 PMEXPORT PmError Pm\_SetChannelMask ( PortMidiStream \* stream, int mask )

[Pm\\_SetChannelMask\(\)](#) filters incoming messages based on channel.

The mask is a 16-bit bitfield corresponding to appropriate channels. The `Pm_Channel` macro can assist in calling this function. i.e. to set receive only input on channel 1, call with `Pm_SetChannelMask(Pm_Channel(1))`; Multiple channels should be OR'd together, like `Pm_SetChannelMask(Pm_Channel(10) | Pm_Channel(11))`

Note that channels are numbered 0 to 15 (not 1 to 16). Most synthesizer and interfaces number channels starting at 1, but PortMidi numbers channels starting at 0.

All channels are allowed by default

Definition at line 831 of file portmidi.c.

### 3.2.2.4 PmError Pm\_Synchronize ( PortMidiStream \* stream )

[Pm\\_Synchronize\(\)](#) instructs PortMidi to (re)synchronize to the `time_proc` passed when the stream was opened.

Typically, this is used when the stream must be opened before the `time_proc` reference is actually advancing. In this case, message timing may be erratic, but since timestamps of zero mean "send immediately," initialization messages with zero timestamps can be written without a functioning time reference and without problems. Before the first MIDI message with a non-zero timestamp is written to the stream, the time reference must begin to advance (for example, if the `time_proc` computes time based on audio samples, time might begin to advance when an audio stream becomes active). After `time_proc` return values become valid, and BEFORE writing the first non-zero timestamped MIDI message, call [Pm\\_Synchronize\(\)](#) so that PortMidi can observe the difference between the current `time_proc` value and its MIDI stream time.

In the more normal case where `time_proc` values advance continuously, there is no need to call `Pm_Synchronize`. PortMidi will always synchronize at the first output message and periodically thereafter.

Definition at line 892 of file portmidi.c.

## 3.3 Reading and Writing Midi Messages

### Functions

- PMEXPORT int [Pm\\_Read](#) (PortMidiStream \*stream, [PmEvent](#) \*buffer, int32\_t length)  
[Pm\\_Read\(\)](#) retrieves midi data into a buffer, and returns the number of events read.
- PMEXPORT PmError [Pm\\_Poll](#) (PortMidiStream \*stream)  
[Pm\\_Poll\(\)](#) tests whether input is available, returning `TRUE`, `FALSE`, or an error value.
- PMEXPORT PmError [Pm\\_Write](#) (PortMidiStream \*stream, [PmEvent](#) \*buffer, int32\_t length)  
[Pm\\_Write\(\)](#) writes midi data from a buffer.

- PMEXPORT PmError [Pm\\_WriteShort](#) (PortMidiStream \*stream, PmTimestamp when, int32\_t msg)  
*[Pm\\_WriteShort\(\)](#) writes a timestamped non-system-exclusive midi message.*
- PMEXPORT PmError [Pm\\_WriteSysEx](#) (PortMidiStream \*stream, PmTimestamp when, unsigned char \*msg)  
*[Pm\\_WriteSysEx\(\)](#) writes a timestamped system-exclusive midi message.*

### 3.3.1 Function Documentation

3.3.1.1 PMEXPORT int Pm\_Read ( PortMidiStream \* *stream*, PmEvent \* *buffer*, int32\_t *length* )

[Pm\\_Read\(\)](#) retrieves midi data into a buffer, and returns the number of events read.

Result is a non-negative number unless an error occurs, in which case a PmError value will be returned.

#### Buffer Overflow

The problem: if an input overflow occurs, data will be lost, ultimately because there is no flow control all the way back to the data source. When data is lost, the receiver should be notified and some sort of graceful recovery should take place, e.g. you shouldn't resume receiving in the middle of a long sysex message.

With a lock-free fifo, which is pretty much what we're stuck with to enable portability to the Mac, it's tricky for the producer and consumer to synchronously reset the buffer and resume normal operation.

Solution: the buffer managed by PortMidi will be flushed when an overflow occurs. The consumer ([Pm\\_Read\(\)](#)) gets an error message (pmBufferOverflow) and ordinary processing resumes as soon as a new message arrives. The remainder of a partial sysex message is not considered to be a "new message" and will be flushed as well.

Definition at line 357 of file portmidi.c.

3.3.1.2 PMEXPORT PmError Pm\_Write ( PortMidiStream \* *stream*, PmEvent \* *buffer*, int32\_t *length* )

[Pm\\_Write\(\)](#) writes midi data from a buffer.

This may contain:

- short messages or
- sysex messages that are converted into a sequence of [PmEvent](#) structures, e.g. sending data from a file or forwarding them from midi input.

Use [Pm\\_WriteSysEx\(\)](#) to write a sysex message stored as a contiguous array of bytes.

Sysex data may contain embedded real-time messages.

Definition at line 448 of file portmidi.c.

Referenced by [Pm\\_WriteShort\(\)](#), and [Pm\\_WriteSysEx\(\)](#).

3.3.1.3 PMEXPORT PmError Pm\_WriteShort ( PortMidiStream \* *stream*, PmTimestamp *when*,  
int32\_t *msg* )

[Pm\\_WriteShort\(\)](#) writes a timestamped non-system-exclusive midi message.

Messages are delivered in order as received, and timestamps must be non-decreasing.  
(But timestamps are ignored if the stream was opened with latency = 0.)

Definition at line 581 of file portmidi.c.

References [Pm\\_Write\(\)](#).



## Chapter 4

# Data Structure Documentation

### 4.1 PmDeviceInfo Struct Reference

#### Data Fields

- int [structVersion](#)  
*this internal structure version*
- const char \* [interf](#)  
*underlying MIDI API, e.g.*
- const char \* [name](#)  
*device name, e.g.*
- int [input](#)  
*true iff input is available*
- int [output](#)  
*true iff output is available*
- int [opened](#)  
*used by generic PortMidi code to do error checking on arguments*

#### 4.1.1 Detailed Description

Definition at line 207 of file portmidi.h.

#### 4.1.2 Field Documentation

##### 4.1.2.1 const char\* PmDeviceInfo::interf

underlying MIDI API, e.g.

MMSystem or DirectX

Definition at line 209 of file portmidi.h.

#### 4.1.2.2 `const char* PmDeviceInfo::name`

device name, e.g.

USB MidiSport 1x1

Definition at line 210 of file portmidi.h.

The documentation for this struct was generated from the following file:

- portmidi.h

## 4.2 PmEvent Struct Reference

All midi data comes in the form of [PmEvent](#) structures.

```
#include <portmidi.h>
```

### Data Fields

- [PmMessage](#) **message**
- PmTimestamp **timestamp**

#### 4.2.1 Detailed Description

All midi data comes in the form of [PmEvent](#) structures.

A sysex message is encoded as a sequence of [PmEvent](#) structures, with each structure carrying 4 bytes of the message, i.e. only the first [PmEvent](#) carries the status byte.

Note that MIDI allows nested messages: the so-called "real-time" MIDI messages can be inserted into the MIDI byte stream at any location, including within a sysex message. MIDI real-time messages are one-byte messages used mainly for timing (see the MIDI spec). PortMidi retains the order of non-real-time MIDI messages on both input and output, but it does not specify exactly how real-time messages are processed. This is particularly problematic for MIDI input, because the input parser must either prepare to buffer an unlimited number of sysex message bytes or to buffer an unlimited number of real-time messages that arrive embedded in a long sysex message. To simplify things, the input parser is allowed to pass real-time MIDI messages embedded within a sysex message, and it is up to the client to detect, process, and remove these messages as they arrive.

When receiving sysex messages, the sysex message is terminated by either an EOX status byte (anywhere in the 4 byte messages) or by a non-real-time status byte in the low order byte of the message. If you get a non-real-time status byte but there was no EOX byte, it means the sysex message was somehow truncated. This is not considered an error; e.g., a missing EOX can result from the user disconnecting a MIDI cable during sysex transmission.

A real-time message can occur within a sysex message. A real-time message will always occupy a full [PmEvent](#) with the status byte in the low-order byte of the [PmEvent](#)

message field. (This implies that the byte-order of sysex bytes and real-time message bytes may not be preserved -- for example, if a real-time message arrives after 3 bytes of a sysex message, the real-time message will be delivered first. The first word of the sysex message will be delivered only after the 4th byte arrives, filling the 4-byte [PmEvent](#) message field.

The timestamp field is observed when the output port is opened with a non-zero latency. A timestamp of zero means "use the current time", which in turn means to deliver the message with a delay of latency (the latency parameter used when opening the output port.) Do not expect PortMidi to sort data according to timestamps -- messages should be sent in the correct order, and timestamps **MUST** be non-decreasing. See also "Example" for `Pm_OpenOutput()` above.

A sysex message will generally fill many [PmEvent](#) structures. On output to a PortMidiStream with non-zero latency, the first timestamp on sysex message data will determine the time to begin sending the message. PortMidi implementations may ignore timestamps for the remainder of the sysex message.

On input, the timestamp ideally denotes the arrival time of the status byte of the message. The first timestamp on sysex message data will be valid. Subsequent timestamps may denote when message bytes were actually received, or they may be simply copies of the first timestamp.

Timestamps for nested messages: If a real-time message arrives in the middle of some other message, it is enqueued immediately with the timestamp corresponding to its arrival time. The interrupted non-real-time message or 4-byte packet of sysex data will be enqueued later. The timestamp of interrupted data will be equal to that of the interrupting real-time message to insure that timestamps are non-decreasing.

Definition at line 578 of file portmidi.h.

The documentation for this struct was generated from the following file:

- portmidi.h

# Index

- Events and Filters Handling, [7](#)
  - Pm\_Abort, [9](#)
  - Pm\_Close, [9](#)
  - PM\_FILT\_REALTIME, [9](#)
  - Pm\_Message, [9](#)
  - Pm\_SetChannelMask, [9](#)
  - Pm\_Synchronize, [10](#)
- Input/Output Devices Handling, [5](#)
  - Pm\_GetDeviceInfo, [5](#)
  - Pm\_OpenInput, [5](#)
- interf
  - PmDeviceInfo, [13](#)
- name
  - PmDeviceInfo, [13](#)
- Pm\_Abort
  - Events and Filters Handling, [9](#)
- Pm\_Close
  - Events and Filters Handling, [9](#)
- PM\_FILT\_REALTIME
  - Events and Filters Handling, [9](#)
- Pm\_GetDeviceInfo
  - Input/Output Devices Handling, [5](#)
- Pm\_Message
  - Events and Filters Handling, [9](#)
- Pm\_OpenInput
  - Input/Output Devices Handling, [5](#)
- Pm\_Read
  - Reading and Writing Midi Messages, [11](#)
- Pm\_SetChannelMask
  - Events and Filters Handling, [9](#)
- Pm\_Synchronize
  - Events and Filters Handling, [10](#)
- Pm\_Write
  - Reading and Writing Midi Messages, [11](#)
- Pm\_WriteShort
  - Reading and Writing Midi Messages, [11](#)
- PmDeviceInfo, [13](#)
  - interf, [13](#)
  - name, [13](#)
- PmEvent, [14](#)
- Reading and Writing Midi Messages, [10](#)
  - Pm\_Read, [11](#)
  - Pm\_Write, [11](#)
  - Pm\_WriteShort, [11](#)