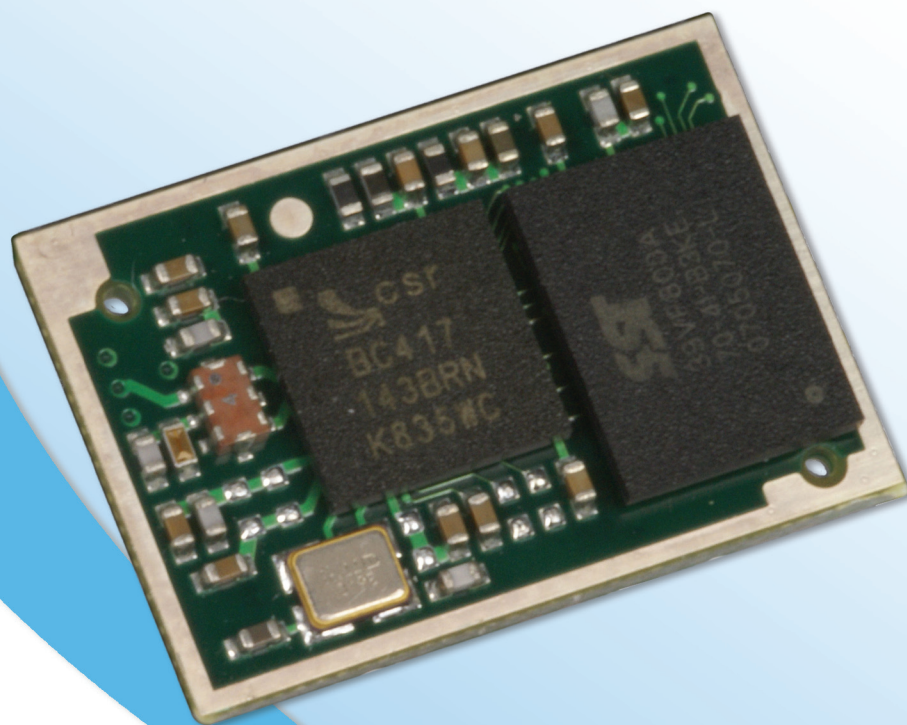


BTM410/411 DATA MODULE

USER MANUAL



Innovative **Technology**
for a **Connected** World

BTM410/411

Bluetooth® AT Data Module

REVISION HISTORY

REVISION HISTORY

Revision

Description

BTM410/411

Bluetooth® AT Data Module

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BTM410/411

Bluetooth® AT Data Module

OVERVIEW AND KEY FEATURES

The BTM410 and BTM411 Bluetooth® modules from Laird Technologies have been designed to meet the needs of developers who wish to add robust, short range Bluetooth data connectivity to their products. They are based on the market leading Cambridge Silicon Radio BC04 chipset, providing exceptionally low power consumption with outstanding range. They support the latest Bluetooth® Version 2.1 Specification, providing the important advantage of Secure Simple Pairing, which improves security and enhances the ease of use for end customers.

With physical sizes as small as 12.5 x 18.0mm and best of class, low-power operation, these modules are the ideal choice for applications where designers need both performance and minimum size. For maximum flexibility in systems integration, the modules are designed to support a separate power supply for I/O.

To aid product development and integration, Laird Technologies has integrated a complete Bluetooth protocol stack within the modules, including support for the Bluetooth Serial Port Profile. The modules are fully qualified as Bluetooth End Products, allowing designers to integrate them within their own products with no further Bluetooth Qualification. They can then list and promote their products on the Bluetooth website free of charge.

Future releases include support for the Bluetooth Health Device Profile, making this module the ideal choice for manufacturers who are developing Continua Health Alliance compliant devices.

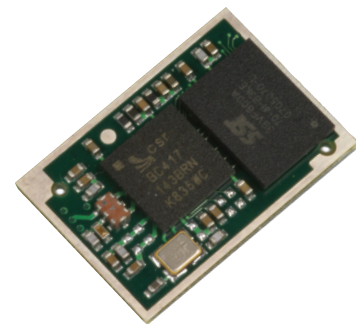
A comprehensive AT command interface is included, which simplifies firmware integration. Combined with a low cost developers kit, this ensures that the choice of Laird Technologies Bluetooth modules guarantees the fastest route to market.

FEATURES AND BENEFITS

- Bluetooth® v2.1+EDR
- Adaptive Frequency Hopping to cope with interference from other wireless devices
- Secure Simple Pairing support
- External or internal antenna options
- Comprehensive AT interface for simple programming
- Bluetooth® END Product Qualified
- Compact size
- Class 2 output – 4dBm
- Low power operation
- UART interface
- Multi-point support
- PCM and SCO for external codec
- GPIO lines under AT control
- Support for Serial Port Profile
- Support for Health Device Profile (Q3 '09)
- Wi-Fi co-existence

APPLICATION AREAS

- Embedded Devices
- Phone Accessories
- Security Devices
- Medical and Wellness Devices
- Automotive Applications
- Bluetooth® Advertising
- ePOS



BTM410/411

Bluetooth® AT Data Module

SPECIFICATIONS

CATEGORIES	FEATURE	IMPLEMENTATION
Wireless Specification	Bluetooth®	Version 2.1+EDR
	Transmit Class	Class 2
	Frequency	2.402 – 2.480 GHz
	Channels	79 channels Frequency Hopping Adaptive Frequency Hopping
	Max Transmit Power	+4 dBm at antenna pad – BTM410 +4 dBm from integrated antenna – BTM411 (provisional)
	Min Transmit Power	-27 dBm at antenna pad – BTM410 -27 dBm from integrated antenna – BTM411 (provisional)
	Receive Sensitivity	-84dBm
	Range	Up to 50 metres free space
	Data Transfer Rate	Up to 300 kbps
	Antenna Modes	External Antenna
Integrated Antenna (option)		+0dBi multilayer ceramic – BTM411 (provisional)
UART Interface	Serial Interface	RS-232 bi-directional for commands and data 16550 compatible
	Baud Rate	Configurable from 1,200 to 921,600bps Non-standard baud rates supported
	Bits	8
	Parity	Odd, even, none
	Stop bits	1 or 2
	Default Serial parameters	9600,n,8,1
	Levels	Set by VDD_USB input
	Modem Control	DTR, DSR, DCD, RI, RTS, CTS
General Purpose Interface	I/O	8 general purpose I/O pins
Audio	Support	3 PCM Channels @ 64kbps
	SCO Channels	Support SCO and eSCO
	PCM Interface	Configurable as master or slave 8 bit A-law 8 bit μ -law 13 bit linear PCM Clock available when in slave mode
Protocols and Firmware	Bluetooth Stack	V2.1 compliant. Fully integrated.
	Profiles	GAP (Generic Access Profile) SDP (Service Discovery Profile) SPP (Serial Port Profile) HDO (Health Device Profile) – 2009 release
	Firmware Upgrade	Available over UART
	Connection Modes	Point to point (cable replacement) Multipoint – max 3 slaves

BTM410/411

Bluetooth® AT Data Module

SPECIFICATIONS

CATEGORIES	FEATURE	IMPLEMENTATION
Command Interface	AT Instructions set	Comprehensive control of connection and module operation S Registers for non-volatile storage of parameters
	Multipoint Software	Supports multiple connections
Current Consumption	Data Transfer	Typically 32mA
	Low Power Sniff Mode	Less than 2.5mA
Supply Voltage	Supply	3.0V – 3.3V DC
	I/O	1.7V – 3.3V DC (independent of Supply)
	USB & UART	1.7V – 3.6V DC (independent of Supply)
Coexistence / Compatibility	WLAN (802.11)	2-wire and 3-wire hardware coexistence schemes supported
Connections	Interface	Surface Mount Pads
	External Antenna (BTM410)	Pad for 50 Ohm antenna
Physical	Dimensions	12.5mm x 18.0 x 1.6mm BTM410 12.5mm x 24.0mm x 1.6mm BTM411 (provisional)
	Weight	3 grams
Environmental	Operating Temperature	-30°C to +70°C
	Storage Temperature	-40°C to +85°C
Approvals	Bluetooth	Qualified as an END product
	FCC	Meets FCC requirements Modular Approval (Integrated Antenna option – BTM411)
	CE & R&TTE	Meets CE and R&TTE requirements
Miscellaneous	Lead free	Lead-free and RoHS compliant
	Warranty	12 Months
Development Tools	Development Kit	Development board and software tools DVK-BTM410 Dev Kit with BTM410 module fitted DVK-BTM411 Dev Kit with BTM411 module fitted

SPECIFICATIONS

PIN	SIGNAL	DESCRIPTION	VOLTAGE SPECIFICATION
1	Unused		
2	GND		
3	UART_CTS	Clear to Send I/P	VUSB
4	UART_RXD	Receive data I/P	VUSB
5	UART_RTS	Request to Send O/P	VUSB
6	UART_TXD	Transmit data O/P	VUSB
7	GND		
8	SPI_CSB	SPI bus chip select I/P	VIO
9	SPI_MISO	SPI bus serial O/P	VIO
10	SPI_MOSI	SPI bus serial I/P	VIO
11	SPI_CLK	SPI bus clock I/P	VIO
12	VDD_USB	USB & UART supply voltage	
13	VDD_IO	I/O supply voltage	
14	VDD_IN	Main supply voltage	
15	GND		
16	PCM_IN	PCM clock I/P	VIO
17	PCM_SYNC	PCM sync I/P	VIO
18	PCM_CLK	PCM clock I/P	VIO
19	PCM_OUT	PCM Data O/P	VIO
20	RESET	Module reset I/P	See note 2
21	GPIO5	I/O for host	VIO
22	GPIO3 / UART_DCD	I/O for host	VIO
23	GND		
24	Unused		
25	Unused		
26	Unused		
27	Unused		
28	GND		
29	ANT (BTM410)	Antenna connection (50 ohm matched)	
30	GND		
31	Unused		
32	Unused		
33	Unused		
34	Unused		
35	Unused		
36	Unused		
37	Unused		
38	Unused		
39	Unused		
40	Unused		
41	GND		
42	GPIO2 / UART_RI	I/O for host	VIO
43	GPIO9 /UART_ DTR	I/O for host	VIO
44	GPIO10 / UART_DSR	I/O for host	VIO
45	GND		
46	D-	Not used for AT module variants	VUSB
47	D+	Not used for AT module variants	VUSB
48	GPIO7	I/O for host	VIO
49	GPIO6	I/O for host	VIO
50	GPIO4	I/O for host	VIO

- Note:
1. Unused pins may have internal connections and must not be connected.
 2. Reset input is active low. Input is pulled up to VDD_IN via 22k. Minimum reset pulse width is 5ms.

OPERATING PARAMETERS

OPERATING PARAMETERS

RECOMMENDED OPERATING CONDITIONS		
OPERATING CONDITION	MIN	MAX
VDD_USB (USB compatibility not required)	1.7	3.6
VDD_USB (USB compatibility required)	3.1	3.6
VDD_IO	1.7	3.3
VDD_IN	3.0	3.3

VOLTAGE SPECIFICATIONS

LOGIC LEVELS (VUSB)			
INPUT VOLTAGE LEVELS	MIN	TYP	MAX
V_{ih}	0.7VDD_IO		
V_{il}	1.7 < VDD_USB < 1.9	-0.4	+0.8
	2.7 < VDD_USB < 3.0	-0.4	+0.4
OUTPUT VOLTAGE LEVELS (1.7 < VDD_USB < 1.9)			
V_{oh} (Iout = -4mA)	VDD_USB - 0.4		
V_{ol} (Iout = 4mA)	0.4		
OUTPUT VOLTAGE LEVELS (2.7 < VDD_USB < 3.0)			
V_{oh} (Iout = -4mA)	VDD_USB - 0.2		
V_{ol} (Iout = 4mA)	0.2		

Note: VDD_USB must be connected to power the USB and UART interfaces.

LOGIC LEVELS (VIO)			
INPUT VOLTAGE LEVELS	MIN	TYP	MAX
V_{ih}	0.7VDD_IO		
V_{il}	-0.4		+0.8
	-0.4		+0.4
OUTPUT VOLTAGE LEVELS (1.7 < VDD_IO < 1.9)			
V_{oh} (Iout = -4mA)	VDD_IO - 0.4		
V_{ol} (Iout = 4mA)	0.4		
OUTPUT VOLTAGE LEVELS (2.7 < VDD_IO < 3.0)			
V_{oh} (Iout = -4mA)	VDD_IO - 0.2		
V_{ol} (Iout = 4mA)	0.2		

CONFIGURING THE BTM410/411

INTRODUCTION

This document describes the protocol used to control and configure the BT Data Bluetooth device.

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 device perform the two core actions of a Bluetooth device, which is make/break a connection and Inquiry. Many other AT commands are also provided to perform ancillary functions, such as, pairing, trusted device database management and S Register maintenance.

Just like telephony modems, the device powers up in an unconnected state and will only respond via the serial interface. In this state the device will not even 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 (default setting is 9600) and an RF communications end point. The latter has a concept of connected and unconnected modes and the former will have a concept of command and data modes. This leads to the matrix of states shown below.

	RF UNCONNECTED	RF CONNECTED
Local Command Mode	OK	OK
Remote Command Mode	ILLEGAL	OK
Data Mode	ILLEGAL	OK

The combinations, 'Data and RF Unconnected Mode' and 'Remote Command and RF Unconnected Mode' do not make sense and will be ignored.

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

**CONFIGURING
THE BTM410/411****AT COMMAND SET****Assumptions**

The CSR (Cambridge Silicon Radio) Bluecore chipset in Laird Technologies 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 will have a protocol similar to an AT modem. In fact, the protocol is similar enough so that existing source code written for modems, can be used with very little modification with a Laird Technologies device.

Therefore the following assumptions are made:

1. All commands are terminated by the carriage return character 0x0D, which is represented by the string <cr> in descriptions below this cannot be changed.
2. All responses from the 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>.
3. All Bluetooth addresses are represented by a fixed 12 digit hexadecimal string, case insensitive.
4. All Bluetooth Device Class codes are represented by a fixed 6 digit hexadecimal string, case insensitive.

Commands

This section describes all available AT commands. Many commands require mandatory parameters and some take optional parameters. These parameters are either 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 which could be positive or negative, which can be entered as a decimal value or in hexadecimal if preceded by the '\$' character. E.g. the value 1234 can also be entered as \$4D2
<string>	A string delimited by double quotes. E.g. "Hello World". The " character MUST be supplied as delimiters.
<uuid>	A 4 character UUID number consisting of ASCII characters '0' to '9', 'A' to 'F' and 'a' to 'f'.

1. **^^^ {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, so can be changed. In addition, the escape sequence guard time is specified by S Register 12. By default the guard time is set to 100 milliseconds. Please refer to Section 5: Dropping Connections for more related 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>

2. **!!! {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 step 12)

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

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

**CONFIGURING
THE BTM410/411**

3. **AT**
Used to check the module is available.
Response: <cr,lf>OK<cr,lf>

4. **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>

5. **ATD<U><Y><bd_addr>,<uuid> {Make Outgoing Connection}**
Make a connection to device with Bluetooth address <bd_addr> and SPP profile <uuid>. The <uuid> is an optional parameter which specifies the UUID of the profile server to attach to, and if not supplied then the default UUID from S Register 101 is used. As this is a device which utilises the RFCOMM layer as described in the Bluetooth specification, it necessarily 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 in a single power up session. Therefore if that number is exceeded, then the connection attempt will fail with the following response:-
Response: <cr,lf>CALL LIMIT
Or <cr,lf>NO CARRIER<cr,lf>

In that case, issuing an ATZ to reset the device will reset the count to 0 and more connections are possible.

The following RFCOMM based UUIDs are defined in the Bluetooth Specification:-

PROFILE NAME	UUID
Serial Port	0x1101
LAN Access Using PPP	0x1102
Dialup Networking	0x1103
IrMC Sync	0x1104
OBEX Object Push	0x1105
OBEX File Transfer	0x1106
IrMC Sync Command	0x1107
Headset	0x1108
Cordless Telephony	0x1109
Intercom	0x1110
Fax	0x1111
Audio Gateway	0x1112
WAP	0x1113
WAP_CLIENT	0x1114

**CONFIGURING
THE BTM410/411****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 will be returned if the 'L' modifier is specified AND a Bluetooth address.

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

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

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

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

Make a SPP 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 will be returned if the 'R' modifier is specified AND a Bluetooth address.

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

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

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

8. ATEn {Enable/Disable Echo}

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

E1 Enable echo.

All other values of n will generate an error.

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

Or

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

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>

10. ATIn {Information}

This will return the following information about the Laird Technologies device.

10	The product name/variant.
11	The CSR firmware build number.
12	The Laird Technologies firmware build number. For internal use only.
13	The Laird Technologies firmware revision.
14	A 12 digit hexadecimal number corresponding to the Bluetooth address of the device.
15	The manufacturer of this device.
16	The maximum size of trusted device database.
17	The manufacturer of the Bluetooth chipset.
18	The chipset format.
19	0 if not in a connect state and 1 if in a connect state.

**CONFIGURING
THE BTM410/411**

111	<p>The reason why a “NO CARRIER” resulted in the most recent attempt at making an outgoing connection. Where the response values are as follows:</p> <ul style="list-style-type: none"> 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
-----	--

112	The last ERROR response number.
-----	---------------------------------

113	<p>The Sniff status is returned as follows:-</p> <p>Response: <cr,lf>a:b,c,d,e<cr,lf>OK<cr,lf></p> <p>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.</p>
-----	---

114	The current boot mode (Only for firmware 1.18.0 and newer)
-----	--

115	The maximum length of an AT command, including the terminating carriage return (only for firmware 1.6.10 and newer)
-----	---

116	The size of AT command input buffer
-----	-------------------------------------

120	Returns the number of bytes pending to be sent in the rf buffer when a connection is up.
-----	--

133	Version number of Multipoint application (Note: ATI is provided for compatibility in multipoint mode, other AT commands are not available).
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142	<p>State information. Where the response values are as follows:</p> <ul style="list-style-type: none"> 13 = NotOpen 14 = OpenIdle 15 = Ringing 16 = OnlineCommand 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. <p>Note when n=16, ATI9 will return 1.</p>
-----	---

1101	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 this is quite a large band, therefore RSSI is not always a useful indicator. Use ATI111 instead which returns the bit error rate.
------	--

1111	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. As the value approaches 1000 (BER = 0.1%) it is an indication that the link is very bad and a large number of Bluetooth packets are being lost.
------	--

**CONFIGURING
THE BTM410/411**

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

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

Or

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

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

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

12. ATSn=m {Set S Register}

As with modems, the Bluetooth module employs a concept of registers which are used to store parameters, such as escape sequence character, inquiry delay time etc, 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 that 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.

REGISTER	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 will in turn use '+' as default. So if both used '+' there will be confusion. 0x5e is the character '^'.
S12	100	40..5000	Escape sequence guard time in milliseconds, with a granularity of 20ms. New values are rounded down to the nearest 20ms multiple
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	Defines a set of bits masks for enabling profile servers. Values can be ORed. 1 is the default and only value allowed for this module which enables Serial Port Profile
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
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.

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CONFIGURING THE BTM410/411

REGISTER	DEFAULT	RANGE	COMMENT
S504	0	0..1	Setting to 1 will force S0 to -1 and will suppress messages arising from connections or pairing. E.g. CONNECT, NO CARRIER, RING, PAIR etc. Suppressing connection based messages allows the 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 also. 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 will be immediate. See S register 560 for specifying disconnect max timeout.
S506	1	0..1	Enable/Disable echoes. The ATEn command also affects this.
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 be 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 11.25ms so 10/11ms will give 11.25ms.
S509	320	10..2550	Page Scan Window in milliseconds. Minimum is 11.25ms so 10/11ms will give 11.25ms.
S510	640	10..2550	Inquiry Scan Interval in milliseconds. Minimum is 11.25ms so 10/11ms will give 11.25ms.
S511	320	10..2550	Inquiry Scan Window in milliseconds. Minimum is 11.25ms so 10/11ms will give 11.25ms.
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 will be discoverable only, similar to issuing AT+BTQ. When set to 3, it will be connectable but not discoverable e.g. AT+BTG When set to 4, it will be connectable and discoverable e.g. AT+BTP. When set to 5, it will be 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 will be 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 will be 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 that 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 will fall back to the mode specified in S Register 555. S512 continued.... 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, SReg 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.

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REGISTER	DEFAULT	RANGE	COMMENT
S515	0x001F00	0.. 0xFFFFF	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.
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 will remain unchanged for that particular firmware build.
S519	500	100..6000	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 100ms
S520	9600	1200..115200	Change to a standard baud rate. The effect is immediate and in fact the OK will be sent at the new baud rate. Only one of the following baud rates are accepted: 1200,2400,4800,9600,19200,28800,38400,57600,115200.
S521	See Comment	1200..921600	Change baud rate to non-standard value. Laird Technologies' 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 will be returned and the old baud rate will prevail. To inspect the actual baud rate, do AT\$S21? S521 should only be used for non-standard baud rates. For standard baud rates use S520. The effect is immediate and in fact the OK will be sent at the new baud rate. 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 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"
S522	1	1	1 = CTS/RTS hardware handshaking enabled
S523	1	1..2	Number of Stop bits
S524	0	0..2	Parity. 0=None, 1=Odd, 2=Even
S526	3	1..3	This register specifies a 2 bit mask used to qualify how S Registers 520 to 524 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 So for example, to change comms parameters, but have them come into effect only after subsequent power cycles, then this register should be set to 2, and likewise to affect immediately and yet not have it persist over a power cycle, the value should be set to 1. 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 100ms. See S Register 505 and 543 also

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REGISTER	DEFAULT	RANGE	COMMENT
S531	0	0..5	<p>Specifies the mode on connection establishment.</p> <p>0 = Normal, that data is exchanged between UART and RF</p> <p>1 = LOCAL_COMMAND. UART input is parsed by the AT interpreter and RF data is discarded</p> <p>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 will be returned</p> <p>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.</p> <p>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.</p> <p>5 = DEAMON mode</p>
S532	0	0..7	If non zero then on every connection, a SCO channel (audio) will be initiated. Bit 0 for HV1, Bit1 for HV2 and Bit2 for HV3. When the connection is lost, the SCO channel disappears along with it.
S533	1	0..2	<p>If set to 1 then GPIO5 follows RI state, if set to 2 then it follows the state of DSR and if 0 it is not driven and GPIO5 is available as a user I/O.</p> <p>This register will not necessarily 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.</p>
S534	1	0..2	<p>When set to 0, GPIO4 is available as user i/o</p> <p>If set to 1 then GPIO4 follows DCD state. If set to 2 then GPIO4 behaves as per setting 1, but in addition, when not in a connection, if the device is connectable or discoverable, then GPIO4 will blink.</p> <p>This register will not necessarily 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.</p>
S535	20	0..41	Link Supervision Timeout. If units go out of range, then a NO CARRIER message will be sent to the host after the time specified here
S536	0	0..1	<p>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.</p> <p>If S Register 507 is >= 2, then reading this register will always return 0 and writing 1 will result in ERROR 33.</p>
S538	0	0..1	If 1, then when a successful pairing occurs, it is automatically saved in the trusted device database – if it 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 is taken to mean that the current value should remain.
S541	6	-50..6	This sets the power level in dBm when inquiring or paging. Reading this register returns the value stored in non-volatile memory.
S542	6	-50..6	As per S541, however reading this register returns the current power level as set in the base band. The read can be different from S541 because 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	<p>If this is set to 1, then incoming pairing attempts will be 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).</p> <p>See S Register 505 and 530 also</p>
S544	1	0..1	Configure the UART for either low latency or maximum throughput. A setting of 1 gives maximum throughput.

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REGISTER	DEFAULT	RANGE	COMMENT
S551	0x3211	0xFFFF	<p>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.</p> <p>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)</p> <p>Each nibble can take the following value:-</p> <ol style="list-style-type: none"> 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 4 If DSR (pin 10) is asserted then 1 otherwise 0 <p>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 will cause the Bluetooth connection to be dropped.</p> <p>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.</p> <p>If this register is changed while in command and connected mode, then on going back online using the ATO command, a fresh signal will be sent to the peer to update the bits.</p>
S552	0x0122	0xFFFF	<p>This register specifies in each 4 bit nibble, how the DTR, DCD, RI output pins are controlled when in a Bluetooth connection</p> <p>Nibble 0..3 specifies the source for DTR 4..7 specifies the source for DCD 8..11 specifies the source for RI</p> <p>Each nibble can take the following value:-</p> <ol style="list-style-type: none"> 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 <p>If this register is changed while in command and connected mode, then on going back online using the ATO command, the modem output lines will get refreshed.</p>
S553	0x0201	0xFFFF	<p>This register specifies in each 4 bit nibble, how the DTR,DCD,RI output pins are controlled when NOT in a Bluetooth connection</p> <p>Nibble 0..3 specifies the source for DTR 4..7 specifies the source for DCD 8..11 specifies the source for RI</p> <p>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.</p> <p>Each nibble can take the following value:-</p> <ol style="list-style-type: none"> 0 Always deassert 1 Always assert 2 Assert if RING is being sent to the host

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REGISTER	DEFAULT	RANGE	COMMENT
S554	0	0..900	<p>If S Register 512 >= 2 and <= 7 then this register specifies a time in seconds for which the device will stay in the S512 mode after power up or reset. On timeout, it will abort the discoverable and/or connectable and fall back into S512=1 mode, when it is deaf and dumb.</p> <p>Note that if AT+BTR has been used to specify a peer device, then on reverting to mode 1, it will attempt to make a connection to that peer device.</p> <p>A power cycle, reset via BREAK or ATZ is required to see the effects of change.</p>
S555	1	1..7	<p>If S Register 554 is nonzero, then after the post reset window expires, the mode will revert 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).</p> <p>A power cycle, reset via BREAK or ATZ is required to see effects of a change.</p> <p>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, SReg 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.</p>
S556	0	0..3	<p>Allows GPIO or ADC values to be read via the minor class field in an inquiry response.</p> <p>When this value is non-zero, bits 2 to 7 contain information as follow:-</p> <ul style="list-style-type: none"> 1 :- ADC1 2 :- ADC2 3 :- GPIO1 to GPIO6 <p>Set to 0 to disable this feature.</p> <p>This allows i/o information to be conveyed without a connection.</p>
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 will eliminate ambiguity when the module has a Bluetooth connection to an AT modem which also gives these responses.
S559	0	0..3	<p>This specifies a mask.</p> <p>When Bit 0 is 1, the response word "ERROR" is replaced by "BTERR" and "OK" is replaced by "ok".</p> <p>When Bit 1 is 1, then error responses do not include the error number and instead the error number can be retrieved using AT112.</p>
S560	15	15..120	<p>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 and so 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.</p> <p>Time is specified with 15 seconds intervals.</p>
S561	0	0..1000	<p>Sniff Attempt Time in units of milliseconds. 0 means disable.</p> <p>See section "Power Consumption and Reset" in the user guide for more details.</p>
S562	0	0..1000	<p>Sniff timeout Time in units of milliseconds. 0 means disable.</p> <p>See section "Power Consumption and Reset" in the user guide for more details.</p>
S563	0	0..1000	<p>Sniff Minimum Interval in units of milliseconds. 0 means disable.</p> <p>See section "Power Consumption and Reset" in the user guide for more details.</p>
S564	0	0..1000	<p>Sniff Maximum Interval in units of milliseconds. See section "Power Consumption and Reset" in the user guide for more details.</p>
S565	0	1	If set to 1, RI (Ring Indicate) line is configured as an input and forces the start-up mode (SReg512) and post-timeout on Start-up mode (SReg555) to be dependent on the state of RI. The RI conditional modes are defined by SRegs 566 to 569 inclusive.
S566	1	7	If S565=1, and RI is asserted then this is the mode the device will start up in.
S567	1	7	If S565=1, and RI is deasserted then this is the mode the device will start up in.
S568	1	7	If S565=1, and RI is asserted then this is the mode the device will assume after the post-start-up timeout defined in SReg 554 instead of mode defined in SReg555

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REGISTER	DEFAULT	RANGE	COMMENT
S569	1	7	If S565=1, and RI is deasserted then this is the mode the device will assume after the post-start-up timeout defined in SReg 554 instead of mode defined in SReg555
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 so the new value cannot be accepted. For the former, drop the connection, then issue the command AT+BTX and then set the new value and for the latter issue 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 percent (rounded to the nearest multiple of 4)
S588	0	0..1	After a disconnection, there will be 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 just 1 record when autosaving of pairing is enabled via S reg 538
S593	0	0..1	Automatically append last 6 digits of local bluetooth address to the friendlyname which was set via AT+BTN or AT+BTF
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 will initialise it to a certain value
S601	0	0..1	If this is 1, then on reset S Reg 600 value will be 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 4 for GPIO5.
S611	0	1	Set to 1 to invert the logic of GPIO outputs. For example, ATS621=1 will set the output pin to low and vice versa.
S620	n/a	0..31	Read/Write to all 8 Digital lines in one atomic step. The value is returned as a 4 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 – Not available in Bism1
S627	n/a	0..1	Read/Write to GPIO7 – Not available in Bism1
S628	n/a	0..1	Read/Write to GPIO8 – Not available in Bism1
S629	n/a	0..1	Read/Write to GPIO9 – Not available in Bism1
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.

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REGISTER	DEFAULT	RANGE	COMMENT
S641	n/a	0..65535	As per 631, but the action of reading the value will reset the count to 0.
S642	n/a	0..65535	As per 632, but the action of reading the value will reset the count to 0.
S701	n/a	0..65535	Read/Write to Analogue Line 0, when reading value is returned in decimal
S702	n/a	0..65535	Read/Write to Analogue Line 1, when reading value is returned in decimal
S711	n/a	0000..FFFF	Read/Write to Analogue Line 0, when reading value is returned in hexadecimal
S712	n/a	0000..FFFF	Read/Write 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	10 General Purpose 32 bit Registers for use by host. These are stored in non-volatile memory.

13. ATSn? {Read S Register Value}

This will return 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>

14. ATSn=? {Read S Register – Valid Range}

This will return 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>

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 will be converted into a single byte before transmission to the peer.

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

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 will all pending data in the output rf buffer be 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 3 character sequence \hh will be converted into a single byte before transmission to the peer.

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

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

Forces the device through a hardware reset which means it will eventually come alive in the local command and unconnected mode. This allows changes to the PS store to take effect. The module will issue an OK response after the reset is complete and it is ready to receive commands once again.

ATZ and ATZ0 signify reset and emerge into the current mode (see command ATI14). ATZ1 to ATZ4 instructs the module to reset and then emerge into the appropriate boot mode. Note that S Reg 103 specifies the boot mode from cold.

Response: <cr,lf>OK<cr,lf> and OK is returned after the RESET

18. AT&Fn {Set S Register Defaults}

This command will only work 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.

Legal values of 'n' are as per the following table. All other values of n will 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.

&F0 (Default)	Medium power consumption, UART baud rate unchanged.
&F1	Minimum power consumption, UART baud rate set to 9600.
&F2	Minimum power consumption, UART baud rate set to 38400.
&F3	Minimum power consumption, UART baud rate set to 115200.
&F4	Medium power consumption, UART baud rate set to 115200.
&F5	Maximum power consumption, UART baud rate set to 115200.
&F6	Maximum power consumption, UART baud rate set to 115200.

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

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

Or

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

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, 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>

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>

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>

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22. AT+BTAn {Control Audio Channel}

Once a Bluetooth connection is active, and assuming the peer device is also a Laird Technologies device, this command is used to start/stop a SCO channel which will connect the PCM interfaces of the two peer devices. This means that 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, and as soon as 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>

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

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

<devclass> is a 6 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 4 fields briefly described as follows (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 Technologies devices do not map to any predefined Major Service Class or Major Device Class and so the default devclass as shipped is 001F00, which means no Major Service Class and "Unclassified" Major Device class.

Other examples of device class codes are follows:-

CODE (HEXADECIMAL)	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 6 hexadecimal characters long).

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

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>

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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 then the response will still be an OK.

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

26. AT+BTD* {Remove All Trusted Devices}

This command is used to remove all devices from the list of trusted devices in the non-volatile database. No confirmation will be asked for. So beware!!!

WARNING: If you make an authenticated connection, the link key gets cached in the underlying stack. So if you subsequently delete the key using AT+BTD* and immediately request an authenticated connection to the same device, then the connection 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>

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>

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

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

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

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, as per 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>

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>

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>

**CONFIGURING
THE BTM410/411****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>

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>

34. AT+BTI<devclass> {Inquire}

This will make 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 6 digit device class code or a 2 digit major device class. If it is not specified, then the value is taken from S register 516.

When <devclass> is 6 hexadecimal characters long, it specifies an AND mask which is used to filter inquiry responses. When <devclass> is 2 hexadecimal characters long, it forces the inquiry to filter responses to devices that match their major device class code to this value – which 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 will respond 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>

ERROR RESPONSE

A Bluetooth inquiry process is such that for a single inquiry request 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 as such if the memory allocation fails then the inquiry procedure is aborted and in that case an error response is sent to the host.

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

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

35. AT+BTIV<devclass> {Inquire}

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

**CONFIGURING
THE BTM410/411****36. 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 RESPONSE' 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 will return the product name as LAIRD, e.g.

Response: <cr,lf>12346789012,123456,"TDK SYSTEMS AT DONGLE 1"
<cr,lf>12345678914,123456,"TDK SYSTEMS RS232"
<cr,lf>OK<cr,lf>

We strongly recommend that any software implementation that uses this command should check for LAIRD, EZURIO and TDK SYSTEMS to ensure backwards and forwards compatibility.

37. 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 will be returned.

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

38. 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 then it will wait 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 will connect to anyone.

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

39. 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>

40. 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>000000000000
<cr,lf>OK<cr,lf>

41. 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 will be 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 ("") will delete the string from non-volatile memory which will force the default name to be used.

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

**CONFIGURING
THE BTM410/411**

42. **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>
43. **AT+BTO<devclass>** {Open and make Unit Detectable}
After power up and ATZ, this command is sent so that 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 0.
Response: <cr,lf>OK<cr,lf>
44. **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, as is 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>
45. **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>
46. **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>
47. **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>
48. **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>
49. **AT+BTQ** {Enable Inquiry Scans ONLY}
When inquiry scan is enabled, it implies that this device will respond to inquiries from other devices. Use AT+BTX to disable inquiries.
Response: <cr,lf>OK<cr,lf>

**CONFIGURING
THE BTM410/411****50. 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 will periodically (time specified via S register 505) attempt to connect to the peer address specified. In this circumstance all commands from the host are buffered in the receive buffer, until a Bluetooth connection is established with the peer device and it then sends the buffer across. This means 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>

51. 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>

52. AT+BTR? {Read Outgoing Peer Address}

This command is used to display the peer address stored in non-volatile memory, used to put the 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>000000000000

<cr,lf>OK<cr,lf>

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

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

54. 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>

**CONFIGURING
THE BTM410/411****55. 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 will respond with an ERROR. If the device is already in the database, then the key is replaced.

If the link key cache is empty, that is, a pairing has not been performed since the device was powered, then the response will be an ERROR.

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

Or

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

56. 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 AT+I6 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>

58. 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 will be 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 every 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 on receipt of the AT+BTW command. On pairing completion, an unsolicited message will be sent to the host which will be in the form PAIR n <bd_addr>. See section 3.7 for more details.

If AT+BTI or AT+BTP or AT+BTG or AT+BTQ or ATD is issued between the AT+BTW command and the subsequence PAIR asynchronous response, then an ERROR response will be 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>

59. 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>

60. AT+BTX {Disable Page/Inquiry Scanning}

Disable page/inquiry scanning. This means it will not 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>

**CONFIGURING
THE BTM410/411****UNSOLICITED RESPONSES**

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

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

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 2 seconds until the host either accepts the connection using the ATA command or rejects it using the ATH command.

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 pairing will proceed as normal.

AUDIO ON

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

AUDIO OFF

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

AUDIO FAIL

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

ERROR 27

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

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 will be 2.

The parameter <bd_addr> is the address of the peer device if available.

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.

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 3 character escape sequence starting with '\'. For example the embedded <cr><lf> sequence would be sent as the 6 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

**CONFIGURING
THE BTM410/411****INCOMING CONNECTIONS**

The device can be configured using the AT+BTP or AT+BTG command so that it will scan 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
```

Where 'A' means authenticated connection and 'E' means encryption has been 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.

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 Technologies 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 is to eliminate 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 85kbps instead of about 200kbps. 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, and the other mode allows for a connection drop using the DTR method only. By default, the device is in former mode. This mode is selected using the S507 register. See S register table described in an earlier section.

To reiterate, the escape sequence is as follows:-

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

This means that even when a file transfer is occurring and it happens to be full of <Esc Chr> characters then it is not going to drop into command mode because, when transferring a file it is going to happen as fast as possible and so 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.

**CONFIGURING
THE BTM410/411****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 will require 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 will be 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 will be searched automatically and if one exists will be provided without host interaction. If the link key is not present, then the connection attempt will be terminated and a NO CARRIER response will be given to the ATD command.

A typical session to pair, say an Ericsson T68i, to a serial module would be:

- Make the T68i discoverable and send AT+BTI to the serial module. This will result in inquiry responses from all devices. Make a note of the Bluetooth address of the phone e.g. 123456789012
- On the T68i start pairing procedure by selecting "Phone accepts" in the relevant Bluetooth menu.
- Send command AT+BTW123456789012 to the serial module
- Confirm that you get an OK response and then PIN? responses on a 2 second interval.
- Enter a pin code on the phone. Say it is 12345768
- Then enter the command AT+BTK="12345678".
- The phone will confirm success and likewise the serial module will respond with OK
- On success the serial module will send an unsolicited message in the form of PAIR 0 <bd_addr>
- Send AT+BTT to the serial module so that the pairing information is stored in the non-volatile database.
- Confirm that the link key has been stored by sending the command AT+BTT?. This will result in a list of all devices paired with the module.

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

- To device 1 send ATI4, it will respond with the local Bluetooth address. E.g. 123456789001
- To device 1 send AT+BTP. It will become discoverable and connectable.
- To device 2 send AT+BTW123456789001 and it will respond with OK
- Then on both devices you will see PIN? asynchronous responses
- To both modules send AT+BTK="12345678"
- On success the serial module will send an unsolicited message in the form of PAIR 0 <bd_addr>
- The pairing link key, is at this stage, in volatile memory, so send AT+BTT to both.
- The two units now have pairing information which will survive a power cycle.

**CONFIGURING
THE BTM410/411****ERROR RESPONSES**

All error responses from the device will be in the form <cr,<lf>ERROR nn<cr,<lf>, where nn will be 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
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

CONFIGURING THE BTM410/411

FACTORY DEFAULT MODE

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

In fact, as long as the equation $\text{BAUDRATE} * 0.004096$ produces an integer value, then there will be 0% error in clocking for that baud rate.

So 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.

To cater for this circumstance, if DSR is de-asserted, the device will come out of reset using 9600,N,8,1 comms settings for exactly 750 milliseconds and then revert 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 750ms period, then the module will remain at 9600,N,8,1 and will also configure itself using factory default S Register values.

MISCELLANEOUS FEATURES

This chapter describes various features which cannot be categorized appropriately.

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.

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.

Flash GPIO4 on Connectable Mode

S reg 534 now takes a value up to 2. A value of 2 configures GPIO4 so that it will blink when the module is in connectable mode.

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.

Digital I/O Cable Replacement

The module has a number of general purpose digital i/o pins. The direction of these are specified via S Reg 610. When S Reg 531 is set to 4 at both ends of the connection, then on connection, any changes in the states of the inputs at one end will be transmitted to the peer, which will then reflect 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 one's 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 0, which disables echos.

Note that due to inherent latency of Bluetooth transmission, expect the change of state to be delayed. This value is typically 100ms 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.

Append Bluetooth Address to Friendly name

If S Reg 593 is set to 1, then the last 6 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.

BTM410/411

Bluetooth® AT Data Module

CONFIGURING THE BTM410/411

DISCLAIMERS

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

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.

Data Sheet Status

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

APPLICATION
EXAMPLES

APPLICATION EXAMPLES

RS232 Modem Signals

Just as a telephony modem has control and status lines, the BT Data Module also provides for 6 control and status lines as per the table below. The direction column is as seen from the module's viewpoint.

DIRECTION	FUNCTION
IN or OUT *	CI also known as RI (Ring Indicate)
IN or OUT *	DCD (Data Carrier Detect)
IN	DSR (Data Set ready)
OUT	DTR (Data Terminal Ready)
IN	CTS (Clear to Send)
OUT	RTS (Request to Send)

* configurable with S register 552

The first four lines are under program control. These use four of the GPIO pins and are mapped to I/O as per the table below. The last two are under control of the UART driver and their functionality is always enabled.

DIRECTION	CONNECTOR PIN LABEL	FUNCTION
IN/OUT	GPIO1	General Purpose I/O
IN/OUT	GPIO2	General Purpose I/O
IN/OUT	UART_RI	Input/Output from module
IN/OUT	UART_DCD	Input/Output from module
IN	UART_DSR	Input to Module
IN/OUT	GPIO3/UART_DTR	General Purpose I/O (or DTR functionality)
IN/OUT	GPIO4/LED	General Purpose I/O (LED)
IN/OUT	GPIO5	General Purpose I/O
IN/OUT	GPIO6	General Purpose I/O
IN/OUT	GPIO7	General Purpose I/O
IN/OUT	GPIO8	General Purpose I/O

Notes:

1. PIO4 (DSR) is used by the blu2i module to sense that the host is connected, and is intricately linked with connections. For outgoing calls, if this line is not asserted then an error is indicated. Similarly for AT+BTP and AT+BTG.

While in a call, for appropriate modes, a de-assertion means fall into command state. If the de-assertion exists for longer than the period specified in S Register 519 then the connection is dropped as if an ATH command was received.

2. PIO2 (RI), is normally de-asserted. When an incoming connection is detected it will be asserted, until the connection is either answered or rejected using ATA and ATH respectively. See S Registers 552 & 553 for more details
3. PIO3 (DCD) will be de-asserted when the device is in the unconnected state. Asserted when a connection is active. See S Registers 552 and 553 for more details.
4. PIO5 is either used as GPIO or driven as UART_DTR. When the unit is configured in pure host mode, this pin is forced into UART_DTR and is asserted when there is a Bluetooth connection.

GPIO Pins 1 to 8 are available for general purpose use.

**APPLICATION
EXAMPLES****Modem signalling over Bluetooth**

The RFCOMM protocol used in Bluetooth for implementing the serial port profile allows for the exchange of four modem signals. This information is contained in a special transparent message which contains bits identified as RTR, RTC, DV and IC which depending on the type of serial device being emulated maps to DTR or DSR, RTS, DCD and RI respectively. In addition, this message also includes the ability to convey a BREAK input from one end to the other.

To allow for the greatest flexibility and variability in how the modem control signals are used out in the real world, S Registers 551, 552 and 553 have been provided which allow for any of RTR,RTC,DV and IC to be mapped to any modem control/status line.

BREAK signal on RX line

If the host sends a break signal of duration greater than 100ms, then the blu2i module is configured to treat that as a signal to perform a hardware reset.

This being the case it is not possible to convey a BREAK over Bluetooth to the peer device.

Reset

The module can be reset by the host without the need of any I/O using a BREAK signal. The module has been configured to reset when the RX line detects a break condition for durations greater than 100 milliseconds.

The Reset line has a fixed pull down resistor of 10kOhm

Pure Cable Replacement Mode

The module has the capability of being preset into a pure 5-wire data cable replacement mode. The 5 wires being RX, TX, CTS, RTS and GND. This mode requires no changes to a host application since the Bluetooth connection is automatically set up on power up. If the connection is lost the BISM2 module will constantly retry until the connection is reinstated.

By implication, two devices are needed to replace a cable. One device is pre-configured to always be a master and the other, a slave.

Assuming the Bluetooth address of the master to be <bdaddr_m> and that of the slave to be <bdaddr_s>, the master module is configured by sending it the following AT commands:

```
AT&F*
ATS512=1
ATS504=1
ATS507=2
ATS530=2000
AT&W
AT+BTR<bdaddr_s>
```

The ATS507=2 setting puts the device in DSR drop mode only. This means that when the device needs to be reconfigured, deasserting the DSR line will ensure that the module responds quickly to AT commands. This further means that in stand alone mode, the DSR input line MUST be asserted e.g. 0V in TTL signal mode.

The slave is configured by:

```
AT&F*
ATS512=4
ATS0=-1
AT&W
AT+BTR<bdaddr_m>
```

**APPLICATION
EXAMPLES**

Where <bdaddr_m> is optional. If it is not specified, then the slave unit will accept connections from any device. If specified then only connections from the device specified will be accepted.

If it is desired that the slave unit should not be discoverable (the master is by default not discoverable), then the configuration commands are:

```
AT&F*
ATS512=3
ATS0=-1
AT&W
AT+BTR<bdaddr_m>
```

Where <bdaddr_m> is optional. If it is not specified, then the slave unit will accept connections from any device. If specified then only connections from the device specified will be accepted.

When the units are next power cycled, the slave unit will wait for the master to connect to it and the master will continually look for the slave. If a connection attempt fails, the master will wait for 2 seconds before reattempting a connection. This 2 second delay can be varied by issuing it an ATS530 command with an appropriate value in the range 100ms to 15000ms.

IMPORTANT NOTE: The DSR input to the module **MUST** be asserted for the auto connection to succeed. When operating at TTL levels a 0V is seen as an assert state. When operating at RS232 levels and voltage greater than 3V is seen as assert. It is usual to connect the DTR line of the host to the DSR line of this device.

Audio Cable (voice)

With a pair of these modules it is possible to replace a mono audio cable with two way traffic. That is, a setup where a microphone is connected to a speaker at the remote end and vice versa. So this mode effectively replaces two audio cables.

Assuming the Bluetooth address of the master to be <bdaddr_m> and that of the slave to be <bdaddr_s>, the master module is configured by sending it the following AT commands:

```
AT&F*
ATS512=1
ATS504=1
ATS530=2000
ATS532=7
AT&W
AT+BTR<bdaddr_s>
```

And the slave is configured by:

```
AT&F*
ATS512=4
ATS0=-1
AT&W
AT+BTR<bdaddr_m>
```

**APPLICATION
EXAMPLES****Modem Control and Status Signals**

A serial port has DTR, DSR, RTS, CTS, DCD and RI control lines. RTS and CTS are locally controlled to prevent local buffer overflow.

The status of DTR, DSR, DCD and RI can be exchanged with the remote peer device. If for example, the DTR/DSR lines are to be exchanged between the two peers to simulate the performance of a physical cable, then it is possible to do so. Refer to the description for S Registers 551, 552 and 553 for more details.

Some serial implementations link CTS and RTS to remove the need for handshaking. Ezurio do 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 Bluetooth Serial Module deasserts its RTS signal, then there is a significant risk that internal receive buffers will overflow which could lead to an internal processor crash. This will lead to a drop in connection and may require a power cycle to reset the module.

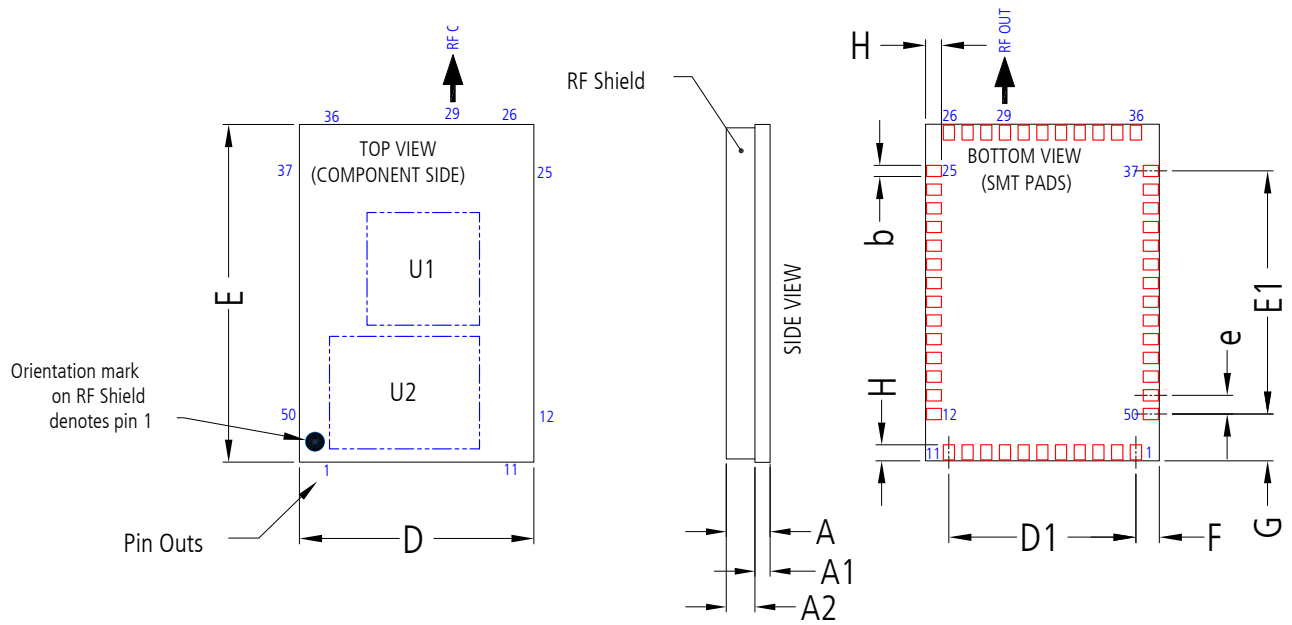
Ezurio recommend that the correct CTS/RTS handshaking protocol be adhered to for proper operation.

BTM410/411

Bluetooth® AT Data Module

MECHANICAL DRAWINGS

MECHANICAL DETAILS



Description	50 pin BT Data Module			
Size	18.0 x 12.5 x 2.5mm			
Pitch	1mm			
Dimension	Minimum	Typical	Maximum	Notes
A	2.3	2.4	2.7	
A1	0.8	0.9	1.0	PCB Thickness
A2	1.3	1.5	1.7	RF Shield Height
b	0.55	0.60	0.65	Global pad width
D	12.37	12.5	12.63	
E	17.87	18.0	19.13	
e		1.0		Global pitch
D1		10.0		
E1		12.0		
F		1.25		Pad Centre to Board edge
G		2.50		Pad Centre to Board edge
H		0.85		Global length of pad to edge of board
Units	mm			

BTM410/411

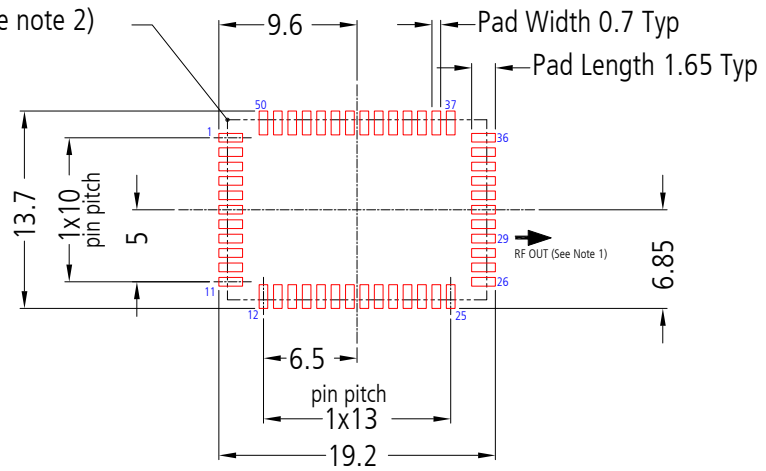
Bluetooth® AT Data Module

MECHANICAL DRAWINGS

RECOMMENDED PCB FOOTPRINT

MODULE OUTLINE

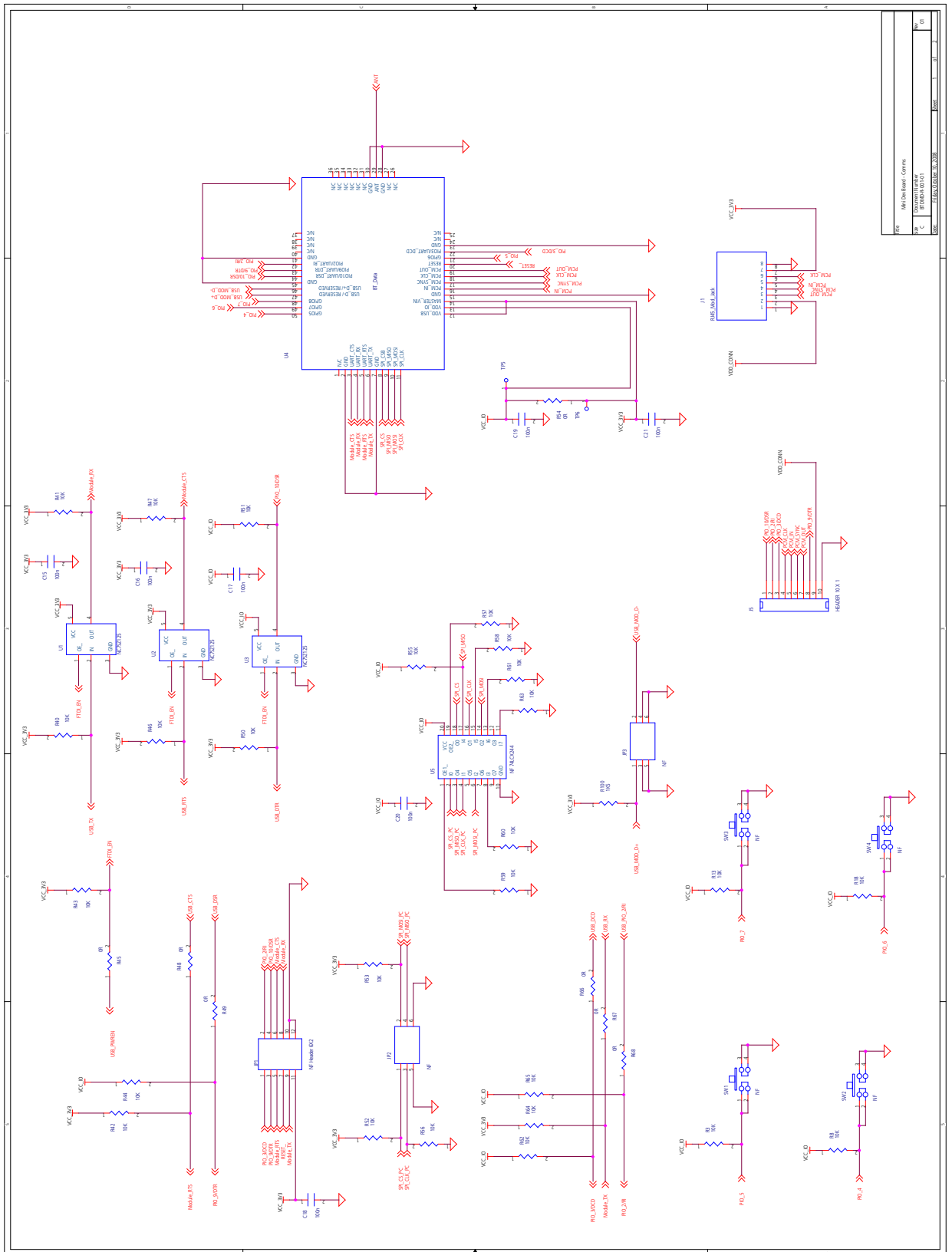
(See note 2)



NOTES FOR PCB LAYOUT:

1. The RF output pin must be matched to a 50Ω strip-line or coplanar waveguide on the antenna-less version (BTM410).
2. Ensure that there are no exposed conductors under the module to avoid shorts to the test points on the module underside.
3. The pcb footprint is provided for guidance only. Users may wish to modify the PCB land dimensions to suit their specific manufacturing or process.

MECHANICAL DRAWINGS



BTM410/411

Bluetooth® AT Data Module

ORDERING INFORMATION

ORDERING INFORMATION

PART NUMBER	DESCRIPTION
BTM410	Bluetooth AT Data Module (external antenna)
BTM411	Bluetooth AT Data Module (with integrated antenna) Q1-2009
DVK – BTM410	Development board with BTM410 module soldered in place
DVK – BTM411	Development board with BTM411 module soldered in place Q2-2009

GENERAL COMMENTS

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

Refer to the schematic BTDMD-R-001.pdf for the Development Kit on the following two pages for examples of typical pin connections. A pdf of the schematic can be downloaded from the product web page.

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LWS-UM-BTM410-411 0409

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