Smart Technology. Delivered.

Class 1 Bluetooth v2.0 Module

USER'S GUIDE
VERSION 0.9

Part # BT730-SA, BT730-SC

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REVISION HISTORY

Revision	Revision Date	Description
Version 0.7	07/03/13	Prelim for KP
Version 0.8	10/04/13	Updated Mechanical Drawing – Pad Definitions
Version 0.9	01/05/13	Clean Up and DW Regulatory Updates

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1. OVERVIEW AND KEY FEATURES

Every BT730 series Bluetooth® module from Laird Technologies is designed to add robust, long-range Bluetooth data connectivity to any device. Based on the market-leading Cambridge Silicon Radio (CSR) BC04 chipset, BT730 modules provide exceptionally low power consumption with outstanding Class 1 range via 18 dBm of transmit power. A broad range of Bluetooth profiles and other vital features make BT730 modules superior to other Bluetooth modules.

With a compact footprint of 15.29 x 28.71 mm, the modules deliver maximum range with minimum size. Another integration advantage is the inclusion of a complete Bluetooth v2.0 protocol stack with support for multi-point connections and numerous Bluetooth profiles including Serial Port Profile (SPP), Dial Up Networking (DUN), OBEX Client, FTP Client plus partial support for Headset (HSP) and HandsFree (HFP). BT730 modules are fully qualified as Bluetooth end products, enabling designers to integrate the modules in devices without the need for further Bluetooth qualification.

An integrated AT command processor interfaces to the host system over a serial port using an extensive range of AT commands. The AT command set abstracts the Bluetooth protocol from the host application, saving many months of programming and integration time. It provides extremely short integration times for data oriented Bluetooth applications.

The included firmware provides programming support for multi-point applications that use up to three simultaneous data connections to and from the robust BT730 module. A low-cost developer's kit makes it easy for an OEM to integrate the module and guarantees the fastest route to prototype and then mass production.

Features & Benefits

- Bluetooth v2.0 + EDR
- External or internal antennas
- Comprehensive AT command set
- Bluetooth EPL
- Compact footprint
- Class 1 output - 18dBm
- UART interface with GPIO, PCM, and ADC lines
- Industrial temperature range
- Field proven firmware used on BTM40x and BISM II product ranges

Application Areas

- Medical devices
- ePOS terminals
- Automotive diagnostic equipment
- Barcode scanners
- Industrial cable replacement

2. SPECIFICATIONS

2.1 Detailed Specifications

Table 2-1: Detailed specifications

Categories	Feature	Implementation
Wireless Specification	Bluetooth®	V2.0 + EDR
	Frequency	2.402 - 2.480 GHz
	Max Transmit Power	Class 1 18 dBm from integrated antenna 18 dBm at UFL antenna connector
	Receive Sensitivity	Better than -87 dBm (at 25°C)
	Range	>1000m
	Data Rates	Up to 2.1 Mbps (over the air)
	UART Data Transfer Rate	Circa 300 kbps
Host Interface	UART	TX, RX, DCD, RI, DTR, DSR, CTS, RTS[1] Default 9600, n,8, 1 From 1,200 to 921,600 bps
	GPIO	8 configurable lines
	ADC	2 lines, 8 bit resolution
	PCM	4 lines – see Audio section
Profiles	SPP	Serial Port Profile
	DUN	Dial Up Networking
	OBEX Client & FTP Client	Object Exchange & File Transfer Client Profiles
	HFP & HSP (Audio Gateway)	Hands Free & Headset
Command Interfaces	Operation Modes	AT Command Set Multi-Point API - 3 simultaneous connections
	Firmware Upgrade	Firmware Upgrade over UART
Audio	Support SCO Channels PCM Interface	3 x PCM Channels @ 64 kpbs SCO and eSCO Configurable as master or slave 8 bit A-law 8 bit µ-law 13 bit linear PCM Clock available when in slave mode
Supply Voltage	Supply	3.0 – 5.0 V On-board regulators and brown-out detection

Categories	Feature	Implementation
Power Consumption	Various Modes – Typical values	Idle Mode – TBC Discoverable –TBC Inquiry Mode – TBC Connecting Mode – TBC Connected Mode (No Data Transfer) – TBC Connected Mode (Max Data Transfer) – TBC Sniff Mode – TBC
Antenna Options	Internal	Multilayer ceramic - BT730-SA
	External	Connection via u.FL - BT730-SC
Physical	Dimensions	15.29 mm x 28.71 mm x 2.5 mm
	Weight	1.5 g
Environmental	Operating	-40°C to +85°C
	Storage	-40°C to +85°C
Miscellaneous	Lead Free	Lead-free and RoHS compliant
	Warranty	1 Year
Development Tools	Development Kit	Development kit DVK-BT730 and software tools
Approvals	Bluetooth®	End Product Listing (EPL) (to be completed)
	FCC / IC / CE	All BT730 Series (to be completed)

1. DSR, DTR, RI and DCD are configurable either as GPIO or as modem control lines.

3. HARDWARE SPECIFICATIONS

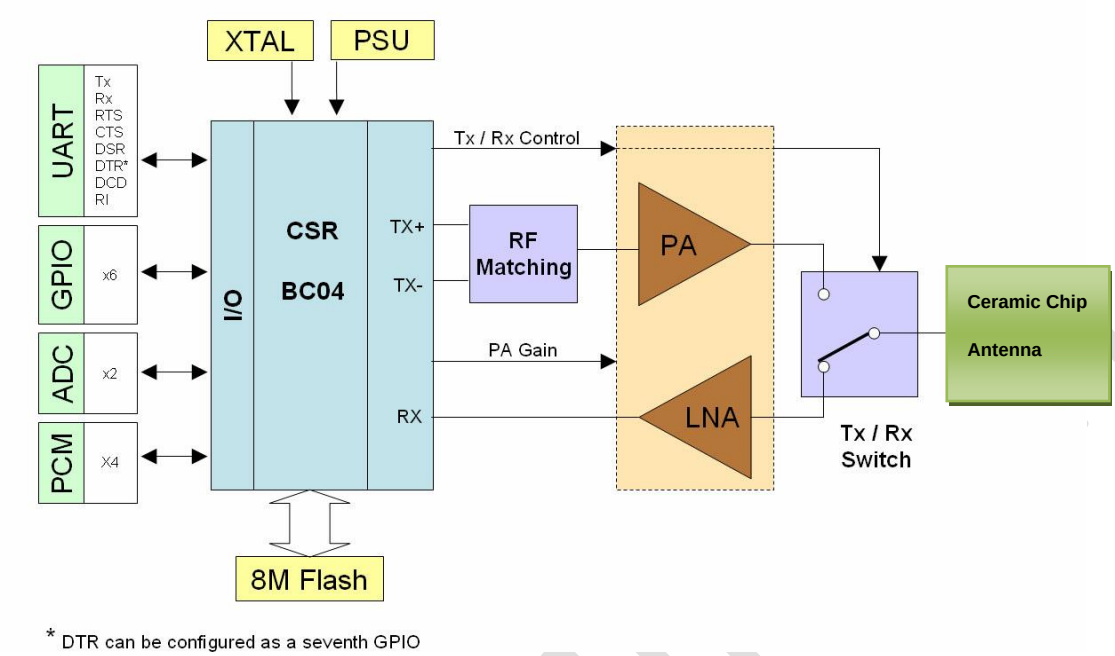


Figure 1: Functional Block Diagram

3.1 Pin Definitions

Table 3-1: Pin definitions

Pin	Signal	Description	Comment
1	GND		
2	SPI_MOSI	SPI bus serial I/P	See Note 2
3	GPIO6	I/O for host	
4	GPIO7	I/O for host	
5	RESET	Module reset I/P	See Note 4
6	SPI_CLK	SPI bus clock I/P	See Note 2
7	PCM_CLK	PCM clock I/P	
8	PCM_SYNC	PCM sync I/P	
9	PCM_IN	PCM data I/P	
10	PCM_OUT	PCM Data O/P	
11	VCC_5VIN	3.0 V < VIN < 5.0 V	
12	GND		
13	VCC_3V3	3.3 V Monitor	See Note 5
14	Analogue 1	1.8 V max	
15	GND		
16	UART_DSR	UART_DSR I/P	

Pin	Signal	Description	Comment
17	UART_DCD	UART_DCD I/P or O/ P	
18	GPIO_9	I/O for host	
19	GPIO_8	I/O for host	
20	GND		
21	Analogue 00	1.8 V max	
22	UART_RX	Receive data I/P	
23	UART_TX	Transmit data O/P	
24	UART_RTS	Request to Send O/P	
25	UART_CTS	Clear to Send I/P	
26	USB_D+	Not used for AT module variants	
27	USB_D-	Not used for AT module variants	
28	UART_RI	Ring Input or Output	
29	GPIO_3/UART_DTR	I/O for host/UART_DTR	
30	GPIO_5	I/O for host	
31	GPIO_4	I/O for host	
32	SPI_CSB	SPI bus chip select I/P	See Note 2
33	SPI_MISO	SPI bus serial O/P	See Note 2
34	GND	Only on uFL version	See Note 3
35	RF_OUT	Only on uFL version	See Note 3
36	GND	Only on uFL version	See Note 3

Notes:

1. Unused pins may have internal connections and must not be connected.
2. Pins 2, 6, 32, and 33 (SPI related) are only for Laird internal production purposes.
3. Pins 34 - 36 are only for uFL connector version of module – BT730-SC
4. Power-on-reset (power cycling and brown out consideration) – The reset circuitry within the BT730 module incorporates a brown-out detector; this may simplify power supply design. The BT730 reset line is an active low. Input debounced so must be low for more than 5 ms to cause a reset. Upon the application of power, the Power On Reset circuit built into the module ensures that the unit starts correctly. There is no need for an external power reset monitor.
5. Power Supply Consideration – The power supply for the module should be a single voltage source of VCC within the VCC_IN range of 3.0 V to 5.0 V. It must be able to provide sufficient current in a transmit burst. This can rise to 200 mA. To limit dissipation it is recommended that you use a voltage at the lower end of the range.
6. The module includes regulators to provide local 3.3 V. This rail is accessible on pin 13 for monitoring purposes only. Under no circumstances should this pin be used to source current.

COMPATIBILITY NOTE FOR LEGACY DEVICES

If **Reset compatibility is required with BTM402 and BTM404**: Reset logic must be inverted (on the host PCB), by using suitable BJT (MMBT3904) with collector connected to Reset pin BT730 module pin 5. A fixed 10k Ohm pull down resistor to ground (BJT input) then ensures that the BT730 module is out of reset for the condition when host has yet to control the reset line.

Add a 10k pull-up to the host PCB on the UART_RX, otherwise the module will remain in deep sleep if not driven to high.

Add a 10k pull-down to the host PCB on the UART_CTS that if it is not connected (which we do not recommend) then the default state for UART_CTS input will be asserted which means can send data out of UART_TX line.

PIO lines can be configured through software to be either inputs or outputs with weak or strong pull-ups or pull-downs. At reset, all PIO lines are configured as inputs with weak pull-downs.

UART_RX, UART_TX, UART_CTS, UART_RTS, UART_RI, UART_DCD, and UART_DSR are all 3.3 V level logic. For example, when RX and TX are idle they will be sitting at 3.3 V. Conversely, for handshaking pins CTS, RTS, RI, DCD, and DSR, a 0 V is treated as an assertion.

Pin 28 (UART_RI) is active low. It is normally 3.3 V. When a remote device initiates a connection, this pin goes low. This means that when this pin is converted to RS232 voltage levels it will have the correct voltage level for assertion.

Pin 17 (UART_DCD) is active low. It is normally 3.3 V. When a connection is live, this pin is low. This means that when this pin is converted to RS232 voltage levels it will have the correct voltage level for assertion.

Pin 16 (UART_DSR) is an input, with active low logic. It should be connected to the DTR output of the host. When the BTM730 module is in high speed mode (see definition for S Register 507), this pin should be asserted by the host to ensure that the connection is maintained. A deassertion means that the connection should be dropped or an online command mode is being requested.

Pin 13 (VCC_3V3 monitor) may only be used for monitoring purposes. It must not be used as a current source.

The GPIO pins can be accessed using S Registers 623 to 629.

GPIO3 is also used for DTR output (active low).See S Register 552 and553.

Analogue 0 and 1 should not exceed 1.8 V and S Registers 701 and 702 are used to access them.

3.2 Electrical Specifications

3.2.1 Absolute Maximum ratings

Absolute maximum ratings for supply voltage and voltages on digital and analogue pins of the module are listed below; exceeding these values will cause permanent damage.

Parameter	Min	Max	Unit
Peak current of power supply	0	200	mA
Voltage at digital pins	-0.4	3.7	V
Voltage at POWER pin	2.9 *	6.0	V

3.2.2 Recommended Operating Parameters

3.2.2.1 Power Supply

Signal Name	Pin No	I/O	Voltage level	Comments
VCC_VIN	11	I	3.0 V to 5.0 V * Typ 3.3 V	I_{typ} = TBC mA?
GND	1, 12, 15, 20, 34, 36			6 Ground terminals to be attached in parallel
VCC_3V3	13	O	3.3 V typical	For monitoring only. No current source

Note:

VCC_3V3 refers to internal voltage generated by the LDO inside the module which is typically 3.3V. Internal LDO drop is 0.2V. So to achieve 3.3V for VCC_3V3 requires VCC_IN of 3.5V. IO voltage levels follows VCC_3V3.

3.2.2.2 Signal Levels for Interface, PCM, SPI and GPIO

Signal Type	Signal level	Signal level @ 0mA load
Input	VILmin= -0.4V VILmax=0.8V VIHmin=2.3V VIHmax=3.7V	
Output		VOLmax=0.2V VOHmin=3.1V

3.2.2.3 RS-232 Interface

Signal Name	Pin No	I/O	Comments
UART_TX	23	O	
UART_RX	22	I	
UART_CTS	25	I	
UART_RTS	24	O	
UART_DSR	16	I	
UART_DTR	29	O	Shared with GPIO3
UART_RI	28	I or O	Direction may be programmed.
UART_DCD	17	I or O	Direction may be programmed.

SPI Bus

Signal Name	Pin No	I/O	Comments
SPI_MOSI	2	I	INTERNAL USE ONLY - Used to reprogram Flash in Laird production.
SPI_MISO	33	O	
SPI_CSB	32	I	
SPI_CLK	6	I	

3.2.2.4 PCM Interface

Signal Name	Pin No	I/O	Comments
PCM_CLK	7	I or O	If unused keep pins open. PCM output signals are tri-stated when there is not an active SCO or eSCO connection.
PCM_IN	9	I	
PCM_SYNC	8	I or O	
PCM_OUT	10	O	

3.2.2.5 General Purpose I/O and ADC

Signal Name	Pin No	I/O	Signal level	Comments
GPIO_3 - 9	3, 4, 16, 17, 18, 19, 29, 30, 31	I or O	See 3.2.2.2	
Analogue0, Analogue1	14, 21	I	Range 0 – 1.8 V	8 bit

3.2.2.6 Miscellaneous

Signal Name	Pin No	I/O	Signal level	Comments
USB D-	27	I	V_{IL}max =0.3vdd_usb V_{IH}min =0.7vdd_usb	Normally inactive. Pull to GND through 10kΩ.
USB D+	26	I	V_{IL}max =0.3vdd_usb V_{IH}min =0.7vdd_usb	Normally inactive. Pull to GND through 10kΩ.
RESET	5	I	V_{IL}max=1.0V V_{IH}min=2.3V	Active LOW. The Reset input contains a 10kΩ pull-up resistor (internal to module).

Terminology:

USB Signal Levels.vdd_usb refers to the internal voltage generated by the LDO regulator on the module, which is typically 3.3 V. Hence 0.3vdd_usb and 0.7vdd_usb correspond to 1.0 V to 2.3 V. To achieve 3.3V for vdd_usb requires VCC_IN of 3.5V. USB IO voltage levels follows VCC_3V3. For correct USB operation, would require vdd_usb on 3.1V which requires of VCC_IN of ~3.3V (0.2V LDO drop).

4. IO CHARACTERISTICS

4.1 Power Consumption

The current drain from the VCC power input line is dependent on various factors. The three most significant factors are the voltage level at VCC, UART baud rate, and the operating mode. The hardware specification for the module allows for a voltage range of 3.0 to 5.0 at VCC. The unit includes a linear regulator and tests have shown that there is no significant difference in current draw when VCC changes within the operating limits. Tests have shown that where power dissipation is an issue, it is best to keep VCC at the lower end of the range.

The UART baud rate has a bearing on power dissipation because as is normal for digital electronics, the power requirements increase linearly with increasing clocking frequencies. Because of this, higher baud rates result in a higher current drain. Finally, the significant operating modes are: idle, waiting for a connection, inquiring, initiating a connection, sniff, and connected. With connected mode, it is also relevant to differentiate between no data being transferred and when data is being transferred at the maximum rate possible. The AT command set document describes how to configure the module for optimal power performance.

4.2 Typical Current Consumption in mA

Table 4-2: Current Consumption

VCC = 3.8V, Baudrate = 9600bps Range = >1 meters	Typical Current (mA)
Idle Mode, S512=1	TBC
Wait for Connection Or Discoverable Mode, AT+BTP S508=S510=640, S509=S511=320	TBC
Wait for Connection Or Discoverable Mode, AT+BTP S508=S510=1000, S509=S511=11	TBC
Inquiry Mode, AT+BTIN	TBC
Connecting Mode (ATDxxx)	TBC
Connected Mode (No Data Transfer)	TBC
Connected Mode (Max Data Transfer)	TBC

5. FUNCTIONAL DESCRIPTION

The BT730 Bluetooth module is a self-contained Bluetooth product and requires only power to implement full Bluetooth communication. The integrated, high performance antenna, together with the RF and base-band circuitry provides the Bluetooth wireless link and the UART interface provides a connection to the host system.

The variety of interfaces and the AT command set allow the BT730 module to be used for a wide number of long range wireless applications, from simple cable replacement to complex multipoint applications, where multiple radio links are active at the same time.

The complexity and flexibility of configuration are made simple for the design engineer by the integration of an extremely comprehensive set of AT commands, supplemented with a range of "S" registers which are used for non-volatile storage of system parameters.

To provide the widest scope for integration a range of different physical host interfaces are provided.

5.1 UART Interface

UART_TX, UART_RX, UART_RTS, and UART_CTS form a conventional asynchronous serial data port with handshaking. The interface is designed to operate correctly when connected to other UART devices such as the 16550A. The signalling levels are nominal 0 V and 3.3 V and are inverted with respect to the signalling on an RS232 cable. The interface is programmable over a variety of bitrates; no, even, or odd parity; stop bit and hardware flow control. The default condition on power-up is pre-assigned in the external flash. Two-way hardware flow control is implemented by UART_RTS and UART_CTS. UART_RTS is an output and is active low. UART_CTS is an input and is active low.

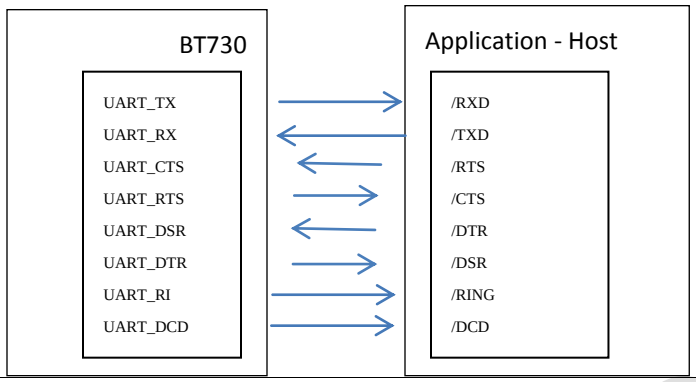
These signals operate according to normal industry convention. UART_RX, UART_TX, UART_CTS, UART_RTS, UART_RI, UART_DCD, and UART_DSR are all 3.3 V level logic. For example, when RX and TX are idle they sit at 3.3 V. Conversely for handshaking pins CTS, RTS, RI, DCD, and DSR, a 0 V is treated as an assertion.

By writing different values to the relevant S register the UART_RI can be continuously polled to detect incoming communication. The UART_RI signal serves to indicate incoming calls.

UART_DSR is an active low input. It should be connected to DTR output of the host. When the module is running in high speed mode (see definition for S Reg 507), this pin should be asserted by the host to ensure connection is maintained. A de-assertion means that the connection should be dropped or an online command mode is being requested.

The module communicates with the customer application using the following signals:

- Port /TXD of the application sends data to the module's UART_RX signal line
- Port /RXD of the application receives data from the module's UART_TX signal line



Note: The serial module output is at 3.3 V CMOS logic levels. Level conversion must be added to interface with an RS-232 level compliant interface.

Some serial implementations link CTS and RTS to remove the need for handshaking. Laird does not recommend linking CTS and RTS other than for testing and prototyping. If these pins are linked and the host sends data at the point that the BT740 deasserts its RTS signal, then there is a significant risk that internal receive buffers will overflow; this could lead to an internal processor crash. This also leads to a drop in connection and may require a power cycle to reset the module. Laird recommends that the correct CTS/RTS handshaking protocol be followed for proper operation.

5.2 SPI Bus

The module is a slave device that uses terminals SPI_MOSI, SPI_MISO, SPI_CLK, and SPI_CSB. This interface is used for program firmware updates at the factory. Laird supplies a PC-based utility to allow a firmware upgrade over the UART port. It is highly recommended that customers use this method for updating firmware.

Note: The designer should be aware that no security protection is built into the hardware or firmware associated with this port, so the terminals should not be permanently connected in a PC application.

5.3 PCM Interface

PCM_OUT, PCM_IN, PCM_CLK, and PCM_SYNC carry up to three bi-directional channels of voice data, each at 8 k samples/s. The format of the PCM samples can be 8-bit A-law, 8-bit µ-law, 13-bit linear, or16-bit linear. The PCM_CLK and PCM_SYNC terminals can be configured as inputs or outputs, depending on whether the module is the master or slave of the PCM interface. Please contact a Laird FAE for further details.

The module is compatible with the Motorola SSI TM interface and interfaces directly to PCM audio devices including the following:

5.3.1 Compatible Codec Chips

- OKI 7702 single channel A-law and µ-law CODEC
- Winbond W681360 13 bit linear CODEC

5.4 General Purpose I/O and ADC

5.4.1 GPIO

Seven lines of programmable bi-directional input/outputs (I/O) are provided that can be accessed either via the UART port, or Over The Air (OTA) from a second Bluetooth unit. These can be used as data inputs or to control external equipment. By using these in OTA mode, a BT730 module can be used for control and data acquisition without the need for any additional host processor. Each of the GPIO[3:9] ports can be independently configured to be either an input or output. A selection of ports can be accessed synchronously.

The ports are powered from VCC. The mode of these lines can be configured and the lines are accessed via S Registers 623 to 629.

5.4.2 ADC

The BT730 provides access to two 8-bit ADCs (Analogue 0 and 1). These provide an input range of 0 mV to 1,800 mV, which can be read using the S registers 701 and 702.

Suitable external scaling and over-voltage protection should be incorporated in your design. The module provides five samples per second at the UART with a baud rate of 115,200 or above.

6. AT COMMAND SET REFERENCE

6.1 Introduction

This document describes the protocol used to control and configure the following Laird Technologies Bluetooth devices:

- BT730-SA
- BT730-SC

The protocol is similar to the industry standard Hayes AT protocol used in telephony modems which is appropriate for cable replacement scenarios, as both types of devices are connection oriented. The telephony commands have been extended to make the Laird device perform the two core actions of a Bluetooth device, which is make/break a connection and Inquiry. Other AT commands are also provided to perform ancillary functions, such as pairing, trusted device database management, and S register maintenance.

Similar to telephony modems, the Laird device powers up in an unconnected state and only responds via the serial interface. In this state, the Laird device does not respond to Bluetooth inquiries. Then, just like controlling a modem, the host can issue AT commands which map to various Bluetooth activities. The command set is extensive enough to allow a host to make connections which are authenticated and/or encrypted or not authenticated and/or encrypted or any combination of these. Commands can be saved, so that on a subsequent power-up the device is discoverable or automatically connects.

The device has a serial interface which can be configured for baud rates from 1200 up to 921600 and an RF communications end point. The latter has a concept of connected and unconnected modes and the former has a concept of command and data modes. This leads to the matrix of states shown in Table 6-1.

Table 6-1: Matrix of mode states

	RF Unconnected	RF Connected
Local Command Mode	OK	OK
Remote Command Mode	ILLEGAL	OK
Data Mode	ILLEGAL	OK

The following combinations do not make sense and are ignored:

- Data and RF Unconnected Mode
- Remote Command and RF Unconnected Mode

Navigation between these states occurs using the AT commands which are described in detail in subsequent sections.

6.2 Assumptions

The CSR (Cambridge Silicon Radio) BC04 chipset in Laird devices is memory resource limited. 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 so similar that existing source code written for modems can be used with very little modification with a Laird device.

The following assumptions are made:

- All commands are terminated by the carriage return character 0x0D, which is represented by the string <cr> in descriptions below this cannot be changed.
- 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 shall be represented by the string <cr,lf>.
- All Bluetooth addresses are represented by a fixed 12 digit hexadecimal string, case insensitive.
- All Bluetooth Device Class codes are represented by a fixed six digit hexadecimal string, case insensitive.
- All new Bluetooth specific commands are identified by the string +BT**x**, where **x** is generally a mnemonic of the intended functionality.

6.3 Commands

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.

<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 (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'.

6.3.1 ^^^{Enter Local Command Mode}

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. Refer to Section 6.6: Dropping Connections for more information.

In modems this escape sequence is usually "+++". "^^^" is specified to avoid confusion when the module is providing access to a modem.

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

6.3.1 !!!{Enter Remote Command Mode}

When in data and connected mode, the host can force the remote device into a command and connected mode so that AT commands can be issued to the device remotely. The escape sequence guard time is specified by S Register 12 and is the same as per the ^^^ escape sequence. By default the guard time is set to 100 milliseconds. The remote device issues ATO as normal to return to data mode. (Refer to 2.2.12)

For this command to be effective, S Register 536 must be set to 1.

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

6.3.2 AT

Used to check the module is available.

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

6.3.3 ATA{Answer Call}

Accept an incoming connection, which is indicated by the unsolicited string

<cr,lf>**RING 123456789012**<cr,lf> every second. **123456789012** is the Bluetooth address of the connecting device.

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

6.3.4 ATD<U><Y><bd_addr>,<uuid> {Make Outgoing Connection}

Make a connection to a 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; if not supplied, then the default UUID from S Register 101 is used. Because this is a Laird device which utilises the RFCOMM layer as described in the Bluetooth specification, it implies that only profiles based on RFCOMM can be accessed.

If <U> is not specified, then authentication is as per register 500, otherwise the connection will be authenticated.

If <Y> is not specified, then encryption is as per register 501, otherwise the connection will have encryption enabled.

The timeout is specified by S register 505.

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

Or <cr,lf>**NO CARRIER**<cr,lf>

Due to a known issue in the Bluetooth RFCOMM stack, it is not possible to make more than 65525 outgoing connections. Therefore if that number is exceeded, then the connection attempt fails with the following response:

Response: <cr,lf>**CALL LIMIT**<cr,lf>

Or <cr,lf>**NO CARRIER**<cr,lf>

In that case, issuing an ATZ to reset the device resets the count to zero and allows more connections.

The following RFCOMM based UUIDs are defined in the Bluetooth specification:

Profile Name	UUID
Serial Port	1101
LAN Access Using PPP	1102
Dialup Networking	1103
IrMC Sync	1104
OBEX Object Push	1105
OBEX File Transfer	1106
IrMC Sync Command	1107
Headset	1108
Cordless Telephony	1109
Intercom	1110
Fax	1111
Audio Gateway	1112
WAP	1113
WAP_CLIENT	1114

6.3.5 ATD<U><Y><bd_addr>,<ServiceName>{Make Connection}

Make a connection to device with Bluetooth address <bd_addr> and profile specified via S Reg 101 AND which has a service name starting with the string <ServiceName>. The service name parameter is a string delimited by ".

If <U> is not specified, then authentication is as per register 500, otherwise the connection is authenticated.

If <Y> is not specified, then encryption is as per register 501, otherwise the connection has encryption enabled.

The timeout is specified by S register 505.

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

Or <cr,lf>**NO CARRIER**<cr,lf>

6.3.6 ATD<U><Y>L{Remake Connection}

Make a connection with the same device and service as that specified in the most recent ATD command. The <UY> modifiers are optional. An error is returned if the 'L' modifier is specified as well as a Bluetooth address.

If both 'L' and 'R' modifiers are specified then an error is returned.

Response: <cr,lf>**CONNECT 123456789012 AE**<cr,lf>

Or <cr,lf>**NO CARRIER**<cr,lf>

6.3.7 ATD<U><Y>R{Make Connection to peer specified in AT+BTR}

Make a connection with the device address specified in the most recent AT+BTR command. The service is as specified in S Register 101. The <UY> modifiers are optional. An error is returned if the 'R' modifier is specified as well as a Bluetooth address.

If both 'R' and 'L' modifiers are specified then an error is returned.

Response: <cr,lf>**CONNECT 123456789012 AE**<cr,lf>

Or <cr,lf>**NO CARRIER**<cr,lf>

6.3.8 ATEn{Enable/Disable Echo}

This command enables or disables the echo of characters to the screen. A valid parameter value is written to S Register 506.

E0 Disable echo.

E1 Enable echo.

All other values of n generate an error.

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

Or <cr,lf>**ERROR nn**<cr,lf>

6.3.9 ATH{Drop Connection}

Drop an existing connection or reject an incoming connection indicated by unsolicited RING messages.

Response: <cr,lf>**NO CARRIER**<cr,lf>

6.3.10 ATIn{Information}

This returns the following information about the Laird device.

I0	The product name/variant.
I1	The CSR firmware build number.
I2	The Laird firmware build number. For internal use only.
I3	The Laird firmware revision.
I4	A 12 digit hexadecimal number corresponding to the Bluetooth address of the Laird device.
I5	The manufacturer of this device.
I6	The maximum size of trusted device database.
I7	The manufacturer of the Bluetooth chipset.
I8	The chipset format.
I9	0 if not in a connect state and 1 if in a connect state.
I11	The reason why a "NO CARRIER" resulted in the most recent attempt at making an outgoing connection. Where the response values are as follows: ▪ 0 = No prior connection

	▪ 1 = Connection timeout ▪ 2 = Connection attempt cancelled ▪ 3 = Normal disconnection ▪ 4 = Peer device has refused connection ▪ 5 = Service profile <uuid> requested not available on remote device ▪ 6 = Connection has failed ▪ 32 = ATH was entered ▪ 33 = Incoming connection aborted because too many rings ▪ 34 = Unexpected incoming connection ▪ 35 = Invalid address ▪ 36 = DSR is not asserted ▪ 37 = Call limit of 65531 connections has been reached ▪ 38 = Pairing in progress ▪ 39 = No link key ▪ 40 = Invalid link key ▪ 255 = Unknown reason
I12	The last ERROR response number.
I13	The Sniff status is returned as follows: **Response:**<cr,lf>**a:b,c,d,e**<cr,lf>**OK**<cr,lf> Where 'a' = 0 when not online and 1 when online and Sniff has been enabled, 'b' is the Sniff Attempt parameter, 'c' is the Sniff timeout parameter, 'd' is the minimum sniff interval and 'e' is the maximum sniff interval. All parameters 'b', 'c', 'd' and 'e' are given as Bluetooth slots which are 625 microseconds long converted from values of S Registers 561, 562, 563, and 564 respectively.
I14	The current boot mode (only for firmware 1.18.0 and newer)
I15	The maximum length of an AT command, including the terminating carriage return (only for firmware 1.6.10 and newer).
I16	The size of AT command input buffer.
I20	Returns the number of bytes pending to be sent in the RF buffer when a connection is up.
I33	Version number of Multipoint application **Note:** ATI is provided for compatibility in multipoint mode; other AT commands are not available.
I42	State information. Where the response values are as follows: 13 = Not Open 14 = Open Idle 15 = Ringing 16 = Online Command 172 to 177 = waiting for connectable and/or discoverable where the lowest significant digit equates to the value stored in S Register 512 or 555. **Note**: When n=16, ATI9 returns 1.
I101	The RSSI value in dBm. If a connection does NOT exist then a value of -32786 is returned. A value of 0 means the RSSI is within the golden range; because this is a very large band, RSSI is not always a useful indicator. Use ATI111 instead which returns the bit error rate.
I111	Returns LinkQual which in the CSR chipset is defined as BER (bit error rate). This returns a value which is the number of bits in error out of 1 million. Hence a value of 0 is best, and larger values are worse. A value approaching 1000 (BER = 0.1%) is an indication that the

	link is bad and a large number of Bluetooth packets are being lost.
I333	Returns extended firmware version number.

For recognised values of n. All other values of n generate an error.

Response: <cr,lf>**As Appropriate**<cr,lf>OK<cr,lf>

Or <cr,lf>**ERROR**nn<cr,lf>

6.3.11 ATO{Enter Data Mode}(letter 'o')

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

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

Or <cr,lf>**ERROR**nn<cr,lf>

6.3.12 ATSn=m{Set S Register}

As with modems, the Laird Bluetooth module employs a concept of registers which are used to store parameters (such as escape sequence character and inquiry delay time) as listed in detail below.

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 are changed, the changes are **not** stored in non-volatile memory *until* the AT&W command is used.

Note: AT&W does not affect S registers 520 to 525 or 1000 to 1010 as they are updated in non-volatile memory when the command is received.

Table 6-2: S Registers

Reg. #	Default	Range	Comment
S0	1	-1..15	Number of RING indication before automatically answering an incoming connection. A value of 0 disables autoanswer. If -1, then autoanswer on one RING and do NOT send RING/CONNECT response to the host. This emulates a serial cable replacement situation. Setting values >/= 0, resets S Register 504 to 0 and <0 forces 504 to 1. If S0 <> 0 and S100 <> 0 then S0 must be < S100. If a value is entered which violates this rule, then ERROR 29 is sent in response. If S504 =1 then this register will return -1, regardless of the actual value stored in non-volatile memory.
S2	0x5E	0x20..0x7E	Escape sequence character. It is not '+' by default as a Bluetooth serial link can be used to connect to a mobile phone which exposes an AT command set, which in turn uses '+' as default. So if both used '+' there is confusion. 0x5e is the character '^'.
S12	100	40..5000	Escape sequence guard time in milliseconds, with a granularity of 20 ms. New values are rounded down to the nearest multiple of 20 ms.

Reg. #	Default	Range	Comment
S100	15	0..15	Number of RING indications before an auto disconnection is initiated. A value of 0 disables this feature. If S0 <> 0 and S100 <> 0 then S0 must be < S100. If a value is entered which violates this rule, then ERROR 29 is sent in response.
S101	$1101	0..$ffff	UUID of default SPP based profile when not specified explicitly in the ATD command.
S102	1	1..$7F	Defines a set of bits masks for enabling profile servers. Values can be ORed. ▪ 1 is Serial Port Profile ▪ 2 is Headset (S Reg 580 allows remote volume control bit to be adjusted) ▪ 4 is DUN ▪ 8 is Audio Gateway (Headset) ▪ 16 is Handsfree (S Reg 581 allows supported feature field to be adjusted) ▪ 32 is OBEX FTP ▪ 64 is Audio Gateway (Handsfree) It is recommended that, due to memory resource issues, no more than two profiles are activated at the same time.
S103	1	1..7	Boot mode on cold boot.
S126	?	0 .. 0xFFFF	Primer for changing to Multipoint mode
S127	?	0 .. 0xFFFF	0x100 for AT mode 0x200 for Multipoint mode Other values are reserved
S400	0	0..1	Piodeamon. 1 = Hostless Audio gateway Operation
S401	1000	100..5000	In Hostless Audio Gateway Operation – GPIO4 flash period while inquiring
S402	0	0..100	In Hostless Audio Gateway Operation – GPIO4 flash duty cycle while inquiring
S403	1000	100..5000	In Hostless Audio Gateway Operation – GPIO4 flash period when there is an ACL connection only to the headset
S404	0	0..100	In Hostless Audio Gateway Operation – GPIO4 flash duty cycle when there is an ACL connection only to the headset
S405	1000	100..5000	In Hostless Audio Gateway Operation – GPIO4 flash period when there is an ACL and SCO connection to the headset
S406	0	0..100	In Hostless Audio Gateway Operation – GPIO4 flash duty cycle when there is an ACL and SCO connection to the headset
S407	0	0..1	In Hostless Audio Gateway Operation – 'Lift-Hook' output follows SCO state
S408	0	0..1	In Hostless Audio Gateway Operation – if set to 1 then delete trusted device database when inquiry is initiated to look for headsets

Reg. #	Default	Range	Comment
S409	0	0..1	In Hostless Audio Gateway Operation – when inquiring and pairing, use the device class code of the response to classify which UUID to connect to the headset when initiating a Bluetooth connection from the gateway
S410	0	0..1	In AudioGatewayHostless mode, if set to 1, AG"" async responses will be forced out from the UART – good for debugging
S411	500	4000	In AudioGatewayHostless mode, Short press duration in milliseconds. 500 msec granularity
S412	500	4000	In AudioGatewayHostless mode, component of medium press duration in milliseconds. 500 msec granularity. Actual duration is this value plus S411
S413	500	4000	In AudioGatewayHostless mode, component of long press duration in milliseconds. 500 msec granularity. Actual duration is this value plus S412 plus S411
S414	30	240	In AudioGatewayHostless mode, the inquiry to search for headsets is aborted after this amount of time, in seconds. The granularity is 30 seconds.
S420	0	1	If this is set, then the module maintains a seconds counter. Use ATI420 to read the count value. It is basically the time the module has been powered up in seconds.
S500	0	0..1	Authentication for outgoing connections. Set to 1 to enable authentication.
S501	0	0..1	Encryption for outgoing connections. Set to 1 to enable encryption.
S502	0	0..1	Authentication for incoming connections. Set to 1 to enable authentication.
S503	0	0..1	Encryption for incoming connections. Set to 1 to enable encryption.
S504	0	0..1	Setting to 1 forces S0 to -1 and suppresses messages arising from connections or pairing. E.g. CONNECT, NO CARRIER, RING, PAIR etc. Suppressing connection-based messaged allows the Laird device to be configured in cable replacement mode.
S505	10	2..120	Minimum delay before abandoning connection attempt as a master. Referenced by ATD. In units of seconds. See S Registers 530 and 543. Please note that as disconnection time can vary, this register only guarantees the minimum delay. Note that for invalid addresses specified in the ATD command, the "NO CARRIER" response is immediate. See S register 560 for specifying disconnect max timeout.
S506	1	0..1	Enable/Disable echoes. The ATEn command also affects this.

Reg. #	Default	Range	Comment
S507	0	0..2	When set to 0, a connection can be dropped using ^^^ escape sequence only and the state of DSR line is ignored. When set to 1, a connection can be dropped using EITHER the ^^^ escape sequence OR the DSR handshaking line. When set to 2, a connection can only dropped using a deassertion of DSR. Mode 2 provides for the highest data transfer rate. If the status of the DSR line is to be conveyed to the remote device as a low bandwidth signal then this register MUST be set to 0, otherwise a deassertion of DSR will be seen as a request to drop the Bluetooth connection. This register affects S Register 536 – see details of 536. For the Go blue Activator variant this can only be set to 0.
S508	640	10..2550	Page Scan Interval in milliseconds. Minimum is 11.25 ms so 10/11 ms gives 11.25ms.
S509	320	10..2550	Page Scan Window in milliseconds. Minimum is 11.25 ms so 10/11 ms gives 11.25 ms.
S510	640	10..2550	Inquiry Scan Interval in milliseconds. Minimum is 11.25 ms so 10/11 ms gives 11.25ms.
S511	320	10..2550	Inquiry Scan Window in milliseconds. Minimum is 11.25 ms so 10/11 ms gives 11.25 ms.

Reg. #	Default	Range	Comment
S512	1	0..7	Specify power up state. When set to 0, AT+BTO is required to open the device for Bluetooth activity. When set to 1, it proceeds to a state as if AT+BTO was entered. When set to 2, it is discoverable only, similar to issuing AT+BTQ. When set to 3, it is connectable but not discoverable e.g. AT+BTG When set to 4, it is connectable and discoverable e.g. AT+BTP. When set to 5, it is like 2, but all UART RX traffic is discarded in absence of a connection while DSR is asserted. If DSR is not asserted, then it behaves exactly as per mode 2. When set to 6, it is like 3, but all UART RX traffic is discarded in absence of a connection while DSR is asserted. If DSR is not asserted, then it behaves exactly as per mode 3. When set to 7, it is like 4, but all UART RX traffic is discarded in absence of a connection while DSR is asserted. If DSR is not asserted, then it behaves exactly as per mode 4. **Note:** By implication, a change to this can only be seen after a power cycle AND if AT&W is actioned prior to the power cycle. If S Reg 554 is non-zero and this register is between 2 and 7 inclusive, then the value of S554 specifies the time in seconds that the device will remain in the specified mode after power up. On timeout, the device falls back to the mode specified in S Register 555. In modes 5, 6, and 7, when all RX activity is ignored, only the special command (capitalised) AT+BT&BISM& terminated by a <cr> forces the module temporarily back into modes 2,3 and 4 respectively. In some firmware builds, S Registers 565 to 569 inclusive are visible, which allows the start-up mode to depend on the state of RI line (Setting S Reg 565 forces the RI pin to be configured as an input). For this feature to be active, S Reg 565 should be set to 1. In that case, on start-up, if RI is asserted, then the start-up mode is defined by S Reg 566 and if deasserted then S Reg 567.
S513	1	0..1	Pairing Authentication, 1 = Enable
S514	10	1..60	Pairing Timeout in seconds. This includes the time a host takes to supply the PIN number when PIN? messages are indicated.
S515	0x001F00	0.. 0xFFFFFF	Default Device Class Code to be used with AT+BTO when it is not explicitly specified. When queried, the value is always printed as a hexadecimal number. To change the device class of the module, after AT+BTO, use the command AT+BTC.

Reg. #	Default	Range	Comment
S516	0x000000	0..0x2FFFFFF	Default Device Class filter to be used with AT+BTI when it is not explicitly specified. When queried the value is always printed as a hex number. The seventh most significant digit, can be 0, 1, or 2, and is used to specify the type of device class filter. When 0, it specifies no filtering. When 1, it specifies an AND mask and all 24 bits are relevant When 2, it specifies a filter to look for devices with matching major device class which occupies a 5 bit field from bits 8 to 12 inclusive (assuming numbering starts at bit 0). All other 19 bits MUST be set to 0.
S517	20	2..61	Inquiry Length in units of seconds. This parameter is referenced by the AT+BTI command
S518	8	0..255	Maximum number of responses from an inquiry request. This parameter is reference by the AT+BTI command. If this number is set too high, then AT+BTI will return ERROR 27. For a particular firmware revision, determine the effective maximum value by trial and error. That is, set to a high value, send AT+BTI and if ERROR 27 is returned, then retry with a smaller value. This effective max value remains unchanged for that particular firmware build.
S519	500	100..3000	When S507>0, and in a connection, DSR can be used to change from data to command state by deasserting the DSR line for less than the time specified in this register. This value is rounded down to the nearest 100 ms.
S520	TBC	1200..115200	Change to a standard baud rate. The effect is immediate and the OK is sent at the new baud rate. Only one of the following baud rates are accepted: 1200, 2400, 4800, 9600, 19200, 28800, 38400, 57600, 115200. If S register 525=1, then the maximum baud rate is limited to 115200. See S Register 526 for further information.

Reg. #	Default	Range	Comment
S521	TBC	1200..921600	Change baud rate to non-standard value. Laird modules support any baud rate. The only limitation is the integer arithmetic involved, which may adjust the applied rate slightly. If the internally computed baud rate is more than 2% offset from the desired input value, then an ERROR is returned and the old baud rate prevails. To inspect the actual baud rate, do ATS521? S521 should only be used for non-standard baud rates. For standard baud rates use S520. The effect is immediate and the OK is sent at the new baud rate. If S Register 525=1, then the max baud rate is limited to 115200 In the event that a non-standard baud rate is requested, it is entirely possible that the host is not capable of generating such a baud rate. In this case the Laird Technologies device cannot be communicated with. If this happens, there is a procedure to recover from this situation which is described in section titled "Factory Default Mode" The default is 9600 for the Laird module and 115200 for other Laird devices. See S Register 526for further information.
S522	1	1	1 = CTS/RTS hardware handshaking enabled For the Go blue Activator variant of the module this register is read only. See S Register 526 for further information.
S523	1	1..2	Number of Stop bits For the Go blue Activator variant of the module this register is read only. See S Register 526 for further information.
S524	0	0..2	Parity. 0=None, 1=Odd, 2=Even For the Go blue Activator variant of the module this register is read only. See S Register 526 for further information.
S525	0	0..1	Apply multiplier of 8 to baud rate internally. This is set to 0 (disabled) by default for the Laird Technologies Module/RS-232 Adaptor/Universal RS-232 Adaptor, and set to 1 (enabled) by default for the Laird Technologies PC Card. It is required in the PC Card because the UART chip on the PC Card is driven by a 14.7456MHZ crystal instead of 1.8432MHz. This means that when a host asks for a baud rate, in reality it gets a baud rate which is 8 times faster. If S Register 521 > 115200 then this register cannot be set to 1. For the Go blue Activator variant of the module this register is read only. See S Register 526 for further information.

Reg. #	Default	Range	Comment
S526	3	1..3	This register specifies a two bit mask used to qualify how S Registers 520 to 525 are actioned. When bit 0 is 1, the new comms parameter affects the UART immediately. When bit 1 is 1, the new comms parameter is stored in non-volatile memory. For example, to change comms parameters but have them come into effect only after subsequent power cycles, set this register to 2. Likewise, for an immediate effect that does not persist over a power cycle, set the value to 1. This must be set before the baud rate change.
S530	1000	100..15000	Reconnect delay when configured as master in pure-cable-replacement mode. This value is rounded down to the nearest 100 ms. See S Register 505 and 543.
S531	0	0..5	Specifies the mode on connection establishment. 0 = Normal. Data is exchanged between UART and RF 1 = LOCAL_COMMAND. UART input is parsed by the AT interpreter and RF data is discarded 2 = REMOTE_COMMAND. RF input is parsed by the AT interpreter and UART data is discarded. If S Reg 536 is not 1 then this register cannot be set to 2 and an ERROR is returned 3=LOCAL_COMMAND. UART input is parsed by the AT interpreter and incoming RF data is sent to the host using the RX<string> asynchronous response. 4=LOCAL_COMMAND and on the RF side, the GPIO is automatically sent when there is a change in input. See Section 9.5 for more details. 5=DEAMON mode
S532	0	0..7	If non zero, then on every connection, a SCO channel (audio) is initiated. Bit 0 for HV1, Bit1 for HV2, and Bit2 for HV3. When the connection is lost, the SCO channel also disappears.
S533	1	0..2	If set to 1, then GPIO5 follows RI state; if set to 2, it follows the state of DSR and if 0 it is not driven and GPIO5 is available as a user I/O. This register may not be effective immediately after changing the value. It must be saved to non-volatile memory using AT&W and will operate as expected after an ATZ or a power cycle.
S534	1	0..2	When set to 0, GPIO4 is available as user I/O If set to 1 then right LED follows DCD state. If set to 2 then the LED behaves as per setting 1; but in addition, when not in a connection, if the device is connectable or discoverable, then the LED blinks. This register may not be effective immediately after changing the value. It must be saved to non-volatile store using AT&W and will operate as expected after an ATZ or a power cycle.
S535	20	0..41	Link Supervision Timeout. If units go out of range, then a NO CARRIER message is sent to the host after the time specified here

Reg. #	Default	Range	Comment
S536	0	0..1	When set to 1, a remote device can capture the AT parser of this unit by it sending this module an escape "!!!" sequence. The inter character timing is set via S Register 12. If S Register 507 is >/= 2, then reading this register always returns 0 and writing 1 results in ERROR 33.
S537	X	X..X	This register is no longer available – See 551,552, and 553 instead. It only exists in firmware version 1.1.12 to 1.1.47 The functionality it controlled is now defined by registers 551,552, and 553
S538	0	0..1	If 1, then when a successful pairing occurs, it is automatically saved in the trusted device database, if the database has room to store it.
S539	0	0..1	When set to 1, in idle mode (S512=1), UART Rx characters are discarded if DSR is deasserted.
S540	0	0 48..127	Sets the MTU in L2CAP configuration negotiations. The value of 0 is a special value which means that the current value should remain.
S541	TBC	TBC	This sets the power level in dBm when inquiring or paging. Reading this register returns the value stored in non-volatile memory.
S542	TBC	TBC	As per S541, however reading this register returns the current power level as set in the base band. The read can be different from S541because the actual power is set using a lookup table and the base band rounds down to the nearest value in the table.
S543	0	0..1	If this is set to 1, then incoming pairing attempts are accepted (if a pin code has been pre-entered using AT+BTK) while in the wait phase of auto connect cycle initiated by the AT+BTR command. In addition to accepting pairing attempts, if the pairing is successful, then the new device is automatically set as the peer address for automatic connections (as if an explicit AT+BTR command was entered). See S Register 505 and 530.
S544	1	0..1	Configure the UART for either low latency or maximum throughput. A setting of 1 gives maximum throughput.

Reg. #	Default	Range	Comment
S551	0x3211	0xFFFF	This register specifies in each 4 bit nibble, how the outgoing modem status bits to the remote peer gets its value. Bluetooth allows for RTR, RTC, DV, and IC bits to be exchanged over an RFCOMM connection. Nibble 0..3 specifies the source for RTC 4..7 specifies the source for RTR 8..11 specifies the source for DV (i.e. DCD) 12..15 specifies the source for IC (i.e. RI) Each nibble can take the following value: ▪ 0 – Always set to 0 ▪ 1 – Always set to 1 ▪ 2 – If DCD (pin 8 on module connector) is output then always 1 If DCD is input then 1 if DCD is asserted otherwise 0 ▪ 3 – If RI (pin 6) is output then always 0 If RI is input then 1 if RI is asserted otherwise 0 If DSR (pin 10) is asserted then 1 otherwise 0 In the event that a nibble specifies DSR as the source of its state, be aware that if S Register 507 is anything other than 0, a de-assertion of DSR causes the Bluetooth connection to be dropped. If bits 0..3 and 4..7 are set to 0, then some Bluetooth devices will use that as a signal to stop sending any data back. For example, Nokia 6310 stops responding. If this register is changed while in command and connected mode, then on going back online using the ATO command, a fresh signal is sent to the peer to update the bits.
S552	0x0122	0x0FFF	This register specifies in each 4 bit nibble, how the DTR, DCD, RI output pins are controlled when in a Bluetooth connection Nibble 0..3 specifies the source for DTR 4..7 specifies the source for DCD 8..11 specifies the source for RI Each nibble can take the following value: ▪ 0 – Do NOT touch the I/O ▪ 1 – Always deassert ▪ 2 – Always assert ▪ 3 – If RTC bit in CONTROL_IND is 1 then assert otherwise deassert ▪ 4 – If RTR bit in CONTROL_IND is 1 then assert otherwise deassert ▪ 5 – If DV bit in CONTROL_IND is 1 then assert otherwise deassert ▪ 6 – If IC bit in CONTROL_IND is 1 then assert otherwise deassert If this register is changed while in command and connected mode, then on going back online using the ATO command, the modem output lines are refreshed.

Reg. #	Default	Range	Comment
S553	0x0201	0x0FFF	This register specifies in each 4 bit nibble, how the DTR,DCD,RI output pins are controlled when NOT in a Bluetooth connection Nibble 0..3 specifies the source for DTR 4..7 specifies the source for DCD 8..11 specifies the source for RI In addition it also refers to S Register 552 to see if the relevant pin is an input or not to be touched. If the nibble in 552 is 0, then the relevant pin is an input. Each nibble can take the following value: ▪ 0 – Always deassert ▪ 1 – Always assert ▪ 2 – Assert if RING is being sent to the host The default for the Universal RS-232 Adaptor is $0200.
S554	0	0..900	If S Register 512 >/=2 and </=7 then this register specifies a time in seconds for which the device stays in the S512 mode after power up or reset. On timeout, it aborts the discoverable and/or connectable and falls back into S512=1 mode, when it is deaf and dumb. **Note:** If AT+BTR has been used to specify a peer device, then on reverting to mode 1, it attempts to make a connection to that peer device. A power cycle, reset via BREAK or ATZ is required to see the effects of change.
S555	1	1..7	If S Register 554 is nonzero, then after the post reset window expires, the mode reverts to the mode specified in this register. This allows, for example, the device to be discoverable and connectable on power up (mode 4 or 7) and on window timer expiry to revert to connectable only (mode 3 or 6). A power cycle, reset via BREAK or ATZ is required to see effects of a change. In some firmware builds, S Registers 565 to 569 (inclusive) are visible, which allows the start-up mode to depend on the state of RI line (Setting S Reg 565 forces the RI pin to be configured as an input). For this feature to be active, S Reg 565 should be set to 1. In that case, on start-up, if RI is asserted, then the start-up mode is defined by S Reg 568 and if deasserted then S Reg 569.
S556	0	0..3	Allows GPIO or ADC values to be read via the minor class field in an inquiry response. When this value is non-zero, bits2 to 7 contain information as follow: ▪ 1 – ADC1 ▪ 2 – ADC2 ▪ 3 – GPIO1 to GPIO6 Set to 0 to disable this feature. This allows i/o information to be conveyed without a connection.

Reg. #	Default	Range	Comment
S557	32	4..900	Specified in seconds, the update interval for the feature enabled via S Reg 556
S558	0	0..1	When 1, the following responses; "RING", "NO CARRIER", and "CONNECT" are replaced by "BTIN", "BTDOWN", and "BTUP" respectively. This eliminates ambiguity when the module has a Bluetooth connection to an AT modem which also gives these responses.
S559	0	0..3	This specifies a mask. When Bit 0 is 1, the response word "ERROR" is replaced by "BTERR" and "OK" is replaced by "ok". When Bit 1 is 1, then error responses do not include the error number; instead the error number can be retrieved using ATI12.
S560	15	15..120	Disconnect timeout in seconds. This timer specifies how long to wait for confirmation (from the peer device and/or the underlying stack) that the connection has been successfully torn down. There can be instances where a confirmation does not arrive; in this case this timer is used to 'close off' the procedure and put the state machine back into a proper mode for new operations. Time is specified with 15 seconds intervals.
S561	0	0..1000	Sniff Attempt Time in units of milliseconds. 0 means disable. See section "Power Consumption and Reset" in the user guide for more details.
S562	0	0..1000	Sniff timeout Time in units of milliseconds. 0 means disable. See section "Power Consumption and Reset" in the user guide for more details.
S563	0	0..1000	Sniff Minimum Interval in units of milliseconds. 0 means disable. See section "Power Consumption and Reset" in the user guide for more details.
S564	0	0..1000	Sniff Maximum Interval in units of milliseconds. See section "Power Consumption and Reset" in the user guide for more details.
S565	0	1	If set to 1, RI (Ring Indicate) line is configured as an input and forces the start-up mode (S Reg 512)and post-timeout on Start-up mode (S Reg 555) to be dependent on the state of RI. The RI conditional modes are defined by S Regs 566 to 569 inclusive.
S566	1	7	If S565=1 and RI is asserted then this is the mode in which the device starts up.
S567	1	7	If S565=1 and RI is deasserted then this is the mode in which the device starts.
S568	1	7	If S565=1 and RI is asserted then this is the mode the device assumes after the post-start-up timeout defined in S Reg 554 instead of the mode defined in S Reg 555.
S569	1	7	If S565=1 and RI is deasserted then this is the mode the device assumes after the post-start-up timeout defined in S Reg 554 instead of the mode defined in S Reg 555.

Reg. #	Default	Range	Comment
S580	0	0..1	Remote volume control feature for Headset profile when ATS102 enables headset profile.
S581	0	0..63	Lowest 6 bits of the supported features field for Handsfree profile when ATS102 enables handsfree profile. See also S Reg 594 which allows the HandsFree profile version number to be selected.
S582	0	0..1	FTP Related: 0 = BodyLen in PUT obex packet = 0 1 = BodyLen in PUT obex packet = 1
S583	0xB	0 .. 0x1F	This specifies the initial state of the following modem control lines sent to the peer Bit 0 – RTC (DTR/DSR) Bit 1 – RTR (RTS/CTS) Bit 2 – IC (Ring Indicate RI) Bit 3 – DV (DCD) Bit 4 – FC (Reserved)
S584	0	0..1	Enable/Disable eSCO When changing the unit returns ERROR 14, it implies the device is either in a connection or waiting for a connection and the new value cannot be accepted. For the former, drop the connection, issue the command AT+BTX, and then set the new value and issue (for the latter) the command AT+BTX prior to setting the register.
S585	0	0..9	GPIO pin set to 0 to disable the feature.
S586	1000	100..5000	Pulse period in milliseconds (rounded down to nearest multiple of 50).
S587	0	0..100	Duty cycle in percentage (rounded to the nearest multiple of four).
S588	0	0..1	After a disconnection, there is a cold reset.
S589	8	0..F	Codec output gain.
S590	1	0..3	Codec input gain.
S591	0	0..1FF	Default GPIO output states when not in a connection. This is used when virtual digital I/O cable replacement mode is in operation.
S592	0	0..1	Set this to 1 to reduce the trusted device database to one record when autosaving of pairing is enabled via S Reg 538.
S593	0	0..1	Automatically append last six digits of local Bluetooth address to the friendly name which was set via AT+BTN or AT+BTF.
S594	0	0..1	Set handsfree profile version in sdp record. Set to 0 for 1.1 and to 1 for 1.5.
S595	1	0..1	Set handsfree gateway profile version in sdp record. Set to 0 for 1.1 and to 1 for 1.5.
S596	0	1..1FF	Audio Gateway features to be advertised in SDP record. See handsfree profile specification for exact bit mapping.

Reg. #	Default	Range	Comment
S597	0	0..2	Audio Gateway mode: ▪ 0 – SDP record advert only ▪ 1 – Hosted operation ▪ 3 – Hostless operation See Audio Gateway specific documentation for more details.
S598	0	0..1	In hostless audio gateway serviced mode, if this is 1, then incoming voice calls are reflected to bonded headset.
S599	0	0..2	SCO control for hostless gateway operation. ▪ 0 – Normal ▪ 1 – As early as possible ▪ 2 – Leave SCO to be controlled by headset
S600	?	0..65535	Number of times this module has gone through a reset cycle. This feature is enabled by S Reg 601. Writing any value to this register initialises it to a certain value.
S601	0	0..1	If this is 1, then on reset S Reg 600 value is incremented.
S610	0	0..7FFF	Set direction of digital I/O lines. This is a mask made up of 5 bits. Setting a bit to 1 makes that I/O line an output. GPIO1 is bit 0, GPIO2 is bit 1, up to bit 8 for GPIO9.
S611	0	1	Set to 1 to invert the logic of GPIO outputs. For example, ATS621=1 sets the output pin to low and vice versa.
S620	n/a	0..31	Read/Write to all eight digital lines in one atomic step. The value is returned as a four digit hexadecimal value with trailing 0s.
S621	n/a	0..1	Read/Write to GPIO1.
S622	n/a	0..1	Read/Write to GPIO2.
S623	n/a	0..1	Read/Write to GPIO3.
S624	n/a	0..1	Read/Write to GPIO4.
S625	n/a	0..1	Read/Write to GPIO5.
S626	n/a	0..1	Read/Write to GPIO6.
S627	n/a	0..1	Read/Write to GPIO7.
S628	n/a	0..1	Read/Write to GPIO8.
S629	n/a	0..1	Read/Write to GPIO9.
S631	n/a	0..65535	When GPIO1 is configured as an input, low to high transitions are counted. There is no software debouncing. External RC circuit may be required. The counter wraps to 0 when it overflows beyond 65535.
S632	n/a	0..65535	When GPIO2 is configured as an input, low to high transitions are counted. There is no software debouncing. External RC circuit may be required. The counter wraps to 0 when it overflows beyond 65535.
S641	n/a	0..65535	As per 631, but the action of reading the value resets the count to 0.
S642	n/a	0..65535	As per 632, but the action of reading the value resets the count to 0.
S701	n/a	0..65535	Read to Analogue Line 0, when reading value is returned in decimal.

Reg. #	Default	Range	Comment
S702	n/a	0..65535	Read to Analogue Line 1, when reading value is returned in decimal.
S711	n/a	0000..FFFF	Read to Analogue Line 0, when reading value is returned in hexadecimal.
S712	n/a	0000..FFFF	Read to Analogue Line 1, when reading value is returned in hexadecimal.
S721	0	0	Set direction of Analogue Line 0.
S722	0	0	Set direction of Analogue Line 1.
S1001 to S1010		0.. 2^32	Ten General Purpose 32 bit Registers for use by host. These are stored in non-volatile memory.

6.3.13 ATSn?{Read S Register Value}

This returns the current value of register n.

For recognised values of n:

Response: <cr,lf>**As Appropriate**<cr,lf>**OK**<cr,lf>

For unrecognised values of n:

Response: <cr,lf>**ERROR nn**<cr,lf>

6.3.14 ATSn=?{Read S Register – Valid Range}

This returns the valid range of values for register n.

For recognised values of n:

Response: <cr,lf>**Sn:(nnnn..mmmm)**<cr,lf>**OK**<cr,lf>

For unrecognised values of n:

Response: <cr,lf>**ERROR**nn<cr,lf>

6.3.15 ATX<string>{Send Data in Local Command and Connected Mode}

This command is used to send data to the remote device when in local command and connected mode.

The parameter <string> is any string not more than 24 characters long. If a non-visual character is to be sent, then insert the escape sequence \hh where hh are two hexadecimal digits. The 3 character sequence \hh is converted into a single byte before transmission to the peer.

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

6.3.16 ATY<string>{Send Data in Local Command and Connected Mode}

This command is similar to ATX in syntax and functionality, except that the string is only copied to the output RF buffer. Only when an empty string is presented are all pending data in the output RF buffer flushed out.

The parameter <string> is any string not more than 24 characters long. If a non-visual character is to be sent then insert the escape sequence \hh where hh are two hexadecimal digits. The three character sequence \hh is converted into a single byte before transmission to the peer.

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

6.3.17 ATZ<n>{Hardware Reset and emerge into mode 'n'}

Forces the device through a hardware reset which means it eventually comes alive in the local command and unconnected mode. This allows changes to the PS store to take effect. Prior to version 2.7.0, allow for approximately two seconds for the device to once again start responding to AT commands. The best way to determine if the device is alive is to keep sending it AT<cr> until it responds with an OK response. After version 2.7.0, it is safe to communicate after receiving an OK.

The optional parameter <n> is only available for firmware 2.7.0 and newer and is a value in the range 0 to 7 (up to version 7.18.0). After version 9.18.6, valid values are 0 to 4 (inclusive).

ATZ and ATZ0 signify reset and emerge into the current mode (see command ATI14 TBC). ATZ1 to ATZ4 instructs the module to reset and then emerge into the appropriate boot mode.

Note: S Reg 103 specifies the boot mode from cold.

For firmware prior to v2.7.0:

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

Note: OK is returned before the RESET.

For firmware v2.7.0 and newer:

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

Note: OK is returned after the RESET.

6.3.18 AT&Fn{Set S Register Defaults}

This command only works when the device is in local command and unconnected mode. Depending on the value of 'n', it installs S Register values appropriate for various power modes, ranging from minimum power consumption to maximum.

See Table 6-3 for the legal values of 'n'. All other values of n generate a syntax error response. If 'n' is not specified, then a default value of 0 is assumed where the baud rate is NOT changed.

Table 6-3: Legal values of 'n"

&F0 (Default)	Medium power consumption, UART baud rate unchanged, Left LED off, Right LED = DCD
&F1	Minimum power consumption, UART baud rate set to 9600, Left and Right LED off
&F2	Minimum power consumption, UART baud rate set to 38400, Left and Right LED off
&F3	Minimum power consumption, UART baud rate set to 115200, Left and Right LED off
&F4	Medium power consumption, UART baud rate set to 115200, Left LED off, Right LED = DCD
&F5	Maximum power consumption, UART baud rate set to 115200, Left LED=DSR, Right LED = DCD
&F6	Maximum power consumption, UART baud rate set to 115200, Left LED=DSR, Right LED = DCD Explicitly set higher baud rates using ATS521=n

Refer to the "Power Consumption" chapter in the relevant Laird device user guide for more detailed information of power usage.

The new values are NOT updated in non-volatile memory until the AT&W command is sent to the Laird device.

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

Or

Response: <cr,lf>**ERROR nn**<cr,lf>

6.3.19 AT&F{Clear Non-volatile Memory}*

The AT&F* variant of the command installs values in S registers as per command AT&F4 and then all other user parameters in non-volatile memory are erased. This means that the trusted device database is cleared, as well as parameters related to the following commands: AT+BTR, AT+BTN, AT+BTS.

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

Or

Response: <cr,lf>**ERROR nn**<cr,lf>

6.3.20 AT&F+{Clear Non-volatile Memory}

This command erases all user parameters in non-volatile memory except S Registers 520 to 525. This means that the trusted device database is cleared, and so are parameters related to the following commands:- AT+BTR, AT+BTN, AT+BTS.

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

Or

Response: <cr,lf>**ERROR nn**<cr,lf>

6.3.21 AT&W{Write S Registers to Non-volatile Memory}

Writes current S Register values to non-volatile memory so that they are retained over a power cycle.

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

Or

Response: <cr,lf>**ERROR nn**<cr,lf>

6.3.22 AT+BTAn{Control Audio Channel}

Once a Bluetooth connection is active, *and assuming the peer device is a Laird device,* this command is used to start/stop a SCO channel which connects the PCM interfaces of the two peer devices. If a codec is attached to the PCM pins, then 2-way audio can be established.

+BTA0 Switch off the channel.
+BTA1 Switch on the channel.

On receipt of the command, the following response immediately follows.

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

The lower layers then go through the process of setting up the SCO channel. Once a SCO link is established, the following response is asynchronously sent to the host.

Response: <cr,lf>**AUDIO ON**<cr,lf>

Or if the SCO failed to be established.

Response: <cr,lf>**AUDIO FAIL**<cr,lf>

On the peer device, the host will asynchronously get ….

Response: <cr,lf>**AUDIO ON**<cr,lf>

6.3.23 AT+BTC<devclass>{Set Device Class Code}

This command is used to set the device class code which is sent in subsequent inquiry responses. It can be read back using the AT+BTC? command as described below.

<devclass> is a six digit hexadecimal number derived as per section "1.2 The Class of Device/Service Field" of the Bluetooth specification "Bluetooth Assigned Numbers".

The 24 bits are made of the following four fields (bit 0 corresponds to the least significant bit):

Bits 0-1:	Format Type. This field currently only has a value of 00 (i.e. format type 1).
Bits 2-7:	These 6 bits define the Minor Device Class and the value is interpreted differently based on the Major Device class stored in the next 5 bits.
Bits 8-12:	These 5 bits define the Major Device Class as per Table 1.3 in "Bluetooth Assigned Numbers".
Bits 13-23:	This is an 11 bit field used as a mask to define the Major Service Class, as per Table 1.2 in "Bluetooth Assigned Number".

Laird devices do not map to any predefined Major Service Class or Major Device Class. The default devclass as shipped is 001F00 which means no Major Service Class and "Unclassified" Major Device class.

Table 6-4 shows examples of device class codes.

Table 6-4: Device class codes

Code (Hex)	Name	Major Service	Major Device	Minor Device
001F00	Unclassified	None	Unclassified	n/a
200404	Headset	Audio	Audio	Headset

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

Or for an invalid <devclass> value (usually a value which is not six hexadecimal characters long).

Response: <cr,lf>**ERROR 08**<cr,lf>

6.3.24 AT+BTC?{Read Device Class Code}

This command is used to read the current device class code.

Response: <cr,lf>**123456**<cr,lf>**OK**<cr,lf>

6.3.25 AT+BTD<bd_addr>{Remove Trusted Device}

This command is used to remove the specified device from the list of trusted devices in the non-volatile database. If the device is not in the database, the response is still **OK**.

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

6.3.26 AT+BTD{Remove All Trusted Devices}*

WARNING: This command is used to remove all devices from the list of trusted devices in the non-volatile database. The software does not ask for confirmation.

WARNING: If you make an authenticated connection, the link key gets cached in the underlying stack. If you subsequently delete the key using AT+BTD* and immediately request an authenticated connection to the same device, then the connection will be established. To ensure this does not happen, either send ATZ after the AT+BTD* OR send AT+BTD<bd_addr> for each item in the trusted device database.

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

6.3.27 AT+BTF=<string>{Set Friendly Name}

This sets the friendly name of this device as seen by other devices.

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

6.3.28 AT+BTF<bd_addr>{Get Remote Friendly Name}

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

Response: <cr,lf>**<bd_addr>,"Friendly Name"**
<cr,lf>**OK**<cr,lf>

6.3.29 AT+BTG<bd_addr>{Enable Cautious Page Scanning ONLY}

Enable page scanning and wait for a connection from device with Bluetooth address <bd_addr>. If the specified address is 000000000000 then incoming connections are accepted from any device (like AT+BTP without an address). Inquiry Scans are disabled.

This command also has variants which allow authentication and encryption to be explicitly specified. For example:

AT+BTGU123456789012

AT+BTGY123456789012

AT+BTGUY123456789012

AT+BTGYU123456789012

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

6.3.30 AT+BTG{Enable Promiscuous Page Scanning ONLY}

Enable page scanning only and wait for a connection from any device. Inquiry scans are disabled. Authentication and encryption is as per S registers 502 and 503.

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

6.3.31 AT+BTGU{Enable Promiscuous Page Scanning ONLY}

Enable page scanning only and wait for a connection from any device. Inquiry scans are disabled. Authentication is enabled and encryption is disabled.

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

6.3.32 AT+BTGY{Enable Promiscuous Page Scanning ONLY}

Enable page scanning only and wait for a connection from any device. Inquiry scans disabled. Authentication is disabled and encryption is enabled.

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

6.3.33 AT+BTGUY{Enable Promiscuous Page Scanning ONLY}

Enable page scanning only and wait for a connection from any device. Inquiry scans are disabled. Authentication and encryption are both enabled. The order of U and Y is not significant.

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

6.3.34 AT+BTI<devclass>{Inquire}

This makes the device perform an inquiry for device class code for **delay** milliseconds and **max** number of unique responses, where **delay** is specified by S register 517 and **max** is specified by S register 518.

The <devclass> is an optional parameter where the value specifies either a six digit device class code or a two digit major device class. If it is not specified, the value is taken from S register 516.

When <devclass> is six hexadecimal characters long, it specifies an AND mask which is used to filter inquiry responses. When <devclass> is two hexadecimal characters long, it forces the inquiry to filter responses to devices that match their major device class code to this value (can only be in the range 00 to 1F).

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

<cr,lf>**12345678914**

<cr,lf>**OK**<cr,lf>

If the module is waiting for an incoming connection, (entered via AT+BTP, AT+BTG, AT+BTQ), then it responds with ERROR 14. To perform the inquiry, send AT+BTX to put the module back into idle mode.

Response: <cr,lf>ERROR 14<cr,lf>

6.3.35 ERROR RESPONSE

For a single inquiry request with the Bluetooth inquiry process, a device could respond many times. To ensure that an address is sent to the host only once for a particular AT+BTI, an array of addresses is created at the start of each AT+BTI and is filled as responses come in. This array of addresses is stored in dynamic memory and, if the memory allocation fails, the inquiry procedure is aborted. If that occurs, an error response is sent to the host.

To clarify, a single AT+BTI never returns the same Bluetooth address more than once, but as long as the responding device is active, all AT+BTI commands always return it.

Response: <cr,lf>**ERROR 27**<cr,lf>

6.3.36 AT+BTIV<devclass>{Inquire}

As per AT+BTI but the response includes the device class code for all inquiry responses. Refer to the 'ERROR RESPONSE' note in the description for AT+BTI<devclass>.

Response: <cr,lf>**12346789012,123456**

<cr,lf>**12345678914,123456**

<cr,lf>**OK**<cr,lf>

6.3.37 AT+BTIN<devclass>{Inquire}

As per AT+BTI but the response includes the device class code and friendly name for all inquiry responses. Please refer to the 'ERROR ESPONSE' note in the description for AT+BTI<devclass>. The friendly name strings are in UTF-8 format as per the Bluetooth specification.

Response: <cr,lf>**12346789012,123456,"TDK SYSTEMS AT DONGLE 1"**

<cr,lf>**12345678914,123456, "TDK SYSTEMS RS232"**

<cr,lf>**OK**<cr,lf>

Note: Many releases of firmware return the product name as LAIRD TECHNOLOGIES, e.g.

Response: <cr,lf>**12346789012,123456,"TDK SYSTEMS AT DONGLE 1"**

<cr,lf>**12345678914,123456, "TDK SYSTEMS RS232"**

<cr,lf>**OK**<cr,lf>

Note: We strongly recommend that any software implementation that uses this command should check for any of Laird, EZURIO, and TDK SYSTEMS to ensure backward and forward compatibility.

6.3.38 AT+BTK=<string>{Set Passkey}

This command is used to provide a passkey when **PIN? 12345678** indications are received asynchronously. If a pairing is not in progress then the pin is written to non-volatile memory for future use. Specifying an empty string deletes the key from the non-volatile memory.

The string length must be in the range 0 to 8, otherwise an error is returned.

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

6.3.39 AT+BTM<bd_addr>{Set Incoming Peer Address}

This command is used to store a peer address for incoming connections in non-volatile memory. A value of 000000000000 has the special meaning of invalid peer address.

When S register 512 = 3, 4, 6, or 7 it waits for an incoming connection from the peer address specified. If the peer address is not 000000000000, then it waits for a connection from the specified master, otherwise it connects to anyone.

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

6.3.40 AT+BTM{Delete Incoming Peer Address}

This command is used to delete the peer address previously stored using AT+BTR<bd_addr>.

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

6.3.41 AT+BTM?{Read Incoming Peer Address}

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

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

<cr,lf>**OK**<cr,lf>

If the location is empty the response is as follows.

Response: <cr,lf>**00000000000**

<cr,lf>**OK**<cr,lf>

6.3.42 AT+BTN=<string>{Set Friendly Name in Non-volatile Memory}

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

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

6.3.43 AT+BTN?{Read Friendly Name from Non-volatile Memory}

Read the default friendly name from non-volatile memory.

Response: <cr,lf>**"My FriendlyName"**<cr,lf>

<cr,lf>**OK**<cr,lf>

6.3.44 AT+BTO<devclass>{Open and make Unit Detectable}

After power up and ATZ, this command is sent to ensure that the RFCOMM is initialised and opened and the service name as specified in AT+BTN is exposed via the SDP registry.

The <devclass> value specifies an optional fixed length hexadecimal device class code. If it is not specified, then the device class code is taken from S Register 515.

For this command to be effective, S Register 512 must be set to zero.

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

6.3.45 AT+BTP<bd_addr>{Enable Cautious Page/Inquiry Scanning}

Enable page scanning and wait for a connection from device with Bluetooth address <bd_addr>. If the specified address is 000000000000 then incoming connections are accepted from any device, is as per AT+BTP without an address. Inquiry scanning is also enabled.

This command also has variants which allow authentication and encryption to be explicitly specified. For example:

- AT+BTPU123456789012
- AT+BTPY123456789012
- AT+BTPUY123456789012
- AT+BTPYU123456789012

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

6.3.46 AT+BTP{Enable Promiscuous Page/Inquiry Scanning}

Enable page scanning and wait for a connection from any device. Inquiry scanning is also enabled. Authentication and encryption is as per S registers 502 and 503.

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

6.3.47 AT+BTPU{Enable Promiscuous Page/Inquiry Scanning}

Enable page scanning and wait for a connection from any device. Inquiry scanning is also enabled. Authentication is enabled and encryption is disabled.

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

6.3.48 AT+BTPY{Enable Promiscuous Page/Inquiry Scanning}

Enable page scanning and wait for a connection from any device. Inquiry scanning is also enabled. Authentication is disabled and encryption is enabled.

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

6.3.49 AT+BTPUY{Enable Promiscuous Page/Inquiry Scanning}

Enable page scanning and wait for a connection from any device. Inquiry scanning is also enabled. Authentication and encryption are both enabled. The order of U and Y is not significant.

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

6.3.50 AT+BTQ{Enable Inquiry Scans ONLY}

When inquiry scan is enabled, it implies that this device responds to inquiries from other devices. Use AT+BTX to disable inquiries.

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

6.3.51 AT+BTR<bd_addr>{Set Outgoing Peer Address}

This command is used to store 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 periodically (time specified via S register 505) attempts 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 0 the buffer across. This means that if the peer device is not in the vicinity 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.

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

6.3.52 AT+BTR{Delete Outgoing Peer Address}

This command is used to delete the peer address previously stored using AT+BTR<bd_addr>.

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

6.3.53 AT+BTR?{Read Outgoing Peer Address}

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

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

<cr,lf>**OK**<cr,lf>

If the location is empty the response is as follows.

Response: <cr,lf>**00000000000**

<cr,lf>**OK**<cr,lf>

6.3.54 AT+BTS=<string>{Set Service Name}

This writes the name to non-volatile memory. It is used after ATZ, power cycle, or AT+BTO if it has not yet been issued. Use **AT+BTS?** to read it back from non-volatile memory. An empty string ("") deletes the string from non-volatile memory which forces the default service to be used.

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

If the service name cannot be set for any reason then an error response **ERROR 11** is returned.

6.3.55 AT+BTS?{Read Service Name from Non-volatile Memory}

Reads the default service name from non-volatile memory.

Response: <cr,lf>**"My ServiceName"**<cr,lf>

<cr,lf>**OK**<cr,lf>

6.3.56 AT+BTT{Add Trusted Device}

This command is used to store the cached link key in the non-volatile database. If the database is full it responds with an ERROR. If the device is already in the database, then the key is replaced.

If the link key cache is empty (a pairing has not been performed since the device was powered) then the response is an ERROR.

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

Or

Response: <cr,lf>**ERROR**<cr,lf>

6.3.57 AT+BTT?{List Trusted Device}

This command is used to list the contents of the trusted device database. The link key is not displayed so the response is as shown below. If the list is empty then just the OK response is sent otherwise an OK is used to terminate the list. Use the command ATI6 to read the maximum size of the trusted device database.

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

<cr,lf>**12345678913**

<cr,lf>**12345678914**

<cr,lf>**OK**<cr,lf>

6.3.58 AT+BTV<U><Y><bd_addr>,<uuid>{SDP Query for Service }

This command is used to interrogate the SDP database of the peer device <bd_addr> for the service <uuid>. It results in an ACL connection and then a SDP transaction.

If the <uuid> service is present then

Response: <cr,lf>**0**

<cr,lf>**OK**<cr,lf>

If the <uuid> service is not present then

Response: <cr,lf>**1**

<cr,lf>**OK**<cr,lf>

If the device <bd_addr> cannot be reached, or is in non-connectable mode then

Response: <cr,lf>**2**

<cr,lf>**OK**<cr,lf>

If the SDP database is corrupt or invalid then

Response: <cr,lf>**3**

<cr,lf>**OK**<cr,lf>

If the device is not in idle mode then

Response: <cr,lf>**4**

<cr,lf>**OK**<cr,lf>

and in this case, the command AT+BTX may put the device into the correct idle mode.

6.3.59 AT+BTW<bd_addr>{Initiate Pairing}

This initiates pairing with a device whose Bluetooth address is <bd_addr>. An OK response is sent and when the PIN is required, asynchronous indications are sent to the host in the form **PIN? <bd_addr>** where the address confirms the device with which the pairing is to be performed. To supply a PIN, use the AT+BTK command.

For a successful pairing, the link key is stored in a volatile cache which is overwritten each time a new pairing is initiated using this command. The link key can be stored in a non-volatile database within the device. The list of trusted devices is managed using commands AT+BTT?, AT+BTT, and AT+BTD. The AT+BTT? command produces a list of trusted Bluetooth addresses (link key is *never* displayed) and AT+BTT is used to store the cached link key. The command AT+BTD123456789012 is used to remove the specified device from the database.

The OK response is sent immediately upon receipt of the AT+BTW command. On pairing completion, an unsolicited message is sent to the host which is in the form PAIR n <bd_addr>. See section 3.7 TBC for more details.

If AT+BTI, AT+BTP, AT+BTG, AT+BTQ, or ATD is issued between the AT+BTW command and the subsequence PAIR asynchronous response, then an ERROR response is sent to those commands as the device is not in a mode from where such commands can be actioned.

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

6.3.60 AT+BTW?{List Cached Trusted Device}

This command is used to list the cached trusted device.

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

<cr,lf>**OK**<cr,lf>

If the cache is empty the response is as follows.

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

6.3.61 AT+BTX{Disable Page/Inquiry Scanning}

Disable page/inquiry scanning. This means it is accept incoming connections or inquiry requests. In fact, this negates the effect of AT+BTQ, AT+BTG and AT+BTP commands.

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

6.3.62 AT+AG<command><parm>{Audio gateway Control}

See audio gateway specific specification for more details.

6.4 Unsolicited Responses

The 'AT' Protocol is a command/response type of protocol. This means that the Laird device will normally only respond to AT commands.

Under special circumstances, unsolicited responses are sent to the host. They are described in the following subsections.

6.4.1 RING

This string is sent to the host when a remote device is initiating 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. This response is sent to the host every two seconds until the host either accepts the connection using the ATA command or rejects it using the ATH command.

6.4.2 PIN?

This response is sent to the host during a pairing negotiation.

The fully qualified string is PIN? 012345678901 where 012345678901 is the Bluetooth address of the peer device. In response, the host must supply a pin code which is entered using the AT+BTK command.

If the peer address does not supply the address in the message exchange, then the address is specified as 000000000000 – and the paring will proceed as normal.

6.4.3 AUDIO ON

This response is sent to the host when a SCO channel has been established.

6.4.4 AUDIO OFF

This response is sent to the host when an existing SCO channel has been closed.

6.4.5 AUDIO FAIL

This response is sent to the host when a SCO channel setup fails.

6.4.6 ERROR 27

This response is sent to the host on power up if the firmware is unlicensed.

6.4.7 PAIR n <bd_addr>

This response is sent to the host on termination of a pairing process. If pairing was successful then 'n' = 0, if a timeout occurred 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.

6.4.8 PAIR 0 <bd_addr> MM

This response is sent to the host on termination of a successful pairing process. The optional MM is sent only if S Register 538 is set to 1 to automatically save the link key. The value MM indicates the result of the save operation and a value of 00 implies success, otherwise the value corresponds to an error code.

6.4.9 RX<string>

This response is sent to the host when the unit is in online-command mode and S Register 531 is set to 3 and data arrives from a peer.

If the data from the string contains non-visual characters (for example ASCII 0 to 31 and ASCII 128 to 255), then those characters are translated into a three character escape sequence starting with '\'. For example the embedded <cr><lf> sequence would be sent as the six character string \0D\0A.

If the data contains the character '"' then it is sent as \22.

If the data contains the character '\' then it is sent as \5C

6.4.10 AG<string>

This response is sent to the host when a serviced audio gateway connection is in progress and the profile requires some action from the host.

6.5 Incoming Connections

The Laird device 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 is sent to the host every second. The command ATA is used to accept the connection and ATH to reject it.

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

- CONNECT 123456789012
- CONNECT 123456789012 A
- CONNECT 123456789012 E
- CONNECT 123456789012 AE

(A = Authenticated connection; E = Encryption enabled)

When S0 register is -1, neither RING nor CONNECT is sent to the host and the connection is silently accepted.

If the S 100 register is non-zero, then after the ring indications specified by this register have been sent to the host, and the host has failed to accept or reject the incoming connection, then an automatic 'hangup' is initiated.

6.6 Dropping Connections

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

Laird Bluetooth modules provide a variety of ways of dropping a connection. One method is similar to the above, but instead a ^^^ character sequence is used; this eliminates ambiguity when a data call is in progress via a mobile phone which was established using the mobile phone's Bluetooth AT modem. The second method involves the host dropping the DTR (DSR from the module's viewpoint) handshaking line.

Being able to drop a connection using the escape sequence ^^^ has a severe penalty on data throughput. In fact, the data rate is of the order of 85 kbps instead of about 200 kbps. To cater for this performance hit, the device's connection drop capability is configurable to be in one of two modes.

One mode allows for a connection to be dropped using either method; the other mode allows for a connection drop using the DTR method only. By default, the device is in the former mode. This mode is selected using the S507 register. See 錯誤! 找不到參照來源。 for more information on S Registers.

To reiterate, the escape sequence is as follows:

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

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 because, when transferring a file, it is going to occur as fast as possible; this means that the inter character gap is going to be significantly shorter than the <Guard time>.

The <Esc Chr> character can be changed via the S2 register and the <Guard time> interval can be specified via the S12 register.

6.7 Pairing and Trusted Devices

When authentication is enabled via S register 500 or when using the 'u' modifier in the ATD and AT+BTP commands, a connection attempt requires a link key for the peer device. The link key can be obtained prior to connection by invoking the AT+BTW and AT+BTK commands. A new link key can be obtained as often as required and is stored in a volatile cache. At any time, this cached link key can be added to the trusted devices database using the AT+BTT command. A trusted device can be deleted using the AT+BTD command. To view a list of trusted device, issue the command AT+BTT?.

In addition, if S Register 538 is set to 1, then on a successful pairing, the link key is automatically saved to the trusted device database. In that case, the asynchronous message PAIR 0 <bd_addr> has an error code appended at the end to convey the result of the save operation.

When a connection attempt requires a link key, the trusted device database is searched automatically and if one exists, it is provided without host interaction. If the link key is not present, then the connection attempt is terminated and a NO CARRIER response is given to the ATD command.

A typical session to pair an Ericsson T68i (for example) to a serial module would be:

1. Make the T68i discoverable and send AT+BTI to the serial module. This results in inquiry responses from all devices. Make a note of the Bluetooth address of the phone e.g. 123456789012.
2. On the T68i start pairing procedure by selecting "Phone accepts" in the relevant Bluetooth menu.
3. Send command AT+BTW123456789012 to the serial module.
4. Confirm that you get an OK response and then PIN? responds on a two second interval.
5. Enter a pin code on the phone (such as 12345768).
6. Enter the command AT+BTK="12345678".
   The phone confirms success and likewise the serial module responds with OK.
7. On success, the serial module sends an unsolicited message in the form of PAIR 0 <bd_addr>.
8. Send AT+BTT to the serial module so that the pairing information is stored in the non-volatile database.
9. Confirm that the link key has been stored by sending the command AT+BTT?. This results in a list of all devices paired with the module.

   If two Laird devices need to be paired, then it can be accomplished as follows:

   - To device 1 send ATI4, it responds with the local Bluetooth address (e.g., 123456789001).
   - To device 1 send AT+BTP. It becomes discoverable and connectable.
   - To device 2 send AT+BTW123456789001 and it responds with OK.

     Both devices display PIN? asynchronous responses.
   - To both modules. send AT+BTK="12345678".

- On success, the serial module sends an unsolicited message in the form of PAIR 0 <bd_addr>
- The pairing link key is now in volatile memory; send AT+BTT to both.
- The two units now have pairing information which will survive a power cycle.

6.8 Error Responses

All error responses from the Laird device are in the form <cr,lf>**ERROR nn**<cr,lf>, where nn is a number in the range 00 to 99.

Error	Description
01	Register not recognised
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

Error	Description
32	Analogue Value cannot be written as it is set for input
33	S Register value is invalid
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 – call waiting has not been enabled by peer or in hostless mode
46	GPIO line can't be set as it has not been configured as an output

6.9 Factory Default Mode

Laird devices are capable of operating at a wide range of baud rates. S Registers 520 and 521 allow the baud rate to be easily set. The baud rate clock generator in the Laird device is more versatile than one available in a standard 16550 UART commonly available in PCs.

In fact, as long as the equation BAUDRATE * 0.004096 produces an integer value, there is 0% error in clocking for that baud rate.

Because of this, it is possible to set a baud rate that a PC cannot cope with and, in that circumstance, it is virtually impossible to communicate with it.

For this type of circumstance, the Laird device comes out of reset using 9600,N,8,1 comms settings for exactly 750 milliseconds and then reverts to the comms parameters as per the S Registers.

If the host sends the string **!<BISM>!<cr>** where <cr> is the carriage return character within that 750 ms period, then the module remains at 9600,N,8,1 and configures itself using factory default S Register values.

6.10 Miscellaneous Features

This chapter describes various features which cannot be categorized appropriately.

6.10.1 RI dependent Start-up Mode

The UART_RI line can be configured as an input and on power its state can be used to force the device into one of two modes. See description for S Registers 565 to 569 inclusive for more details.

For example, the feature could allow a device to make an outgoing connection if RI is in one state, and be ready for an incoming connection in the other.

6.10.2 Pulse a GPIO pin

To flash a GPIO pin, set it as an output using S reg 610 and then use S reg 585 to 587 inclusive to set the pin, period, and duty cycle respectively.

6.10.3 Flash LED on Connectable Mode

S reg 534 now takes a value up to two. A value of two configures it so that it blinks when the module is in connectable mode.

6.10.4 Reset via BREAK

The module can be reset by sending a BREAK signal. A BREAK signal exists when the module's UART_RX input is in a non-idle state (0v) for more than 125 milliseconds.

6.10.5 Digital I/O Cable Replacement

The module has a number of general purpose digital I/O pins. The direction of these is specified via S Reg 610.

When S Reg 531 is set to four at both ends of the connection, on connection, any changes in the states of the inputs at one end are transmitted to the peer, which then reflects those states on the appropriate I/O pins if they have been configured as outputs.

It is recommended that the value of S Reg 610 at one end be the complement of the other end. That way, inputs at one end are mirrored at the other end and vice versa.

In addition S Reg 506 *must* be set to zero, which disables echoes.

Note: Due to inherent latency of Bluetooth transmission, expect the change of state to be delayed. This value is typically 100 ms and can be much more if the quality of the link is bad which results in many retries.

It is assumed that an audio channel is not active at any time.

6.10.6 Append Bluetooth Address to Friendly name

If S Reg 593 is set to one, then the last six hex digits of the Bluetooth address are automatically appended to the friendly name. This allows multiple devices with the same name in a neighbourhood to be differentiated.

6.11 Disclaimers

LAIRD WIRELESS PRODUCTS ARE NOT AUTHORISED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE MANAGING DIRECTOR OF LAIRD TECHNOLOGIES LTD.

The definitions used herein are:

a) Life support devices or systems are devices which (1) are intended for surgical implant into the body, or (2) support or sustain life and whose failure to perform when properly used in accordance with the instructions for use provided in the labelling can reasonably be expected to result in a significant injury to the user.

b) A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

Laird Technologies does not assume responsibility for use of any of the circuitry described, no circuit patent licenses are implied and Laird Technologies reserves the right at any time to change without notice said circuitry and specifications.

6.12 Data Sheet Status

Laird reserves the right to change the specification without prior notice in order to improve the design and supply the best possible product.

6.13 Changes between release

Although every effort is made to ensure compatibility, the functionality of some features has changed due to the evolution of the Bluetooth chips and stack implementations. Users migrating between firmware variants should check the following differences:

- ATZ
- AT+BTIN

Please check with Laird Technologies Ltd for the most recent data before initiating or completing a design.

7. PCM CODEC INTERFACE

PCM_OUT, PCM_IN, PCM_CLK, and PCM_SYNC carry up to three bi-directional channels of voice data, each at 8ksamples/s. The format of the PCM samples can be 8-bit A-law, 8-bit μ-law, 13-bit linear, or 16-bit linear. The PCM_CLK and PCM_SYNC terminals can be configured as inputs or outputs, depending on whether the module is the master or slave of the PCM interface.

Contact a Laird FAE for further details.

The module is compatible with the Motorola SSI TM interface and interfaces directly to PCM audio devices including the following:

7.1 Compatible Codec Chips

- Winbond W61360 13-bit linear CODEC (Motorola MC145483 compatible)
- OKI MSM7702 single channel A-law and μ-law CODEC

The default codec support is for the Winbond W61360.

8. FTP CLIENT PROFILE COMMANDS

The FTP profile provides a capability allowing a host to act as an 'ftp client' to a peer device providing an 'ftp server' profile as shown in the diagram below.

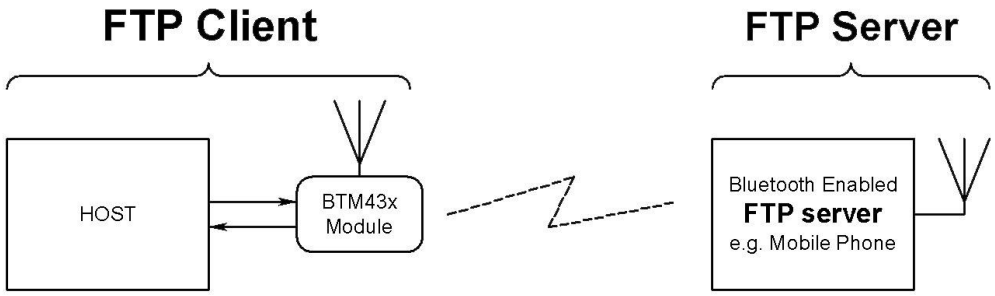


Figure 2: FTP client and server

An FTP client capability implies the ability to send and receive files and also to manipulate file objects in the remote device. The Bluetooth FTP server profile specification describes the profile as one built on Obex Exchange (OBEX) which is in turn built on SPP.

The FTP implementation allows a host attached to the module to send and receive files and in addition to manipulate files and folders.

The format used for describing this protocol is a series of message sequence charts with accompanying notes as appropriate, which unambiguously convey how a host and the module shall interact to perform the task.

8.1 Generic Notes and Guidance

In the message sequence charts the following abbreviations apply:

- <filename> shall mean a string delimited by the " character. For example, "hello.txt".
- <foldername> shall mean a string delimited by the " character.
- nnn shall be a decimal number with at least one digit.
- The backspace character is not supported.
- All FTP commands are case sensitive.
- FTP commands shall not exceed 32 characters in total.
- While an FTP session is open, the host shall not deassert the modules UART_CTS line and conversely the host MUST always be ready to accept data.
- When Unicode data is transmitted, it shall be assumed that the most significant byte is transmitted first.
- If an FTP command is expecting a Unicode string as a parameter and the host has an ASCII string, the string shall be expanded with a 0 byte in the most significant position.

8.2 FTP related AT Commands

8.2.1 AT+FTP<bd_addr>

This command is used to establish a connection to an FTP server profile in a peer device with Bluetooth address <bd_addr>.

When a connection is successfully established, the host assumes that the current folder is the root folder. This root folder is always relative to the host. It is *not* necessarily the absolute root folder of the host machine.

8.2.2 AT+OFT<bd_addr>

This command is used to establish a connection to an FTP server profile in a peer device with Bluetooth address <bd_addr> and functions similarly to AT+FTP, but instead of the response being "\r\nNNN FTP\r\n" it is "\r\nNNN OBX\r\n", where NNN is a decimal number.

This capability of choosing the response type is to allow a host to cater generically a connection which is either FTP or ObexPush.

8.2.3 ATSn=m

The following values of n are relevant to FTP operation: 582. A description of these values is given on page 18 TBC.

8.3 FTP related Subcommands

This section describes FTP-related subcommands that the host can use to control the FTP session.

8.3.1 PUT <filename><length> (Send file)

This FTP subcommand is used to send a file to the FTP server.

The length of <filename> shall not exceed 24 characters.

The optional <length> value is inserted into the OBEX length header field. This is optional for FTP.

There is some ambiguity as to how the first OBEX PUT packet is formed with respect to the 'Body' header. The OBEX specification does not prohibit the first 'Body' header to be empty; neither does it say that it must *not* be empty. If the first body is not empty when sending a file to a Nokia 6820 phone then it seems to confuse it. Because of this, Laird sends out an empty 'Body' header by default which is also what the Windows PC based Widcomm Bluetooth stack sends.

To cater for future devices which require the first 'Body' header to be non-empty, a new S Register 582 has been added to allow a host to have control over how the first body header is constructed.

The new S register 582 takes values in the range 0 to 1. The default value is 0 which implies that the first 'Body' header in the PUT OBEX packet is empty. A value of 1 forces that 'Body' header to have one byte of data – and in this case, when the module prompts the host for a length value it shall respond accordingly.

Laird hopes that the default value of zero suffices for all occasions, but provides the control to modify the packet as required.

8.3.2 PUT –nnn<length>(Send file)

This FTP subcommand is used to send a file to the FTP server where the filename is in UNICODE text and the filename is –nnn bytes long.

The optional <length> value is inserted into the OBEX length header field. This is optional for FTP.

See comment above TBC with regards to S Reg 582.

8.3.3 GET <filename>(Retrieve a file)

This FTP subcommand is used to retrieve a file from the FTP server.

The length of <filename> shall not exceed 24 characters.

8.3.4 GET -nnn(Retrieve a file)

This FTP subcommand is used to retrieve a file from the FTP server where the filename is in UNICODE and the filename is –nnn bytes long.

8.3.5 DIR(Get folder listing)

This FTP subcommand is used to retrieve the folder listing.

The Bluetooth FTP specification requires a server to transmit a folder listing as a properly formed XML document. In a properly formed document, the character '&' is supposed to be escaped into a five character string &. Testing shows that the Widcomm Bluetooth stack and the Microsoft Windows CE Bluetooth stack do not comply with that requirement; they send the '&' unescaped.

This means that if a folder contains filenames with '&' characters, this results in a failed parsing of the XML document and this command fails with the response "090 FTP".

In this circumstance, the only way for the host to extract the folder listing from the server is to request the folder listing in raw XML form. This is expedited using the DIR -RAW(Get folder listing, XML document) command.

8.3.6 DIR -RAW(Get folder listing, XML document)

This FTP subcommand is used to retrieve the folder listing. In this variant, the OBEX response packet, which is in ASCII XML format, is sent to the host verbatim.

WARNING: The Widcomm stack seems to append two null characters at the end of the XML document. This means extra care if the host stores data as null terminated strings, because the final "200 FTP" prompt appears corrupted when it is not.

8.3.7 MD <foldername>(Create a folder)

This FTP subcommand is used to create a subfolder. The length of <foldername> shall not exceed 24 characters.

8.3.8 MD -nnn(Create a folder)

This FTP subcommand is used to create a subfolder which is specified in Unicode.

8.3.9 CD <foldername>(Change folder)

This FTP subcommand is used to navigate to the subfolder specified. The length of <foldername> shall not exceed 24 characters.

8.3.10 CD -nnn(Change folder)

This FTP subcommand is used to navigate to the subfolder specified in Unicode.

8.3.11 CD \(Change folder to root)

This FTP subcommand is used to navigate to the root folder.

8.3.12 CD ..(Change folder to parent)

This FTP subcommand is used to navigate to the parent folder.

8.3.13 RD <foldername>(Delete a folder)

This FTP subcommand is used to delete the folder specified. Some FTP servers do not allow non-empty folders to be deleted. In that case, an appropriate error response shall be returned to the host. The length of <foldername> shall not exceed 24 characters.

8.3.14 RD -nnn(Delete a folder)

This FTP subcommand is used to delete the folder specified where the foldername is specified in Unicode.

8.3.15 DEL <filename>(Delete a file)

This FTP subcommand is used to delete the file specified.

8.3.16 DEL -nnn(Delete a file)

This FTP subcommand is used to delete the file specified where the filename is specified in Unicode.

8.3.17 ABORT(Abort current ftp command)

This FTP subcommand is used to abort a file transfer where appropriate. To abort a PUT session, send 0 when the module prompts for a length value.

8.3.18 QUIT (Terminate the FTP session)

This FTP subcommand is used to terminate the FTP session and also results in the Bluetooth connection being terminated.

8.3.19 MAX(Max outgoing obex packet size)

This FTP subcommand is used to get the maximum OBEX packet size tolerated by server and can be used by the host to optimize the data throughput.

8.4 FTP-Related Subresponses

All FTP-related sub responses sent from the module to the host SHALL be 11 characters long in the format:

<cr><lf>nnn AAA<cr><lf>

The characters nnn shall be decimal digits '0' to '9', then there is a space character and finally a three character word followed by <cr><lf>.

The <cr><lf> envelope plus the fixed length will hopefully make the parsing task in the host much simpler.

Values for 'nnn' are as specified for HTTP status codes, and reproduced from the OBEX specification as follows:

OBEX Response Code	HTTP Status Code	Definition
0x00to 0x0F	None	Reserved
0x10(0x90)	100	Continue
0x20(0xA0)	200	OK, Success
0x21(0xA1)	201	Created
0x22(0xA2)	202	Accepted
0x23(0xA3)	203	Non-Authoritative Information
0x24(0xA4)	204	No Content
0x25(0xA5)	205	Reset Content
0x26(0xA6)	206	Partial Content
0x30(0xB0)	300	Multiple Choices
0x31(0xB1)	301	Moved Permanently
0x32(0xB2)	302	Moved temporarily
0x33(0xB3)	303	See Other
0x34(0xB4)	304	Not modified
0x35(0xB5)	305	Use Proxy
0x40(0xC0)	400	Bad Request - server couldn't understand request
0x41(0xC1)	401	Unauthorized
0x42(0xC2)	402	Payment required
0x43(0xC3)	403	Forbidden - operation is understood but refused
0x44(0xC4)	404	Not Found
0x45(0xC5)	405	Method not allowed
0x46(0xC6)	406	Not Acceptable
0x47(0xC7)	407	Proxy Authentication required
0x48(0xC8)	408	Request Time Out
0x49(0xC9)	409	Conflict
0x4A(0xCA)	410	Gone
0x4B(0xCB)	411	Length Required
0x4C(0xCC)	412	Precondition failed
0x4D(0xCD)	413	Requested entity too large

OBEX Response Code	HTTP Status Code	Definition
0x4E(0xCE)	414	Request URL too large
0x4F(0xCF)	415	Unsupported media type
0x50(0xD0)	500	Internal Server Error
0x51(0xD1)	501	Not Implemented
0x52(0xD2)	502	Bad Gateway
0x53(0xD3)	503	Service Unavailable
0x54(0xD4)	504	Gateway Timeout
0x55(0xD5)	505	HTTP version not supported
0x60 (0xE0)	- - -	Database Full
0x61 (0xE1)	- - -	Database Locked

For more details of these values, refer to the irDA specification which can be freely downloaded from www.irda.org.

In addition, values in the range 050 to 099 and 250 to 299 inclusive are specific to this Laird application and are defined in Table 8-1.

Table 8-1: nnn Codes

Response Code 'nnn'	(Laird Technologies Specific) Definition
050	Syntax Error / Command Unrecognized
051	Server sent unexpected information in obex packet
052	Obex connection fail, because it is unauthorized
053	Memory allocation failure (Please contact Laird Technologies with details)
055	Unicode File/Folder name length cannot be an odd value
056	Command not recognized
090	An XML parsing error occurred (while processing response to DIR command)
099	The Bluetooth connection has unexpected been dropped. (I.e., remote out of range etc.)
250	GET procedure was aborted

8.4.1 nnn FTP

This FTP response is used, when the connection was opened using AT+FTP, to convey the outcome of a subcommand to the host where 'nnn' is a fixed three digit decimal number as defined in the irDAspecification and map to HTTP status codes.

For example, a value of n=200 implies successful operation, any other value usually conveys an error as described in the irDA specification (except the range 050 to 099 inclusive and 250 to299 inclusive).

Note: When a Bluetooth OBEX session is established, we will be specifying v1.0 in the header packets by default as that is what the Widcomm stack seems to be using and the FTP specifies.

8.4.2 nnn OBX

This has the same meaning as "nnn FTP" and is used when AT+OFT command was used to open an FTP connection.

8.4.3 nnn GET

This FTP response is used during a GET file operation. See appropriate message sequence charts for more details. See Table 8-1 for 'nnn' values.

8.5 FTP line multiplexing commands

When transferring a file, the single serial interface between the host and the module is used to send and receive data and commands. In other words, a scheme is required to unambiguously determine when a byte on the line corresponds to a command or data belonging to a file.

The module uses negotiated multiplexing to achieve this and commands are used to toggle the line between command and data mode.

This scheme is symmetrical and the commands for toggling the state of the line are relevant for both direction. The only difference being that the terminator is <cr> in the host to module direction and<crlf> in the reverse direction.

The commands are described in the following sub sections.

8.5.1

This command is used to ask the other end how many bytes of a filename or foldername it will send next.

8.5.2 >

This command is used to inform the other end that it is safe to send the number of bytes belonging to a filename or foldername as indicated in the most recent # command.

8.5.3 !

This command is used to ask the module/host how many bytes of data it will send next. If the module/host sends a length value that is too large to handle, it can be rejected by sending the ! command again. This is because accepting a value implies this end should send a ? prompt to trigger the data phase (See Section 8.5.4).

8.5.4 ?

This command is used to inform the other end that it is safe to send the number of bytes belonging to 'data' phase indicated in the most recent ! command.

8.6 Message Sequence Charts

In the following sections, the color scheme uses RED text as commands from a host to the module and BLUE text as responses and prompts from the module to the host. Command/responses shown in BLACK are associated with non-FTP related states.

Apart from FTP connection and disconnection scenarios, to avoid repetition, all message sequence charts assume that the module is in a FTP-connected state. It also assumes that where "nnn FTP" occurs, it can be read as "nnn OBX" if the command AT+OFT was used to initiate the command.

8.6.1 Usage: Make FTP connection (No Authentication)

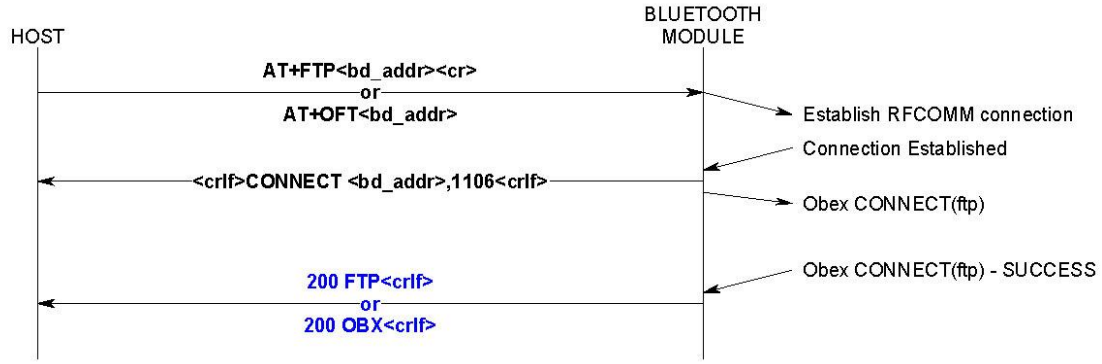


Figure 3: Make FTP connection (no authentication)

8.6.2 Usage: FTP Disconnection

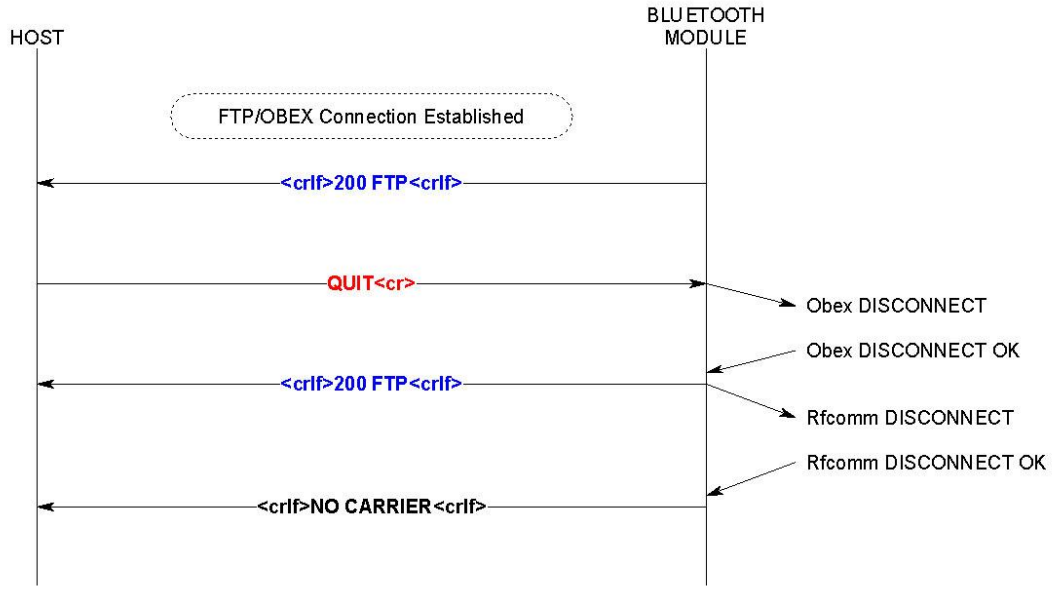


Figure 4: FTP disconnection

8.6.3 Usage: Folder Listing

Note: If a number follows a name then that implies a file.

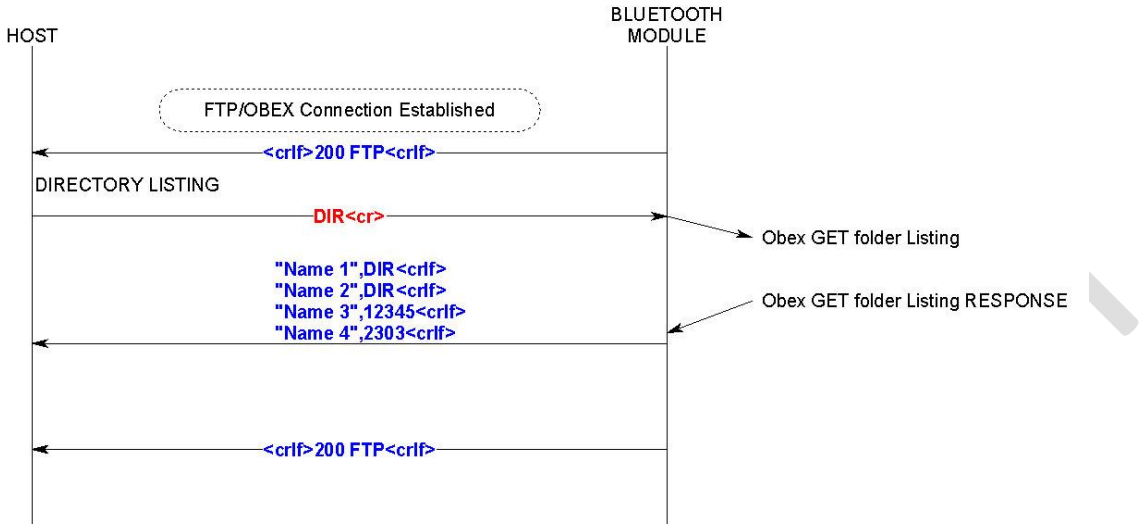


Figure 5: Folder listing

8.6.4 Usage: Folder Listing (Raw Output)

Note: The raw output is ASCII text and is in XML format.

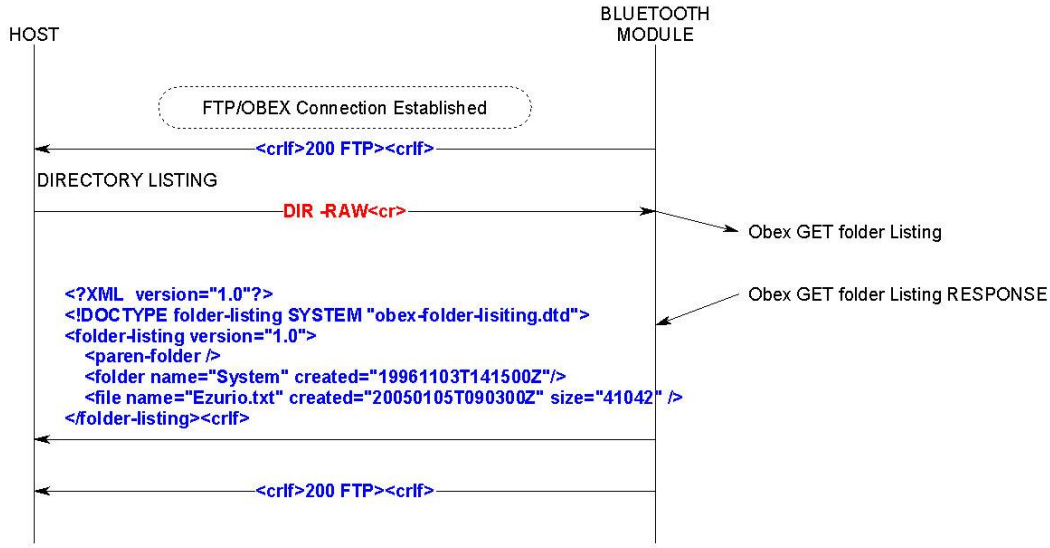


Figure 6: Folder listing (raw output)

8.6.5 Usage: Create Folder (Short Folder name)

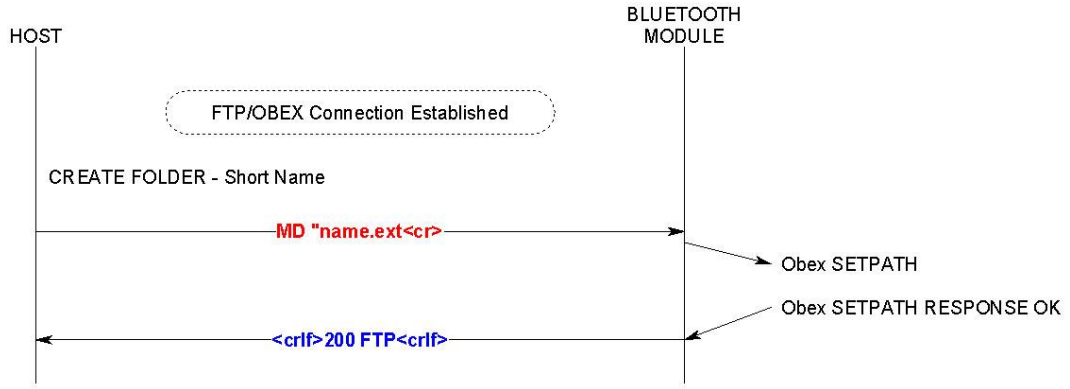


Figure 7: Create folder (short folder name)

8.6.6 Usage: Create Folder (Long Folder name - UNICODE)

Note: 'nn' is the size of folder name in bytes. The folder name is supplied in Unicode.

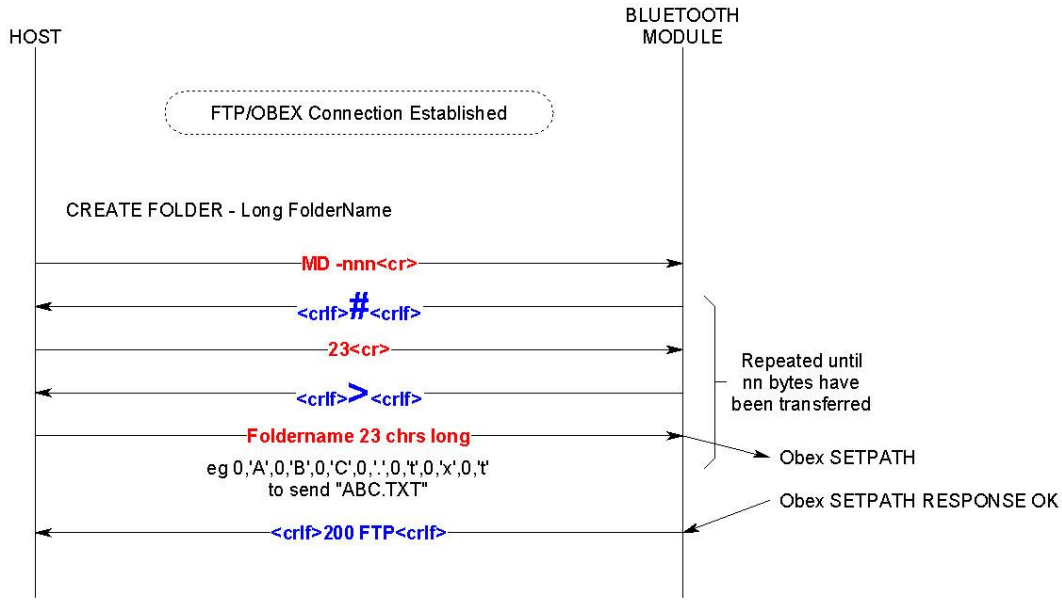


Figure 8: Create folder (long name - UNICODE)

8.6.7 Usage: Create Folder (Unsuccessful)

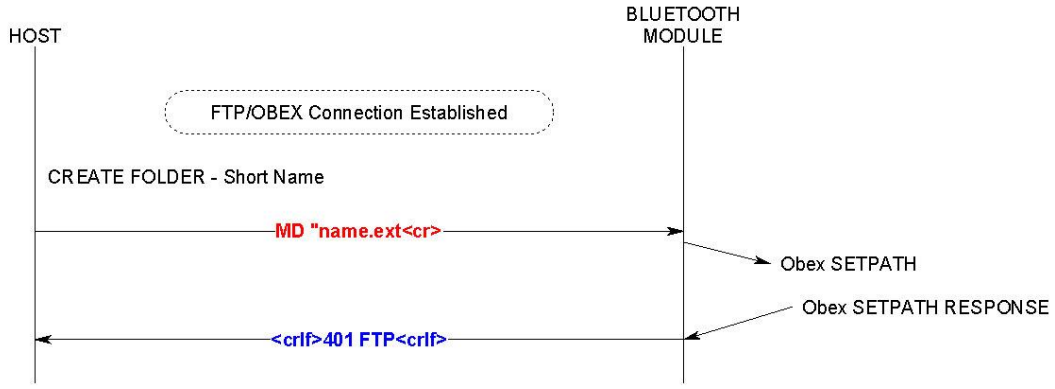


Figure 9: Create folder (unsuccessful)

8.6.8 Usage: Change Folder (Short Folder name)

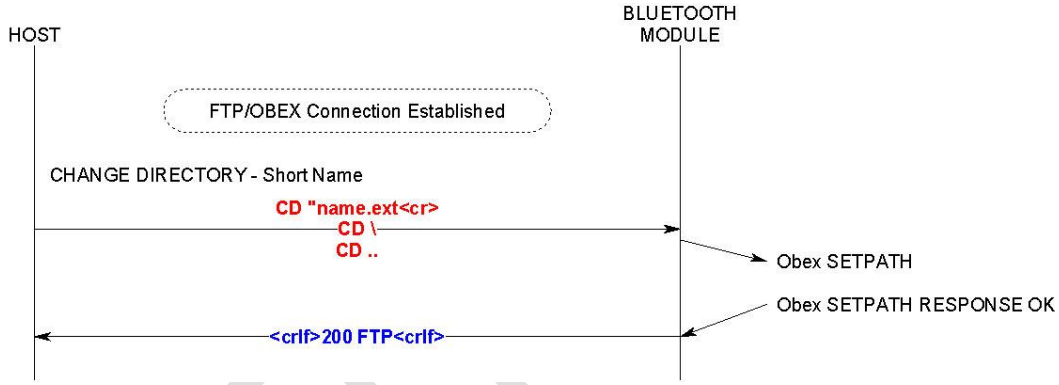


Figure 10: Change folder (short folder name)

8.6.9 Usage: Change Folder (Long Folder name - UNICODE)

Note: 'nn' is the size of folder name in bytes. The folder name is supplied in Unicode.

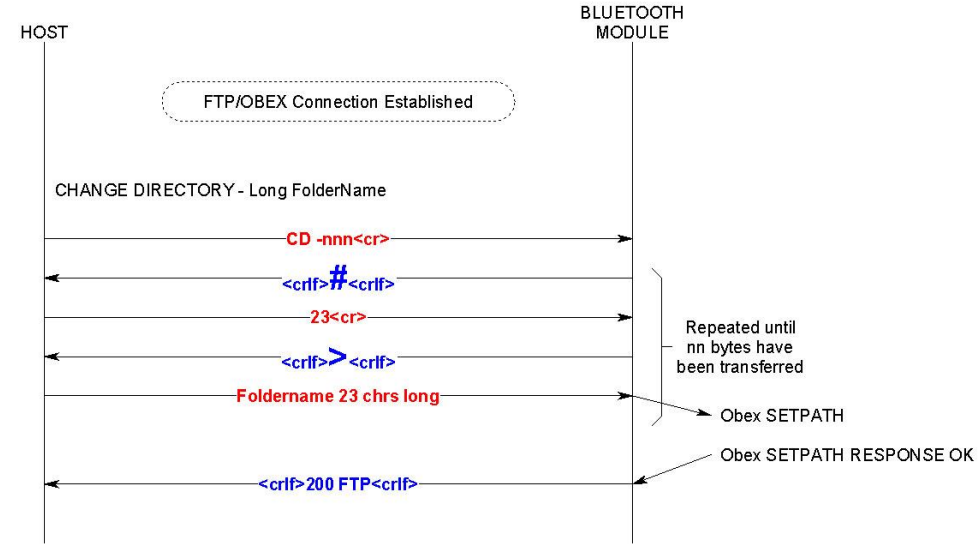


Figure 11: Change folder (long folder name - UNICODE)

8.6.10 Usage: Remove Folder (Short Folder name)

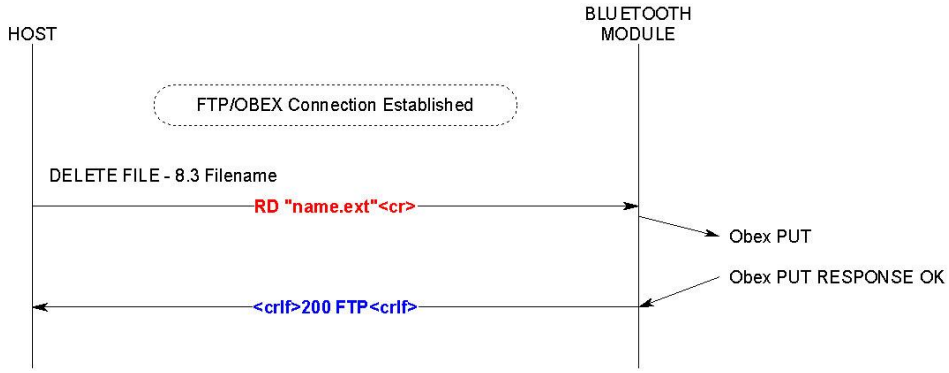


Figure 12: Remove folder (short folder name)

8.6.11 Usage: Remove Folder (Long Folder name – UNICODE)

Note: 'nn' is the size of folder name in bytes. The folder name is supplied in unicode.

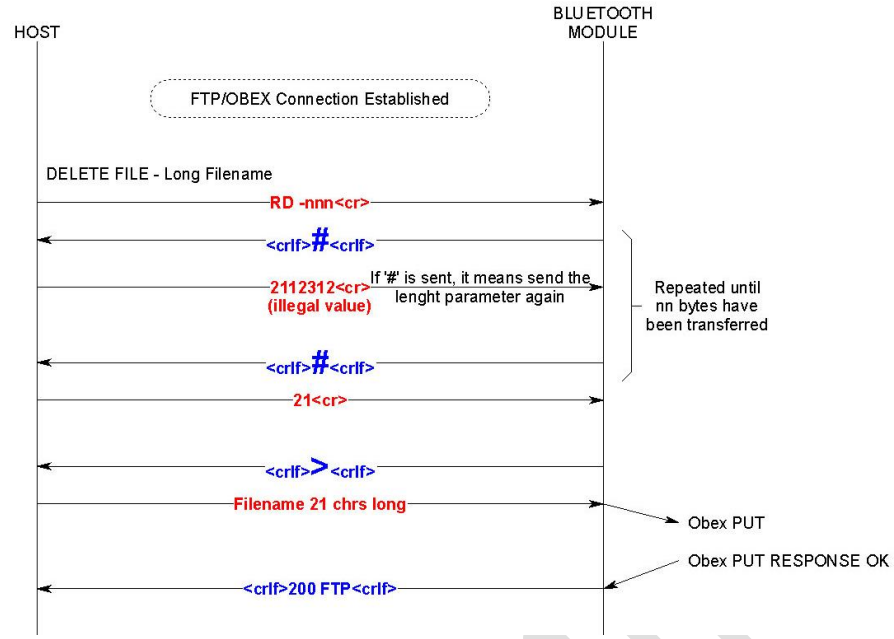


Figure 13: Remove folder (long folder name - UNICODE)

8.6.12 Usage: Delete File (Short Filename)

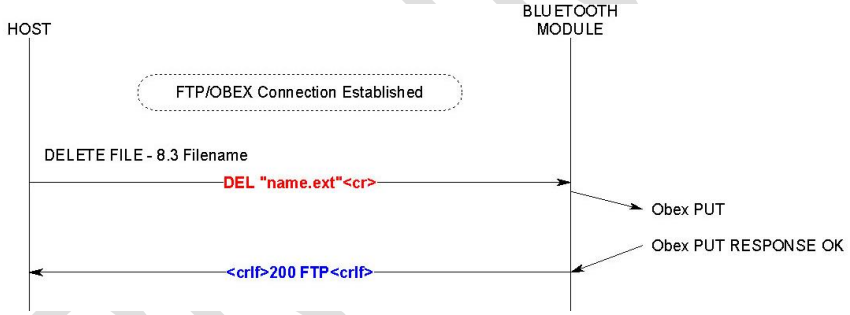


Figure 14: Delete file (short filename)

8.6.13 Usage: Delete File (Long Filename – UNICODE)

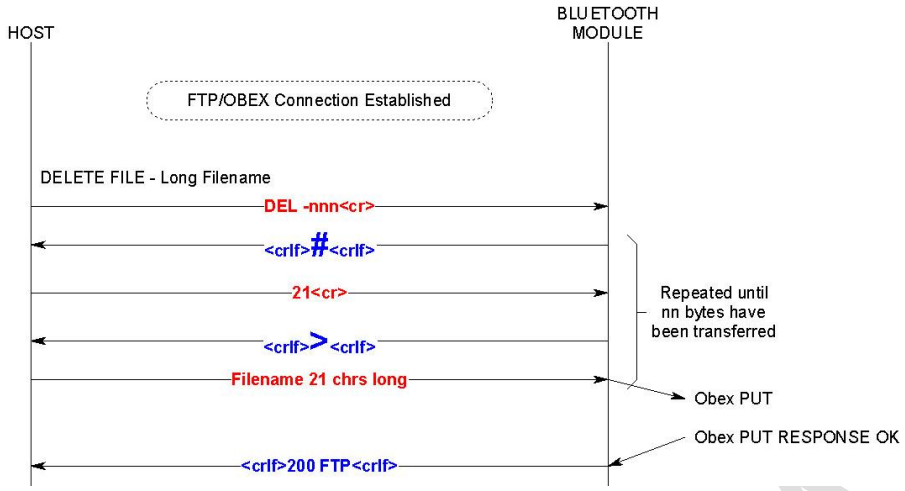


Figure 15: Delete file (long filename - UNICODE)

8.6.14 Usage: Put File (Short Filename)

Note: The first NN from the host shall specify a value of 1.
Subsequent NN values shall be less than the value returned to command MAX

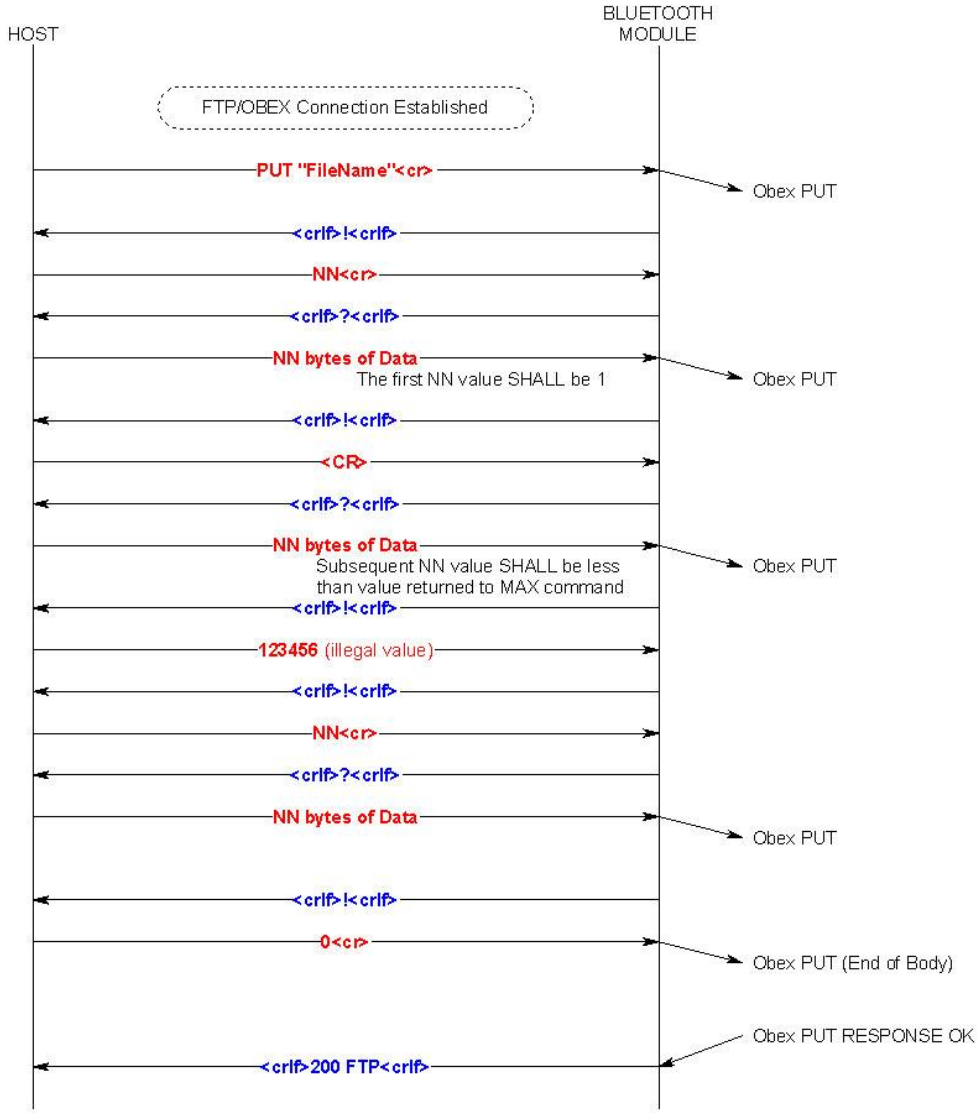


Figure 16: Put file (short filename)

8.6.15 Usage: Put File (Long Filename - UNICODE)

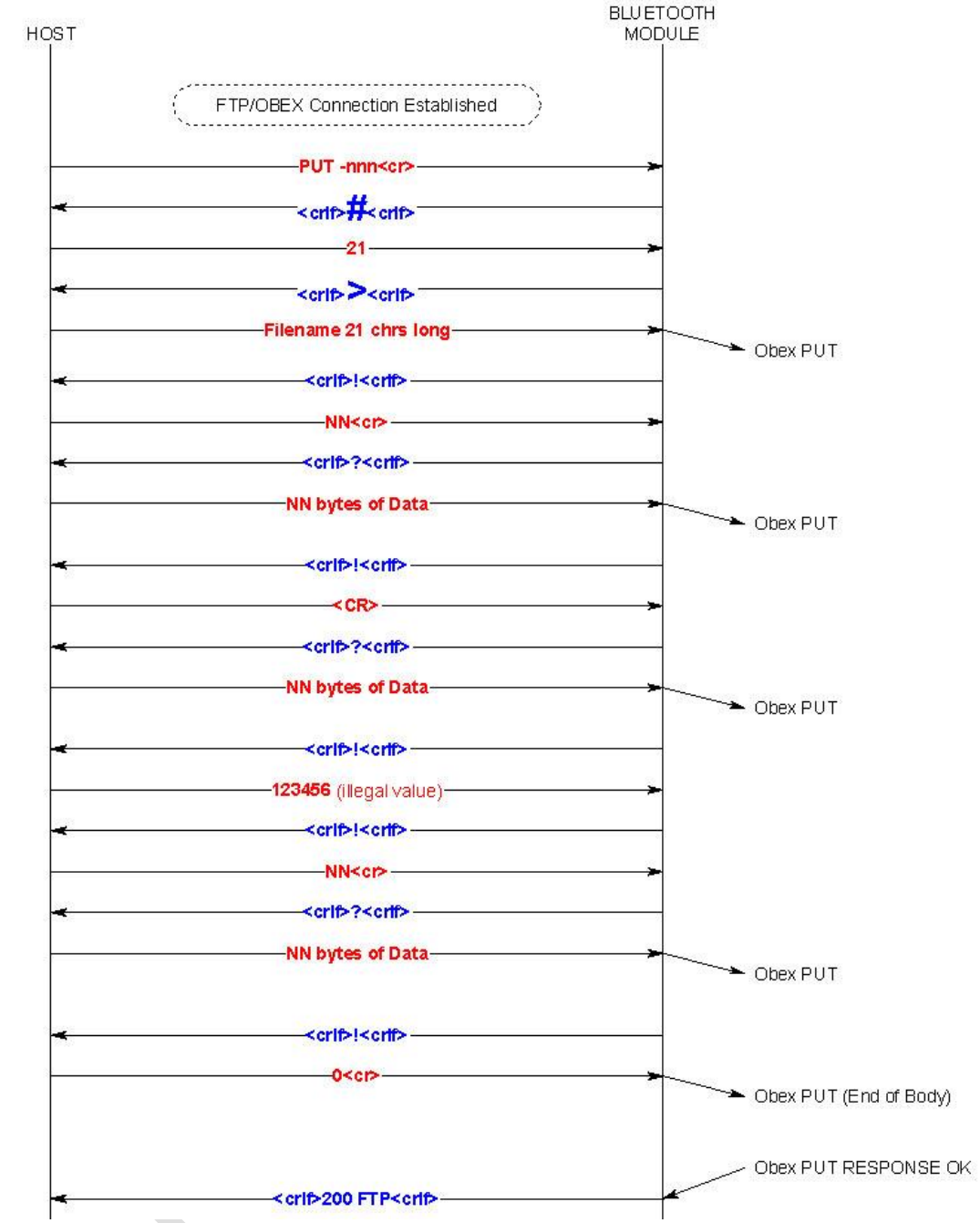


Figure 17: Put file (long filename - UNICODE)

8.6.16 Usage: Get File (Short Filename)

Note: After each !command, if a +NN response is not received after 2 seconds, the host can repeat that command.
The response to ! is "+NN" instead of just "NN" to make easier for the host to predict the command, since on completion the standard response is "200 FTP" which also happens to start with a number. The '+' shall be early warning to the host that the procedure is not complete.

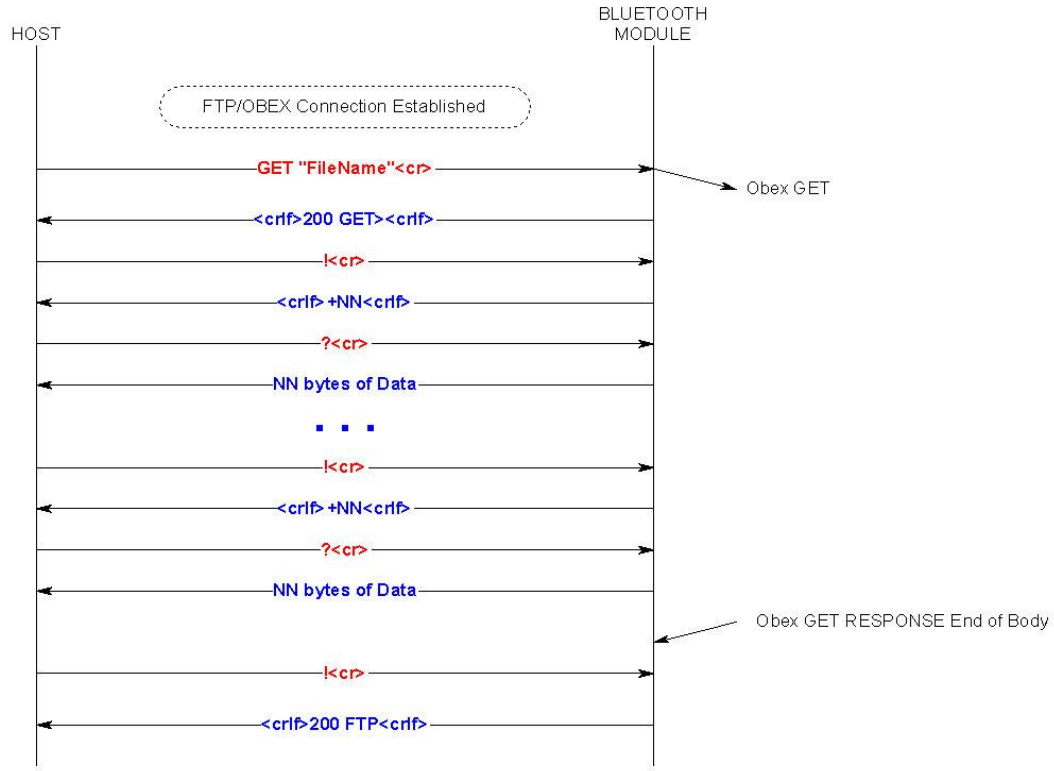


Figure 18: Get file (short filename)

8.6.17 Usage: Get File (Empty file in server)

Note: If the file size is 0, then the host shall receive "200 FTP" instead of "200 GET". The latter is invitation to the host that data needs to be marshalled across.

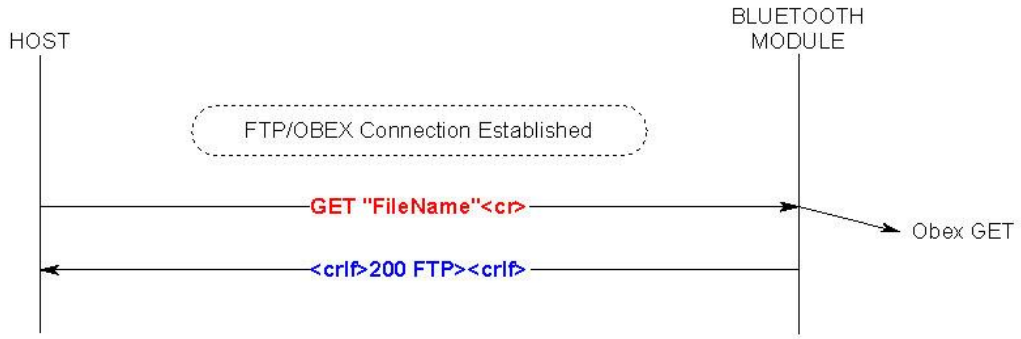


Figure 19: Get file (empty file in server)

8.6.18 Usage: Get File (Long Filename - UNICODE)

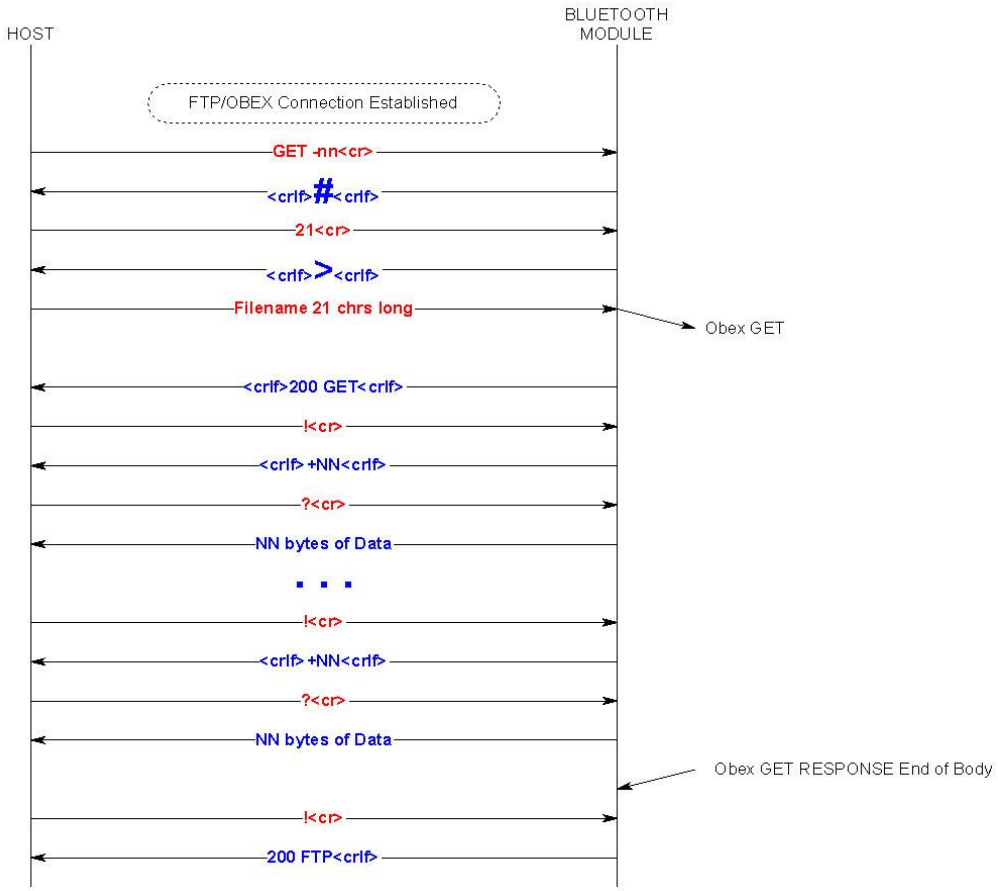


Figure 20: Get file (long filename - UNICODE)

8.6.19 Usage: Get File – ABORT

Note: If "200 FTP" is received after submitting an ABORT command then it implies that the entire file was transferred before the abort had been received.

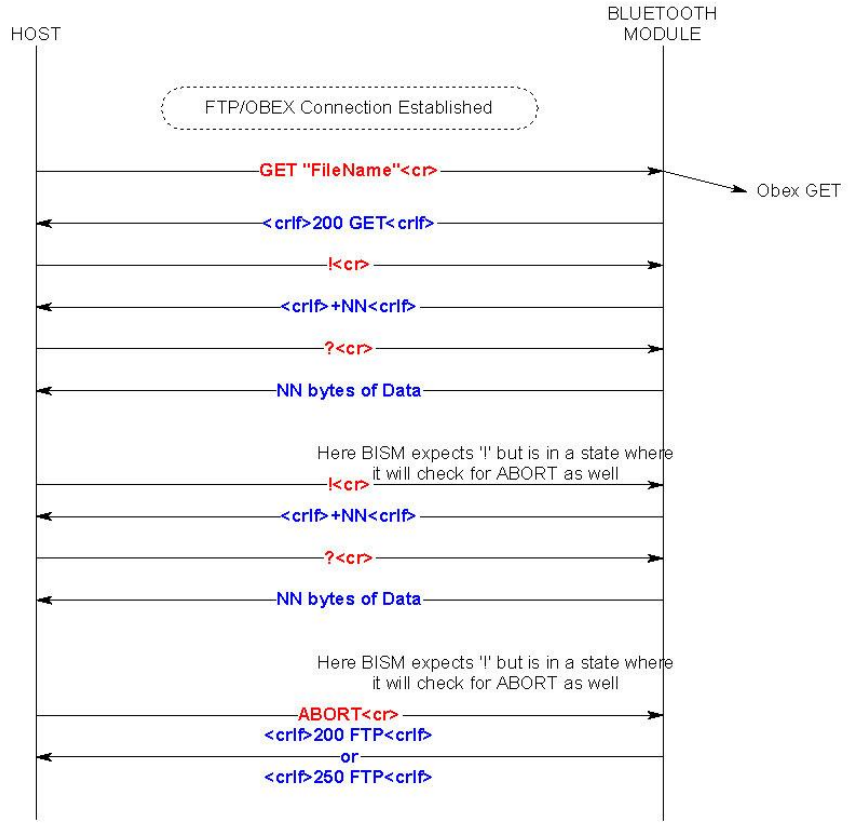


Figure 21: Get file - ABORT

8.6.20 Usage: Unsuccessful FTP connection

Note: Reason for connection failure could be:
Device is not in range
Device is not connectable
Device does not support FTP server profile.

Figure 22: Unsuccessful FTP connection

8.6.21 Usage: ABORT a DIR request

Note: The host may get more file/folder names after submitting an ABORT request because the device could have received a folder data OBEX packet at the same time but slightly earlier so it may have started processing it.

Hence the host must look out for a "200 FTP<crlf>" to be sure that the DIR operation has terminated. Some ftp servers (like widcomm stack) will return a 500 response code.

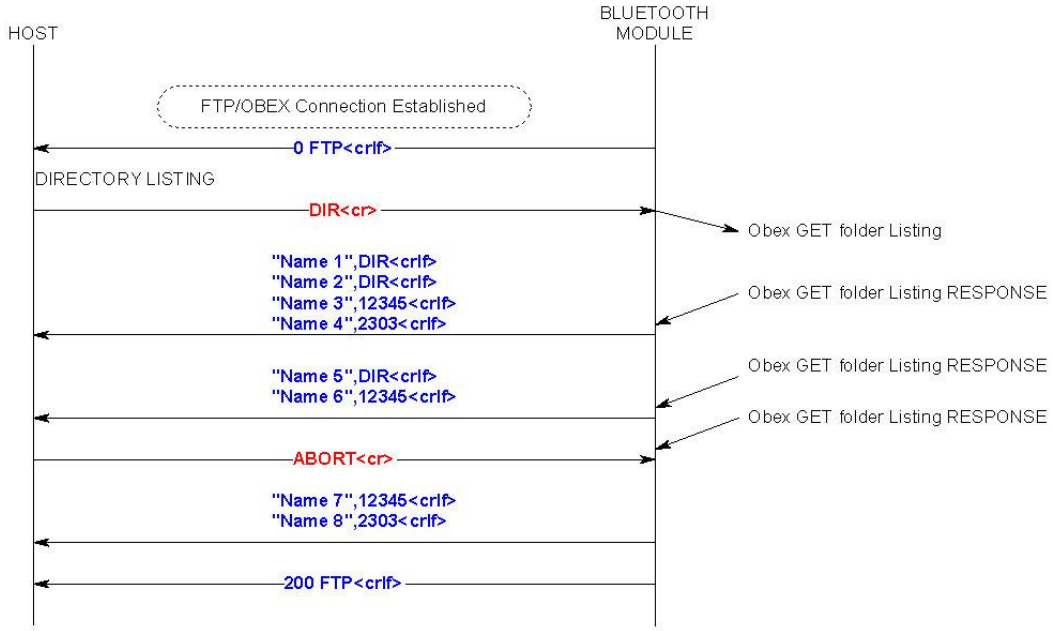


Figure 23: ABORT a DIR request

9. OBEX PROFILE COMMANDS

This section describes the OBEX implementation on BTM430/431 which allows performing the role of 'Obex Push Client' as illustrated in the diagram below.

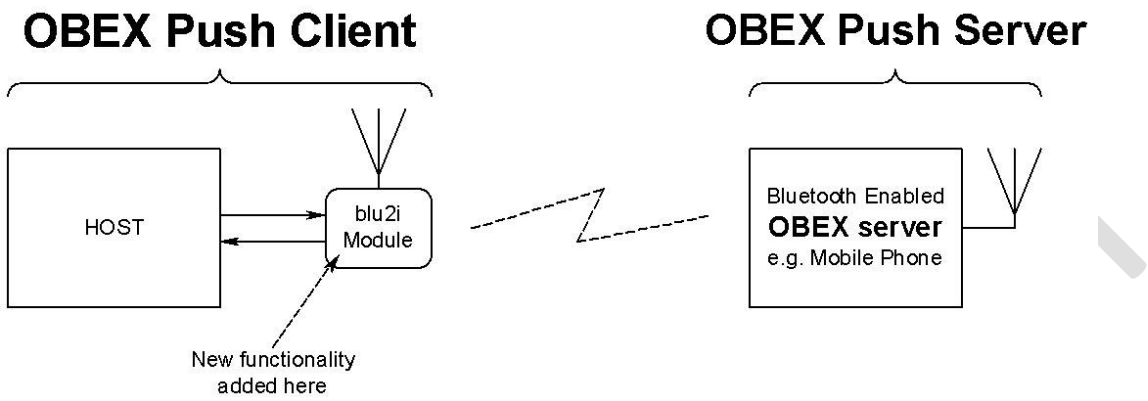


Figure 24: OBEX Push client and server

The Obex Push profile implementation provides the capability to a host to act as an 'Obex Push client' to a peer device providing an 'obex push server' profile.

An Obex Push client capability implies the ability to send and optionally receive a default file. The Bluetooth Obex Push server profile specification describes the profile as one built on Obex Exchange (OBEX) which is in turn built on SPP.

The Object Push Profile [3] describes the profile as having the three following features:

- Object Push – Mandatory
- Business Card Pull – Optional
- Business Card Exchange – Optional

This implementation only offers the Mandatory Object Push feature.

The implementation on BTM430/431 allows a host attached to the module to send and receive files and to manipulate files and folders.

The format used in this document for describing this protocol is a series of message sequence charts with accompanying notes as appropriate, which unambiguously convey how a host and the module shall interact to perform the task.

9.1 Generic Notes and Guidance

In the message sequence charts the following abbreviations apply:

- <crlf> shall mean a two character sequence made up of the ASCII characters 0x0D (carriage return) and 0x0A (line feed).
- <cr> shall mean a one character sequence made up of the ASCII character 0x0D.
- <lf> shall mean a one character sequence made up of the ASCII character 0x0A.
- <bd_addr> shall mean a 12 digit string consisting of only hexadecimal digits 0-9, A-F, and a-f.
- <filename> shall mean a string delimited by the " character. For example, "hello.txt".
- <foldername> shall mean a string delimited by the " character.

- nnn shall be a decimal number with at least one digit.
- The backspace character is not supported.
- All OBEX commands are case sensitive.
- OBEX Commands shall not exceed 32 characters in total.
- While an OBEX session is open, the host shall not deassert the modules UART_CTS line and conversely the host MUST always be ready to accept data.
- When Unicode data is transmitted, it shall be assumed that the most significant byte is transmitted first.
- If an OBEX command is expecting a Unicode string as a parameter and the host has an ASCII string, the string shall be expanded with a 0 byte in the most significant position.

9.2 OBEX Push related AT Commands

9.2.1 AT+OPS<bd_addr>

This command is used to establish a connection to an Obex Push server profile in a peer device with Bluetooth address <bd_addr>.

9.2.2 ATSn=m

The following values of n are relevant to OBEX operation: 582. A description of these values is given on page 18 TBC.

9.3 OBEX Push related Subcommands

This section describes Obex Push-related subcommands that the host can use to control the OBEX Push session.

9.3.1 PUT <filename> length(Send file)

This OBEX subcommand is used to send a file to the obex server.

The length of <filename> shall not exceed 24 characters.

The length value is inserted into the OBEX length header field.

There is some ambiguity as to how the first obex PUT packet is formed with respect to the 'Body'header. The OBEX specification does not prohibit the first 'Body' header to be empty, neither does it say that it must NOT be empty. If the first body is NOT empty when sending a file to a Nokia6820 phone then it seems to confuse it. Hence Laird sends out an empty 'Body' header by default as does the Windows PC based Widcomm Bluetoothstack.

To cater for future devices which NEED the first 'Body' header to be non-empty, a new S Register582 has been added to allow a host to have control over how the first body header is constructed.

The new S register 582 takes values in the range 0 to 1. The default value is 0 which implies that the first 'Body' header in the PUT obex packet is empty. A value of 1 forces that 'Body' header to have one byte of data – and in this case when the module prompts the host for a length value it shall respond accordingly.

Hopefully the default value of zero suffices for all occasions but, in case it does not, we provide the control to modify the packet as required.

9.3.2 PUT –nnnlength(Send file)

This OBEX subcommand is used to send a file to the OBEX push server where the filename is in UNICODE text and the filename is –nnn bytes long.

The length value is inserted into the OBEX length header field.

See comment above with regards to S Reg 582 TBC.

9.3.3 ABORT(Abort current OBEX command)

This OBEX subcommand is used to abort a file transfer where appropriate.

To abort a PUT session, please send 0 when the module prompts for a length value.

9.3.4 QUIT (Terminate the OBEX Push session)

This OBEX subcommand is used to terminate the OBEX push session and also results in the Bluetooth connection being terminated.

9.3.5 MAX(Max outgoing OBEX packet size)

This OBEX subcommand is used to get the maximum obex packet size tolerated by server and can be used by the host to optimize the data throughput.

9.3.6 WHO(Identify current profile)

This OBEX subcommand is used to identify the current profile. 0 means Obex Push and 1 means FTP.

9.4 OBEX Push Related Subresponses

All Obex Push-related sub responses sent from the module to the host are 11 characters long in the following format:

<cr><lf>**nnn AAA**<cr><lf>.

The characters nnn shall be decimal digits '0' to '9', then there is a space character and finally a 3 character word followed by <cr><lf>.

The <cr><lf> envelope plus the fixed length hopefully makes the parsing task in the host much simpler.

Values for 'nnn' are as specified for HTTP status codes and reproduced from the OBEX specification as indicated in Table 9-1.

Table 9-1: OBEX response and HTTP status codes

OBEX Response Code	HTTP Status Code	Definition
0x00to 0x0F	None	Reserved
0x10(0x90)	100	Continue
0x20(0xA0)	200	OK, Success
0x21(0xA1)	201	Created
0x22(0xA2)	202	Accepted
0x23(0xA3)	203	Non-Authoritative Information

OBEX Response Code	HTTP Status Code	Definition
0x24(0xA4)	204	No Content
0x25(0xA5)	205	Reset Content
0x26(0xA6)	206	Partial Content
0x30(0xB0)	300	Multiple Choices
0x31(0xB1)	301	Moved Permanently
0x32(0xB2)	302	Moved temporarily
0x33(0xB3)	303	See Other
0x34(0xB4)	304	Not modified
0x35(0xB5)	305	Use Proxy
0x40(0xC0)	400	Bad Request - server couldn't understand request
0x41(0xC1)	401	Unauthorized
0x42(0xC2)	402	Payment required
0x43(0xC3)	403	Forbidden - operation is understood but refused
0x44(0xC4)	404	Not Found
0x45(0xC5)	405	Method not allowed
0x46(0xC6)	406	Not Acceptable
0x47(0xC7)	407	Proxy Authentication required
0x48(0xC8)	408	Request Time Out
0x49(0xC9)	409	Conflict
0x4A(0xCA)	410	Gone
0x4B(0xCB)	411	Length Required
0x4C(0xCC)	412	Precondition failed
0x4D(0xCD)	413	Requested entity too large
0x4E(0xCE)	414	Request URL too large
0x4F(0xCF)	415	Unsupported media type
0x50(0xD0)	500	Internal Server Error
0x51(0xD1)	501	Not Implemented
0x52(0xD2)	502	Bad Gateway
0x53(0xD3)	503	Service Unavailable
0x54(0xD4)	504	Gateway Timeout
0x55(0xD5)	505	HTTP version not supported
0x60 (0xE0)	- - -	Database Full
0x61 (0xE1)	- - -	Database Locked

For more details of these values, Refer to the irDA specification which can be freely downloaded from www.irda.org.

In addition, values in the range 050 to 099 and 250 to 299 inclusive are specific to this Laird application and are defined as per the table below.

Response Code 'nnn'	(Laird Technologies Specific) Definition
050	Syntax Error / Command Unrecognized
051	Server sent unexpected information in OBEX packet
052	OBEX connection fail, because it is unauthorized
053	Memory allocation failure (Please contact Ezurio with details)
055	Unicode File/Folder name length cannot be an odd value
056	Command not recognized
090	An XML parsing error occurred (while processing response to DIR command)
099	The Bluetooth connection has unexpected been dropped (i.e., remote out of range etc.)
250	GET procedure was aborted

9.4.1 nnn OBX

This OBEX response is used to convey the outcome of a subcommand to the host where 'nnn' is a fixed three digit decimal number as defined in the irDA specification and map to HTTP status codes.

For example, a value of n=200 implies successful operation, any other value usually conveys an error as described in the irDA specification (except the range 050 to 099 inclusive and 250 to 299 inclusive).

Note: When a Bluetooth OBEX session is established, we will be specifying v1.0 in the header packets by default.

9.5 OBEX Push Line Multiplexing Commands

When transferring an object, the single serial interface between the host and the module is used to send and receive data and commands. This means a scheme is required to unambiguously determine when a byte on the line corresponds to a command or data belonging to a file.

The module uses negotiated multiplexing to achieve this, and commands are used to toggle the line between command and data mode.

This scheme is symmetrical and the commands for toggling the state of the line are relevant for both direction. The only difference being that the terminator is <cr> in the host to module direction and <crlf> in the reverse direction.

The commands are described in the following sub sections.

9.5.1

This command is used to ask the other end how many bytes of a filename or object it will send next.

9.5.2 >

This command is used to inform the other end that it is safe to send the number of bytes belonging to a filename or object as indicated in the most recent # command.

9.5.3 !

This command is used to ask the module/host how many bytes of data it will send next.

If the module/host sends a length value that is too large to hanlde, then it can be rejected by resending the !command. This is because accepting a value implies this end should send a ? prompt to trigger the data phase (see Section 9.5.4).

9.5.4 ?

This command is used to inform the other end that it is safe to send the number of bytes belonging to 'data' phase indicated in the most recent ! command.

9.6 Message Sequence Charts

The color scheme uses RED text as commands from a host to the module and BLUE text as responses and prompts from the module to the host. Command/responses shown in BLACK are associated with non-obex related states.

Apart from OBEX connection and disconnection scenarios, to avoid repetition, all message sequence charts shall assume that the module is in an Obex connected state.

9.6.1 Usage: Make OBEX PUSH connection (No Authentication)

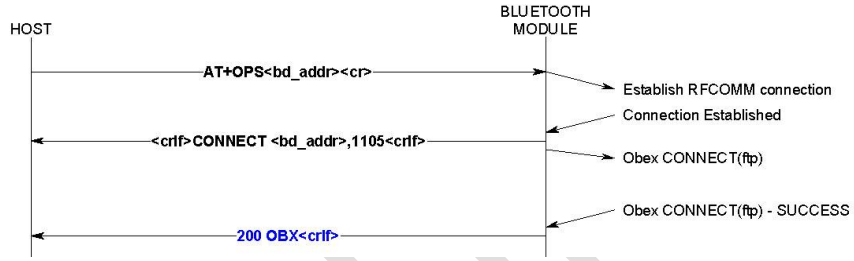


Figure 25: Make OBEX PUSH connection (no authentication)

9.6.2 Usage: OBEX Push Disconnection

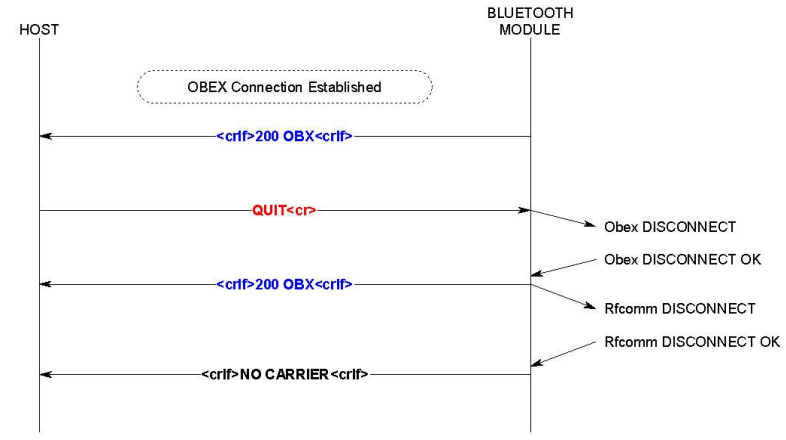


Figure 26: OBEX Push disconnection

9.6.3 Usage: Put File (Short Filename)

Note: The first NN from the host shall specify a value of 1.
Subsequent NN values shall be less than the value returned to command MAX

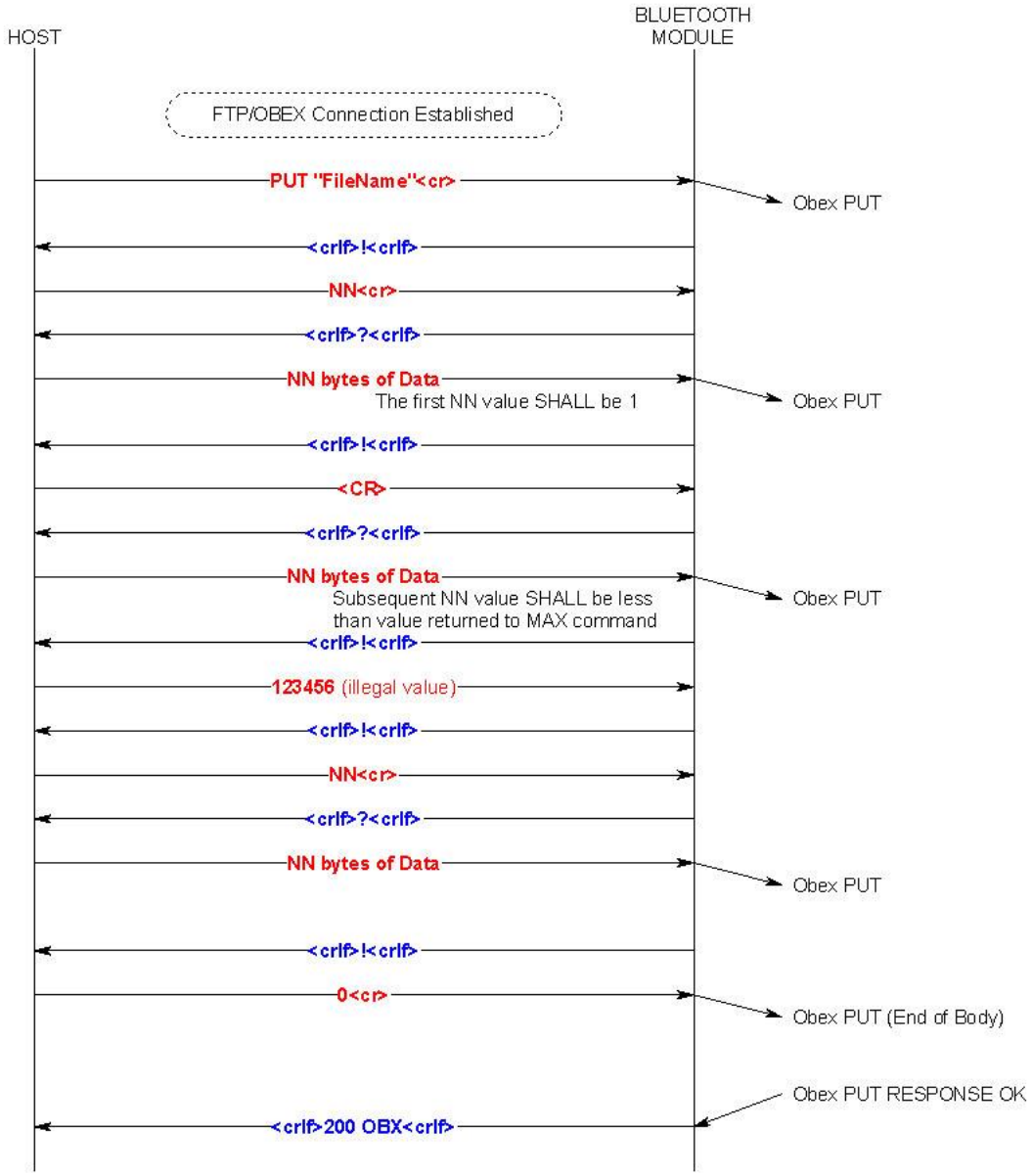


Figure 27: Put file (short filename)

9.6.4 Usage: Put File (Long Filename - UNICODE)

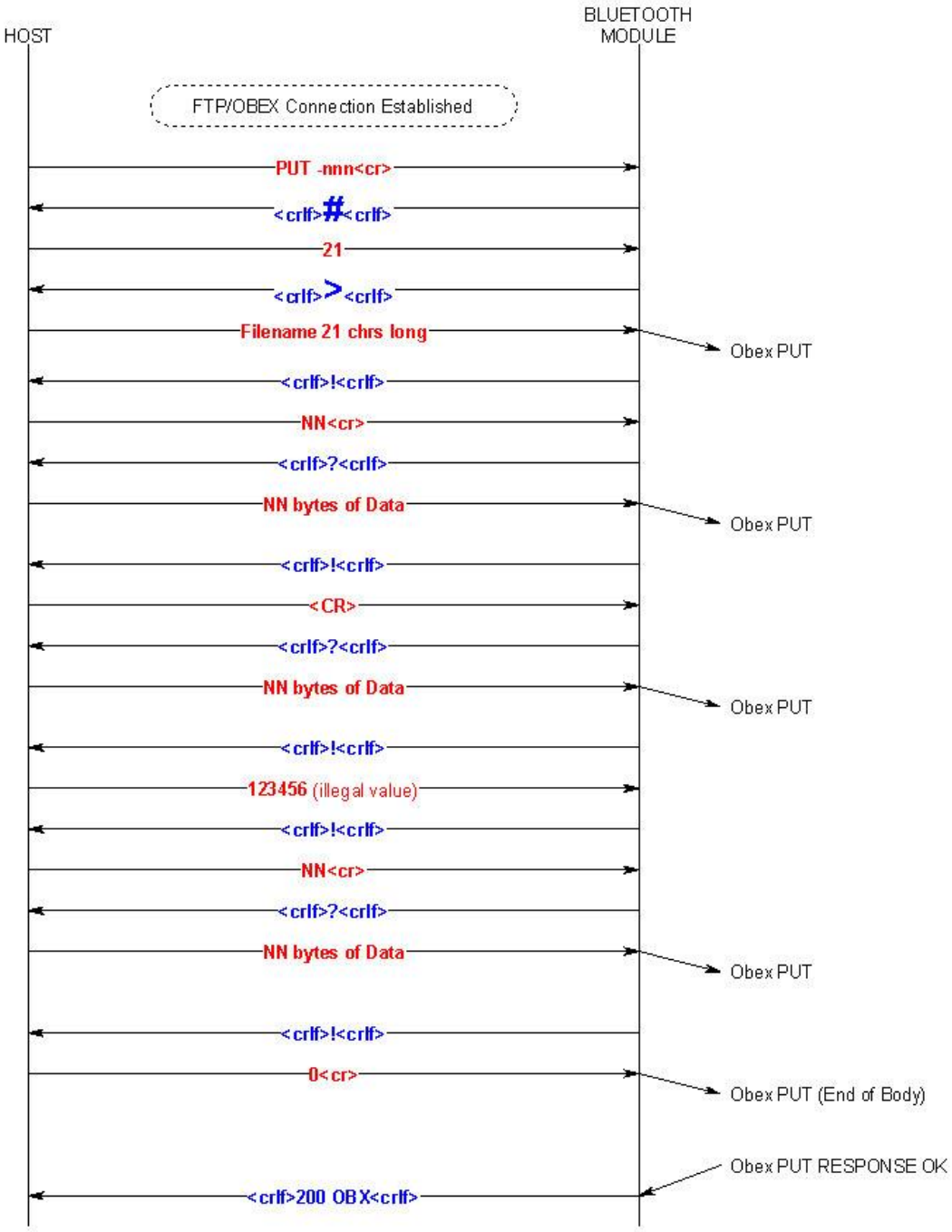


Figure 28: Put file (long filename - UNICODE)

9.6.5 Usage: Unsuccessful OBEX Push connection

Note: Reason for connection failure could be:
Device is not in range,
Device is not connectable,
Device does not support OBEX Push server profile.

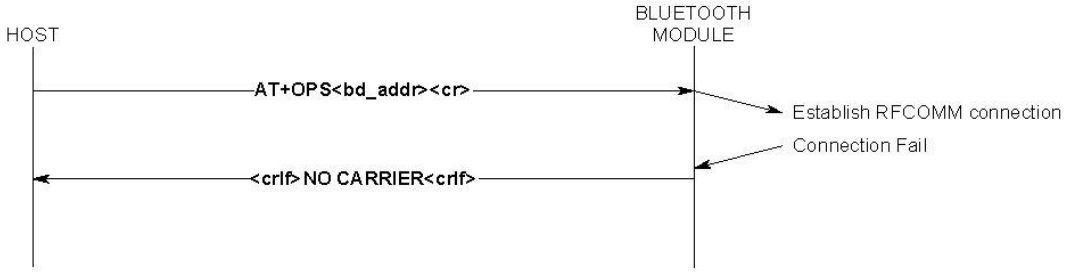


Figure 29: Unsuccessful OBEX Push connection

10. Application Note for Surface Mount Modules

10.1 Introduction

Laird surface mount modules are designed to conform to all major manufacturing guidelines. This application note is intended to provide additional guidance beyond the information that is presented in the User Manual. This Application Note is considered a living document and will be updated as new information is presented.

The modules are designed to meet the needs of a number of commercial and industrial applications. The modules are designed to be easily manufactured and conform to current automated manufacturing processes.

10.2 Shipping

Modules are shipped in ESD (Electrostatic Discharge) safe trays that can be loaded into most manufacturers pick and place machines. Layouts of the trays are provided in Figure 10-1..

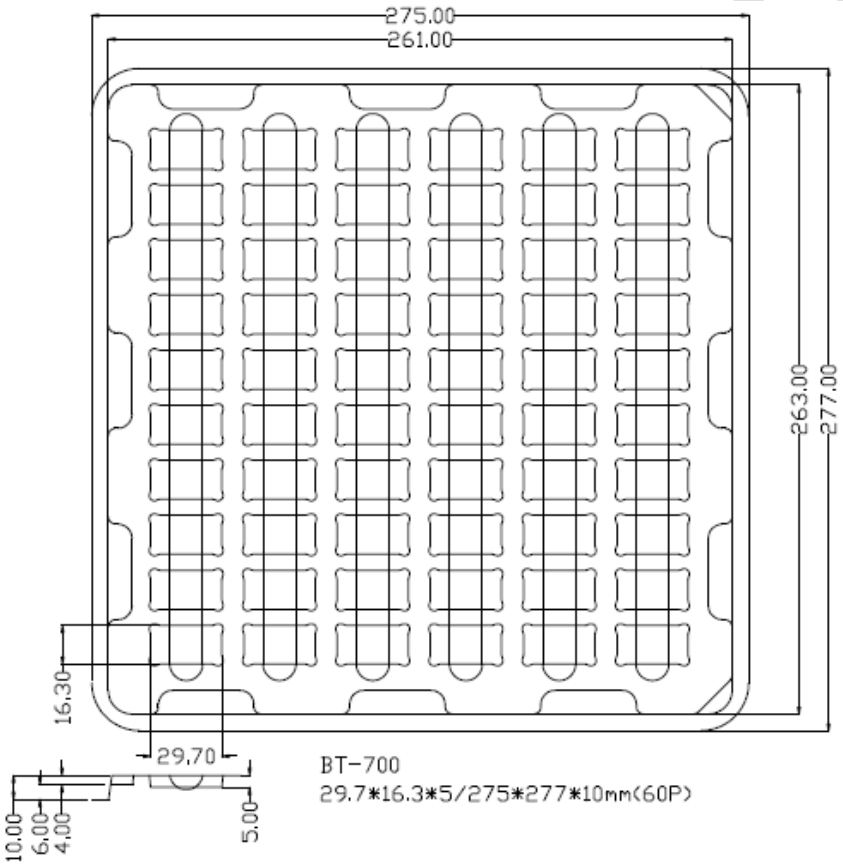


Figure 10-1: BT730 Shipping Tray Details

10.3 Reflow Parameters

Laird surface mount modules are designed to be easily manufactured including reflow soldering to a PCB. Ultimately it is the responsibility of the customer to choose the appropriate solder paste and to ensure oven temperatures during reflow meet the requirements of the solder paste. Laird Technologies' surface mount modules conform to J-STD-020D1 standards for reflow temperatures.

Important: During reflow, modules should not be above 260° and not for more than 30 seconds.

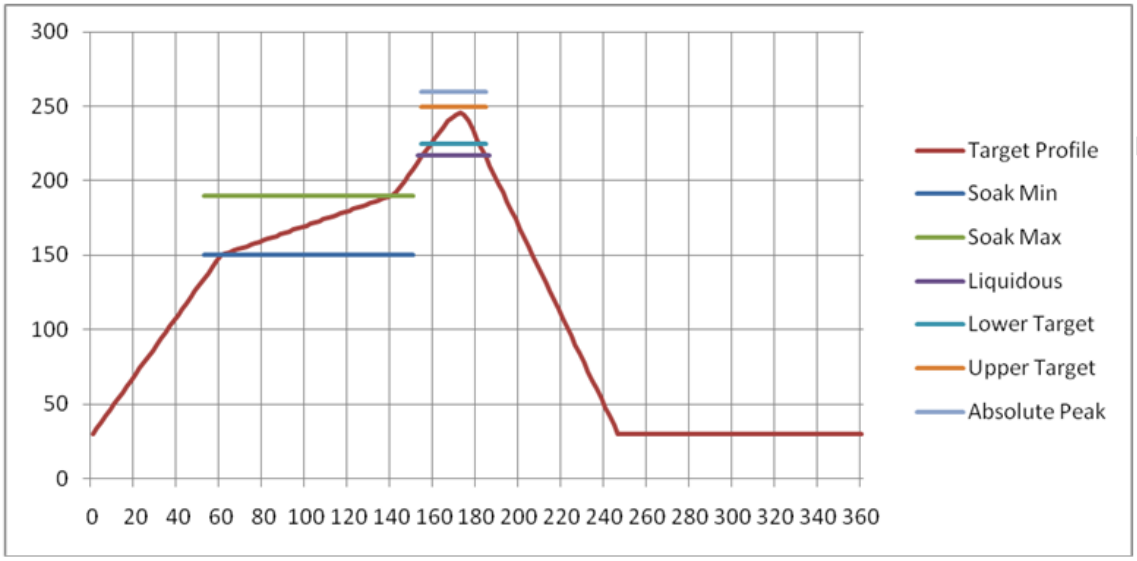


Figure 10-2: Recommended Reflow Temperature

Temperatures should not exceed the minimums or maximums presented in Table 10-1.

Table 10-1: Recommended Maximum and minimum temperatures

Specification	Value	Unit
Temperature Inc./Dec. Rate (max)	1~3	°C / Sec
Temperature Decrease rate (goal)	2-4	°C / Sec
Soak Temp Increase rate (goal)	.5 - 1	°C / Sec
Flux Soak Period (Min)	70	Sec
Flux Soak Period (Max)	120	Sec
Flux Soak Temp (Min)	150	°C
Flux Soak Temp (max)	190	°C
Time Above Liquidous (max)	70	Sec
Time Above Liquidous (min)	50	Sec
Time In Target Reflow Range (goal)	30	Sec
Time At Absolute Peak (max)	5	Sec
Liquidous Temperature (SAC305)	218	°C
Lower Target Reflow Temperature	240	°C
Upper Target Reflow Temperature	250	°C

Absolute Peak Temperature	260	°C

11. FCC Regulatory Statements

Family	US/FCC	CANADA/IC
BT7x0	SQGBT700	3147A-BT700

PART #	FORM FACTOR	TX OUTPUT	ANTENNA
BT730-SA-XX	Surface Mount	18dBm	Chip
BT730-SC-XX	Surface Mount	18dBm	U.FL

*Last two slots "XX" in Part # are used for production firmware release changes. Can be values 01-99, aa-zz

The BT730 family has been designed to operate with the antennas listed below with a maximum gain of 2dBi. The required antenna impedance is 50 ohms.

Item	Part Number	Mfg.	Type	Gain (dBi)
1	AT3216-B2R7HAAT	ACX	Chip	0.5
2	MAF94045	Laird	PCB	2
3	ACC-008	EZURIO	Ceramic Patch	2
4	WRR2400- IP04-B(MAF94019)	Laird	Dipole	1.5
5	WTC2450-IP04-K(MAF94006)	Laird	Dipole	2
6	S181FL-L-RMM-2450S	Nearson (Laird)	Dipole	2

Note: The OEM is free to choose another vendor's antenna of like type and equal or lesser gain as an antenna appearing in the table and still maintain compliance. Reference FCC Part 15.204(c)(4) for further information on this topic. To reduce potential radio interference to other users, the antenna type and gain should be chosen so that the equivalent isotropic radiated power (EIRP) is not more than that permitted for successful communication.

11.1 Power Exposure Information

In general, there are two agency classifications for RF radiation exposure in wireless applications; portable and mobile.

Mobile – A mobile device is defined as a transmitting device designed to be used in such a way that a separation distance of at least 20 centimeters is normally maintained between the transmitter's radiating structures and the body of the user or nearby persons. The BT730 is fully modular approved for mobile and fixed applications. Reference FCC Part 2.1091 for further details on mobile devices.

This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

Portable – Portable is a classification of equipment where the user, in general, will be within 20 cm of the transmitting antenna. Portable equipment is further broken down into two classes; within 2.5 cm of human contact and beyond 2.5 cm. The BT730 does not hold a portable approval classification due to its peak output power and modular approval restrictions. Further RF evaluation is required by customers who want to use the BT730 in portable applications. Contact a qualified test house or a Laird Technologies

representative for further information on this topic. Reference FCC Part 2.1093 for further details on portable devices.

Maximum Permissible Exposure report has been created which shows the minimum distances for Public and Occupational use of the BT730.

Note: Occupational Limit Minimum Distance = 1.5cm Public Limit Minimum Distance = 3cm

Note: This equipment was tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference does not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to correct the interference by one or more of the following measures:

Reorient or relocate the receiving antenna
Increase the separation between the equipment and the receiver
Connect the equipment to an outlet on a circuit that is different from that to which the receiver is connected.
Consult the dealer or an experienced radio/TV technician for help

CAUTION: THIS DEVICE COMPLIES WITH PART 15 OF THE FCC RULES AND INDUSTRY CANADA LICENSE-EXEMPT RSS STANDARD(S). OPERATION IS SUBJECT TO THE FOLLOWING TWO CONDITIONS: (1) THIS DEVICE MAY NOT CAUSE HARMFUL INTERFERENCE, AND (2) THIS DEVICE MUST ACCEPT ANY INTERFERENCE RECEIVED, INCLUDING INTERFERENCE THAT MAY CAUSE UNDESIRED OPERATION.

CAUTION: The OEM should have the device incorporating with the BT730 tested by a qualified test house to verify compliance with FCC Part 15 Subpart B limits for unintentional radiators.

CAUTION: Any changes or modifications not expressly approved by Laird could void the user's authority to operate the equipment.

OEM Responsibilities

This device is intended only for OEM integrators under the following conditions:

1) The antenna must be installed such that 20 cm is maintained between the antenna and users.

2) The transmitter module may not be co-located with any other transmitter or antenna

As long as 2 conditions above are met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed

IMPORTANT NOTE:

In the event that these conditions can not be met (for example certain laptop configurations or co-location with another transmitter), then the FCC authorization is no longer considered valid and the FCC ID can not be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC authorization.

End Product Labeling

This transmitter module is authorized only for use in device where the antenna may be installed such that 20 cm may be maintained between the antenna and users. The final end product must be labeled in a visible area with the following: "Contains FCC ID: SQGBT700".

Manual Information To the End User

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module.

The end user manual shall include all required regulatory information/warning as show in this manual.

Industry Canada (IC) Warning:

Radiation Exposure Statement:

This equipment complies with IC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

Déclaration d'exposition aux radiations:

Cet équipement est conforme aux limites d'exposition aux rayonnements IC établies pour un environnement non contrôlé. Cet équipement doit être installé et utilisé avec un minimum de 20 cm de distance entre la source de rayonnement et votre corps.

This device is intended only for OEM integrators under the following conditions: (For module device use)

1) The antenna must be installed such that 20 cm is maintained between the antenna and users.

2) The transmitter module may not be co-located with any other transmitter or antenna.

As long as 2 conditions above are met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed.

Cet appareil est conçu uniquement pour les intégrateurs OEM dans les conditions suivantes: (Pour utilisation de dispositif module)

1) L'antenne doit être installée de telle sorte qu'une distance de 20 cm est respectée entre l'antenne et les utilisateurs.

2) Le module émetteur peut ne pas être coïmplanté avec un autre émetteur ou antenne.

Tant que les 2 conditions ci-dessus sont remplies, des essais supplémentaires sur l'émetteur ne seront pas nécessaires. Toutefois, l'intégrateur OEM est toujours responsable des essais sur son produit final pour toutes exigences de conformité supplémentaires requis pour ce module installé.

IMPORTANT NOTE:

In the event that these conditions can not be met (for example certain laptop configurations or co-location with another transmitter), then the Canada authorization is no longer considered valid and the IC ID can not be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate Canada authorization.

NOTE IMPORTANTE:
Dans le cas où ces conditions ne peuvent être satisfaites (par exemple pour certaines configurations d'ordinateur portable ou de certaines co-localisation avec un autre émetteur), l'autorisation du Canada n'est plus considéré comme valide et l'ID IC ne peut pas être utilisé sur le produit final. Dans ces circonstances, l'intégrateur OEM sera chargé de réévaluer le produit final (y compris l'émetteur) et l'obtention d'une autorisation distincte au Canada.

End Product Labeling

This transmitter module is authorized only for use in device where the antenna may be installed such that 20 cm may be maintained between the antenna and users. The final end product must be labeled in a visible area with the following: "Contains IC: ".

Plaque signalétique du produit final

Ce module émetteur est autorisé uniquement pour une utilisation dans un dispositif où l'antenne peut être installée de telle sorte qu'une distance de 20cm peut être maintenue entre l'antenne et les utilisateurs. Le produit final doit être étiqueté dans un endroit visible avec l'inscription suivante: "Contient des IC: ".

Manual Information To the End User

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module.

The end user manual shall include all required regulatory information/warning as show in this manual.

Manuel d'information à l'utilisateur final

L'intégrateur OEM doit être conscient de ne pas fournir des informations à l'utilisateur final quant à la façon d'installer ou de supprimer ce module RF dans le manuel de l'utilisateur du produit final qui intègre ce module.
Le manuel de l'utilisateur final doit inclure toutes les informations réglementaires requises et avertissements comme indiqué dans ce manuel.

12. CE REGULATORY

The BT730 has been tested for compliance with relevant standards for the EU market. The OEM should consult with a qualified test house before entering their device into an EU member country to make sure all regulatory requirements have been met for their complete device.

The BT730 was tested with a 2dBi dipole antenna. The OEM is free to use any manufacturer's antenna and type of antenna but it must be ≤2dBi to remain in compliance with the Laird reports.

Reference the Declaration of Conformities listed below for a full list of the standards that the modules were tested to. Test reports are available upon request.

13. EU DECLARATIONS OF CONFORMITY

13.1 BT730-SA

Manufacturer:	Laird Technologies
Product:	BT730-SA
EU Directive:	RTTE 1995/5/EC
Conformity Assessment:	Annex IV

Reference standards used for presumption of conformity:

Article Number:	Requirement	Reference standard(s):
3.1a	Health and Safety	EN 60950-1:2006
3.1b	Protection requirements with respect to electromagnetic compatibility	EN 301 489-1 V1.8.1 EN 301 489-17 V2.1.1 Emissions: EN55022:2006/A1:2000/A2:2006(ClassB) Immunity: EN61000-4-2:1995/A1:1998/A2:2001 EN61000-4-3:2002/A1:2002
3.2	Means of the efficient use of	EN 300 328 V1.7.1 (2006-10)

	the radio frequency spectrum

Declaration:

We, Laird Technologies, declare under our sole responsibility that the essential radio test suites have been carried out and that the above product to which this declaration relates is in conformity with all the applicable essential requirements of Article 3 of the EU Directive 1995/5/EC, when used for its intended purpose.

Place of Issue:	Laird Technologies Saturn House, Mercury Park Wooburn Green HP100HH, United Kingdom tel:+44 (0)1628 858 940 fax: +44 (0)1628 528 382
Date of Issue:	June 2013
Name of Authorized Person:	Andrew Dobbing, Engineering Manager
Signature:	

13.2 BT730-SC

Manufacturer:	Laird Technologies
Product:	BT730-SC
EU Directive:	RTTE 1995/5/EC
Conformity Assessment:	Annex IV

Reference standards used for presumption of conformity:

Article Number:	Requirement	Reference standard(s):
3.1a	Health and Safety	EN 60950-1:2006
3.1b	Protection requirements with respect to electromagnetic compatibility	EN 301 489-1 V1.8.1 EN 301 489-17 V2.1.1 Emissions: EN55022:2006/A1:2000/A2:2006(ClassB) Immunity: EN61000-4-2:1995/A1:1998/A2:2001 EN61000-4-3:2002/A1:2002
3.2	Means of the efficient use of the radio frequency spectrum	EN 300 328 V1.7.1 (2006-10)

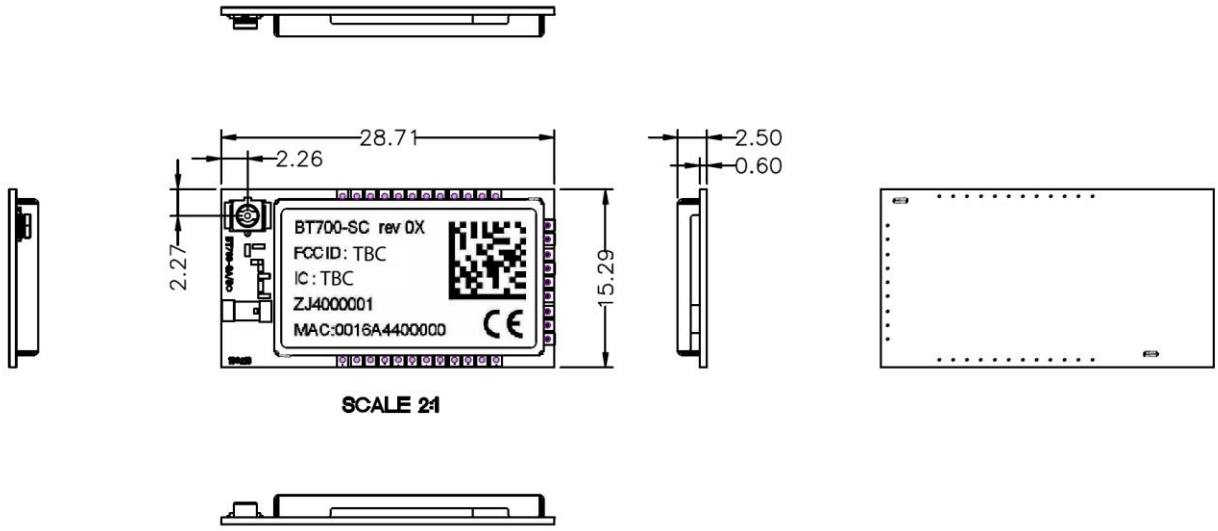
Declaration:

We, Laird Technologies, declare under our sole responsibility that the essential radio test suites have been carried out and that the above product to which this declaration relates is in conformity with all the applicable essential requirements of Article 3 of the EU Directive 1995/5/EC, when used for its intended purpose.

Place of Issue:	Laird Technologies Saturn House, Mercury Park Wooburn Green HP100HH, United Kingdom tel:+44 (0)1628 858 940 fax: +44 (0)1628 528 382
Date of Issue:	June 2013
Name of Authorized Person:	Andrew Dobbing, Engineering Manager
Signature:	

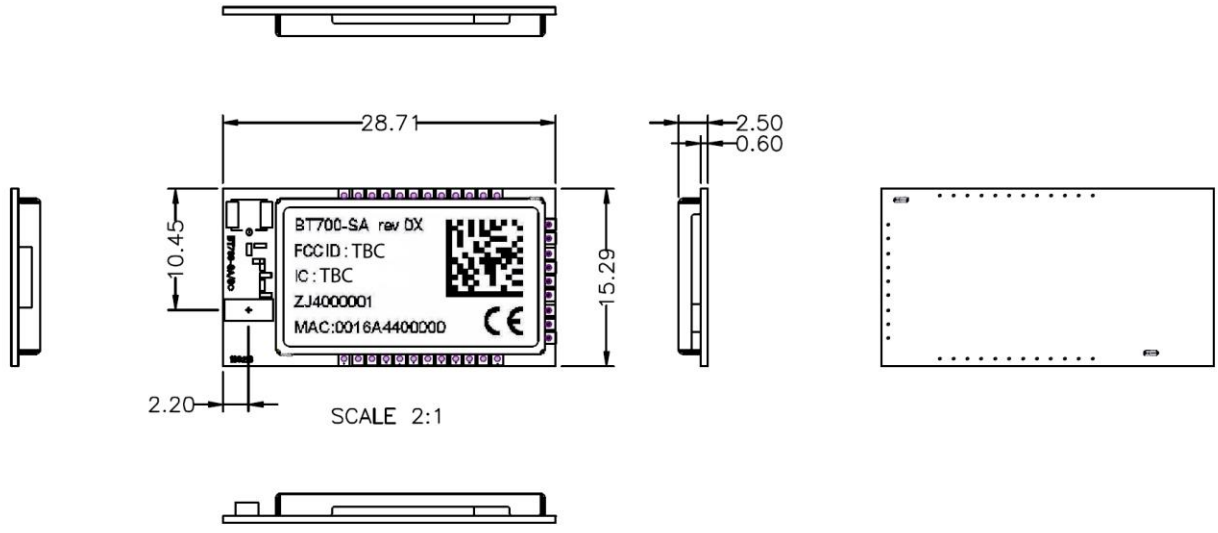
14. MECHANICAL DETAILS

BT730-SC Mechanical Details



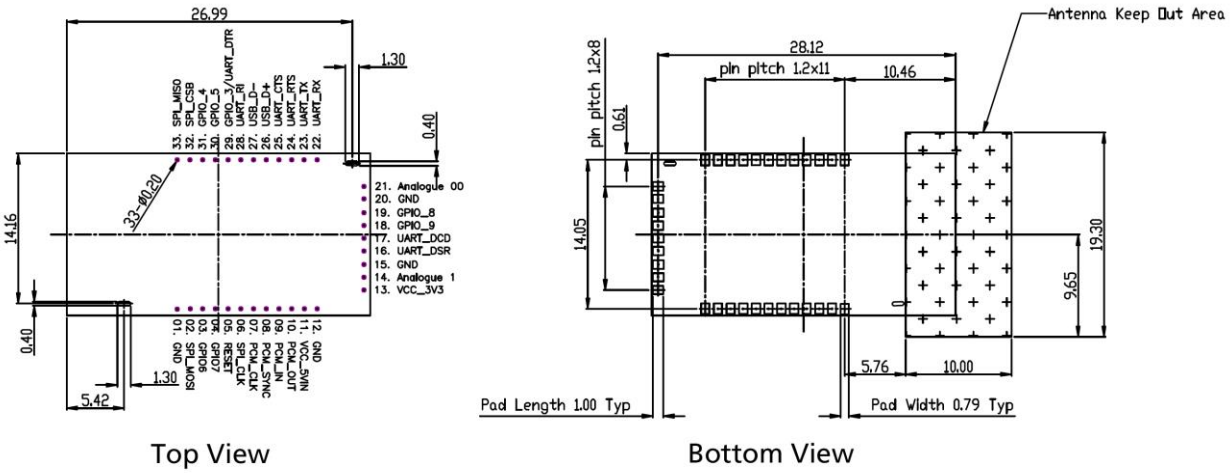
Module Keep-Out Area: An area of 1.5mm around the module should be reserved as a keep-out area .No other components should be placed in this area.

BT730-SA Mechanical Details



Module Keep-Out Area: An area of 1.5mm around the module should be reserved as a keep-out area. No other components should be placed in this area.

BT730 Pad Definitions – Mechanical Drawing



15. ORDERING INFORMATION

Part Number	Description
BT730-SA	Class 1 Bluetooth V2.0Module (internal antenna)
BT730-SC	Class 1 Bluetooth v2.0 Module (uFL for external antenna)
DVK – BT730-SA	Development board with BT730-SA module soldered in place
DVK – BT730-SC	Development board with BT730-SC module soldered in place

15.1 General Comments

This is a preliminary datasheet. Please check with Laird Technologies for the latest information before commencing a design. If in doubt, ask.

16. BLUETOOTH SIG APPROVALS

The BT730-SA and BT730-SC modules are fully Bluetooth SIG qualified as END products.

DesignName	Owner	QDID number	Link to listing on the SIG website
BT730-SA BT730-SC	EZURiO (a unit of Laird Technologies)	TBC	

It is a mandatory requirement of the Bluetooth Special Interest Group (SIG) that every product implementing Bluetooth technology is listed on the Bluetooth SIG End Product Listing (EPL). The EPL process is simple and free of charge but does require registration of your company at the Bluetooth SIG website – www.bluetooth.org

The following link provides an overview of the EPL system – the user will be required to register / login first:

https://www.bluetooth.org/login/register/

https://www.bluetooth.org/technical/qualification/eploverview.htm

For a detailed procedure of how to make an EPL entry, please refer to the following SIG document;

https://www.bluetooth.org/docman/handlers/DownloadDoc.ashx?doc_id=71880

Additionally there is on EPL online training guide at the following link:-

https://www.bluetooth.org/events/training/epltraining.htm

In the case of Laird'sBT730-SA / BT730-SC, please search for QDID TBC in step 4 and then 'Create New EPL' as per step 5.

16.1 Additional Assistance

Please contact your local sales representative for further assistance:

Laird Technologies

wirelessinfo@lairdtech.com

Americas : +1-800-492-2320 Option 2

Europe: +44-1628-858-940

Hong Kong: +852-2923-0610

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Laird Technologies is the world leader in the design and manufacture of customized, performance-critical products for wireless and other advanced electronics applications.

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- Computers
- Aerospace
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- Medical Equipment
- Consumer Electronics

Laird Technologies offers its customers unique product solutions, dedication to research and development, as well as a seamless network of manufacturing and customer support facilities across the globe.

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CONN-UM-BT730_v0.9