BTM520/521 DATA MODULE

USER MANUAL

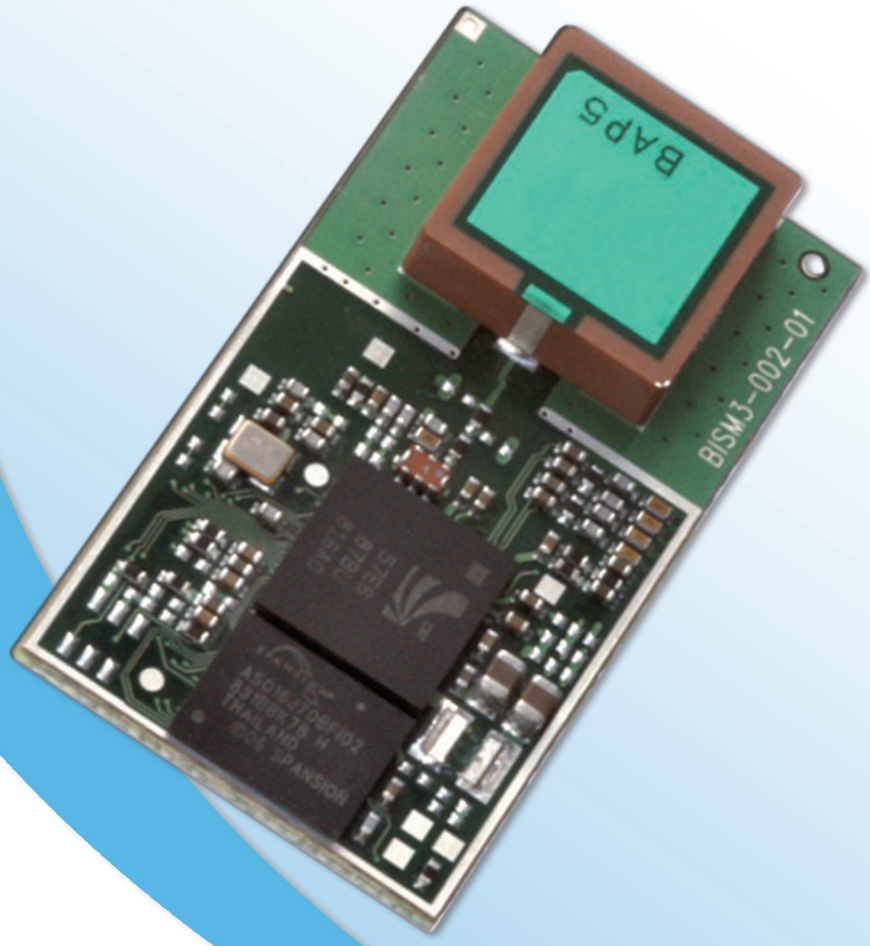

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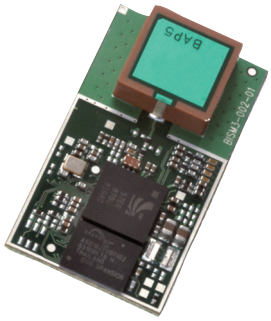
TABLE OF CONTENTS

CONTENTS

OVERVIEW AND KEY FEATURES



The BTM520 and BTM521 are the most advanced low power, multimedia Bluetooth modules on the market. They have been designed by Laird Technologies to meet the needs of developers who require the ultimate Bluetooth audio performance and flexibility, along with fast time to market. The modules include everything needed for a fully qualified and functional Bluetooth multimedia application. As well as providing best in class radio performance, range and power consumption, they support all of the functionality to run Cambridge Silicon Radio's Road Tunes and Blue Tunes development environments. They support the latest Bluetooth Version 2.1+EDR Specification, providing the important advantage of Secure Simple Pairing, which improves security and enhances the ease of use for end customers. The BTM521, with an integrated high performance multilayer ceramic antenna can achieve open field ranges in excess of 300 metres.

The modules include a 16 bit stereo codec and microphone input to support both stereo and mono applications, with the ability to drive 16Ω stereo speakers. They also contain all of the necessary audio filtration and biasing components, so that the module only requires the addition of speakers, microphone and push buttons to make a complete implementation.

The modules contain a full, integrated Bluetooth stack along with SPP, HFP 1.5, HSP, AVRCP and A2DP profiles, all of which have been qualified, so that no further Bluetooth qualification is required. For users with more complex applications, additional profiles will be available for file transfer, object exchange, dial up networking, messaging and phone book control. Future support also includes the Health Device Profile, making this the ideal module for development of Continua compliant medical devices. Because these modules are pre-qualified, customers using these modules can list and promote their products on the Bluetooth website free of charge.

The BTM520 and BTM 521 modules include an embedded 32 bit, 64 MIPS DSP core within the BC05, which is integrated with the Bluetooth functionality and which allows designers to add significant product enhancements. These include features such as echo cancellation, noise reduction and audio enhancement using additional soft codecs. 16MB of flash memory is available within the module, so that complex functionality can be included. DSP routines are licensable from a number of specialist partners. Typical applications for these modules include Bluetooth headsets, Bluetooth stereo headsets, VoIP phones, automotive products, wireless audio links and medical / healthcare devices.

To speed product development and integration, Laird Technologies has developed a comprehensive AT command interface, which simplifies application development and includes support for audio and headset functionality. It provides access to GPIO pins, allowing these to be mapped for direct connection to actuator buttons on headsets. Combined with a low cost developer's kit, this ensures that the choice of Laird Technologies Bluetooth modules guarantees the fastest route to market.

OVERVIEW AND KEY FEATURES

FEATURES

- Fully featured Bluetooth multimedia module
- Supports CSR Road Tunes and Blue Tunes applications
- Bluetooth v2.1+EDR
- Supports mono and stereo headset applications
- Ideal for medical applications using health device profile
- Adaptive Frequency Hopping to cope with interference from other wireless devices
- 32bit Kalimba DSP for enhanced audio applications
- Support for Secure Simple Pairing
- External or internal antenna options
- HSP, HFP, A2DP and AVRCP audio profiles
- Future support for OBEX, DUN, FTP, HDP profiles for additional functionality
- 16 bit stereo codec and microphone input
- Integrated audio amplifiers for driving 16Ω speakers
- Comprehensive AT interface for simple programming
- Bluetooth END Product Qualified
- Compact Size
- Class 1 output – 8dBm (typical)
- Low power operation
- Wi-Fi Coexistence Hardware Support

APPLICATION AREAS

- High Quality Stereo Headsets
- Mono Voice Headsets
- Hands-free devices
- Wireless Audio Cable Replacement
- MP3 and music players
- Medical and Healthcare Devices
- Phone Accessories
- VoIP products
- Cordless Headsets
- Automotive Applications

SPECIFICATIONS

CATEGORIES	FEATURE	IMPLEMENTATION
Wireless Specification	Standards Supported	Bluetooth® v2.1 + EDR
	Transmit Class	Class 1
	Frequency	2.402 – 2.480 GHz
	Channels	79 channels Frequency Hopping Adaptive Frequency Hopping
	Max Transmit Power	+8 dBm (typical) @ antenna pad – BTM520 +10 dBmi (typical) from integrated antenna – BTM521 (provisional)
	Min Transmit Power	-27 dBm @ antenna pad – BTM520 -27 dBmi from integrated antenna – BTM521 (provisional)
	Receive Sensitivity	Better than -86 dBm
	Data Transfer rate	Up to 300kbps
	Range	> 300 metres free space (Data)
Antenna Modes	External Antenna	50 Ohm U.FL – BTM520
	Integrated Antenna	+2dB multilayer ceramic – BTM521
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	1.7 - 3.6V CMOS (independent of Vcc)
	Modem Control	RTS, CTS DTR, DSR, DCD, RI†
General Purpose Interface	I/O	16 general purpose I/O pins†
	ADC	2 x ADC
	I²S	Stereo Audio Digital Interface Bus
	PCM	Shared with I²S
	SPDIF	Shared with I²S
	LED	Two dedicated
Audio	Codec	Integrated stereo codec with -95dB SNR for DAC
	Amplifiers	Direct drive for 16Ω speakers On board filters
	Microphone	Input with bias for low noise microphone On board filters
	Sample Rates (DAC & ADC)	8, 11.025, 16, 22.05, 32 & 44.1kHz
Protocols & Firmware	Bluetooth® Stack	V2.1 compliant. Fully integrated.
	Profiles	GAP (Generic Access Profile) SDP (Service Discovery Profile) SPP (Serial Port Profile) HSP HFP – Audio Gateway and Handsfree A2DP – Source and Sink AVRCP – Target and Controller SCO/eSCO FTP Client (future release) DI (future release) GOEP (future release) PBAP (future release) MAP (future release) HDP (future release)
	Protocols	RFCOMM AVCTP AVDTP OBEX (future release) MCAP (future release)
	Firmware Upgrade	Available over UART

SPECIFICATIONS

CATEGORIES	FEATURE	IMPLEMENTATION
Command Interface	AT Instruction set	Comprehensive control of connection and module operation, including extensions for Audio control. Direct mapping of GPIO to audio functions, e.g. Play, Volume, etc. S Registers for non-volatile storage of parameters
	Additional Support	All I/O available for CSR Road Tunes and Blue Tunes applications
DSP	Kalimba DSP	Integrated in BC05 32bit, 64MIPS, 16Mbps Flash Memory (shared)
	Applications	Available from partners
Current Consumption	Data Transfer	Typically < 70mA (including speaker drive)
	Low Power Sniff Mode	Less than 1.5mA
Supply Voltage	Supply	3.0V – 4.2V DC
	I/O	1.7V – 3.6V DC
Coexistence / Compatibility	WLAN (802.11)	2, 3 and 5-wire hardware coexistence schemes supported
Connections	External Antenna (option)	Pad for 50 Ohm antenna – BTM520
	Interface	Surface Mount Pads
Physical	Dimensions	20.0mm x 36.0mm x 4.9mm
	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 – BTM521)
	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

†Modem control pins and GPIO are shared

SPECIFICATIONS

PIN OUT

PIN	SIGNAL	DESCRIPTION	VOLTAGE SPECIFICATION
1	PCM_IN	PCM Data I/P	VPADS
2	PCM_OUT	PCM Data O/P	VPADS
3	PCM_SYNC	PCM Sync I/P	VPADS
4	PCM_CLK	PCM CLK I/P	VPADS
5	GND		
6	SPI_MOSI	SPI bus serial I/P	VPADS
7	SPI_CSB	SPI bus chip select I/P	VPADS
8	SPI_MISO	SPI bus serial O/P	VPADS
9	SPI_CLK	SPI bus clock I/P	VPADS
10	LED_EXT1	Host I/O	Open Drain
11	LED_EXT0	Host I/O	Open Drain
12	PIO0 / RX_ENABLE		VIO
13	PIO1 / TX_ENABLE		VIO
14	GND		
15	VDD_PADS	VPADS supply	
16	VDD_PIO	VIO supply	
17	VDD_IN	Main supply	
18	GND		
19	AUDIO_GND		
20	SPKR_B_P	Speaker, channel B+ (right) – Note 3	
21	SPKR_B_N	Speaker, channel B- (right) – Note 3	
22	SPKR_A_P	Speaker, channel A+ (left) – Note 3	
23	SPKR_A_N	Speaker, channel A- (left) – Note 3	
24	MIC_BIAS	Microphone bias – Note 4	
25	MIC_BN_C	Microphone, channel A+ (left) – Note 4	
26	MIC_BP_C	Microphone, channel A- (left) – Note 4	
27	MIC_AP_C	Microphone, channel B- (right) – Note 4	
28	MIC_AN_C	Microphone, channel B+ (right) – Note 4	
29	Unused		
30	Unused		
31	Unused		
32	Unused		
33	Unused		
34	Unused		
35	Unused		
36	Unused		
37	Unused		
38	Unused		
39	Unused		
40	Unused		
41	Unused		
42	Unused		
43	Unused		
44	Unused		
45	Unused		
46	Unused		
47	Unused		
48	Unused		
49	Unused		
50	Unused		
51	Unused		
52	Unused		
53	Unused		
54	Unused		

SPECIFICATIONS

PIN OUT (continued)

PIN	SIGNAL	DESCRIPTION	VOLTAGE SPECIFICATION
55	Unused		
56	Unused		
57	Unused		
58	PIO3 / USB_VSENSE		VIO
59	PIO14 / CSB	Host I/O	VPADS
60	AUX_DAC		VIO
61	PIO4	Host I/O	VIO
62	PIO5 / BT_STATE / BT_PRORITY	Host I/O / BT Co-existence	VPADS
63	PIO7 / RF_ACTIVE	Host I/O / BT Co-existence	VPADS
64	PIO15	Host I/O	VPADS
65	PIO12 / SCL	Host I/O	VPADS
66	GND		
67	AIO1	ADC Input, 10 bit 0-1.5V input range	
68	PIO10 / DSR	Host I/O	VPADS
69	PIO11 / DTR	Host I/O	VPADS
70	AIO0	ADC Input, 10 bit 0-1.5V input range	
71	PIO9 / DCD	Host I/O	VPADS
72	PIO13 / SDA	Host I/O	VPADS
73	PIO8 / RI	Host I/O	VPADS
74	PIO6 / WLAN_ACTIVE	Host I/O / BT Co-existence	VPADS
75	GND		
76	USB_D-		VUSB
77	USB_D+		VUSB
78	PIO2 / USB_PULL_UP		VIO
79	VDD_USB	VUSB supply	
80	VREGENABLE_H	Main regulator enable – pull high for correct operation	
81	GND		
82	UART_RTS	Request to Send O/P	VUSB
83	UART_CTS	Clear to Send I/P	VUSB
84	UART_TX	Transmit data O/P	VUSB
85	UART_RX	Receive data I/P	VUSB
86	Reset	Module reset I/P (active low) – Note 1	VPADS

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	3.6
VDD_PADS	1.7	3.6
VDD_IN	3.0	3.3

VOLTAGE SPECIFICATIONS

LOGIC LEVELS (VUSB)			
Input Voltage Levels	**Min**	**Typ**	**Max**
V_{ih}	0.625VDD_USB		VDD_USB+0.3
V_{il}	-0.3		0.25VDD_USB
Output Voltage Levels			
V_{oh} (Iout = -4mA)	0.75VDD_USB		VDD_USB
V_{ol} (Iout = 4mA)	0		0.125

LOGIC LEVELS (VIO)			
Input Voltage Levels	**Min**	**Typ**	**Max**
V_{ih}	0.625VDD_IO		VDD_IO+0.3
V_{il}	-0.3		0.25VDD_IO
Output Voltage Levels			
V_{oh} (Iout = -4mA)	0.75VDD_IO		VDD_IO
V_{ol} (Iout = 4mA)	0		0.125

LOGIC LEVELS (VPADS)			
Input Voltage Levels	**Min**	**Typ**	**Max**
V_{ih}	0.625VDD_PADS		VDD_PADS+0.3
V_{il}	-0.3		0.25VDD_PADS
Output Voltage Levels			
V_{oh} (Iout = -4mA)	0.75VDD_PADS		VDD_PADS
V_{ol} (Iout = 4mA)	0		0.125

LOGIC LEVELS (VUSB – USB TERMINALS D+, D-)			
Input Voltage Levels	**Min**	**Typ**	**Max**
V_{ih}	0.7VDD_USB		
V_{il}			0.3VDD_USB
Output Voltage Levels (to correctly terminated USB cable)			
V_{oh}	2.8		VDD_USB
V_{ol}	0		0.2

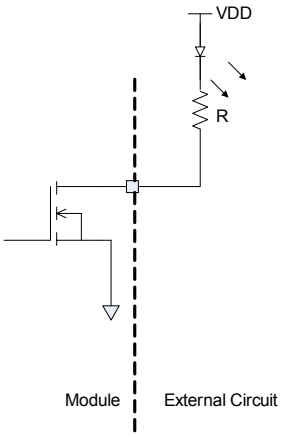
OPERATING PARAMETERS

Note:

1. Reset input is active low. Input is pulled up to VDD_PADS via 22k. Minimum reset pulse width is 5ms.
2. LED drive pins are open drain outputs and hence the external circuit to the right should be used.

   The voltage on the module pad should be maintained below 0.5V in which case the R_{on} of the FET is around 20Ω. Provided that this condition is met, then the current flowing through the diode is:

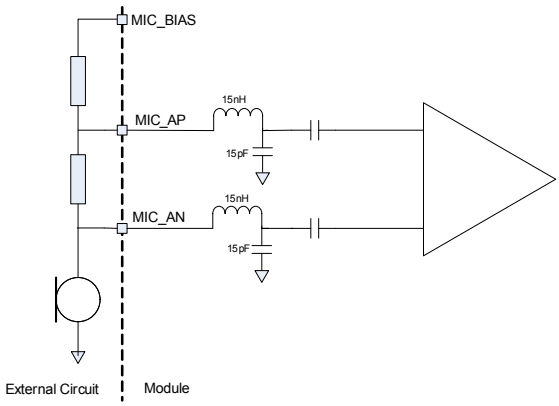
   $$I_{led} = \frac{VDD - V_F}{R + 20}$$ Where V_F is the forward bias voltage of the LED.



3. The speaker output is capable of driving loads with a minimum impedance of 16Ω directly.

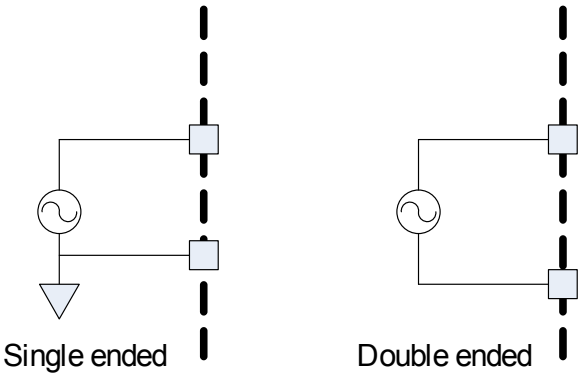
4. The audio inputs can operate in either line input mode or microphone mode. The input circuit has a two stage amplifier – the first stage provides a fixed 24dB gain and the second a variable gain of between -3dB and 18dB. If an input gain of less than 24dB is selected, then the first stage is switched out and the module is operating in line input mode.

When operating in microphone mode the microphone should be biased as follows:



The input impedance on the microphone inputs (in microphone mode) is typically 6kΩ. In order to maintain the regulation on the MIC_BIAS pin, the current drawn must be in the range 0.2 – 1.23mA. If the resistor draws less current than this then an additional resistor to ground must be added to pre-load the microphone output. The audio input is designed for use with inputs of between 1µA and 10µA at 94dB SPL. If the biasing resistors are set to 1kΩ this implies a microphone with a sensitivity in the range -40dBV to -60dBV.

When operating in line input mode, the input can be connected directly to the module input pins in either single or double ended configuration as follows:



CONFIGURING THE BTM520/521

INTRODUCTION

This document describes the protocol used to control and configure the BT-MM+ Bluetooth device. The AT commands described in the document apply to firmware releases from V14.0.9 onwards.

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.

Just like telephony modems, Laird Technologies' devices 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.

REFERENCES

[1] "AT Command Set"

[2] "BlueLab_v4.0_Release_Note.pdf"

[3] "Audio/Video Distribution Transport Protocol Specification" Rev.V12, 16/04/2007

[4] "Advanced Audio Distribution Profile Specification" Rev. V12, 16/04/2007

[5] "Audio/Video Remote Control Profile" Revision V14r00, 26/06/2008

[6] "Software Release Note Stereo Headset SDK Q3 2007 RC3.1" CS-117522-RNP1, CSR

[7] "Stereo Headset SDK Q3 2007 User Guide" CSR, CS-116451-UGP1, CSR, December2007

[8] "Bluetooth Specification Version 2.1 + EDR [vol3]", 26 July 2007

CONFIGURING THE BTM520/521

Glossary of Terms

		DESCRIPTION
A2DP	:	Advanced Audio Distribution Profile
ADC	:	Analogue to Digital Converter
AGHFP	:	Audio Gateway Hands-Free Profile
AT	:	Command prefix, 'Attention'
AVRCP	:	Audio/Video Remote Control Profile
BISM	:	Bluetooth Intelligent Serial Module
Codec	:	Device capable of encoding / decoding an analogue / digital signal
DAC	:	Digital to Analogue Converter
DSP	:	Digital Signal Processor
DUN	:	Dial-Up Network Profile
FTP	:	File Transfer Profile
GOEP	:	Generic Object Access Exchange Profile
GPIO	:	General Purpose Input Output
HFP	:	Hands Free Profile
HID	:	Human Interface Device Profile
I/O (IO)	:	Input/Output
Mic	:	Microphone
OPP	:	Object Push Profile
PBAP	:	Phone Book Access Profile
PWM	:	Pulse Width Modulation
Sxxx	:	S-Register No. xxx
SBC	:	Sub Band Codec
SPP	:	Serial Port Profile
TBD	:	To Be Determined
UART	:	Universal Asynchronous Receiver / Transmitter
PT	:	PASS THROUGH Command
UI	:	UNIT INFO Command
SUI	:	SUBUNIT INFO Command

CONFIGURING THE BTM520/521

AT Command Set

Assumptions

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

The following syntax is employed throughput this document to describe optional or mandatory parameters for 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'.

General AT Commands

1. AT

   Used to check the module is available.

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

2. 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>

3. ATD<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 utilizes the RFCOMM layer as described in the Bluetooth specification, it necessarily implies that only profiles based on RFCOMM can be accessed.

   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.

CONFIGURING THE BTM520/521

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

4. ATDL {Remake Connection}

Make a connection with the same device and service as that specified in the most recent ATD command. 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>

5. ATDR {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. 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>

6. 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.

E0	Disable echo.
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>

7. ATH {Drop Connection}

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

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

CONFIGURING THE BTM520/521

8. 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.

Table 3-1: S-Register List

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..0x7FF	Defines a set of bits masks for enabling profile servers. Values can be ORed. 0x001 is Serial Port Profile 0x080 is A2DP 0x100 is AVRCP
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
S300	1	0..2	Set A2DP role: 0 is feature not set 1 is A2DP Sink (default) 2 is A2DP Source
S301	1	0..2	Set AVRCP role: 0 is feature disabled 1 is Control (CT) (default) 2 is Target (TG)

CONFIGURING THE BTM520/521

REGISTER	DEFAULT	RANGE	COMMENT
S302	0	0..4	Set AVRCP category: 0 is Feature disabled (default) 1 is Player/Recorder 2 is Monitor/Amplifier 3 is Tuner 4 is Menu
S303	0	0..0xFFFFFF	Set Company ID: IEEE Company ID, 24bit hexadecimal, Required for UNIT INFO Response in AVRCP target mode, default value is 0.
S305	1	0..1	Accept UNIT INFO request: 0 – reject 1 – accept
S306	1	0..1	Accept SUBUNIT INFO request: 0 – reject 1 – accept
S310	1	0..1	Configure PASS THROUGH (PT) Response: 1 = Enable automatic PT-response, response type is read from S311, (default) 0 = Host is required to respond to PT-Indication, see 'AT+AVR'
S311	1 w 9 r	0..7 (Write)	Set automatic PT response: This value is queried for automatic PT-Response, see Table 3-10. The written value is mapped internal, that is why the Read-value is different from the written value. The Read-value is actually sent out as response
S312	1	0..15	A2DP sink supported features (Bitmask) : Bit 0 = Headphone (default) Bit 1 = Speaker Bit 2 = Recorder Bit 3 = Amplifier
S313	1	0..15	A2DP source supported features (Bitmask) : Bit 0 = Player (default) Bit 1 = Microphone Bit 2 = Tuner Bit 3 = Mixer
S320	2	1..3	Security Level: see [12], Generic Access Profile - Table 5.7 needs subsequent 'AT&W' and power cycle to take effect
S321	1	0..4	Set IO capability: 0 – display only 1 – display yes no 2 – keyboard only 3 – no input no output 4 – reject IO-cap requests
S322	0	0..1	Force man-in-the-middle-protection (MITM): 0 – disabled 1 – enabled
S323	0	0..1	Disable legacy (pre-BT2.1) Pairing: 0 – legacy pairing enabled 1 – legacy pairing disabled
S324	90	1..255	Secure Simple Pairing timeout in s This value must be at least 90 in order to meet the recommendation of BT2.1 specification

CONFIGURING THE BTM520/521

REGISTER	DEFAULT	RANGE	COMMENT
S325	1	0..1	Store link key automatically on dedicated bonding outgoing (DBO), identical with S538
S326	1	0..1	Store link key automatically on general bonding outgoing (GBO)
S327	1	0..1	Store link key automatically on dedicated bonding incoming (DBI)
S328	1	0..1	Store link key automatically on general bonding incoming (GBI)
S329	0	0..1	Enable legacy (BISM2) response format
S330	1	1..15	Configure inquiry response of AT+BTI (Bitmask): 1 – show device address 2 – show class of device 4 – show friendly name 8 – show extended inquiry data Values can be ORed
S415	0	0..1	Enable Microphone Input Gain, adds extra 24dB to input gain
S416	0	0..1	Enable MicBias
S417	0	0..15	Set MicBiasCurrent
S418	0	0..15	Set MicBiasVoltage
S419	6	0..6	Set sampling rate for Audio Loopback Mode 0 = 8 kHz 1 = 11.025 kHz 2 = 16 kHz 3 = 22.050 kHz 4 = 24 kHz 5 = 32 kHz 6 = 44.1 kHz
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 messaged 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 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

CONFIGURING THE BTM520/521

REGISTER	DEFAULT	RANGE	COMMENT
S512	1	0..7	Specify power up state. When set to 0, AT+BTO is required to open the device for Bluetooth® activity. When set to 1, it proceeds to a state as if AT+BTO was entered. When set to 2, it 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. 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.
S514	10	1..60	Pairing Timeout in seconds. This includes the time a host takes to supply the PIN number when PIN? messages are indicated.
S515	0x001F00	0.. 0xFFFFFF	Default Device Class Code to be used with AT+BTO when it is not explicitly specified. When queried, the value is always printed as a hexadecimal number. To change the device class of the module, after AT+BTO, use the command AT+BTC.
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
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.

CONFIGURING THE BTM520/521

REGISTER	DEFAULT	RANGE	COMMENT
S531	0	0..5	Specifies the mode on connection establishment. 0 = Normal, that data is exchanged between UART and RF 1 = LOCAL_COMMAND. UART input is parsed by the AT interpreter and RF data is discarded 2 = REMOTE_COMMAND. RF input is parsed by the AT interpreter and UART data is discarded. If S Reg 536 is not 1 then this register cannot be set to 2 and an ERROR will be returned 3 = LOCAL_COMMAND. UART input is parsed by the AT interpreter and incoming RF data is sent to the host using the RX<string> asynchronous response. 4 = LOCAL_COMMAND and on the rf side, the gpio is automatically sent when there is a change in input. See section 9.5 for more details. 5 = DEAMON mode
S532	0	0..7	If non zero then on every connection, a SCO channel (audio) 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	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. 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.
S534	1	0..2	When set to 0, GPIO4 is available as user i/o 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. 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.
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	When set to 1, a remote device can 'capture' the AT parser of this unit by it sending this module an escape "!!!" sequence. The inter character timing is set via S Register 12. If S Register 507 is >= 2, then reading this register will always return 0 and writing 1 will result in ERROR 33.
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.
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 S541because the actual power is set using a lookup table and the base band rounds down to the nearest value in the table.
S543	0	0..1	If this is set to 1, then incoming pairing attempts 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). See S Register 505 and 530 also

CONFIGURING THE BTM520/521

REGISTER	DEFAULT	RANGE	COMMENT
S551	0x3211	0xFFFF	This register specifies in each 4 bit nibble, how the outgoing modem status bits to the remote peer gets its value. Bluetooth® allows for RTR, RTC, DV and IC bits to be exchanged over an RFCOMM connection. Nibble 0..3 specifies the source for RTC 4..7 specifies the source for RTR 8..11 specifies the source for DV (i.e. DCD) 12..15 specifies the source for IC (i.e. RI) Each nibble can take the following value:- 0 Always set to 0 1 Always set to 1 2 If DCD (pin 8 on module connector) is output then always 1 If DCD is input then 1 if DCD is asserted otherwise 0 3 If RI (pin 6) is output then always 0 If RI is input then 1 if RI is asserted otherwise 0 4 If DSR (pin 10) is asserted then 1 otherwise 0 In the event that a nibble specifies DSR as the source of its state, be aware that if, S Register 507 is anything other than 0, a de-assertion of DSR will cause the Bluetooth connection to be dropped. If bits 0..3 and 4..7 are set to 0, then some Bluetooth devices will use that as a signal to stop sending any data back. For example, Nokia 6310 stops responding. If this register is changed while in command and connected mode, then on going back online using the ATO command, a fresh signal will be sent to the peer to update the bits.
S552	0x0122	0x0FFF	This register specifies in each 4 bit nibble, how the DTR, DCD, RI output pins are controlled when in a Bluetooth connection Nibble 0..3 specifies the source for DTR 4..7 specifies the source for DCD 8..11 specifies the source for RI Each nibble can take the following value:- 0 Do NOT touch the I/O 1 Always deassert 2 Always assert 3 If RTC bit in CONTROL_IND is 1 then assert otherwise deassert 4 If RTR bit in CONTROL_IND is 1 then assert otherwise deassert 5 If DV bit in CONTROL_IND is 1 then assert otherwise deassert 6 If IC bit in CONTROL_IND is 1 then assert otherwise deassert If this register is changed while in command and connected mode, then on going back online using the ATO command, the modem output lines will get refreshed.
S553	0x0201	0x0FFF	This register specifies in each 4 bit nibble, how the DTR,DCD,RI output pins are controlled when NOT in a Bluetooth connection Nibble 0..3 specifies the source for DTR 4..7 specifies the source for DCD 8..11 specifies the source for RI In addition it also refers to S Register 552 to see if the relevant pin is an input or not to be touched. If the nibble in 552 is 0, then the relevant pin is an input. Each nibble can take the following value:- 0 Always deassert 1 Always assert 2 Assert if RING is being sent to the host

CONFIGURING THE BTM520/521

REGISTER	DEFAULT	RANGE	COMMENT
S554	0	0..900	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. 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. A power cycle, reset via BREAK or ATZ is required to see the effects of change.
S555	1	1..7	If S Register 554 is nonzero, then after the post reset window expires, the mode 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). A power cycle, reset via BREAK or ATZ is required to see effects of a change. In some firmware builds, S Registers 565 to 569 inclusive are visible, which allows the start-up mode to depend on the state of RI line (Setting S Reg 565 forces the RI pin to be configured as an input). For this feature to be active, 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.
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	This specifies a mask. When Bit 0 is 1, the response word "ERROR" is replaced by "BTERR" and "OK" is replaced by "ok". When Bit 1 is 1, then error responses do not include the error number and instead the error number can be retrieved using ATI12.
S560	15	15..120	Disconnect timeout in seconds. This timer specifies how long to wait for confirmation from the peer device and/or the underlying stack that the connection has been successfully torn down. There can be instances where a confirmation does not arrive 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. Time is specified with 15 seconds intervals.
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
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
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.
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

CONFIGURING THE BTM520/521

REGISTER	DEFAULT	RANGE	COMMENT
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
S689	0	-450..+215	Set codec output gain in dBr * 10 (applies to sink), default = 0
S690	0	-450..+215	Set codec input gain in dBr * 10 (applies to source), default = 0
S730	0	0..1	Enable Auxiliary DAC
S731	0	0..225	Set Auxiliary DAC Level

9. 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>

10. 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>

11. 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

12. 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>

CONFIGURING THE BTM520/521

13. ATIn {Information}

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

I0	The product name/variant.
I1	The CSR firmware build number.
I2	The Laird Technologies firmware build number. For internal use only.
I3	The Laird Technologies firmware revision.
I4	A 12 digit hexadecimal number corresponding to the Bluetooth address of the device.
I5	The manufacturer of this device.
I6	The maximum size of trusted device database.
I7	The manufacturer of the Bluetooth chipset.
I8	The chipset format.
I9	0 if not in a connect state and 1 if in a connect state.
I11	The reason why a "NO CARRIER" resulted in the most recent attempt at making an outgoing connection. Where the response values are as follows: 0 = No prior connection 1 = Connection timeout 2 = Connection attempt cancelled 3 = Normal disconnection 4 = Peer device has refused connection 5 = Service profile <uuid> requested not available on remote device 6 = Connection has failed 32 = ATH was entered 33 = Incoming connection aborted because too many rings 34 = Unexpected incoming connection 35 = Invalid address 36 = DSR is not asserted 37 = Call limit of 65531 connections has been reached 38 = Pairing in progress 39 = No link key 40 = Invalid link key 255 = Unknown Reason
I12	The last ERROR response number.
I60	Connection status of SPP 0 = not connected 1 = connected identical with ATI9
I61	Connection status of A2DP 0 = not connected 1 = connected
I62	Connection status of AVRCP 0 = not connected 1 = connected

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>

CONFIGURING THE BTM520/521

14. 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>

15. 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>

General Bluetooth Control

1. 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 to transfer audio between the two peer devices.

+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>

CONFIGURING THE BTM520/521

2. 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>

3. 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>

4. AT+BTD<bd_addr> {Remove Trusted Device}

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

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

5. 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>

6. 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>

CONFIGURING THE BTM520/521

7. 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>

8. 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, is as per AT+BTP without an address. Inquiry Scans are disabled.

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

9. AT+BTG {Enable Promiscuous Page Scanning ONLY}

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

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

10. 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>

11. 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 BTM520/521

12. 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.

13. 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>

14. 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>

15. AT+BTM? {Read Incoming Peer Address}

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

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

If the location is empty the response is as follows.

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

16. 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>

17. 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>

CONFIGURING THE BTM520/521

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

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

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

19. AT+BTP {Enable Promiscuous Page/Inquiry Scanning}

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

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

20. 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>

21. 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>

22. 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>

23. 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>00000000000
<cr,lf>OK<cr,lf>

CONFIGURING THE BTM520/521

24. 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>

25. AT+BTT? {List Trusted Device}

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

Response: <cr,lf>12346789012
<cr,lf>12345678913
<cr,lf>12345678914
<cr,lf>OK<cr,lf>

26. 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>

27. 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>

28. 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 BTM520/521

Hardware Unit Control

This section covers S-Registers and AT-Commands that are related to hardware units within the module.

1. Audio Loopback Mode

For testing purposes, an audio loopback mode will be introduced. The stereo audio input signal is fed through the Kalimba DSP with running SBC codec, and is directed back to the audio stereo output. Audio Loopback Mode is controlled with the new AT Command "AT+BTL".

Table 3-2: Audio Loopback AT-Commands and S-Registers

TASK	AT-COMMAND / SREGISTER	COMMENT
Set audio loopback mode	AT+BTL<Mode>	Mode: 0 = off 1 = on, via PCM 2 = on, via SBC encoder/decoder
Set sampling rate for Audio Loopback Mode	S419 [0..6], default=6	0 = 8 kHz 1 = 11.025 kHz 2 = 16 kHz 3 = 22.050 kHz 4 = 24 kHz 5 = 32 kHz 6 = 44.1 kHz

2. Codec Gain

On BC05-MM, analogue input and output gains can be set to one of 23 steps called "Gain Level". To each gain level, an overall gain (dBr) is assigned, according to Table 3 3: Gain Table. Gain values can be specified either as gain level or as overall gain by separate S Registers. Please note that a pair of such S-Registers always updates the other corresponding S-Register (e.g. S589 – S689 and S590 – S690).

For S689 and S690 the overall gain (dBr) must be entered multiplied by 10. If the input value doesn't match a gain table entry, the nearest possible value is set. The actually set value can be checked by reading back S689/S690. The value of S689/S690 is printed out multiplied by 10 in order to avoid non integer numbers.

The new command class "AT+G…" is introduced in Bism3 which enables incremental and decremental gain settings. The increment/decrement command corresponds to one row up/down in the gain table (Table 3 3). The Gain level registers S589/S689 and S590/S690 are not affected by increment/decrement commands. Instead, the current gain level is cached and can be retrieved by "AT+G(I|O)?". There are 2 further commands to restore the cached gain level from S589/S590 ("AT+G(I|O)R") and to save the currently cached gain level to S589/S590 ("AT+G(I|O)S").

CONFIGURING THE BTM520/521

Table 3-3: Gain Table

OUTPUT GAIN LEVEL OR INPUT GAIN LEVEL S589 OR S590	OVERALL GAIN (DBR) S689 OR S690
22	+21.5
21	+18.0
20	+15.5
19	+12.0
18	+9.5
17	+6.0
16	+3.5
15	0
14	-3.0
13	-6.0
12	-9.0
11	-12.0
10	-15.0
9	-18.0
8	-21.0
7	-23.5
6	-27.0
5	-29.5
4	-33.0
3	-35.5
2	-39.0
1	-41.5
0	-45.0

Table 3-4: Gain Settings AT Commands and S-Registers

TASK	AT-COMMAND / SREGISTER	COMMENT
Set output gain level	S589 [0..22], default=15	See Gain Table; S689 is affected, too
Set output overall gain (dBr)	S689 [-450..+215], default=0	See GainTable; value must be entered (and is returned) multiplied by 10; S589 is affected, too
Set input gain level	S590 [0..22], default=15	See Gain Table; S690 is affected, too
Set input overall gain (dBr)	S690 [-450..+215], default=0	See GainTable; value must be entered (and is returned) multiplied by 10; S590 is affected, too
Increment current output gain level	AT+GOU	Error 57 may appear if maximum gain level reached
Decrement current output gain level	AT+GOD	Error 58 may appear if minimum gain level reached
Query current output gain level	AT+GO?	
Restore current output gain level from S589	AT+GOR	
Save current output gain level to S589	AT+GOS	
Increment current input gain level	AT+GIU	Error 57 may appear if maximum gain level reached
Decrement current input gain level	AT+GID	Error 58 may appear if minimum gain level reached
Query current input gain level	AT+GI?	
Restore current input gain level from S590	AT+GIR	
Save current input gain level to S590	AT+GIS	

CONFIGURING THE BTM520/521

3. Mic Input Gain

A microphone preamplifier which adds extra 20dB to input gain, is controlled by S-Register 415.

4. Mic Bias

Mic Bias will be enabled with S-Register 416.

Mic Bias Current is controlled by S-Register 417.

Mic Bias Voltage is controlled by S-Register 418.

5. Auxiliary DAC

The auxiliary DAC is enabled with S-Register 730.

The DAC output level is set by S-Register 731.

6. LED

The BT-MM+ module provides two dedicated output pins for LEDs (LED_EXT0, LED_EXT1). Following modes are supported: LED_OFF, LED_ON, LED_PWM and LED_PULSE.

In LED_PWM mode, the parameters "Duty Cycle" an "PWM Period" can be specified via S-Registers. This enables either a to dim the brightness of an LED (PWM Period=0) or to specify blinking with defined on-time in a defined period (PWM Period > blinking visible for the eye)

In LED_PULSE mode, the brightness of an LED is modulated. Modulation speed is defined by parameter "Pulse Rate" and maximum brightness is defined by parameter "Duty Cycle".

Table 3-5: LED S-Registers

TASK	AT-COMMAND / SREGISTER	COMMENT
Set LED_EXT0 mode	S335 [0..3], default=0	Mode: 0 = LED_OFF 1 = LED_ON 2 = LED_PWM 3 = LED_PULSE
Set LED_EXT1 mode	S340 [0..3], default=0	
Set LED_EXT0 Duty Cycle	S336 [0..4095], default = 2048	referenced if LED mode = LED_PWM or LED_PULSE
Set LED_EXT1 Duty Cycle	S341 [0..4095], default = 2048	
Set LED_EXT0 PWM Period	S337 [0..15], default = 0	referenced if LED mode = LED_PWM
Set LED_EXT1 PWM Period	S342 [0..15], default = 0	
Set LED_EXT0 Pulse Rate	S338 [0..15], default = 0	referenced if LED mode = LED_PULSE
Set LED_EXT1 Pulse Rate	S343 [0..15], default = 0	

Bluetooth Profiles

This section covers S-Registers and AT-Commands that are related to the supported Bluetooth Profiles on the BT-MM+ module.

1. Profile Server Activation

In order to advertise available services to potential client devices, S-Register 102 is used.

Supported profiles can be activated by setting the appropriate Flag in S-Register 102 (see Table 3 1). After S-Register 102 has been written, all S-Registers must be saved to non-volatile memory ("AT&W") and subsequently a reset has to be carried out ("ATZ").

2. A2DP

The "Advanced Audio Distribution Profile" is used to transmit high quality audio streams between two Bluetooth devices. An A2DP role must be assigned to a BT-MM+ module, either source or sink. After this has been done, the appropriate service can be advertised. An attempt to advertise A2DP-service without prior set up of a role will result in a (new) response error code 46.

An incoming A2DP connection request is accepted automatically if a valid link key for the paging device exists. If no link key is available, Secure Simple Pairing (SSP, BT2.1) or legacy pairing (BT2.0 or earlier) is carried out, depending on the Bluetooth Version of the paging device.

After an A2DP connection has been established, the module remains in AT Command mode. S Register 531 is ignored for A2DP connections.

CONFIGURING THE BTM520/521

Table 3-6: A2DP - S-Registers and AT-Commands

TASK	AT-COMMAND / SREGISTER	COMMENT
Set A2DP role	S300 [0..2]	0 = feature not set 1 = A2DP Sink (default) 2 = A2DP Source
Advertise service	S102	128 = A2DP, Error 46 if A2DP role has not been set (see S300)
Initiate outgoing A2DP connection	AT+APD<bd_addr>	Response if accepted: "CONNECT 0123456789012,110D" Response if rejected: "NO CARRIER 110D"
close only A2DP connection	"AT+APH" or "ATH110D"	Response: "NO CARRIER 110D" if connection has existed and S329=0 "NO CARRIER" if connection has not existed and S329=0
close all connections	ATH*	Response: "NO CARRIER <profileUUID>" for each profile that was previously connected (see section 3.7.2)
Set gain level	S589 [0..22], default = 15	Set codec output gain level (applies to sink)
	S590 [0..22], default = 15	Set codec input gain level (applies to source)
Set overall gain (dBr * 10)	S689 [-450..215]	Set codec output gain in dBr * 10 (applies to sink), default = 0
	S690 [-450..215]	Set codec input gain in dBr * 10 (applies to source), default = 0
Set A2DP sink supported features bit mask	S312 [0..15]	Bitmask - sink supported features: Bit 0 = Headphone (default) Bit 1 = Speaker Bit 2 = Recorder Bit 3 = Amplifier
Set A2DP source supported features bit mask	S313 [0..15]	Bitmask - source supported features: Bit 0 = Player (default) Bit 1 = Microphone Bit 2 = Tuner Bit 3 = Mixer

3. AVRCP

The "Audio/Video Remote Control Profile" is used to remotely control audio or video streaming devices. A device must be defined as either control or target. Furthermore, one of four categories (Player/Recorder, Monitor/Amplifier, Tuner, Menu) has to be assigned to a device.

The AVRCP specification [5] adopts the AV/C Digital Interface Command Set (AV/C command set, defined by the 1394 Trade Association) device model and control message format. In this device model a remote control target consists of one or more subunits. At least the subunit "PANEL" must exist. Remote control commands are passed to a subunit with the "PASS THROUGH" command. A BT-MM+ Module, configured as target will support one PANEL subunit.

3.1 AVRCP - Control (CT)

This section describes AT Commands and S registers used when BT-MM+ is configured as an AVRCP Controller (S301=1).

CONFIGURING THE BTM520/521

3.1.1 Initiate AVRCP control connection

AT+AVD<bd_addr$_{hex}$>

Initiate AVRCP control connection to Bluetooth address <bd_addr$_{hex}$>. The module must be configured as AVRCP Control by S register 301 = 1. Furthermore, a category be selected in S register 302.

Response: <cr,lf>CONNECT 123456789012,110E<cr,lf>

Or: <cr,lf>NO CARRIER 110E<cr,lf>

Or: <cr,lf>ERROR 47<cr,lf>

Or: <cr,lf>ERROR 48<cr,lf>

After an AVRCP connection has been established, the module remains in AT command mode. S Register 531 is ignored for AVRCP connections.

3.1.2 Release AVRCP control connection

AT+AVH

Release AVRCP control connection.

Response: <cr,lf >NO CARRIER 110E<cr,lf>

3.1.3 Send UNIT INFO Request

AT+AVU

Send a Unit Info request to a connected AVRCP target.

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

On command completion:

<cr,lf>AVUR <n> <unit_id$_{hex}$> <unit_type$_{hex}$> <company_id$_{hex}$><cr,lf>

n = status$_{dec}$: 0 – success

1 – fail

4 – timeout

For unit_type see Table 3 9: AV/C Unit/Subunit Types.

3.1.4 Send SUBUNIT INFO Request (incomplete)

AT+AVS<page$_{dec}$>

Send a Subunit Info request to a connected AVRCP target.

Response: <cr,lf>OK<cr,lf> (immediately)

And: <cr,lf>AVSR <page$_{dec}$> <pagedata$_{hex}$> <cr,lf> (after command completion)

<page$_{dec}$> : requested page [0..31]

<pagedata$_{hex}$> : 1st word of requested page

3.1.5 Send remote control command

AT+AVC<operation_id$_{hex}$>,<button_state>

Send a remote control command to a connected AVRCP target. Internally, a PASS THROUGH command is created and sent to the PANEL subunit of the AVRCP target.

<operation_id$_{hex}$> is the value for the actual remote control command. Valid values are specified in Table 3 8. Some Operation IDs can be replaced by mnemonics, see Table 3 8.

<button_state> represents "Button pushed" (=0) or "Button released" (=1)
If <button_state> is not specified, two PASS THROUGH commands, each with button_state=0 and button_state=1 will be created and sent consecutively.

The "OK" response is sent immediately on receipt of AT+AVC command. On command completion, an unsolicited message will be sent to the host in the form "AVPTC n <bd_addr> <button_state>". AVPTC means "AVrcp Pass Through Confirmation". Parameter n indicates the command status:

'n'=0: successful, command confirmation received from target

'n'=1: timeout, target has not sent confirmation within the specified maximum time

'n'=2: all other unsuccessful outcomes

Parameters:

<operation_id$_{hex}$>	(mandatory):	see Table 3 8
<button_state>	(optional) :	'0' - Button pushed
		'1' - Button released

Response: <cr,lf>OK<cr,lf> (immediately)

And: <cr,lf>AVPTC n <operation_id$_{hex}$> <button_state><cr,lf> (after command completion)

If status n indicates an unsuccessful outcome,<operation_id$_{hex}$> and <button_state> are omitted.

3.2 AVRCP – Target (TG)

This section describes AT Commands and S registers when BT-MM+ is configured as an AVRCP Target (S301=2). In this mode, BT-MM+ supports one subunit PANEL (see [5]).

3.2.1 Incoming AVRCP Connection Request

An incoming AVRCP connection request is accepted automatically if a valid link key for the paging device exists. If no link key is available, Secure Simple Pairing (SSP, BT2.1) or legacy pairing (BT2.0 or earlier) is carried out, depending on the Bluetooth Version of the paging device.

After an AVRCP connection has been established, the module remains in AT command mode. S Register 531 is ignored for AVRCP connections.

3.2.2 UNIT INFO Response

It is mandatory to respond to a UNIT INFO command if configured as AVRCP target. Required response parameters are IEEE Company ID and a Unit Type.

The IEEE Company ID is a 24 bit integer which can be set via new S register 303.

In the current revision of BT-MM+ firmware, subunit "Panel" (=0x09) will be returned always. Values of unit/subunit types are outlined in Table 3 9.

3.2.3 SUBUNIT INFO Response

It is mandatory to respond to a SUBUNIT INFO command if configured as AVRCP target. Required response parameters are Subunit type and MaxSubUnitId.

Subunit type will always be returned as 0x09 (Panel).

MaxSubUnitId will always be returned as 0x00 (only one subunit exists, which is panel)

3.2.4 PASS THROUGH Indication

An incoming PASS THROUGH command will be indicated by an unsolicited message

AVPTI <subunit_id$_{hex}$> <operation_id$_{hex}$> <button_state>

For subunit_id$_{hex}$ see Table 3 9. For operation_id$_{hex}$ see Table 3 8.

<button_state>: '0' is Button pushed

'1' is Button released

3.2.5 PASS THROUGH Response

AT+AVR<avrc_response_type$_{hex}$>

If S register 310 = 0, a Pass Through (PT) response is required from the host. The response is sent with:

AT+AVR<avrc_response_type$_{dec}$>

Parameter:

<avrc_response_type$_{dec}$>: see Table 3 10, write-value.

If S register 310 == 1, a Pass Through response is sent automatically with an <avrc_response_type> configured by S register 311. In this case, the host is not required to respond.

Table 3-7: AVRCP - S-Registers and AT-Commands

TASK	AT-COMMAND / SREGISTER	COMMENT
Set AVRCP role	S301 [0..2]	0 = disabled 1 = Control "CT" (default) 2 = Target "TG"
Set AVRCP category	S302 [0..4]	0 = Feature disabled (default) 1 = Player/Recorder 2 = Monitor/Amplifier 3 = Tuner 4 = Menu
Set Company Id	S303 [0..0xFFFFFF]	IEEE Company ID, 24bit hexadecimal,Required for UNIT INFO Response in AVRCP target mode, default value is 0.
Enable Unit Info Response	S305 [0..1]	default = 1
Enable Subunit Info Response	S306 [0..1]	default = 1
Configure PASS THROUGH (PT) Response	S310 [0..1]	1 = Enable automatic PT-response, response type is read from S311, (default) 0 = Host is required to respond to PT-Indication, see 'AT+PTR'
Set automatic response type	S311 [0.. 7]	This value is queried for automatic PT-Response, see Table 3-10 Default value is "accepted" 1w/ 9r
Advertise service	S102	256 = AVRCP, Error 47 if AVRCP role has not been set (see S301); Error 48 if S301== 2 and Category has not been set (see S302)
Initiate outgoing AVRCP control connection	AT+AVD<bd_addr>	Response if accepted: "CONNECT 0123456789012,110E" Response if rejected: "NO CARRIER 110E"
Close only AVRCP connection	"AT+AVH" or "ATH110E"	Response: "NO CARRIER 110E" if connection has existed and S329=0 "NO CARRIER" if connection has not existed and S329=0
Close all connections	ATH*	Response: "NO CARRIER <profileUUID>" for each profile that was previously connected (see Miscellaneous section 2)
Send a Unit Info request	AT+AVU	
Send a Subunit Info request	AT+AVS	(incomplete!)
Send remote control command	AT+AVC<operation_id$_{hex}$>,<state>	<operation_id>: see Table 3 8, mnemonics possible instead of hexval <state> (optional): '0' Button pushed '1' Button released Response on command completion: "AVPTC n <operation_id$_{hex}$> <state>"
Respond to incoming Pass Through command	AT+AVR<avrc_response_type$_{hex}$>	<avrc_response_type$_{hex}$>: see Table 3 10 If S 310 == 1, response from host is not required.

CONFIGURING THE BTM520/521

Table 3-8: AVRCP - Operation ID and Mnemonic for Remote Control Commands

COMMAND	OPERATION ID	MNEMONIC
Select	0x00	
Up	0x01	
Down	0x02	
Left	0x03	
Right	0x04	
Right up	0x05	
Right down	0x06	
Left up	0x07	
Left down	0x08	
Root menu	0x09	
Setup menu	0x0A	
Contents menu	0x0B	
Favorite menu	0x0C	
Exit	0x0D	
0	0x20	
1	0x21	
2	0x22	
3	0x23	
4	0x24	
5	0x25	
6	0x26	
7	0x27	
8	0x28	
9	0x29	
Dot	0x2A	
Enter	0x2B	
Clear	0x2C	
Channel up	0x30	
Channel down	0x31	
Sound select	0x32	
Input select	0x33	
Display information	0x34	
Help	0x35	
Page up	0x36	
Page down	0x37	
Power	0x40	
Volume up	0x41	
Volume down	0x42	
Mute	0x43	
Play	0x44	PLAY
Stop	0x45	STOP
Pause	0x46	PAUSE
Record	0x47	
Rewind	0x48	REWIND
Fast forward	0x49	FFORWARD
Eject	0x4A	
Forward	0x4B	FORWARD
Backward	0x4C	BACKWARD
Angle	0x50	
Sub picture	0x51	
F1	0x71	
F2	0x72	
F3	0x73	
F4	0x74	
F5	0x75	
Vendor unique	0x7e	

CONFIGURING THE BTM520/521

Table 3-9: AV/C Unit/Subunit Types

UNIT / SUBUNIT TYPE	VALUE
Monitor	0x00
Audio	0x01
Printer	0x02
Disc	0x03
Tape recorder player	0x04
Tuner	0x05
CA	0x06
Camera	0x07
Reserved	0x08
Panel	0x09
Bulletin board	0x0A
Camera storage	0x0B
Vendor unique	0x1C
Reserved for all	0x1D
Extended	0x1E
Unit	0x1F

Table 3-10: AVRC Response Types

AVRC RESPONSE TYPE	READ-VALUE (S311, SENT IN RESPONSE)	WRITE-VALUE (S311)
Not implemented	8	0
Accepted	9	1
Rejected	10	2
In transition	11	3
Stable	12	4
Changed	13	5
Interim	15	6
Bad profile	16	7

Table 3-11: AVRCP Unsolicited Messages

MESSAGE	COMMENT
RING 0123456789012 110E	Indication of AVRCP control connection request
CONNECT 0123456789012 AE 110E	AVRCP control connection established'0123456789012' – bd_addr of peer device 'A' - authenticated 'E' – encrypted '110E' – UUID indicating AVRCP
NO CARRIER 110E	AVRCP connection rejected or closed
NO CARRIER	All Connections closed
AVUR <unit_type$_{hex}$> <company_id$_{hex}$>	AV Unit Info Response, sent in response to AT+AVU (UNIT INFO Request), <unit_type>: see Table 3 9 <company_id>: IEEE Company ID
AVSR	AV Subunit Info Response, sent in response to AT+AVS (SUBUNIT INFO Request), incomplete
AVPTI <subunit_id$_{hex}$> <operation_id$_{hex}$> <state>	Indication of incoming Pass Through command <subunit_id$_{hex}$>: subunit id <operation_id$_{hex}$>: see Table 3 8 <state>: '0' – Button pushed '1' – Button released
AVPTC n <operation_id$_{hex}$> <state>	Confirmation of AT+AVC (Control Command Request) n: '0' – successful '1' – timeout '2' – not successful, other than timeout
RING 0123456789012 110E	Indication of AVRCP control connection request

CONFIGURING THE BTM520/521

SECURE SIMPLE PAIRING (SSP)

Secure Simple Pairing is supported on the BT-MM+ module. A set of S Registers provides configuration capabilities for SPP:

- Security Level – S320
- IO-Capability – S321
- Force man-in-the-middle-protection (MITM) – S322
- Disable legacy pairing – S323

For details see Table 3 1.

LINK KEY MANAGEMENT

On BT-MM+ link keys are managed by the AT firmware.

1. Dedicated Bonding

   In BT2.1 specification, "dedicated bonding" is defined as the exchange of link keys between two devices without the intention of establishing a connection immediately.

   Dedicated bonding is initiated by "AT+BTW<BdAddr>" (initiation of pairing).

2. General Bonding

   In BT2.1 specification, "general bonding" is defined as the exchange of link keys between two devices with the intention of establishing a connection immediately. This is the case if a device wants to connection to another device without existing link key. Hence, pairing (authentication and exchange of link keys) is initiated automatically prior to the connection.

   General bonding is initiated by "ATD<BdAddr>", "AT+APD<BdAddr>", "AT+AVD<BdAddr>" if there are no link keys for the peer device existing.

3. Legacy Issues (BT2.0)

   There are some special cases if a legacy device (BT2.0 or earlier, e.g.BISM2) requests a connection to a BT-MM+ (BT2.1) module.

   General bonding does not work if initiated by the legacy device. Instead, the legacy device must initiate dedicated bonding first (for example on BISM2 the command "AT+BTW<BdAddr>" would be used). After successful pairing, the connection can be initiated by the legacy device (for example on BISM2 the "ATD<BdAddr>" command would be used).

CONFIGURING THE BTM520/521

MISCELLANEOUS

1. Profile Connection Status

The connection status of a profile can be queried by an ATI-Command. This might be helpful in order to decide whether to disconnect all connected profiles (via ATH*) or a certain one. For details please see Table 3-12.

Table 3-12: Profile Connection Status

TASK	AT-COMMAND	COMMENT
Get connection status of SPP	ATI60	0 = not connected 1 = connected identical with ATI9
Get connection status of A2DP	ATI61	0 = not connected 1 = connected
Get connection status of AVRCP	ATI62	0 = not connected 1 = connected

2. Disconnecting Profiles

A connection to a profile can be released by "ATH<Profile-UUID>" or by using the profile specific disconnect command.

The response on a disconnect command is "NO CARRIER <profileUUID>". If no connection existed then the profileUUID is omitted.

If all connections are to be released, ATH* may be used. Please see Table 3-13.

Table 3-13: Profile Release Commands

TASK	AT-COMMAND	COMMENT
Disconnect A2DP	ATH110D orAT+APH	If A2DP connection released: response = "NO CARRIER 110D"; If no A2DP connection has existed: response = "NO CARRIER"
Disconnect AVRCP	ATH110E or AT+AVH	If AVRCP connection released: response = "NO CARRIER 110D"; If no AVRCP connection has existed: response = "NO CARRIER"
Disconnect all profiles	ATH*	Response = "NO CARRIER <ProfileUUID>" for each previously connected profile

3. Production Info String

A string with production information can be retrieved by "ATI200".

CONFIGURING THE BTM520/521

APPENDIX

BT-MM+ Unsolicited Messages

MESSAGE	COMMENT
CONNECT 0123456789012,110D	A2DP control connection established '0123456789012' – bd_ addr of peer device '110D' – Profile UUID indicating A2DP
NO CARRIER 110D	A2DP connection rejected or closed (if S329==0)
CONNECT 0123456789012,110E	AVRCP control connection established '0123456789012' – bd_ addr of peer device '110E' – Profile UUID indicating AVRCP
NO CARRIER 110E	AVRCP connection rejected or closed (if S329==0)
AVUR n <unit_id$_{hex}$> <unit_type$_{hex}$> <company_id$_{hex}$>	AV Unit Info Response, sent in response to AT+AVU (UNIT INFO Request), <unit_id$_{hex}$>: unit id <unit_type$_{hex}$>: see Table 3 9 <company_id>: IEEE Company ID
AVSR <page$_{dec}$> <pagedata$_{hex}$>	AV Subunit Info Response, sent in response to AT+AVS (SUBUNIT INFO Request), Page data: 1st word of requested page, incomplete
AVPTI <operation_id$_{hex}$> <button_state> <subunit_id$_{hex}$> <subunit_type$_{hex}$>	Indication of incoming Pass Through command <operation_id$_{hex}$>: see Table 3 8 <button_state>: '0' – pushed '1' – released <subunit_id$_{hex}$>: subunit id <subunit_type$_{hex}$>: subunit type, see Table 3 9
AVPTC n <operation_id$_{hex}$> <state>	Confirmation of AT+AVC (Control Command Request) n: '0' – successful '1' – timeout '2' – not successful, other than timeout
PAIR ? <BdAddr>	Incoming pairing request from device with BdAddr
PAIR 0 <BdAddr>	Succesfully paired with device with BdAddr
PAIR 1 <BdAddr>	Pairing error
PASSKEY ? <BdAddr>	Incoming passkey request (respond with at+btb012345)
PASSKEY N <BdAddr> 012345	Passkey notification (if MITM protection is enabled)

BT-MM+ Error Responses

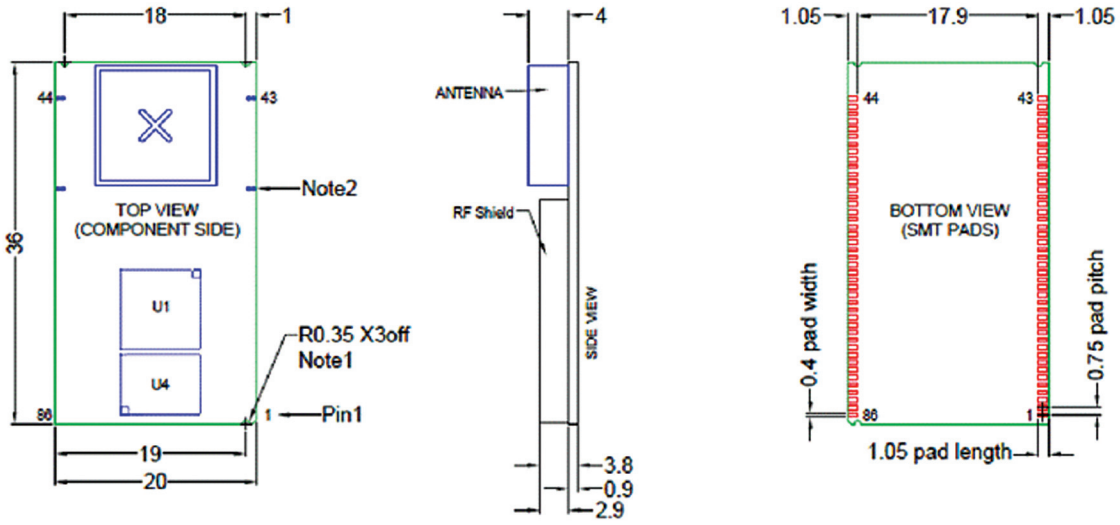
ERROR	DESCRIPTION
01	Register not recognised
02	Value for register is out of range
03	Incoming call NOT pending
04	No call to connect to. This error code has meaning for ATO only
05	Syntax Error
06	Empty String
06	Device Class could not be stored
08	Invalid Device Class Code
09	Invalid Bluetooth Address
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

CONFIGURING THE BTM520/521

ERROR	DESCRIPTION
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
41	Unused
42	Unused
43	Unused
44	Unused
45	Unused
46	No A2DP role has been set (see S register 300)
47	No AVRCP role has been set (see S register 301)
48	No AVRCP category has been set (see S register 302)
49	No AVRCP control connection
50	No A2DP or AVRCP connection currently incoming
50	No A2DP or AVRCP connection currently incoming
51	Invalid operation ID (AVRCP)
52	Wrong AVRCP role
53	Command disabled by S-Register 310
54	Production info string does not exist
55	Audio resource error
56	Invalid UUID
57	Maximum gain level reached
58	Minimum gain level reached

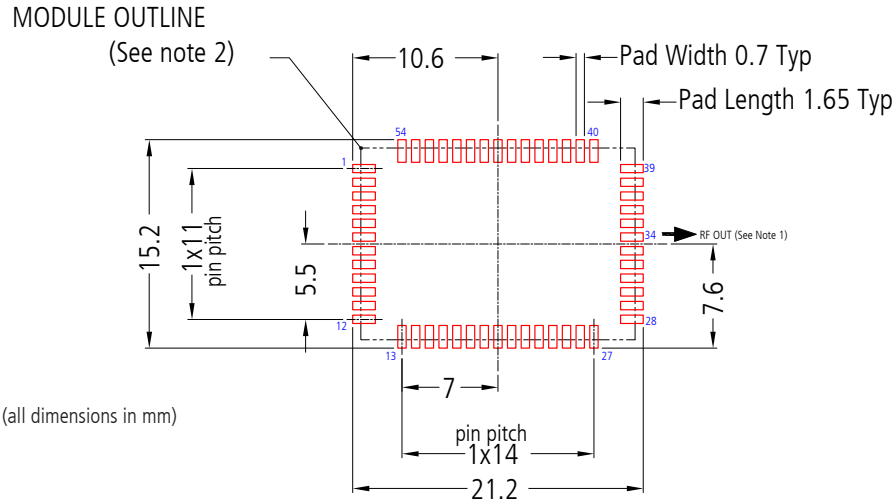
MECHANICAL DRAWINGS

MECHANICAL DETAILS

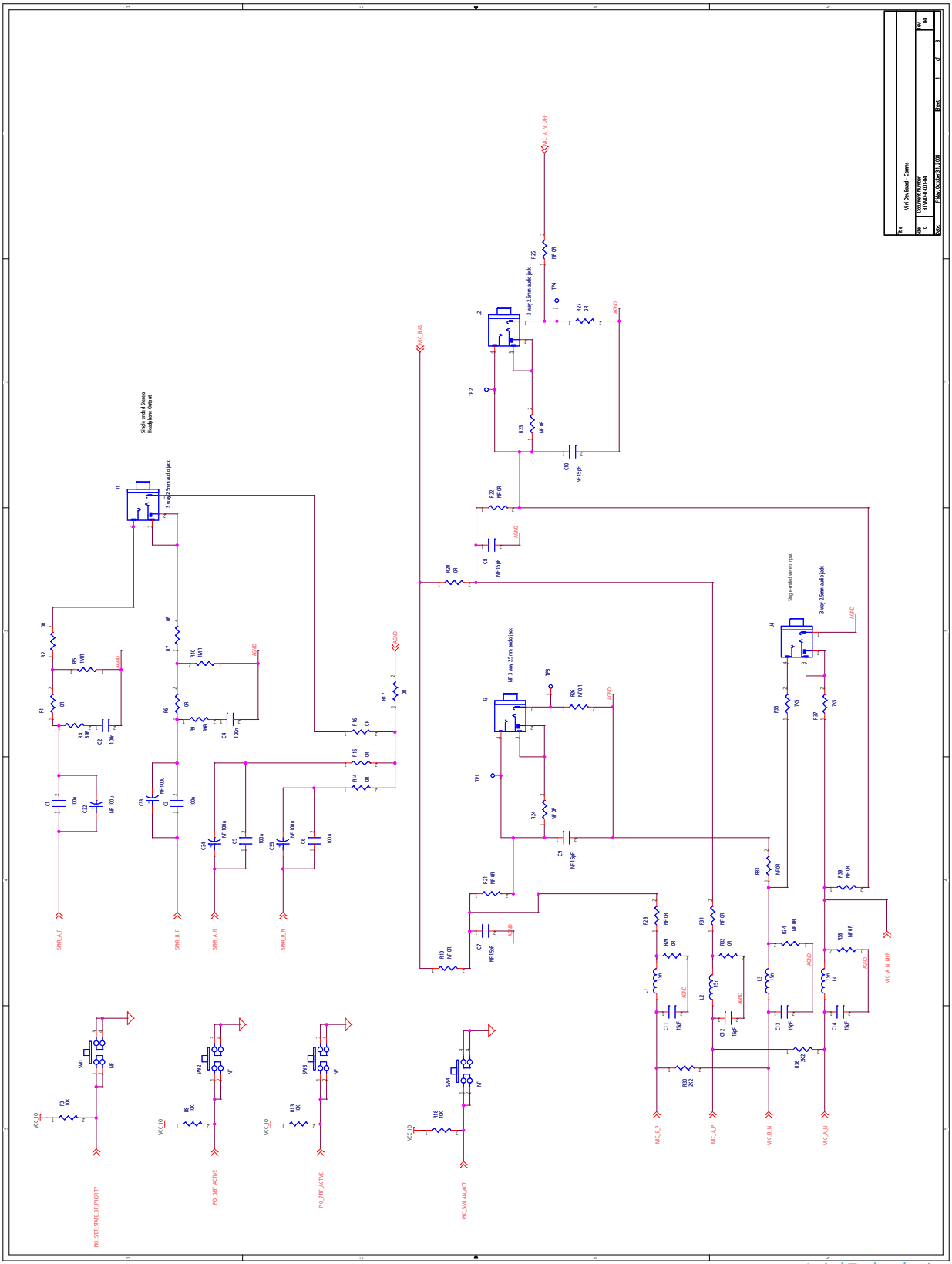


Description	54 pin BT Voice Module (8X6 Flash)			
Size	20.0 x 14.0 x 2.4mm			
Pitch	1.0mm			
Dimension	Minimum	Typical	Maximum	Notes
A	2.3	2.4	2.7	
A1	0.8	0.9	1.0	PCB Thickness
A2	1.3	1.5	1.7	RF Shield Height
b	0.55	0.60	0.65	Global pad width
D	13.87	14.0	14.13	
E	19.87	20.0	20.13	
e		1.0		Global pitch
D1		11.0		
E1		14.0		
F		1.50		Pad Centre to Board edge
G		3.00		Pad Centre to Board edge
H		0.85		Global length of pad to edge of board
Units	mm			

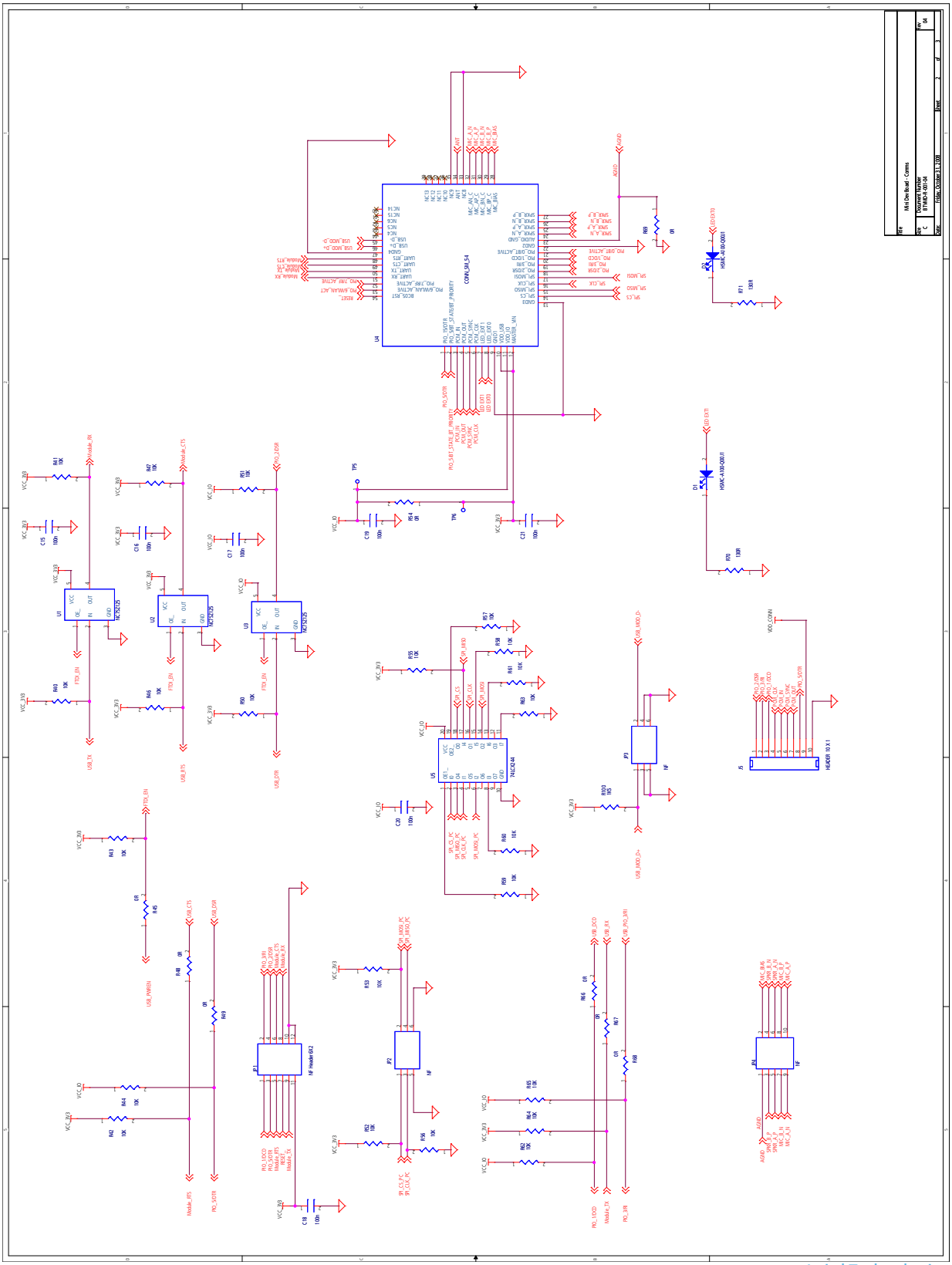
RECOMMENDED PCB FOOTPRINT



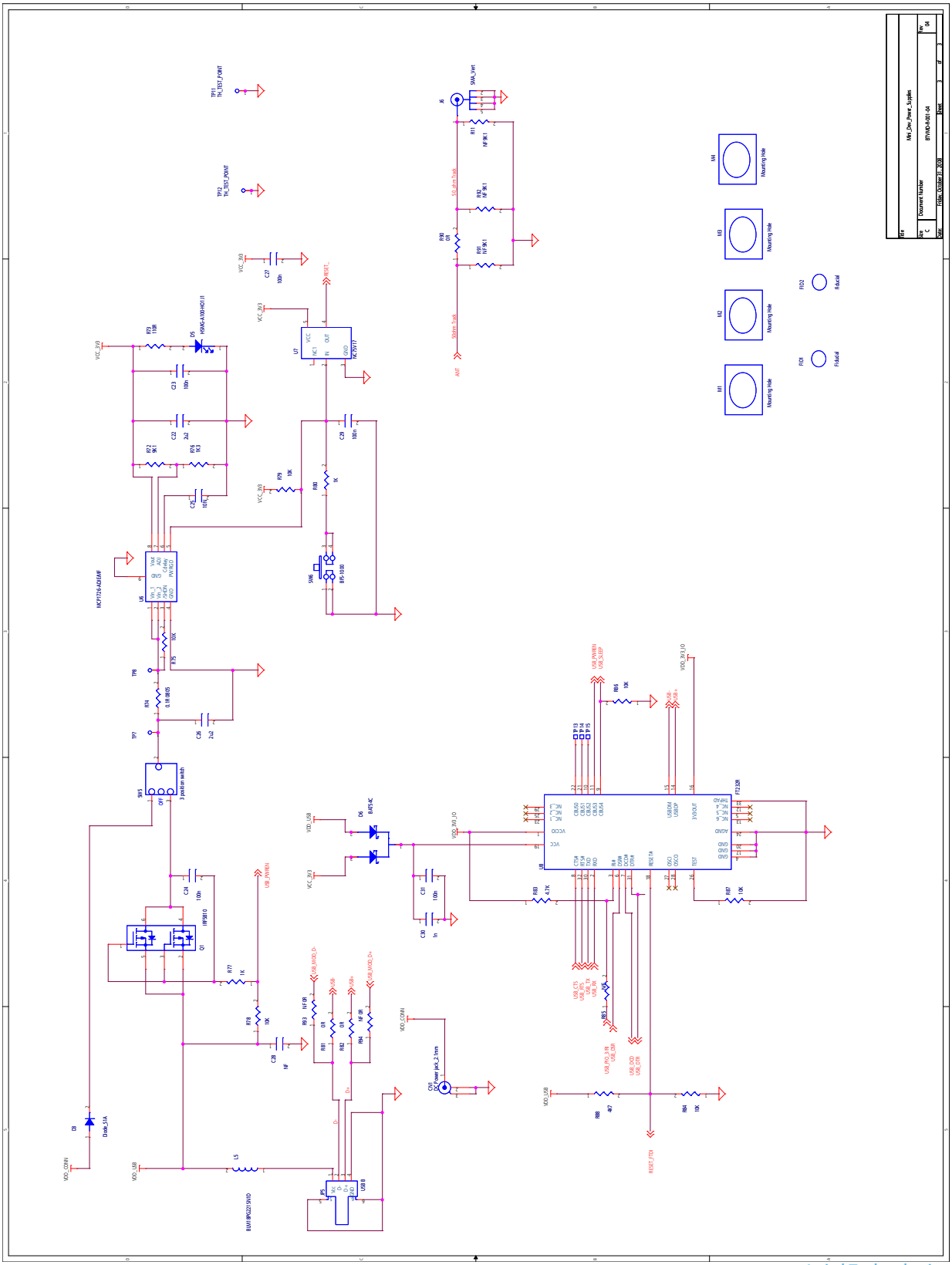
MECHANICAL DRAWINGS



MECHANICAL DRAWINGS



MECHANICAL DRAWINGS



ORDERING INFORMATION

ORDERING INFORMATION

BTM520	Bluetooth® Multimedia Plus Module (external antenna)
BTM521	Bluetooth® Multimedia Plus Module with integrated antenna
DVK-BTM520	Development Board with BTM520 soldered in place
DVK-BTM521	Development Board with BTM521 soldered in place

GENERAL COMMENTS

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

Refer to the schematic BTV-R-003.pdf for the Development Kit for examples of typical pin connections. A pdf of the schematic can be downloaded from the product web page.

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