

# HxM Bluetooth API Guide



# **Document History**

Version	Date	Description
1.1	16-05-2008	Initial version
1.2	14-07-2008	Added requirement for a security passkey to the security section.
1.3	28-08-2008	Added comms. packet information
1.4	19-01-2009	Added HyperTerminal Hardware Check
1.5	19-05-2010	Remove cadence
1.6	31-05-2010	Correct stride rollover value to 128
1.7	22-07-2010	Add Packet Logger Utility

# **Document Notes**

All numbers in this document are written in decimal, except hexadecimal numbers which are prefixed by '0x'. For example 5436 is decimal, while 0x5436 is hexadecimal.



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# 1. References

Ref #	ID	Description
[1]	9700.0028c	General Comms Link Specification.

# 2. Abbreviations

Abbreviation	Description			
API	Application Programmer's Interface			
ECG	ElectroCardioGram			
HRM	Heart Rate Monitor			
HxM	Heart Rate / Speed and Distance Monitor			
PC	Personal Computer			
RTC	Real Time Clock			
SPP	Serial Port Profile			

# 3. Introduction

This document is intended as a user's guide for implementing an API to enable communications with a Zephyr Technology Bluetooth Heart Rate / Speed & Distance Monitor (HxM)



# 4. System Overview

#### 4.1. System Architecture

Mobile Device	НхМ
<b>₩</b>	Bluetooth Link

Figure 1 : HxM System Architecture

The diagram above shows that the Bluetooth HxM typically communicates with a mobile device over the Bluetooth link. The HxM only supports one link at a time and uses the Bluetooth **SPP** (Serial Port Profile) to communicate with other devices with the following low-level protocol:

- 115,200 baud
- 8 data bits
- 1 stop bit
- No parity

#### 4.2. Connecting to HxM Device

The device is discoverable. The discoverable name of the device is HXMXXXXX where XXXXXX is the programmed serial number of the HxM device.

When the HxM device is in a connected state it is not discoverable.

The following steps have to be undertaken to connect to a HxM device.

- 1) Activate the Bluetooth service of the device/computer wanting to connect to the HxM
- 2) Scan for Bluetooth devices in range
- 3) Pair with the HxM device found in range
- 4) Discover Services of Paired HxM
- 5) Connect to serial port of HxM device

The following screenshots show the above process with the standard Microsoft Bluetooth driver and Microsoft Windows XP Operating System.

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My Bluetooth Places\Entire B	luetooth Neighborhood		
Ele Edit ⊻lew Bluetooth Favo	rites <u>T</u> ools <u>H</u> elp		
3 Back 🔹 🕥 🕣 🏂 🔎	Search 😥 Folders 🛄 🔹	Folder Sync	
dress 🔮 My Bluetooth Places\Entire	Bluetooth Neighborhood		💌 🋃 G
	Device Name	Туре	Additional Information
Bluetooth Tasks         Image: Control of the services           Image: Display the services         Image: Control of the services           Image: Display the services         Image: Control of the services           Image: Display the services         Image: Control of the services           Image: Display the services         Image: Control of the services           Image: Display the services         Image: Control of the services           Image: Display the services         Image: Control of the services           Image: Display the services         Image: Control of the services           Image: Display the services         Image: Control of the services           Image: Display the services         Image: Control of the services           Image: Display the services         Image: Control of the services           Image: Display the services         Image: Control of the services           Image: Display the services         Image: Control of the services           Image: Display the services         Image: Control of the services           Image: Display the services         Image: Control of the services           Image: Display the services         Image: Control of the services           Image: Display the services         Image: Control of the services           Image: Display the services         Image: Control of the services           Image: Display the	BH ZBH001033 BH ZBH001084 CH ZBH001084 PEWTER RI 000043 RI 000051 RI ZBH000048	Unknown: Major(31), Minor(0) Unknown: Major(31), Minor(0) Unknown: Major(31), Minor(0) Laptop Unknov Minor(0) Unknov Minor(0) Unknown: Major(31), Minor(0)	Paired Paired
Other Places	ZEPHYR_BAA	Desktop	

Figure 2 : Scan for Bluetooth devices in range

The device is discoverable. The discoverable name of the device is its serial number. To connect to the device a passkey must be used.

The passkey is "1234", and cannot be changed.

Bluetoot	h PIN Code Request
P	Device Name: HXM001041
	Before a connection can be established, this computer and the device above must be "paired."
	The Bluetooth pairing procedure creates a secret key that is used in all future connections between these two devices to establish identity and encrypt the data that these devices exchange.
	To create the paired relationship, enter the PIN code and click OK.
	Bluetooth PIN Code:
	OK Cancel <u>H</u> elp

Figure 3 : Pair with HxM and provide PIN



Figure 4 : Discover services of HxM device

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Figure 5 : Connect to Bluetooth HxM serial port



Figure 6 : Connected to Bluetooth HxM serial port



# 5. HxM Communications Link

Once a Bluetooth connection has been established with the HxM, the data packets can be received by the connecting device. The following sequence diagram shows an example session:



Figure 7 : Example link session

The diagram shows that after the mobile device has connected to the HRM it receives a data packet from the HxM at 1 second intervals.

The Heart Rate, Speed & Distance message cannot be disabled. The device will not respond to or acknowledge.



# 6. Communications Packet Structure Overview

The serial communication between the HxM device and the paired device operates in a simplex mode. The HxM device transmits the HxM data packet and does not process any received data.

#### 6.1. Basic Message Format



#### Figure 8 : Basic Message Format

#### 6.1.1. <u>STX</u>

The STX field (Start of Text) is a standard ASCII control character (0x02) and denotes the start of the message. Although the protocol does not guarantee this value will not appear again within a message, it gives some delimiting to the message and therefore a start character to search for when receiving data.

#### 6.1.2. <u>Msg ID</u>

The Message ID uniquely identifies each message type and is in binary format. For the HxM the message ID is 0x26 for the standard HxM data packet.

#### 6.1.3. <u>DLC</u>

The Data Length Code is used to specify the number of bytes within the data payload field of the message. Valid values range between zero and 128 (inclusive). For the standard HxM data packet the DLC has a value of 0x37.

#### 6.1.4. Data Payload

This field contains the actual data sent between the local and remote units and can contain anywhere between zero and 128 bytes of data. The number of bytes in this field is dictated by the DLC field.



### 6.1.5. <u>CRC</u>

An 8-bit CRC is used and has a polynomial of 0x8C (CRC-8), with the accumulator being initialised to zero before the CRC calculation begins. The following source code indicates the required implementation:

#### crc: The current CRC.

#### Ch: Value to add to the CRC calculation.

```
Void crc8PushByte(uint8_t *crc, uint8_t ch)
{
   uint8_t i;
   *crc = *crc ^ ch;
   for (i=0; i<8; i++)
   {
      if (*crc & 1)
      {
         *crc = (*crc >> 1) ^0x8C;
      }
      else
      {
         *crc = (*crc >> 1);
      }
   }
}
```

pcrc: Pointer to running CRC to update (set this to something before first call). Block: Pointer to the block of data to push through.

Count: The number of bytes to push.

Return: The computed CRC (result also updated in pcrc if that is non-NULL).

```
Uint8_t crc8PushBlock(uint8_t *pcrc, uint8_t *block, uint16_t count)
{
    uint8_t crc = pcrc ? *pcrc : 0;
    for (; count>0; --count,block++)
    {
        crc8PushByte(&crc, *block);
    }
    if (pcrc) *pcrc = crc;
    return crc;
}
```

### 6.1.6. <u>ETX</u>

The ETX field (End of Text) is a standard ASCII control character (0x03) and denotes the end of the message.



# 7. Standard HxM Data Message

#### 7.1. MSG:0x26 – Heart Rate, Speed & Distance packet

This message contains the heart rate data, including the last 15 RR timestamps, and speed & distance data. The packet is transmitted periodically at 1Hz.

Byte/Bit	7	6	5	4	3	2	1	0	Field
0					STX				STX
1	0x26				Msg ID				
2					55				DLC
3					Firmware	e ID			
5				Fir	mware V	ersion			
7					Hardware	e ID			_
9				Ha	rdware V	ersion			_
11	Battery Charge Indicator								
12		Heart Rate					_		
13				Hea	rt Beat N	lumber			_
14			He	eart Beat	Timestan	1p #1 (Ne	west)		_
16				Heart E	Beat Lime	estamp #2	2		_
18				Heart E	Beat Time	estamp #:	3		_
20				Heart E	Seat Time	estamp #4	4 -		_
22				Heart		estamp #	2		-
24					Seat Time	estamp #	2 7		-
20					Seat Time	stamp #	2		-
30	Heart Beat Timestamp #9						Payload		
32				Heart B	eat Time	stamp #1	0		-
34				Heart B	eat Time	stamp #1	1		-
36				Heart B	eat Time	stamp #1	2		
38				Heart B	eat Time	stamp #1	3		
40				Heart B	eat Time	stamp #1	4		
42			He	eart Beat	Timestarr	np #15 (C	ldest)		
44					Reserve	ed			
46					Reserve	ed			
48					Reserve	ed			
50					Distanc	e			
52				Insta	Intaneous	s speed			_
54					Strides	5			4
55					Reserve	ed			4
56					Reserve	ed			
58					CRC				CRC
59					ETX				ETX

Table 7.1

Message: Heart Rate, Speed & Distance Packet



#### 7.1.1. Packing Format

All bytes are little endian.

All 16 bit unsigned integers are sent least significant byte first.

#### Firmware ID & Version

Zephyr Firmware releases are identified with identification codes of the following form "9500.xxxx.Vyz" where xxxx is a number indentifying the firmware type (0000 - 9999), and y is the major version (1 - 9) and z is the minor version (A - Z, or a-z).

The firmware ID field represents xxxx, and the firmware version field is two ASCII bytes representing yz.

#### Hardware ID & Version

Zephyr Hardware releases are identified with identification codes of the following form "9800.xxxx.Vyz" where xxxx is a number indentifying the product (0000 - 9999), and y is the major version (1 - 9) and z is the minor version (A - Z, or a-z).

The hardware ID field represents xxxx, and the hardware version field is two ASCII bytes representing yz.

#### Battery Charge Indicator

The battery charge indicator is an unsigned byte, representing the percentage of charge remaining. The valid range is 0 to 100%.

The unit will continue to run for a short time once the charge indication has reached 0%.

#### Heart Rate

The heart rate is an unsigned byte, representing the heart rate in beats per minute. The valid range is 30 to 240bpm, but the value will go to zero if no valid heart beat is detected within the timeout period.

#### Heart Beat Number

The heart beat number is an unsigned byte, which is incremented each time a heart beat event is detected. The valid range is 0 - 255. The count rolls over after 255.

This enables the receiver to determine how many new heart beat timestamps are present in the received packet, even in the event of a dropped packet.



#### Heart Beat Timestamp (1 to 15)

The heart beat timestamp is a 16 bit unsigned integer, representing the time at which the heart beat occurred, in milliseconds. (Valid range 0 – 65535ms)

The time used to populate the timestamp rolls over after 65535ms. This should be taken into consideration when calculating the heart beat interval (RR time).

The R to R data consists of a series of R-detection timestamps with 1 millisecond resolution. The internal clock rolls over at 65535 ms.



#### Figure 9 : PQRS Waveform showing the R-R Interval.

The R to R interval is the time between subsequent R peaks in an ECG waveform.

15 values are sent, such that at the fastest valid heart rate (240bpm) 3 consecutive packets can be dropped without loss of information. Timestamp #1 is the most recent heart beat and timestamp #15 is the oldest.

#### Distance

The distance is a 16 bit unsigned integer, representing the cumulative distance travelled since the device was powered on, in 16ths of a meter (valid range 0 to 4095). The distance travelled rolls over every 256m.

#### Instantaneous speed

The Instantaneous speed is a 16 bit unsigned integer, representing the Instantaneous speed of the wearer in steps of 1/256 m/s. The valid range is 0 - 4095 steps or 0 to 15.996 m/s.

#### Strides

The strides count is an unsigned byte, representing the number of strides since the unit was powered on. The valid range is 0 to 255 strides. The number of strides rolls over every 128 strides.



# 8. Hardware Check Using Hyper Terminal

The following steps can be used to confirm output from the device using Hyper Terminal. In this example, the Bluetooth Utility used is IVT BlueSoleil in a desktop PC in conjunction with a USB Bluetooth dongle.

1. Start your Bluetooth utility and establish a connection with the HxM

IVT Corporation BlueSoleil - Ma Ello Wenn Mu Bluetoeth Mu Services	iin Window Toole Halo	
The New My Bidecood, My Services		<u>×</u>
- \$P\$ € \$P\$ = \$P\$	昭興家の多	de que n
		i.
and the second se	KM0011	27
and the second sec		BOTCICCIA3,53/CB
Ø?		PEWTER
вн звноосоо	HA	NS-LT
Bluetooth Basic Imaging Service	Connected	PAN TP: 192 168 50 1

In the example above the device is HxM001127

2. Establish a Connection with the device using Passkey '1234'

Enter I	Bluetooth Pa	sskey	🛛
<b>?</b> ®	A remote devic relationship for passkey on thi Remote Devic	the needs a Bluetooth Passkey to create Paired future connections. Please use the same s device and on the remote device: e: 00:07:00:07:24:05	<u>O</u> K <u>C</u> ancel
	Passkey: Time Left: 12 s	xxxx xxxx	



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3. Determine which COM Port is being used:



The Serial Port Service is COM47 in this example

Use Windows > Start > All Programs > Accessories > Communications > Hyper Terminal

Connection Descriptio	n		?
8			
Enter a name and choose	an icon for th	e connectio	n:
Name:			
HxM Test			
lcon:			
	MCI	<b>6</b>	H 🚫
S 😒 🔊		V 🔇	2 13
<			>
		r I C	Cancel
			Caricer

Enter 'HxM Test' or similar as a New Connection name.



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4. Select the COM Port from the pulldown list and click OK

Connect To	? 🛛
🦓 HxM Tes	st
Enter details for	the phone number that you want to dial:
Country/region:	New Zealand (64)
Ar <u>e</u> a code:	09
Phone number:	
Connect using:	Bluetooth Fax Modem
	Bluetooth DUN Modem Bluetooth Fax Modem Standard Modem COM45 COM46
	COM47
	COM48 COM49 COM50 COM51 COM52 COM53 COM54 COM55 COM9 COM10 COM10

5. Set the Connection Properties as shown

OM47 Properties		?
Port Settings		
<u>B</u> its per second:	115200	¥
<u>D</u> ata bits:	8	~
<u>P</u> arity:	None	~
<u>S</u> top bits:	1	~
<u>F</u> low control:	None	~
	Restore	Defaults

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6. The Hyper Terminal Window should now show output from the device



Note that the device outputs binary data. Hyper Terminal displays this as ASCII.

Notes:

1. The device has wear-detect circuitry which switches on data output. If no data is observed, moisten the sensors pads with water.

Excessively dry skin may not have sufficient conductivity to turn the device on.

![](_page_17_Picture_0.jpeg)

# 9. HxM Packet Logger Utility

A PC Tool is included as part of the SDK to allow you to receive and record data from a PC with a Bluetooth Interface. This can be a native PC Bluetooth card, or a Bluetooth USB dongle.

#### 9.1. Installation

#### 9.1.1. <u>.NET 3.5 SP1</u>

This utilities requires that Microsoft® .NET3.5SP1 be installed on your PC for it to operate (this framework is embed in Windows 7).

To install, browse the CD to locate

#### .. \BT HxM SDK\Microsoft\DotNetFX35SP1\dotNetFx35setup.exe

And double-click to install the software. Follow the Microsoft wizard instructions.

#### 9.1.2. <u>HxM Packet Logger</u>

To install, browse the CD and locate

#### .. \BT HxM SDK\BT HxM Packet Logger\setup.exe

And follow the installation wizard.

A desktop shortcut will be installed.

![](_page_18_Picture_0.jpeg)

#### 9.2. Operation

In order to use the Packet Logger, you must determine which COM Port is receiving the HxM data. Wear the device and moisten the sensor pads to power it on.

Use the Bluetooth Interface of your PC, or that supplied with your Bluetooth USB dongle, to display the Properties of the connection to the device:

![](_page_18_Picture_4.jpeg)

Note the COM Port number which has been allocated to the connection.

![](_page_19_Picture_0.jpeg)

Start the Packet Logger utility, enter the COM Port number, and click Open to start the tool:

Z BT HXM Packet I	.ogger - 9500.0	030.V1e	
<u>Eile E</u> dit			
Com Port			
СОМ51	Open	Clos	e
Live Data			
Hardware ID	9800.0080.V1d	RR Timestamp 1 RR Timestamp 2	52091 51247
Firmware ID	9500.0026.V1f	RR Timestamp 3 RR Timestamp 4	50399 49531
Battery		RR Timestamp 5 RR Timestamp 6	48651 47779
Heart Hate (bpm		RR Timestamp / RR Timestamp 8	46059
Heartbeat Loun	98	RR Timestamp 10	45215 44359 42497
Distance (m		RR Timestamp 12 RR Timestamp 12	43487 42619 41763
Distance (m	) U	RR Timestamp 14	40911
Strider		nn Tillestallp 15	40051
50008	. 0		
Logging BB log file			
1 Hz log file			
	C		
	Start Loggin	Stop Lo	gging
Debug Log			
LUM51 opened.			<u>~</u>
			~

To record data, click the browse buttons ., find a suitable location and enter the name of the file you want recorded. Do this for both the RR Log (text) file and the 1Hz Log (.csv) file

RR Log file name	1 Hz Log File		? 🔀
Save jm 📄 Sample HxM Packet Logger Data 🔹 🔇 🎓 📴 📰 •	Save jr	in: 🔁 Sample HxM Packet Logger Data 🔹	G 🦸 📂 🖽 -
My Recent Documents	My Recent Documents		
Desktop	Desktop		
My Documents	My Documents	8	
My Computer	My Computer		
File game: Sample HxM RR Log data.txt	<u>Save</u>	File name: Sample HxM packet Logger1 Hz log I	ile <u>Save</u>
My Network Save as type: Text Files	Cancel My Network	Save as type: CSV files	Cancel

![](_page_20_Picture_0.jpeg)

Click the Start Logging button to create the log files. Click Stop Logging when required.

Note: Each time the *Start Logging* button is clicked subsequently, the utility will overwrite any data already in the file displayed in the log file path. A new file must be created <u>prior</u> to clicking the *Start Logging* button if you don't want to over-write data already recorded.

#### 9.2.1. RR Log data

The text file contains heart rate RR intervals, measured in milliseconds. There is no timestamp information.

#### 9.2.2. <u>1 Hz Log Data</u>

The .csv file contains columns corresponding to lines 3 - 56 in Table 7.1