Enhanced Class 1 Bluetooth v2.1 Module

Firmware User's Guide

Version 1.3

Part # BT740-SA, BT740-SC

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REVISION HISTORY

Revision	Revision Date	Description
1.0	24 June 13	First Release
1.1	16 July 13	Minor changes to GPIO
1.2	25 August 14	Addition of Appendices for AT Commands, S Registers, and Error Codes.
1.3	19 June 15	Updated command examples

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1 AT COMMAND SET

1.1 Introduction to AT Commands

This chapter describes the 'AT' protocol used to control and configure the BT740-Sx Bluetooth modules after it is configured to present an 'AT' protocol instead of the alternate multipoint packet-based interface. The Multipoint Protocol is also described in this document.

The protocol is similar to the industry standard Hayes AT protocol used in telephony modems, as both types of devices are connection oriented. The extended AT command set makes the Laird device performs the three core actions of a Bluetooth device: establish Bluetooth connections, pair, and inquire. Many other provided AT commands perform ancillary functions, such as trusted device database management and S Register maintenance.

Just like telephony modems, the Laird device powers up in an unconnected state and only responds via the serial interface. In this state the Laird device can respond to Bluetooth Inquiries. Then, just like controlling a modem, the host issues AT commands which map to various Bluetooth activities. These AT commands have appropriate counterparts in the alternate multipoint packet based protocol which also achieve the same goal.

The nature of 'AT' protocol allows it to control and manage only one connection at a time; this is in contrast to the multipoint packet protocol which can simultaneously control many connections. The main advantage 'AT' protocol offers is simplicity.

The module has a serial interface through which the 'AT' protocol is channeled, which can be configured for baud rates from 1200 up to 921600 and has an RF communications end point. The default baud rate for AT command mode modules is 9600 bps.

The RF communications endpoint has a concept of connected and unconnected modes and the 'AT' protocol at the serial interface has a concept of command and data modes. This leads to the matrix of states shown below.

	RF Unconnected	RF Connected
Command Mode	Allowed	Allowed
Data Mode	**Illegal**	Allowed

The combination 'Data + RF Unconnected Mode' does not make sense and is ignored.

Navigation between these states uses the AT command/responses, described in detail in subsequent sections.

There are many references to the term 'S Register' in the rest of this document. These are an array of integer values stored in non-volatile memory which are used to configure the module so that it behaves in a certain way after powering. These 'S Registers' have two attributes; a value and an ID. The 'ID' is a positive integer number used in appropriate commands to read/write the values.

1.2 AT Protocol Mode

1.2.1 AT Protocol Assumptions

The CSR (Cambridge Silicon Radio) Bluetooth chipset in Laird devices has limited memory resources. Therefore it is NOT proposed that there be full implementation of the AT protocol as seen in modems. The claim made for this device is that it has a protocol *similar* to an AT modem. In fact, the protocol is similar

enough so that existing source code written for modems can be used with very little modification with a Laird device.

Therefore the following assumptions are made:

- All commands terminate by the carriage return character 0x0D, represented by the string <cr> in subsequent sections. It cannot be changed at runtime.
- All responses from the Laird device have carriage return and linefeed characters preceding and appending the response. These dual character sequences have the values 0x0D and 0x0A respectively and are represented by the string <cr,lf>.
- All Bluetooth addresses are represented by a fixed 12 digit case insensitive hexadecimal string.
- All Bluetooth Device Class codes are represented by a fixed 6 digit case insensitive hexadecimal string.
- Most new Bluetooth specific commands are identified by the string +BTx, where x is generally a mnemonic of the intended functionality.

1.2.2 Protocol Activation

Depending on the variant of the module, the AT protocol needs to activate so that on power up it presents this protocol interface instead of the alternate multipoint protocol.

The method that is always available and works is activation via S Register 255 in multipoint mode (and mapped to 9255 in AT mode), where setting a value of 1 selects multipoint packet protocol and a value of 2 selects AT protocol.

Note: Changes to this S register store in non-volatile memory at time of change and does not require the AT&W command (or the equivalent in multipoint mode CMD_STORE_REG) to commit to non-volatile memory.

Optionally, some firmware variants allow a value of 0 in this S Register and in this case on power up the protocol selection depends on the state of one of the GPIO pins (user settable) so that one state forces AT and the other forces multipoint.

1.3 AT Commands and Responses

This section describes all available AT commands. Many commands require mandatory parameters and some take optional parameters. These parameters are integer values, strings, Bluetooth addresses or device classes. The following convention is used when describing the various AT commands, and the response to a command is also stated.

<bd_addr>	A 12 character Bluetooth address consisting of ASCII characters '0' to '9', 'A' to 'F' and 'a' to 'f'.
<devclass>	A 6 character Bluetooth device class consisting of ASCII characters '0' to '9', 'A' to 'F' and 'a' to 'f'.
N	A positive integer value.
M	An integer value which could be positive or negative, which can be entered as a decimal value or in hexadecimal if preceded by the '$' character. E.g. the value 1234 can also be entered as $4D2
<string>	A string delimited by double quotes. E.g. "Hello World". The " character MUST be supplied as delimiters.
<uuid>	A 4 character UUID number consisting of ASCII characters '0' to '9', 'A' to 'F' and 'a' to 'f'.

1.3.1 Enter Local Command Mode

Command: ^^^

Response: <cr,lf>OK<cr,lf>

Description: When in data and connected mode, the host can force the device into a command and connected mode so that AT commands can be issued to the device. The character in this escape sequence is specified in the S2 register, therefore it can be changed. In addition, the escape sequence guard time is specified by S Register 12. By default the guard time is set to 100 milliseconds. Please refer to the Dropping Connections section for more related information.

In modems this escape sequence is typically "{delay}+{delay}+{delay}+{delay}", and configures by default to avoid confusion when the module is providing access to a modem.

1.3.2 Command Mode Status Check

Command: AT

Response: <cr,lf>OK<cr,lf>

Description: <cr,lf>OK<cr,lf>

1.3.3 Accept Incoming Connection (Answer Call)

Command: ATA

Response: <cr,lf>CONNECT 123456789012,<uuid>,<<cr,lf>

Where <uuid> is the profile with the established connection.

Description: Accept an incoming connection, which is indicated by the unsolicited string <cr,lf>RING 123456789012<cr,lf>, where 123456789012 is the Bluetooth address of the connecting device.

1.3.4 Make Outgoing Connection

Command: ATD<bd_addr>,<uuid>

Response: <cr,lf>CONNECT 123456789012,<uuid>,><cr,lf>

Or

<cr,lf>NO CARRIER<cr,lf>

Description: Make a connection to device with Bluetooth address <bd_addr> and profile <uuid>. The <uuid> is an optional parameter which specifies the UUID of the profile server to attach to, and if not supplied then uses the default UUID for SPP (1101).

The UUIDs in the following table are allowed:

Profile Name	UUID
Serial Port	1101
HID	1124
HDP	Use appropriate canned HDP commands instead

1.3.5 Enable/Disable Echo

Command: ATEn

Response: <cr,lf>OK<cr,lf>
Or
<cr,lf>ERROR nn<cr,lf>

Description: This command enables or disables the echo of characters to the host. The default echo condition sets via S Register 506. This command does not affect the S Register 506.

0 Disable echo.

1 Enable echo.

All other values of n generate an error.

1.3.6 Drop Connection

Command: ATH

Response: <cr,lf>NO CARRIER<cr,lf>
Or
<cr,lf>OK<cr,lf>

Description: Drop an existing connection or reject an incoming connection indicated by the unsolicited RING message. If a connection does not exist then the response is OK.

1.3.7 Information

Command: ATIn

Response: For recognized values of n.
<cr,lf>As Appropriate<cr,lf>OK<cr,lf>
All other values of n generate
<cr,lf> Laird Technologies Inc (c)2010 <cr,lf> OK<cr,lf>

Description: This returns the information in the following table about the Laird device. The list is not exhaustive as there are some values of 'n' which generate information for use by Laird Support.

Table 1-1: Laird device information

Index	Description
0	The product name/variant.
1	The underlying CCL Stack version information.
3	The Laird firmware revision Format A.B.C.F.G (See 333 for further details)
333	The full Laird firmware revision Format A.B.C.D.E.F.G, where A = Hardware Platform B = Major Stack Version Number (Changes when CCL stack changes : see ATi1) C = Major App Version Number (Changes when number of profiles change) D = Developer ID

Index	Description
	E = Branch ID F = Build Number (divisible by 10 for production releases and Odd for Engineering) G = Twig Number (will normally be 0, but minor releases on sub-branches is non-zero)
4	A 12 digit hexadecimal number corresponding to the Bluetooth address of the Laird device.
6	The maximum size of trusted device database.
9	0 if not in a connect state and 1 if in a connect state.
11	The reason why a "NO CARRIER" results in the most recent attempt at making an outgoing connection. Where the response values are as follows: 3 = Normal disconnection
13	Current Sniff parameters in two lines as follows A,B,C,D A,B,C,D Where first line is in units of milliseconds and the second in baseband slots. A = Attempt (see S Reg 73, 561 in AT Mode) B = Timeout (see S Reg 74, 562 in AT Mode)) C = Minimum Interval (see S Reg 75, 563 in AT Mode) D = Maximum Interval (see S reg 76, 564 in AT Mode)
21	Current discoverable mode: 0 = Not Discoverable 1 = Generic Discoverable mode 2 = Limited Discoverable mode
22	Current connectable mode: 0 = Not Connectable 1 = Connectable
23	Same as (9) above. 0 if not in a connect state and 1 if in a connect state.
42	Current state of the module 14 = Not discoverable and not connectable and not in connection 18 = Connected mode 174 = Connectable and Discoverable 173 = Connectable only 172 = Discoverable only
56	The number of devices in the trusted device database in format a,b where 'a' is the number of devices in the 'rolling' database and 'b' in the 'persistant' database.
100	Returns the hardware ID (100 for BTM4xx platform)
201	UART receive buffer and hardware handshaking information in the format: A,B,C Where A = UART receive buffer size B = Threshold at which the RTS output line deasserts C = Threhsold at which the RTS output line re-asserts again.

Index	Description
202	The number of times the UART_DSR input line has been detected to toggle since the module was powered or reset via appropriate commands in AT and MP mode.
224-239	Memory Diagnostics information in the format "A,B" where A is the size of pmalloc block and B is the number that are free. Low 'B' values imply trhe module is operating at the limits of it's heap resource.

1.3.8 Enter Data Mode When Connected and in Command Mode

Command: ATO

Response: <cr,lf>CONNECT<cr,lf>
Or
<cr,lf>ERROR nn<cr,lf>

Description: Return to data mode. Assume that the module is in data mode after it receives an OK. Responds with an error if there is no Bluetooth connection.

1.3.9 Set S Register

Command: ATSn=m

Response: <cr,lf>OK<cr,lf>
Or
<cr,lf>ERROR nn<cr,lf>

Description: As with modems, the Laird Bluetooth module employs a concept of registers used to store parameters, such as escape sequence character, inquiry delay time, etc.
The value part 'm' can be entered as decimal or hexadecimal. A hexadecimal value is specified via a '$' leading character. For example, $1234 is a hexadecimal number.
When S register values change, the changes are **not** normally stored in non-volatile memory UNTIL the AT&W command is used.
Note that AT&W does not affect some S registers; for example 520 to 525, or 9240 to 9255, as they are updated in non-volatile memory when the command processes.

1.3.10 Read S Register Value in Decimal or Hex

Command: ATSn?<$>

Response: For recognised values of n:
<cr,lf>As Appropriate<cr,lf>**OK**<cr,lf>
For unrecognised values of n:
<cr,lf>ERROR nn<cr,lf>

Description: This returns the current value of register n. If the optional $ character supplies after the ?, then the returned value is hexadecimal with a leading $. For example, the value 1000 returns as $3E8.

1.3.11 Read S Register's Valid Range

Command: ATSn=?

Response: For recognised values of n:
<cr,lf>nnnn..mmmm<cr,lf>OK<cr,lf>
For unrecognised values of n:

<cr,lf>ERROR nn<cr,lf>

Description: This returns the valid range of values for register n.

1.3.12 Send Data to Peer When In Command Mode

Command: ATX<string>

Response: <cr,lf>OK<cr,lf>
Or if a connection does not exist
<cr,lf>ERROR 56<cr,lf>

Description: This command sends data to the remote device when in local command and connected mode.
If a non-printable ASCII character needs sending then insert the escape sequence \hh where hh are two hexadecimal digits. The three character sequence \hh converts into a single byte before transmission to the peer.
Note: For HID connections, the entire <string> is deemed to be a single HID report.

1.3.13 Factory Default (Full)

Command: AT&F*

Response: <cr,lf>OK<cr,lf>
Or
<cr,lf>ERROR nn<cr,lf>

Description: This command erases all user parameters in non-volatile memory.
The new settings become active after a reset.

1.3.14 Factory Default (Preserve Uart Settings)

Command: AT&F+

Response: <cr,lf>OK<cr,lf>
Or
<cr,lf>ERROR nn<cr,lf>

Description: This command erases all user parameters in non-volatile memory except S Registers 520 to 525, and 9240 to 9255. This means that the trusted device database clears, but 'AT' protocol mode is retained and UART config (baudrate, stopbits etc) is preserved.
The new protocol and settings become active after a reset.

1.3.15 Factory Default (Preserve Protocol Setting)

Command: AT&F*AT*

Response: <cr,lf>OK<cr,lf>
Or
<cr,lf>ERROR nn<cr,lf>

Description: This command erases all user parameters in non-volatile memory except S Register 9255. This means that the trusted device database clears, but 'AT' protocol mode retains and UART parameters reset to factory default settings.
The new protocol and settings become active after a reset.

1.3.16 Factory default (Full, then change into MP mode)

Command: AT&F*MP*

Response: <cr,lf>OK<cr,lf>
Or
<cr,lf>ERROR nn<cr,lf>

Description: This command erases all user parameters in non-volatile memory including S Register 9255 and S Reg 9255 is set to 1 for MP mode. This means that the trusted device database clears, and protocol sets to MP mode and all UART parameters are reset to factory default settings.
The new protocol and settings become active after a reset.

1.3.17 Write S Registers To Non-Volatile Memory

Command: AT&W

Response: <cr,lf>OK<cr,lf>
Or
<cr,lf>ERROR nn<cr,lf>

Description: Writes current S Register values to non-volatile memory so that they retain over a power cycle.

1.3.18 Write <String> To Blob(0)

Command: AT+BTB=<string>

Response: <cr,lf>OK<cr,lf>
Or
<cr,lf>ERROR nn<cr,lf>

Description: This command clears BLOB(0) first and then <string> appended to that BLOB **after the string de-escapes**. This allows binary data to load into the BLOB buffer for subsequent processing using the AT+BTBnnnn command syntax.

1.3.19 Append <String> To Blob(0)

Command: AT+BTB+<string>

Response: <cr,lf>OK<cr,lf>
Or
<cr,lf>ERROR nn<cr,lf>

Description: This command appends <string> BLOB(0) **after the string de-escapes**. This allows binary data to load into the BLOB buffer for subsequent processing using the AT+BTBnnnn command syntax.

1.3.20 Action And Process Data In Blob(0)

Command: AT+BTBnnnn

Response: <cr,lf>OK<cr,lf>
Or
<cr,lf>ERROR nn<cr,lf>

Description: This command processes BLOB(0) as per the action specified by 'nnnn'. The actions are described briefly as per the table below (more details in the MP protocol section):

Index	Action
0	Clear Blob(0)
1	Get byte count in Blob(0)
2	Destructively read Blob(0). Data sends so that non-printable data bytes are escaped with \hh.
3	Save Blob(0) as Hid Descriptor(0) in non-volatile memory
4	Load Blob(0) as Hid Descriptor(0) from non-volatile memory
5	Save Blob(0) as Hid Service Name in non-volatile memory
6	Load Blob(0) as Hid Service name from non-volatile memory
7	Commit Blob(0) as Enhanced Inquiry Data
8	Save Blob(0) as Enhanced Inquiry Data in non-volatile memory, to be used automatically after subsequent resets
9	Load Blob(0) from the Enhanced Inquiry Data from non-volatile memory.

1.3.21 Remove Trusted Device

Command: AT+BTD<bd_addr>

Response: <cr,lf>OK<cr,lf>
Or
<cr,lf>ERROR nn<cr,lf>

Description: This command removes the specified device from the list of trusted devices in the non-volatile database. If the device is not in the database then the response is still an OK. Error response is for when the address is not a 12 character hex string.

1.3.22 Remove All Trusted Devices

Command: AT+BTD*

Response: <cr,lf>OK<cr,lf>
Or
<cr,lf>ERROR nn<cr,lf>

Description: This command removes all devices from the list of trusted devices in the non-volatile database. The device does not ask for confirmation.

WARNING: If you make a connection, the link key caches in the underlying stack. So if you subsequently delete the key using AT+BTD* and immediately request an authenticated connection to the same device, then the connection may be established. To ensure this does not happen, send ATZ after the AT+BTD*.

1.3.23 Get the Remote Friendly Name

Command: AT+BTF<bd_addr>

Response: <cr,lf>Friendly Name
<cr,lf>OK<cr,lf>
Or
<cr,lf>ERROR nn<cr,lf>

Description: This command gets the remote friendly name of the specific address.
If the friendly name has non printable characters (including the character ") then those characters escape into a 3 character '\hh' sequence.

1.3.24 Enable Connectable Mode

Command: AT+BTG

Response: <cr,lf>OK<cr,lf>
Or
<cr,lf>ERROR nn<cr,lf>

Description: Enable page scanning only and waits for a connection from any device. Inquiry scans are disabled.
The page scan window and interval timing derives from S Reg 9009 and 9010.
Use ATi21 and ATi22 to determine the discoverable and connectable modes at any time.

1.3.25 Inquire

Command: AT+BTI

Response: <cr,lf>12346789012
<cr,lf>12345678914
<cr,lf>OK<cr,lf>

Description: This makes the device perform an inquiry for 'duration' milliseconds and 'max' number of unique responses, where S register 517 specifies 'duration' and S register 518 specifies 'max'. Only the Bluetooth address of responding devices is listed.

1.3.26 Inquire And Display Devclass Too

Command: AT+BTIV

Response: <cr,lf>12346789012,123456
<cr,lf>12345678914,123456
<cr,lf>OK<cr,lf>

Description: As per AT+BTI but the response includes the device class code for all inquiry responses.

1.3.27 Inquire and Get Friendly Names Too

Command: AT+BTIN

Response: <cr,lf>12346789012,123456,"Laird BT Module"
<cr,lf>12345678914,123456, "Nokia N70"
<cr,lf>OK<cr,lf>

Description: As per AT+BTI but the response includes the device class code and friendly name for all inquiry responses. The friendly name strings are in UTF-8 format as per the Bluetooth specification.

1.3.28 Inquire with Enhanced Inq Resp

Command: AT+BTIE

Response: <cr,lf>12346789012,123456,"",-45,"\0A\08Laird FEF"
<cr,lf>12345678914,123456,"",-75,""
<cr,lf>OK<cr,lf>

Description: As per AT+BTI but the response includes the device class code, RSSI, and the enhanced inquiry information. The friendly name is not acquired, as it is a time-expensive procedure and therefore an empty string sends as a placeholder.

1.3.29 Set Pincode or Passcode

Command: AT+BTK=<string>

Response: <cr,lf>OK<cr,lf>
Or
<cr,lf>ERROR nn<cr,lf>

Description: This command provides a passkey when PIN? 12345678 or PASSKEY? 12345678 indications are received asynchronously.
The string length must be in the range 1 to 16, for PIN? otherwise an error returns.
The string length must be exactly 6 characters, for PASSKEY? otherwise an error returns and each character MUST be a decimal digit in the range 0 to 9.
If there is no ongoing pairing in progress, then the <string> stores in non-volatile memory and may be used in subsequent legacy pairing attempts. To delete the pincode stored in non-volatile memory, submit the command with an empty string. A stored value is not used for a PASSKEY? Event.

1.3.30 Reject Yes/No Simple Secure Pairing

Command: AT+BTKN

Response: <cr,lf>OK<cr,lf>
Or
<cr,lf>ERROR nn<cr,lf>

Description: When the module configures for 'Display with Yes/No' security via S Register 9006, this command conveys a 'NO' for the simple pairing procedure. This command is sent as a result of receiving a "PASSKEY? 2 <bd_addr>" asynchronous response.

1.3.31 Accept Yes/No Simple Secure Pairing

Command: AT+BTKY

Response: <cr,lf>OK<cr,lf>
Or
<cr,lf>ERROR nn<cr,lf>

Description: When the module configures for 'Display with Yes/No' security via S Register 9006 then this command conveys a 'YES' for the simple pairing procedure. This command is sent as a result of receiving a "PASSKEY? 2 <bd_addr>" asynchronous response.

1.3.32 Set Friendly Name in Non-Vol Memory

Command: AT+BTN=<string>

Response: <cr,lf>OK<cr,lf>
Or
<cr,lf>ERROR nn<cr,lf>

Description: This sets the default friendly name of this device as seen by other devices. It is stored in non-volatile memory. Use AT+BTN? To read it back. An empty string ("") deletes the string from non-volatile memory which forces the use of the default friendly name.

1.3.33 Read Friendly Name From Non-Vol Memory

Command: AT+BTN?

Response: <cr,lf>My FriendlyName<cr,lf>
<cr,lf>OK<cr,lf>
Or
<cr,lf>ERROR nn<cr,lf>

Description: Read the friendly name from non-volatile memory.

1.3.34 Enable Connectable+Discoverable Mode

Command: AT+BTP

Response: <cr,lf>OK<cr,lf>
Or
<cr,lf>ERROR nn<cr,lf>

Description: Enable page and inquiry scanning and wait for a connection from any device.
The page scan window and interval timing derives from S Reg 9009 and 9010.
The inquiry scan window and interval timing derives from S Reg 9007 and 9008.

1.3.35 Enable Discoverable Mode Only

Command: AT+BTQ

Response: <cr,lf>OK<cr,lf>
Or
<cr,lf>ERROR nn<cr,lf>

Description: Set discoverable mode only by enabling inquiry scanning.
The inquiry scan window and interval timing derives from S Reg 9007 and 9008.
Use ATi21 and ATi22 to determine the discoverable and connectable modes at any time.

1.3.36 Set Outgoing Peer Address

Command: AT+BTR<bd_addr>

Response: <cr,lf>OK<cr,lf>

Description: This command stores a peer address for outbound connections in non-volatile memory. A value of 000000000000 has the special meaning of invalid peer address.

This command is used to set up a module in pure cable replacement mode.

If S register 512 = 1 and the peer address is NOT 000000000000, then it will periodically (time specified via S register 505) attempt to connect to the peer address specified. In this circumstance all commands from the host are buffered in the receive buffer, until a Bluetooth connection is established with the peer device and it then sends the buffer across. This means if the peer device is not nearby and will never be there, the device effectively becomes useless, as in this circumstance a host would want to get attention of the AT parser to send it new commands – probably one to delete the peer device.

In this circumstance, a recovery is possible by one of two methods. The first method assumes that the DTR from the host is connected to the DSR line of the module and the second method assumes that this connection is absent. In the first method it is enough to deassert the DTR line from the host and that will abort the autoconnect cycle. The second method is initiated by resetting the device and then ensuring that the text string "AT+BT&BISM&<cr>" is sent (where <cr> is the carriage return character). There is special code which looks out for this magic command and terminates the autoconnect cycle if it sees it and confirms to the host of that fact by sending an "OK" response.

1.3.37 Delete Outgoing Peer Address

Command: AT+BTR

Response: <cr,lf>OK<cr,lf>

Description: This command is used to display the peer address stored in non-volatile memory, used to put the EZURiO device in pure cable replacement mode.

1.3.38 Read Outgoing Peer Address

Command: AT+BTR?

Response: <cr,lf>12346789012
<cr,lf>OK<cr,lf>

Description: This command deletes the peer address previously stored using AT+BTR<bd_addr>.

1.3.39 List Trusted Device

Command: AT+BTT?

Response: <cr,lf>12346789012
<cr,lf>12345678913
<cr,lf>12345678914
<cr,lf>OK<cr,lf>
Or
<cr,lf>ERROR nn<cr,lf>

Description: This command lists the contents of both the 'rolling' and the 'persist' trusted device database. The link key does NOT display so the response is as shown above. If the list is

empty, only the OK response sends; otherwise an OK terminates the list. Use the command ATI6 to read the maximum size of the trusted device database.

Note: All new successful pairings automatically store in the 'rolling' database. If the database is full, then the oldest is deleted to make room for the new one. To ensure a link key is never deleted, transfer it to the 'persist' database using the command AT+BTT<bd_addr> described in detail later.

1.3.40 List Trusted Device

Command: AT+BTTn?

Response: <cr,lf>12346789012
<cr,lf>12345678913
<cr,lf>12345678914
<cr,lf>OK<cr,lf>
Or
<cr,lf>ERROR nn<cr,lf>

Description: This command lists the contents of either the 'rolling' or the 'persist' trusted device database, where n=0 for the rolling database and 1 for the persist database. The link key does NOT display so the response is as shown below. If the list is empty then just the OK response is sent; otherwise an OK terminates the list. Use the command ATI6 to read the maximum size of the trusted device database.

1.3.41 Transfer Device To 'Persist' List

Command: AT+BTT<bd_addr>

Response: <cr,lf>OK<cr,lf>
Or
<cr,lf>ERROR nn<cr,lf>

Description: When a successful pairing occurs, the new link key automatically stores in the 'rolling' database where if the database is full, the oldest device is deleted. This poses a risk of a trusted device automatically deleting, especially when the module is in 'just works' simple pairing mode and so pairings can occur without the host being involved and so there is a definite risk of link key deletion.
This command transfers a device specified via the address supplied to the 'persist' database so that a trusted device is never deleted automatically.

1.3.42 Initiate a Pairing

Command: AT+BTW<bd_addr>

Response: <cr,lf>OK<cr,lf>
Or
<cr,lf>ERROR nn<cr,lf>

Description: This initiates pairing with a device whose Bluetooth address is <bd_addr>. An OK response is sent immediately and when the PIN or PASSCODE is required. Asynchronous indications are sent to the host in the form PIN? <bd_addr> or PASSKEY? <bd_addr> or PAIR ? <bd_addr> where the address confirms the device with which the pairing is to be performed. To supply a PIN or passcode, use the AT+BTK command. To respond with a

YES or NO, use the command AT+BTKY or AT+BTKN respectively.

For a successful pairing, the link key automatically stores in the 'rolling' database which can be queried using the AT+BTT0? Command.

Note: The "OK" response is sent immediately on receipt of the AT+BTW command. On pairing completion, an unsolicited message is sent to the host in the form PAIR n <bd_addr>, where n is 0 for a successful pairing.

1.3.43 Disable Connectable And Discoverable Mode

Command: AT+BTX

Response: <cr,lf>OK<cr,lf>
Or
<cr,lf>ERROR nn<cr,lf>

Description: Disable page/inquiry scanning. This means it does not accept incoming connections or inquiry requests. More specifically it negates the effect of AT+BTQ, AT+BTG and AT+BTP commands.

Use ATi21 and ATi22 to determine the discoverable and connectable modes at any time.

1.3.44 HDP: Associate The Agent With Manager

Command: AT+HAAhhhh

Response: <cr,lf>OK<cr,lf>
Or
<cr,lf>ERROR nn<cr,lf>

Description: This is a Health Device Profile (HDP Agent related command. Refer to Application Examples for details). Please note ERROR 59 implies that the profile has not been activated which means bit 2 in S Reg 9003 is not set AND S Reg 9070 is not 0.

'hhhh' is obtained as a response to the AT+HAB command.

1.3.45 HDP: Bind Manager to Agent

Command: AT+HAB<bd_addr>,iiii

Response: <cr,lf>hhhh<cr,lf>OK<cr,lf>
Or
<cr,lf>ERROR nn<cr,lf>

Description: This is a Health Device Profile (HDP Agent related command. Refer to Application Examples for details). Please note ERROR 59 implies that the profile has not been activated which means bit 2 in S Reg 9003 is not set AND S Reg 9070 is not 0.

'iiii' is the nominal code for the data specialization.

1.3.46 HDP: Disassociate The Agent From Manager

Command: AT+HADhhhh

Response: <cr,lf>OK<cr,lf>
Or
<cr,lf>ERROR nn<cr,lf>

Description: This is a Health Device Profile (HDP Agent related command. Refer to Application Examples for details). Please note ERROR 59 implies that the profile has not been activated which means bit 2 in S Reg 9003 is not set AND S Reg 9070 is not 0.

1.3.47 HDP: Endpoint Definition In SDP Record

Command: AT+HAE,iiii,"endpointname"

Response: <cr,lf>OK<cr,lf>
Or
<cr,lf>ERROR nn<cr,lf>

Description: This is a Health Device Profile (HDP Agent related command. Refer to Application Examples for details). Please note ERROR 59 implies that the profile has not been activated which means bit 2 in S Reg 9003 is not set AND S Reg 9070 is not 0.
It inserts details in the SDP record.

1.3.48 HDP: Read Attribute Value In Agent

Command: AT+HAGhhhh,aaaa,ssss

Response: <cr,lf>OK<cr,lf>
Or
<cr,lf>ERROR nn<cr,lf>

Description: This is a Health Device Profile (HDP Agent related command. Refer to Application Examples for details). Please note ERROR 59 implies that the profile has not been activated which means bit 2 in S Reg 9003 is not set AND S Reg 9070 is not 0.

1.3.49 HDP: Activate SDP Record For Agent

Command: AT+HAL

Response: <cr,lf>OK<cr,lf>
Or
<cr,lf>ERROR nn<cr,lf>

Description: This is a Health Device Profile (HDP Agent related command. Refer to Application Examples for details). Please note ERROR 59 implies that the profile has not been activated which means bit 2 in S Reg 9003 is not set AND S Reg 9070 is not 0.

1.3.50 HDP: Trigger Agent Scan Report

Command: AT+HARhhhh,pppp[,aaaa[,aaaa[…]]]

Response: <cr,lf>OK<cr,lf>
Or
<cr,lf>ERROR nn<cr,lf>

Description: This is a Health Device Profile (HDP Agent related command. Refer to Application Examples for details). Please note ERROR 59 implies that the profile has not been activated which means bit 2 in S Reg 9003 is not set AND S Reg 9070 is not 0.

1.3.51 HDP: Write Attribute Value To Agent

Command: AT+HAShhhh,aaaa,ssss,ddddd

Response: <cr,lf>OK<cr,lf>
Or
<cr,lf>ERROR nn<cr,lf>

Description: This is a Health Device Profile (HDP Agent related command. Refer to Application Examples for details). Please note ERROR 59 implies that the profile has not been activated

which means bit 2 in S Reg 9003 is not set AND S Reg 9070 is not 0.

1.3.52 HDP: Endpoint Definition in SDP Record (Manager)

Command: AT+HME,iiii,"endpointname"

Response: <cr,lf>OK<cr,lf>
Or
<cr,lf>ERROR nn<cr,lf>

Description: This is a Health Device Profile (HDP Manager related command. Refer to Application Examples for details. Please note ERROR 59 implies that the profile has not been activated which means bit 2 in S Reg 9003 is not set AND S Reg 9070 is not 1.

1.3.53 HDP: Endpoint Definition in SDP Record (Manager)

Command: AT+HME,iiii,"endpointname"

Response: <cr,lf>OK<cr,lf>
Or
<cr,lf>ERROR nn<cr,lf>

Description: This is a Health Device Profile (HDP Manager related command. Refer to Application Examples for details). Please note ERROR 59 implies that the profile has not been activated which means bit 2 in S Reg 9003 is not set AND S Reg 9070 is not 1.

1.3.54 HDP: Activate SDP Record For Agent (Manager)

Command: AT+HML

Response: <cr,lf>OK<cr,lf>
Or
<cr,lf>ERROR nn<cr,lf>

Description: This is a Health Device Profile (HDP Manager related command. Refer to Application Examples for details). Please note ERROR 59 implies that the profile has not been activated which means bit 2 in S Reg 9003 is not set AND S Reg 9070 is not 1.

1.3.55 HDP: Read Attribute Value (Manager)

Command: AT+HMGhhhh,oooo,aaaa

Response: <cr,lf>OK<cr,lf>
Or
<cr,lf>ERROR nn<cr,lf>

Description: This is a Health Device Profile (HDP Manager related command. Refer to Application Examples for details). Please note ERROR 59 implies that the profile has not been activated which means bit 2 in S Reg 9003 is not set AND S Reg 9070 is not 1.

1.3.56 HDP: Send Time to Agent (Manager)

Command: AT+HMThhhh,ttttttt

Response: <cr,lf>OK<cr,lf>
Or
<cr,lf>ERROR nn<cr,lf>

Description: This is a Health Device Profile (HDP Manager related command. Refer to Application Examples for details). Please note ERROR 59 implies that the profile has not been activated which means bit 2 in S Reg 9003 is not set AND S Reg 9070 is not 1.

1.3.57 Add To Trusted Device Database (Rolling)

Command: AT+KY<addr>,<link_key>

Response: <cr,lf>OK<cr,lf>
Or
<cr,lf>ERROR nn<cr,lf>

Description: This command adds (or replaces) the <addr> and<link_key> pair to the rolling trusted device database. <addr> is a 12 hex digit Bluetooth address and <link_key> is a 32 hex digit random number. For more details, see the multipoint command CMD_TRUSTED_DB_ADD.

1.3.58 Read The Link Key For Address Specified

Command: AT+KY<addr>?

Response: <cr,lf>OK<cr,lf>
Or
<cr,lf>ERROR nn<cr,lf>
nn is 49 if the device is not in the trusted device database
nn is 45 is S Reg 47 is not set to 1

Description: This command reads the link key from the trusted device database for device with address <addr>. The link key information is sent only if S Reg 47 (9047) is set to 1. This command is gated through S Reg 47 (9047) to get confirmation from the user that they acknowledge that security is compromised by allowing link keys to be read.

1.3.59 Unsolicited/Async Responses

The 'AT' Protocol is a command/response type of protocol. This means that the Laird device normally only responds to AT commands and in addition only responds to one AT command at a time.

Under special circumstances, unsolicited responses are sent to the host. They are described in the following subsections. Each unsolicited response is prefixed and postfixed by a cr,lf two character sequence.

Command: No Command. This is a status message.

Response: RING

Description: This string is sent to the host every second repeatedly when a remote device initiates a serial port connection. The fully qualified string is in the form RING 012345678901, where 012345678901 is a 12 digit hexadecimal number which corresponds to the remote device's Bluetooth address.
The host responds with the ATA command to accept the connection or reject it using the ATH command.
If S Register 0 is set to a non-zero value then the incoming SPP connection automatically accepts after the number of RINGS specified in S Register 0 sends to the host.
Only incoming SPP connections invoke a RING response. Connections on other profiles are automatically accepted.

Command:	**No Command. This is a status message.**
Response:	PIN ? <bd_addr>
Description:	This response is sent to the host during a legacy pairing negotiation (pre BT version 2.1 compliant devices). The fully qualified string is PIN? 012345678901, where 012345678901is the Bluetooth address of the peer device. In response, the host must supply a pin code using the AT+BTK command.
Command:	**No Command. This is a status message.**
Response:	PASSKEY ? N <bd_addr>[,passcode]
Description:	This response is sent to the host during a simple secure pairing (SSP) negotiation and when the module is configured appropriately via S Register 9006. Where N is 1 for the host to display the passkey supplied, 2 for the host to respond with either the command AT+BTKY or AT+BTKN and 3 for the host to respond with AT+BTK="nnnnnn". The fully qualified string is : ▪ PASSKEY? 1 012345678901,123456 where 012345678901 is the Bluetooth address of the peer device and 123456 is the passcode to display to the user. ▪ PASSKEY? 2 012345678901,123456 where 012345678901 is the Bluetooth address of the peer device and 123456 is the passcode to display to the user. ▪ PASSKEY? 3 012345678901 where 012345678901 is the Bluetooth address of the peer device and the user echoes the passcode displayed on the peer device, or agree with the other user to enter the same random 6 digit passcode at both ends.
Command:	**No Command. This is a status message.**
Response:	PAIR N <bd_addr>
Description:	This response is sent to the host on completion (success or otherwise) of a pairing process. If pairing succeeds then 'n' = 0; if a timeout occurs then 'n'=1; and for all other unsuccessful outcomes the value is 2. The parameter <bd_addr> is the address of the peer device if available.
Command:	**No Command. This is a status message.**
Response:	RX<string>
Description:	This response is sent to the host when the unit is in online-command mode, S Register 531 is set to 3, and data arrives from a peer. For profiles other than SPP (1101), use S Register 531 as a flag. If it is 0, then the profile is serviced in 'canned' mode and in that case RX"" responses are not sent and neither does the ATX<string> command need to send data. If the data from the string contains non-printable characters (for example ASCII 0 to 31 and ASCII 128 to 255), then those characters translate into a 3 character escape sequence starting with '\'. For example, the embedded <cr><lf> sequence sends as the 6 character string \0D\0A. If the data contains the character '"' then it sends as \22. If the data contains the character '\' then it sends as \5C
Command:	**No Command. This is a status message.**
Response:	HDA:ASSOCIATED hhhh,iiii,cccc,sssssss
Description:	This is a Health Device Profile (HDP Agent) related asynchronous response. Refer to Application Examples for details.
Command:	**No Command. This is a status message.**
Response:	HDA:DISASSOCIATED hhhh

Description:	This is a Health Device Profile (HDP Agent) related asynchronous response. Refer to Application Examples for details.
Command:	**No Command. This is a status message.**
Response:	HDA:TIME hhhh,ttttttt
Description:	This is a Health Device Profile (HDP Agent) related asynchronous response. Refer to Application Examples for details.
Command:	**No Command. This is a status message.**
Response:	HDM:ASSOCIATED hhhh,iiii,cccc,sssssss
Description:	This is a Health Device Profile (HDP Manager) related asynchronous response. Refer to Application Examples for details.
Command:	**No Command. This is a status message.**
Response:	HDM:DISASSOCIATED hhhh
Description:	This is a Health Device Profile (HDP Manager) related asynchronous response. Refer to Application Examples for details.
Command:	**No Command. This is a status message.**
Response:	HDM:ASSOCIATED hhhh,iiii,cccc,sssssss
Description:	This is a Health Device Profile (HDP Agent) related asynchronous response. Refer to Application Examples for details.
Command:	**No Command. This is a status message.**
Response:	HDM:SCANREPORT hhhh:pppp …..<more>…
Description:	This is a Health Device Profile (HDP Agent) related asynchronous response. Refer to Application Examples for details.

2 S REGISTERS

All S registers are accessible when operating in AT protocol mode, but in MP protocol mode the only visible S Registers are listed as 'Standard' and 'Special'.

'Standard' and 'AT' S Registers share the same numbers in some cases. For this reason, the Standard and Special registers are accessed from AT mode by offsetting 9000. For example, the standard S register 3 for profiles is read by using the command ATS9003? and set using ATS9003=n.

2.1 Standard S Registers

This section details all the standard configuration 'S' registers. Minimum and Maximum values are given in decimal, unless the value is prefixed by 0x, in that case the value is in hexadecimal.

Table 2-1: Standard configuration S registers

RegNo Dec (Hex)	Min	Max	Category	Description
3 (03)	0	3	Profiles	Server Profile record Mask Bit 0 = SPP Bit 1 = HID Bit 2 = HDP If HID is enabled, see S Reg 39 for further configuration options in terms of device or host implementation. If HDP is enabled, see S Reg 70 for further configuration options in terms of Agent or Manager services. **Note:** Depending on the firmware build, some profiles are not available; in that case setting or clearing the appropriate bit in this register has no effect as that bit is ignored.
4 (04)	0	1	GAP	Default Connectable Mode on power up/reset 0: Disable 1: Enable
5 (05)	0	2	GAP	Default Discoverable Mode on power up/reset 0 : Disable 1 : Enable General Discoverable mode (uses GIAC = 0x9E8B33) 2 : Enable Limited Discoverable mode (used LIAC = 0x9E8B00))
6 (06)	12	15	GAP Security IO Capability	Default Security Mode on power up/reset 12 = SSP + IO_CAP_NO_INPUT_NO_OUTPUT 13 = SSP + IO_CAP_DISPLAY_YES_NO 14 = SSP + IO_CAP_KEYBOARD_ONLY 15 = SSP + IO_CAP_DISPLAY_ONLY
7 (07)	12	2560	GAP	Inquiry Scan Interval in units of msec
8 (08)	12	2560	GAP	Inquiry Scan Window in units of msec

RegNo Dec (Hex)	Min	Max	Category	Description
9 (09)	12	2560	GAP	Page Scan Interval in units of msec
10 (0A)	12	2560	GAP	Page Scan Window in units of msec
11 (0B)	23	4096	SPP	RFCOMM frame size for all RFCOMM based profiles. 23-512 range has a granularity of 1; 512 to 4096 range has a granularity of 4. For example: Setting 4095 sets a value of 4092 (round down new values). **Note:** Testing and calculations by our stack vendor show that the incremental benefit above 990 is not worth the downside of handling larger payloads.
12 (0C)	1	30	General / GAP	Link supervision Timeout in seconds. This value only reads on power up when the profiles are registers. After changing the value it needs committing to non-volatile memory using AT&W or CMD_SREG_STORE and then the module needs a power cycle.
14 (0E)	0	1	SSP	Auto Accept Channel Setup. If this is 1, incoming connections automatically accept. If this is 1, EVT_CONNECTION_SETUP events are not sent to the host when an incoming connection arrives.
32 (20)	0	4	SPP	Master/Slave role preference for SPP incoming connections. 0 = Don't Care 1 = Prefer Master 2 = Prefer Slave 3 = Must be Master 4 = Must be Slave
33 (21)	0	4	SPP	Master/Slave role preference for SPP outgoing connections. 0 = Don't Care 1 = Prefer Master 2 = Prefer Slave 3 = Must be Master 4 = Must be Slave
34 (22)	0	7	SPP	If Profiles Reg 3 bit 0 is set and this is not 0, then incoming SPP connections are allowed up to the number specified in this register.
35 (23)	0	7	SPP	If Profiles Reg 3 bit 0 is set and this is not 0, then outgoing SPP connections are allowed up to the number specified in this register
36 (24)	0	1	Profiles	Enable DeviceID SDP record, and use the vid/pid as per registers 37 and 38.
37 (25)	0	0xFFFF	Profiles	USB Vendor ID to use in the DeviceID record

RegNo Dec (Hex)	Min	Max	Category	Description
38 (26)	0	0xFFFF	Profiles	USB Product ID to use in the DeviceID record
39 (27)	-2	2	HID	Significant if the HID profile enables via Register 3. Negative values imply that HID HOST Profile is registered. Value 0 and above imply HID DEVICE Profile is registered and 0 = standard KEYBOARD device (104 keys). All other positive values are associated with custom HID Device Descriptors which are preloaded using the CMD_BLOBMANAGE or AT+BTB command into non-volatile memory. There is MIMIMAL validation of the HID Descriptor that a user uploads. It is extremely important that a properly constructed descriptor is uploaded for storage in nonvolatile memory **Note:** If HID functionality is not included in the firmware build, then this register is not available.
40 (28)	0	0x1F	SPP	On SPP connection, this specifies the initial state of the following modem control lines sent to the peer. Bit 0 := RTR (RTS/CTS) Bit 1 := RTC (DTR/DSR) Bit 2 := DV (DCD) Bit 3 := IC (Ring Indicate RI) Bit 4 := FC (Reserved – Future use)
41 (29)	0	0xFF	HID	HID Device options: Bit MASK Values. When the module configures as an HID device (Sreg39>=0) and Sreg3 has the correct value, then this and S Reg 42 modify optional flags that are exposed in the service record that tell the host what capabilities are built into the device. The capabilities expose as bit masks. If a bit is set in this register, then the corresponding bit in SReg42 is the value used for that capability. The flag masks are : HID_SIF_BATTERYPOWER 0x01 HID_SIF_BOOTDEVICE 0x02 HID_SIF_NORMALLYCONNECTABLE 0x04 HID_SIF_RECONNECTINITIATE 0x08 HID_SIF_REMOTEWAKE 0x10 HID_SIF_SDPDISABLE 0x20 HID_SIF_VIRTUALCABLE 0x40 HID_SIF_SUPERVISIONTIMEOUT 0x80 For more details about what these flags do and mean, see the HID profile specification available on the BT SIG website. **Note:** If HID functionality is not included in the firmware build, then this register is not available.

<table>
<tr><th>RegNo
Dec (Hex)</th><th>Min</th><th>Max</th><th>Category</th><th>Description</th></tr>
<tr><td>42 (2A)</td><td>0</td><td>0xFF</td><td>HID</td><td>HID Device options: bit values.
See description for SReg 41.
Note: If HID functionality is not included in the firmware build, then this register is not available.</td></tr>
<tr><td>43 (2B)</td><td>0</td><td>63</td><td>HID</td><td>Country Code exposed in HID Device Descriptor which have the following values:
<table>
<tr><td>Not Supported</td><td>0</td><td>Netherlands_Dutch</td><td>18</td></tr>
<tr><td>Arabic</td><td>1</td><td>Norwegian</td><td>19</td></tr>
<tr><td>Belgian</td><td>2</td><td>Persian_Farsi</td><td>20</td></tr>
<tr><td>Canadian_Bilingua</td><td>3</td><td>Poland</td><td>21</td></tr>
<tr><td>Canadian_French</td><td>4</td><td>Portuguese</td><td>22</td></tr>
<tr><td>Czech Republic</td><td>5</td><td>Russia</td><td>23</td></tr>
<tr><td>Danish</td><td>6</td><td>Slovakia</td><td>24</td></tr>
<tr><td>Finnish</td><td>7</td><td>Spanish</td><td>25</td></tr>
<tr><td>French</td><td>8</td><td>Swedish</td><td>26</td></tr>
<tr><td>German</td><td>9</td><td>Swiss_French</td><td>27</td></tr>
<tr><td>Greek</td><td>10</td><td>Swiss_German</td><td>28</td></tr>
<tr><td>Hebrew</td><td>11</td><td>Switzerland</td><td>29</td></tr>
<tr><td>Hungary</td><td>12</td><td>Taiwan</td><td>30</td></tr>
<tr><td>International_ISO</td><td>13</td><td>Turkish_Q</td><td>31</td></tr>
<tr><td>Italian</td><td>14</td><td>UK</td><td>32</td></tr>
<tr><td>Japan_ Katakana</td><td>15</td><td>US</td><td>33</td></tr>
<tr><td>Korean</td><td>16</td><td>Yugoslavia</td><td>34</td></tr>
<tr><td>Latin American</td><td>17</td><td>Turkish_F</td><td>35</td></tr>
</table>
Note: If HID functionality is not included in the firmware build, then this register is not available.</td></tr>
<tr><td>44 (2C)</td><td>0x6161</td><td>0x7A7A</td><td>HID</td><td>Language Code exposed in the HID Device Descriptor which have the following values. Each value contains ASCII values of two lower case characters. For example 'en'== 0x656E</td></tr>
</table>

RegNo Dec (Hex)	Min	Max	Category	Description

Note: If HID functionality is not included in the firmware build, then this register is not available.

Afar	'aa'	Interlingua	'ia'	Quechua	'qu'
Abkhazian	'ab'	Interlingue	'ie'	Rhaeto_Romance	'rm'
Afrikaans	'af'	Inupiak	'ik'	Kirundi	'rn'
Amharic	'am'	Indonesian	'in'	Romanian	'ro'
Arabic	'ar'	Icelandic	'is'	Russian	'ru'
Assamese	'as'	Italian	'it'	Kinyarwanda	'rw'
Aymara	'ay'	Hebrew	'iW'	Sanskrit	'sa'
Azerbaijani	'az'	Japanese	'ja'	Sindhi	'sd'
Bashkir	'ba'	Yiddish	'ji'	Sangro	'sg'
Byelorussian	'be'	Javanese	'jw'	Serbo_Croatian	'sh'
Bulgarian	'bg'	Georgian	'ka'	Singhalese	'si'
Bihari	'bh'	Kazakh	'kk'	Slovak	'sk'
Bislama	'bi'	Greenlandic	'kl'	Slovenian	'sl'
Bengali	'bn'	Cambodian	'km'	Samoan	'sm'
Tibetan	'bo'	Kannada	'kn'	Shona	'sn'
Breton	'br'	Korean	'ko'	Somali	'so'
Catalan	'ca'	Kashmiri	'ks'	Albanian	'sq'
Corsican	'co'	Kurdish	'ku'	Serbian	'sr'
Czech	'cs'	Kirghiz	'ky'	Siswati	'ss'
Welsh	'cy'	Latin	'la'	Sesotho	'st'
Danish	'da'	Lingala	'ln'	Sudanese	'su'
German	'de'	Laothian	'lo'	Swedish	'sv'
Bhutani	'dz'	Lithuanian	'lt'	Swahili	'sw'
Greek	'el'	Latvian	'lv'	Tamil	'ta'
English	'en'	Malagasy	'mg'	Tegulu	'te'
Esperanto	'eo'	Maori	'mi'	Tajik	'tg'
Spanish	'es'	Macedonian	'mk'	Thai	'th'
Estonian	'et'	Malayalam	'ml'	Tigrinya	'ti'
Basque	'eu'	Mongolian	'mn'	Turkmen	'tk'
Persian	'fa'	Moldavian	'mo'	Tigrinya	'tl'
Finnish	'fi'	Marathi	'mr'	Turkmen	'tn'
Fiji	'fj'	Malay	'ms'	Tagalog	'to'
Faeroese	'fo'	Maltese	'mt'	Setswana	'tr'
French	'fr'	Burmese	'my'	Tonga	'ts'
Frisian	'fy'	Nauru	'na'	Tatar	'tt'
Irish	'ga'	Nepali	'ne'	Twi	'tw'
Gaelic	'gd'	Dutch	'nl'	Ukrainian	'uk'
Galician	'gl'	Norwegian	'no'	Urdu	'ur'
Guarani	'gn'	Occitan	'oc'	Uzbek	'uz'
Gujarati	'gu'	Oromo	'om'	Vietnamese	'vi'
Hausa	'ha'	Oriya	'or'	Volapuk	'vo'
Hindi	'hi'	Punjabi	'pa'	Wolof	'wo'
Croatian	'hr'	Polish	'pl'	Xhosa	'xh'
Hungarian	'hu'	Pashto	'ps'	Yoruba	'yo'
Armenian	'hy'	Portuguese	'pt'	Chinese	'zh'
Zulu	'zu'				

RegNo Dec (Hex)	Min	Max	Category	Description
45 (2D)	0	0x3FF	HID	Primary Language exposed in the HID Device Descriptor and the value is specified as follows (where the values are in hexadecimal), refer to the HID specification for a complete list:

NEUTRAL	00	SLOVENIAN ESTONIAN	24
ARABIC	01	LATVIAN	25
BULGARIAN	02	LITHUANIAN	26
CATALAN	03	FARSI	27
CHINESE	04	ARMENIAN	29
CZECH	05	AZERI	2b
DANISH	06	BASQUE	2c
GERMAN	07	MACEDONIAN	2d
GREEK	08	VIETNAMESE	2f
ENGLISH	09	AFRIKAANS	2a
SPANISH	0a	GEORGIAN	36
FINNISH	0b	FAEROESE	37
FRENCH	0c	HINDI	38
HEBREW	0d	MALAY	39
HUNGARIAN	0e	KAZAK	3e
ICELANDIC	0f	SWAHILI	3f
ITALIAN	10	UZBEK	41
JAPANESE	11	TATAR	43
KOREAN	12	BENGALI	44
DUTCH	13	PUNJABI	45
NORWEGIAN	14	GUJARATI	46
POLISH	15	ORIYA	47
PORTUGUESE	16	TAMIL	48
ROMANIAN	18	TELUGU	49
RUSSIAN	19	KANNADA	4a
SERBIAN	1a	MALAYALAM	4b
CROATIAN	1a	ASSAMESE	4c
SLOVAK	1b	MARATHI	4d
ALBANIAN	1c	SANSKRIT	4e
SWEDISH	1d	KONKANI	4f
THAI	1e	MANIPURI	57
TURKISH	1f	SINDHI	58
URDU	20	KASHMIRI	59
INDONESIAN	21	NEPALI	60
UKRAINIAN	22		61
BELARUSIAN	23		

Note: If HID functionality is not included in the firmware build, then this register is not available.

RegNo Dec (Hex)	Min	Max	Category	Description
46 (2E)	0	0x3F	HID	Sub Language exposed in the HID Device Descriptor and the value is specified as follows for English (where the values are in hexadecimal); refer to the HID specification for a complete list: ENGLISH_US 01 ENGLISH_UK 02 ENGLISH_AUSTRALIAN 03 ENGLISH_CANADIAN 04 ENGLISH_NEWZEALAND 05 ENGLISH_IRELAND 06 ENGLISH_SOUTHAFRICA 07 ENGLISH_JAMAICA 08 ENGLISH_CARIBBEAN 09 ENGLISH_BELIZE 0A ENGLISH_TRINIDAD 0B ENGLISH_ZIMBABWE 0C ENGLISH_PHILIPPINES 0D **Note:** If HID functionality is not included in the firmware build, then this register is not available.
47	0	1	Pairing	When this register is 1, in MP Mode it enables the EVT_LINK_KEY_EX event to be sent to the host when the module receives the CMD_TRUSTED_DB_IS_TRUSTED command and in AT mode it enables the AT+KY? command so that the link key information is sent to the host in the response. By default this key is 0. By setting this to 1, the customer acknowledges that security can be compromised.

RegNo Dec (Hex)	Min	Max	Category	Description
50..65 (32..41)	0	0 or 15	GPIO	This specifies the functionality attached to GPIO 0 to 15 appropriately. 50 for GPIO_0 onwards to 65 for GPIO_15. Depending on the platform, if the GPIO does not physically exist then the max value is 0. The functionality is specified as follows: 0 : None (the pio hardware is not touched) 1 : Input 2 : Output (0 on reset) 3 : Output (1 on reset) 4 : Input Inverted 5 : Output Inverted (0 on reset) 6 : Output Inverted (1 on reset) 7 : UART RI Input (DTE) (Ring Indicate) 8 : UART DCD Input (DTE) 9 : UART DSR Input 10 : UART RI Output (DCE) 11 : UART DCD Output (DCE) 12 : UART DTR Output 13 : UART TX Buffer NOT Empty Output 14 : Input pin – Select Protocol 0=AT,1=MP 15 : Output pin – 0 for AT, 1 for MP For all UART input/outputs (except 13, 14, & 15) there is an implied inversion. A logical 1 applies to assert the output, but by the time it hits the output pin or after it is read, there is automatic inversion. When writing to this location(s), validation prevents a write if the new value is UART functionality and the same value already exists in another register. The best approach to writing to this group of registers is to first write 0 to all 16 registers and then write new values to all. New values for these registers only come into effect after a reset/power cycle. For details of functionality 13, see section UART Host Power Saving Facility which describes how this output can be used to wake a UART host. Contact the manufacturer for specific mapping and functionality allocations.
70 (46)	0	1	HDP	If set to 0 then an HDP AGENT profile implements; otherwise with 1, a HDP MANAGER implements. In addition, bit 2 of Profiles S Reg3 has to be set. **Note:** If HDP functionality is not included in the firmware build, then this register is not available.
71 (47)	0	6500	HDP	HDP AGENT profile related.

RegNo Dec (Hex)	Min	Max	Category	Description
		0		This is the default time in milliseconds an HDP Agent remains in associated state while there is no activity with the HDP Manger. If the value is 0, that is taken as infinite time. This time is referenced when performing a new HDP agent IEEE specialization binding with an HDP manager Bluetooth. In AT mode see command AT+HAB, and in MP mode see CMD_HDP_BIND **Note:** If HDP functionality is not included in the firmware build, then this register is not available.
72 (48)	48	1024	HDP	HDP Profile related. This is the max TX pdu size and computes to the nearest multiple of 16. **Note:** If HDP functionality is not included in the firmware build, then this register is not available.
73 (49)	0	20000	Sniff Mode / Power Saving	Sniff Attempt Time in units of milliseconds. 0 means disable. This value must be less than half the Sniff Minimum Interval (SReg 75). The value stores in an 8 bit number and so a non-linear algorithm converts between the value to the 8 bit number. This means writing and reading may yield different values. See section Sniff Mode Explained.
74 (4A)	1	40000	Sniff Mode / Power Saving	Sniff Timeout Time in units of milliseconds. 0 means disable. The value stores in an 8 bit number and so a non-linear algorithm converts between the value to the 8 bit number. This means writing and reading may yield different values. See section Sniff Mode Explained.
75 (4B)	1	40000	Sniff Mode / Power Saving	Sniff Minimum Interval in units of milliseconds. The value stores in an 8 bit number and so a non-linear algorithm converts between the value to the 8 bit number. This means writing and reading may yield differing values. See section Sniff Mode Explained.
76 (4C)	1	40000	Sniff Mode / Power Saving	Sniff Maximum Interval in units of milliseconds. The value stores in an 8 bit number and so a non-linear algorithm converts between the value to the 8 bit number. This means writing and reading may yield differing values. See section Sniff Mode Explained.

RegNo Dec (Hex)	Min	Max	Category	Description
80 (50)	1000	75000	UART Comms	UART latency time in microseconds. In a connection, the data pump waits for X bytes (specified by SReg 11) before transferring the data to the air-side. In the event that the host sends fewer than X bytes this has the potential of those bytes never being transmitted. Therefore, to cater for that scenario a timer detects how long they sat in the buffer and if too long, send those bytes air-side anyway. How long to wait is specified by this S register. The timer starts once when a byte arrives in an empty buffer, not every time a byte arrives in the buffer.
81	10	80	UART Comms	Memory usage in percent for MP mode UART RX processing. Leave to default value. Only change on advice from manufacturer. New values round up to the nearest 10. This register controls how many memory blocks are reserved when the module receives a flood of UART data packets with small payloads.
82	2	99	UART Comms	The UART interface in the module uses hardware RTS/CTS handshaking to ensure that the low level receive buffer does not overflow. This register specifies at what fill percentage the RTS output line deasserts. This value validates to ensure it is always more than register 83. In AT mode, use the command ATi201 to return a response in the format X,Y,Z, where X is the actual size of the UART receive buffer, Y is the RTS deassert threshold, and Z is the RTS re-assert threshold.
83	1	98	UART Comms	The UART interface in the module uses hardware RTS/CTS handshaking to ensure that the low level receive buffer does not overflow. This register specifies at what fill percentage the RTS output line reasserts. This value validates to ensure it is always less than register 83. In AT mode, use the command ATi201 to return a response in the format X,Y,Z, where X is the actual size of the UART receive buffer, Y is the RTS deassert threshold, and Z is the RTS re-assert threshold.

RegNo Dec (Hex)	Min	Max	Category	Description
84	0	3	UART Comms	Configure UART Latency. The default value of 0 configures the module for maximum throughput at the expense of latency. Select 1 for HIGH latency (25 ms polling of UART RX buffer) Select 2 for MEDIUM latency (8 ms polling of UART RX buffer) Select 3 for BEST latency (1 ms polling of UART RX buffer) Selecting 3 has a severe detrimental impact on throughput. **Note:** Polling times are correct as of this document. Contact Laird for updates.
128 (80)	0	0xFFFFFFF	GAP	Module's Class of Device. If Profiles SReg3=2 (that is only HID Profile) and SReg39 sets for 0 (I.E. built in keyboard HID descriptor), then this class of device is overridden with a value which specifies a HID keyboard device.

Note: Most registers read by the firmware at reset. Hence the radio requires a reset after setting a register for it to be effective. This means the relevant S Register set MUST commit to non-volatile memory before initiating a reset. The S Registers store to non-volatile memory using the command [CMD_STORE_SREG].

2.2 Special S Registers (240 to 255)

Registers 240 to 255 inclusive are special in the sense that when written, the value automatically commits to non-volatile memory.

Table 2-2: Special S registers

RegNo Dec (Hex)	Min	Max	Category	Description
240 (F0)	0	921600	UART Comms	UART Baudrate Writing 0 implies default baudrate which may be different for all the different protocols as follows: MP mode = 115200 AT mode = 9600 Automatically saves to non-volatile memory on write.
241 (F1)	1	1	UART Comms	UART Handshaking. 1=CTS/RTS Automatically saves to non- volatile memory on write.
242 (F2)	1	2	UART Comms	UART Stopbits Automatically saves to non- volatile memory on write.

RegNo Dec (Hex)	Min	Max	Category	Description
243 (F3)	0	2	UART Comms	UART Parity 0=None 1=Odd 2=Even Automatically saved to non- volatile memory on write
255 (FF)	0	2	Protocol Mode	Host Communications Protocol 0 = Select protocol based on the state of GPIO input pin. 1 = Multipoint Packet Protocol 2 = AT Protocol If this register contains 0, then at least one S register in the range 50 to 65 should be set to the value (14 = PROTOCOL_MODE_IN) so that the GPIO pin corresponding to that S Register automatically configures as an input and if on power up, the state of that pin is 0, then AT protocol activates, oitherwise MP. If no GPIO pin is configured to specify protocol and the value in this register is 0, then MP Protocol is selected. Automatically saves to non-volatile memory on write.

All these S Registers, unless specifically mentioned, become effective after a power cycle or reset.

2.3 'AT' S Registers

These registers are specific to AT protocol operation **only** and are not accessible from MP protocol mode. Any S Register marked 'remapped' is detailed with the descriptions of the mapped-to S Registers.

Table 2-3: 'AT' S registers

RegNo	Min	Max	Category	Description
0	0	15	SPP	Rings before auto answering an incoming SPP connection. Setting 0 means a connection is not auto answered.
2	0x21	0x7E	SPP	Escape character used to change from data mode to command parsing mode when in a data connection. Three of these character enveloped by delays result in a transition from data into command mode
504	0	1	General	This register controls what debug shows on the terminal program during the connection process. 0 – All debug shown. 1 - Inhibits the printing of connection debug on the terminal screen.
506	0	1	General	If this is set to 1, then AT commands echo back to the host. This becomes effective after a power cycle. To make immediate effect on echoes, use the command ATE0 or ATE1. **Note:** This register only specifies the initial state of echoes on power up.

RegNo	Min	Max	Category	Description
507	0	1	SPP	When set to 1, which is the default, the DSR modem status input line enters command mode and/or drop a connection. When set to 0 the DSR line is not checked for connection related functionality. This is so that the input can convey a digital status to the peer using S Registers 651/654 and 661/664 inclusive.
508	Remapped		GAP	To S Reg 9009 (9 in MP Mode see section Standard S Registers)
509	Remapped		GAP	To S Reg 9010 (10 in MP Mode. See section Standard S Registers).
510	Remapped		GAP	To S Reg 9007 (7 in MP Mode. See section Standard S Registers)
511	Remapped		GAP	To S Reg 9009 (8 in MP Mode. See section Standard S Registers).
514	2	60	Pairing	Minimum time in seconds to wait for the conclusion of a pairing operation.
517	2	60	Inquiry	Maximum time in seconds to perform an inquiry.
518	1	255	Inquiry	Maximum number of inquiry responses in an inquiry.
520	Remapped		UART Comms	To S Reg 9240 (240 in MP Mode. See section Standard S Registers).
521	Remapped		UART Comms	To S Reg 9240 (240 in MP Mode. See section Standard S Registers).
522	Remapped		UART Comms	To S Reg 9241 (241 in MP Mode. See section Standard S Registers).
523	Remapped		UART Comms	To S Reg 9242 (242 in MP Mode. See section Standard S Registers).
524	Remapped		UART Comms	To S Reg 9243 (243 in MP Mode. See section Standard S Registers).
530	1	60	SPP	Reconnect delay when configured as master in auto connection mode.
531	0	3	SPP/ AT Parser	Specifies the AT Parser mode on connection establishment. 0 = Normal, that data exchanges between UART and RF. 1 = LOCAL_COMMAND. The AT interpreter parses UART input and RF data is discarded. 2 = REMOTE_COMMAND. The AT interpreter parses RF input and UART data is discarded. If S Reg 536 is not 1 then this register cannot be set to 2 and an ERROR returns. 3= LOCAL_COMMAND. The AT interpreter parses UART input and incoming RF data sends to the host using the RX<string> asynchronous response.
561	Remapped		Sniff Mode	To S Reg 9073 (73 in MP Mode. See section Standard S Registers).

RegNo	Min	Max	Category	Description
562	Remapped		Sniff Mode	To S Reg 9074 (74 in MP Mode. See section Standard S Registers).
563	Remapped		Sniff Mode	To S Reg 9075 (75 in MP Mode see section Standard S Registers).
564	Remapped		Sniff Mode	To S Reg 9076 (76 in MP Mode. See section Standard S Registers)
619	0	0xFFFF	GPIO	This specifies a write mask when ATS620=X sets multiple GPIO states.
620	0	0xFFFF	GPIO	ATS620? reads all the GPIO states at once. ATS620=X writes new GPIO states using the mask in S Register 619.
621	0	0xFF	ADC	Reads and digitises the voltage on AIO0 and outputs it as an 8 bit number on the terminal program.
622	0	0xFF	ADC	Reads and digitises the voltage on AIO1 and outputs it as an 8 bit number on the terminal program.
651	-1	8	GPIO	-1 means no GPIO pin allocation. See Note 1 and 3 below. Requires firmware build 185 or newer.
652	-1	8	GPIO	-1 means no GPIO pin allocation. See Note 1 and 3 below. Requires firmware build 185 or newer.
653	-1	8	GPIO	-1 means no GPIO pin allocation. See Note 1 and 3 below. Requires firmware build 185 or newer.
654	-1	8	GPIO	-1 means no GPIO pin allocation. See Note 1 and 3 below. Requires firmware build 185 or newer.
661	-1	8	GPIO	-1 means no GPIO pin allocation. See Note 2 and 3 below. Requires firmware build 185 or newer.
662	-1	8	GPIO	-1 means no GPIO pin allocation. See Note 2 and 3 below. Requires firmware build 185 or newer.
663	-1	8	GPIO	-1 means no GPIO pin allocation. See Note 2 and 3 below. Requires firmware build 185 or newer.
664	-1	8	GPIO	-1 means no GPIO pin allocation. See Note 2 and 3 below. Requires firmware build 185 or newer.
717	2	15	GAP	Maximum time to wait for a remote friendly name to read (AT+BTI command).

All these S Registers, unless specifically mentioned, become effective after a power cycle or reset.

Note 1: S Reg 651 to 654 take a GPIO pin number in the range 1 to 8 inclusive (or as per the full range for the specific module) which maps from the RTR, RTC,DV,IC bits in the RFCOMM Modem Control signal which exchanges for serial port profile. When a fresh Modem Control Sig message arrives from the peer, if the corresponding S register is NOT -1 and the specific GPIO pin is configured as an output (using S Reg 50 to 65 inclusive), then the state of the bit outputs to that pin.

Note 2: S Reg 661 to 664 take a GPIO pin number in the range 1 to 8 inclusive (or as per the full range for the specific module) which maps to the RTR, RTC,DV,IC bits in the RFCOMM Modem Control signal which exchanges for serial port profile. If a GPIO pin specifies in one of these S Registers and it changes state AND there is an SPP connection, then the state of that input pin copies into an RFCOMM modem control message and sent to the peer.

Note 3: This capability enables the state of between 2 and 4 (depends on the direction of the connection) digital pins to exchange between peers without any host intervention.

3 MULTIPOINT PROTOCOL

3.1 Introduction to Multipoint Protocol

This chapter describes a packet based messaging interface which a host uses to send commands, receive responses, receive asynchronous events and exchange multiplexed data with the Bluetooth serial module, henceforth described as the module.

The module consists of a Bluetooth chipset with an approved Bluetooth stack which allows simultaneous connections to a minimum of one slave and, depending on hardware build and conditions, up to seven slaves. It also allows connections to multiple profiles to one or more slaves. Hence this document adopts a concept of channels instead of slave connections. You can also view these channels as logical data pipes.

The term 'host' in this document refers to any entity which is a source of command messages, sink for response/event messages, and both source and sink for multiplexed data packets.

To further eliminate any confusion, when the terms 'command message' and 'confirm message' are used, it implies a message from the host to the module. Likewise the terms 'response message' and 'event message' imply a message from the module to the host.

There is an implied client/server model in the protocol described in this document and the host should ensure that no new commands issue to the module until after a response is received for that command or an appropriate timeout. *If multiple commands are sent, they queue and process only after the oldest command processes*. Confirm messages do not have the same restrictions. Data packets do not follow that model. It is likely that asynchronous event messages are sent before response messages but that should not be taken as a signal to issue new commands. The only exception to this is when an unknown command receives; in this case the transaction terminates by an UNKNOWN_COMMAND event.

This document does *not* describe how the packets are physically exchanged between the host and the module. The transport medium could be either UART or USB. It also does *not* describe the format of any envelope that may be required to reliably and quickly transfer the message packet between the host and module.

This implies that when the packets proposed in this document are processed, they are assumed not to contain any errors by either peer entities.

3.2 Flow control & Data Integrity

The transport mechanism streams in nature. If the transport medium is USB, then flow control and data integrity is inherently provided by the USB protocol.

If the medium is UART, then it is assumed that there is a minimum of a five wire interface: RX, TX, CTS, RTS, and GND. Any host attached to the UART of the module strictly observes CTS/RTS hardware handshaking. Packet data integrity may or may not be provided depending on the build. For a UART transport media, guaranteeing data integrity is at the severe expense of data throughput.

3.3 Packet Format

This section describes the general format of incoming and outgoing packets.

The term 'incoming' henceforth implies packets sent by the host to the module and 'outgoing' in the reverse direction. That is, the direction terminology is module (server) centric.

All packets have octet granularity. When an octet is described as containing bit fields, it shall be taken that bit 0 is the least significant bit and bit 7 is the most significant bit.

Subfields in the packet which require multiple octets shall be ordered so that the lowest significant octet transmits LAST over the transport media, unless specifically described otherwise – this is also referred to as Big endian format. For example, a 16-bit word value requires two octets within the packet and the first transmitted octet corresponds to the upper byte. Similarly, a 6-byte Bluetooth address transports the most significant byte first. If the order is reversed then it is specifically highlighted in the description of appropriate packets.

Subfields which are data arrays shall be described with the '[ ]' operator in descriptions which come in subsequent chapters.

Apart from data packets, all command, confirm, respond and event packets are of fixed size. If there isn't enough data to fill a packet, then the packet fills with 0s. The protocol and fixed packet format is optimized to ensure maximum data throughput over the air. Subsequent sections describe the packets in detail.

3.4 Host to Module Packets

These are packets used to convey commands and confirms to the module or raw data to be sent over an open Bluetooth connection.

3.5 Command & Confirm Packets

The format for command and confirm packets is displayed in Table 3-1.

Table 3-1: Command and confirm packets

Octet	Field	Description
0	LENGTH	Total length of this packet, including this octet
1	CHANNEL	Always zero
2	CMD_ID/CNF_ID	Described in the subsequent chapters and have CMD_ or CNF_ prefixes
3	FLOW_IN	Bit 0 to 6 specify a mask. A clear bit means the module should NOT send any more packets to that corresponding SPP data channel. Bit 7 is always zero and is used as an extension bit in the future. It is assumed that the host is always able to receive a response or status packet.
4..N	DATA[]	Data as required and has meaning specific to CMD_ID or CNF_ID. For example, if the command is to make a connection to a peer device, then it is at least a six octet array specifying the Bluetooth address of the peer.

The value of CMD_ID is in the range of 0 to 63 and commands are queued until a previous command is completed by sending a response packet to the host.

The value of CNF_ID is in the range of 64 to 127 inclusive.

Unknown command values result in an EVT_UNKNOWN_COMMAND event, with the command value reflected in the data field. If the octet value is specified in the range 128 to 255 (0x80 to 0xFF), then

reflecting that value in the data field of an EVT_UNKNOWN_COMMAND instead of the COMMAND field of a response packet guarantees that the packet is NOT mistakenly processed as an event.

Confirm packets are not queued by the UART packet processor in the module and are processed as soon they are received. As an example, this allows passkeys and pincodes to submit to the module while a response is awaited by the CMD_CONNECTION_MAKE command. In other words, confirm packets always go to the head of the packet queue.

3.6 Data Packets

The format for data packets is displayed in Table 3-2 and can arrive at any time; that is, they do not adhere to a client/server model. The only method by which the host can be stopped from sending this message is by sending a zero value in the FLOW_OUT field of a response or status message. The module is prepared to receive at least one data packet after deasserting the appropriate flow control bit.

Table 3-2: Data packet format

Octet	Field	Description
0	LENGTH	Total length of this packet, including this octet
1	CHANNEL	0 is an invalid value as this marks the packet as command/response or event. 1 to 7 are dedicated serial port profile connections. 128 is dedicated as Hid Device data channel. All other channels are reserved for future use.
2..N	DATA[]	For channels 1 to 7, this data array unconditionally sends over the air in the appropriate SPP connection For channel 128 data is interpreted before appropriate HIT reports transmit.

3.7 Packet Processing Logic

Data and Confirm packets process as soon as they are received.

A command packet processes in a transaction, meaning it processes as soon as it is received *if and only if* there is no previous command processing and waiting for completion. Completion happens when an appropriate response packet is sent to the host. If a command transaction is currently in progress, then the packet inserts in a first-in, first-out queue. When an on-going command transaction completes, the queue is inspected and, if non-empty, the oldest queued command is processed.

3.7.1 Module to Host Packets

These packets convey responses or events from the module and raw data received over an open Bluetooth connection or internal data source. Response packets are *always* a result of a command packet and event packets *asynchronously* send to the host as and when required. *The host shall ensure that it is always ready to accept response and event packets, especially event packets as they can be sent at any time including where there is an incomplete transaction in progress.*

3.7.2 Response Packets

The format for response packets is displayed in Table 3-3.

Table 3-3: Response packet format

Octet	Field	Description

0	LENGTH	Total length of this packet, including this octet
1	CHANNEL	Always zero
2	CMD_ID	Echoed from the command packet (Shall be > 0 and < 128)
3	FLOW_OUT	Bit 0 to 6 specify a mask. A clear bit means the host should NOT send any more packets to that corresponding data channel. Bit 7 is always 0 and is an extension bit in the future.
4	STATUS	Zero means success, otherwise see section "STATUS values"
N..M	DATA[]	Data as required and has meaning specific to the response for CMD_ID

3.7.3 Event Packets

The format for event packets is displayed in Table 3-4.

Table 3-4: Event packet format

Octet	Field	Description
0	LENGTH	Total length of this packet, including this octet
1	CHANNEL	Always zero
2	EVT_ID	Described in subsequent chapters, but bit 7 is always set, hence >= 128
3	FLOW_OUT	Bit 0 to 6 specify a mask. A clear bit means the host should NOT send any more packets to that corresponding data channel. Bit 7 is always zero and is an extension bit in the future.
N..M	DATA[]	Data as required and has meaning specific to the response for EVT_ID

The only difference between a response and an event packet is that octet 2 is defined as CMD_ID in the former and EVT_ID in the latter; in addition, the STATUS field is missing in the event packet.

The value of CMD_ID will be in the range 0 to 0x3F and EVT_ID will take values in the range 0x80 to 0xFF. This allows bit 7 of that octet to be decoded whether the packet is a response packet or an event packet.

The value of STATUS is in the range of 0 to 255. A value of zero means SUCCESS and any other value is a failure, where the value gives more details of the failure type. The values of STATUS are defined in a 'C' header file which can be obtained on request from Laird.

3.7.4 Data Packets

The format for data packets is displayed in Table 3-5. The only method by which the host can stop the module from sending this message is by sending a zero value in the FLOW_IN field of command message, and even that is only for channels 1 to 7 inclusive.

Table 3-5: Data packet format

Octet	Field	Description
0	LENGTH	Total length of this packet, including this octet
1	CHANNEL	0 is an invalid value as this marks the packet as command/response or event. The channel number is allocated as follows: 1 to 7 are dedicated serial port profile connections. 0x20, 0x80, 0x90..0x97,0xA0 are dedicated as HID data channels. 0x98..0x9F are dedicated for BLOB sending and receiving data from BLOBs. 0xB0 conveys HDP data and 0xB1 is a HDP continuation data channel. 0xF0 conveys Enhanced Inquiry Response Data to the host. All other channels are reserved for future use.
2..N	DATA[]	Data to be processed for channel CHANNEL.

Data packets are symmetrical in format in both directions.

Note: Only data channels 1 to 7 inclusive have flow control via the FLOW_IN and FLOW_OUT fields of command /confirm and response/event packets.

3.7.5 Data Channel Numbers

Table 3-6 summarizes channel ID allocation for various connections and profiles.

Table 3-6: Channel ID allocation

Channel Number	Profile	Comments
0x0	-	All traffic routed to/from the protocol parser –this is a command, confirm, or response packet
0x1 .. 0x7	SPP	Serial Port profile data channels. See Note 1 below
0x20	HID DEVICE	Hid Device Channel – only one device allowed at a time. See Note 2 below
0xA0	HID DEVICE	Hid Device Channel – only one device allowed at a time. See Note 3 below
0x90 .. 0x97	HID HOST	Hid Host Channels – multiple connections to devices is possible. See Note 4 below
0x98 .. 0x9F	BLOB MANAGER	Blob Manager Channels. See Note 5 below
0xA0	HID DEVICE	Hid Device Channel for sending and receiving raw HID reports.
0xB0 .. 0xB1	HDP DATA	HDP Data Channels. See HDP Data Channels for further details of the logical channel conveyed in these data channel
0xF0	Enhance Inq Response	Enhanced Inquiry Response Data

Note 1: In MP mode this module can support connections to up to seven other modules. This channel differentiates between the various connections.

Note 2: This channel is used for 'canned' HID Keyboard Device reports. Data in this channel is interpreted as ASCII and for each ASCII character two INPUT reports send to the host – the first being the press event and the second the unpress event. If the ASCII value is in the range 0x7F to 0xFF then it is silently discarded.

Note 3: This channel is used for raw HID device INPUT reports. For example, if the built-in keyboard HID descriptor is active then the INPUT report is eight bytes long.

If a host sends an OUTPUT report it appears in this channel as a single data packet.

It is essential that all INPUT or OUTPUT reports maintain the packet boundaries.

Note 4: These channels are used to receive INPUT reports from HIDs and send OUTPUT reports when the module configures as an HID host. The size and format of the reports shall be as per the HID descriptor that is active on that channel.

Note 5: These channels are used to send and receive data from BLOBs (Binary Long Objects) which are arbitrary length data buffers. If a BLOB does not exist, then the data sent on that channel is silently discarded. The BLOBs are identified by a 0-based index number; to send data to BLOB 0, channel 0x98 is used and 0x99 for BLOB 1.

Once data uploads into a BLOB, then CMD_BLOBMANAGE manipulates that data. For example, the BLOB mechanism uploads new HID Device Descriptors into the module.

3.7.6 Host Packet Receive Flowchart

As optimal data throughput is the design goal, the format and detail of packets have been constructed appropriately. It is recommended that the host implement the following flowchart, for rapid servicing and flow control of packets.

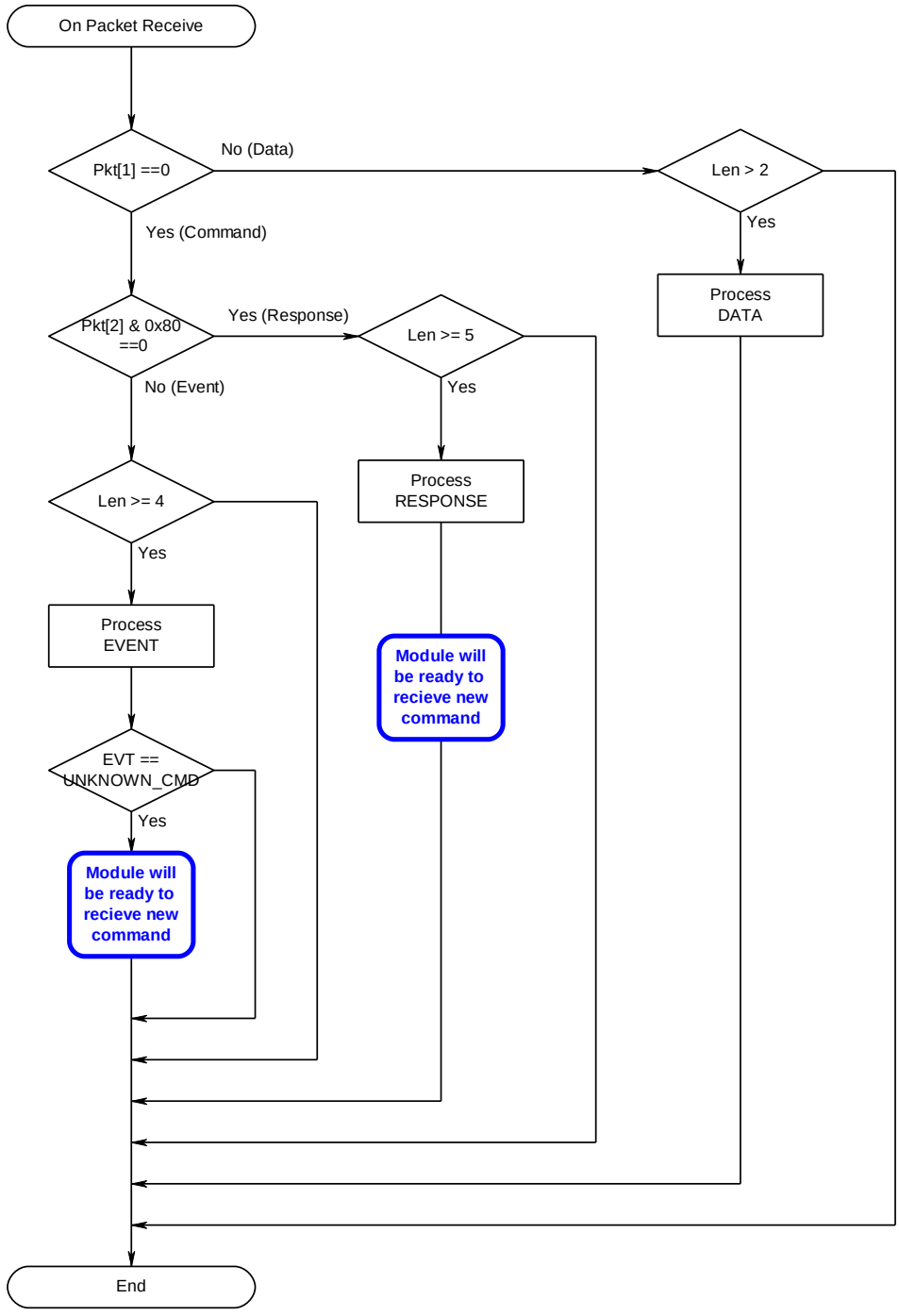


Figure 3-1: Host packet receive flowchart

3.8 Host Command/Responses

This section describes all host commands and confirms in detail what is specified via the CMD_ID/CNF_ID field of all command and confirm packets.

The description for each command/confirm below is in the form of a command or confirm packet table and a corresponding response packet table when appropriate.

Each command has a unique CMD_ID value in the range 1 to 63 (0x01 to 0x3F). 0 is reserved and confirms a CNF_ID in the range 64 to 127 (0x40 to 0x7F).

The actual value of CMD_ID in the Value column is described as [Descriptive_Name] where "Descriptive_Name" can be found in a 'C' header file which can be obtained on request from Laird.

The value of STATUS is similarly defined in a header file which can also be obtained from Laird.

The commands are grouped as:

- Informational
- Configuration
- Connection
- Inquiry
- Pairing
- Miscellaneous

They are described in subsequent sub chapters.

3.9 Information Commands

This group of commands obtains information about the module.

3.9.1 No Operation

This command results in no action other than to convey new FLOW_IN status to the module and get a response packet with the latest status for the FLOW_OUT bits.

It is expected that a host uses this packet to poll for a change in the flow bits.

Command Packet			
Offset	Field	Value	Comments
0	LENGTH	4	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_NO_OPERATION]	
3	FLOW_IN	??	Runtime value

Response Packet			
Offset	Field	Value	Comments
0	LENGTH	5	
1	CHANNEL	0	
2	COMMAND	[CMD_NO_OPERATION]	
3	FLOW_OUT	??	Runtime value
4	STATUS	[OK]	Or [INVALID_LICENSE]

3.9.2 Get Connectable, Discoverable, Security Modes

This command gets the current connectable, discoverable, and security modes.

Command Packet			
Offset	Field	Value	Comments
0	LENGTH	4	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_GET_MODES]	
3	FLOW_IN	??	Runtime value

Response Packet			
Offset	Field	Value	Comments
0	LENGTH	8	
1	CHANNEL	0	
2	COMMAND	[CMD_GET_MODES]	
3	FLOW_OUT	??	Runtime value
4	STATUS	OK or INVALID_LICENSE	
5	DISCMODE	0..3	Bit 0: 1 for discoverable mode Bit 1: 0 for generic, 1 for limited discovery mode. Bits 4..7: Future use specifying which limited inquiry access code to use.
6	CONNMODE	0..3	Bit 0: 1 for connectable mode Bit 1: 1 for Auto Accept Channel
7	SECMODE	12..15	12 = SSP + IO_CAP_NO_INPUT_NO_OUTPUT 13 = SSP + IO_CAP_DISPLAY_YES_NO 14 = SSP + IO_CAP_KEYBOARD_ONLY 15 = SSP + IO_CAP_DISPLAY_ONLY

Note 1: SECMODE is now driven by the Simple Secure Pairing procedure included in and after v.2.1 of the BT specification.

Note 2: For SECMODE, the No I/O Capability option is equivalent to the 'Just Works' scenario in SSP.

Note 3: When this module interacts with a pre-2.1 device, it is unconditionally forced into legacy pairing mode.

Note 4: Laird recommends that the reader become familiar with the SSP concept introduced in all subsequent version of BT (post v2.1). The best introduction is to Google the phrase *Bluetooth Simple Secure Pairing*.

Note 5: Contact Laird for an informal discussion if necessary.

3.9.3 Read Local Bluetooth Address

This command reads the Bluetooth address of the module.

Command Packet			
Offset	Field	Value	Comments
0	LENGTH	4	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_READ_BLUETOOTH_ADDRESS]	
3	FLOW_IN	??	Runtime value

Response Packet			
Offset	Field	Value	Comments
0	LENGTH	11	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_READ_BLUETOOTH_ADDRESS]	
3	FLOW_OUT	??	Runtime value
4	STATUS	[OK]	
5..10	BDADDR[]	Nap[0,1]:Uap[2]:Lap[3,4,5]	Bluetooth address

3.9.4 Information

This command extracts information from the module, for example version number.

Command Packet			
Offset	Field	Value	Comments
0	LENGTH	5	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_INFORMATION]	
3	FLOW_IN	??	Runtime value
4	INFOTYPE	0..255	

Response Packet			
Offset	Field	Value	Comments
0	LENGTH	14	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_INFORMATION]	
3	FLOW_OUT	??	Runtime value
4	STATUS	[OK]	
5	INFOTYPE	0..255	Echoed from command
6.13	DATA[8]	As per the table below	

The type of information requested is specified by the INFOTYPE parameter, as per the table below.

INFOTYPE = GET_VERSION (0)			
Offset	Field Name	Range	Comments
0	Format/Firmware/Platform ID	0..255	Bit 7: 1 Bit654: Spare Bit3210: Firmware/Platform ID
1	STACK_MAJOR	0..255	CCL Version number index
2	APP_MAJOR	0..255	Laird Application Version number index
3	DEVELOPER/BRANCH ID	0..255	Bit7654: Developer ID Bit3210: Branch ID
4..5	MSB/LSB of BUILD NUMBER	0..65535	Odd number == engineering Even Number == production
6	Reserved	0..255	Laird private use
7	TWIG number/SDK ID	0..255	B7654321 : Twig number B1 : Laird private use

INFOTYPE = GET_MANUFACTURER (1)			
Offset	Field Name	Range	Comments
0..7	Manufacturer/Stack information	E.g. "CSR/CCL"	Chip manufacturer, null terminated string

INFOTYPE = GET_CHIP_INFO (2)			
Offset	Field Name	Range	Comments
0..7	Chip Designation	E.g. "BC4-EXT"	Chip designation, null terminated string

INFOTYPE = GET_PHYSICAL_MEDIUM (3)			
Offset	Field Name	Range	Comments
0	Physical Medium	0	0=Bluetooth
1..7	Reserved	0	

INFOTYPE = GET_HARDWARE_PLATFORMID (100, 0x64)			
Offset	Field Name	Range	Comments
0	Hardware ID (msb)	0..255	
1	Hardware ID (lsb)	0..255	
2..7	Unused, set to 0's		

Hardware ID is 0x0100 for the BTM4xx series module.

INFOTYPE = MEMORY POOLS (224..239 0xE0..0xEF)			
Offset	Field Name	Range	Comments
0..1	Pool Block Size	E.g. 0004	Size of block
2..3	Available Blocks	E.g. 1234	Available and free to use

INFOTYPE = CCL STACK TRUNK VERSION (240 0xF0)			
Offset	Field Name	Range	Comments
6..7	Stack Trunk Version	E.g. 1234	Trunk Version of CCL stack

INFOTYPE = CCL STACK BRANCH VERSION (241 0xF1)			
Offset	Field Name	Range	Comments
6..7	Stack Branch Version	E.g. 1234	Branch Version of CCL stack

INFOTYPE = CCL STACK VENA VERSION (248 0xF8)			
Offset	Field Name	Range	Comments
6..7	Stack VENA Version	E.g. 1234	VENA Version of CCL stack

3.10 Configuration Commands

This group of commands configures the module.

3.10.1 Read 'S' Register

Configure the module using 32 bit integer values, which can be stored in non-volatile memory. Valid register numbers are in the range 0 to 255.

See the S Registers section for a full list of all registers.

The following command reads the current value of the S register REGNO.

Command Packet			
Offset	Field	Value	Comments
0	LENGTH	5	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_READ_SREG]	
3	FLOW_IN	??	Runtime value
4	REGNO	0 to 255	

Response Packet			
Offset	Field	Value	Comments
0	LENGTH	10	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_READ_SREG]	
3	FLOW_OUT	??	Runtime value
4	STATUS	As appropriate	
5	REGNO	0 to 255	Echoed from Command
6..9	REGVAL[]	Register Value	REGVAL[0] is the most significant octet.

3.10.2 Write 'S' Register

This command writes a new value to the S register REGNO.

See the S Registers section for a full list of all registers.

Command Packet			
Offset	Field	Value	Comments
0	LENGTH	9	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_WRITE_SREG]	
3	FLOW_IN	??	Runtime value
4	REGNO	0 to 255	
5..8	REGVAL[]	New Register Value	REGVAL[0] is the most significant octet.

Response Packet			
Offset	Field	Value	Comments
0	LENGTH	10	
1	CHANNEL	0	
2	COMMAND	[CMD_WRITE_SREG]	
3	FLOW_OUT	??	Runtime value
4	STATUS	As appropriate	
5	REGNO	0 to 255	Echoed from Command
6..9	REGVAL[]	Register Value	REGVAL[0] is the most significant octet.

3.10.3 Store 'S' Registers

This command saves current 'S' register values in cache into non-volatile memory so they survive power cycle.

Command Packet			
Offset	Field	Value	Comments
0	LENGTH	4	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_STORE_SREG]	
3	FLOW_IN	??	Runtime value

Response Packet			
Offset	Field	Value	Comments
0	LENGTH	5	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_STORE_SREG_]	
3	FLOW_OUT	??	Runtime value
4	STATUS	As appropriate	

3.10.4 Default 'S' Registers

This command forces all S register values in cache to factory defaults.

Command Packet			
Offset	Field	Value	Comments
0	LENGTH	4	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_ DEFAULT_SREG]	
3	FLOW_IN	??	Runtime value

Response Packet			
Offset	Field	Value	Comments
0	LENGTH	5	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_ DEFAULT_SREG_]	
3	FLOW_OUT	??	Runtime value
4	STATUS	As appropriate	

3.11 Connection Commands

This group of commands manages connections.

3.11.1 Set Connectable Mode

This command enables/disables connectable mode and specifies auto accept parameters for channels and muxs.

Command Packet			
Offset	Field	Value	Comments
0	LENGTH	6	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_ CONNECTABLE_MODE]	
3	FLOW_IN	??	Runtime value
4	ENABLE	0..1, 0xFF	0 = Disable, 1=Enable 0xFF = Read current mode
5	ACCEPT	Bit mask	Bit 0: Set to auto accept channel setup Bit 1..7: Reserved for future use If bit 0 is set then it overrides SReg 14, otherwise that S Register is consulted or incoming connections.

Response Packet			
Offset	Field	Value	Comments
0	LENGTH	6	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_ CONNECTABLE_MODE]	
3	FLOW_OUT	??	Runtime value
4	STATUS	As appropriate	
5	CURMODE	0..1	0 = Not connectable

3.11.2 Service Incoming Connection

When the module is in connectable mode, incoming connection requests pass to the host via an EVT_CONNECTION_SETUP message – if and only if autoaccept is not enabled (via command or S register 14). The host accepts or rejects the remote connection request using this message.

Command Packet			
Offset	Field	Value	Comments
0	LENGTH	12	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_ CONNECTION_SETUP]	
3	FLOW_IN	??	Runtime value
4..9	BDADDR[]	Nap[0,1]:Uap[2]:Lap[3,4,5]	Bluetooth addr
10	HANDLE	0..255	This value is echoed by the module
11	ACCEPT	0..1	0 = reject. 1..255 = accept

Response Packet			
Offset	**Field**	**Value**	**Comments**
0	LENGTH	6	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_	
3	FLOW_OUT	??	Runtime value
4	STATUS	As appropriate	
5	HANDLE	0..255	Echoed from the command

Receipt of the response is **not** an indication that the connection has established. If the connection is to be accepted, the module sends EVT_INCOMING_CONNECTION when the connection is fully established, as shown in the message sequence chart below.

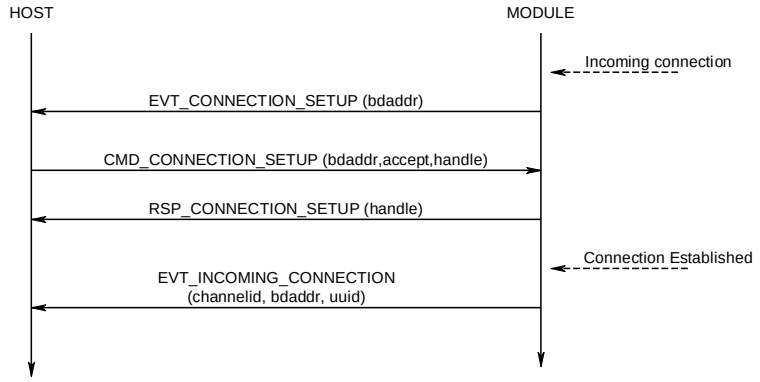


Figure 3-2: Service Incoming Connection sequence diagram

Note: If auto accept was specified when the module was put into connectable mode, then for incoming connections there is only an EVT_INCOMING_CONNECTION message.

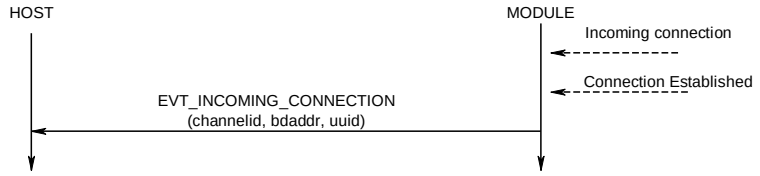


Figure 3-3: Service Incoming Connection with auto accept specified

3.11.3 Make Outgoing Connection

This command makes an outgoing connection to a profile in the remote peer.

Command Packet			
Offset	Field	Value	Comments
0	LENGTH	13	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_ MAKE_CONNECTION]	
3	FLOW_IN	??	Runtime value
4	HANDLE	0..255	This value is echoed by the module in the
5..10	BDADDR[]	Nap[0,1]:Uap[2]:Lap[3,4,5]	Bluetooth address
11..12	UUID[]	0x1101(SPP)	Uuid of the profile to connect to. Offset 11
13	RFU	0	Always set to zero

Response Packet			
Offset	Field	Value	Comments
0	LENGTH	7	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_ MAKE_CONNECTION]	
3	FLOW_OUT	??	Runtime value
4	STATUS	As appropriate	
5	HANDLE	0..255	Echoed from the command
6	CHANNEL	1..7 (SPP) 0x20,0x9x,0xA0 (HID DEVICE)	Channel ID to be used for subsequent SPP data packets, and also when dropping the connection

If the STATUS field in the response is MPSTATUS_OK, then a connection successfully established. Any other value is a failure.

The content of 'S' register 11 specifies the max frame size to be used by the lower layers.

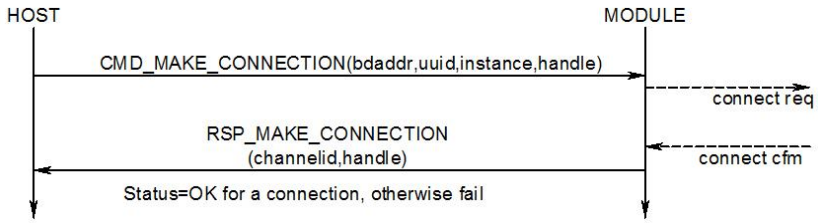


Figure 3-4: Make Outgoing Connection sequence diagram

When at least one connection is active (regardless of profile), the DCD output pin asserts.

3.11.4 Drop Connection

This command destroys an existing channel.

Command Packet			
Offset	Field	Value	Comments
0	LENGTH	6	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_ DROP_CONNECTION]	
3	FLOW_IN	??	Runtime value
4	HANDLE	0..255 Can be any value the host wants to set.	This value is echoed by the module in the response.
5	CHANNEL	1..7, As appropriate for other profiles	As was specified in either RSP_MAKE_CONNECTION or EVT_INCOMMING_CONNECTION

Response Packet			
Offset	Field	Value	Comments
0	LENGTH		Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_ DROP_CONNECTION]	
3	FLOW_OUT	??	Runtime value
4	STATUS	As appropriate	
5	HANDLE	0..255	Echoed from the command

If the STATUS field in the response is MPSTATUS_OK, then the request to drop the channel successfully submitted to the lower layers of the stack.

When the channel drops, an EVT_DISCONNECT event sends to the host.

When at least one connection is active (regardless of profile) the DCD output pin remains asserted.

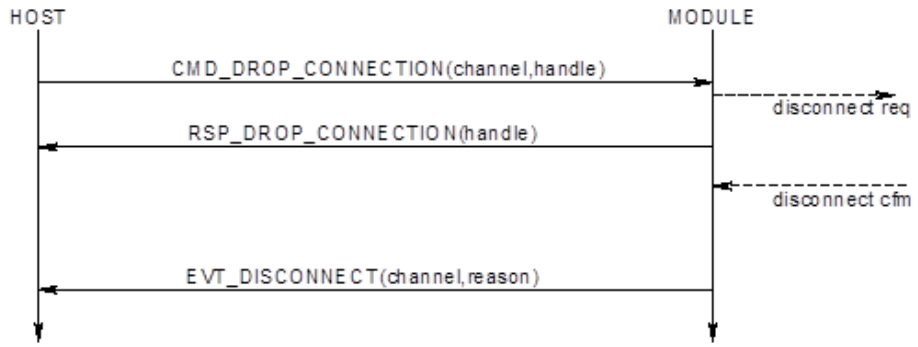


Figure 3-5: Drop Connection sequence diagram

3.12 Set Modem Lines

Bluetooth Serial Port Profile is capable of exchanging modem signals DTR, DSR, RTS, CTS, DCD, and RI over air.

From a host's perspective, it can have DTR, RTS, DCD and RI as output lines.

Note: DCD and RI are outputs for modems and 'host' in this context can mean either a PC or a peripheral like a modem.

Additionally UARTs are capable of sending BREAK signals. BREAK output signals are non-idle state TX pins for a period much greater than the character width at the current baud rate setting.

This command sends DTR, RTS, DCD, and RI states to the peer device and also to specify a BREAK – Future Feature.

Command Packet			
Offset	Field	Value	Comments
0	LENGTH	7	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_ CONTROLMODEMLINES]	
3	FLOW_IN	??	Runtime value
4	CHANNEL	1..7	Channel ID of an open channel
5	MODEM	Bit Mask	Bit 0: DTR state Bit 1: RTS state Bit 2: DCD state Bit 3: RI state Bits 4 .. 7 : Ignored
6	BREAK	0	Not Available

Response Packet			
Offset	Field	Value	Comments
0	LENGTH	6	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_ CONTROLMODEMLINES]	
3	FLOW_OUT	??	Runtime value
4	STATUS	As appropriate	
5	CHANNEL	1..7	Echoed from command

The STATUS value is MPSTATUS_OK if the message succeeded.

Modem signals sent by the peer device present to the host in the message EVT_MODEM_STATUS defined in subsequent chapters.

Note: BREAK signal capability is currently not provided by the lower stack, and so it is mentioned in the context of this command message for future implementation.

3.12.1 RSSI and Link Quality

This command obtains the RSSI and Link Quality values for a given open connection. This is a parameter associated with the ACL connection to a peer device and does not have any meaning with channel IDs.

Command Packet			
Offset	Field	Value	Comments
0	LENGTH	10	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_RSSI_LINKQUAL]	
3	FLOW_IN	??	Runtime value
4..9	BDADDR[]	Nap[0,1]:Uap[2]:Lap[3,4,5]	Bluetooth addr

Response Packet			
Offset	Field	Value	Comments
0	LENGTH		Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_RSSI_LINKQUAL]	
3	FLOW_OUT	??	Runtime value
4	STATUS	As appropriate	
5..10	BDADDR[]	Nap[0,1]:Uap[2]:Lap[3,4,5]	Bluetooth addr
11	RSSI	-128 to 127	RSSI value. Is zero if the signal is within the golden range
12	LINKQUAL	0 – 255	

The definitions of RSSI and LINKQUAL are paraphrased from the Bluetooth specification as follows:

3.12.1.1 RSSI

This value is the difference between the measured Received Signal Strength Indication (RSSI) and the limits of the Golden Receive Power Range (see Golden Receive Power Range). Any positive RSSI value returned by the Host Controller indicates how many dB the RSSI is above the upper limit; any negative value indicates how many dB the RSSI is below the lower limit. A value of zero indicates that the RSSI is inside the Golden Receive Power Range.

Note: How accurate the dB values are depends on the Bluetooth hardware. The only requirements for the hardware are that the Bluetooth device is able to tell whether the RSSI is inside, above or below the Golden Device Power Range.

3.12.1.2 Golden Receive Power Range

The lower threshold level of the golden receive power range corresponds to a received power between -56 dBm and 6 dB above the actual sensitivity of the receiver. The upper threshold level is 20 dB above the lower threshold level to an accuracy of +/- 6 dB.

3.12.1.3 Link Quality

Link_Quality is a value from 0-255, which represents the quality of the link between two Bluetooth devices. The higher the value, the better the link quality. Each Bluetooth module vendor determines how to measure the link quality.

In the case of CSR, this value is a measure of BER (Bit Error Rate).

3.13 Get Open Channel List

This command obtains a list of channel IDs corresponding to connections which are open. It is a good method of querying the module to see how many Bluetooth connections are established and their corresponding channel ID numbers.

A host should not need to use this command as it should be keeping track of the following two events and responses: EVT_DISCONNECT, EVT_CONNECTION_SETUP, RSP_MAKE_CONNECTION.

Command Packet			
Offset	Field	Value	Comments
0	LENGTH	10	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_CHANNEL_LIST]	
3	FLOW_IN	??	Runtime value

Response Packet			
Offset	Field	Value	Comments
0	LENGTH	22	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_CHANNEL_LIST]	
3	FLOW_OUT	??	Runtime value
4	STATUS	As appropriate	
5	Count	0..N	Number of connections which have been established
6..21	Channel ID List[16]	Array of 16 bytes	A nonzero value implies a connection exists and the array element value identifies the channel ID

3.14 Inquiry Commands

This group of commands performs inquiries and puts the module into discoverable mode.

3.14.1 Inquiry Request

This command performs a Bluetooth inquiry.

Command Packet

Offset	Field	Value	Comments
0	LENGTH	7	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_INQUIRY_REQ]	
3	FLOW_IN	??	Runtime value
4	MAXRESP	1..255	Maximum number of responses before aborting the inquiry procedure
5	TIMEOUT	1..120	Time in seconds, before aborting the inquiry procedure.
6	FLAGS	0..1	Bit 0 : 1 To allow repeat addresses. Bits 1..6 Reserved for future Bit 7 : Get Enhanced Inquiry responses

Response Packet			
Offset	Field	Value	Comments
0	LENGTH	7	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_INQUIRY_REQ]	
3	FLOW_OUT	??	Runtime value
4	STATUS	As appropriate	
5	TOTAL	??	The total number of inquiry responses that were received from peers.
6	DUMP	??	The total number of inquiry result events that were *not* sent because the transmit buffer of the module was full. This is a result of the host deasserting its RTS line.

As a result of this command, as and when peer devices respond with inquiry responses, for each inquiry response, if bit 7 of the FLAGS field is zero then an event EVT_INQUIRY_RESULT is sent to the host. If bit 7 of FLAGS field is one then, given that enhanced inquiry data has variable length data for any given response, the entire inquiry response is sent via data channel 0xF0 to the host, with format described in subsections below.

When the number of command-specified inquiry responses are received OR the specified time has elapsed, the final response is sent to indicate to the host that the inquiry procedure is complete.

If the DUMP field in the response is non-zero, it is indicating that the host is not reading it's receive buffer fast enough and is resulting in RTS deasserting towards the module.

FLAGS bit 1-4 in future are to specify a limited access code inquiry.

See message sequence diagram (Figure 3-6) which illustrates that the RSP_INQUIRY_REQ message terminates the inquiry process.

3.14.2 Enhanced Inquiry Data Packet Format

When enhanced inquiry responses are requested via FLAGS bit 7 being set, each inquiry response sends to the host in data channel 0xF0 and the packet is formatted as follows:

LL F0 AAAAAAAAAAAA CCCCCC RR EE…….EE
Where::
LL is the total length of the packet, and given only the EE..EE field is of variable length, the length of the EE..EE field is calculated by subtracting 12 (decimal) from LL.
F0 is the channel number and is fixed
AAAAAAAAAAAA is a 6 byte field containing the Bluetooth address of the responding device.
CCCCCC is the device class code of the responding device
RR is the measured RSSI value for that response (8 bit signed integer)
EE..EE is a variable length field, with a maximum of 240 bytes, containing the enhanced inquiry data which is formatted as multiple len/tag/data structures as specified in the Bluetooth specification. Where both len and tag fields are single bytes and len does not include itself.

Any data passed from the baseband must match the format defined in the Bluetooth Specification Version 2.1 + EDR [1], vol3, Part C – Generic Access Profile, 8 Extended Inquiry Response Data Format (page 1305 in the *.pdf file).

A typical message sequence is as follows:

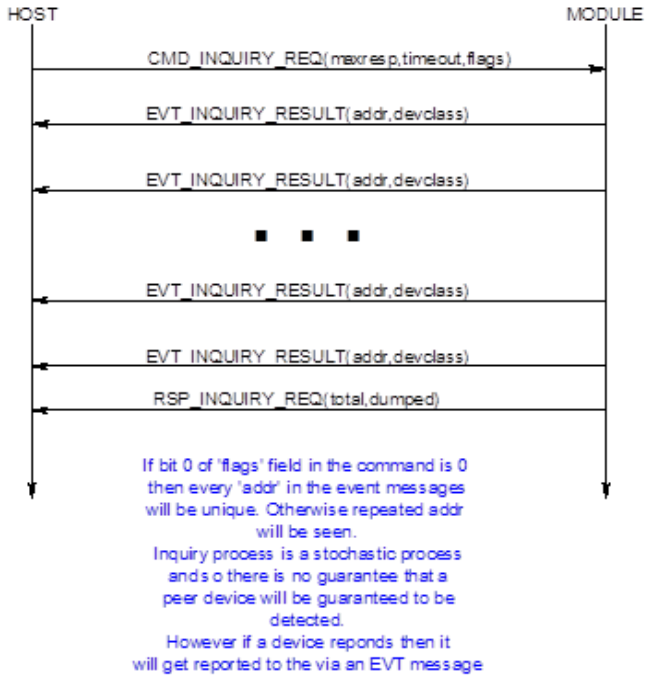


Figure 3-6: Typical message sequence

3.14.3 Set Discoverable Mode

This command enables/disables discoverable mode.

Command Packet			
Offset	Field	Value	Comments
0	LENGTH	5	Fixed
1	CHANNEL	0	Fixed

2	COMMAND	[CMD_ DISCOVERABLE_MODE]	
3	FLOW_IN	??	Runtime value
4	MODE	0..1, 0xFF	0 = Disable, 1 = Generic Access Code 0xFF = Read current mode

Response Packet			
Offset	Field	Value	Comments
0	LENGTH	6	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_ DISCOVERABLE_MODE]	
3	FLOW_OUT	??	Runtime value
4	STATUS	As appropriate	
5	CURMODE	0..1	1 = Generic Access Code

The module uses the parameters stored in 'S' Registers 7 and 8 to set the inquiry scan interval and window. Inquiry scan is how often (interval) the radio listens for an inquirer and for how long (window) each time.

3.15 Pairing Commands

This group of commands manages either incoming or outgoing pairings and the trusted device database which resides in the non-volatile memory of the module.

The trusted device database is a database with two tables, each with records of two fields. One field is the Bluetooth address of a paired device and the other stores the 16 byte link key.

One database is classed a ROLLING database and stores new pairing information as they happen. If the database is full, then the oldest is discarded to make space for the latest one.

The other database is classed as a PERSISTANT database which stores pairing information which can ONLY be deleted when a new pairing initiates to that particular device OR on request from the host.

The host protocol provides for a command to transfer a record between these two databases. In addition there is a command for the host to determine if a device is trusted. There is also a command to manually insert a device and its link key into the database.

Depending on the peer device, either a legacy pairing procedure or a simple secure pairing occurs. A legacy pairing occurs if the peer device is older than v2.1 of the Bluetooth specification. Simple Secure Pairing (for v2.1 and newer devices) uses a Diffie-Hellman procedure to exchange the secret link key, but is vulnerable to man-in-the-middle attack.

When pairing initiates and a legacy 2.0 or older device is not involved, then the basebands perform an I/O capability negotiation with each other to see whether it shall perform a 'Just Works' unauthenticated pairing with no man-in-the-middle (MITM) protection or an authenticated pairing which requires user interaction.

The I/O capability is one of:

- Display Only
- Keyboard Only
- Display with Yes/No button

For example:

If one end has Display only, but the other end has keyboard only, then the negotiation results in one end displaying a six digit passcode on the Display Only side, which is then required to be entered at the keyboard only end.

If both ends have Display with Yes/No, then during the procedure both ends display a six digit passcode which needs to be visually compared and then the Yes/No buttons are used to confirm that they match. This provides for a one in a million probability that a MITM attach is successful.

To enable this new interaction with a user during pairing a new EVT_SIMPLE_PAIRING was defined.

3.15.1 Pair Initiate

This command initiates a pairing with a peer device which is assumed to be ready and waiting for a pairing. If that device is compliant with v2.0 and older of the Bluetooth specification then a legacy pairing results and the pincode pin[] in this message is used otherwise there is a simple pairing procedure.

Command Packet			
Offset	Field	Value	Comments
0	LENGTH	28	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_ PAIR_INITIATE]	
3	FLOW_IN	??	Runtime value
4	TIMEOUT	5..120	Pairing timeout in seconds
5..10	BDADDR[]	Nap[0,1]:Uap[2]:Lap[3,4,5]	Bluetooth addr of device to be paired
11..27	PIN[]	17 byte string array	Null Terminated Pin code String. Maximum pin code length is 16.

Response Packet			
Offset	Field	Value	Comments
0	LENGTH	5	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_ PAIR_INITIATE]	
3	FLOW_OUT	??	Runtime value
4	STATUS	As appropriate	

If pairing is successful, the event message EVT_LINK_KEY or EVT_LINK_KEY_EX is sent to the host before the response to close the procedure, as shown in the message sequence chart below.

Pair Initiate may fail if there are any existing open connections. The status byte in the response will have an appropriate value.

3.15.1.1 Simple Secure Pairing 'Just Works'

The message sequence diagram for 'Just Works' when the device has specified no I/O capability is as follows:

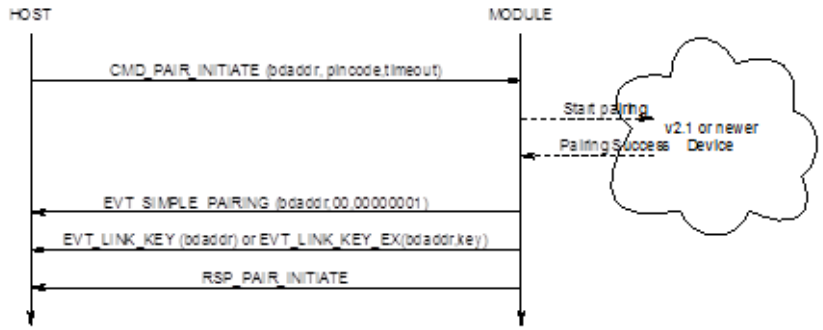


Figure 3-7: Just Works sequence diagram

The EVT_SIMPLE_PAIRING displays a success/fail indication. If it fails, then the EVT_LINK_KEY event does not send to the host.

3.15.1.2 Simple Secure Pairing 'Display Yes/No'

The message sequence diagram for when the device has display and yes/no capability is as follows:

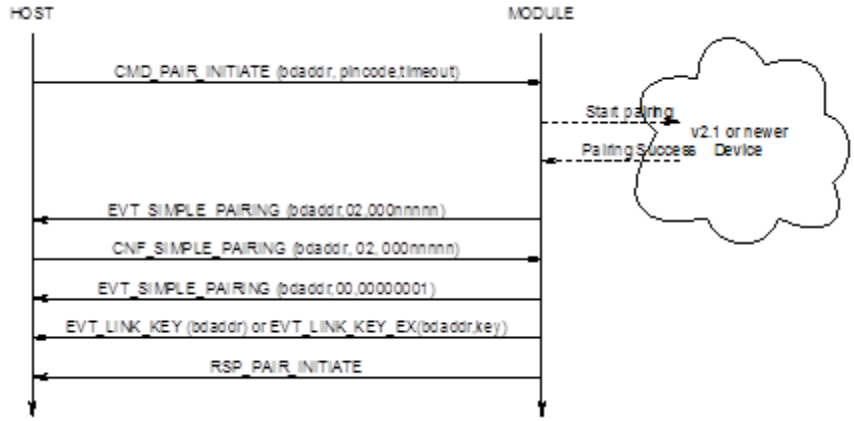


Figure 3-8: Display Yes/No capability sequence diagram

The first EVT_SIMPLE_PAIRING contains a passcode that needs to be confirmed by the host. To confirm the passcode, the host sends a CNF_SIMPLE_PAIRING packet which has a passcode value of 00000001; to reject it, uses a value of 00000000.

If pairing is successful, another EVT_SIMPLE_PAIRING with a success value is sent and then a EVT_LINK_KEY event is sent to the host; if not the second EVT_SIMPLE_PAIRING displays a 00000000 value.

3.15.1.3 Simple Secure Pairing 'Display Only'

The message sequence diagram for when the device has display only capability is as follows:

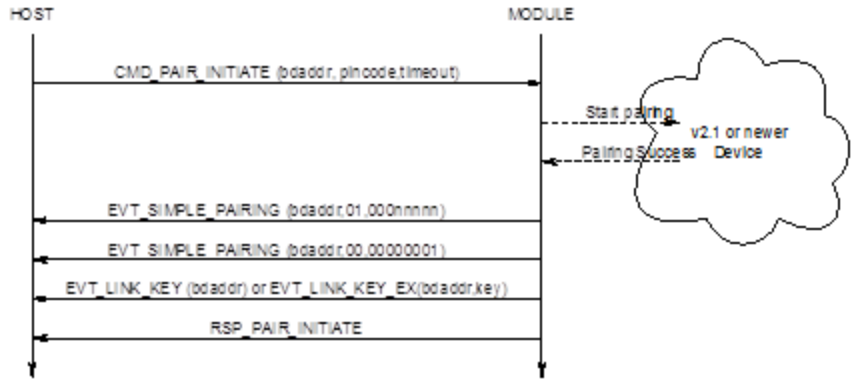


Figure 3-9: Display Only sequence diagram

The first EVT_SIMPLE_PAIRING contains the passcode which must be displayed. When the peer confirms the passcode or otherwise, a second EVT_SIMPLE_PAIRING is sent to the host with an appropriate success/fail code.

If pairing is successful, EVT_LINK_KEY is sent to the host; if not RSP_PAIR_INITIATE indicates a non-ok status code.

3.15.1.4 Simple Secure Pairing 'Keyboard Only'

The message sequence diagram for when the device has keyboard only capability is as follows:

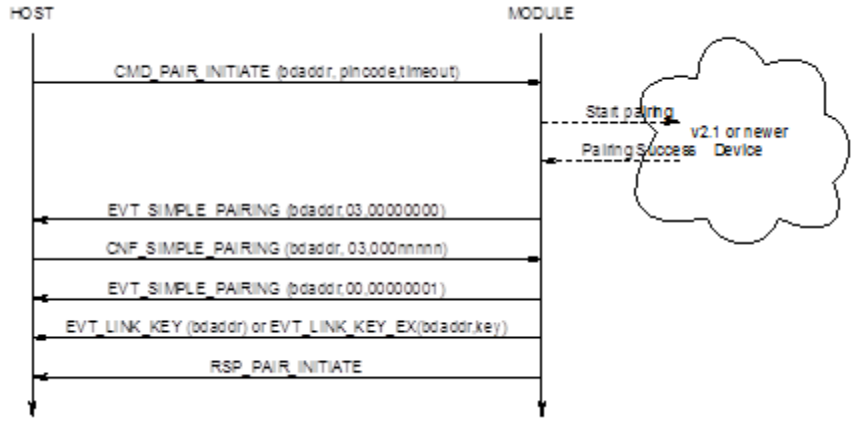


Figure 3-10: Keyboard Only sequence diagram

The first EVT_SIMPLE_PAIRING indicates that a simple pairing procedure has started; at that point the host responds with a confirm packet which contains the passcode that was visually obtained from the peer device (or both peers decided to use the same code). When the peer confirms the pairing a second EVT_SIMPLE_PAIRING is sent to the host with an appropriate success/fail code.

If pairing is successful, EVT_LINK_KEY is sent to the host; if not, RSP_PAIR_INITIATE indicates a non-ok status code.

3.15.2 Incoming Pairing Procedure

As long as the module is in connectable mode (see CMD_CONNECTABLE_MODE) it can accept pairing from peers.

In that situation, when a pairing procedure is detected, a pincode request event packet is sent to the host and the host responds with a CMD_PINCODE or CNF_PINCODE command as shown in the message sequence diagram below (Figure 3-11). It responds with CNF_PINCODE if it is in the middle of making a connection and a response for 'make connection' is still pending.

If the host does not send a pincode command, then the peer that initiated the pairing eventually timeouts.

3.15.2.1 Legacy Pairing

The message sequence diagram for incoming legacy pairing is as follows:

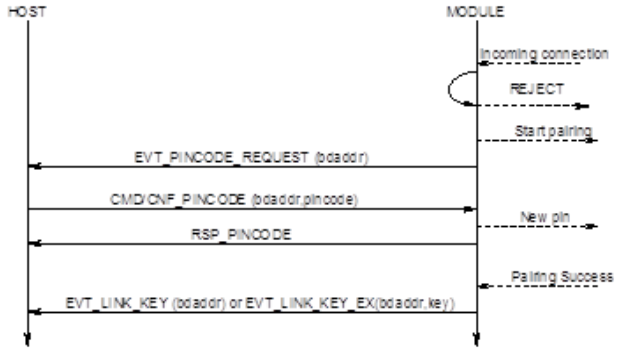


Figure 3-11: Legacy Pairing sequence diagram

3.15.2.2 Simple Secure Pairing 'Just Works'

The message sequence diagram for 'Just Works' when the device has specified no I/O capability is as follows:

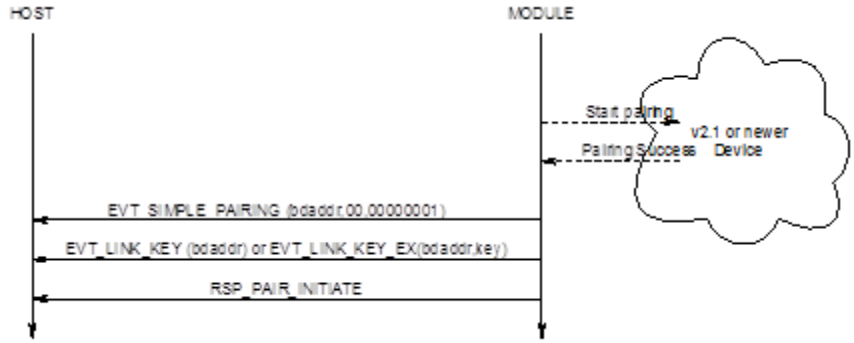


Figure 3-12: Just Works with no I/O capability sequence diagram

The EVT_SIMPLE_PAIRING displays a success indication.

3.15.2.3 Simple Secure Pairing 'Display Yes/No'

The message sequence diagram for when the device has display and yes/no capability is as follows:

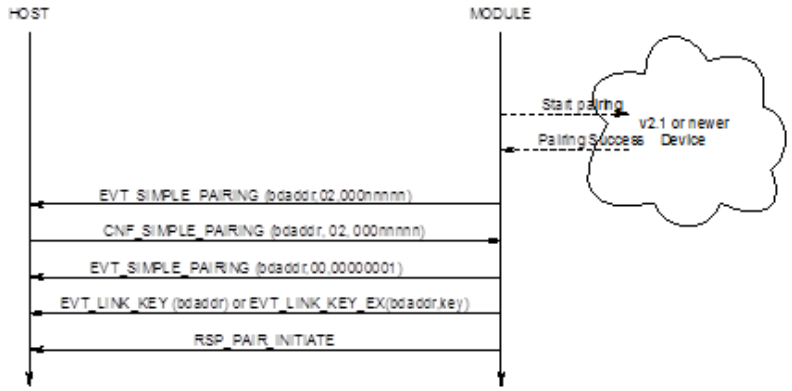


Figure 3-13: SSP, Display Yes/No sequence diagram

The first EVT_SIMPLE_PAIRING contains a passcode that must be confirmed by the host. To confirm the passcode, the host sends a CNF_SIMPLE_PAIRING packet which echoes the passcode. To reject it, the host uses any non-matching value.

If pairing is successful, another EVT_SIMPLE_PAIRING with a success value is sent and then a EVT_LINK_KEY event is sent to the host, if not the second EVT_SIMPLE_PAIRING displays a 00000000 value.

3.15.2.4 Simple Secure Pairing 'Display Only'

The message sequence diagram for when the device has display only capability is as follows:

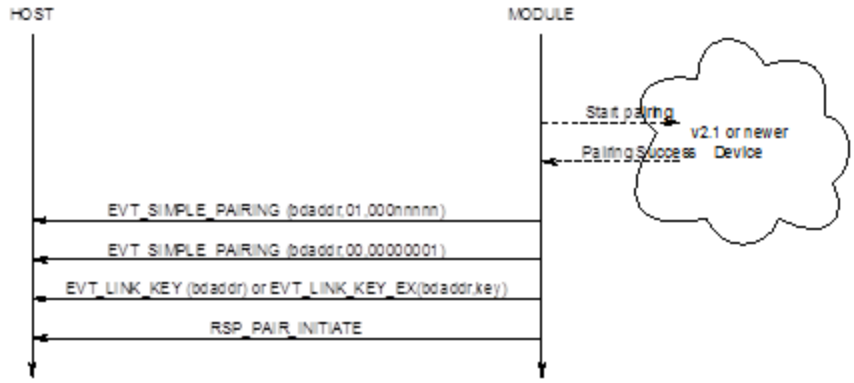


Figure 3-14: SSP, Display Only sequence diagram

The first EVT_SIMPLE_PAIRING contains the passcode which must display. When the peer confirms the passcode or otherwise a second EVT_SIMPLE_PAIRING is sent to the host with an appropriate success/fail code.

If pairing is successful, EVT_LINK_KEY is sent to the host; if not RSP_PAIR_INITIATE indicates a non-ok status code.

3.15.2.5 Simple Secure Pairing 'Keyboard Only'

The message sequence diagram for when the device has keyboard only capability is as follows:

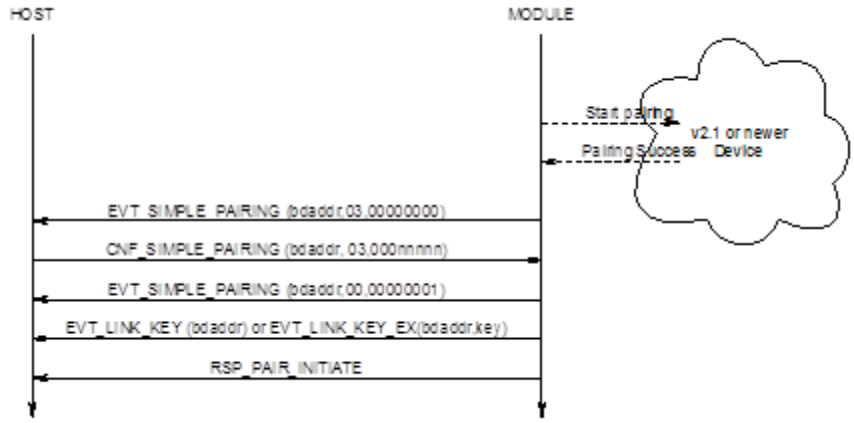


Figure 3-15: SSP, Keyboard Only sequence diagram

The first EVT_SIMPLE_PAIRING indicates that a simple pairing procedure started and at that point the host responds with a confirm packet which contains the passcode that was visually obtained from the peer device (or both peers decided to use the same code). When the peer confirms the pairing, a second EVT_SIMPLE_PAIRING is sent to the host with an appropriate success/fail code.

If pairing is successful, EVT_LINK_KEY is sent to the host; if not RSP_PAIR_INITIATE indicates a non-ok status code.

3.15.3 SIMPLE PAIRING Confirmation

This confirmation packet provides a response to the module as a result of a EVT_SIMPLE_PAIRING event and conveys to the module additional information required to complete a simple pairing procedure.

This is a confirmation packet and does not result in a response from the module.

Event Packet			
Offset	Field	Value	Comments
0	LENGTH	15	
1	CHANNEL	0	
2	EVENT	[CNF SIMPLE PAIRING]	
3	FLOW_OUT	??	Runtime value
4..9	BDADDR[6]	Nap[0,1]:Uap[2]:Lap[3,4,5]	Bluetooth address of pairing device
10	action	2..3	See description below
11..14	actionval	4 bytes	See description below

Action :: 0 & 1

This is illegal and is ignored by the module.

Action :: 2

This informs the module the response to a YES/NO query. Set 'actionval' to 00000000 for NO and non-00000000 for YES.

Action :: 3

This informs the module the response to a passcode query. In this case the 'actionval' conveys the passcode value.

Note: A successful connection to an unpaired 2.1 and newer device requires this confirmation packet because the MP protocol does not process new commands unless the previous command was completed by sending an appropriate response packet.

The packet processor in the module queues all commands until a response sends, but processes confirmation packets as they come.

3.15.4 PinCode (Command)

This command sends a pincode in response to an EVT_PINCODE_REQUEST message and results in a RSP_PINCODE from the module to the host.

This command can also register a pincode for all subsequent incoming legacy pairings from BT2.0 and older devices. In that case the BDADDR[] field MUST be set to all zeros.

COMMAND PACKET			
Offset	Field	Value	Comments
0	LENGTH	27	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_PINCODE]	
3	FLOW_IN	??	Runtime value
4..9	BDADDR[]	Nap[0,1]:Uap[2]:Lap[3,4,5]	Bluetooth address of device requesting the pairing
10..26	PIN[]	17 byte string array	Null Terminated Pin code String. Max pin code length is 16.

Response Packet			
Offset	Field	Value	Comments
0	LENGTH	5	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_PINCODE]	
3	FLOW_OUT	??	Runtime value
4	STATUS	As appropriate	

If pairing is successful the event message EVT_LINK_KEY or EVT_LINK_KEY_EX sends to the host after the response. The latter event sends if S Register 47 is set to 1.

3.15.5 PinCode (Confirmation)

This is a confirmation packet which sends a pincode in response to an EVT_PINCODE_REQUEST message while making an outgoing connection to a legacy pairing device and there was a pairing challenge by the peer prior to connection acceptance.

This packet, just like the command version of this packet, can also register a pincode for all subsequent incoming legacy pairings from BT2.0 and older devices. In that case the BDADDR[] field MUST be set to all zeros.

COMMAND PACKET			
Offset	Field	Value	Comments
0	LENGTH	27	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_PINCODE]	
3	FLOW_IN	??	Runtime value
4..9	BDADDR[]	Nap[0,1]:Uap[2]:Lap[3,4,5]	Bluetooth address of device requesting the pairing
10..26	PIN[]	17 byte string array	Null Terminated Pin code String. Max pin code length is 16.

If pairing is successful, the event message EVT_LINK_KEY or EVT_LINK_KEY_EX is sent to the host after the response. The latter event sends if S Register 47 is set to one.

Note: A successful connection to an unpaired 2.0 and newer device requires this confirmation packet because the MP protocol does not process new commands unless the previous command was completed by sending an appropriate response packet.

The packet processor in the module queues all commands until a response sends, but processes confirmation packets as they come hence in this case CMD_PINCODE does not work.

3.15.6 Trusted Database Record Count

This command obtains the number of trusted devices in the database specified.

Command Packet			
Offset	Field	Value	Comments
0	LENGTH	5	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_ TRUSTED_DB_COUNT]	
3	FLOW_IN	??	Runtime value
4	DBTYPE	0..1	0 = ROLLING DATABASE 1 = PERSISTANT DATABASE

Response Packet			
Offset	Field	Value	Comments
0	LENGTH	8	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_ TRUSTED_DB_COUNT]	
3	FLOW_OUT	??	Runtime value
4	STATUS	As appropriate	
5	DBTYPE	0..1	Echoed from command
6	COUNT	0..N	Number of trusted devices in this database
7	MAXCOUNT	0..N	Maximum number of devices that can be

	stored in this database

Note: ROLLING database stores all new pairings automatically. It is up to the host to transfer a record from ROLLING to the PERSISTANT database so that it does not get overwritten.

3.15.7 Trusted Database Read Record

This command reads the Bluetooth address of the ITEMNO pairing in the database specified, counted from the top. ITEMNO is indexed from one.

Command Packet			
Offset	Field	Value	Comments
0	LENGTH	6	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_TRUSTED_DB_READ]	
3	FLOW_IN	??	Runtime value
4	DBTYPE	0..1	0 = ROLLING DATABASE 1 = PERSISTANT DATABASE
5	ITEMNO	1..N	Item number to read

Response Packet			
Offset	Field	Value	Comments
0	LENGTH	13	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_TRUSTED_DB_READ]	
3	FLOW_OUT	??	Runtime value
4	STATUS	As appropriate	
5	DBTYPE	0..1	Echoed from command
6	ITEMNO	1..N	Echoed from command
7..12	BDADDR[]	Nap[0,1]:Uap[2]:Lap[3,4,5]	Bluetooth addr is zeros if specified item does not exist

If S Reg 47 is set to one, then it is possible to read a record so that both the address and link key information is supplied by sending the command CMD_ TRUSTED_DB_ISTRUSTED. In that case, the event EVT_LINK_KEY_EX is sent before the response to CMD_TRUSTED_DB_ISTRUSTED.

3.15.8 Trusted Database Delete Record

This command deletes a pairing from the databases. It is not necessary to specify the database type, as both databases are scanned.

Command Packet			
Offset	Field	Value	Comments
0	LENGTH	10	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_ TRUSTED_DB_DELETE]	
3	FLOW_IN	??	Runtime value
4..9	BDADDR[]	Nap[0,1]:Uap[2]:Lap[3,4,5]	Bluetooth addr of device to be unpaired

Response Packet			
Offset	Field	Value	Comments
0	LENGTH	11	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_ TRUSTED_DB_DELETE]	
3	FLOW_OUT	??	Runtime value
4	STATUS	As appropriate	
5..10	BDADDR[]	Nap[0,1]:Uap[2]:Lap[3,4,5]	Bluetooth addr, echoed from the command

3.15.9 Trusted Database Change Type

This command transfers a record to the database specified.

Command Packet			
Offset	Field	Value	Comments
0	LENGTH	11	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_TRUSTED_DB_CHANGETYPE]	
3	FLOW_IN	??	Runtime value
4	DBTYPE	0..1	
5..10	BDADDR[]	Nap[0,1]:Uap[2]:Lap[3,4,5]	Bluetooth addr

Response Packet			
Offset	Field	Value	Comments
0	LENGTH	12	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_TRUSTED_DB_CHANGETYPE]	
3	FLOW_OUT	??	Runtime value
4	STATUS	As appropriate	
5	DBTYPE	0..1	Echoed from command
6..11	BDADDR[]	Nap[0,1]:Uap[2]:Lap[3,4,5]	Bluetooth addr, echoed from command

3.15.10 Trusted Database Is Peer Trusted

This command checks if a device is trusted.

Command Packet			
Offset	Field	Value	Comments
0	LENGTH	10	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_ TRUSTED_DB_ISTRUSTED]	
3	FLOW_IN	??	Runtime value
4..9	BDADDR[]	Nap[0,1]:Uap[2]:Lap[3,4,5]	Bluetooth addr

Response Packet			
Offset	Field	Value	Comments
0	LENGTH	11	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_ TRUSTED_DB_ISTRUSTED]	
3	FLOW_OUT	??	Runtime value
4	STATUS	As appropriate	
5..10	BDADDR[]	Nap[0,1]:Uap[2]:Lap[3,4,5]	Bluetooth addr, echoed from the command

The STATUS value is MPSTATUS_OK if the device is trusted; any other value means not trusted.

If S Reg 47 is set to one, then if the peer device is found in the trusted device database, then the event EVT_LINK_KEY_EX is sent to the host BEFORE the response. That event contains the address and link key associated with that address.

3.15.11 Trusted Database Add Key (Out-Of-Band Facilitator)

This command manually adds a link key/address pair into the rolling trusted database.

The module does not care how the key was generated and the only validation it performs is to check that it is 16 bytes long.

Command Packet			
Offset	Field	Value	Comments
0	LENGTH	1E	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_TRUSTED_DB_ADD]	
3	FLOW_IN	??	Runtime value
4..9	BDADDR[6]	Nap[0,1]:Uap[2]:Lap[3,4,5]	Bluetooth addr
10..25	KEY[16]	16 byte Link Key	Any random value
26..29	FLAGS[4]	05 00 00 00	For future use and MUST be set to 05000000

Response Packet			
Offset	Field	Value	Comments
0	LENGTH	11	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_ TRUSTED_DB_ADD]	
3	FLOW_OUT	??	Runtime value
4	STATUS	As appropriate	

The STATUS value is MPSTATUS_OK if the device was successfully added to the database.

If the device Bluetooth address is already in the trusted device database, then the old one is deleted and is replaced by this new one.

3.16 Miscellaneous Commands

3.16.1 Get Security Mode

This command gets the current security mode of the module. Bluetooth v2.1 and newer devices cannot disable security therefore only values 12 to 15 inclusive are valid. These values specify Simple Secure Pairing with appropriate I/O capabilities.

Specifying a value of 0xFF means leave the mode as it is, but inform the host with regards to current mode.

Command Packet			
Offset	Field	Value	Comments
0	LENGTH	5	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_SECURITY_MODE]	
3	FLOW_IN	??	Runtime value
4	SECMODE	0xFF	0xFF = Get current mode

Response Packet			
Offset	Field	Value	Comments
0	LENGTH	6	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_SECURITY_MODE]	
3	FLOW_OUT	??	Runtime value
4	STATUS	As appropriate	
5	SECMODE	12..15	Current mode 12 = SSP with no input no output 13 = SSP with yes/no display 14 = SSP with keyboard only 15 = SSP with Display only

1. SECMODE is now driven by the 'Simple Secure Pairing' procedure included in and after v2.1 of the Bluetooth specification
2. For 'SECMODE' the 'No I/O capability' option is equivalent to 'Just works' scenario in Simple Secure pairing.
3. When this module interacts with a pre 2.1 device it is unconditionally forced into legacy pairing mode.
4. The reader should become familiar with the 'Simple Secure Pairing' concept introduced in and all subsequent version of Bluetooth after v2.1. The best introduction is to Google the phrase "Bluetooth Simple Secure Pairing".
5. The reader is also welcome to contact Laird for an informal discussion.

3.16.2 Get Remote Friendly Name

This command gets the friendly name of the specified peer device.

According to the Bluetooth specification, a friendly name can be up to 248 bytes long. Sending this name in its entirety to the host could violate the max packet length capability of the host because memory restrictions in the host or transmit buffers in the module may not be able to cope. Therefore, the mechanism for getting the name to the host is via multiple event packets is EVT_REM_FNAME. The host decides how many bytes of the name are passed up to it via these events from the offset it also specifies. This implies that in a memory constraint environment, it is possible to relay the name to the host using multiple commands.

For example, if the host has space for only 10 bytes and a peer happens to have a very long name, the host can ask for 10 byte fragments of the name over multiple get name requests.

Command Packet

Offset	Field	Value	Comments
0	LENGTH	13	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_GET_REM_FNAME]	
3	FLOW_IN	??	Runtime value
4..9	BDADDR[]	Nap[0,1]:Uap[2]:Lap[3,4,5]	Bluetooth addr
10	TIMEOUT	2..120	Timeout in seconds
11	START	N	Offset into the friendly name string
12	MAXBYTES	M	Maximum number of characters to read

Response Packet			
Offset	**Field**	**Value**	**Comments**
0	LENGTH	8	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_GET_REM_FNAME]	
3	FLOW_OUT	??	Runtime value
4	STATUS	As appropriate	
5	NAMELEN	0..248	Actual size of the friendly name
6	START	N	Echoed from the command
7	SENTLEN	S	Total number of bytes sent

Note: SENTLEN could be less than MAXBYTES. It can happen if there is no space in the module's TX buffer to send events.

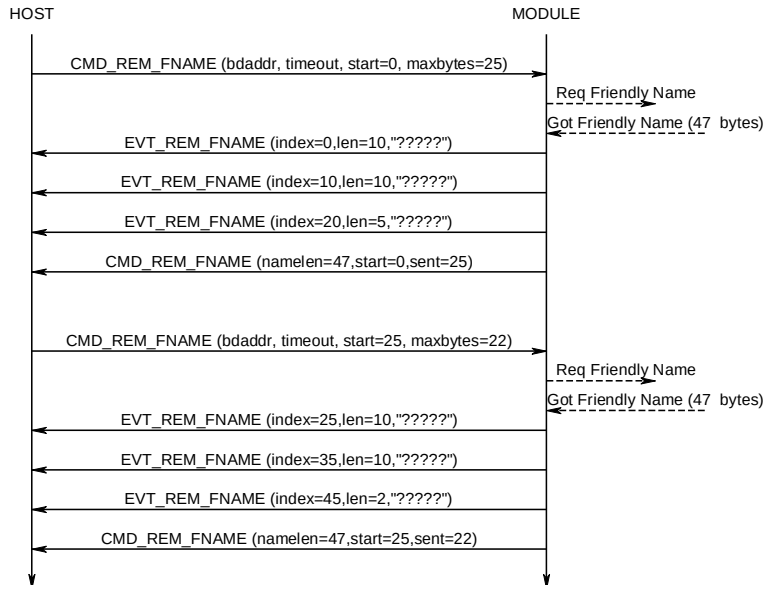


Figure 3-16: Get Remote Friendly Name sequence diagram

3.16.3 Get Local Friendly Name

This command reads the local friendly name which is stored in non-volatile memory. Unlike remote friendly name (with no control over the max. length) the max. local friendly name is 31 characters.

This length may still be too big to send to the host in one packet. Therefore it is sent in a similar fashion to 'get friendly name' described above.In this case, the event EVT_LCL_FNAME gets the name to the host.

Command Packet			
Offset	Field	Value	Comments
0	LENGTH	6	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_GET_LCL_FNAME]	
3	FLOW_IN	??	Runtime value
4	START	n	Offset into the friendly name string
5	MAXBYTES	m	Maximum number of characters to read

Response Packet			
Offset	Field	Value	Comments
0	LENGTH		Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_GET_LCL_FNAME]	
3	FLOW_OUT	??	Runtime value
4	STATUS	As appropriate	
5	NAMELEN	0..31	Actual size of the friendly name
6	START	n	Echoed from the command
7	SENTLEN	S	Total number of bytes sent in preceding events.

The name string is sent to the host in EVT_LCL_FNAME packets. See description of Get Remote Friendly name

Note: SENTLEN could be less than MAXBYTES. It can happen if there is no space in the module's TX buffer to send events.

3.16.4 Set Local Friendly Name

This command sets the local friendly name in non-volatile memory so that it is used after a power up/reset cycle.

Since the module can cope with large packets, the name is sent to the module in a single command packet as a null terminated string.

Command Packet			
Offset	Field	Value	Comments
0	LENGTH	37	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_SET_LCL_FNAME]	
3	FLOW_IN	??	Runtime value
4	FLAGS	1..2	1 = Write to non-vol store for use on next power up

Command Packet			
Offset	Field	Value	Comments
			2 = Make the name visible now
5	NAMELEN	1..30	
6..36	NAME[31]	Null terminated string	Not more than 30 characters

Response Packet			
Offset	Field	Value	Comments
0	LENGTH	5	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_SET_LCL_FNAME]	
3	FLOW_OUT	??	Runtime value
4	STATUS	As appropriate	

3.16.5 Set Device Class

This command sets the device class code so that the base band makes it visible immediately. This is opposed to setting it via S Register 120 which only expedites on power up.

Command Packet			
Offset	Field	Value	Comments
0	LENGTH	7	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_SET_DEVCLASS]	
3	FLOW_IN	??	Runtime value
4..6	DEVCLASS[3]	New 24 bit device class	MSB of device class is at offset 4

Response Packet			
Offset	Field	Value	Comments
0	LENGTH		Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_SET_DEVCLASS]	
3	FLOW_OUT	??	Runtime value
4	STATUS	As appropriate	

3.16.6 Factory Default

This command clears non-volatile memory in the module so that it reverts to factory default state.

The FLAGS field is a bit mask which selectively clears various types of non-volatile memory and should be set to FF.

Command Packet			
Offset	Field	Value	Comments
0	LENGTH	5	Fixed
1	CHANNEL	0	Fixed

2	COMMAND	[CMD_FACTORYDEFAULT]	
3	FLOW_IN	??	Runtime value
5	FLAGS	8 bit mask	See notes below 0xFF to delete all groups, present and future

Response Packet			
Offset	Field	Value	Comments
0	LENGTH		Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_FACTORYDEFAULT]	
3	FLOW_OUT	??	Runtime value
4	STATUS	As appropriate	

Note: Non-volatile information in the module is divided into various subgroups and the FLAGS bits allow selective resetting to factory state for those subgroups. The bits are allocated as follows:

Bit 0 : S registers
Bit 1 : Local Friendly Name
Bit 2 : HID Device Descriptors
Bit 3 : Reserved – Always set to 1
Bit 4 : Reserved – Always set to 1
Bit 5 : Reserved – Always set to 1
Bit 6 : Link Keys
Bit 7 : Special S registers (240 to 255 in the multipoint space)

3.16.7 Get Digital/Analog I/O

This command reads the states of up to 16 digital input lines and optionally requests an analogue input reading.

This response packet contains two octets containing the digital input states. If an analogue input reading is requested then the ADC reading is supplied in an EVENT_ADC event.

Command Packet			
Offset	Field	Value	Comments
0	LENGTH	6	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_GET_IO]	
3	FLOW_IN	??	Runtime value
4	digId	0	0 = Digital I/o in Module
5	analogId	0	0 = No ADC access 1 = AIO0 2 = AIO1 3..255 = FUTURE USE (See Note 1)

Response Packet			
Offset	Field	Value	Comments

0	LENGTH		Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_GET_IO]	
3	FLOW_OUT	??	Runtime value
4	STATUS	As appropriate	
5	digId	0	Echoed from command packet
6..7	digIn[2]	??	Digital inputs 0 to 15. Bit 15 is bit 7 in the MSB. (See Note 2)

Note 1: If the analogID field in the command is non-zero and a valid value, then an EVENT_ADC is generated when the ADC is read.

Note 2: Bit 0 corresponds to GPIO0, Bit 1 corresponds to GPIO1, etc. Refer to the module's data sheet to check which GPIO pins are available for use.

3.16.8 Set Digital I/O

This command controls the states of up to 16 digital output lines.

Command Packet			
Offset	Field	Value	Comments
0	LENGTH	6	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_SET_IO_EX]	
3	FLOW_IN	??	Runtime value
4	ioId	0	0 = Digital I/o in Module
5..6	mask[2]	0000..FFFF	Only set bits specify which bits in ioVal submit to the digital I/O (See Note 1)
7..8	ioVal[2]	0000..FFFF	Only the bits set in mask update at the output. (See Note 1)

Response Packet			
Offset	Field	Value	Comments
0	LENGTH		Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_SET_IO]	
3	FLOW_OUT	??	Runtime value
4	STATUS	As appropriate	

1. Bit 0 corresponds to GPIO0, Bit 1 to GPIO1 etc. Please refer to the module's data sheet to check which GPIO pins are available for use.

3.16.9 Reset

This command resets the module.

Command Packet			
Offset	Field	Value	Comments
0	LENGTH	7	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_RESET]	

3	FLOW_IN	??	Runtime value
4..6	RESVD[3]	00 00 00	Reserved for future use, set to zeros.

There is no response to this command packet. However, on reset there is at least one EVT_STATUS event, so that can be used to detect that the device has rebooted.

3.16.10 BLOB Manage

This command manages binary data uploaded from the host through data channels 0x98 to 0x9F (the number of BLOB data channels is compile time dependent). The binary data is referred to as a 'BLOB' (binary long object).

Command Packet			
Offset	Field	Value	Comments
0	LENGTH	14	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_BLOBMANAGE]	
3	FLOW_IN	??	Runtime value
4	subCmdId	0..9	
5	blobId	0..1	Identifies the BLOB that this command acts on. Data Channels correspond to (0x98 + blobID)
6..9	ParmA	Offset 6 is MSB Offset 9 is LSB	Parameter A
10..13	ParmB	Offset 10 is MSB Offset 13 is LSB	Parameter B

Response Packet			
Offset	Field	Value	Comments
0	LENGTH	15	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_ BLOBMANAGE]	
3	FLOW_OUT	??	Runtime value
4	STATUS	As appropriate	
5	subCmdId	Echoed from command	
6	blobId	Echoed from command	
7..10	ParmA	Offset 7 is MSB Offset 10 is LSB	Depends on subCmdId
11..14	ParmB	Offset 11 is MSB Offset 14 is LSB	Depends on subCmdId

Action to perform

SubCmdId field specifies the actions that the BLOB manager should take on the BLOB specified in field blobID and are described in the following sub sections.

Clear :: 0

Use this subcommand to clear the BLOB specified by 'blobID', On return ParmA and ParmB are set to zero.

Get Size :: 1

Use this subcommand to get the number of bytes in the BLOB specified by 'blobID', On return ParmA contains the number and ParmB is set to zero.

Read :: 2

Use this subcommand to transmit the content of the BLOB specified by 'blobID'. If there is data in the BLOB then it results in one or more data packets being sent to the host on channel (0x98+BlobID).The data in the BLOB is not destroyed. On return ParmA contains the number of bytes in the BLOB and ParmB contains the number actually sent in the data packets.

Save Hid Descriptor :: 3

Use this subcommand to first do a basic validation of the data block identified by blobID to see that it contains a valid HID descriptor and if so, save the data to a non-volatile memory set aside to save an array of HID descriptors. The index into that array is specified by ParmA which is referred to as the HIDID.

In the response, ParmA contains 0 for success, 1 for invalid HID descriptor, 2 for failed to save to nonvol array and 000000FF for invalid blobID or invalid HIDID.

Load Hid Descriptor :: 4

Use this subcommand to append the content of the HID descriptor in non-volatile memory identified by a HIDID which is specified in ParmA into the data object identified by blobID.

In the response, ParmA contains 0 for success, 2 for failed to load from nonvol array and 000000FF for invalid blobID or invalid HIDID.

After the BLOB loads, use subcommand Read::2 to force the transmission of the HID descriptor to the host.

Save Custom HID Descriptor Service name :: 5

Use this subcommand to save the service name (Less than 30 characters) that is used when a custom HID device SDP record is registered (When SReg 39 > 0).

In the response, ParmA contains 0 for success, 1 for invalid service name, 2 for failed to save to nonvol array and 000000FF for invalid blobID.

Load Custom HID Descriptor Service name :: 6

Use this subcommand to append the content of the HID service name in non-volatile memory.

In the response, ParmA contains 0 for success, 2 for failed to load from nonvol array and 000000FF for invalid blobID.

After the BLOB loads, use subcommand Read::2 to force the transmission of the name to the host.

Commit BLOB as Enhanced Inquiry :: 7

Use this subcommand to commit the current content of the BLOB specified as Enhanced Inquiry Responses. The data validates so that it conforms to the format specified in described in the Bluetooth Specification Version 2.1 + EDR [1], vol3, Part C – Generic Access Profile, 8 Extended Inquiry Response Data Format (page 1305 in the .pdf-file).

The data block consists of one or more objects, where the first byte of each object specifies the length and the second byte specifies the type of data and the rest of the bytes for that object are the associated data.

For example, to send the string "HelloWorld" and "LairdRules!" as the manufacturer specific data objects, then the BLOB should load with the following data :

0B FF 'H' 'e' 'l' 'l' 'o' 'W' 'o' 'r' 'l' 'd' 0C FF 'L' 'a' 'l' 'r' 'd' 'R' 'u' 'l' 'e' 's' '!'

Where 0B and 0C are length bytes and FF is the type value for 'manufacturer specific data'.

Before submission, the data block is verified to see if the length bytes are consistent with total length of the block.

Save Enhanced Inquired Response Data :: 8

Use this subcommand to save the BLOB data in non-volatile memory so that the data installs the custom EIR data response on every power up. Before committing to memory, the data block is verified to see if the length bytes are consistent with total length of the block.

Load Enhanced Inquired Response Data:: 9

Use this subcommand to load the BLOB specified with data from non-volatile memory associated with Enhanced Inquiry responses; the data that was saved using subcommand 8 described above.

3.17 HDP Profile Commands

Health Device Profile (HDP) is available on the module in both Agent and Manager roles as defined by the Continua Alliance (see www.continua.org). The manager role is for **testing** the agent implementation only and **it is not expected or designed for eventual certification by the Continua Alliance**.

It is assumed that the reader is familiar with all the HDP and IEEE documentation and relevant guidelines published by the Continua Alliance. For further background information related to the HDP implementation in this module please refer to AT Application Examples.

The HDP commands, responses and events described in the subsequent chapters are merely the MP way of managing the functionality and do not add any new features other than those described in the AT Applications Example section. Laird recommends the reader to refer to the AT Application Examples section for further details.

To assist with this cross referencing of details, the table below shows the equivalent commands in AT and MP mode respectively to achieve the same effect in the module.

AT Mode Commands	MP Mode Commands	Comments
AT+HAEiiii,"name" AT+HMEiiii,"name"	CMD_HDP_ENDPOINT	Affects an entry in the SDP record
AT+HAL AT+HML	CMD_HDP_SDPREGISTER	Register and activate HDP service record
AT+HABeeeee,iiii	CMD_HDP_BIND	Create an agent data specialization of type iiii which will connect to a manager with Bluetooth address 'eeeeee'
AT+HAAhhhh	CMD_HDP_ASSOCIATE	
AT+HARhhhh,pppp[…]	CMD_HDP_SCANREPORT_FIXED CMD_HDP_SCANREPORT_VAR	In MP, the attribute list for var report is supplied via a BLOB channel.
AT+HAGhhhh,aaaa,ssss AT+HMGhhhh,oooo,aaaa	CMD_HDP_ATTRIBUTE_READ	Read an attribute value. In MP mode the data value sends in data channel B0
AT+HAShhhh,aaaa,ssss,dddddd	CMD_HDP_ATTRIBUTE_WRITE	Write an attribute value. In MP mode the data value is taken from data channel B0
AT+HMThhhh,ttttt	CMD_HDP_SETTIME	Used at manager end to send new date/time to the agent
AT+HADhhhh	CMD_HDP_DISASSOCIATE	

The following table shows the equivalent AT asynchronous responses and MP events.

AT Mode Async Responses	MP Mode Events	Comments
HDA:DISASSOCIATED hhhh HDM:DISASSOCIATED hhhh	EVT_HDP_DISASSOCIATED	Sent to host when the agent disassociates from the manager or fails to connect to it
HDA:ASSOCIATED hhhh,.. HDM:ASSOCIATED hhhh,..	EVT_HDP_ASSOCIATED	
HDA:TIME hhhh,ttttt	EVT_HDP_TIMEUPDATE	At Agent end only. Manager informs Agent host of new date/time. Manager triggers this using the command AT+HMD or CMD_HDP_SETTIME

3.17.1 HDP related S Registers

To enable HDP profile, Bit 2 in **SReg 3** must be set to one and **SReg 70** specifies whether it is an agent role (= 0) or a manager role (= 1).

In addition **SReg 71** specifies the auto-disassociate timeout in the agent role only, where 0 denotes no timeout. If this is a non-zero value, then after an association or the triggering of a scan report if no further activity occurs in that time, then an automatic disassociation initiates.

SReg 72 specifies the maximum transmit PDU size for HDP packets in the underlying Bluetooth transport layer.

3.17.2 Create Endpoint in SDP Record

This command creates a data specialization source (for agent role) or a sink (for manager role) which registers using the CMD_HDP_SDPREGISTER command. This SDP entry allows peers to determine which data specialization the module services.

It is not necessary to specify which role explicitly in the command because S Reg 70 determines whether the module is configured for an Agent or Manager role. For Agent role SReg 70 is set to 0 and 1 for Manager.

This command is relevant for both Agent and Manager roles.

Command Packet			
Offset	Field	Value	Comments
0	LENGTH	22	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_HDP_ENDPOINT]	
3	FLOW_IN	??	Runtime value
4..5	SpecType[2]	As per IEEE spec [4]=msb,[5]=lsb	Data Specialization code. For example: 100F (4111 dec) for Weigh Scale
6..21	Name[15+1]	Null Terminated Name	Max. name size is 15. MUST be terminated by a NULL

Response Packet			
Offset	Field	Value	Comments
0	LENGTH	5	Fixed
1	CHANNEL	0	Fixed

2	COMMAND	[CMD_HDP_ENDPOINT]	
3	FLOW_OUT	??	Runtime value
4	STATUS	As appropriate	

Create multiple data specialization endpoints by submitting this command an appropriate number of times.

Internally in the module, the SpecType[2] and Name[15+1] information caches in heap memory until the command CMD_HDP_SDPREGISTER transfers that information into the SDP record for final submission to the underlying Bluetooth stack.

3.17.3 Register SDP record

This command registers and activates an HDP related SDP record after creating the endpoints using CMD_HDP_ENDPOINT. Only after this is done can incoming HDP connections be serviced.

It is not necessary to specify which role explicitly in the command because S Reg 70 determines whether the module is configured for an Agent or Manager role. For Agent role SReg 70 is set to 0 and 1 for Manager.

This command is relevant for both Agent and Manager roles.

Command Packet			
Offset	Field	Value	Comments
0	LENGTH	4	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_HDP_SDPREGISTER]	
3	FLOW_IN	??	Runtime value

Response Packet			
Offset	Field	Value	Comments
0	LENGTH	5	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_HDP_SDPPREGISTER]	
3	FLOW_OUT	??	Runtime value
4	STATUS	As appropriate	

Internally in the module, the SpecType[2] and Name[15+1] information previously cached in heap memory from CMD_HDPENDPOINT commands transfers into an SDP record and submits to the underlying stack. After this a peer is able to see this device offering HDP services.

3.17.4 Bind Agent to a Manager

This command binds the Bluetooth address of a manager and an agent data specialization to create an object within the module which a 16 bit handle can subsequently reference, which returns in the response if the command successfully accepts.

This command is relevant for Agent role only.

Command Packet			
Offset	Field	Value	Comments
0	LENGTH	14	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_HDP_BIND]	

Command Packet			
Offset	Field	Value	Comments
3	FLOW_IN	??	Runtime value
4..9	BDADDR[]	Nap[0,1]:Uap[2]:Lap[3,4,5]	Bluetooth address
10.11	SpecType[2]	As per IEEE spec [10]=msb,[11]=lsb	Data Specialization code. For example: 100F (4111 dec) for Weigh Scale
12.13	AssocTout[2]	[12]=msb,[13]=lsb	Automatic deassociation timeout. 0 = no timeout

Response Packet			
Offset	Field	Value	Comments
0	LENGTH	7	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_HDP_BIND]	
3	FLOW_OUT	??	Runtime value
4	STATUS	As appropriate	
5..6	HANDLE[2]	[5]=msb,[6]=lsb	Handle identifying this instance of data specialization agent

The handle returned in the response, if STATUS equals 0, is subsequently used in many commands. If the STATUS byte is not 0, then the HANDLE value i 0.

3.17.5 Associate with Manager

This command associates an agent with a manager, using the pre-defined object created using the CMD_HDP_BIND command which returns a handle to represent that object.

This command is relevant for Agent role only.

Command Packet			
Offset	Field	Value	Comments
0	LENGTH	6	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_HDP_ASSOCIATE]	
3	FLOW_IN	??	Runtime value
4..5	HANDLE[2]	[4]=msb,[5]=lsb	Handle identifying an instance of data specialization agent/manager combination

Response Packet			
Offset	Field	Value	Comments
0	LENGTH	5	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_HDP_ASSOCIATE]	
3	FLOW_OUT	??	Runtime value
4	STATUS	As appropriate	

The host waits until the response receives before submitting further commands.

If association is successful prior to receiving the response, the host sends EVT_ASSOCIATED, which contains the config ID of the MDS configuration that was negotiated and the system ID of the peer. See EVT_ASSOCIATED for further details.

If association was not successful, because for example the manager is not in range or the Bluetooth device specified in CMD_HDP_BIND does not offer HDP services, then the EVT_DISASSOCIATED sends to the host prior to the response message. This is shown in the message sequence diagram below.

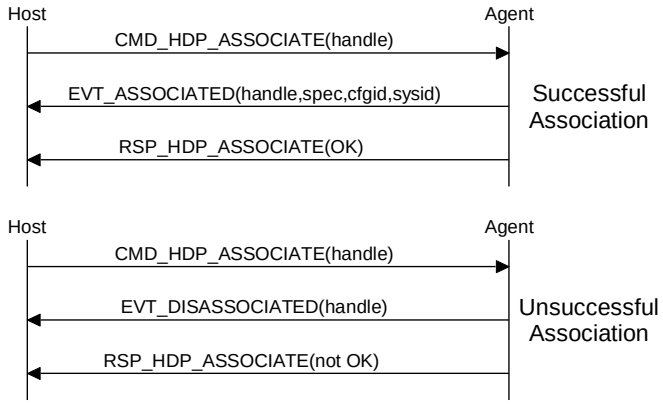


Figure 3-17: Associate sequence diagram

3.17.6 Send Fixed Scan Report to Manager

This command associates (if not already associated) and sends a fixed scan report from an agent to the bound manager. The binding specified via the CMD_HDP_BIND command which returns a handle to represent that combination object.

This command is relevant for Agent role only, and results in an EVT_HDP_SCANREPORT event at the manager end.

A fixed report sends the values for a list of attributes to a manager where the list is predefined in the MDC_ATTR_ATTRIBUTE_VAL_MAP attribute of the NU collection object.

Command Packet			
Offset	Field	Value	Comments
0	LENGTH	9	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_HDP_SCANREPORT_FIXED]	
3	FLOW_IN	??	Runtime value
4..5	HANDLE[2]	[4]=msb,[5]=lsb	Handle identifying an instance of data specialization agent/manager combination
6..7	PERSONID[2]	[6]=msb,[7]=lsb	This identifies a person ID which the manager can uses appropriately
8	HOSTCONTEXT	XX	This echos back in the response and helps the host to keep track of

			them

Response Packet			
Offset	Field	Value	Comments
0	LENGTH	8	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_HDP_SCANREPORT_FIXED]	
3	FLOW_OUT	??	Runtime value
4	STATUS	As appropriate	
5..6	HANDLE[2]	[4]=msb,[5]=lsb	Echoed back from the command
7	HOSTCONTEXT	XX	This is echoed back from the command

The host waits until the response receives before submitting further commands.

If the agent is not associated, then this command first results in an association request and if that is successful the host receives EVT_ASSOCIATED which contains the config ID of the MDS configuration that was negotiated and the system ID of the peer. See EVT_ASSOCIATED for further details.

If the agent is already associated, then there is a response as soon as there is acknowledgement from the manager that the scan report was received.

If association was not successful, because for example the manager is not in range or the Bluetooth device specified in CMD_HDP_BIND does not offer HDP services, then the EVT_DISASSOCIATED sends to the host prior to the response message. This is shown in the message sequence diagram below (Figure 3-18).

3.17.7 Message Sequence Chart for Fixed Scan Report

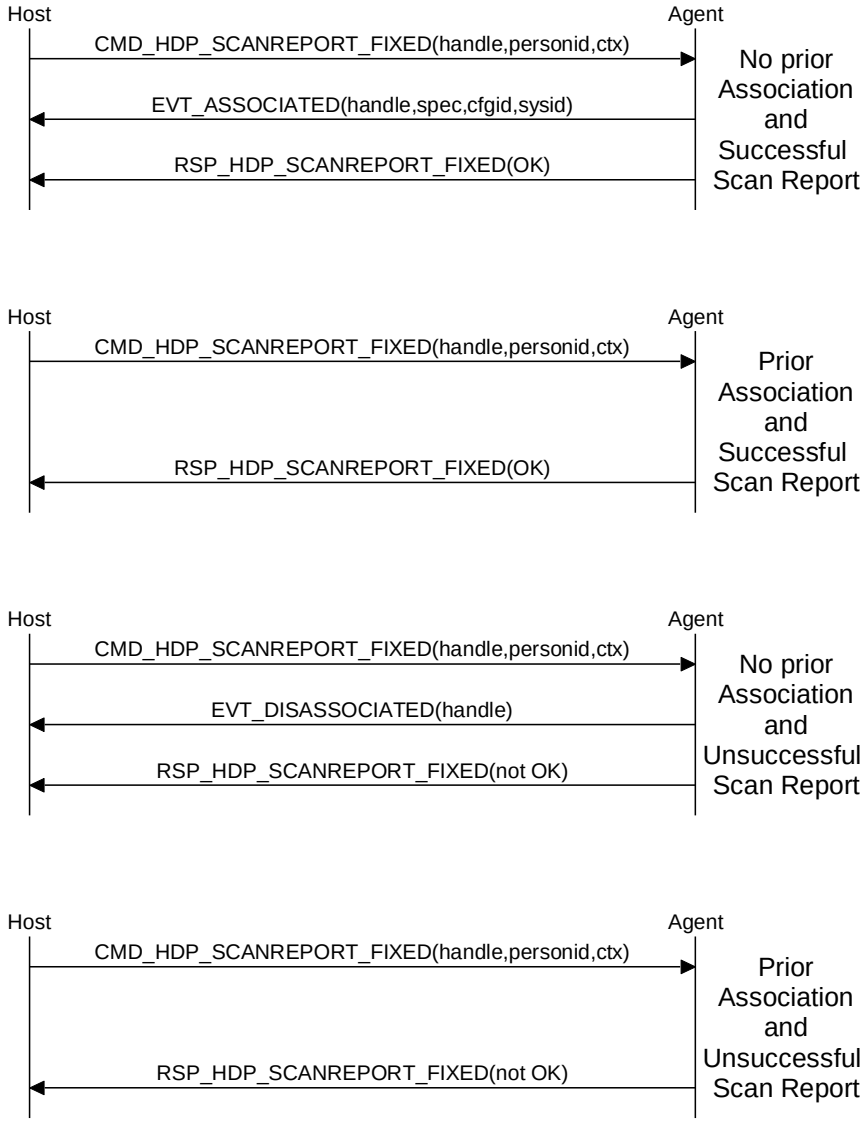


Figure 3-18: Fixed Scan Report sequence diagram

3.17.8 Send VAR Scan Report to Manager

This command associates (if not already associated) and then sends a VAR scan report from an agent to the bound manager; the binding is specified via the CMD_HDP_BIND command which returns a handle to represent that combination.

This command is relevant for Agent role only, and results in an EVT_HDP_SCANREPORT event at the manager end.

A VAR report sends the values for a list of attributes in the NU Collection object to a manager where the host pre-supplies the list. If an attribute does not exist in the NU collection then it is silently ignored. The list is provided by the host via the BLOB data channel for the BLOBID specified in the command (that is, channel number 0x98 plus BLOBID).

Command Packet			
Offset	Field	Value	Comments
0	LENGTH	10	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_HDP_SCANREPORT_VAR]	
3	FLOW_IN	??	Runtime value
4..5	HANDLE[2]	[4]=msb,[5]=lsb	Handle identifying an instance of data specialization agent/manager combination
6..7	PERSONID[2]	[6]=msb,[7]=lsb	This identifies a person ID which the manager can use appropriately
8	HOSTCONTEXT	XX	This echoes back in the response and helps the host to keep track of them
9	BLOBID	0..N	See section "Blob Manage" for details of how to send BLOB data using channel 0x98 for blobID=0 etc

Response Packet			
Offset	Field	Value	Comments
0	LENGTH	8	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_HDP_SCANREPORT_VAR]	
3	FLOW_OUT	??	Runtime value
4	STATUS	As appropriate	
5..6	HANDLE[2]	[4]=msb,[5]=lsb	Echoed back from the command
7	HOSTCONTEXT	XX	This echoes back from the command

The host waits until the response receives before submitting further commands.

If the agent is not associated, then this command first results in an association request and if that is successful the host sends EVT_ASSOCIATED which contains the config ID of the MDS configuration that was negotiated and the system ID of the peer. See EVT_ASSOCIATED for further details.

If the agent is already associated, then there is a response as soon as the manager acknowledges that the scan report was received.

If association was not successful, because for example the manager is not in range or the Bluetooth device specified in CMD_HDP_BIND does not offer HDP services, then the EVT_DISASSOCIATED sends to the host prior to the response message. This is shown in the message sequence diagram below (Figure 3-19).

3.17.9 Message Sequence chart for VAR Scan Report

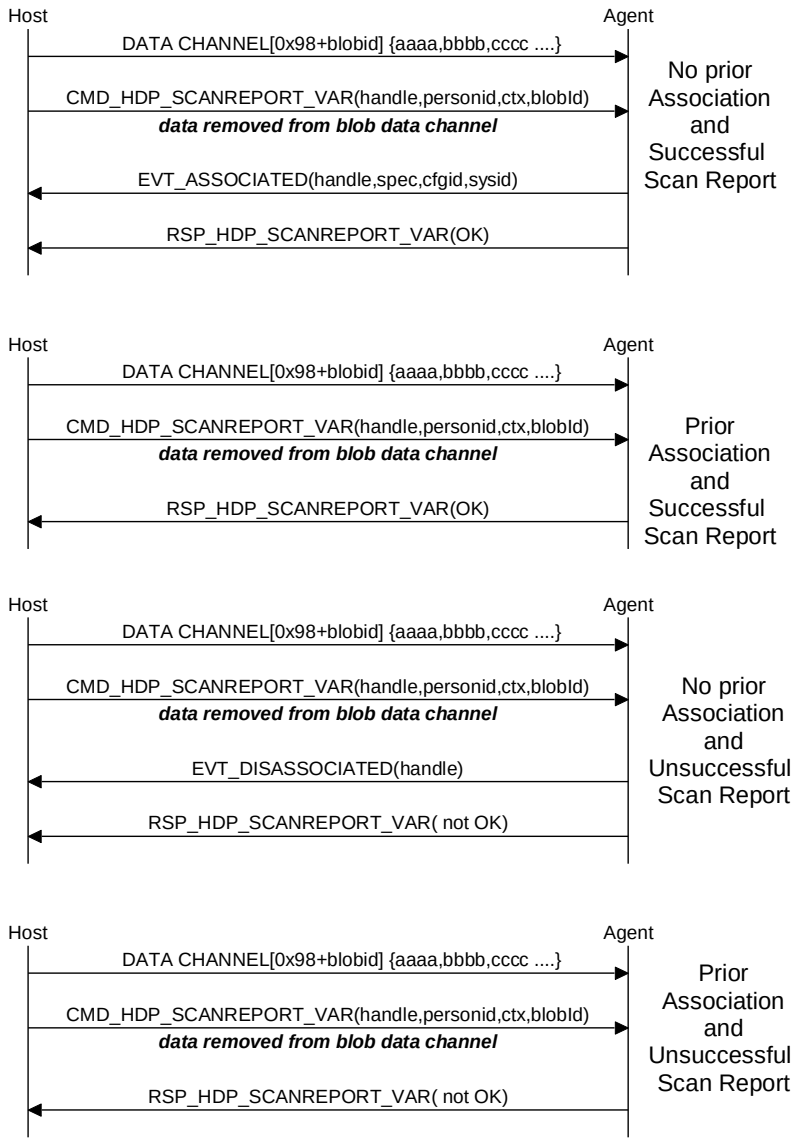


Figure 3-19: VAR Scan Report sequence diagram

3.17.10 Read Attribute Value

This command is valid for both agent and manager role and reads the value of the attribute specified via the attribute ID and the qualifier ID. The value returns in HDP data channel 0xB0 formatted as described below.

Command Packet			
Offset	Field	Value	Comments
0	LENGTH	10	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_HDP_ATTRIBUTE_READ]	
3	FLOW_IN	??	Runtime value
4..5	HANDLE[2]	[4]=msb,[5]=lsb	Handle identifying an instance of data specialization agent/manager combination
6..7	ATTRID[2]	[6]=msb,[7]=lsb	
8..9	QUALIFIERID[2]	[8]=msb,[9]=lsb	See Note 1

Response Packet			
Offset	Field	Value	Comments
0	LENGTH	8	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_HDP_ATTRIBUTE_READ]	
3	FLOW_OUT	??	Runtime value
4	STATUS	As appropriate	
5	HOSTCONTEXT	XX	This is echoed back from the command
6..7	HANDLE[2]	[6]=msb,[7]=lsb	Echoed back from the command

1. For manager role, this is the object ID (MDS=0,NU=1 etc) and for Agent please refer to 'Section Weigh Scale Data Specialization'. As more data specializations are added, the qualifierID specifies appropriately for that specialization.
   The host shall wait until the response receives before submiting further commands.
   If the attribute exists, then the data sends in a Logical HDP data packet transported in one or more physical data packets over channel 0xB0. The physical packets of incoming data in channel 0xB0 is viewed as a **stream** of data making up logical packets.

The logical packet format is as follows and is also addressed in a dedicated section later:

LEN[2],00,HANDLE[2],ATTRID[2],QUALIFIERID[2],DATA[N]

Where LEN[2], HANDLE[2],ATTRID[2],QUALIFIERID[2] are in big endian format (msb sent first) and N is equal to LEN[2]+9.

The 00 after the LEN[2] field signifies that this logical packet consists of attribute data.

Since all data is transparently treated in the module, the endian of DATA[N] should be determined by trial and error with the aid of an HDP manager and finalized to be correct by the time the implementation submits for certification by the Continua Alliance. However, if the attribute data type is a 16 or 32 bit integer/float, then it is little endian.

3.17.11 Write Attribute Value

This command is valid for agent role only and writes the value of the attribute, already preloaded in HDP data channel 0xB0, where the attribute ID and the qualifierID is supplied in the command packet.

Command Packet			
Offset	Field	Value	Comments
0	LENGTH	10	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_HDP_ATTRIBUTE_WRITE]	
3	FLOW_IN	??	Runtime value
4..5	HANDLE[2]	[4]=msb,[5]=lsb	Handle identifying an instance of data specialization agent/manager combination
6..7	ATTRID[2]	[6]=msb,[7]=lsb	
8..9	QUALIFIERID[2]	[8]=msb,[9]=lsb	See Note 1

Response Packet			
Offset	Field	Value	Comments
0	LENGTH	8	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_HDP_ATTRIBUTE_WRITE]	
3	FLOW_OUT	??	Runtime value
4	STATUS	As appropriate	
5	HOSTCONTEXT	XX	This echoes back from the command
6..7	HANDLE[2]	[6]=msb,[7]=lsb	Echoes back from the command

1. For manager role, this is the object ID (MDS=0,NU=1 etc). As more data specializations are added, the qualifierID specifies appropriately for that specialization.
   The host waits until the response receives before submiting further commands.
   If the attribute exists, then the data moves from channel 0xB0 to the attribute container variable. If the attribute does not exist, then the data discards. All the data in the channel is treated as the data for the attribute; that is, there is no qualifying information affixed to the data. In addition, if the attribute exists but the data length does not match that of the attribute, then the write fails (with an appropriate error code) and the data in the channel is discarded.

Since all data is transparently treated in the module, the endian of DATA[N] should be determined by trial and error with the aid of a HDP manager and finalized to be correct by the time the implementation is submitted for certification by the Continua Alliance. However, if the attribute data type is a 16 or 32 bit integer/float, then it will be little endian.

3.17.12 Set Date and Time

This command is valid for manager role only and updates the date and time in the associated agent identified by the handle. When any HDP manager sends a time update to an agent, it results in an EVT_HDP_UPDATE event to the host of that agent.

Command Packet

Offset	Field	Value	Comments
0	LENGTH	14	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_HDP_SET_TIME]	
3	FLOW_IN	??	Runtime value
4..5	HANDLE[2]	[4]=msb,[5]=lsb	Handle identifying an instance of data specialization agent/manager combination
6..13	DATETIME[8]	Ccyymmddhhssnnxx	See Note 1

Response Packet			
Offset	Field	Value	Comments
0	LENGTH	14	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_HDP_SET_TIME]	
3	FLOW_OUT	??	Runtime value
4	STATUS	As appropriate	

1. This command supplies the date/time information as a string of 8 bytes "ccyymmddhhssnnxx" where each byte is as follows:

   CC Century e.g for 2011 the value shall be 0x14

   YY Year e.g for 2011 the value shall be 0x0B

   MM Month e.g for January the value shall be 0x01 and for say December 0x0C

   DD Day e.g for 31 the value shall be 0x1F (0 is illegal value)

   HH Hour e.g for 6:45pm the value shall be 0x12

   NN Minutes e.g for 6:45pm the value shall be 0x2D

   XX fraction This is a fraction of a seconds in hundredths of unit. Valid 00..0x63 (99

   For example the date and time "2 Feb 2011, 16:43:33.78" sends at the string "150C020C102D214E

   The host waits until the response receives before submitting further commands.

3.17.13 Disassociate From Manager

This command disassociates an agent identified by the handle specified in the command from a manager.

This command is relevant for Agent role only.

Command Packet			
Offset	Field	Value	Comments
0	LENGTH	6	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_HDP_DISASSOCIATE]	
3	FLOW_IN	??	Runtime value
4..5	HANDLE[2]	[4]=msb,[5]=lsb	Handle identifying an instance of data specialization agent/manager combination

Response Packet

Offset	Field	Value	Comments
0	LENGTH	5	Fixed
1	CHANNEL	0	Fixed
2	COMMAND	[CMD_HDP_DISASSOCIATE]	
3	FLOW_OUT	??	Runtime value
4	STATUS	As appropriate	

The host waits until the response receives before submitting further commands.

The response sends immediately after initiating the disassociation and when the procedure is complete, an EVT_DISASSOCIATED is sent to the host as shown in the message sequence diagram below (Figure 3-20).

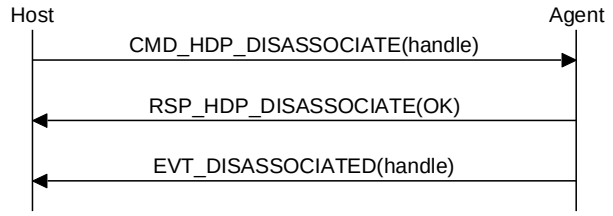


Figure 3-20: Disassociate sequence diagram

4 MODULE EVENTS

This section describes all module originated asynchronous events in detail and is specified via the EVT_ID field of all event packets.

The description for each event below is in the form of an event packet tables.

Each event has a unique EVT_ID value in the range 129 to 255 (0x81 to 0xFF), 0x80 is reserved.

The actual value of EVT_ID in the Value column is described as [Descriptive_Name] where "Descriptive_Name" can be found in a 'C' header file, obtained on request from Laird.

4.1 Inquiry Events

This group of events is inquiry related.

4.1.1 Inquiry Result

This event sends the inquiry response from a peer as a result of an inquiry request.

Event Packet			
Offset	Field	Value	Comments
0	LENGTH	13	
1	CHANNEL	0	
2	EVENT	[EVT_ INQUIRY_RESULT]	
3	FLOW_OUT	??	Runtime value
4..9	BDADDR[6]	Nap[0,1]:Uap[2]:Lap[3,4,5]	Bluetooth address of responding device
10..12	DEVCLASS[3]	0x000000 .. 0xFFFFFF	Device class of responding device

4.2 Information Events

This group of events conveys information about the module, for example to status.

4.2.1 Unknown Command

This event informs the host that a received command had an unknown COMMAND value. The COMMAND value echoes in offset 4.

Event Packet			
Offset	Field	Value	Comments
0	LENGTH		
1	CHANNEL		
2	EVENT	[EVT_UNKNOWN_COMMAND]	
3	FLOW_OUT	??	Runtime value
4	Command	xx	CMD_ID value echoed from command

4.2.2 Status

This event asynchronously sends current status to the host. This event is sent to the host after power up to inform the host that the module is ready and operational. You can also obtain the information contained in this message by sending the CMD_GET_MODES command.

Event Packet			
Offset	Field	Value	Comments
0	LENGTH	8	
1	CHANNEL	0	
2	EVENT	[EVT_ STATUS]	
3	FLOW_OUT	??	Runtime value
4	STATUS	OK or INVALID_LICENSE	
5	DISCMODE	0..1	1 for discoverable mode
6	CONNMODE	0..1	Bit 0: 1 for connectable mode In future bit 1, if set, may indicate that incoming SPP connections are auto accepted
7	SECMODE	12..15	12 = SSP + IO_CAP_NO_INPUT_NO_OUTPUT 13 = SSP + IO_CAP_DISPLAY_YES_NO 14 = SSP + IO_CAP_KEYBOARD_ONLY 15 = SSP + IO_CAP_DISPLAY_ONLY

4.2.3 Invalid Packet Size

This event informs the host that a command packet was received whose length does not match the size of the structure published in the interface header file BmHostProtocol.h.

Event Packet			
Offset	Field	Value	Comments
0	LENGTH	7	
1	CHANNEL	0	
2	EVENT	[EVT_INVALID_PKTSIZE]	
3	FLOW_OUT	??	Runtime value
4	CMD_ID	1..127	Echoed from the command
5	ACT_SIZE	A	Actual size of the packet
6	DES_SIZE	D	Desired size of the packet

4.3 Connection Events

This group of events are connection related.

4.3.1 Connection Setup

This event informs the host that a remote device is requesting a connection.

The host responds with a CMD_CONNECTION_SETUP with an accept or reject flag.

Event Packet			
Offset	Field	Value	Comments
0	LENGTH	12	
1	CHANNEL	0	
2	EVENT	[EVT_ CONNECTION_SETUP]	
3	FLOW_OUT	??	Runtime value
4..9	BDADDR[6]	Nap[0,1]:Uap[2]:Lap[3,4,5]	BT address of device requesting connection
10..11	UUID[]	Server profile UUID the peer wishes to connect to	0x1101 = SPP 0x1124 = HID DEVICE

The UUID field tells the host which server profile the peer wishes to connect to.

4.3.2 Incoming Connection

This event informs the host that an incoming connection established.

Event Packet			
Offset	Field	Value	Comments
0	LENGTH	13	
1	CHANNEL	0	
2	EVENT	[EVT_ CONNECTION_SETUP]	
3	FLOW_OUT	??	Runtime value
4	CHANNEL	1..254	Channel ID to be used to send/receive data, see Note 1 for channel number allocation.
5..10	BDADDR[6]	Nap[0,1]:Uap[2]:Lap[3,4,5]	Bluetooth address of device requesting connection
11..12	UUID[]	Server profile UUID the peer wishes to connect to	0x1101 = SPP 0x1124 = HID DEVICE

The UUID field tells the host which server profile the peer has connected to.

1. Channel number allocation is as follows:

Profile	Channel ID Range
Command Parser	0x00
SPP	0x1 .. 0x7
HID DEVICE(Canned)	0x20
HID HOST(Raw)	0x90 .. 0x97
HID DEVICE(Raw)	0xA0
BLOB	0x98 .. 0x9F
HDP	0xB0..0xB1 (B1 is continuation channel)
Enhanced Inquiry Response	0xF0

4.3.3 Disconnect

This event informs the host that a connection was dropped by the remote device.

Event Packet			
Offset	Field	Value	Comments
0	LENGTH	6	
1	CHANNEL	0	
2	EVENT	[EVT_ DISCONNECT]	
3	FLOW_OUT	??	Runtime value
4	CHANNEL	1..7	Channel number
5	REASON	0..255	As per the table below

The Bluetooth specification specifies the Reason value. Please note that values in the range 0xF0 to 0xFF are custom values defined for this implementation and do not appear in the Bluetooth specification.

0x01…0x3F	See header file MPSTATUS.H which is supplied on request.
0xFF	High probability that the remote device went out range for longer than the link supervision timeout or was powered down.

4.3.4 Modem Status

This event conveys modem status signals originating from the peer device for an SPP connection.

Event Packet			
Offset	Field	Value	Comments
0	LENGTH	6	
1	CHANNEL	0	
2	EVENT	[EVT_ MODEM_STATUS]	
3	FLOW_OUT	??	Runtime value
4	CHANNEL	1..7	Channel ID of an open SPP channel
5	MODEMSIG	Bit Mask	Bit 0: DSR state Bit 1: CTS state Bit 2: DCD state Bit 3: RI state
6	BREAKSIG	0	For future implementation

4.4 Miscellaneous Events

4.4.1 Link Key

This event informs the host that a new link key was created for the device indicated and the result of writing to the ROLLING database.

Event Packet

Offset	Field	Value	Comments
0	LENGTH	11	
1	CHANNEL	0	
2	EVENT	[EVT_ LINK_KEY]	
3	FLOW_OUT	??	Runtime value
4..9	BDADDR[6]	Nap[0,1]:Uap[2]:Lap[3,4,5]	Bluetooth address of paired device
10	DBRESULT	0: Success	Any other value is a failure and the reason is a STATUS value as per MPSTATUS.H

4.4.2 Link Key Ex

This event is sent to the host when CMD_TRUSTED_DB_ISTRUSTED processes, a link key for that peer device exists, and S Register 47 is set to 1. It conveys the link key along with the Bluetooth address to the host.

Event Packet			
Offset	Field	Value	Comments
0	LENGTH	30	
1	CHANNEL	0	
2	EVENT	[EVT_ LINK_KEY_EX]	
3	FLOW_OUT	??	Runtime value
4..9	BDADDR[6]	Nap[0,1]:Uap[2]:Lap[3,4,5]	Bluetooth address of paired device
10..25	KEY[16]	16 byte array	The link key
26..29	RFU[4]	4 byte array	Reserved for future

4.4.3 Pin Code Request

This event informs the host that a remote device requested a pairing and the procedure requires a pin code to complete.

Event Packet			
Offset	Field	Value	Comments
0	LENGTH	10	
1	CHANNEL	0	
2	EVENT	[EVT_ PINCODE_REQUEST]	
3	FLOW_OUT	??	Runtime value
4..9	BDADDR[6]	Nap[0,1]:Uap[2]:Lap[3,4,5]	Bluetooth address of pairing device

The host sends a CMD_PINCODE in response to this event.
This event receives if 'accept pairing while in connectable mode' enables via S Register 15.

4.4.4 Simple Pairing

This event informs the host that a simple pairing procedure is in progress and the 'action' byte in offset 10 tells the host what to do.

Event Packet			
Offset	Field	Value	Comments

Event Packet			
Offset	Field	Value	Comments
0	LENGTH	15	
1	CHANNEL	0	
2	EVENT	[EVT_ SIMPLE_PAIRING]	
3	FLOW_OUT	??	Runtime value
4..9	BDADDR[6]	Nap[0,1]:Uap[2]:Lap[3,4,5]	Bluetooth address of pairing device
10	action	0..3	See description below
11..14	actionval	4 bytes	See description below

The host reacts to this event based on the value of the 'action' byte in offset 10 as follows:

Action :: 0

This informs the host that a simple pairing procedure has been completed and 'actionval' is 00000001 for success and 00000000 for fail. The host shall NOT react to this event with the CNF_SIMPLE_PAIRING packet.

Action :: 1

This informs the host that a simple pairing procedure is in progress and it will only display the passcode in 'actionval' as a six digit decimal number WITH leading zeroes. The host shall NOT react to this event with the CNF_SIMPLE_PAIRING packet.

Action :: 2

This informs the host that a simple pairing procedure is in progress and it displays the passcode in 'actionval' as a 6 digit decimal number WITH leading zeros. The host reacts to this event with the CNF_SIMPLE_PAIRING packet with a 00000000 value for No and a non-00000000 value for Yes. The former value, if the host deems that the passcode is not acceptable, and the latter if acceptable.

Action :: 3

This informs the host that a simple pairing procedure is in progress and the module is expecting a passcode from the host embedded in a CNF_SIMPLE_PAIRING packet. The host shall react to this event with the CNF_SIMPLE_PAIRING packet with a passcode value. The passcode in the CNF_SIMPLE_PAIRING is either obtained by reading the display on the peer device, or if the peer device is also a keyboard only, then the same random 6 digit value (with leading 0s) that is entered at both ends.

4.4.5 Local Friendly Name

This event sends a fragment of the local friendly name to the host. The maximum length of the fragment is 10, so at least 3 of these events are required to convey a local friendly name, if it has the maximum length of 30.

Event Packet			
Offset	Field	Value	Comments
0	LENGTH	16	
1	CHANNEL	0	
2	EVENT	[EVT_LCL_FNAME]	
3	FLOW_OUT	??	Runtime value
4	INDEX	0..29	Start index into the string
5	LEN	1..10	Number of valid characters in the NAME[] field that follows
6..15	NAME[10]	Xx xx xx xx	The name fragment

4.4.6 Remote Friendly Name

This event sends a fragment of the remote friendly name to the host. The maximum length of the fragment is 10, so at least 25 of these events are required to convey a remote friendly name, if it has the maximum length of 248.

Event Packet			
Offset	Field	Value	Comments
0	LENGTH	16	
1	CHANNEL	0	
2	EVENT	[EVT_REM_FNAME]	
3	FLOW_OUT	??	Runtime value
4	INDEX	0..247	Start index into the string
5	LEN	1..10	Number of valid characters in the NAME[] field that follows
6..15	NAME[10]	Xx xx xx xx	The name fragment

4.4.7 Event_ADC

This event returns after a CMD_GET_IO command where the analogID is set to either 1 or 2. In these circumstances the module digitises the voltage on either Analogue 0 or Analogue 1 and reports the value as an eight bit hex number. Therefore the value shown in the ValMSB field should always be zero.

Event Packet			
Offset	Field	Value	Comments
0	LENGTH	16	
1	CHANNEL	0	
2	EVENT	[EVT_ADC]	
3	FLOW_OUT	??	Runtime value
4	analogId	1..2	1 – AIO0 2 – AIO1
5	valMSB	0	MSB of 16 bit digitised input
6	valLSB	0..FF	LSB of 16 bit digitised inoput

5 HDP Profile Related Events

5.1 Associated

This event informs the host that an agent has associated with the manager and contains the handle, data specialization nominal code, device config ID (as per the IEEE standard) and a unique 8 byte identification number for the agent (or manager).

It is relevant for both agent and manager roles.

EVENT PACKET			
Offset	Field	Value	Comments
0	LENGTH	11	
1	CHANNEL	0	
2	EVENT	[EVT_HDP_ASSOCIATED]	
3	FLOW_OUT	??	Runtime value
4	ROLE	00=Agent, 01==Manager	
5..6	HANDLE[2]	[5]=msb, [6]=lsb	Handle of the agent
7..8	SPECTYPE[2]	[7]=msb, [8]=lsb	Data specialization nominal code. E.g 4111 (0x100F) for Weigh Scale
9..10	DEVCFGID[2]	[9]=msb, [10]=lsb	The negotiated config ID. Will be defined in the appropriate IEEE data specialization standard.
11..18	SYSID[8]	8 bytes	This is a system ID which is unique to the agent instant.

5.2 Deassociated

This event informs the host that an agent has disassociated from the manager and contains the handle of the agent.

It is relevant for both agent and manager roles.

Event Packet			
Offset	Field	Value	Comments
0	LENGTH	7	
1	CHANNEL	0	
2	EVENT	[EVT_HDP_DISASSOCIATED]	
3	FLOW_OUT	??	Runtime value
4	ROLE	00=Agent, 01==Manager	
5..6	HANDLE[2]	[5]=msb, [6]=lsb	Handle of the agent

5.3 Time Update

This event generates for an agent role only and informs the host that the agent received an updated date and time from the manager.

Event Packet			
Offset	Field	Value	Comments
0	LENGTH	11	
1	CHANNEL	0	
2	EVENT	[EVT_HDP_TIMEUPDATE]	
3	FLOW_OUT	??	Runtime value
4	ROLE	00=Agent, 01==Manager	
5..6	HANDLE[2]	[5]=msb, [6]=lsb	Handle of the agent
11..14	DATETIME[8]	ccyymmddhhssnnxx	See Note 1

1. The date/time information is supplied in this command as a string of 8 bytes "ccyymmddhhssnnxx" where each byte is as follows:

   CC Century e.g for 2011 the value shall be 0x14
   YY Year e.g for 2011 the value shall be 0x0B
   MM Month e.g for January the value shall be 0x01 and for say December 0x0C
   DD Day e.g for 31 the value shall be 0x1F (0 is illegal value)
   HH Hour e.g for 6:45pm the value shall be 0x12
   NN Minutes e.g for 6:45pm the value shall be 0x2D
   XX fraction This is a fraction of a seconds in hundredths of unit. Valid 00..0x63 (99

   For example the date and time "2 Feb 2011, 16:43:33.78" shall be sent at the string "150C020C102D214E"

6 DEBUG EVENTS

6.1 Debug Packet

This event conveys debugging information to the host, and is available in engineering/beta builds only.

Event Packet			
Offset	Field	Value	Comments
0	LENGTH	16	
1	CHANNEL	0	
2	EVENT	[EVT_DEBUG_PACKET]	
3	FLOW_OUT	??	Runtime value
4	TYPE_FLAG	XX	Bit 0: First Packet Bit 1: Last Packet Bit 2..5: Reserved Bit 6..7: Message Type
5..15	DATA[]	Contains Ascii data	String conveying message

6.2 Malloc Statistics

This event conveys pool malloc statistics to the host and is available in engineering/beta builds only.

Event Packet			
Offset	Field	Value	Comments
0	LENGTH	16	
1	CHANNEL	0	
2	EVENT	[EVT_DEBUG_PACKET]	
3	FLOW_OUT	??	Runtime value
4..5	ELSIZE[2]	0..N	Pool Element Size
6..7	NUMELS[2]	0..N	Number of elements
8..9	TAKEN[2]	0..N	Number of elements taken
10..11	MAXTKN[2]	0..N	Tide mark for taken
12..13	OVFLO[2]	0..N	Number of allocations from next bigger element because this size is maxed out

7 DATA CHANNELS

This section provides details of some data channels which require further explanation.

7.1 HDP Data Channels

7.1.1 Host to Module Direction

Channels B0 and B1 upload attribute data which then transfers to the appropriate data specialization data variable on receipt of a CMD_HDP_ATTRUBUTE_WRITE command.

The host ensures that the correct number of bytes for that attribute accumulate in the channel, as length is the only validation performed on the data; the module does not interpret the data in any way besides length. With regards to the endienness of the data, this shall be determined by trial and error using an appropriate certified HDP manager.

It is entirely possible that an attribute can be defined which contains data requiring more than 253 bytes. A data packet cannot contain data more than 253 bytes so this could present a problem. The solution to that is both channels B0 and B1 write into a buffer in the module to allow the host to accumulate attribute data using several data packets. However when using B0 it always first deletes any data already accumulated in the buffer and then writes to that buffer, whereas writing to channel B1 shall always append the data to the buffer.

7.1.2 Module to Host Direction

Channels B0 and B1 send logical HDP packets to the host. Channel B0 is always the first fragment of the logical packet and subsequent fragments send in channel B1. This means that when the host receives a packet on channel B0, it deletes all data accumulated for an existing ongoing logical packet.

7.2 Logical Packet Format

The format of the HDP logical packet is as follows:

LEN	PACKET_TYPE	DATA
2 bytes	1 byte	N bytes

LEN is set to N+3 and big endian, so that the first byte of LEN sent on the wire is the MSB. The DATA field structure depends on the logical packet type specified by PACKET_TYPE and the following subsections describe the types of packets available at the time of writing.

7.2.1 Packet Type: Attribute Value

This logical packet is sent to the host as a result of processing the CMD_HDP_ATTRIBUTE_READ command in either the agent or manager roles.

For this logical packet type the PACKET_TYPE field sets to 0x00 and the DATA field consists of 4 fields as follows:

Agent Handle	Attr Nominal Code	Attr Qualifier Field	Attr Value
2 bytes	2 bytes	2 bytes	N bytes

The 'Agent Handle', 'Attr Nominal Code' and 'Attr Qualifier ID' fields are all 2 byte fields in big endian format (MSB first) and echo from the CMD_HDP_ATTRIBUTE_READ command, and 'Attr Value' is the actual value of the attribute.

Calculate the length of N by subtracting 9 from the LEN field of the logical packet.

7.2.2 Packet Type: Scan Report

This logical packet sends to the host in a manager role as a result of scan report arriving from an agent.

For this logical packet type the PACKET_TYPE field sets to 0x01 and the DATA field consists of multiple fields as follows:

Agent Handle	Person ID	Num of Objects	Data Lists
2 bytes	2 bytes	1 byte	N bytes

The 'Agent Handle' and 'PersonID' fields are 2 byte fields in big endian format (MSB first), 'Num of Objects' is a one byte field which specifies the number of objects, and the field 'Data Lists' consists of multiple composite fields structured as follows:

Field Type	Data
1 byte	N bytes

'Field Type' can be 0x00 for 'OBJECT HANDLE' and 0x01 for 'ATTRIBUTE TAG/VALUE', and the size of the 'Data' field depends on the Field Type. The available Field Types/Data are described in the following sections.

7.2.3 Field Type: Object Handle

This is the format of the 'Object Handle' field type and is always 3 bytes long:

00	Object Handle
Always 0x00	2 bytes

7.2.4 Field Type: Attribute Tag/Value

This is the format of the 'Attribute Tag/Value' field type which is of variable size:

01	ATTR CODE	ATTR VALUE LEN	ATTR VALUE
Always 0x01	2 bytes	2 bytes	N bytes

The size of this field is 'ATTR VALUE LEN' + 5

7.2.4.1 Example: Scan Report

A sample logical 'scan report' packet is as follows:

```
0021 01 72B4 1234 01
  00 0001
  01 0A56 0004 12345678
  01 0990 0008 2112021216453378
```

Which is interpreted and expanded as follows-

```
SCAN REPORT handle=29364 personId=4660, reports=1
            O:1 (0001)
            A:2646 (0A56),<len=4> 12345678
            A:2448 (0990),<len=8> 2112021216453378
```

7.2.5 Sample code to interpret a ScanReport logical packet

The following code shows how a logical 'Scan Report' packet could be separated into its constituent parts:

```
void PrintScanReport(unsigned char *pRxPkt, unsigned nRxPktLen)
{
    char baMsg[512];
    uint16 nHandle;
    uint16 nPersonId;
    uint16 nObject;
    uint16 nAttrId;
    uint16 nAttrLen;
    uint8 *pSrc;
    char *pMsg;

    nHandle   = (pRxPkt[3]<<8)+pRxPkt[4];
    nPersonId = (pRxPkt[5]<<8)+pRxPkt[6];
    printf(baMsg,"SCAN REPORT handle=%d personId=%d, reports=%d",
                            nHandle,  nPersonId,   pRxPkt[7]);
    pSrc = &pRxPkt[8];
    while(pSrc < &pRxPkt[nRxPktLen])
    {
        switch(*pSrc)
        {
        case HDP_SCANREPORT_INFOTYPE_OBJECT: /* 0x00 */
            pSrc++;
            if( pSrc >= &pRxPkt[nRxPktLen] )
            {
                printf("INSUFFICIENT LENGTH -- ABORT display of msg");
                break;
            }
            nObject = (pSrc[0]<<8)+pSrc[1];
            printf("               O:%d (%04X)",nObject,nObject);
            pSrc+=2;
            break;
        case HDP_SCANREPORT_INFOTYPE_ATTRIBUTE: /* 0x01 */
            pMsg = baMsg;
            pSrc++;
            nAttrId = (pSrc[0]<<8)+pSrc[1];
            pSrc+=2;
            nAttrLen = (pSrc[0]<<8)+pSrc[1];
            pSrc+=2;
          if( &pSrc[nAttrLen] > &pRxPkt[nRxPktLen] )
          {
              printf("INSUFFICIENT LENGTH -- ABORT display of msg");
              break;
          }
          pMsg += sprintf(pMsg,"             A:%d (%04X),<len=%d> ",
```

```
                                                    nAttrId,
                                                          nAttrId,
                                                                nAttrLen);
            {
                uint16 nBlockLen = (nAttrLen>24)
                                    ? 24
                                    : nAttrLen;
                uint8 *pData = pSrc;
                while(nBlockLen--)
                {
                    pMsg += sprintf(pMsg,"%02X",*pData++);
                }
                if( nAttrLen > 24 )
                {
                    pMsg += sprintf(pMsg,"...");
                }
            }
            pSrc +=  nAttrLen;
            printf(baMsg);
            break;
        default:
            printf("OBJECT TYPE TAG unknown %d -- ABORT display of msg",*pSrc);
            return;
        }
    }
```

8 MULTIPOINT APPLICATION EXAMPLES

8.1 BLOB Manager

BLOB stands for 'Binary Long OBject'.

There are many Bluetooth related operations which require large strings to be submitted to the underlying Bluetooth stack. For example, friendly names and extended inquiry responses fall into this category. These strings can be larger than the data packets allowed by the multipoint protocol defined in this specification.

The BLOB manager is basically a software entity in the module which enables these large objects to be uploaded into the module in small packets and have them accumulated in a single object.

The BLOB manager can be compiled time configured to manage up to N objects and unless special firmware builds are generated, this manual assumes that N is 2. Each BLOB is given a zero based identifier. BlobID 0 is the first object etc.

A command packet called CMD_BLOBMANAGE exists to manage these BLOBs as required. This command takes four parameters:

- Parameter 1 – The subcommand ID which tells the BLOB manager what to do.
- Parameter 2 – The BLOB ID
- Oarameters 3 and 4 – 4 byte integer values used as arguments for the subcommand specified in parameter 1.

The response packet also contains four parameters in exactly the same fashion. Where parameters 1 and 2 echo from the command and parameters 3 and 4 depend on the subcommand.

Recall that this entity manages BLOBs and CMD_BLOBMANAGE is the command to act on them. To get data into the BLOBs requires the use of data packets with specific dedicated channel numbers. Channel numbers 0x98 hex to 0x9F hex are reserved for use with BLOBs 0 to 7 respectively.

If data is sent in a data packet with a channel number corresponding to a BLOB that does not exist, then the data is silently discarded.

Data packets sent to the same BLOB append to any existing data in that BLOB.

Please be warned that sending data to a BLOB reduces memory for other uses, so Laird highly recommends that the BLOB be cleared or used up as quickly as possible. The Bluetooth chipset has very limited RAM.

Once data accumulates in a BLOB, CMD_BLOBMANAGE performs various actions on that BLOB which is specified via parameter 1 described as 'subcommand ID above. Some of the actions possible are:

- CLEAR – Empties the BLOB identified by the blobID parameter 2.
- GETSIZE – Returns the size of the BLOB in bytes in parameter 3 of the response.
- COPYREAD – Sends a copy of all the data in the BLOB back over the UART in data channel (blobId+0x98).
- HIDSET – Moves the data to the nonvolatile memory location, which stores custom HID descriptors. Many HID descriptors can store and each is identified by a zero indexed identifier. In this case, the HID ID is specified in parameter 3 of the command
- HIDGET – Appends the content of HID descriptor in nonvolatile storage identified by the HID ID in parameter 1 into the BLOB identified by parameter 2.

See description of the command CMD_BLOB_MANAGE for all the actions possible.

8.2 HID Connections

HID (Human Interface Device) was originally described in detail in a specification published by the USB organization. The Bluetooth SIG has built on that idea but uses wireless instead of USB as the transport mechanism.

The HID specifications are very dry and heavy tomes from a developer's perspective, denying the user experience, which is 'it just works' and 'is simple'.

The objective of the HID functionality provided in the Laird Bluetooth module is to provide the same 'it just works' and 'is simple' concept, but for developers.

With this in mind, Laird encourages that the developer views the module's HID functionality as a black box and the only concepts to be aware and fully understand are input reports, output reports, and how to create a HID descriptor.

The terminology for input/output is HID Host centric where 'input' means information flow from the HID Device to the HID Host, and vice versa 'output' means information flow from HID Host to HID Device. USB developers are familiar with this concept.

Input and output are packets of information whose format and size are predefined in the HID Descriptor that totally describes the devices functionality. For example, the standard PC keyboard is defined by a HID Descriptor which specifies that when a key is pressed or unpressed, an 8 byte INPUT packet shall be sent to the host and likewise, if the host wants to update one of the LEDs on the keyboard (for example the numlock LED) then it shall send a 1 byre OUTPUT packet. How the bits in the INPUT and OUTPUT packets are interpreted are specified in the HID Descriptor.

In a nutshell, when something happens at the device end, it informs the host via an INPUT packet, which is also called 'HID Input Report' and likewise the host sends information at any time using OUTPUT packets which are also called 'HID Output Reports'.

This implies that a developer using HID supplied in the Laird module only needs to ask, "What is the current active HID Descriptor" and then from there decide how to generate and process the reports. A simple interface supplied at the UART of the module enables appropriate mapping of data into and out of INPUT and OUTPUT reports. The same interface also enables the developer to upload custom HID Descriptors into the non-volatile memory of the module.

If no HID Descriptor is uploaded, and the module is configured to expose a HID Device profile, then by default a HID Descriptor for a 104 key keyboard is exposed, meaning INPUT reports are 8 bytes long and OUTPUT reports are 1 byte long. In this case, when the host conveys a key press, an 8 byte data packet has to submit to the module via the UART with data channel ID 0xA0. Likewise any OUTPUT packets sent by the host appear on data channel 0xA0. If a HID Host profile is active, then the INPUT packets appear on data channel 0x90 and it send OUTPUT reports as data on channel 0x90.

The built-in HID Device keyboard descriptor has been made even simpler to use if all you want is to send ASCII characters in the range 0x00 to 0x7F inclusive. In that case, all you must do is send the ASCII string in a data packet on channel 0x20. The data parser in the module generates two INPUT reports for each ASCII character. The first INPUT report specifies a key press and the second INPUT report specifies the unpress event.

Note: If S reg 3 specifies ONLY HID profile, and S Reg 39 specifies the built in keyboard HID descriptor, then the device class for the device in S Reg 128 automatically overrides.

8.3 Sending INPUT Reports

Once a connection establishes, a report sends by a device end by sending an entire INPUT report in a **single** data packet with channel ID 0xA0.

For example, if the descriptor specifies a standard keyboard and if the 'a' key pressed, then the following data sends over the UART to the module:

0A **A0** 00 00 04 00 00 00 00 00

And to convey that the left shift was pressed, the data is:

0A **A0** 02 00 04 00 00 00 00 00

8.4 Getting OUPUT Reports from a Host

Once a connection establishes, a report sends by a host to the device by sending an entire OUPUT report in a **single** data packet with channel ID 0x90, for example: 03 **90** 01

8.5 Uploading a HID Descriptor into the Module

Uploading of HID descriptors, which can be large blocks of arbitrary binary data, is done using the BLOB manager. The BLOB manager is an entity in the module which allows for blocks of binary data to be received over the UART and accumulate in 'BLOB' objects, of which two are made available. The two BLOBs of data have identifiers 0 and 1 respectively. In addition, data channels 0x98 to 0x9F are dedicated to data transfer to/from those BLOBs. Where channel 0x98 is for BLOB 0, 0x99 is for BLOB 1. There is also a command called CMD_BLOBMANAGE which performs various actions on the BLOBs. See the definition of that command for more details; suffice to say that there are subcommands for clearing, getting size, saving to non-volatile storage, and getting from non-volatile storage.

In the case of uploading a HID Descriptor, the BLOB commands to use are 'clear' and 'save'.

For example, if the contrived thirteen byte HID Descriptor 05 01 09 06 A1 01 05 07 29 65 81 00 C0 is uploaded using BLOB 1 into non-volatile location 1, (where this non-volatile location reference is used in S Register 39) then the following packets submit to the module on the UART.

0E 00 2D 7F 00 01 00000000 00000000 //CMD_BLOBMANAGE --- clear BLOB 1

0D **99** 05 01 09 06 A1 01 05 07 29 65 81 //send data into BLOB 1

04 **99** 00 C0 //send more data into BLOB 1 which is appended to any existing data

0E 00 2D 7F 03 01 00000001 00000000 // CMD_BLOBMANAGE --- save BLOB 1 into nonvol storage ID 1

8.6 Specifying a Custom Hid Descriptor for Use

After a custom HID descriptor uploads into the module where a HID descriptor in the range 0..N has been specified, the module can configure to use that descriptor when HID Device profile is active by modifying S Register 39. Basically, take the 0 based HID ID, add 1 to it and store that value in that register.

8.6.1 Specifying Service Record Name for Custom Hid

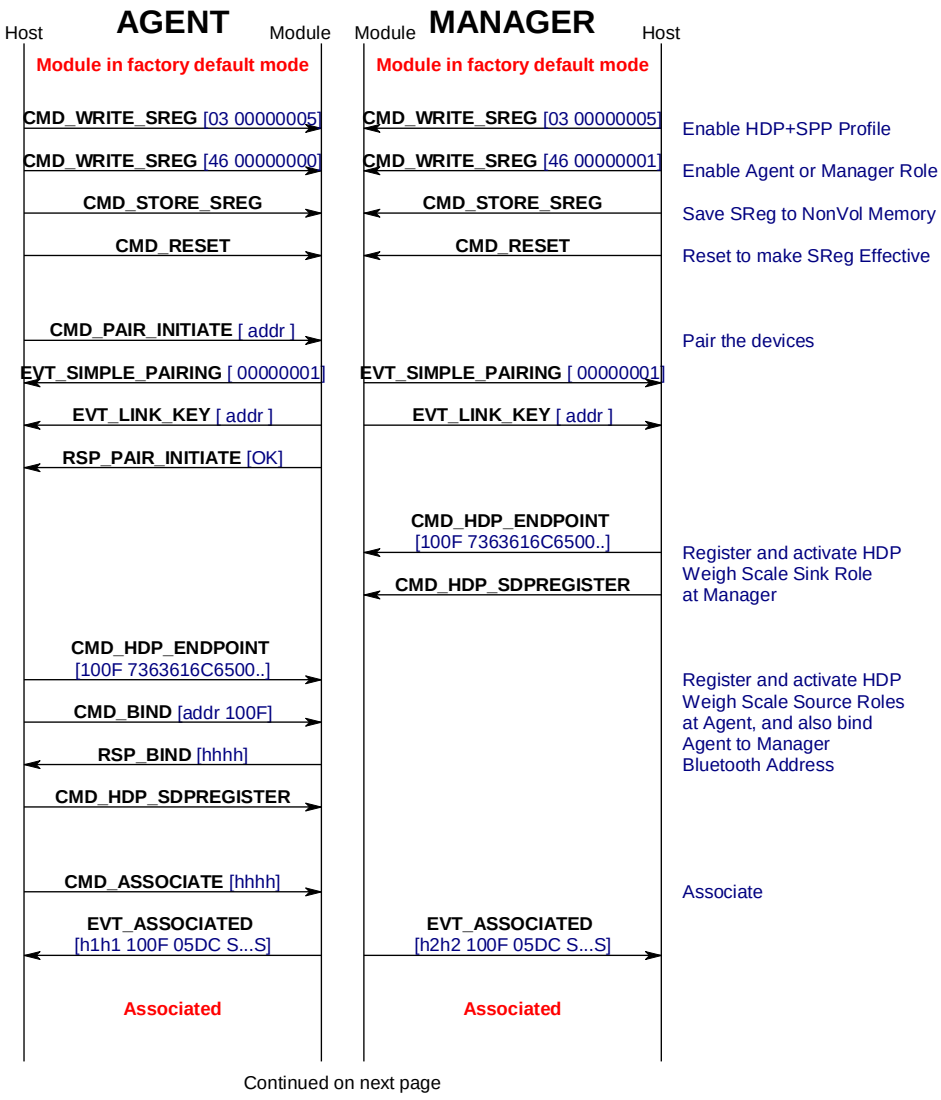
For a custom HID descriptor, the device can also register a custom service name if it is saved using the BLOB manager. At any time, the default service name "BTHIDCUSTOM" can be invoked by deleting the service name from non-volatile memory. This can be done by writing an empty name via the BLOB manager.

8.6.2 HDP Usage Message

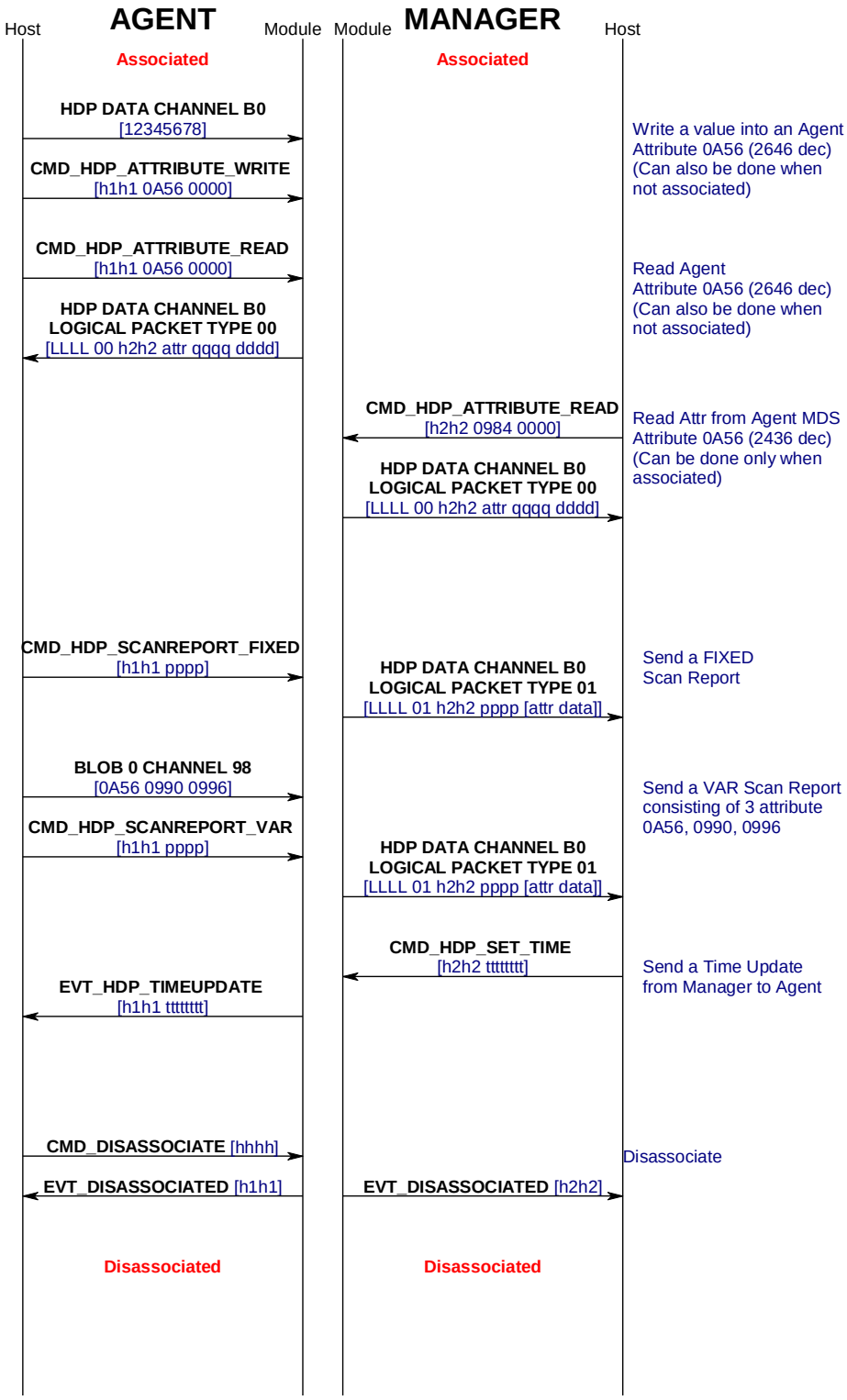
The module offers both HDP Agent and HDP Manager roles with IEEE Data Specialization functionality. HDP Manager functionality is provided mainly for prototyping and testing an Agent implementation and is not intended for eventual Continua Alliance certification.

Given two modules in factory default state, the following sections illustrate a typical usage session which consists of a pairing, an association, scan report, time update from manager, and disassociation.

8.6.3 Message Sequence Chart



Continued on next page


Host
AGENT
Module
Module
MANAGER
Host
Associated
Associated
HDP DATA CHANNEL B0
[12345678]
Write a value into an Agent Attribute 0A56 (2646 dec) (Can also be done when not associated)
CMD_HDP_ATTRIBUTE_WRITE
[h1h1 0A56 0000]
CMD_HDP_ATTRIBUTE_READ
[h1h1 0A56 0000]
Read Agent Attribute 0A56 (2646 dec) (Can also be done when not associated)
HDP DATA CHANNEL B0
LOGICAL PACKET TYPE 00
[LLLL 00 h2h2 attr qqqq dddd]
CMD_HDP_ATTRIBUTE_READ
[h2h2 0984 0000]
Read Attr from Agent MDS Attribute 0A56 (2436 dec) (Can be done only when associated)
HDP DATA CHANNEL B0
LOGICAL PACKET TYPE 00
[LLLL 00 h2h2 attr qqqq dddd]
CMD_HDP_SCANREPORT_FIXED
[h1h1 pppp]
HDP DATA CHANNEL B0
LOGICAL PACKET TYPE 01
[LLLL 01 h2h2 pppp [attr data]]
Send a FIXED Scan Report
BLOB 0 CHANNEL 98
[0A56 0990 0996]
Send a VAR Scan Report consisting of 3 attribute 0A56, 0990, 0996
CMD_HDP_SCANREPORT_VAR
[h1h1 pppp]
HDP DATA CHANNEL B0
LOGICAL PACKET TYPE 01
[LLLL 01 h2h2 pppp [attr data]]
CMD_HDP_SET_TIME
[h2h2 ttttttt]
Send a Time Update from Manager to Agent
EVT_HDP_TIMEUPDATE
[h1h1 ttttttt]
CMD_DISASSOCIATE [hhhh]
Disassociate
EVT_DISASSOCIATED [h1h1]
EVT_DISASSOCIATED [h2h2]
Disassociated
Disassociated

8.7 Agent UART Traffic for Chart

This section shows the UART traffic for a module operating as a HDP Weigh Scale agent communicating with a manager. It is NOT a log of the UART traffic for the message sequence chart illustrated in the previous section.

```
*******************************************
*******************************************
<70 006.896 08 00 81 7F  00 00 00 0C
            EVT_STATUS
//State: RESET_GETADDR
>70 000.000 04 00 02 7F
            CMD_READ_BDADDR
<70 000.078 0B 00 02 7F 00  0016A4FEF000
            RSP_READ_BDADDR  (MPSTATUS_OK)
>70 000.015 05 00 17 7F  00
            CMD_INFORMATION
//State: RESET_GETVER
<70 000.078 0E 00 17 7F 00  00 8100001300790673
            RSP_INFORMATION  (MPSTATUS_OK)
<70 001.810 08 00 81 7F  00 01 01 0C
            EVT_STATUS
>70 057.018 09 00 04 7F  03 00000005
            CMD_WRITE_SREG
<70 000.109 0A 00 04 7F 00  03 00000005
            RSP_WRITE_SREG  (MPSTATUS_OK)
>70 046.192 09 00 04 7F  46 00000000
            CMD_WRITE_SREG
<70 000.109 0A 00 04 7F 00  46 00000000
            RSP_WRITE_SREG  (MPSTATUS_OK)
>70 004.790 04 00 05 7F
            CMD_STORE_SREG
<70 000.109 05 00 05 7F 00
            RSP_STORE_SREG  (MPSTATUS_OK)
>70 024.523 07 00 29 7F 000000
            CMD_RESET
<70 001.918 08 00 81 7F  00 01 01 0C
            EVT_STATUS
>70 775.201 1C 00 10 7F  10 0016A4FEF001 31323334000000000000000000000000
            CMD_PAIR_INITIATE
<70 007.300 0F 00 95 7F  0016A4FEF001 00 00000001
            EVT_SIMPLE_PAIRING
<70 000.156 0B 00 89 7F  0016A4FEF001 00
            EVT_LINK_KEY
<70 001.014 05 00 10 7F 00
            RSP_PAIR_INITIATE  (MPSTATUS_OK)
>70 032.246 16 00 2E 7F  100F 7363616C650000000000000000000000
            CMD_HDP_ENDPOINT
<70 000.109 05 00 2E 7F 00
            RSP_HDP_ENDPOINT  (MPSTATUS_OK)
>70 009.298 0E 00 32 7F  0016A4FEF001 100F 0000
            CMD_HDP_BIND
<70 000.125 07 00 32 7F 00  B538
            RSP_HDP_BIND  (MPSTATUS_OK)
```

```
>70 026.037 04 00 2F 7F
            CMD_HDP_SDPREGISTER
<70 000.125 05 00 2F 7F 00
            RSP_HDP_SDPREGISTER  (MPSTATUS_OK)
>70 011.918 06 00 31 7F  B538
            CMD_HDP_ASSOCIATE
<70 000.109 05 00 31 7F 00
            RSP_HDP_ASSOCIATE  (MPSTATUS_OK)
<70 002.013 08 00 81 7F  00 00 01 0C
            EVT_STATUS
<70 003.775 13 00 97 7F  00 B538 100F 05DC 4C414952444D4752
            EVT_HDP_ASSOCIATED
>70 029.235 06 B0 12345678
>70 018.127 0B 00 36 7F  B538 0A56 0000 CD
            CMD_HDP_ATTRIBUTE_WRITE
<70 000.109 08 00 36 7F 00  CD 0004
            RSP_HDP_ATTRIBUTE_WRITE  (MPSTATUS_OK)
>70 013.697 0B 00 35 7F  B538 0A56 0000 AB
            CMD_HDP_ATTRIBUTE_READ
<70 000.109 0F B0 000D00B5380A56000012345678
//HDP Channel : ATTRIBUTE for handle=46392 Attr=2646  QualifierId=0}  VALUE = 12345678
<70 000.016 08 00 35 7F 00  AB 0004
            RSP_HDP_ATTRIBUTE_READ  (MPSTATUS_OK)
>70 042.900 09 00 33 7F  B538 1234 AB
            CMD_HDP_SCANREPORT_FIXED
<70 000.421 08 00 33 7F 00  B538 AB
            RSP_HDP_SCANREPORT_FIXED  (MPSTATUS_OK)
>70 021.185 08 B0 0A5609900996
>70 014.571 0A 00 34 7F  B538 1234 CD 00
            CMD_HDP_SCANREPORT_VAR
<70 000.109 08 00 34 7F 8F  B538 CD
            RSP_HDP_SCANREPORT_VAR  (MPSTATUS_ATTRLIST_INVALID)
>70 035.365 0A 98 34 7F  0A56 0990 09 96
            CMD_HDP_SCANREPORT_VAR
>70 008.752 0A 00 34 7F  0A56 0990 09 96
            CMD_HDP_SCANREPORT_VAR
<70 000.125 08 00 34 7F 8B  0A56 09
            RSP_HDP_SCANREPORT_VAR  (MPSTATUS_INVALID_BLOBID)
>70 019.906 08 98 0A5609900996
>70 012.823 0A 00 34 7F  B538 1234 CD 00
            CMD_HDP_SCANREPORT_VAR
<70 000.296 08 00 34 7F 00  B538 CD
            RSP_HDP_SCANREPORT_VAR  (MPSTATUS_OK)
<70 043.166 0E 00 98 7F  B538 140B020C102D214E
    EVT_HDP_TIMEUPDATE
>70 008.486 06 00 30 7F  B538
            CMD_HDP_DISASSOCIATE
<70 000.125 05 00 30 7F 00
            RSP_HDP_DISASSOCIATE  (MPSTATUS_OK)
<70 000.125 07 00 96 7F  00 B538
            EVT_HDP_DISASSOCIATED
```

8.8 Manager UART Traffic for Chart

This section shows the UART traffic for a module operating as a HDP manager communicating with a Weigh Scale agent.

```
*********************************************
*********************************************
*********************************************
<71 003.900 08 00 81 7F  00 00 00 0C
            EVT_STATUS
//State: RESET_GETADDR
>71 000.000 04 00 02 7F
            CMD_READ_BDADDR
<71 000.094 0B 00 02 7F 00  0016A4FEF001
            RSP_READ_BDADDR  (MPSTATUS_OK)
>71 000.015 05 00 17 7F  00
            CMD_INFORMATION
//State: RESET_GETVER
<71 000.078 0E 00 17 7F 00  00 8100001300790673
            RSP_INFORMATION  (MPSTATUS_OK)
<71 001.810 08 00 81 7F  00 01 01 0C
            EVT_STATUS
>71 062.806 09 00 04 7F  03 00000005
            CMD_WRITE_SREG
<71 000.109 0A 00 04 7F 00  03 00000005
            RSP_WRITE_SREG  (MPSTATUS_OK)
>71 022.449 09 00 04 7F  46 00000001
            CMD_WRITE_SREG
<71 000.109 0A 00 04 7F 00  46 00000001
            RSP_WRITE_SREG  (MPSTATUS_OK)
>71 016.209 04 00 05 7F
            CMD_STORE_SREG
<71 000.109 05 00 05 7F 00
            RSP_STORE_SREG  (MPSTATUS_OK)
>71 011.310 07 00 29 7F 000000
            CMD_RESET
<71 000.717 08 00 81 7F  00 00 00 0C
            EVT_STATUS
<71 001.950 08 00 81 7F  00 01 01 0C
            EVT_STATUS
<71 787.103 0F 00 95 7F  0016A4FEF000 00 00000001
            EVT_SIMPLE_PAIRING
<71 000.188 0B 00 89 7F  0016A4FEF000 00
            EVT_LINK_KEY
>71 018.564 16 00 2E 7F  100F 7363616C650000000000000000000000
            CMD_HDP_ENDPOINT
<71 000.125 05 00 2E 7F 00
            RSP_HDP_ENDPOINT  (MPSTATUS_OK)
>71 005.413 04 00 2F 7F
            CMD_HDP_SDPREGISTER
<71 000.125 05 00 2F 7F 00
            RSP_HDP_SDPREGISTER  (MPSTATUS_OK)
<71 067.751 08 00 81 7F  00 00 01 0C
            EVT_STATUS
<71 002.028 13 00 97 7F  01 72B4 100F 05DC 0016A4FEF000B539
            EVT_HDP_ASSOCIATED
>71 093.210 0B 00 35 7F  72B4 0984 0000 AB
            CMD_HDP_ATTRIBUTE_READ
<71 000.110 15 B0 00130072B40984000000080016A4FEF000B539
//HDP Channel : ATTRIBUTE for handle=29364 Attr=2436  QualifierId=0}
VALUE = 00080016A4FEF000B539
<71 000.000 08 00 35 7F 00  AB 000A
            RSP_HDP_ATTRIBUTE_READ  (MPSTATUS_OK)
<71 011.419 23 B0 00210172B4123401000001010A56000478563412010990000800000000000000
//HDP Channel : SCAN REPORT handle=29364 personId=4660, reports=1
//                O:1 (0001)
//                  A:2646 (0A56),<len=4> 78563412
//                  A:2448 (0990),<len=8> 0000000000000000
<71 113.210 47 B0 00450172B4123401000001010A56000478563412010990000800000000000000000010996000206C
3010A56000478563412010990000800000000000000000010996000206C3
//HDP Channel : SCAN REPORT handle=29364 personId=4660, reports=1
//                O:1 (0001)
//                  A:2646 (0A56),<len=4> 78563412
//                  A:2448 (0990),<len=8> 0000000000000000
//                  A:2454 (0996),<len=2> 06C3
//                  A:2646 (0A56),<len=4> 78563412
//                  A:2448 (0990),<len=8> 0000000000000000
```

```
//                  A:2454 (0996),<len=2> 06C3
>71 043.056 0E 00 37 7F  72B4 140B020C102D214E
            CMD_HDP_SET_TIME
<71 000.109 05 00 37 7F 00
            RSP_HDP_SET_TIME  (MPSTATUS_OK)
<71 008.721 07 00 96 7F  01 72B4
            EVT_HDP_DISASSOCIATED
<71 002.059 08 00 81 7F  00 01 01 0C
            EVT_STATUS
```

8.8.1 Sniff Mode Explained

Bluetooth connections are master/slave in nature. A master sends packets and a slave has to acknowledge that packet in the next timeslot. Timeslots in Bluetooth are 625 microseconds wide. This implies that a master always knows when packets are sent and received, which further means it is able to optimize power usage by switching on power hungry circuitry only when needed.

A slave, however, does NOT have prior knowledge of when a packet will be received and has to assume that a packet will be received from a master on every receive slot. This means that it has to leave its receiving circuitry switched on for most of the receive slot duration. The result of this is high power consumption where a slave with no data transmission still consumes around 31 mA, whereas a master consumes only 6 mA.

This problem was identified early in the evolution of Bluetooth (especially since headsets spend all their time as a slave in a Bluetooth connection) and it was solved by having a mode called Sniff, with appropriate lower layer negotiating protocol.

Sniff mode during connection is an agreement between the slave and its master that null packets are only exchanged for N timeslots every M slots. The slave can then assume that it will never be contacted during N-M slots, and so can switch its power hungry circuitry off. The specification goes further by also specifying a third parameter called 'timeout' (T) which specifies 'extra' timeslots that the slave agrees to listen for, after receiving a valid data packet.

Put another way, if a data packet is received by the slave then it knows that it MUST carry on listening for at least T more slots. If within that T slot time period another data packet receives, then the timer restarts. This mechanism ensures low power consumption when there is no data transfer – at the expense of latency. When there is a lot of data to transfer, it acts as if sniff mode was not enabled.

It is stated above that during sniff mode, a slave listens for N slots every M slots. The Bluetooth specification states that a master can have up to 7 slaves attached to it with all slaves requesting varying sniff parameters. It may therefore be impossible to guarantee that each slave gets the M parameter it requested. In light of this, the protocol for enabling sniff mode specifies that a requesting peer specify the M parameter as a minimum and maximum value. This allows the master to interleave the sniff modes for all slaves attached.

For this reason, the sniff parameters are specified in the Bluetooth module via four S registers. SRegister 73 (561 in AT mode) specifies 'N', SRegister 74 (562 in AT mode) specifies 'T', and SRegisters 75/76 (563/564 in AT mode) specify minimum 'M' and maximum 'M' respectively. Although the specification defines these parameters in terms of timeslots, the S register values have to be specified in units of milliseconds and the firmware does the necessary translation to timeslots.

The relationship between M, N, T, and power consumption when sniff mode is activated is illustrated in Figure 8-1.

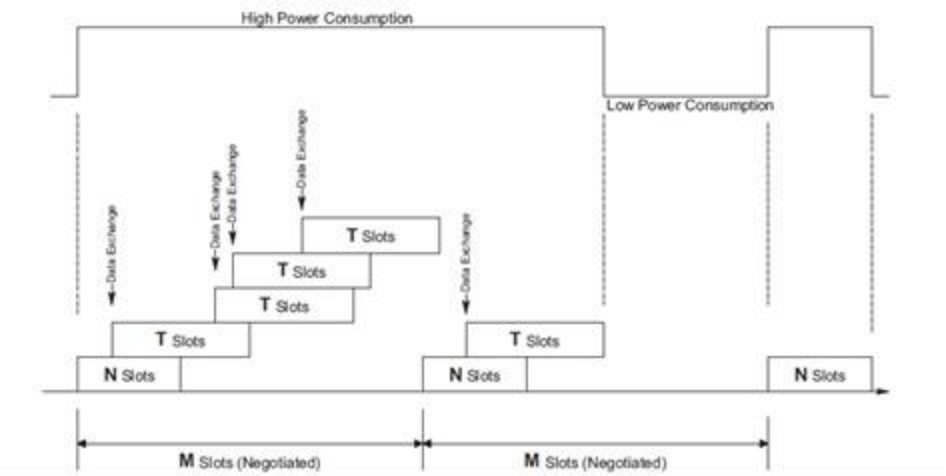


Figure 8-1: Sniff Mode

8.8.2 UART Host Power Saving Facility

There are circumstances where a CPU driving the module consumes a lot of power and some means are necessary to reduce that power consumption *while* the module is in a Bluetooth connection.

To facilitate that, the module has many GPIO pins, and using S Registers 50 to 65, one (and only one) GPIO pin can configure with the value 13 so that it is an output configuration.

The state of the pin is 0 when the module's UART transmit buffer is empty and 1 when there is at least one byte waiting to be transmitted to the UART host.

Hence a workable power saving strategy by the CPU is illustrated in Figure 8-2.

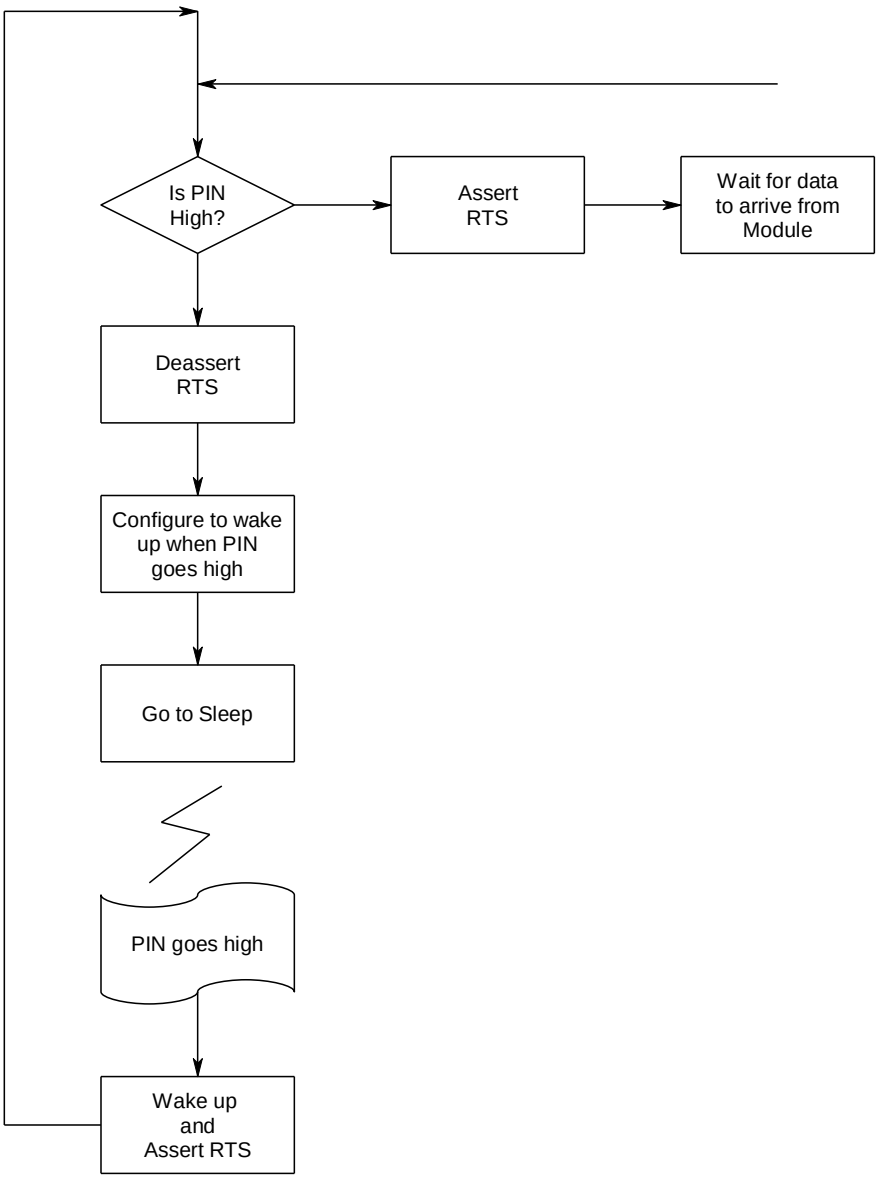


Figure 8-2: CPU power saving strategy

8.8.3 Out of Band (OOB) Pairing

When two devices pair using the legacy procedure or the simple secure pairing method, the end result is that they both end up with the same 16 byte random key. This key is subsequently used to authenticate and encrypt subsequent connections. This means the list of pairing kept in each device as a minimum, needs to store the peer Bluetooth address along with the 16 byte link key.

The Bluetooth specifications do not mandate that this link key shall only generate/exchange over the Bluetooth radio, and in fact mention 'Out-Of-Band' (OOB) pairing as a valid means of expediting the pairing of two devices.

The specification does not describe how the OOB pairing occurs.

Whatever OOB means are chosen, it implies that some externally generated key has to be added to the trusted device database in the device.

The module caters for this link key addition using the CMD_TRUSTED_DB_ADD command when in the multipoint protocol mode and the AT+KY command when in the AT protocol mode.

8.8.4 Throughput Analysis

The following are factors that affect overall data throughput:

- Baudrate – The baudrate at the UART determines the maximum throughput and has a theoretical maximum of 80% of the baudrate if using 'none' parity and one stopbits. That theoretical maximum reduces to around 67% if parity is enabled along with two stopbits.
- Radio utilization – The radio utilization in the sense that at any time, up to three non-transient operations could be active. The radio could be servicing on-going connections, it could be scanning for inquiries, and it could be scanning for incoming connections. For the latter two, the scanning operation has a duty cycle and the worst case of 100% has a major impact on the throughput as the radio is time shared between the connections and the scanning operations.
- RF connection quality –If the quality is bad and there are many retries of packets, then the throughput can drop to close to zero before the connection automatically drops. For Basic Rate connection packets, the best throughput limits to around 600 kbps in asymmetric data transfer falling to around 400 kbps for symmetric transfers when using Base Rate RF packets. This can triple when using EDR packets.
- RFCOMM frame size – The size of the RFCOMM frame, which according to the BT spec can be a value between 23 and 32767. The bigger the value the better, but the incremental gain around 1000 and above is negligible for embedded Bluetooth stack with limited RAM. This value sets via S Register 11 in multipoint mode and 9011 in AT mode
- MP packet payload size – In the multipoint protocol which is packet-based, the size of the MP packet payload has an impact and in fact the packets should be as large as possible, and yet the MP protocol limits the maximum payload to 253 bytes due to the length field of the packet being only a single byte.

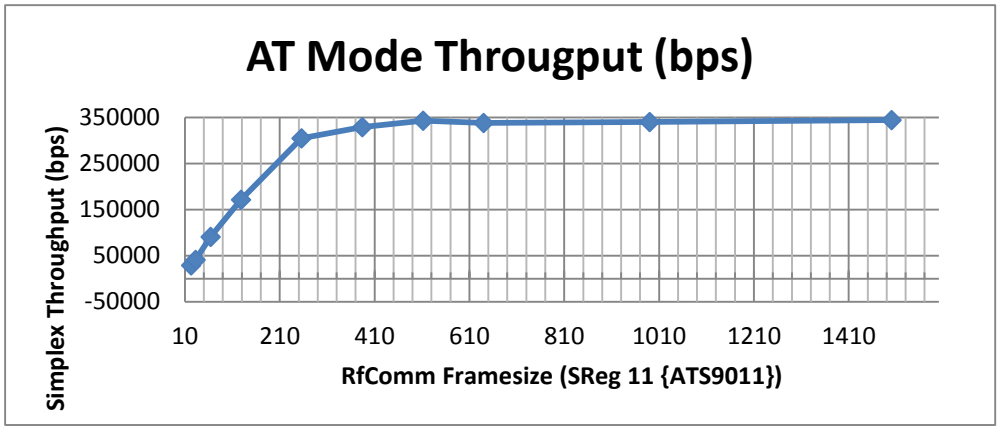
The charts that follow, where actual throughput is plotted against the RFCOMM frame size, show that in multipoint mode the packet structure and scanning for inquiries and paging have a significant impact on the throughput.

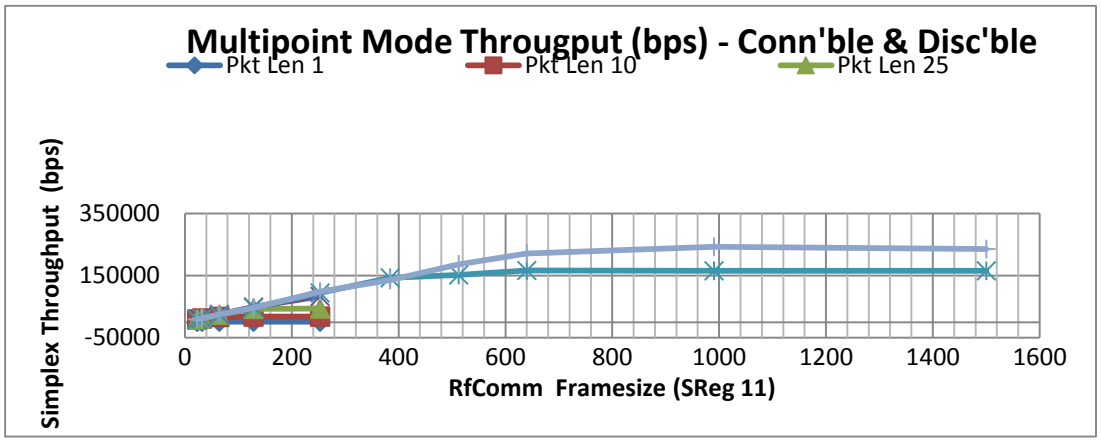
With regards to MP mode, the UART host should optimize performance by sending data to transmit in as large packets as possible and completely disabling all scanning operations by setting S Registers 4 and 5 to zero.

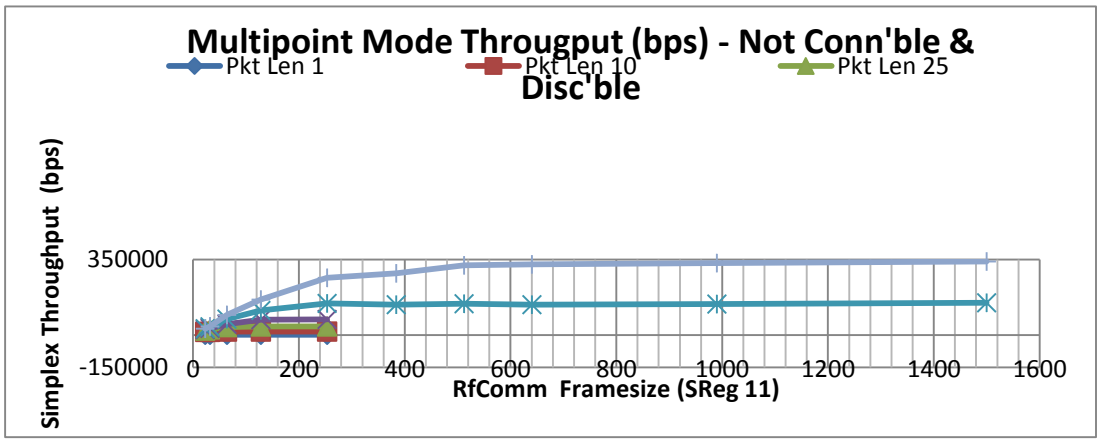
It is entirely possible for the host to bombard the module with the worst case scenario of three byte packets with just one data byte payload. In this case, if too many of these packets are sent and the framesize is large (such as 64 and above), it is entirely possible for the module to lose the connection by resetting. This happens because the module panics when it runs out of memory. On the rare occasion that this happens, it is possible to mitigate this issue by increasing the value of S register 81. By default this value is set to 30%.

Testing by Laird shows that with a framesize larger than 64 and sending a storm of three byte packets (with one byte payload) and the default value of 30%, it is possible to panic the module into a reset. Testing with a value of 50% in S Reg 81 solves the problem. But increasing the value of S Register 81 has an impact on how many simultaneous SPP connections can be sustained.

Basically, users must fine tune S Registers 7,8,9,10,11,81 and MP packet sizes to ensure desired throughput operation.


AT Mode Througput (bps)
Simplex Throughput (bps)
350000
250000
150000
50000
-50000
10
210
410
610
810
1010
1210
1410
RfComm Framesize (SReg 11 {ATS9011})


Multipoint Mode Througput (bps) - Conn'ble & Disc'ble
Pkt Len 1
Pkt Len 10
Pkt Len 25
Simplex Throughput (bps)
350000
150000
-50000
0
200
400
600
800
1000
1200
1400
1600
RfComm Framesize (SReg 11)


Multipoint Mode Througput (bps) - Not Conn'ble & Disc'ble
Pkt Len 1
Pkt Len 10
Pkt Len 25
Simplex Throughput (bps)
350000
-150000
0
200
400
600
800
1000
1200
1400
1600
RfComm Framesize (SReg 11)

8.8.5 UART Protocol Selection & Indication Via GPIO

S register 255 selects either MP(1) or AT(2) protocol mode for communications over the UART.

If S Register 255 is set to zero, then it implies that a GPIO selects the protocol such that zero sets AT mode and one for MP mode.

To configure a particular GPIO pin for this functionality, set the appropriate S Reg (in range 50 to 65) to a value of 14. Only the first S Register in the range 50 to 65 is used, any further S Registers with the value 14 are ignored.

In addition, if at least one S register in the range 50 to 65 is set to a value of 15, then on power up that pin configures as an output and sets to zero if AT protocol is active and one if MP is active.

If S Register 255 is zero and no GPIO is configured for this functionality, then the protocol defaults to MP.

8.8.6 Firmware Upgrade via UART

The module has the capability of upgrading the firmware via the UART port using a Windows PC based utility supplied by Laird.

Firmware upgrades over the air are not planned as this is not inherently supported by the chipset vendor.

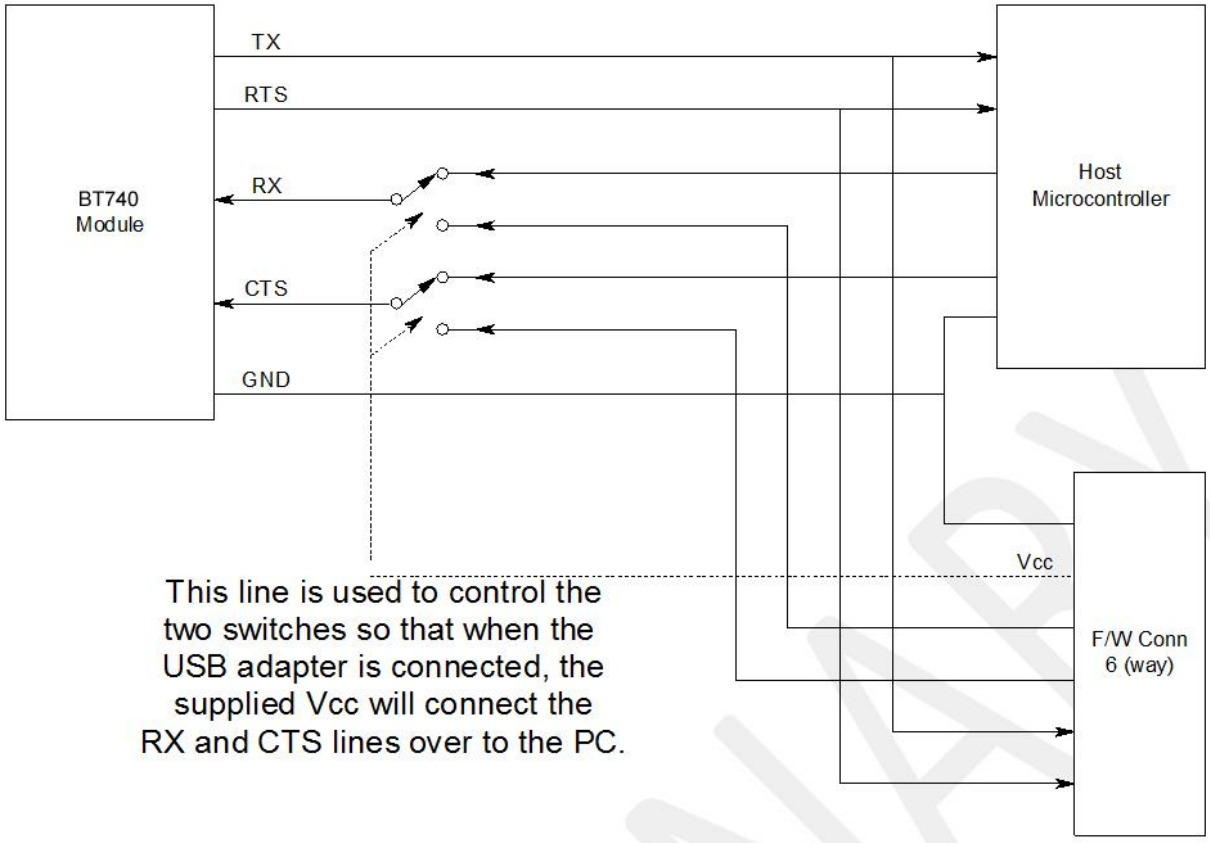
The upgrade process requires a direct connection to RX, TX, CTS, and RTS lines of the module via appropriate RS232 level conversion, to a built-in serial port on the Windows PC.

The new firmware deploys in a .dfu file as and when new firmware is available.

If the user requires the ability to upgrade the firmware when their product is in the field, then provision must be made so that the RX, TX, CTS, and RTS lines are exposed to the 'outside' world. This is complicated if, as in most usage cases, a host microcontroller drives the BT module in the user's end product. In that case, the host microcontroller drive the module's RX and CTS input lines and hence cannot also be driven by a Windows PC unless those two lines are gated appropriately.

One solution is incorporating the hardware logic illustrated below and use a USB to Serial adapter as per http://www.ftdichip.com/Products/Cables/USBTTLSerial.htm which does not require RS232 levels.

Note: This solution *should* work in theory and Laird does not warrant that it *will* work given it has not been implemented and tested. The purpose of the suggestion is to make the user evaluate the convenience arising from it and variations thereof.



8.8.7 The HCOMMAND & EVENT Values

The following is a listing of a snapshot of the file BMHOSTPROTOCOL.H at the time of this document's release. Laird does NOT guarantee that this listing is kept up to date.

For development purposes, please request the latest version of the appropriate 'C' header file.

```
//+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
+++++++
//The following are COMMAND (octet 2) values in command/response
packets
//+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
+++++++
#define CMD_NO_OPERATION                                0x01
#define CMD_READ_BDADDR                                  0x02
#define CMD_READ_SREG                                        0x03
#define CMD_WRITE_SREG                                     0x04
. . . .
. . . .
. . . .
//+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
+++++++
//The following are EVENT (octet 2) values in event packets
```

```
//+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
+++++++
#define EVT_STATUS                                          0x81
#define EVT_INVALID_PKTSIZE                      0x82
#define EVT_UNKNOWN_COMMAND      0x83
#define EVT_INQUIRY_RESULT                       0x84
#define EVT_MODEM_STATUS                   0x85
. . . .
. . . .
. . . .
```

8.8.7.1 STATUS Values

The following is a listing of a snapshot of the file MPSTATUS.H at the time of this document's release. Laird does NOT guarantee that this listing will be kept up to date.

For development purposes, please request the latest version of the appropriate 'C' header file.

```
    #define MPSTATUS_OK                                                 0x00

    #define MPSTATUS_ILLEGAL_COMMAND                0x01
    #define MPSTATUS_NO_CONNECTION                          0x02
    #define MPSTATUS_HARDWARE_FAIL                          0x03
    #define MPSTATUS_PAGE_TIMEOUT                           0x04
. . . .
. . . .
. . . .
```

9 AT Application Examples

9.1 Connection Management

Commands ATD, ATA, ATH, AT+BTP, and AT+BTG are all connection related and are discussed generically in this section.

On connection, depending on the value of S Register 531, the module enters data pass through mode (S Reg 531 = 0) or remains in command mode (S Reg 531 > 0).

In pass through mode, any data received from the host passes to the transmit buffer of the RF connection; in the case of SPP (UUID=1101) and for all other profiles, it depends on whether a 'canned' mode is provided. Data coming from the remote sends out to the host transparently – even in canned mode.

A 'canned' mode, which exists for HID profile, is where the incoming character from the host translates into appropriate multi-byte packets expected by the peer. For example, with HID standard keyboard profile where each key press results in an 8 byte HID INPUT report to the host, the ASCII character appropriately expands into the relevant 8 bytes denoting that the key was pressed and then immediately another 8 byte report denotes that the same key was unpressed.

If a canned mode is not available for a profile, then module is not allowed to get into pass-through mode.

In command and online mode, the command ATX"data" forces the module to send data and conversely any incoming data presents to the host in an RX"data" asynchronous response.

9.1.1 Incoming Connections

The module can be configured using the AT+BTP or AT+BTG command so that it scans for incoming connections from other Bluetooth devices. It can also be configured via S Register 512 to be in this mode by default on power up.

When the lower layers detect an incoming call, a **RING 123456789012** string sends to the host every second. The command ATA accepts the connection and ATH rejects it.

On connection, if the S0 Register is >=0 and S504=0 then confirmation to the host is in the following form:

CONNECT <bd_addr>,<uuid>,<

Where '<uuid>' is the UUID of the profile that accepted the connection.

9.1.2 Dropping Connections

In a conventional telephony modem, a call normally terminates by first sending a +++ escape sequence enveloped by an escape sequence guard time (of the order of 100 to 1000 milliseconds) to enter local command + connected mode, and then the ATH command to force a disconnection.

The Laird modules provide a couple of ways of dropping a connection. One method is similar to the above, but instead uses a ^^^ character sequence. This eliminates ambiguity when a data call is in progress via a mobile phone which established using the mobile phone's Bluetooth AT modem. The second method involves the host deasserting the DTR modem control line (DSR modem status line from the module's viewpoint) for longer than 500 milliseconds.

The escape sequence to force the module from pass-through mode and into command is as follows:

<Guard time><Esc Chr><Guard time><Esc Chr><Guard time><Esc Chr><Guard time>

Where <Guard time> is 100 milliseconds.

The four guard times means that even when a file transfer is occurring and it happens to be full of <Esc Chr> characters, it is not going to drop into command mode. This is because when transferring a file, it happens as fast as possible and so the inter character gap will be significantly shorter than the <Guard time>.

The <Esc Chr> character can be changed via the S2 register.

9.2 Profiles

This section describes all the profiles that the module is capable of making and accepting connection when in AT mode.

9.3 Serial Port Profile (SPP)

UUID : 1101

You must set S Register 9003 bit 0 to make this profile active.

Outgoing connections are initiated using the command: "**ATD<bd_addr>**"

Incoming connections result in at least one "RING <bd_addr>" response to the host. If S Register 0 is a non-zero value then after the appropriate number of RING responses the connection automatically accepts and a "**CONNECT <bd_addr>,1101,<**" response sends to the host. If S Register 0 is 0, then the incoming connection accepts by the host using the command ATA or rejected using ATH.

On connection, depending on the value of S Register 531, the module enters pass-through mode (data transparently exchanged between UART and air-side) or in command+online mode. In the latter, data is sendt

to the peer using the "ATX<string>" command and any data from the peer either dumps silently (S531=1) or send to the host in an "RX<string>" asynchronous response (S531>1).

When in pass-through mode, the escape sequence ^^^ puts the module into command and online mode so that a disconnection can initiate. A disconnection can also initiate by deasserting the DSR input line of the module for more than 500 milliseconds.

On disconnection a "NO CARRIER" async response sends to the host.

9.4 HID Device Profile (HID)

UUID : 1124

S Register 9003 bit 1 must be set to make this profile active. In addition, S register 9039 must be set to 0 and above to enable a DEVICE HID profile and a negative value to enable a HOST HID profile.

Outgoing connections initiate using the command: "ATD<bd_addr>,1124"

Incoming connections are automatically accepted and a "CONNECT <bd_addr>,1124,<" sends to the host.

With the HID profile, a built-in standard keyboard HID descriptor is supplied along with a canned mode of operation. It enables a legacy device generating ASCII characters to present to a host as a compliant HID keyboard.

In canned mode, each ASCII character (ASCII characters 128 and above are silently discarded) results in two INPUT reports to the host. The first is a corresponding key press and the second is a corresponding key unpress. When the host sends the 1 byte OUTPUT report sends to the host as-is.

In non-canned mode (S Reg 531 > 0) the host has to send the raw 8 byte INPUT reports in the ATX<String> command and conversely any OUTPUT reports from the host send to the host in RX<string> asynchronous responses.

Disconnections from the module initiate via DSR deassertion. However, if the module is in non-canned mode (S Register 531 > 0) then it is also possible to initiate a disconnection using the ATH command.

On disconnection a "NO CARRIER" async response is sent to the host.

9.4.1 HID Descriptors

HIDs present their capabilities to a host in a HID descriptor which is essentially a block of octets that describe the device's capability and more importantly how events convey back and forth. This concept was originally developed by the USB organisation and has been adopted by the Bluetooth SIG virtually intact.

The HID descriptor contains information about INPUT and OUTPUT reports. They are both blocks of octets described to contain various bit fields describing the event that needs conveyed to the peer.

Hence, at the end of the day, if a HID implementation was viewed as a communications black box between a device and host, then it could be viewed as the device generating an INPUT report consisting of X bytes which presents to the host and conversely an OUTPUT report consisting of Y bytes sends by the host to the device.

In this module's HID implementation, the module does not care about the content of those INPUT and OUTPUT reports.

An INPUT report presents to the module by the UART host in an ATX<string> which then de-escapes and sends as a single atomic packet to the remote host. Similarly, each OUTPUT package arrives atomically in a single packet from the remote host which then sends to the UART host in a single RX<string> message.

It was mentioned above that by default a standard keyboard HID descriptor is built into the firmware and the default value of S Register 9039 makes the module connectable via a HID Device profile.

It is possible to download up to two custom HID device descriptors to store in the module's non-volatile memory. These custom HID device descriptors are then identified via a number in the range 0 to N. If S Register 9039 changes to a value 1 to N+1, then on power up, if S Reg 9003 indicates that HID profile is to be made available, it implements the appropriate custom HID descriptor in the service discovery database.

When custom HID descriptors are downloaded and stored, there is no validation performed on the block of data. This is because the module has no context to perform such validation.

In MP mode, to download a custom HID descriptor, you can use the utility MpBtHost.exe. Right click on the window to invoke a pop-up menu and select "Upload HID Descriptor". In the new dialog box, enter the BLOB ID (recommend leave at 0) and HID ID to use. Then to use that descriptor update S Register 9039 with a value which is HidId+1.

9.5 HDP Profile (Health Device Profile)

UUID : 1400,1401,1402

9.5.1 Background

Health Device Profile (HDP) is available on the module in both Agent and Manager roles as defined by the Continua Alliance (see www.continua.org). There are two aspects to HDP: one is the transport layer, for which only Bluetooth is catered for by this module (although the Continua Alliance has also ratified others, for example USB), and the other aspect is IEEE data encapsulation.

The Laird module provides a tightly coupled integrated solution for a Weigh Scale Specialization Agent. More specializations will be provided in the future as and when there is demand via a firmware update.

It is assumed that the reader is familiar with all the HDP and IEEE documentation and relevant guidelines published by the Continua Alliance. For HDP, it is assumed that the reader has access to the specification from the Bluetooth SIG. For IEEE it is assumed that the reader has access to the IEEE11073-20601 Optimised Exchange Protocol specification and the device specializations specifications 11073-10401 through to 10499. For the Weigher Scale specialization embedded in the module, the specification is 11073-10415. Obtain the IEEE standards from their website standards.ieee.org, and Bluetooth HDP specifications at www.bluetooth.org.

The IEEE data specialization along with the Bluetooth physical transport defined in the appropriate specifications is very dry and difficult to understand, and it is pointless to reproduce that information here verbatim. However, an attempt is made to describe it from the module's usage point of view where the module and the functionality it provides is treated in a black box manner.

9.5.2 IEEE 'Black Box' Model

In a traditional health related environment, typical actors and props are the patient, instruments that measure appropriate parameters, health professionals, and the (manual and/or automatic) archiving of the records.

Over the years there have been many suppliers of the "instruments that measure appropriate parameters" who have all provided proprietary methods for getting the data stored in records.

It has always been the role of the health professionals to 'transcribe' the data from the various instruments into the archive records. The manual process presents risks associated with errors in the transcribing process and so manufacturers provided even more proprietary solutions to automating that task.

The Continua Alliance came about to address that confused picture with guidelines and a certification process to ensure that a consistent inter-operable picture emerges with regards to the "instruments that measure appropriate parameters" and the "method for getting the data stored in records".

The last thing the Continua Alliance would want to do is dictate how any individual instrument (referred to as an Agent) is physically designed, as that is best left to the engineers who know how best to design them. Instead, they have specified abstract data models for the various types of instruments, which they refer to as Data Specializations, and how they shall convey the data to an entity called a 'Manager' that can be used to consistently store the data in an archive.

Examples of data specialization abstract models exist for weigh scales, thermometers, glucose meters, blood pressure meters, ECGs, and many more will become available as they progress through various stages in appropriate working groups. Any Continua Alliance member is free to recommend creation of data specializations as needed. Once ratified, the end result is always an abstract data model which defines what data is pertinent for that instrument and how it shall be presented to the real world.

9.5.3 Abstract Data Model

From a software engineer's perspective, an abstract data model for an IEEE data specialization can best be described as a collection of arrays of different types of data (which the specifications refer to as attributes).

Each attribute is unambiguously defined to consist of a tag, a type, and the actual value. There is no reliance on any programming language in the definition; it is purely a data model.

As a minimum there shall be one array of attributes called the 'Medical Device System', henceforth referred to as an MDS which represents the properties and services of the device, independent of its health data capabilities and its status. There shall also be one array of attributes called the Numeric, henceforth referred to as NU which contains episodic measurements. There is also an RT-SA collection which to represents continuous samples or waveforms.

Other collections exist and the reader is advised to refer to the IEEE11073-20601 standard for a definitive list, described under the general heading of "Domain Information Model".

At this point, imagine an HDP agent as just a collection of data records that can be read and written to locally under program control and each data point is identified by its tag and publishes its data type. This is analogous to a database table with 4 fields in each record. Three fields are called 'Tag', 'Type', 'Value', and the fourth field is called 'Collection Name' such as MDS or NU or RT-SA.

You should further imagine this 'database' as accessible from a Manager over a physical transport media such as Bluetooth or USB. The procedure a Manager uses to gain access to that database of attributes is rigidly defined and standardised via a 'Service Model' using an association state machine defined in the IEEE11073-20601 standard. This 'Service Model' is encapsulated in the Laird Module and the user is encouraged to think of it in terms of a black box whose internal details are not relevant.

The picture that should emerge for the Laird module user who requires a data specialization is that of a black box consisting of that conceptual database with a 4 field table and an 'engine' that implements the association service model over Bluetooth so that it facilitates the mirroring of that said database at the HDP manager end.

This picture then vastly simplifies the design and development of a health instrument that is required to be Continua Alliance certified. The hope is that, the user is only required to have a general idea about the content of the IEEE 11073-20601 and the data specialization IEEE11073-104xx standards.

The following subsections provide more details as to how you can control and manipulate the black box. Please note that initially only a Weigh Scale data specialization as defined in 11073-10415 is available **embedded** inside the black box. By 'embedded' it is implied that the MDS and NU collections are pre-defined as per the standard and the attributes that may change values are exposed to the user for manipulation.

In future it is hoped that a generic API will be exposed that allows any data specialization to be downloaded and tested. If a user requires a specific data specialization then they are encouraged to contact Laird with that request until that generic API is made available.

It is also pertinent to note that once a user has a working instrument using this module, the user must obtain Bluetooth Listing (quoting the QDID of the Laird module) prior to Continua Alliance testing and certification.

9.5.4 HDP Agent Model

From a software perspective the HDP Agent implementation is as shown in the diagram below.

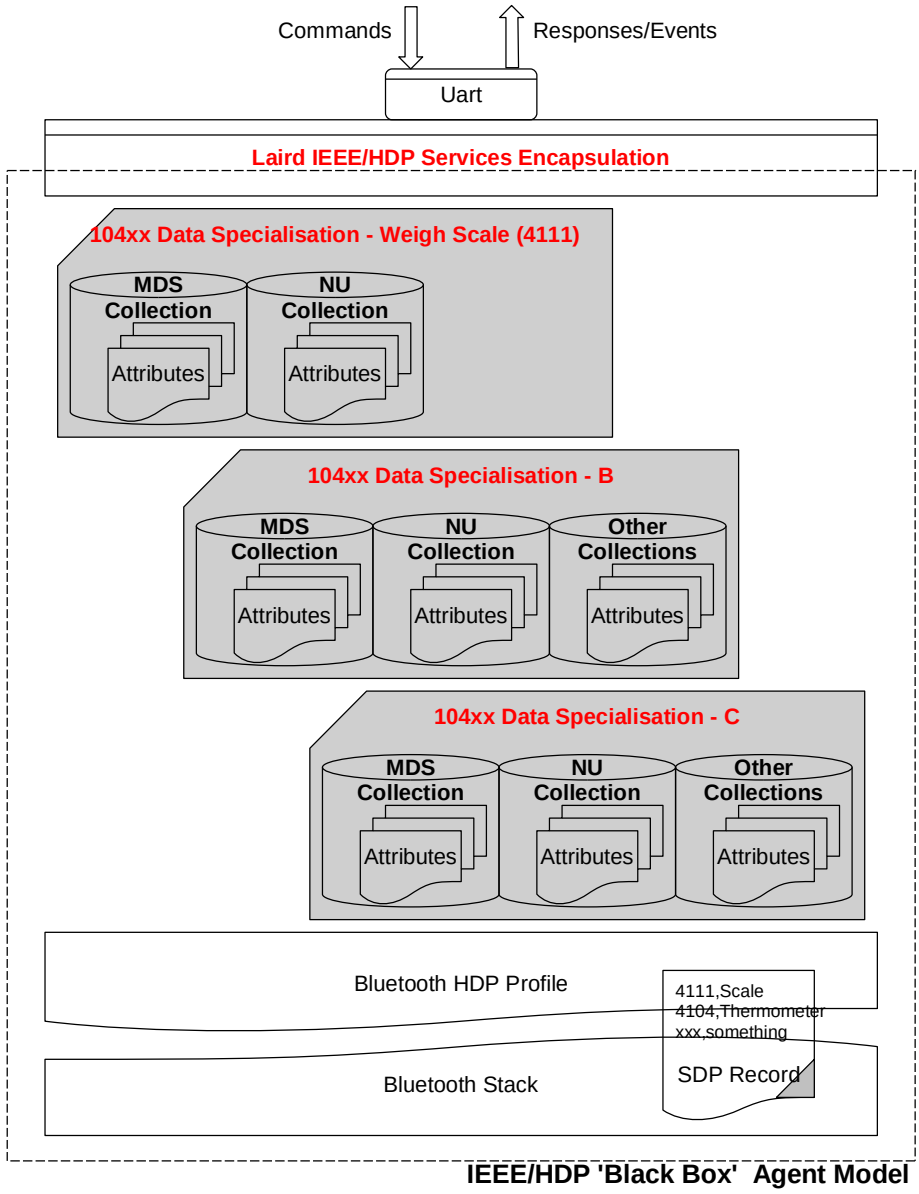


Figure 9-1: HDP Agent implementation

The diagram shows that the agent model is the Bluetooth communications stack. The stack consists of an SDP record that exposes to the outside world the data specializations it is capable of, a 'Laird IEEE/HDP Service Encapsulation' layer which relays commands and responses to the host, and 0 or more instances of Data Specializations. At the time of the first firmware release, only a Weigh Scale specialization is offered.

All UART commands available to the host are provided so that the various entities in the black box can be controlled or interrogated. Given there can be many agent specializations embedded in the firmware, they are identified in various commands using a 16 bit handle.

9.5.5 Weigh Scale Data Specialization

The Weigh Scale Specialization (nominal code 4111) is embedded in the firmware is shown as below and it contains a MDS and an NU object.

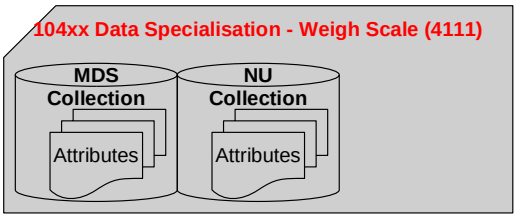


Figure 9-2: Embedded Weigh Scale Specialization

The MDS object is defined in the firmware with the following attributes:

Attribute Tag		Data Type	Comments
MDC_ATTR_ID_HANDLE	2337	HANDLE	Always: 0
MDC_ATTR_SYS_TYPE_SPEC_LIST	2650	TYPE_SPEC_LIST	Const
MDC_ATTR_ID_MODEL	2344	SYSTEM_MODEL	Var:SystemModel
MDC_ATTR_SYS_ID	2436	OCTET_STRING	Var:SystemId
MDC_ATTR_DEV_CONFIG_ID	2628	CONFIG_ID	1500 (0x05DC)
MDC_ATTR_ATTRIBUTE_VAL_MAP	2645	ATTR_VAL_MAP	Const
MDC_ATTR_ID_PROD_SPECN	2349	PROD_SPEC	Const
MDC_ATTR_TIME_ABS	2439	ABSOLUTE_TIME	Var:Time
MDC_ATTR_MDS_TIME_INFO	2629	MDS_TIME_INFO	Const
MDC_ATTR_POWER_STAT	2389	POWER_STATUS	Var:PowerStatus
MDC_ATTR_VAL_BATT_CHARGE	2460	INTU_16	Var: Batt, Chrg.
MDC_ATTR_TIME_BATT_REMAIN	2440	BatMeasure	Var:time_batt_remain

The NU object is defined with the following attributes:

Attribute Tag		Data Type	Comments
MDC_ATTR_ID_HANDLE	2337	HANDLE	Always: 1
MDC_ATTR_ID_TYPE	2351	TYPE	Const
MDC_ATTR_METRIC_SPEC_SMALL	2630	METRIC_SPEC_SMALL	Const
MDC_ATTR_UNIT_CODE	2454	OID_TYPE	Var:Weight Units
MDC_ATTR_ATTRIBUTE_VAL_MAP	2645	ATTR_VAL_MAP	2646,2448
MDC_ATTR_TIME_STAMP_ABS	2448	ABSOLUTE_TIME	Var:Time
MDC_ATTR_NU_VAL_OBS_SIMP	2646	SIMPLE_NU_OBS_VAL	Var:Weight
MDC_ATTR_NU_ACCUR_MSMT	2378	FLOAT_TYPE	Always: 1
MDC_ATTR_MSMT_STAT	2375	MEASUREMENT_STATUS	Var:Meas. Stat.

The attributes commented as 'variables' expose to the host for reading and writing via the UART interface using AT+HAG and AT+HAS commands respectively and are described in detail elsewhere in this document.

The UART interface identifies the variable attributes mentioned above using an attribute ID and an additional sub ID. The concept of 'sub ID' is a Laird artefact and is not part of any IEEE standard, but the attribute ID is the same as those defined in the IEEE standard in most cases. The complete list for the Weigh Scale specialization is as per the table below and should be used with the agent attribute read/write commands AT+HAG and AT+HAS.

Note: The attribute values passed back and forth from the host are NOT validated in any way by the firmware in the Laird module. It is up to the host to ensure that the correct data writes into an attribute. Any illegal values are picked up at time of Continua Alliance certification testing which prevents certification.

Table 9-1: Variable Attributes in Weigh Scale Specialization

Attribute Name (See IEEE spec for format)	Attr ID	Sub ID	Size in bytes
Weight	2646	0	4
Weight Units	2454	0	2
Time	2448	0	8
Power Status	2389	0	2
Battery Charge	2460	0	2
Time Battery Remain – value	2440	0	4
Time Battery Remain – unit	2440	1	2
Measurement Status	2375	0	2
System ID	2436	0	8
System Model – product name	2344	0	12
System Model – model name	2344	1	16
Serial Number	2349	0	8

9.5.6 Thermometer Data Specialization

The Thermometer Specialization (nominal code 4104) is embedded in the firmware is shown as below and it contains a MDS and an NU object.

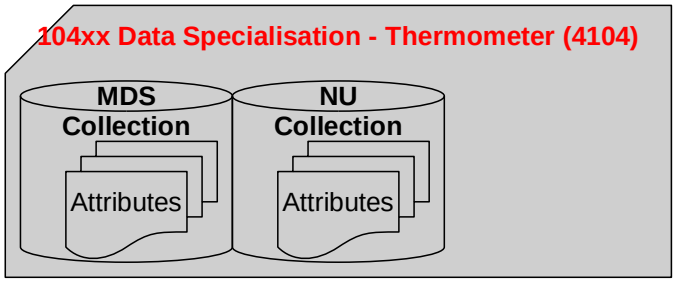


Figure 9-3: Embedded Thermometer Specialization

The MDS object is defined in the firmware with the following attributes:

Attribute Tag		Data Type	Comments
MDC_ATTR_ID_HANDLE	2337	HANDLE	Always: 0
MDC_ATTR_SYS_TYPE_SPEC_LIST	2650	TYPE_SPEC_LIST	Const

MDC_ATTR_ID_MODEL	2344	SYSTEM_MODEL	Var:SystemModel
MDC_ATTR_SYS_ID	2436	OCTET_STRING	Var:SystemId
MDC_ATTR_DEV_CONFIG_ID	2628	CONFIG_ID	800 (0x0320)
MDC_ATTR_ID_PROD_SPECN	2349	PROD_SPEC	Const
MDC_ATTR_TIME_ABS	2439	ABSOLUTE_TIME	Var:Time
MDC_ATTR_MDS_TIME_INFO	2629	MDS_TIME_INFO	Const
MDC_ATTR_POWER_STAT	2389	POWER_STATUS	Var:PowerStatus
MDC_ATTR_VAL_BATT_CHARGE	2460	INTU_16	Var: Batt, Chrg.
MDC_ATTR_TIME_BATT_REMAIN	2440	BAT_MEASURE	Var:time_batt_remain

The NU object is defined with the following attributes:

Attribute Tag		Data Type	Comments
MDC_ATTR_ID_HANDLE	2337	HANDLE	Always: 1
MDC_ATTR_ID_TYPE	2351	TYPE	Const
MDC_ATTR_METRIC_SPEC_SMALL	2630	METRIC_SPEC_SMALL	Const
MDC_ATTR_UNIT_CODE	2454	OID_TYPE	Var:Weight Units
MDC_ATTR_TIME_PD_MSMT_ACTIVE	2649	RELATIVE_TIME	Var:Time (int32)
MDC_ATTR_ATTRIBUTE_VAL_MAP	2645	ATTR_VAL_MAP	2646,2448
MDC_ATTR_TIME_STAMP_ABS	2448	ABSOLUTE_TIME	Var:Time
MDC_ATTR_NU_VAL_OBS_BASIC	2636	BASIC_NU_OBS_VAL	Var:temperature
MDC_ATTR_NU_ACCUR_MSMT	2378	FLOAT_TYPE	Always: 1
MDC_ATTR_MSMT_STAT	2375	MEASUREMENT_STATUS	Var:Meas. Stat.

The attributes commented as 'variables' expose to the host for reading and writing via the UART interface using AT+HAG and AT+HAS commands respectively and are described in detail elsewhere in this document.

The host identifies the variable attributes mentioned above on the UART interface using an attribute ID and an additional sub ID. The concept of 'sub ID' is a Laird artefact and is not part of any IEEE standard, but the attribute ID is the same as those defined in the IEEE standard in most cases. The complete list for the Thermometer specialization is as per the table below and should be used with the agent attribute read/write commands AT+HAG and AT+HAS.

Note: The attribute values passed back and forth from the host are NOT validated in any way by the firmware in the Laird module. It is up to the host to ensure that the correct data writes into an attribute. Any illegal values are picked up at time of Continua Alliance certification testing which prevents certification.

Table 9-2: Variable Attributes in Thermometer Specialization

Attribute Name (See IEEE spec for format)	Attr ID	Sub Id	Size in bytes
Temperature	2636	0	2
Temperature Units	2454	0	2
Absolute Time	2448	0	8

Power Status	2389	0	2
Battery Charge	2460	0	2
Time Battery Remain – value	2440	0	4
Time Battery Remain – unit	2440	1	2
Measurement Status	2375	0	2
System ID	2436	0	8
System Model – product name	2344	0	12
System Model – model name	2344	1	16
Serial Number	2349	0	8
Measurement Active Period	2649	0	4

9.5.7 Glucometer Data Specialization

The Glucometer Specialization (nominal code 4113) embedded in the firmware is shown as below and it contains a MDS and an NU object.

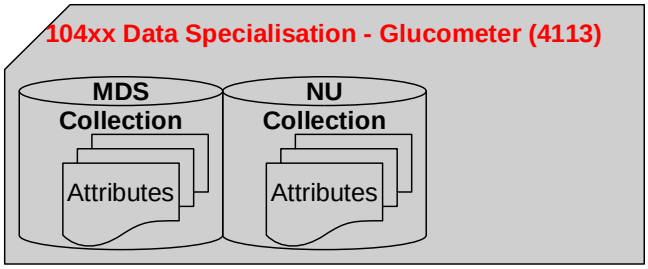


Figure 9-4: Embedded Glucometer Specialization

The MDS object is defined in the firmware with the following attributes:

Attribute Tag		Data Type	Comments
MDC_ATTR_ID_HANDLE	2337	HANDLE	Always: 0
MDC_ATTR_SYS_TYPE_SPEC_LIST	2650	TYPE_SPEC_LIST	Const
MDC_ATTR_ID_MODEL	2344	SYSTEM_MODEL	Var:SystemModel
MDC_ATTR_SYS_ID	2436	OCTET_STRING	Var:SystemId
MDC_ATTR_DEV_CONFIG_ID	2628	CONFIG_ID	1700 (0x06A4)
MDC_ATTR_ID_PROD_SPECN	2349	PROD_SPEC	Const
MDC_ATTR_TIME_ABS	2439	ABSOLUTE_TIME	Var:Time
MDC_ATTR_MDS_TIME_INFO	2629	MDS_TIME_INFO	Const
MDC_ATTR_POWER_STAT	2389	POWER_STATUS	Var:PowerStatus
MDC_ATTR_VAL_BATT_CHARGE	2460	INTU_16	Var: Batt, Chrg.
MDC_ATTR_TIME_BATT_REMAIN	2440	BAT_MEASURE	Var:time_batt_remain

The NU object is defined with the following attributes:

Attribute Tag		Data Type	Comments
MDC_ATTR_ID_HANDLE	2337	HANDLE	Always: 1
MDC_ATTR_ID_TYPE	2351	TYPE	Const

Attribute Tag		Data Type	Comments
MDC_ATTR_METRIC_SPEC_SMALL	2630	METRIC_SPEC_SMALL	Const
MDC_ATTR_UNIT_CODE	2454	OID_TYPE	Var:Weight Units
MDC_ATTR_ATTRIBUTE_VAL_MAP	2645	ATTR_VAL_MAP	2646,2448
MDC_ATTR_TIME_STAMP_ABS	2448	ABSOLUTE_TIME	Var:Time
MDC_ATTR_NU_VAL_OBS_BASIC	2636	BASIC_NU_OBS_VAL	Var:temperature
MDC_ATTR_NU_ACCUR_MSMT	2378	FLOAT_TYPE	Always: 1
MDC_ATTR_MSMT_STAT	2375	MEASUREMENT_STATUS	Var:Meas. Stat.

The attributes commented as 'variables' expose to the host for reading and writing via the UART interface using AT+HAG and AT+HAS commands respectively and are described in detail elsewhere in this document.

The host identifies the variable attributes mentioned above on the UART interface using an attribute ID and an additional sub ID. The concept of 'sub ID' is a Laird artefact and is not part of any IEEE standard, but the attribute ID is the same as those defined in the IEEE standard in most cases. The complete list for the Glucometer specialization is as per the table below and should be used with the agent attribute read/write commands AT+HAG and AT+HAS.

Note: The attribute values passed back and forth from the host are NOT validated in any way by the firmware in the Laird module. It is up to the host to ensure that the correct data is written into an attribute. Any illegal values are picked up at time of Continua Alliance certification testing which prevents certification.

Table 9-3: Variable Attributes in Glucometer Specialization

Attribute Name (See IEEE spec for format)	Attr ID	Sub ID	Size in bytes
Blood Glucose	2636	0	2
Blood Glucose Units	2454	0	2
Absolute Time	2448	0	8
Power Status	2389	0	2
Battery Charge	2460	0	2
Time Battery Remain – value	2440	0	4
Time Battery Remain – unit	2440	1	2
Measurement Status	2375	0	2
System ID	2436	0	8
System Model – product name	2344	0	12
System Model – model name	2344	1	16
Serial Number	2349	0	8

9.6 Agent Related AT Commands

This section describes all the commands used to manage the Agent role for HDP.

9.6.1 Connection to an HDP Manager

Command: AT+HAAhhhh

Response: <cr,lf> OK<cr,lf>
Or
<cr,lf>ERROR nn<cr,lf>
Or
<cr,lf>HAD:ASSOCIATE xxxx<cr,lf>OK<cr,lf>
Or
<cr,lf> HAD:DISASSOCIATE xxxx<cr,lf>ERROR nn<cr,lf>

Description: This command establishes a connection to an HDP manager and associates the agent with it so that attribute data can be exchanged. The Bluetooth address of the HDP manager and the agent specialization that needs to associate is defined by the handle 'hhhh', which is pre-obtained using command AT+HAB.

This command waits for the procedure to complete successfully or otherwise before responding with OK or ERROR. If the agent is already associated then an immediate OK is the response.

If the agent is not already associated then a Bluetooth connection initiates and as soon as a connection establishes, the association state machine progresses through to negotiating a configuration and then ultimately confirms the association. If association is successful, then a "HDA:ASSOCIATE ….." asynchronous response sends to the host. If association fails (because BT connection failed or configuration could not be negotiated) then the async response "HDA:DISASOCIATE …" sends to the host. An OK or ERROR response terminates the procedure.

Note: If S Reg 9071 is non-zero, then there is an automatic disassociation after a time specified by that register. The timer restarts every time a scan report sends to the manager.

SReg Required Settings: Bit 2 set in S9003 and S9070=0

9.6.2 Bind a Data Specialization

Command: AT+HAB<bd_addr>,iiii

Response: <cr,lf>hhhh<cr,lf>OK<cr,lf>
Or
<cr,lf>ERROR nn<cr,lf>

Description: This command binds a data specialization identified by the nominal code 'iiii' (for example 4111 = Weigh Scale) with an HDP manager identified by the Bluetooth address '<bd_addr>'. For this command to be successful, the data specialization identified by 'iiii' has to be pre-embedded in the firmware. Although the firmware allows multiple bindings to the same specialization, please be aware that it is the same object and each instance does not have a

unique set of attributes.

If the binding is successful, then a 16 bit handle 'hhhh' (a decimal number) returns, which is then used as a parameter in many subsequent commands.

SReg Required Settings: Bit 2 set in S9003 and S9070=0

9.6.3 Disassociate an Agent

Command:	AT+HADhhhh
Response:	<cr,lf>OK<cr,lf> Or <cr,lf>> HAD:DISASSOCIATE xxxx<cr,lf>OK<cr,lf> Or <cr,lf>ERROR nn<cr,lf>
Description:	This command disassociates an agent identified by the handle hhhh from a manager. This command waits for the procedure to complete successfully or otherwise before responding with OK or ERROR. If the agent is already disassociated then an immediate OK is the response. SReg Required Settings: Bit 2 set in S9003 and S9070=0
Command:	AT+HAEiiii,"name"
Response:	<cr,lf>OK<cr,lf> Or <cr,lf>ERROR nn<cr,lf>
Description:	This command must be issued prior to sending the AT+HAL commands and includes the data specialization endpoint 'iiii' with the string "name" as an HDP source (agent) in the SDP record that is exposed to potential peers. This tells potential peers that the device offers a 'iiii' data specialization source. Without this entry in the SDP record, a manager is not able to make a connection to the HDP agent, although it is rare for a manager to initiate connections in typical usage scenarios. SReg Required Settings: Bit 2 set in S9003 and S9070=0
Command:	AT+HAGhhhh,aaaa,ssss
Response:	<cr,lf>hhhhhhhhhhhhhh<cr,lf>OK<cr,lf> Or <cr,lf>ERROR nn<cr,lf>
Description:	This command reads (gets) the value of one of the variable attributes identified by 'aaaa' and sub ID 'ssss' in the attribute collections for that agent identified by the handle 'hhhh'. For the embedded weigh scale data specialization this command reads the value of an attribute listed in Table 9-1. The value always returns as a string of hexadecimal digits representing the binary value, and the size of that string is even. Different attributes have different sizes. SReg Required Settings: Bit 2 set in S9003 and S9070=0
Command:	AT+HAL

Response:	<cr,lf>OK<cr,lf> Or <cr,lf>ERROR nn<cr,lf>
Description:	This command must issue after sending at least one AT+HAE command, and registers and activates the SDP record with information supplied in the AT+HAE commands. Without the SDP record, a manager is not able to make a connection to the HDP agent, although it is rare for a manager to initiate connections in typical usage scenarios. SReg Required Settings: Bit 2 set in S9003 and S9070=0
Command:	AT+HARhhhh,pppp[,aaaa[,aaaa[…]]]
Response:	<cr,lf> OK<cr,lf> Or <cr,lf>ERROR nn<cr,lf>
Description:	This command triggers a scan report for person ID 'pppp' (16 bit decimal number) from the agent identified by handle 'hhhh'. If the agent is not associated with the bound manager (see AT+HAB) then it first triggers the start of an association. Once association exists, a scan report sends. If [,aaaa[,aaaa[…]]] is absent from the command, then the standard scan report as identified by the attribute MDC_ATTR_ATTRIBUTE_VAL_MAP in the NU collection sends to the manager. Otherwise, the [,aaaa[,aaaa[…]]] can be a list of any attribute mentioned in the NU collection. For example, to send a scan report with just the measurement status, just specify the single value 2375. Please note that only attributes mentioned in the NU collection are allowed. Any 'aaaa' value not found in the NU collection is silently ignored. SReg Required Settings: Bit 2 set in S9003 and S9070=0
Command:	AT+HAShhhh,aaaa,ssss,hhhhhhhhhhhh
Response:	<cr,lf> OK<cr,lf> Or <cr,lf>ERROR nn<cr,lf>
Description:	This command writes (sets)a new value 'hhhhhhhhhhhh' to one of the variable attributes (identified by 'aaaa' and sub ID 'ssss') in the attribute collections for the agent identified by the handle 'hhhh'. For the embedded weigh scale data specialization, this command writes to an attribute listed in Table 9-1. The value 'hhhhhhhhh' is in hexadecimal and is NOT validated in any way apart from the requirement that it shall be twice the size in bytes as specified for that attribute. SReg Required Settings: Bit 2 set in S9003 and S9070=0

9.6.4 Agent Related AT Asynchronous Responses

This section describes all the asynchronous responses sent to the host by the HDP Agent. Each response is framed by a <cr,lf> at the start and end.

Command:	No Command. This is a status message.
Response:	HDA:DISASSOCIATED hhhh

Description: This response sends the host when an association attempt fails (as a result of AT+HAA or AT+HAR commands) or when an association terminates by either AT+HAD or due to loss of Bluetooth connectivity. The parameter 'hhhh' which is a 16 bit decimal number identifies the agent.

Command: No Command. This is a status message.

Response: HDA:ASSOCIATED hhhh,iiii,cccc,sssssssssssss

Description: This response is sent to the host when a successful association happens for the agent identified by 'hhhh' (16 bit decimal number). For completeness, the data specialization nominal code 'iiii' (16 bit decimal) and the device configuration ID 'cccc' (16 bit decimal), that got negotiated with the manager, is also provided. The 16 character parameter 'ssssssss' specifies the system ID of the manager.

Note: An agent data specialization can be basic as specified in the relevant spec, or one of the more enhanced ones which have more capabilities. For example, with the weigh scale, Laird provides for the basic MDS collection, but it is possible to specify multiple MDS collections which expose more functionality (e.g. body mass index attributes). These extended collections are identified by configuration IDs and are offered to a manager during the association phase in descending order of complexity until the manager accepts one that it can work with.

Command: No Command. This is a status message.

Response: HDA:TIME hhhh,ccyymmddhhmmssaa

Description: This response sends to the host when a manager sends new time information by writing to the MDC_ATTR_TIME_ABS attribute in the MDS collection of the agent identified by 'hhhh'. The time ccyymmddhhmmssaa is a 16 character hexadecimal value which is encoded as follows:
CC Century (e.g. 14==20)
YY Year (e.g. 0B==11)
MM Month (e.g. 0C==12)
DD Day (e.g 1F==31)
HH Hour (e.g. 17==23)
MM Minutes (e.g 32==50)
SS Seconds (e.g. 2F==47)
AA Hundreths of seconds (e.g 63==99)
For example, the data and time 12 Feb 2011, 16:45:33.78 sends as 140B020C102D214E

9.6.5 HDP Manager Model

From a software perspective the HDP Manager implementation is as shown in the diagram below and the functionality is provided mainly to enable prototyping and regression testing of agent specializations. There are many far more capable HDP Managers available which are hosted on a PC. For example, the latest Toshiba Bluetooth Stack is HDP capable and there are imminent BlueZ releases for Linux PCs.

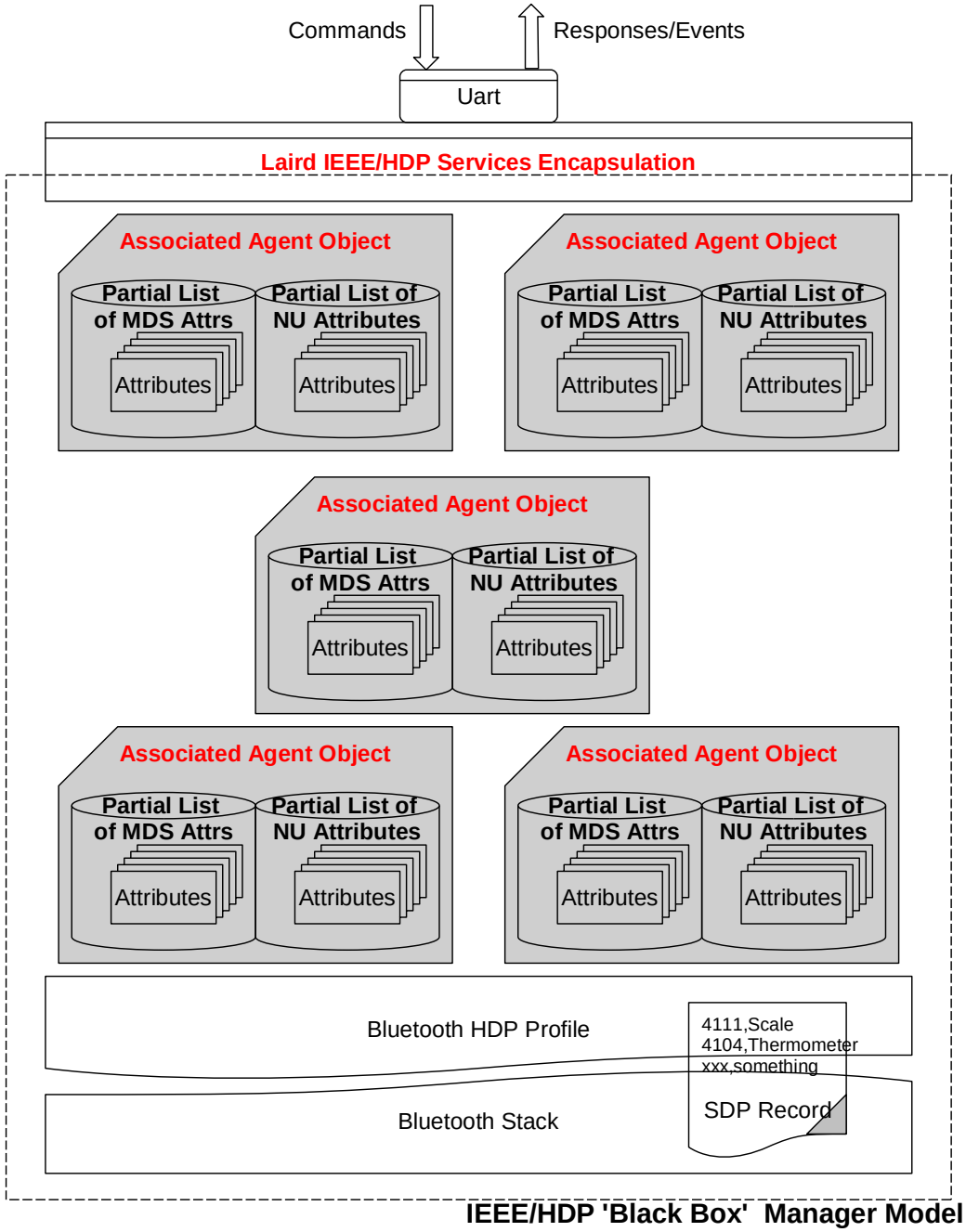


Figure 9-5: Manager model with Bluetooth communications stack

Figure 9-5 shows that the Manager model consists of the Bluetooth communications stack. The stack consists of:

- An SDP record that exposes to the outside world the data specializations it may accept as sinks
- A 'Laird IEEE/HDP Service Encapsulation' layer which relays commands and responses to the host
- 0 or more instances of Specialization Associations.

These 'Associated Agent Objects' are transient and come into existence only when an agent successfully associates. The associated process results in the top few attributes in the MDS and NU collections caching in the Manager which the host reads using the AT+HMG command after an association.

Just like the Agent end, the Manager indicates via its SDP record which Data Specializations it is capable of sinking, and commands analogous to the ones provided for the Agent model have been provided to manipulate that SDP record content.

9.7 Manager Related AT Commands

This section describes all the commands used to manage the agent role for HDP.

Command:	AT+HMEiiii,"name"
Response:	<cr,lf>OK<cr,lf> Or <cr,lf>ERROR nn<cr,lf>
Description:	This command must issue prior to sending the AT+HML commands and includes the data specialization endpoint 'iiii' with the string "name" as a HDP sink in the SDP record that is exposed to potential agents. This tells potential peers that the device offers a 'iiii' data specialization sink. Without this entry in the SDP record, an appropriate agent is not able to make a connection to the HDP Manager. SReg Required Settings: Bit 2 set in S9003 and S9070=1
Command:	AT+HMGhhhh,oooo,aaaa
Response:	<cr,lf>hhhhhhhhhhhhhhh<cr,lf>OK<cr,lf> Or <cr,lf>ERROR nn<cr,lf>
Description:	This command reads the value of one of the cached attributes for an agent identified by 'hhhh'. The parameter 'oooo' is for 0 for attributes in the MDS collection cache and '1' for the NU collection cache and 'aaaa' is the ID of the attribute to read. The value always returns as a string of hexadecimal digits representing the binary value, and the size of that string is even. Different attributes have different sizes. SReg Required Settings: Bit 2 set in S9003 and S9070=1
Command:	AT+HML
Response:	<cr,lf>OK<cr,lf> Or <cr,lf>ERROR nn<cr,lf>
Description:	This command must issue after sending at least one AT+HME command and registers and activate the SDP record with information supplied in the AT+HME commands. Without the SDP record, an agent is not able to make a connection to the HDP manager. SReg Required Settings: Bit 2 set in S9003 and S9070=1
Command:	AT+HMThhhh, ccyymmddhhmmssaa

Response: <cr,lf> OK<cr,lf>
Or
<cr,lf>ERROR nn<cr,lf>

Description: This command sends the current data and time to the associated agent identified by handle 'hhhh'.
The time ccyymmddhhmmssaa is a 16 character hexadecimal value which is encoded as follows:
CC Century (e.g. 14==20)
YY Year (e.g. 0B==11)
MM Month (e.g. 0C==12)
DD Day (e.g 1F==31)
HH Hour (e.g. 17==23)
MM Minutes (e.g 32==50)
SS Seconds (e.g. 2F==47)
AA Hundreths of seconds (e.g 63==99)

For example, the data and time 12 Feb 2011, 16:45:33.78 sends as 140B020C102D214E
SReg Required Settings: Bit 2 set in S9003 and S9070=1

9.7.1 Manager Related AT Asynchronous Responses

This section describes all the asynchronous responses sent to the host by the HDP Manager. Each response is framed by a <cr,lf> at the start and end.

Command: No Command. This is a status message.

Response: HDM:DISASSOCIATED hhhh

Description: This response sends to the host when an association terminates by an agent or due to loss of Bluetooth connectivity. The parameter 'hhhh' which is a 16 bit decimal number identifies the agent.

Command: No Command. This is a status message.

Response: HDM:ASSOCIATED hhhh,iiii,cccc,ssssssssssss

Description: This response sends to the host when a successful association happens for the agent identified by 'hhhh' (16 bit decimal number). For completeness, the data specialization nominal code 'iiii' (16 bit decimal) and the device configuration ID 'cccc' (16 bit decimal) that got negotiated with the manager, is also provided. The 16 character parameter 'ssssssss' specifies the system ID of the agent.

Note: An agent data specialization can be basic as specified in the relevant spec, or more enhanced with more capabilities. For example, with the weigh scale Laird provides for the basic MDS collection, it is possible to specify multiple MDS collection which expose more functionality (such as body mass index attributes). These extended collections are identified by configuration IDs and are offered to a manager during the association phase in descending order of complexity until the manager accepts one that it can work with.

Command: No Command. This is a status message.

Response: HDM:SCANPERIOD hhhh<more>

Description: This response sends to the host when a scan report receives from agent identified by handle 'hhhh'. Since a scan report can consist of data values for many attributes, this report is formatted with embedded <lf> characters as follows:

<cr><lf>HDM:SCANREPORT hhhh:pppp
<lf>O:oooo
<lf>A:aaaa,ddd..ddd
<lf>A:aaaa,ddd..ddd
…
<lf>O:oooo
<lf>A:aaaa,ddd..ddd
<lf>A:aaaa,ddd..ddd
…
…
<cr><lf>

Where <lf>O: identifies the collection object (oooo == 1 for NU etc) and then subsequence <lf>A: lines consist of value pairs aaaa,ddd.ddd where 'aaaa' is the attribute nominal code and ddd...ddd is its value in hexadecimal. The size of the value for each attribute is specified in the IEEE standards.

9.7.1.1 Sample Host/Module Message Sequence

In a typical weigh scale usage, the sequence of commands (red) and responses (blue) from the module is as follows, where it assumed that the both ends start of from factory default state:

```
================================    ================================
                AGENT                                MANAGER
================================    ================================
                                    ats9003=5
                                    OK
                                    ats9070=1
                                    OK
                                    at&w
                                    OK
ats9003=5
OK
ats9070=0
OK
at&w
OK
                        ============================
                                PAIRING
                        ============================
AT+BTW0016a4fef005
OK
PAIR 0 0016A4FEF005                 PAIR 0 0016A4FEF004
                        ============================
                           REGISTER SDP RECORDS
                        ============================
                                    AT+HME4111,"scale"
                                    OK
                                    AT+HML
                                    OK
AT+HAE4111,"scale"
OK
AT+HAB0016a4fef005,4111
46392
OK
AT+HAL
OK

                        ============================
                               ASSOCIATE
                        ============================
AT+HAA46392
HDA:ASSOCIATED
46392,4111,1500,4C414952444D4752
                                    HDM:ASSOCIATED
                                    29364,4111,1500,0016A4FEF004B538
OK
                        ============================
                         READ ATTIBUTES @ MANAGER
                        ============================
                                    AT+HMG29364,0,2628
                                    05DC
                                    OK
                        ============================
                           READ ATTIBUTES @ AGENT
                        ============================
```

```
AT+HAG46392,2646,0
0000004B
OK
                              ============================
                                WRITE ATTIBUTES @ AGENT
                              ============================
AT+HAS46392,2646,0,00000123
OK
AT+HAG46392,2646,0
00000123
OK
                              ============================
                                        SEND TIME
                              ============================
                                                    AT+HMT29364,140B020C102D214E
                                                    OK
HDA:TIME 46392,140B020C102D214E
                              ============================
                                SEND FIXED SCAN REPORT
                              ============================
AT+HAR46392,1234
                                                    HDM:SCANREPORT 29364:1234
                                                    O:1
                                                    A:2646,00000123
                                                    A:2448,2011021216453378
OK
                              ============================
                               SEND VARIABLE SCAN REPORT
                              ============================
AT+HAR46392,1234,2454,2448,2646,2375

                                                    HDM:SCANREPORT 29364:1234
                                                    O:1
                                                    A:2454,06C3
                                                    A:2448,2011021216453378
                                                    A:2646,0000004B
                                                    A:2375,8000
OK
                              ============================
                                        DISASSOCIATE
                              ============================
AT+HAD46392
OK
      HDA:DISASSOCIATED 46392              HDM:DISASSOCIATED 29364
```

9.7.2 Authentication and Encryption

The module and firmware is BT v2.1 compliant so it uses Simple Secure Pairing (SSP) to authenticate devices to trust, and only invokes a legacy pairing procedure when a peer device is v2.0 or older.

It is not possible to configure the unit to be only capable of legacy pairing and still have v2.1 approvals.

The purpose of pairing, whether legacy or SSP, is to generate the same random 16 byte key at both ends. The key is then used in subsequent connections for authentication and encryption.

9.7.3 Legacy Pairing

A legacy pairing procedure is automatically used when pairing is initiated (by either end) and the peer is approved to v2.0 and below.

9.7.3.1 Outgoing

To initiate a pairing, the host shall submit the command "AT+BTW<bd_addr>" to which it gets an immediate OK or ERROR response. The host then waits for a "PIN ? <bd_addr>" response to which it responds with the command AT+BTK="pincode".

When the pairing procedure completes, the module sends to the host the following asynchronous response: "PAIR N <bd_addr>". N is 0 when the pairing is successful, 1 for a timeout, and 2 for a generic failure (for example, mismatching pincode).

9.7.3.2 Incoming

The module has to be in at least connectable mode for it to participate in a pairing initiated from a legacy peer. The first indication the host gets that an incoming legacy pairing has initiated is when it receives the asynchronous response "PIN ? <bd_addr>". To this, the host responds with a shared pincode conveyed in the command AT+BTK="pincode".

When the pairing procedure completes, the module sends to the host the following asynchronous response: "PAIR N <bd_addr>". N is 0 when the pairing is successful, 1 for a timeout, and 2 for a generic failure (for example, mismatching pincode).

9.7.4 Simple Secure Pairing

Simple secure pairing was introduced in v2.1 of the Bluetooth specification to simplify the pairing procedure so it did not rely on a pre-shared pincode and so that all connections are forced to be encrypted. Unlike pre v2.1 devices, it is not possible to create connections without encryption.

Simple secure pairing uses the Diffie-Hellman public/private encryption methodology to expedite a common 128 bit key at both ends. This eliminates the need for pre-shared pincodes but introduces the 'man in the middle' (MITM) attack vulnerability.

To address the MITM vulnerability the concept of verification via a 6 digit passcode was also added. A 6 digit passcode was selected, as that reduces the probability of a random MITM attack succeeding to one in a million.

The 6 digit passcode is NOT a pre shared code, but is a random 6 digit artefact derived from the Diffie-Hellman calculations such that knowledge of that 6 digit number by an attacker cannot result in back-calculation of the 128 bit key that generated.

For a user to interact and process the 6 digit passcode the SSP procedure requires that each Bluetooth device have an I/O capability which is one of the following:

- None

- Display Only
- Display with a Yes/No button
- Keyboard only

This I/O capability exchanges by the two peers going through a pairing procedure so that the optimal user interaction selects at both ends. For example, if one end admits to keyboard only and the other to Display only, then the two negotiate that the display end shows the passcode with an appropriate prompt to get the user at the other end to type in the passcode.

When either has 'none' capability, then pairing procedure completes without any MITM protection by both ends automatically accepting the passcode generated by the pairing algorithm.

9.7.4.1 I/O Capability

The I/O capability of the module is set via S Register 6 (9006 in AT mode) where the value to set is as follows:

- 12 = No I/O capability
- 13 = Display with Yes/No
- 14 = Keyboard only
- 15 = Display Only

When both ends are keyboard only, you can enter a pre-shared 6 digit number.

When both ends are Display Only it is unlikely the two devices have services that are of use to either and so it could be contrived combination.

9.7.4.2 Outgoing

To initiate a pairing, the host shall submit the command "AT+BTW<bd_addr>" to which it gets an immediate OK or ERROR response. The host then shall wait for a "PASSKEY? N <bd_addr>" response to which it shall respond with the command AT+BTK="passcode" or "AT+BTKY" or "AT+BTKN" depending on the value of N in the "PASSKEY?" message.

When the pairing procedure completes, the module sends to the host the following asynchronous response: "PAIR N <bd_addr>". N is 0 for a successful pairing, 1 for a timeout, and 2 for a generic failure (for example, mismatching pincode).

As you can see, the host is able to determine if SSP or legacy pairing is in progress because in the former the challenge message is "PASSKEY?" whereas in the latter it is "PIN ?"

9.7.4.3 Incoming

The module has to be in at least connectable mode for it to participate in a pairing initiated from a SSP capable peer. The first indication the host may get is that an incoming pairing has initiated is when it receives the asynchronous response "PASSKEY? N <bd_addr>". To this, the host responds with the command AT+BTK="passcode" or "AT+BTKY" or "AT+BTKN" depending on the value of N in the "PASSKEY?" message.

When the pairing procedure completes, and for 'just works', the module sends to the host the following asynchronous response: "PAIR N <bd_addr>". N is 0 for a successful pairing, 1 for a timeout, and 2 for a generic failure (for example, mismatching pincode).

As you can see, the host is able to determine if SSP or legacy pairing is in progress because in the former the challenge message is "PASSKEY?" whereas in the latter it is "PIN ?". In the 'just works' scenario the PAIR 0 message informs the host that a pairing is complete.

9.7.4.4 Host processing of the "PASSKEY? N" response

The full format of the PASSKEY? message to the host is:

PASSKEY? N <bd_addr>[,passcode]

N is 1, 2, or 3 and ",passcode" is not present when N=3.

When N=1, this message requires the host to just display the passcode. The module does not expect any confirmation from the host.

When N=2, this message requires the host to display the passcode so that the user can accept or reject the pairing. The host sends the AT+BTKY command to accept the pairing, and to reject it sends AT+BTKN.

When N=3, the passcode is not provided and the host submits the AT+BTK="passcode" command. To reject, it can send any value not matching the passcode displayed at the remote end OR send AT+BTK="".

In the case of pairing where the I/O capability is none, the pairing occurs with 'just works' procedure where both ends automatically accept the pairing. In this case the module becomes aware that the pairing happened when it receives the "PAIR N <bd_addr>" response.

9.7.4.5 GPIO Access via SReg 619 and 620

The GPIO can be read and written to in AT mode via S registers 619 and 620.

SReg 620 reads the current states of all GPIO pins and displays as hex value with a '&' prefix.

To write to output pins, a nonzero mask MUST first write to S register 619.

Subsequently, any value written to S Reg 620 only affects GPIO pins which have a corresponding bit in S Reg 619 set to 1.

9.7.5 GPIO Exchange via RFCOMM Modem Signalling

There is a modem signalling message in an SPP connection that exchanges between peers. It conveys the status of 4 bits called RTR, RTC, DV, and IC, which normally map to DTR/DSR, RTS/CTS, DCD and RI respectively. This on-air message is transparent and happens in the 'background' as and when required.

The firmware in the module allows GPIO to map to those 4 bits. In total 8 GPIO pins can be mapped: 4 for inputs mapped to the bits that are sent to the peer, and 4 for outputs updated when a modem signalling message arrives from the peer.

It is not necessary to map all 8 bits and it is perfectly acceptable to have no pins mapped (which is the default).

S Registers 651 to 654 inclusive specify OUTPUT pins which update when a modem signal message arrives from a peer.

S Registers 661 to 664 inclusive specify INPUT pins which are monitored for changes of state, and when detected result in a modem signal to be sent to the peer.

As a result, it is possible to convey the state of a digital pin to the peer with some inherent latency. The latency depends on the quality of the RF connection, and even with the best of connection the user must test actual timings to check that the latency is acceptable for the use case.

9.7.6 Enhanced Inquiry Responses

Bluetooth 2.1 specification allows up to 240 bytes of extended inquiry data. On BT740-Sx modules, this data is limited to a maximum length based on firmware builds due to internal memory restrictions. Extended inquiry data transmits e.g. the friendly name, UUIDs of supported profiles, or user defined data within the inquiry process and without a Bluetooth connection.

The architecture for managing EIR data is composed of a BLOB buffer, a set of AT commands around them, and:

- Baseband (EIR data visible to inquiring devices)
- RAM buffer (allows accumulation of data)
- EIR persistent store (non-volatile buffer, copied to baseband at boot time)

As the input buffer length for one AT command is limited, there is a RAM buffer to accumulate several short data packets. The accumulated data of the RAM buffer can be copied to the baseband where it becomes visible to other inquiring devices immediately.

The content of the RAM buffer can copy to the EIR persistent store. If the EIR persistent store contains data, it copies to the baseband automatically at boot time. This allows a flexible usage of extended inquiry data. For example, data with a low data rate (e.g. temperature) can transmit without creating a connection between Bluetooth devices, however without the benefits of encryption and authentication.

The command AT+BTB is provided to manage EIR data in AT mode.

9.7.6.1 EIR Data Format

When passing EIR data ("<data>") to AT commands (AT+BTB="<data>" / AT+BTB+"<data>"), each byte should be presented by its ASCII representation whenever it is a printable character.

Each non-printable ASCII character must be presented as 2 hex digits with a preceding '\'. For example, a byte of decimal value 5 is presented as "\05" because the ASCII character of 05d is not printable.

A decimal value of 43 should be presented as '+' because '+' is the ASCII character representing 43d. The module also accepts "\2B" (the hexadecimal presentation of 43d) but at the price of two redundant characters.

Exceptions:

'"' (quotation mark) must be presented as \22

'\' (backslash) must be presented as \5C

When querying the content of the BLOB, non-printable ASCII characters are presented by 2 hex digits with preceding '\'.

Exceptions:

'"' (quotation mark) is presented as \22

'\' (backslash) is presented as \5C

',' (comma) is presented as \2C

Any data passed to the baseband must match the format defined in the Bluetooth Specification Version 2.1 + EDR [1], vol3, Part C – Generic Access Profile, 8 Extended Inquiry Response Data Format (page 1305 in the *.pdf file).

The AT command interpreter does not perform any checks on the baseband data format.

10 APPENDICES

For easy reference, this section lists AT Commands, S Registers, and error codes relevant to the BT740 module. These are listed in the following sections with links to their location in this document.

10.1 AT Commands

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ATA	Accept Incoming Connection (Answer Call)	6
ATD<bd_addr>,<uuid>	Make Outgoing Connection	6
ATEn	Enable/Disable Echo	7
ATH	Drop Connection	7
ATIn	Information	7
ATO	Enter Data Mode When Connected and in Command Mode	9
ATSn=m	Set S Register	9
ATSn?<$>	Read S Register Value in Decimal or Hex	9
ATSn=?	Read S Register's Valid Range	10
ATX<string>	Send Data to Peer When In Command Mode	10
AT&F*	Factory Default (Full)	10
AT&F+	Factory Default (Preserve Uart Settings)	10
AT&F*AT*	Factory Default (Preserve Protocol Setting)	11
AT&F*MP*	Factory default (Full, then change into MP mode)	11
AT&W	Write S Registers To Non-Volatile Memory	11
AT+BTB=<string>	Write <String> To Blob(0)	11
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AT+BTD<bd_addr>	Remove Trusted Device	12
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AT+HAE,iiii,"endpointname"	HDP: Endpoint Definition In SDP Record	19
AT+HAGhhhh,aaaa,ssss	HDP: Read Attribute Value In Agent	19
AT+HAL	HDP: Activate SDP Record For Agent	19
AT+HARhhhh,pppp[,aaaa[,aaaa[…]]]	HDP: Trigger Agent Scan Report	19
AT+HAShhhh,aaaa,ssss,ddddd	HDP: Write Attribute Value To Agent	19
AT+HME,iiii,"endpointname"	HDP: Endpoint Definition in SDP Record (Manager)	20
AT+HML	HDP: Activate SDP Record For Agent (Manager)	20
AT+HMGhhhh,oooo,aaaa	HDP: Read Attribute Value (Manager)	20
AT+HMThhhh,ttttttt	HDP: Send Time to Agent (Manager)	21
AT+KY<addr>,<link_key>	Add To Trusted Device Database (Rolling)	21
AT+KY<addr>?	Read The Link Key For Address Specified	21

10.2 S Registers

RegNo Dec (Hex)	Description
0	Rings before auto answering an incoming SPP connection. Setting 0 means a connection is not auto answered.
2	Escape character used to change from data mode to command parsing mode when in a data connection.
3 (03)	Server Profile record Mask
4 (04)	Default Connectable Mode on power up/reset
5 (05)	Default Discoverable Mode on power up/reset
6 (06)	Default Security Mode on power up/reset
7 (07)	Inquiry Scan Interval in units of msec
8 (08)	Inquiry Scan Window in units of msec
9 (09)	Page Scan Interval in units of msec
10 (0A)	Page Scan Window in units of msec
11 (0B)	RFCOMM frame size for all RFCOMM based profiles.
12 (0C)	Link supervision Timeout in seconds.
14 (0E)	Auto Accept Channel Setup.
32 (20)	Master/Slave role preference for SPP incoming connections.
33 (21)	Master/Slave role preference for SPP outgoing connections.
34 (22)	If Profiles Reg 3 bit 0 is set and this is not 0, then incoming SPP connections are allowed up to the number specified in this register.
35 (23)	If Profiles Reg 3 bit 0 is set and this is not 0, then outgoing SPP connections are allowed up to

RegNo Dec (Hex)	Description
	the number specified in this register
36 (24)	Enable DeviceID SDP record, and use the vid/pid as per registers 37 and 38.
37 (26)	USB Vendor ID to use in the DeviceID record
38 (26)	USB Product ID to use in the DeviceID record
39 (27)	Significant if the HID profile enables via Register 3. Negative values imply that HID HOST Profile is registered. Value 0 and above imply HID DEVICE Profile is registered and 0 = standard KEYBOARD device (104 keys). All other positive values are associated with custom HID Device Descriptors which are preloaded using the CMD_BLOBMANAGE or AT+BTB command into non-volatile memory.
40 (28)	On SPP connection, this specifies the initial state of the following modem control lines sent to the peer.
41 (29)	HID Device options: Bit MASK Values.
42 (2A)	HID Device options: bit values.
43 (2B)	Country Code exposed in HID Device Descriptor
44 (2C)	Language Code exposed in the HID Device Descriptor which have the following values. Each value contains ASCII values of two lower case characters. For example 'en'== 0x656E
45 (2D)	Primary Language exposed in the HID Device Descriptor and the value is specified as follows (where the values are in hexadecimal), refer to the HID specification for a complete list:
46 (2E)	Sub Language exposed in the HID Device Descriptor and the value is specified as follows for English (where the values are in hexadecimal); refer to the HID specification for a complete list:
47	When this register is 1, in MP Mode it enables the EVT_LINK_KEY_EX event to be sent to the host when the module receives the CMD_TRUSTED_DB_IS_TRUSTED command and in AT mode it enables the AT+KY? command so that the link key information is sent to the host in the response.
50..65 (32..41)	This specifies the functionality attached to GPIO 0 to 15 appropriately. 50 for GPIO_0 onwards to 65 for GPIO_15.
70 (46)	If set to 0 then an HDP AGENT profile implements; otherwise with 1, a HDP MANAGER implements.
71 (47)	HDP AGENT profile related. This is the default time in milliseconds an HDP Agent remains in associated state while there is no activity with the HDP Manger. If the value is 0, that is taken as infinite time.
72 (48)	HDP Profile related. This is the max TX pdu size and computes to the nearest multiple of 16.
73 (49)	Sniff Attempt Time in units of milliseconds. 0 means disable.
74 (4A)	Sniff Timeout Time in units of milliseconds. 0 means disable.
75 (4B)	Sniff Minimum Interval in units of milliseconds.
76 (4C)	Sniff Maximum Interval in units of milliseconds.
80 (50)	UART latency time in microseconds.
81	Memory usage in percent for MP mode UART RX processing. Leave to default value. Only change on advice from manufacturer.
82	The UART interface in the module uses hardware RTS/CTS handshaking to ensure that the low level receive buffer does not overflow. This register specifies at what fill percentage the RTS

RegNo Dec (Hex)	Description
	output line deasserts.
83	The UART interface in the module uses hardware RTS/CTS handshaking to ensure that the low level receive buffer does not overflow.
84	Configure UART Latency. The default value of 0 configures the module for maximum throughput at the expense of latency.
128 (80)	Module's Class of Device.
240 (F0)	UART Baudrate
241 (F1)	UART Handshaking.
242 (F2)	UART Stopbits
243 (F3)	UART Parity
255 (FF)	Host Communications Protocol
504	This register controls what debug shows on the terminal program during the connection process.
506	If this is set to 1, then AT commands echo back to the host. This becomes effective after a power cycle. To make immediate effect on echoes, use the command ATE0 or ATE1.
507	When set to 1, which is the default, the DSR modem status input line enters command mode and/or drop a connection. When set to 0 the DSR line is not checked for connection related functionality. This is so that the input can convey a digital status to the peer using S Registers 651/654 and 661/664 inclusive.
508	To S Reg 9009 (9 in MP Mode)
509	To S Reg 9010 (10 in MP Mode)
510	To S Reg 9007 (7 in MP Mode)
511	To S Reg 9009 (8 in MP Mode)
514	Minimum time in seconds to wait for the conclusion of a pairing operation.
517	Maximum time in seconds to perform an inquiry.
518	Maximum number of inquiry responses in an inquiry.
520	To S Reg 9240 (240 in MP Mode)
521	To S Reg 9240 (240 in MP Mode)
522	To S Reg 9241 (241 in MP Mode)
523	To S Reg 9242 (242 in MP Mode)
524	To S Reg 9243 (243 in MP Mode)
530	Reconnect delay when configured as master in auto connection mode.
531	Specifies the AT Parser mode on connection establishment.
561	To S Reg 9073 (73 in MP Mode)
562	To S Reg 9074 (74 in MP Mode)
563	To S Reg 9075 (75 in MP Mode)
564	To S Reg 9076 (76 in MP Mode)
619	This specifies a write mask when ATS620=X sets multiple GPIO states.
620	ATS620? reads all the GPIO states at once. ATS620=X writes new GPIO states using the mask in S Register 619.
621	Reads and digitises the voltage on AIO0 and outputs it as an 8 bit number on the terminal program.
622	Reads and digitises the voltage on AIO1 and outputs it as an 8 bit number on the terminal program.
651	-1 means no GPIO pin allocation.
652	-1 means no GPIO pin allocation.

RegNo Dec (Hex)	Description
653	-1 means no GPIO pin allocation.
654	-1 means no GPIO pin allocation.
661	-1 means no GPIO pin allocation.
662	-1 means no GPIO pin allocation.
663	-1 means no GPIO pin allocation.
664	-1 means no GPIO pin allocation.
717	Maximum time to wait for a remote friendly name to read (AT+BTI command).

10.3 Error Responses

All error responses from the device are in the form <cr,lf>**ERROR nn**<cr,lf>, where nn is a number in the range 00 to 99 as follows:

Table 10-1: BTM Error Responses in AT Mode

Error	Description
01	Register not recognized
02	Value for register is out of range
03	Incoming call NOT pending
04	No call to connect to. This error code has meaning for ATO only
05	Syntax Error
06	Empty String
06	Device Class could not be stored
08	Invalid Device Class Code
09	Invalid Bluetooth Address
10	Could not set Service or Friendly name
11	PS Store Write
12	PS Store Read
13	Not Idle
14	Incorrect Mode
15	Already Scanning
16	Pairing is already in progress
17	NOT USED
18	NOT USED
19	NOT USED
20	Not safe to write to Non-volatile Store - Ongoing Bluetooth Connection
21	Link Key Cache is Empty
22	Link Key Database is Full
23	Malloc returned NULL - Resource Issue
24	Remote Address same as Local Address
25	Connection Setup Fail, DSR Not asserted
26	Unauthenticated licence
27	Max Responses (See S Register 518) too high. Memory allocation error
28	The length of Pin in AT+BTK is too long
29	Invalid Ring count specified for S Register 0 or 100. If S0<>0 and S100<>0 then S0 must be < S100
30	ADC Error
31	Analogue Value cannot be read as it is set for output
32	Analogue Value cannot be written as it is set for input
33	S Register Value is invalid

Error	Description
34	Both L and R modifier cannot be specified in ATD command
35	Invalid Major Device Class – valid value in range 0x00 to 0x1F inclusive
36	Pairing in progress – Command cannot be actioned – try again later
37	Invalid Sniff parameter specified. E.g. new Attempt value greater than MinInterval. Solution is to first increase MinInterval and re-enter the Attempt value.
38	Get Remote Friendly name Failed
39	Failed to change mode to Multipoint
40	7 Bit mode requires parity to be even or odd
41	Stream Error
42	Stream Pending
43	Unknown AG command
44	Busy Try Later
45	Not Allowed
46	Invalid String
47	Generic Error
48	Inquiry in progress
49	Link Key Missing
50	String De-escape Error
51	Invalid Passcode (must be 6 decimal digits)
52	Invalid Pincode
53	Invalid UUID (must be 4 hex digits)
54	Connection in progress
55	Profile unsupported
56	No SPP Connection
57	I/O Mask is Zero (see SReg 619)
58	Invalid Friendly Name
59	Profile is not active
60	HDP : Invalid Handle
61	HDP : Unknown IEEE Nominal Code (Data Specialisation)
62	HDP : Report Error
63	HDP : Invalid IEEE Code
64	HDP : Invalid Parameter
65	HDP : Attribute not found
66	HDP : Invalid Number of Arguments
67	HDP : Object Closed
68	HDP : Association Failed
69	HDP : Too many Agents
70	HDP : Object Incomplete
71	HDP : PHDC Failed
72	HDP : PHDC Insufficient Resource
73	HDP : PHDC Invalid Parameter
74	HDP : PHDC Invalid State
75	HDP : PHDC Unknown
99	Functionality yet to be coded (please report to manufacturer)

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