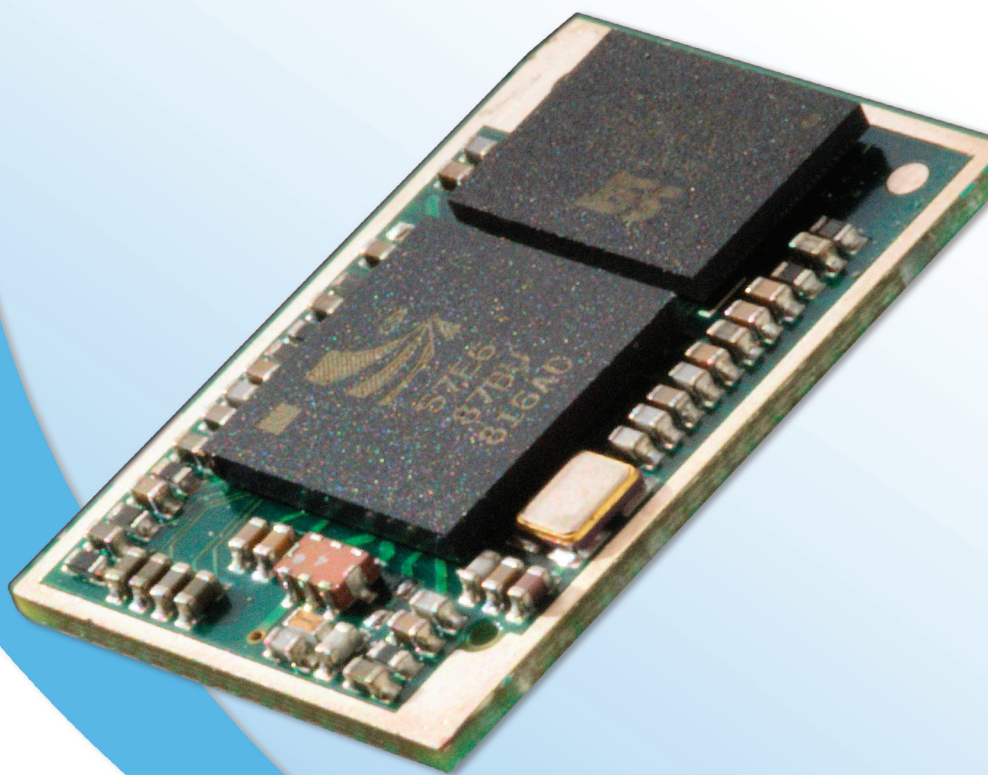


BTM510/511 MULTIMEDIA MODULE

USER MANUAL



Laird
TECHNOLOGIES®

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

BTM510/511

Bluetooth® Multimedia Module

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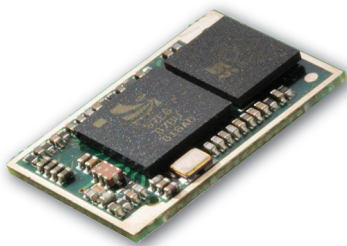
Product Part Numbers 45

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BTM510/511

Bluetooth® Multimedia Module

OVERVIEW AND KEY FEATURES



The BTM510 and BTM511 are low-power Bluetooth® modules designed for adding robust audio and voice capabilities. Based on the market-leading Cambridge Silicon Radio BC05 chipset, these modules provide exceptionally low power consumption with outstanding range. Supporting the latest Bluetooth® Version 2.1+EDR specification, these modules provide the important advantage of secure simple pairing that improves security and enhances easy use.

At only 14mm x 20mm, the compact size of the BTM510 makes it ideal for battery-powered or headset form factor audio and voice devices. With a 16-bit stereo codec and microphone inputs to support both stereo and mono applications, these modules also contain a full, integrated Bluetooth®-qualified stack along with SPP, HFP 1.5, HSP, AVRCP, and A2DP profiles. Customers using these modules may list and promote their products free of charge on the Bluetooth® website.

The BTM510/511 modules include an embedded 32-bit, 64-MIPS DSP core within the BC05. This is integrated with the Bluetooth® functionality which allows designers to add significant product enhancements including features such as echo cancellation, noise reduction, and audio enhancement using additional soft codecs. The availability of the 16MB of flash memory in the module allows complex functionality to be included. DSP routines can be licensed through a number of specialist partners. Typical applications for these modules include Bluetooth® stereo headsets, VoIP phones, and wireless audio links.

To speed product development and integration, Laird Technologies has developed a comprehensive AT command interface that simplifies application development, including support for audio and headset functionality. Access to GPIO pins allows mapping for direct connection to actuator buttons on headsets. Combined with a low-cost development kit, Laird Technologies' Bluetooth® modules provide faster time to market.

FEATURES

- Fully featured Bluetooth® multimedia module
- Bluetooth® v2.1+EDR
- Supports mono and stereo headset applications
- 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
- 16-bit stereo codec and microphone input
- Integrated audio amplifiers for driving stereo speaker
- Comprehensive AT interface for simple programming
- Bluetooth® END product qualified
- Compact size
- Class 2 output – 4dBm
- Low power operation
- Wi-Fi co-existence hardware support

APPLICATION AREAS

- High-quality stereo headsets
- Mono voice headsets
- Hands-free devices
- Wireless audio cable replacement
- MP3 and music players
- Phone accessories
- VoIP products
- Cordless headsets
- Automotive

SPECIFICATIONS

CATEGORIES	FEATURE	IMPLEMENTATION
Wireless Specification	Standards Supported	Bluetooth® v2.1 + EDR
	Transmit Class	Class 2
	Frequency	2.402 – 2.480 GHz
	Channels	79 channels Frequency Hopping Adaptive Frequency Hopping
	Max Transmit Power	+4 dBm @ antenna pad – BTM510 +4 dBm from integrated antenna – BTM511 (provisional)
	Min Transmit Power	-27 dBm @ antenna pad – BTM510 -27 dBm from integrated antenna – BTM511 (provisional)
	Receive Sensitivity	Better than -86 dBm
	Data Transfer rate	Up to 300kbps
	Range	Up to 50 meters free space (Data)
Antenna Modes	External Antenna	50 Ohm matched SMT pad – BTM510
	Integrated Antenna	+0dB (provisional) multilayer ceramic – BTM511
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	9,600,n,8,1
	Levels	Set by VDD_USB pin
	Modem Control	DTR, DSR, DCD, RI, RTS, CTS
General Purpose Interface	I/O	8 general purpose I/O pins
	I ² S	Stereo Audio Digital Interface Bus
	LED	Two
Audio	Codec	Integrated stereo codec with -95dB SNR for DAC
	Amplifiers	Direct drive for 22Ω Mono Speaker / 44Ω Stereo Speakers
	Microphone	Input with bias for low noise microphone
	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
	Protocols	RFCOMM AVCTP AVDTP
	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. 5 Registers for non-volatile storage of parameters
DSP	Kalimba DSP	Integrated in BC05 32bit, 64MIPS, 16Mbps Flash Memory (shared)
	Applications	Available from partners
Current Consumption	Data Transfer	Typically < 35mA
	Stereo Music	Typically < 70mA (including speaker drive)
	Low Power Sniff Mode	Less than 1.5mA
Supply Voltage	Supply	3.0V – 3.6V DC
	I/O	1.7V – 3.6V DC
	USB	1.7V – 3.6V DC
Coexistence / Compatibility	WLAN (802.11)	2-wire and 3-wire hardware coexistence schemes supported
Connections	External Antenna (option)	Pad for 50 Ohm antenna – BTM510
	Interface	Surface Mount Pads
Physical	Dimensions	14.0mm x 20.0 x 1.6mm - BTM510 14.0mm x 26.0mm x 1.6mm - BTM511 (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 – BTM511)
	CE & R&TTE	Meets CE and R&TTE requirements
Miscellaneous	Lead free	Lead-free within EU requirements and RoHS compliant
	Warranty	12 Months
Development Tools	Development Kit	Development board and software tools

SPECIFICATIONS

PIN	SIGNAL	DESCRIPTION	VOLTAGE SPECIFICATION
1	PIO15 / DTR	Host I/O	VIO
2	PIO5/BT_STATE/BT_PRIORITY	Host I/O, BT Co-existence	VIO
3	PCM_IN	PCM Data I/P	VIO
4	PCM_OUT	PCM Data O/P	VIO
5	PCM_SYNC	PCM Sync I/P	VIO
6	PCM_CLK	PCM CLK I/P	VIO
7	LED_EXT1	Host I/O	See Note 2
8	LED_EXT0	Host I/O	See Note 2
9	GND		
10	VDD_USB	USB supply voltage	
11	VDD_IO	I/O supply voltage	
12	VDD_IN	Main supply voltage	
13	GND		
14	SPI_CSB	SPI bus chip select I/P	VIO
15	SPI_MISO	SPI bus serial O/P	VIO
16	SPI_CLK	SPI bus clock I/P	VIO
17	SPI_MOSI	SPI bus serial I/P	VIO
18	PIO2/DSR	Host I/O	VIO
19	PIO3/RI	Host I/O	VIO
20	PIO1/DCD	Host I/O	VIO
21	PIO0/BT_ACTIVE	Host I/O, BT Co-existence	VIO
22	GND		
23	AUDIO_GND	Audio ground	
24	SPKR_A_N	Speaker, channel A- (left)	See note 3
25	SPKR_A_P	Speaker, channel A+ (left)	See note 3
26	SPKR_B_N	Speaker, channel B- (right)	See note 3
27	SPKR_B_P	Speaker, channel B+ (right)	See note 3
28	MIC_BIAS	Microphone bias	See note 4
29	MIC_BP_C	Microphone, channel A- (left)	See note 4
30	MIC_BN_C	Microphone, channel A+ (left)	See note 4
31	MIC_AP_C	Microphone, channel B- (right)	See note 4
32	MIC_AN_C	Microphone, channel B+ (right)	See note 4
33	Unused		
34	ANT	Antenna connection – BTM510 (50 ohm matched)	
35	Unused		
36	Unused		
37	Unused		
38	Unused		
39	Unused		
40	Unused		
41	Unused		
42	Unused		
43	Unused		
44	Unused		
45	USB_D-		VUSB
46	USB_D+		VUSB
47	GND		
48	UART_RTS	Request to Send O/P	VUSB
49	UART_CTS	Clear to Send I/P	VUSB
50	UART_TX	Transmit data O/P	VUSB
51	UART_RX	Receive data I/P	VUSB
52	PIO7/RF_ACTIVE	Host I/O, BT Co-existence	VIO
53	PIO6/WLAN_ACTIVE	Host I/O, BT Co-existence	VIO
54	Reset	Module reset I/P	See Note 1

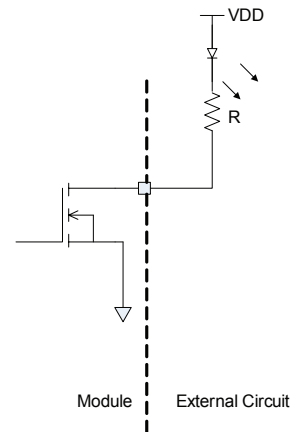
SPECIFICATIONS

- Note:
1. Reset input is active low. Input is pulled up to VDD_IN 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.

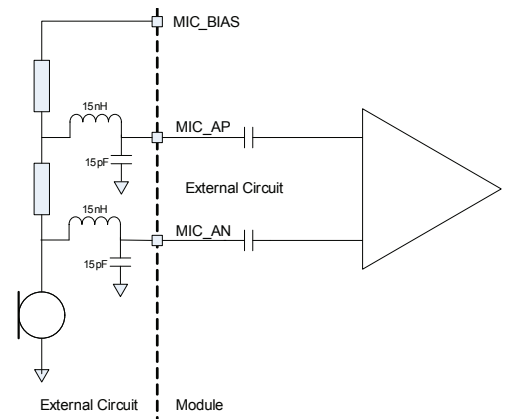
The voltage on the module pad should be maintained below 0.5V in which case the R_{on} of the FET is around 20Ω . Provided that this condition is met, then the current flowing through the diode is:

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

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.



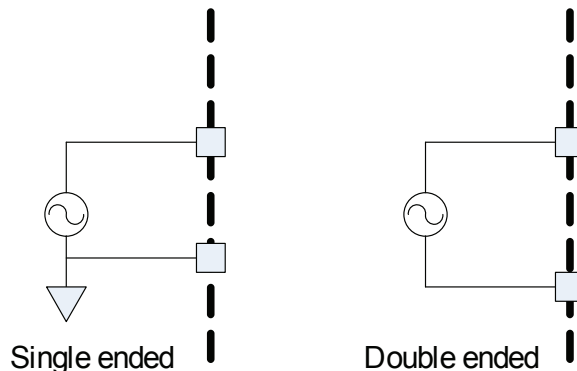
When operating in microphone mode the microphone should be biased as follows:



The input impedance on the microphone inputs (in microphone mode) is typically $6k\Omega$. 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 microphone 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 $1\mu A$ and $10\mu A$ at 94dB SPL. If the biasing resistors are set to $1k\Omega$ this implies a microphone with a sensitivity in the range -40dBV to -60dBV.

The low pass filter elements formed by the inductor and capacitor are required to eliminate RF pick up on the microphone inputs and should be placed as close to the module as possible.

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:



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	3.6

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 (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

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 (BTM510).
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.

**CONFIGURING
THE BTM510/511****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. Configuration can be saved, so that on a subsequent power up the device is discoverable or automatically connects.

The device has a serial interface 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 BTM510/511****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	:	PASSS THROUGH Command
UI	:	UNIT INFO Command
SUI	:	SUBUNIT INFO Command

**CONFIGURING
THE BTM510/511****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 throughout 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 utilises 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 BTM510/511**

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

PROFILE NAME	UUID	PROFILE NAME	UUID
Serial Port	0x1101	Intercom	0x1110
LAN Access Using PPP	0x1102	Fax	0x1111
Dialup Networking	0x1103	Audio Gateway (HSP)	0x1112
IrMC Sync	0x1104	WAP	0x1113
OBEX Object Push	0x1105	WAP_CLIENT	0x1114
OBEX File Transfer	0x1106	Advanced Audio Distribution	0x110D
IrMC Sync Command	0x1107	A/V Remote Control	0x110E
Headset	0x1108	Handsfree	0x111E
Cordless Telephony	0x1109	Audio Gateway (HFP)	0x111F

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 BTM510/511

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	<p>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</p> <p>Setting values ≥ 0, resets S Register 504 to 0 and < 0 forces 504 to 1.</p> <p>If $S0 \neq 0$ and $S100 \neq 0$ then $S0$ must be $< S100$. If a value is entered which violates this rule, then ERROR 29 is sent in response.</p> <p>If $S504 = 1$ then this register will return -1, regardless of the actual value stored in non-volatile memory.</p>
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	<p>Number of RING indications before an auto disconnection is initiated. A value of 0 disables this feature.</p> <p>If $S0 \neq 0$ and $S100 \neq 0$ then $S0$ must be $< S100$. If a value is entered which violates this rule, then ERROR 29 is sent in response.</p>
S101	\$1101	0..\$ffff	UUID of default SPP based profile when not specified explicitly in the ATD command.
S102	1	1..0x7FF	<p>Defines a set of bits masks for enabling profile servers. Values can be ORed.</p> <p>0x001 is Serial Port Profile</p> <p>0x080 is A2DP</p> <p>0x100 is AVRCP</p>
S103	1	1..7	Boot Mode on cold boot.
S126	?	0 .. 0xFFFF	Primer for changing to Multipoint mode
S300	1	0..2	<p>Set A2DP role:</p> <p>0 is feature not set</p> <p>1 is A2DP Sink (default)</p> <p>2 is A2DP Source</p>
S301	1	0..2	<p>Set AVRCP role:</p> <p>0 is feature disabled</p> <p>1 is Control (CT) (default)</p> <p>2 is Target (TG)</p>
S302	0	0..4	<p>Set AVRCP category:</p> <p>0 is Feature disabled (default)</p> <p>1 is Player/Recorder</p> <p>2 is Monitor/Amplifier</p> <p>3 is Tuner</p> <p>4 is Menu</p>

**CONFIGURING
THE BTM510/511**

REGISTER	DEFAULT	RANGE	COMMENT
S303	0	0..0xFFFFF	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
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

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REGISTER	DEFAULT	RANGE	COMMENT
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 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

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REGISTER	DEFAULT	RANGE	COMMENT
S512	1	0..7	<p>Specify power up state.</p> <p>When set to 0, AT+BTO is required to open the device for Bluetooth® activity.</p> <p>When set to 1, it proceeds to a state as if AT+BTO was entered.</p> <p>When set to 2, it will be discoverable only, similar to issuing AT+BTQ.</p> <p>When set to 3, it will be connectable but not discoverable e.g. AT+BTG</p> <p>When set to 4, it will be connectable and discoverable e.g. AT+BTP.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>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.</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 566 and if deasserted then S Reg 567.</p>
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.. 0xFFFFFFFF	<p>Default Device Class Code on power up. When queried, the value is always printed as a hexadecimal number.</p> <p>To change the device class of the module permanently, use this S register plus subsequent AT&W and ATZ. To change the device class temporarily (until next power cycle), use the command AT+BTC.</p>
S516	0x000000	0..0x2FFFFFFF	<p>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.</p> <p>The seventh most significant digit, can be 0,1 or 2, and is used to specify the type of device class filter.</p> <p>When 0, it specifies no filtering.</p> <p>When 1, it specifies an AND mask and all 24 bits are relevant</p> <p>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.</p>
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.

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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	<p>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.</p>
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	<p>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</p>
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	<p>If 1, then when a successful pairing occurs, it is automatically saved in the trusted device database – if it has room to store it.</p>
S539	0	0..1	<p>When set to 1, in idle mode (S512=1), UART Rx characters are discarded if DSR is deasserted.</p>
S541	6	-50..6	<p>This sets the power level in dBm when inquiring or paging. Reading this register returns the value stored in non-volatile memory.</p>
S542	6	-50..6	<p>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.</p>
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>

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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	0x0FFF	<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	0x0FFF	<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>
S558	0	0..1	<p>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.</p>
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>
S565	0	1	<p>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.</p>
S566	1	7	<p>If S565=1, and RI is asserted then this is the mode the device will start up in.</p>
S567	1	7	<p>If S565=1, and RI is deasserted then this is the mode the device will start up in.</p>
S568	1	7	<p>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</p>
S569	1	7	<p>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</p>
S584	0	0..1	<p>Enable/Disable eSCO</p> <p>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.</p>
S588	0	0..1	<p>After a disconnection, there will be a cold reset</p>
S589	15	0..22	<p>Codec output gain</p>
S590	15	0..22	<p>Codec input gain</p>
S591	0	0..1FF	<p>Default GPIO output states when not in a connection. This is used when virtual digital i/o cable replacement mode is in operation</p>

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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>

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THE BTM510/511****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: <div> 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 </div>
I12	The last ERROR response number.
I60	Connection status of SPP <div> 0 = not connected 1 = connected identical with ATi9 </div>
I61	Connection status of A2DP <div> 0 = not connected 1 = connected </div>
I62	Connection status of AVRCP <div> 0 = not connected 1 = connected </div>

For recognised values of n. All other values of n will return the manufacturer details.

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

Or

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

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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.

The value N is a bit mask indicating the packet type to be used on the SCO link

Bit 0	HV1
Bit 1	HV2
Bit 2	HV3
Bit 3 - 14	Unused, set to zero
Bit 15	ESCO

If n is set to 0 the SCO channel is disabled.

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 BTM510/511****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. The device class setting is valid until the module is reset or power cycled.

<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,>OK<cr,>

Or for an invalid <devclass> value (usually a value which is not 6 hexadecimal characters long).

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

3. AT+BTC? {Read Device Class Code}

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

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

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,>OK<cr,>

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,>OK<cr,>

6. AT+BTf=<string> {Set Friendly Name}

This sets the friendly name of this device as seen by other devices. The friendly name specified in this way is valid until the next reset or power cycle. To set a permanent friendly name use AT+BTN.

Response: <cr,>OK<cr,>

**CONFIGURING
THE BTM510/511****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}

Make device connectable 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.

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 seconds 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 BTM510/511****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,"Laird BTMM 789012"
 <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<bd_addr> {Set Incoming Peer Address}

This command is used to set the peer address.

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

15. AT+BTM {Delete Incoming Peer Address}

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

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

16. 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>

17. 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. The friendly name programmed in this way will only be used AFTER the device has been reset (ATZ) or power cycled. To set a temporary friendly name for immediate use, use the AT+BTF command. 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 BTM510/511****18. 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>

19. 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>

20. 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>

21. 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>

22. 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>

23. 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>

24. 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>123456789012
<cr,<lf>OK<cr,<lf>

If the location is empty the response is as follows.

Response: <cr,<lf>000000000000
<cr,<lf>OK<cr,<lf>

**CONFIGURING
THE BTM510/511****25. 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>

26. 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+L6 to read the maximum size of the trusted device database.

Response: <cr,lf>12346789012

<cr,lf>123456789013

<cr,lf>123456789014

<cr,lf>OK<cr,lf>

27. 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>

28. 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>

29. 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>

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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 command class "AT+G..." allows incremental / decremental control of codec 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").

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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	

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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" and "PWM Period" can be specified via S-Registers. This enables the user to either 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
Set LED_EXT1 mode	S340 [0..3], default=0	1 = LED_ON 2 = LED_PWM 3 = LED_PULSE
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.

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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 BTM510/511****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 must 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

**CONFIGURING
THE BTM510/511****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)

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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..0xFFFFF]	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.

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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	
Favourite 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	

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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
CONNECT 123456789012 110E'	AVRCP control connection established'123456789012' – bd_addr of peer device '110E' – UUID indicating AVRCP
NO CARRIER 110E	AVRCP connection rejected or closed
NO CARRIER	All Connections closed
AVUR <n><unit_id _{hex} ><unit_type _{hex} > <company_id _{hex} >	AV Unit Info Response, sent in response to AT+AVU (UNIT INFO Request), <n>: status _{dec} 0 - success 1 - Fail 2 - Timeout <unit_id _{hex} >: Unit ID <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

**CONFIGURING
THE BTM510/511****SECURE SIMPLE PAIRING (SSP)**

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

- 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 BTM510/511****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 or AT+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 BTM510/511

APPENDIX

BT-MM Unsolicited Messages

MESSAGE	COMMENT
CONNECT 123456789012,110D	A2DP control connection established '123456789012' – bd_addr of peer device '110D' – Profile UUID indicating A2DP
NO CARRIER 110D	A2DP connection rejected or closed (if S329==0)
CONNECT 123456789012,110E	AVRCP control connection established '123456789012' – 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>	Successfully 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)

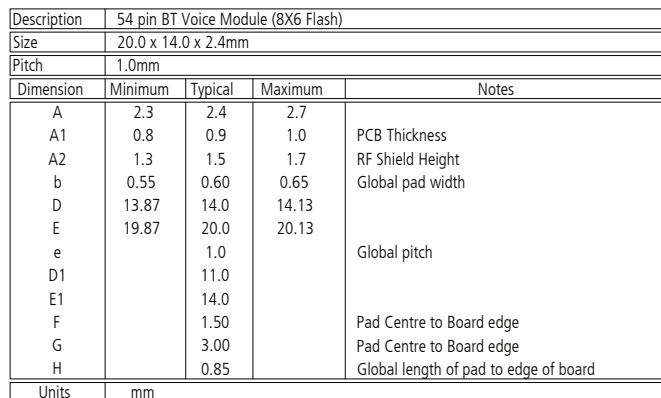
BT-MM Error Responses

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 BTM510/511**

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 DETAILS



(See note 2)

10.6

Pad Width 0.7 Typ

Pad Length 1.65 Typ

15.2

1x14 pin pitch

5.5

7.6

RF OUT (See Note 1)

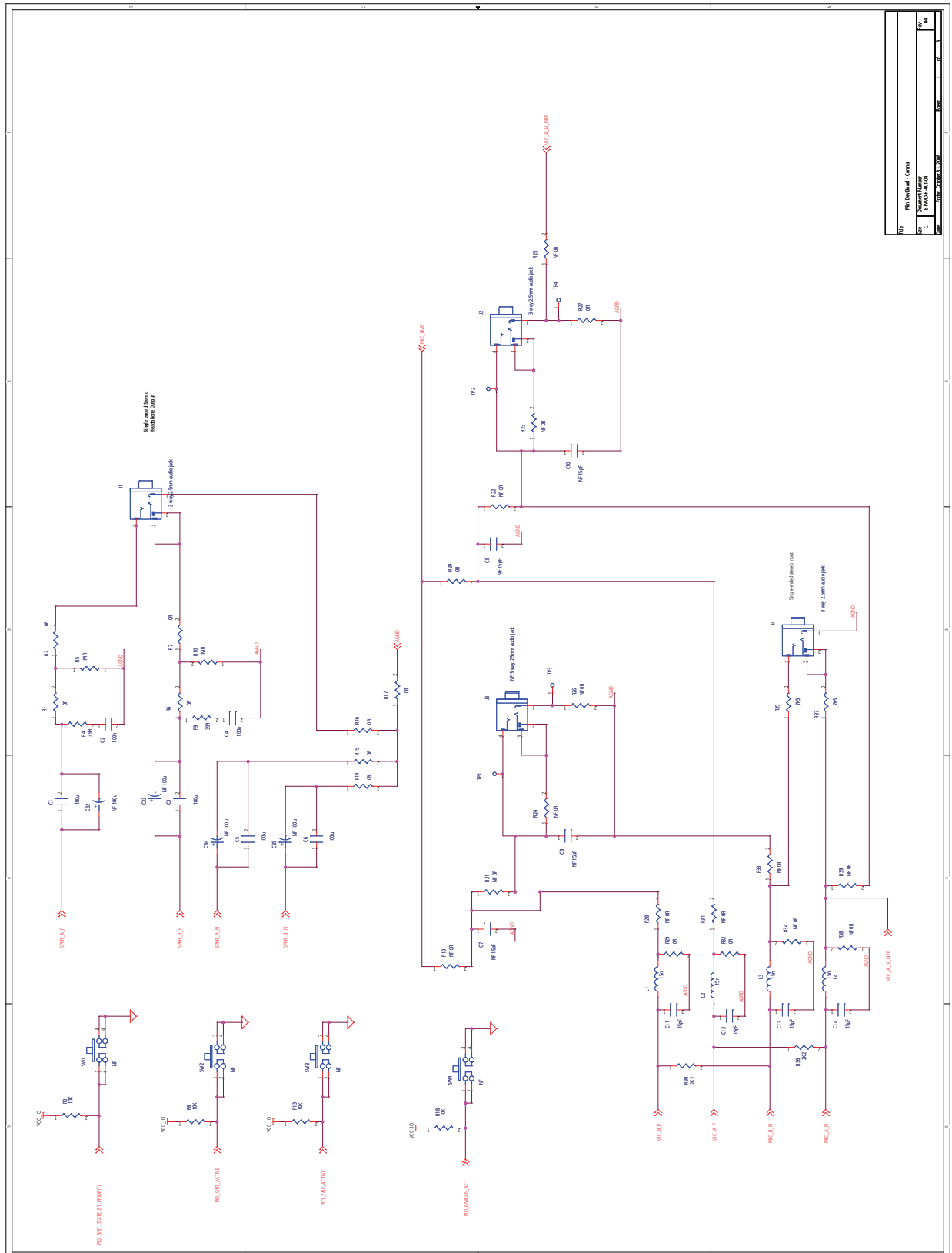
7

pin pitch 1x14

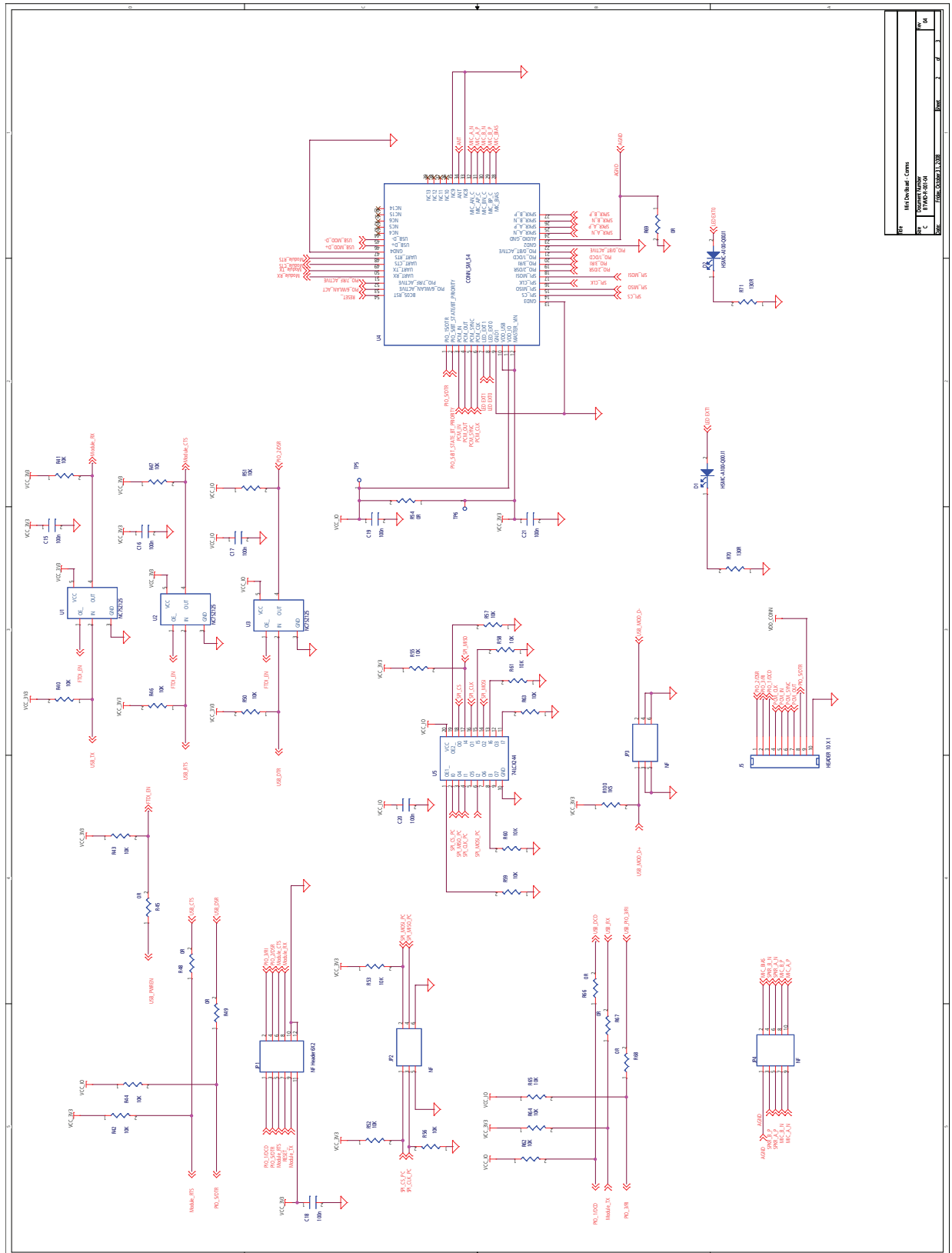
21.2

(all dimensions in mm)

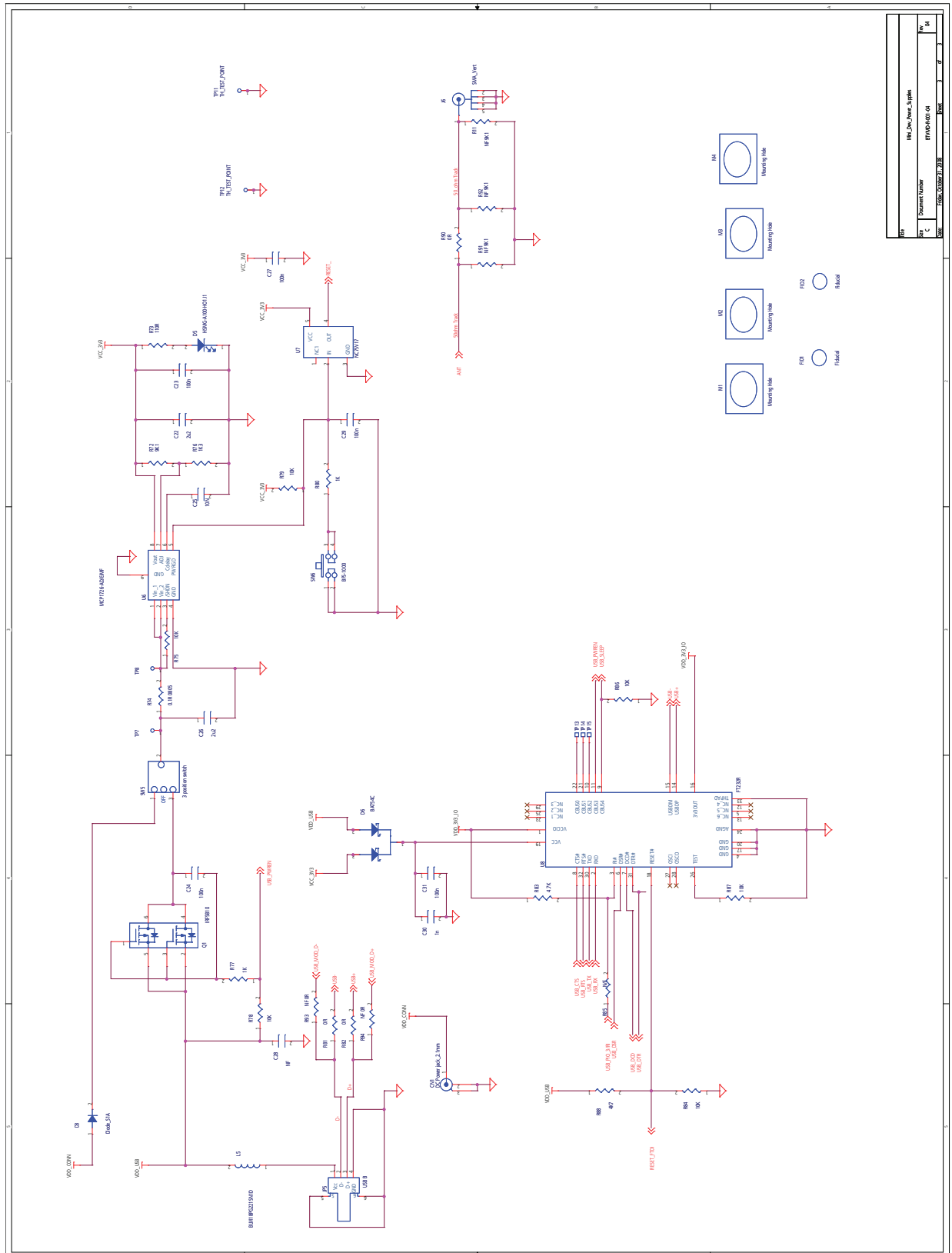
MECHANICAL DRAWINGS



MECHANICAL DRAWINGS



MECHANICAL DRAWINGS



BTM510/511

Bluetooth® Multimedia Module

ORDERING INFORMATION

ORDERING INFORMATION

BTM510	Bluetooth® Multimedia Module (external antenna)
BTM511	Bluetooth® Multimedia Module with integrated antenna Q2-2009
DVK-BTM510	Development Board with BTM510 soldered in place Q1-2009
DVK-BTM511	Development Board with BTM511 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 BTV-R-003.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-BTM510-511 0609

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