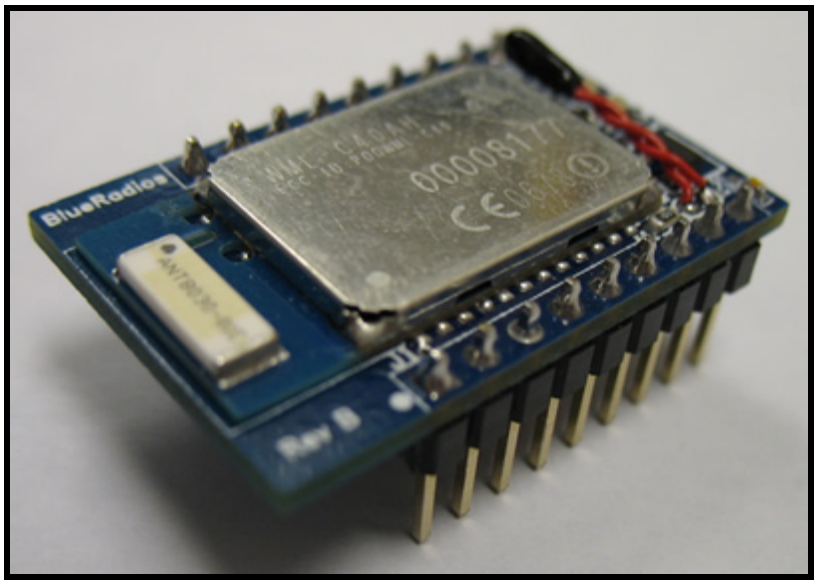
Secure, Versatile and Award Winning Network Radio Devices.

BR-ATM_COMMANDS Rev 3.6.2.1.0.0_1.1.0

User Guide

For:

BlueRadios® Bluetooth®
MEGA BlueStamp® Intelligent Sensor Module



MEGA BlueStamp Module with Thermistor Pictured Above

AT HOME. AT WORK. ON THE ROAD. USING BLUETOOTH WIRELESS TECHNOLOGY MEANS TOTAL FREEDOM FROM THE CONSTRAINTS AND CLUTTER OF WIRES IN YOUR LIFE.

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MBS Firmware Revision History

Rev #	Date	Description	Author
1.0.0	5/1/2007	Production Release	J.M.Sample
1.1.0	5/9/2008	1. Fixed MBS not acknowledging it had been connected to 2. MBS now cancels connection attempts if the pause command or a mode change is issued while it is in the process of connecting, so the user will not have to wait for the connection process to complete	J.M.Sample

Explanation of Versioning

The firmware version is broken down into 3 fields, for example: 3.6.2.1.0.0_1.0.0_2.0.0

1. The first field represents the version of the MBS's Bluetooth module firmware.

2. The second field represents the version of the main MBS firmware. This firmware comprises all commands listed in the ATM Commands section, but not those listed in the Sensor Component Specific ATM Commands section.

3. The third field represents the Sensor Component Specific ATM Command firmware currently loaded on the device. The first digit will differentiate between sensor types, the last two digits will represent version changes. For example 1.#.# represents the Generic Sensor Component and 2.#.# represents the Temperature Sensor Component.

Sensor Component List

Different firmware builds are available for the MEGA BlueStamp, allowing it to be configured for different types of sensors. See the Sensor Component Specific ATM Commands section for detail on how each component behaves.

IMPORTANT: Custom firmware builds are available, please contact BlueRadios for more information.

1. **Generic Sensor Component:** This component build will configure the MEGA BlueStamp to sample data from 0 to 3.33V on the ANALOG_IN pin, allowing it to use an external sensor.

Rev #	Date	Description	Author
1.0.0	5/1/2007	Production Release	J.M.Sample

2. **Temperature Sensor Component:** This component build will configure the MEGA BlueStamp to sample temperature data from the thermistor that is installed on the module. **This is the default firmware build that the unit is shipped with.**

Rev #	Date	Description	Author
2.0.0	5/1/2007	Production Release	J.M.Sample

Important Notes

- **The input voltage on J3 of the development board must be 3.33V.**
- **Due to a part selection error a clock that draws approximately 1mA steady state was used in place of a crystal for the module's oscillator. Because of this error the module will not draw less than 1mA in the low power modes. This error will be fixed in the next board revision.**
- **When the device is sending data using FTP it cannot receive any messages over the SPP channel.**
- **If the MBS is configured to FTP data in Master Mode to a PC at a connection interval (sampling interval * reporting interval) of less than 10 seconds the following results have been seen: the PC will not allow the MBS to establish a connection after running for a few minutes, causing "SLAVE NOT FOUND" to continually be output on the local uart.**

Quick Start Guide for Evaluation Kit

1. **Plug in the 3.3V AC/DC wall transformer that came with the kit and wait a second for the voltage to ramp up.** Then plug the DC receptacle jack into the evaluation board and the red power LED will light up. You will also see a flashing green LED labeled PIO5 on the dev board, and a flashing green LED on the MEGA BlueStamp (MBS) labeled CR2. If the LEDs do not flash at ~1Hz, the power did not ramp up fast enough for the module to boot properly. You can simply press SW1 (black button) on the Evaluation Board to reset.

Using Bluetooth:

2. Using a Bluetooth capable PC, search for a device named BlueRadiosMS#### and connect to its Serial Port Profile (SPP) service named "Temperature." **If your PC requests a passkey, the MBS's default passkey is "default".** The blue LED PIO2 will light on the evaluation board, as well as a blue LED labeled CR1 on the MBS.

3. Run HyperTerminal with factory default settings (do not echo characters or append any additional line feeds). Connect to the COM port assigned to your client Bluetooth Serial Port at 9600 (8,N,1) baud rate settings, and using hardware flow control. The Toshiba stack program defaults and uses virtual COM40 to minimize physical local com port conflicts on the computer.

4. Type "ATM" then press the ENTER key, you will receive the response ":OK". Now try taking a reading by typing "ATMTR" and then pressing ENTER. You will receive the response ":OK" followed by a reading from the sensor.

Using the RS232 Serial Port:

2. Connect the evaluation board to your PC using a standard RS232 pass through cable.

3. Run HyperTerminal with factory default settings (do not echo characters or append any additional line feeds). Connect to the COM port you have connected to the MBS at 9600 (8,N,1) baud rate settings, and using hardware flow control..

4. Type "ATM" then press the ENTER key, you will receive the response ":OK". Now try taking a reading by typing "ATMTR" and then pressing ENTER. You will receive the response ":OK" followed by a reading from the sensor.

1 Introduction

"Our technology delivers a dynamic experience that comes out of the wireless delivery mechanism and the freedom to connect others."

Mark J. Kramer – CEO of ***Blue*****Radios**

Scope: This document describes the hardware and software interface of the ***MEGA BlueStamp*** (***MBS)***. This document along with the ***MBS*** evaluation board was created to enable developers and integrators an opportunity to evaluate our ***MBS*** wireless sensor technology. The goal is to make the transition to *Bluetooth* wireless networks as seamless and easy as possible for our clients.

Background: The ***Blue*****Radios** ***MBS*** combines the wireless flexibility of a ***Blue*****Radios** Class 1 *Bluetooth* module with a low power microcontroller to create a powerful and widely customizable wireless sensor. The ***MBS*** is designed to integrate with a wide range of applications and platforms with a simple electrical and software interface using simple ASCII commands. It can be integrated with other devices or used as a stand-alone wireless sensor module.

The main purpose of the ***MBS*** is to allow the user to configure the device to take readings at a user specified sampling rate and then automatically report the readings at a user specified reporting interval over a *Bluetooth* connection. But it can also be used to take readings upon request or to store data until it is requested by the user. On top of this the user has full control over how the data is delivered, the format of the data, and specific ranges of data to store as well as many other options.

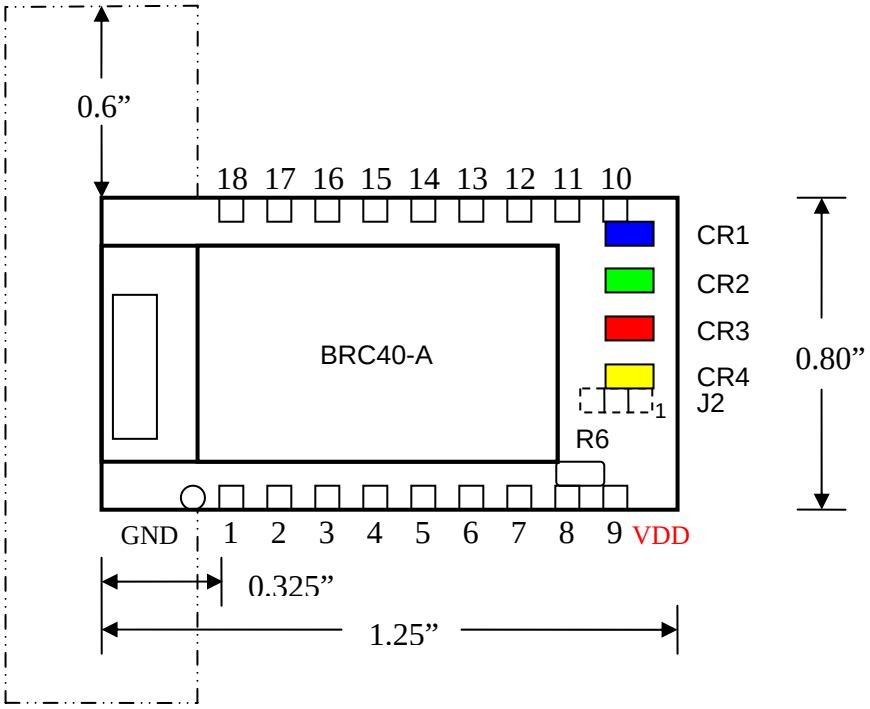
The evaluation board enables a stable platform environment to test the module on before going directly to an embedded printed circuit board design and layout.

2 Hardware Description

2.1 MBS Hardware Description

2.1.1 MBS Board Layout

18 Pin DIP Module



IMPORTANT: Keep metallic components, connectors, copper traces, internal layers, and ground planes away from the antenna area (outlined above.)

Labeled Part Descriptions:

- **Pins (1-18):** 0.1” pitch X 0.8” socket width. The female mating sockets for the MBS pins are Digikey P/N: ED7064-ND
- **Thermistor (R6):** The MBS is shipped without the thermistor installed so that the user can install the part with the proper lead length for their application. The leads on the thermistor can be extended to a max wire length of ~50 feet or less than 10 ohms impedance drop. If greater distances are needed use a shielded twisted pair and cable to maintain an impedance of less than 10 ohms. The thermistor is Digikey P/N: RL0503-5820-97-MS.
- **Multi-Purpose Jumper (J2):** If pins 1 & 2 of J2 are jumped together at power up the MBS will enter update mode. Be sure to remove the jumper after updating the firmware to boot up to allow the MBS to run normally on the next power up. (See the Firmware Updates section for more information)

If pins 2 & 3 of J2 are jumped together at power up the MBS will perform a factory reset. Be sure to remove the jumper after boot up to avoid an unintentional factory reset on the next power up. This feature can be disabled using the ATSSW2 command, see the Utilities section for more details.

- **Connection Led (CR1 - BLUE):** If enabled this led will turn on when the MBS is *Bluetooth* connected. It will also flash at ~5hz when the MBS is trying to make a connection.
- **Clock Led (CR2 - GREEN):** If enabled this led will pulse at a user specified rate. See Utilities – Clock Led Pulse Rate for more information.
- **Alarm Led (CR3 - RED):** If enabled along with limits, this led will toggle from off to on when readings surpass the set limits. As soon as the readings go back within the limits the led will turn off.
- **Pause Led (CR4 - YELLOW):** If enabled this led will turn on when the module has been paused. It will also flash twice when the PAUSE_UNPAUSE pin has been triggered.

2.1.2 MBS Pin Descriptions

IMPORTANT: The I/O of the MBS operates from 0 to 3.33 Volts. Exceeding 3.33V on any of the pins may permanently damage the module.

Placing 3.3V DC into the radio PIO's while they are set as outputs will permanently damage the radio module. The failure mode is caused by a short between power and ground.

Pin	I/O	Signal Name	Signal Description
1	O	GND	Power Ground.
2	I	ANALOG_IN	This input can be used to connect an external sensor to the MBS. To use this input, the Generic Sensor Component firmware must be installed on the MBS in place of the Temperature Sensor Component firmware.
3	I	RESET	Active low – pulled high by MBS. Pull low for > 1.5us to reset the MBS
4	-	Reserved	Do not connect.
5	I	PAUSE_UNPAUSE	Active low – pulled high by MBS. Pull low for > 5ms to pause or unpause the MBS, see Pausing in ATM Commands Section for more information.
6	O	ALARM	User configurable output, see Data Limits Section for more information.
7	I/O	BR_PIO6_CH02	Radio module user configurable I/O.
8	I/O	BR_PIO7_CH03	Radio module user configurable I/O.
9	I	VCC	Power In = +3.33 V (+/- .1V).

10	I	UART_RX	MBS local UART receive
11	O	UART_TX	MBS local UART transmit.
12	I	UART_CTS	MBS local UART CTS.
13	O	UART_RTS	MBS local UART RTS.
14	O	BR_PIO2_CH00	Indicates a Bluetooth connection. 0V = Not Connected, 3.3V = Connected.
15	O	BR_PIO5_CH01	1Hz output signal while discoverable in slave mode or while connecting.
16	I	SUPPLY_VOLTAGE	The MBS uses this signal to read the supply voltage for battery powered applications. The signal must be scaled down to 3.3V using a voltage divider. Use the ATSSW8 command to set the appropriate scaling factor used in your design.
17	NC	Reserved	-
18	NC	Reserved	-

2.1.3 MBS Serial UART

UART_TX, UART_RX, UART_RTS and UART_CTS form a conventional asynchronous serial data port. The interface is designed to operate correctly when connected to other UART devices such as the 16550A, and is user configurable using the ATMSR0 command.

Two-way hardware flow control is implemented by UART_RTS and UART_CTS. UART_RTS is an output and is active low to signal the MBS is ready to receive data. When UART_RTS goes high wait until it returns to low before sending more data to avoid losing information. UART_CTS is an input and is active low. If the user sets UART_CTS to high the unit will stop sending data until the signal is reasserted to low.

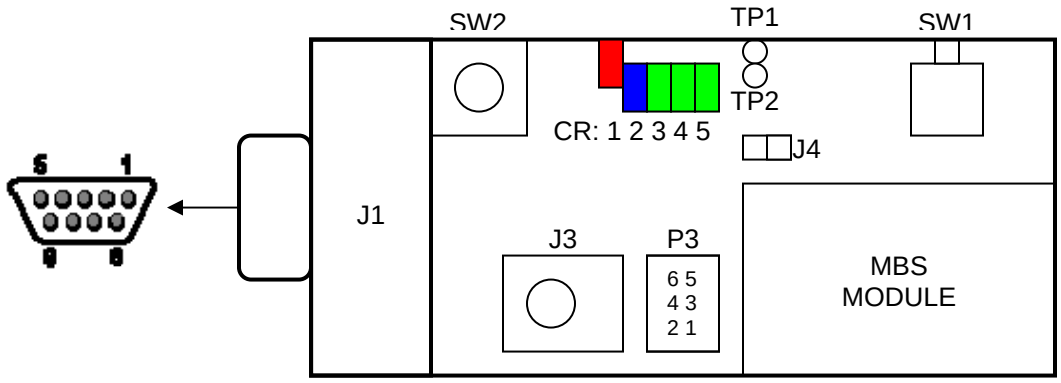
- **Default UART Settings:** 9600, 8-N-1 (9600bps, 8 data bits, no parity, 1 stop bit)

2.2 Evaluation Board Hardware Description

The evaluation board enables a stable platform environment to test the module on before going directly to an embedded printed circuit board design and layout. The schematic for the evaluation board is available for use as a reference design at: www.blueradios.com.

WARNING: Input voltage must on J3 must be 3.3V.

2.2.1 Evaluation Board Layout



Labeled Part Descriptions:

- **RS232 DB-9 (J1):** The Female DB-9 connector is wired to the local UART on the MBS module. The user can connect the evaluation board directly to the PC using a standard RS-232 serial cable. A null modem adaptor is not required. All signals will be inverted through this interface.
- **Power Connector (J3): Input must be 3.3V DC.**
- **LED Enable Jumper (J4):** When mounted this jumper will enable all of the leds on the evaluation board. Each led will consume approximately 15mA when on.
- **Reset Switch (SW1):** Press to reset the MBS.
- **Pause Switch (SW2):** Pauses the MBS, see Pausing in ATM Commands Section for more information.
- **Power Led (CR1):** This led will turn on when the evaluation board is powered. (RED)
- **PIO2_CH00 Led (CR2):** This led is driven by PIO2 of the MBS radio module. It will turn on when the module is *Bluetooth* connected. (BLUE)
- **PIO5_CH01 Led (CR2):** This led is driven by PIO5 of the MBS radio module. It will flash at 1 Hz when the radio is slave discoverable or connecting. (GREEN)
- **PIO6_CH02 Led (CR2):** This led is driven by PIO6 of the MBS radio module. (GREEN)

- **PIO7_CH03 Led (CR2):** This led is driven by PIO7 of the MBS radio module. (GREEN)
- **Test Point 1 (TP1):** This test point is connected to ground.
- **Test Point 2 (TP2):** This test point is connected to the ANALOG_IN pin of the MBS.
- **Connector P3:** The following MBS signals are located on P3:

Pin	I/O	Signal Name	Signal Description
1	O	UART_TX	MBS local UART transmit
2	I	VCC	Power In = +3.3 V (+/- .1V)
3	O	ALARM_SIGNAL	User configurable output, see Data Limits Section for more information.
4	I	UART_RX	MBS local UART receive
5	I	RESET	Active low – pulled high by MBS. Pull low for > 1.5us to reset MBS
6	O	GND	Power Ground

3 Using the MEGA BlueStamp

The MBS is controlled and configured using a simple ASCII command set. These commands can be sent over the MBS's local UART, or using the *Bluetooth* Serial Port Profile. See the ATM Command section for a detailed description of each command.

AT commands can also be sent directly to the MBS radio module for advanced configuration, such as changing the passkey, inquiry and page scan windows, etc. See the Radio Pass Through Mode command section for more information.

3.1 Power Up

Allow at least 750 ms for the unit to boot. During the boot sequence the Clock Led will be on at all times, resuming its normal functionality once the module is ready. At this time it will also output "<cr_lf>:M# ENABLED<cr_lf>" indicating which operational mode it is currently in.

3.2 Making a Connection

The MBS will be discoverable and connectable at all times, unless it is already connected to or is in a low power mode which makes it not connectable. This way it can be wirelessly reconfigured at any time.

To connect to the MBS begin by performing a discovery using a Bluetooth device. The MBS will show up with a default name of BlueRadiosMS####, the last 4 numeric characters being the last 4 digits of the MBS's Bluetooth address. The only service it will have available will be a Serial Port Profile (SPP) Service named "Temperature." Since only one service is available keep in mind that only one device can connect to the MBS at a time.

Connect to the service named "Temperature," once connected the Connection Led will turn on. **If your host device requests a passkey, the MBS's default passkey is "default".**

When connected ATM commands can be sent to the MBS over the Bluetooth link. If connecting from a PC the user can use Hyperterminal with factory default settings (do not echo characters or append any additional line feeds) to communicate with the MBS. Connect to the COM port assigned to your client Bluetooth Serial Port at 9600 (8,N,1) baud rate settings, and using hardware flow control.

3.3 Collecting Data

The MBS can take readings on request, store data until requested, or take readings at a user specified sampling rate and then automatically report the readings at a user specified reporting interval over a *Bluetooth* connection. How the MBS behaves is based on it's current operational mode. The four different modes are: Passive, Local, Slave and Master.

Passive Mode

The MBS will not actively store any data while in Passive Mode. It is mainly used for configuring the device before placing it into another operational mode, or for apps that only need data to gather data upon request. In this mode the MBS will only report readings if requested by the user using the ATMTR command.

Local Mode

In this mode the MBS will automatically report data over the local serial port. It will store readings at a user configurable sampling interval and then automatically report the stored readings at a set reporting interval. This

mode is mainly intended for debugging purposes, as data can be collected locally instead of over the *Bluetooth* connection. But it can also be useful for apps that wish to store data at a given rate but not report it until requested, which can be done by setting the reporting interval to zero. Data can still be manually requested over the *Bluetooth* connection in this mode.

Slave Mode

In this mode the MBS will automatically report data over a *Bluetooth* link once it has been connected to by another radio. It will store readings at a user configurable sampling interval and then automatically report the stored readings at a set reporting interval as long as the link is maintained. The user can configure the unit to store data at all times and only report it when a connection is made, or to only store while connected.

Master Mode

Master Mode is the most efficient and easy way to use the MBS. In this mode the MBS will immediately begin to store readings at a user configurable sampling interval. It will then automatically connect to a slave radio and report the stored readings at a set reporting interval. Once all reports have been sent the MBS will disconnect from the slave radio.

Note: Data can still be manually collected in any operational mode.

4 ATM Commands

This section will give the user a full understanding of the MBS's features and the commands that enable them. All of the ATM Commands can be sent either over the local UART or the *Bluetooth* link.

The MBS has been designed to use the same command structure as the ***Blue*Radios** Intelligent Serial Modules. Since the MBS has the capability of allowing the user to pass AT commands directly to its radio module, the MBS will use the prefix ATM (Attention MegaBlueStamp) with all of its commands to avoid confusion between the two command sets. In addition to using an 'M' in the command prefix, the MBS's responses will be preceded by a ':' character in order to differentiate them from radio module responses.

Please read the following notes before continuing:

IMPORTANT NOTES

- ***All commands are typed exactly as shown in the examples, with the exception that they are not case sensitive.***
- ***<cr> = Carriage Return (0x0D)***
- ***<lf> = Line Feed (0x0A)***
- ***<cr_lf> = Carriage Return /Line Feed (0x0D0A)***
- ***<ht> = Horizontal Tab (0x09)***
- ***All commands are entered in the following format: "COMMAND<cr>"***
- ***All valid commands respond with an <cr_lf>:OK<cr_lf>.***
- ***Some commands will have additional response data that will come after the <cr_lf>:OK<cr_lf> in the following format: <cr_lf>:"response"<cr_lf>.***
- ***Invalid commands respond with <cr_lf>:ERROR<cr_lf>.***
- ***Allow at least a 100ms delay between subsequent ATM commands.***
- ***If using HyperTerminal the following check box should be disabled: Send line ends with line feeds. If not the commands will not be submitted correctly.***
- ***All examples of data output were done using the Temperature Sensor Component firmware.***

4.1 Checking Communication

ATM

ATTENTION MEGABLUESTAMP

Function: The ATM command can be used to check communication with the MBS. It has no

function beyond responding with an OK.

Format: ATM<cr>

Example:
USER: **ATM<cr>**
MBS: **<cr_lf>:OK<cr_lf>**

4.2 Checking the Friendly Name and Firmware Version

ATMVER

GET FIRMWARE VERSION

Function: Reads the MBS's friendly name and firmware version.

Format: ATMVER<cr>

Return Parameters: <Friendly Name> VER: <Firmware Version>

Return Parameter Details:

- **Friendly Name:** The friendly name of the MBS's Bluetooth module.
- **Firmware Version:** The firmware version is broken down into the 3 separate fields listed below.

  1. The first field represents the version of the MBS's Bluetooth module firmware.
  2. The second field represents the version of the main MBS firmware. This firmware comprises all commands listed in the ATM commands section, but not those listed in the Sensor Component Specific ATM commands section.
  3. The third field represents the Sensor Component Specific ATM Command firmware currently loaded on the device. The first digit will differentiate between sensor types, the last two digits will represent version changes. For example 1.#.# represents the Generic Sensor Component and 2.#.# represents the Temperature Sensor Component.

Example:
USER: **ATMVER<cr>**
MBS: **<cr_lf>:OK<cr_lf>**
<cr_lf>:BlueRadiosMS1234 VER: 3.6.2.1.0.0_1.0.0_2.0.0<cr_lf>

4.3 Resetting the MEGA BlueStamp

WARNING: The clock will be reset to 00:00:00T00:00:00 when the MBS is reset.

ATMURST

RESET

Function: Performs a software reset of the MBS.

Format: ATMURST<cr>

Example:

USER: **ATMURST<cr>**
MBS: **<cr_lf>:OK<cr_lf>**
(Module Resets)
<cr_lf>:M0 ENABLED<cr_lf>

Notes:

- *You can send the reset command through the UART or over the Bluetooth RF connection. If issued over the RF connection, the connection will be dropped since the radio must be reset.*

ATMFRST

FACTORY RESET

Function: Performs a software reset of the module and resets the MBS back to factory defaults. Allow 5-7 seconds for the MBS to complete the reset.

Format: ATMFRST<cr>

Example:

USER: **ATMFRST<cr>**
MBS: **<cr_lf>:OK<cr_lf>**
<cr_lf>:RESTORING DEFAULTS…<cr_lf>
(5-7 Second Delay)
<cr_lf>:RESET COMPLETE<cr_lf>

Notes:

- *You can send the factory reset command through the UART or over the Bluetooth RF connection. If issued over the RF connection, the connection will be dropped since the radio must be reset.*

- *The MBS has a convenient hardware factory reset jumper onboard labeled J2. It resets the MBS back to factory defaults if pins 2 & 3 of the jumper are connected during power up.*

4.4 Retrieving Status

ATMGS

GET STATUS

Function: Gives the user the current pause state, SPP connection state, and FTP connection state of the MBS.

Format: ATMGS<cr>

Return Parameters: <Pause State>,<SPP Connection State>,<FTP Connection State>

Pause State	SPP Connection State	FTP Connection State
0: Unpaused	0: Disconnected	0: Disconnected
1: Paused	1: Connecting	1: Connecting
	2: Connected	2: Connected

Example:

USER: **ATMGS<cr>**
MBS: **<cr_lf>:OK<cr_lf>**
<cr_lf>:0,0,0<cr_lf>

4.5 Power Modes

ATMSPM

SET POWER MODE

Function: Use this command to set the power mode of the MBS. If sent over the local UART the new power save mode will take effect immediately. If sent over the *Bluetooth* link the new mode will take effect as soon as the user disconnects from the MBS.

When the MBS is in a power save mode it will sleep until it is paused using the PAUSE_UNPAUSE input, connected to, or until it wakes up to report data. After reporting all of its data or being disconnected from, the MBS will resume sleeping. **When the MBS is asleep the user cannot communicate with it over the local UART.**

If the MBS is paused while in a power save mode it will make the MBS connectable and enable the local UART. To make the MBS connectable in power modes 2 and 3 the MBS will temporarily go into power mode 1, making the radio deep sleep connectable.

See the Typical Characteristics section for information on the amount of current the device will draw in each mode.

Format: ATMSPM,<Power Mode><cr>

Parameters:

Power Mode

0: Always On
1: Power Save – Radio = Connectable Deep Sleep
2: Power Save – Radio = Not Connectable Deep Sleep
3: Power Save – Radio = Off

Parameter Details:

- **0: Always On:** This power mode is optimal for a non battery powered application of the MBS. The benefit of always having the microcontroller on is that the user can always communicate with the MBS over the local UART. With the radio always on the user can connect to the MBS over the Bluetooth Link at any time, unless it is reporting data in Master Mode.

- **1: Power Save – Radio = Connectable Deep Sleep:** This power mode is optimal for battery powered applications that need the MBS to always be connectable. The radio's page and inquiry scan interval will be set to 2560ms and the page and inquiry scan window to 11.25ms. The radio will also go into deep sleep mode when idle. This lowers the chances of making an immediate connection to the radio, but significantly lowers the unconnected current draw of the radio. The MBS can still be connected to at any time, unless it is reporting data in Master Mode.

- **2: Power Save – Radio = Not Connectable Deep Sleep:** This power mode is optimal for battery powered applications that don't need the MBS to be connectable at all times. The radio will go into a deep sleep mode in which it is neither connectable or discoverable, but only draws 25-50uA. If the MBS is in Master Mode the radio will come out of deep sleep mode only to send data.

- **3: Power Save – Radio = Off:** This power mode is also optimal for battery powered applications that don't need the MBS to be connectable at all times. The radio will be completely shut down when sleeping, only turning on to send data in Master Mode. Constantly powering on and off of the radio is not recommended, so we suggest not to use this power mode along with Master Mode if the sampling and reporting intervals are small. Another disadvantage to this mode is that powering up the radio takes approximately 650ms, whereas waking the radio from deep sleep mode only takes approximately 5ms. So if the application needs to constantly be sending data modes 1 or 2 might be a better choice, but if data is reported at large intervals this power mode is ideal.

Example:

USER: **ATMSPM,3<cr>**
MBS: **<cr_lf>:OK<cr_lf>**

Note: *If you find that you can never make a connection to the radio in power mode 1 (or power modes 2 and 3 while paused) you may need to adjust the intervals and windows manually. Do this by first setting the power mode to 1,2, or 3, and then use the Radio Pass Through Mode and the ATSW21 command to adjust the intervals and windows manually. If you set the ATSW21 command before setting the power mode the MBS will overwrite your changes. See the BlueRadios_ATMP_Commands document for information on changing these settings.*

ATMRPM

READ POWER MODE

Function: Reads the current power mode of the MBS.

Format: ATMRPM<cr>

Return Parameters: <Power Mode>

Examples:

USER: **ATMRPM<cr>**
MBS: **<cr_lf>:OK<cr_lf>**
<cr_lf>:0<cr_lf>

4.6 Pausing the Module

ATMPS

PAUSE

Function: Pausing the MBS will do three things:

1. It will cause the MBS to stop automatically reporting data (data will still be stored though).

2. If the MBS is in a power save mode it will make the MBS connectable and enable the local UART. This allows the user to manually collect data or reconfigure the module. Unpausing the MBS will cause it to resume reporting data and reenter its stored power mode.

3. It will enable some commands that cannot be executed unless the unit is paused. If the reporting interval is not equal to zero, then ATMGSR and ATMFTPSR can only be executed when the unit is paused. ATMPT, ATMCFG and ATMFTPCFG can only be executed if the unit is paused or in passive Mode.

Format: ATMPS<cr>

Example:

USER: **ATMPS<cr>**
MBS: **<cr_lf>:OK<cr_lf>**
<cr_lf>:PAUSED<cr_lf>
USER: **ATMPS<cr>**
MBS: **<cr_lf>:OK<cr_lf>**
<cr_lf>:UNPAUSED<cr_lf>

Note: *The MBS can also be paused by pulling the PAUSE_UNPAUSE pin low for > 5ms.*

4.7 Setting and Reading the Clock

WARNING: The clock will be reset to 00:00:00T00:00:00 when the MBS is reset.

ATMSC

SET CLOCK

Function: Use this command to set the MBS's internal clock. It operates using military time, so the hours will be represented as a number 0-23.

Format: ATMSC,<Year>,<Mon>,<Day>,<Hour>,<Min>,<Sec><cr>

Parameters:

Year	Mon	Day	Hour	Min	Sec
0-65535	*1-12*	1–31	0–23	0–59	0–59

Example:

USER: **ATMSC,2006,1,1,0,0,0<cr>**
MBS: **<cr_lf>:OK<cr_lf>**

Note: *The MBS's internal clock will handle leap years, but will not adjust for daylight savings time.*

ATMRC

READ CLOCK

Function: Use this command to read the MBS's internal clock.

Format: ATMRC<cr>

Return Parameters: <Year>,<Mon>,<Day>,<Hour>,<Min>,<Sec>

Example:

USER: **ATMRC<cr>**
MBS: **<cr_lf>:OK<cr_lf>**
<cr_lf>:2006-01-01T00:00:00<cr_lf>

4.8 Operational Modes

The operational mode determines how the MBS will behave. The user can select from four modes: Passive Mode, Local Mode, Slave Mode or Master Mode.

4.8.1 Passive Mode

ATMSM0

SET MODE 0 (PASSIVE MODE)

Function: Use this command to put the MBS into Passive Mode. In this mode the MBS will only report readings if requested by the user using the ATMTR command. **All stored data will be flushed upon entering passive mode and the MBS will not store any data in this mode.**

Format: ATMSM0<cr>

Example:

USER: **ATMSM0<cr>**
MBS: **<cr_lf>:OK<cr_lf>**
MBS: **<cr_lf>:M0 ENABLED<cr_lf>**

4.8.2 Local Mode

ATMSM1

SET MODE 1 (LOCAL MODE)

Function: Use this command to put the MBS into Local Mode. In this mode the MBS will automatically report data over the local serial port. It will store readings at a user configurable sampling interval and then automatically report the stored readings at a set reporting interval.

Format: ATMSM1,<Sampling Interval>,<Reporting Interval>,<Transport Mode><cr>

Parameters:

Sampling Interval	Reporting Interval	Transport Mode
1 – 4,294,967,295 Seconds	0 – 1500 With Timestamp OR 7000 Without	0: Serial
		1: Serial-ACK

Parameter Details:

- ***Sampling Interval:*** The sampling period determines how often the MBS *will take a reading.* Ex: When set to 10, the MBS will store a reading every 10 seconds.
- ***Reporting Interval:*** This parameter determines how many readings the MBS will store before reporting. If set to 0 the MBS will not report data until it is manually requested using either the ATMGSR or ATMFTPSR command. Ex: When set to 6, the MBS will wait until it has 6 readings stored, and then report all 6 of them at once. With the sampling period set to 10 and readings per report set to 6, you will receive 6 readings every 60 seconds.
- ***Transport Mode:*** The transport mode determines what protocol will be used to deliver the data.

0: Serial	The MBS will transmit data over the local serial port. However, once data has been transmitted it will be deleted from the MBS's internal memory.
1: Serial-ACK	This mode is the same as the serial transport mode except that data will not be deleted from the MBS's memory until an ATMACK command is received from the user after a report has been sent. If an ATMACK is not received within the Acknowledgement Timeout Period the MBS will retransmit the last report along with any new reports. (See the Data Acknowledgement section for more details.)

Examples:

- ***Serial Transport Mode***

USER: **ATMSM1,1,2,0,0<cr>**
MBS: **<cr_lf>:OK<cr_lf>**
<cr_lf>:M1 ENABLED<cr_lf>
(STORES TWO READINGS)
<cr_lf>:070.0F 2006-01-01T00:00:01<cr_lf>
<cr_lf>:070.0F 2006-01-01T00:00:02<cr_lf>
(STORES TWO READINGS)
<cr_lf>:070.0F 2006-01-01T00:00:03<cr_lf>
<cr_lf>:070.0F 2006-01-01T00:00:04<cr_lf>

- ***Serial-ACK Transport Mode***

USER: **ATMSM1,1,2,1<cr>**
MBS: **<cr_lf>:OK<cr_lf>**
<cr_lf>:M1 ENABLED<cr_lf>
(STORES TWO READINGS)
<cr_lf>:070.0F 2006-01-01T00:00:01<cr_lf>
<cr_lf>:070.0F 2006-01-01T00:00:02<cr_lf>
<cr_lf>:ACK<cr_lf>
USER: **ATMACK<cr>**
MBS: **<cr_lf>:OK<cr_lf>**
(STORES TWO READINGS)
<cr_lf>:070.0F 2006-01-01T00:00:03<cr_lf>
<cr_lf>:070.0F 2006-01-01T00:00:04<cr_lf>
<cr_lf>:ACK<cr_lf>
USER: **ATMACK<cr>**
MBS: **<cr_lf>:OK<cr_lf>**

USER: **ATMSM1,1,5,2<cr>**
MBS: **<cr_lf>:OK<cr_lf>**
<cr_lf>:M1 ENABLED<cr_lf>
(STORES FIVE READINGS)
<cr_lf>:070.0F 2006-01-01T00:00:01<cr_lf>
<cr_lf>:070.0F 2006-01-01T00:00:02<cr_lf>
<cr_lf>:070.0F 2006-01-01T00:00:03<cr_lf>
<cr_lf>:070.0F 2006-01-01T00:00:04<cr_lf>
<cr_lf>:070.0F 2006-01-01T00:00:05<cr_lf>
<cr_lf>:ACK<cr_lf>

```
USER: (NO ACKNOWLEDGEMENT AFTER 5 SECONDS)
MBS:  (STORES FIVE READINGS)
      <cr_lf>:070.0F 2006-01-01T00:00:01<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:02<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:03<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:04<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:05<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:06<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:07<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:08<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:09<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:10<cr_lf>
      <cr_lf>:ACK<cr_lf>
USER: (NO ACKNOWLEDGEMENT AFTER 5 SECONDS)
MBS:  (STORES FIVE READINGS)
      <cr_lf>:070.0F 2006-01-01T00:00:01<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:02<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:03<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:04<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:05<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:06<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:07<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:08<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:09<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:10<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:11<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:12<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:13<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:14<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:15<cr_lf>
      <cr_lf>:ACK<cr_lf>
```

4.8.3 Slave Mode

ATMSM2

SET MODE 2 (SLAVE MODE)

Function: Use this command to put the MBS into **Slave Mode**. In this mode the MBS will automatically report data over a *Bluetooth* link once it has been connected to by another radio. It will store readings at a user configurable sampling interval and then automatically report the stored readings at a set reporting interval as long as the link is maintained.

Format:
ATMSM2,<Sampling Interval>,<Reporting Interval>,<Transport Mode>,<Storage Mode><cr>

Parameters:

Sampling Interval	Reporting Interval	Transport Mode	Storage Mode

1 – 4,294,967,295 Seconds	0 – 1500 With Timestamp OR 7000 Without	0: Serial	0: Store When Connected
		1: Serial-ACK	1: Always Store
		2: FTP	

Parameter Details:

- ***Sampling Interval:*** The sampling period determines how often the MBS *will take a reading.* Ex: When set to 10, the MBS will store a reading every 10 seconds.

- ***Reporting Interval:*** This parameter determines how many readings the MBS will store before reporting. If set to 0 the MBS will not report data until it is manually requested using either the ATMGSR or ATMFTPSR command. Ex: When set to 6, the MBS will wait until it has 6 readings stored, and then report all 6 of them at once. With the sampling period set to 10 and readings per report set to 6, you will receive 6 readings every 60 seconds.

- ***Transport Mode:*** The transport mode determines what protocol will be used to deliver the data.

0: Serial	The MBS will transmit data using the Bluetooth Serial Port Profile. Connect to the MBS's Serial Port Profile service and you will begin receiving data as soon as the report count is reached. However, once data has been transmitted it will be deleted from the MBS's internal memory.
1: Serial-ACK	This mode is the same as the Serial transport mode except that data will not be deleted from the MBS's memory until an ATMACK command is received from the user after a report has been sent. If an ATMACK is not received within the Acknowledgement Timeout Period the MBS will retransmit the last report along with any new reports. After 3 consecutive transmissions with no acknowledgement the MBS will disconnect and continue to store data, regardless of the power storage. (See the Data Acknowledgement section for more details.)
2: FTP	The MBS will transmit data using the Bluetooth File Transfer Protocol Profile. Connect to the MBS's Serial Port Profile service and the MBS will create an FTP connection back to the master. A soon as the report count is reached the MBS will make an FTP connection back to the master and create a file containing the report data in the master's Bluetooth Exchange Folder. Once the file has been created the data will be deleted from the MBS's internal memory. The first time the MBS sends data using the FTP protocol, it will create a folder in the master radio's default FTP directory (Bluetooth Exchange Folder) named after the MBS's friendly name. By default this is BlueRadiosMS####, the last four characters being the last 4 digits of the MBS's Bluetooth address. (This name can be changed using the ATSN command in pass through mode.) Example File Path:

	Bluetooth Exchange Folder\BlueRadiosMS1234\ Files will be name "Data_" followed by an abbreviated timestamp. If timestamps are enabled then the abbreviated timestamp in the filename will be that of the first reading in the file, else it will be the time that the file was created. The final digit in the filename is used to differentiate files created at the same time. Example File Names: Data_20060101000001_0.txt, Data_20060101000001_0.xml

- ***Storage Mode:*** The storage mode determines when the MBS will store data.

0: Store When Connected	The MBS will begin to store data as soon as another radio connects to it. Once the master radio disconnects the MBS will stop storing data.
1: Always Store	In this storage mode the MBS will always store data regardless of whether it is connected or not. Upon connecting to the MBS the user will receive all of the data that the MBS has stored while it was disconnected.

Examples:

- ***Serial Transport Mode***

USER: **ATMSM2,1,2,0,0<cr>**
MBS: **<cr_lf>:OK<cr_lf>**
<cr_lf>:M2 ENABLED<cr_lf>
USER: **(CONNECTS TO MBS)**
MBS: **(STORES TWO READINGS)**
<cr_lf>:070.0F 2006-01-01T00:00:01<cr_lf>
<cr_lf>:070.0F 2006-01-01T00:00:02<cr_lf>
(STORES TWO READINGS)
<cr_lf>:070.0F 2006-01-01T00:00:03<cr_lf>
<cr_lf>:070.0F 2006-01-01T00:00:04<cr_lf>
USER: **ATMDH<cr>**
MBS: **(DISCONNECTS AND STOPS STORING DATA)**

- ***Serial-ACK Transport Mode***

USER: **ATMSM1,1,2,1,0<cr>**
MBS: **<cr_lf>:OK<cr_lf>**
<cr_lf>:M2 ENABLED<cr_lf>
USER: **(CONNECTS TO MBS)**
MBS: **(STORES TWO READINGS)**
<cr_lf>:070.0F 2006-01-01T00:00:01<cr_lf>
<cr_lf>:070.0F 2006-01-01T00:00:02<cr_lf>
<cr_lf>:ACK<cr_lf>
USER: **ATMACK<cr>**
MBS: **<cr_lf>:OK<cr_lf>**
(STORES TWO READINGS)
<cr_lf>:070.0F 2006-01-01T00:00:03<cr_lf>
<cr_lf>:070.0F 2006-01-01T00:00:04<cr_lf>
<cr_lf>:ACK<cr_lf>

```
USER: ATMACK<cr>
MBS:  <cr_lf>:OK<cr_lf>

USER: ATMSM1,1,5,1,0<cr>
MBS:  <cr_lf>:OK<cr_lf>
      <cr_lf>:M2 ENABLED<cr_lf>
USER: (CONNECTS TO MBS)
MBS:  (STORES FIVE READINGS)
      <cr_lf>:070.0F 2006-01-01T00:00:01<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:02<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:03<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:04<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:05<cr_lf>
      <cr_lf>:ACK<cr_lf>
USER: (NO ACKNOWLEDGEMENT AFTER 5 SECONDS)
MBS:  (STORES FIVE READINGS)
      <cr_lf>:070.0F 2006-01-01T00:00:01<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:02<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:03<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:04<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:05<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:06<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:07<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:08<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:09<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:10<cr_lf>
      <cr_lf>:ACK<cr_lf>
USER: (NO ACKNOWLEDGEMENT AFTER 5 SECONDS)
MBS:  (STORES FIVE READINGS)
      <cr_lf>:070.0F 2006-01-01T00:00:01<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:02<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:03<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:04<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:05<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:06<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:07<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:08<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:09<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:10<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:11<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:12<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:13<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:14<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:15<cr_lf>
      <cr_lf>:ACK<cr_lf>
USER: (NO ACKNOWLEDGEMENT AFTER 5 SECONDS)
MBS:  (DISCONNECTS AND CONTINUES TO STORE DATA)
```

- ***FTP Transport Mode***

```
USER: ATMSM1,1,10,2,0<cr>
MBS:  <cr_lf>:OK<cr_lf>
      <cr_lf>:M2 ENABLED<cr_lf>

USER: (CONNECTS TO MBS)
```

MBS: **(STORES TEN READINGS)**
(CONNECTS TO MASTER USING FTP)
(CREATES FOLDER)
(CREATES FILE)
(DISCONNECTS FTP)

File Contents: **<cr_lf>:070.0F 2006-01-01T00:00:01<cr_lf>**
<cr_lf>:070.0F 2006-01-01T00:00:02<cr_lf>
<cr_lf>:070.0F 2006-01-01T00:00:03<cr_lf>
<cr_lf>:070.0F 2006-01-01T00:00:04<cr_lf>
<cr_lf>:070.0F 2006-01-01T00:00:05<cr_lf>
<cr_lf>:070.0F 2006-01-01T00:00:06<cr_lf>
<cr_lf>:070.0F 2006-01-01T00:00:07<cr_lf>
<cr_lf>:070.0F 2006-01-01T00:00:08<cr_lf>
<cr_lf>:070.0F 2006-01-01T00:00:09<cr_lf>
<cr_lf>:070.0F 2006-01-01T00:00:10<cr_lf>

4.8.4 Master Mode

ATMSM3

SET MODE 3 (MASTER MODE)

Function: Use this command to put the MBS into **Master Mode**. In this mode the MBS will immediately begin to store readings at a user configurable sampling interval. It will then automatically connect to a slave radio and report the stored readings at a set reporting interval. Once all reports have been sent the MBS will disconnect from the slave radio.

If the slave radio cannot be found on the first connection attempt, the MBS will reattempt to connect twice. After failing three consecutive times it will enter a fallback mode in which it will retry connecting at a user specified interval in order to save power in the event that the slave radio is down. While in fallback mode the MBS will continue to store data. Once the MBS has re-established a connection with the slave, the module will then resume making connections at the set reporting interval.

Format: ATMSM3,<Sampling Period>,<Report Count>,<Transport Mode>,<Fall Back Multiple>,<Slave BT Address><cr>

Parameters:

Sampling Interval	Reporting Interval	Transport Mode	Fallback Retry Interval	Slave BT Address
1 – 4,294,967,295 Seconds	0 – 1500 With Timestamp OR 7000 Without	0: SPP	0 – 4,294,967,295 Seconds	000000000000-FFFFFFFFFFFF (HEX)
		1: SPP-ACK		
		2: FTP		

Parameter Details:

- ***Sampling Interval:*** The sampling period determines how often the MBS *will take a reading.* Ex: When set to 10, the MBS will store a reading every 10 seconds.

- ***Reporting Interval:*** This parameter determines how many readings the MBS will store before reporting. If set to 0 the MBS will not report data until it is manually requested using either the ATMRSR or ATMFTPSR command. Ex: When set to 6, the MBS will wait until it has 6 readings stored, and then connect and report all 6 of them at once. With the sampling period set to 10 and readings per report set to 6, you will receive 6 readings every 60 seconds.

- ***Transport Mode:*** The transport mode determines what protocol will be used to deliver the data.

0: Serial	The MBS will transmit data using the Bluetooth Serial Port Profile. It will connect to the slave radio's Serial Port Profile and begin transmitting data as soon as the report count is reached. Once all available reports are transmitted the MBS will disconnect from the slave radio. However, once data has been transmitted it will be deleted from the MBS's internal memory.
1: Serial-ACK	This mode is the same as the Serial transport mode except that data will not be deleted from the MBS's memory until an ATMACK command is received from the user after a report has been sent. If an ATMACK is not received within the Acknowledgement Timeout Period the MBS will retransmit the last report along with any new reports. After 3 consecutive transmissions with no acknowledgement the MBS will disconnect and go into fallback mode. (See the Data Acknowledgement section for more details.)
2: FTP	The MBS will transmit data using the Bluetooth File Transfer Protocol Profile. It will connect to the slave radio's FTP Profile and create a file as soon as the report count is reached. Once all available reports are transmitted the MBS will disconnect from the slave radio. Once a file has been created the data contained in the file will be deleted from the MBS's internal memory. The first time the MBS sends data using the FTP protocol, it will create a folder in the master radio's default FTP directory (Bluetooth Exchange Folder) named after the MBS's friendly name. By default this is BlueRadiosMS####, the last four characters being the last 4 digits of the MBS's Bluetooth address. (This name can be changed using the ATSN command in pass through mode.) Example File Path: Bluetooth Exchange Folder\BlueRadiosMS1234\ Files will be name "Data_" followed by an abbreviated timestamp. If timestamps are enabled then the abbreviated timestamp in the filename will be that of the first reading in the file, else it will be the time that the file was created. The final digit in the filename is used to

	differentiate files created at the same time. Example File Names: Data_20060101000001_0.txt, Data_20060101000001_0.xml

- ***Fallback Retry Interval:*** The fallback retry interval determines how often the MBS will attempt to connect to the slave radio after entering fallback mode. If the interval is set to 0 then the MBS will return to passive mode instead of attempting any more connections. Ex: When set to 60, the MBS will try to reconnect to the slave radio every 60 seconds.

- ***Slave BT Address:*** This parameter is the 12 character Bluetooth address of the slave radio the MBS will connect to.

Examples:

- ***Serial Transport Mode***

USER: **ATMSM2,1,2,0<cr>**
MBS: **<cr_lf>:OK<cr_lf>**
<cr_lf>:M3 ENABLED<cr_lf>
(STORES ONE READING)
(CONNECTS TO SLAVE RADIO)
<cr_lf>:070.0F 2006-01-01T00:00:01<cr_lf>
(STORES ONE READING)
<cr_lf>:070.0F 2006-01-01T00:00:02<cr_lf>

USER: **ATMSM2,1,5,0<cr>**
MBS: **<cr_lf>:OK<cr_lf>**
<cr_lf>:M3 ENABLED<cr_lf>
(STORES FIVE READINGS)
(CONNECTS TO SLAVE RADIO)
<cr_lf>:070.0F 2006-01-01T00:00:01<cr_lf>
<cr_lf>:070.0F 2006-01-01T00:00:02<cr_lf>
<cr_lf>:070.0F 2006-01-01T00:00:03<cr_lf>
<cr_lf>:070.0F 2006-01-01T00:00:04<cr_lf>
<cr_lf>:070.0F 2006-01-01T00:00:05<cr_lf>
(DISCONNECTS)
(STORES FIVE READINGS)
(CONNECTS TO SLAVE RADIO)
<cr_lf>:070.0F 2006-01-01T00:00:01<cr_lf>
<cr_lf>:070.0F 2006-01-01T00:00:02<cr_lf>
<cr_lf>:070.0F 2006-01-01T00:00:03<cr_lf>
<cr_lf>:070.0F 2006-01-01T00:00:04<cr_lf>
<cr_lf>:070.0F 2006-01-01T00:00:05<cr_lf>
(DISCONNECTS)

- ***Serial-ACK Transport Mode***

USER: **ATMSM2,1,5,1<cr>**
MBS: **<cr_lf>:OK<cr_lf>**
<cr_lf>:M3 ENABLED<cr_lf>

MBS: **(STORES FIVE READINGS)**
(CONNECTS TO SLAVE RADIO)

```
        <cr_lf>:070.0F 2006-01-01T00:00:01<cr_lf>
        <cr_lf>:070.0F 2006-01-01T00:00:02<cr_lf>
        <cr_lf>:070.0F 2006-01-01T00:00:03<cr_lf>
        <cr_lf>:070.0F 2006-01-01T00:00:04<cr_lf>
        <cr_lf>:070.0F 2006-01-01T00:00:05<cr_lf>
        <cr_lf>:ACK<cr_lf>
USER: ATMACK<cr>
MBS:  <cr_lf>:OK<cr_lf>
      (DISCONNECTS)
      (STORES FIVE READINGS)
      (CONNECTS TO SLAVE RADIO)
      <cr_lf>:070.0F 2006-01-01T00:00:01<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:02<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:03<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:04<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:05<cr_lf>
      <cr_lf>:ACK<cr_lf>
USER: ATMACK<cr>
MBS:  <cr_lf>:OK<cr_lf>
      (DISCONNECTS)

USER: ATMSM2,1,5,1<cr>
MBS:  <cr_lf>:OK<cr_lf>
      <cr_lf>:M3 ENABLED<cr_lf>
      (STORES FIVE READINGS)
      (CONNECTS TO SLAVE RADIO)
      <cr_lf>:070.0F 2006-01-01T00:00:01<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:02<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:03<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:04<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:05<cr_lf>
      <cr_lf>:ACK<cr_lf>
USER: (NO ACKNOWLEDGEMENT AFTER 5 SECONDS)
MBS:  <cr_lf>:070.0F 2006-01-01T00:00:01<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:02<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:03<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:04<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:05<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:06<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:07<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:08<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:09<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:10<cr_lf>
      <cr_lf>:ACK<cr_lf>
USER: (NO ACKNOWLEDGEMENT AFTER 5 SECONDS)
MBS:  <cr_lf>:070.0F 2006-01-01T00:00:01<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:02<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:03<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:04<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:05<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:06<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:07<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:08<cr_lf>
      <cr_lf>:070.0F 2006-01-01T00:00:09<cr_lf>
```

```
            <cr_lf>:070.0F 2006-01-01T00:00:10<cr_lf>
            <cr_lf>:070.0F 2006-01-01T00:00:11<cr_lf>
            <cr_lf>:070.0F 2006-01-01T00:00:12<cr_lf>
            <cr_lf>:070.0F 2006-01-01T00:00:13<cr_lf>
            <cr_lf>:070.0F 2006-01-01T00:00:14<cr_lf>
            <cr_lf>:070.0F 2006-01-01T00:00:15<cr_lf>
      MBS:  <cr_lf>:ACK<cr_lf>
      USER: (NO ACKNOWLEDGEMENT AFTER 5 SECONDS)
      MBS:  (DISCONNECTS AND ENTERS FALLBACK MODE)
```

- ***FTP Transport Mode***

```
      USER: ATMSM2,1,10,2<cr>
      MBS:  <cr_lf>:OK<cr_lf>
            <cr_lf>:M3 ENABLED<cr_lf>
            (STORES TEN READINGS)
            (CONNECTS TO SLAVE USING FTP)
            (CREATES FOLDER)
            (CREATES FILE)
            (DISCONNECTS FTP)

      File Contents: <cr_lf>:070.0F 2006-01-01T00:00:01<cr_lf>
                     <cr_lf>:071.0F 2006-01-01T00:00:02<cr_lf>
                     <cr_lf>:070.0F 2006-01-01T00:00:03<cr_lf>
                     <cr_lf>:071.0F 2006-01-01T00:00:04<cr_lf>
                     <cr_lf>:070.0F 2006-01-01T00:00:05<cr_lf>
                     <cr_lf>:071.0F 2006-01-01T00:00:06<cr_lf>
                     <cr_lf>:070.0F 2006-01-01T00:00:07<cr_lf>
                     <cr_lf>:071.0F 2006-01-01T00:00:08<cr_lf>
                     <cr_lf>:070.0F 2006-01-01T00:00:09<cr_lf>
                     <cr_lf>:071.0F 2006-01-01T00:00:10<cr_lf>
```

4.8.5 Reading Mode Parameters

ATMRM

READ MODE

Function: Reads the operational mode of the MBS, along with the set parameters for that mode.

Format: ATMRM<cr>

M0 Return Parameters: <Mode Number>

M1 Return Parameters: <Mode Number>,<Sampling Interval>,<Reporting Interval>,<Transport Mode>

M2 Return Parameters: <Mode Number>,<Sampling Interval>,<Reporting Interval>,<Transport Mode>,<Storage Mode>

M3 Return Parameters: <Mode Number>,<Sampling Interval>,<Reporting Interval>,<Transport Mode>,<Fallback Retry Interval>,<Slave BT Address>

Examples:

M0
USER: **ATMRM<cr>**
MBS: **<cr_lf>:OK<cr_lf>**
<cr_lf>:M0<cr_lf>

M1
USER: **ATMRM<cr>**
MBS: **<cr_lf>:OK<cr_lf>**
<cr_lf>:M1,1,10,0,0<cr_lf>

M2
USER: **ATMRM<cr>**
MBS: **<cr_lf>:OK<cr_lf>**
<cr_lf>:M2,1,10,0,0<cr_lf>

M3
USER: **ATMRM<cr>**
MBS: **<cr_lf>:OK<cr_lf>**
<cr_lf>:M3,1,10,1,60,123456789012<cr_lf>

4.9 Data Acknowledgement

4.9.1 Acknowledging a Report

ATMACK

ACKNOWLEDGE

Function: If data acknowledgement is enabled in the operational mode then the user will have to respond with an ATMACK after each data report. Data will not be deleted from the MBS's memory until an ATMACK command is received from the user after a report has been sent. If an ATMACK is not received within the Acknowledgement Timeout Period the MBS will retransmit the last report along with any new reports.

This command can only be executed after the MBS has transmitted the following line: "<cr_lf>:ACK<cr_lf>"

Format: ATMACK<cr>

Example:
MBS: **<cr_lf>:070.0F 2006-01-01T00:00:03<cr_lf>**
<cr_lf>:070.0F 2006-01-01T00:00:04<cr_lf>
<cr_lf>:ACK<cr_lf>
USER: **ATMACK<cr>**
MBS: **<cr_lf>:OK<cr_lf>**

Note: *Enabling the reading count feature in the Data Format Register (ATMSR1) will allow the user to determine if multiple reports are being sent by the MBS.*

4.9.2 Setting the Acknowledgement Timeout Period

ATMSSW4

SET SWITCH 4

Function: Use this command to set the length of the acknowledgement timeout period. This determines the amount of time the MBS will wait before repeating the last report when the transport mode is set to Serial-ACK.

Format: ATMSSW4,<Timeout Period><cr>

Parameters:
- ***Timeout Period:*** 1ms – 32768ms

Factory Default: 5000ms

Example:
USER: **ATMSSW4,10000<cr>**
MBS: **<cr_lf>:OK<cr_lf>**

ATMRSW4

READ SWITCH 4

Function: Reads the Acknowledgement Timeout Period.

Format: ATMRSW4<cr>

Return Parameters: <Timeout Period>

Example:
USER: **ATMRSW4<cr>**
MBS: **<cr_lf>:OK<cr_lf>**
<cr_lf>:10000<cr_lf>

4.10 Manually Reading Sensor Data

4.10.1 Taking a Reading

ATMTR

TAKE READING

Function: Use this command to manually take one reading from the MBS.

Format: ATMTR<cr>

Example:
USER: **ATMTR<cr>**
MBS: **<cr_lf>:OK<cr_lf>**
<cr_lf>:070.0F 2006-01-01T00:00:00<cr_lf>

4.10.2 Reading Stored Data

ATMGSC

GET STORED COUNT

Function: Use this command to get the current number of stored readings in the MBS.

Format: ATMGSC<cr>

Example:
USER: **ATMGSC<cr>**
MBS: **<cr_lf>:100<cr_lf>**

ATMGSR

GET STORED READINGS

Function: Use this command to manually read stored readings from the MBS. **If the reporting interval is not equal to zero, then this command can only be executed if the MBS is paused.**

Format: ATMGSR,<Reading Count><cr>

Parameter Details:
- ***Reading Count:*** The number of stored readings you would like to read. By setting the reading count to zero the MBS will send out all stored readings.

Example:
USER: **ATMPD<cr>**
MBS: **<cr_lf>:OK<cr_lf>**
<cr_lf>:REPORTING PAUSED<cr_lf>
USER: **ATMGSR,2<cr>**
MBS: **<cr_lf>:OK<cr_lf>**
<cr_lf>:070.0F 2006-01-01T00:00:00<cr_lf>
<cr_lf>:070.0F 2006-01-01T00:00:01<cr_lf>

ATMFTPSR

FTP STORED READINGS

Function: Use this command to manually read stored readings from the MBS using the FTP service. **If the reporting interval is not equal to zero, then this command can only be executed if the MBS is paused.**

Format: ATMFTPSR,<Reading Count>,<Slave BT Address><cr>

Parameter Details:

- ***Reading Count:*** The number of stored readings you would like to read. By setting the reading count to zero the MBS will send out all stored readings.
- ***Slave BT Address:*** This parameter is the 12 character Bluetooth address of the slave radio the MBS will connect to.

Example:

USER: **ATMFTPSR,10,123456789012<cr>**
MBS: **<cr_lf>:OK<cr_lf>**
(CONNECTS TO SLAVE USING FTP)
(CREATES FOLDER)
(CREATES FILE)
(DISCONNECTS FTP)

4.10.3 Flushing Stored Data

ATMFSR

FLUSH STORED READINGS

Function: Use this command to flush all stored data from the MBS.

Format: ATMFSR<cr>

Example:

USER: **ATMFSR<cr>**
MBS: **<cr_lf>:OK<cr_lf>**

4.11 Reading the Supply Voltage

4.11.1 Taking a Reading

ATMRV

READ VOLTAGE

Function: Use this command to read the voltage on the SUPPLY_VOLTAGE pin.

Format: ATMRV<cr>

Example:
USER: **ATMRV<cr>**
MBS: **<cr_lf>:OK<cr_lf>**
MBS: **<cr_lf>:03.33V<cr_lf>**

4.11.2 Setting the Supply Voltage Scaling Factor

ATMSSW8

SET SWITCH 8

Function: Use this command to set the supply voltage scaling factor. This allows the MBS to report supply voltages higher than 3.33V. The scaling factor can be calculated using the following equation:

SUPPLY_VOLTAGE_SCALING_FACTOR = (SUPPLY_VOLTAGE_MAX)/3.33

Format: ATMSSW8,<Supply Voltage Scaling Factor><cr>

Parameters:
- ***Supply Voltage Scaling Factor:*** *1.000-9.999. Must be entered as (Value * 1000), so 1.5 would be entered as 1500.*

Factory Default: 1000 (1.000)

Example:
USER: **ATMSSW8,1000<cr>**
MBS: **<cr_lf>:OK<cr_lf>**

ATMRSW8

READ SWITCH 8

Function: Reads the supply voltage scaling factor.

Format: ATMRSW8<cr>

Return Parameters: <Supply Voltage Scaling Factor>

Example:
USER: **ATMRSW8<cr>**
MBS: **<cr_lf>:OK<cr_lf>**
<cr_lf>:1<cr_lf>

4.12 Configuration Registers

4.12.1 Configuring the Local UART

ATMSR0

SET REGISTER 0
Function: Sets the local UART configuration.

Format: ATMSR0,<UBRR>,<Parity>,<Stop Bits><cr>

Parameters:

UBRR	PARITY	STOP BITS
0 - 191	0: None	0: One
	1: Odd	1: Two
	2: Even	

Parameter Details:

- ***UBRR:*** UBRR determines the baud rate for the MBS's serial port, it can be set from 2.4kbps to 230.4kbps. The following equations can be used to calculate UBRR and the percent error in the baud rate. See the table below for UBRR settings for common bauds.

  UBRR = (460750/BAUD) – 1
  BAUD = 460750/(UBRR + 1)
  ERROR = ((TARGETBAUD/BAUD) – 1)*100

UBRR	BAUD	ERROR (%)
191	2400	0.0
95	4800	0.0
47	9600	0.0
31	14.4k	0.0
23	19.2k	0.0
15	28.8k	0.0
11	38.4k	0.0
7	57.6k	0.0
5	76.8k	0.0
3	115.2k	0.0
1	230.4k	0.0

Factory Default: 47,0,1

EXAMPLE:
USER: **ATMSR0,3,0,0<cr>**
MBS: **<cr_lf>:OK<cr_lf>**

Notes:

- *Flow control is always enabled.*

- *RTS will be low when the MBS is ready to receive data and high when its buffer is full. When RTS goes high wait until it returns to low before sending more data to avoid losing information.*

ATMRR0

READ REGISTER 0

Function: Reads the UART register.

Format: ATMRR0<cr>

Return Parameters: <UBRR>,<Parity>,<Stop Bits>

Example:
USER: **ATMRR0<cr>**
MBS: **<cr_lf>:OK<cr_lf>**
<cr_lf>:47,0,1<cr_lf>

4.12.2 Configuring the Data Format

ATMSR1

SET REGISTER 1

This is a sensor component specific command. See the Sensor Component Specific ATM Commands section for a full description of the command functionality based on the component you are using.

Function: This command sets the data format. Data will be padded with leading zeroes in order to keep the length of each reading constant.

Format: ATMSR1,<Units>,<Timestamp>,<Supply Voltage>,<Reading Count>,<Output Mode><cr>

ATMRR1

READ REGISTER 1

Function: Reads the data format register.

Format: ATMRR1<cr>

Return Parameters: <Units>,<Time Stamp>,<Supply Voltage>,<Reading Count>,<Output Mode>

Example:
USER: **ATMRR1<cr>**

```
      MBS:  <cr_lf>:OK<cr_lf>
            <cr_lf>:2,1,1,0,0,0<cr_lf>
```

4.12.3 Configuring Data Limits

ATMSR2

SET REGISTER 2

This is a sensor component specific command. See the Sensor Component Specific ATM Commands section for a full description of the command functionality based on the component you are using.

Function: Configures the MBS data limits. If the minimum reading is enabled the MBS will only store values less than or equal to the set limit. If the maximum reading is enabled the MBS will only store values greater than or equal to the set limit.

The minimum and maximum limits can be used simultaneously. Set the minimum limit lower than the maximum limit to create a bandstop filter – causing the MBS to only reporting readings outside of the two limits. Set the minimum limit greater than the maximum limit to create a bandpass filter – causing the MBS to only report readings between the two limits.

Format: ATMSR2,<Minimum Limit>,<Maximum Limit>,<Alarm Signal><cr>

ATMRR2

READ REGISTER 2

Function: Reads the data limit register.

Format: ATMRR2<cr>

Return Parameters: <Minimum Limit>,<Maximum Limit>,<Alarm Signal>

Example:

```
      USER: ATMRR2<cr>
      MBS:  <cr_lf>:OK<cr_lf>
            <cr_lf>:500,1000,2<cr_lf>
```

ATMRA

RESET ALARM

Function: Use this command to reset the alarm signal on the ALARM pin to its inactive state.

Format: ATMRA<cr>

Example:
USER: **ATMRA<cr>**
MBS: **<cr_lf>:OK<cr_lf>**

4.12.4 Enabling and Disabling the LEDs

ATMSR3

SET REGISTER 3

Function: Configures the MBS's leds.

Format: ATMSR3,<Connection Led>,<Clock Led>,<Alarm Led>,<Pause Led><cr>

Parameters:

Connection Led	Clock Led	Alarm Led	Pause Led
0: Disabled	0: Disabled	0: Disabled	0: Disabled
1: Enabled	1: Enabled	1: Enabled	1: Enabled

Parameter Details:

- ***Connection Led:*** When enabled the connection led will turn on when the MBS is *Bluetooth* connected. It will also flash at ~5hz when the MBS is trying to make a connection.
- ***Clock Led:*** When enabled the clock led will pulse on an off at a user specified rate. See Utilities – Clock Led Pulse Rate for more information.
- ***Alarm Led:*** When enabled along with limits, the led will toggle from off to on when readings surpass the set limits, as soon as the readings go back within the limits the led will turn off.
- ***Pause:*** When enabled this led will turn on when the module has been paused. It will also flash twice when the PAUSE_UNPAUSE pin has been triggered.

Factory Default: 1,1,1,1

Example:
USER: **ATMSR3,0,0,0,0<cr>**
MBS: **<cr_lf>:OK<cr_lf>**

Notes: *Unused leds should be disabled in battery powered applications in order to save power. See Electrical Characteristics section for more info on led current draw.*

ATMRR3

READ REGISTER 3

Function: Reads the led configuration register.

Format: ATMRR3<cr>

Return Parameters: <Connection Led>,<Clock Led>,<Alarm Led>,<Pause Led>

Example:
USER: **ATMRR3<cr>**
MBS: **<cr_lf>:OK<cr_lf>**
<cr_lf>:0,0,0,0<cr_lf>

4.13 Utilities

4.13.1 Offsetting the Analog to Digital Converter

ATMSSW0

SET SWITCH 0

Function: This command sets the value used to offset the raw output data of the analog to digital converter for sensor readings. See appendix B for a table of raw output versus temperature.

Format: ATMSSW0,<ADC Offset><cr>

Parameters:
- ***ADC Offset:*** Integer Value -512 to 512

Factory Default: 0

Example:
USER: **ATMSSW0,-3<cr>**
MBS: **<cr_lf>:OK<cr_lf>**

Note: *This command only offsets the ADC for sensor readings, it will not offset supply voltage readings.*

ATMRSW0

READ SWITCH 0

Function: Reads the ADC offset.

Format: ATMRSW0<cr>

Return Parameters: <ADC Offset>

Example:
USER: **ATMRSW0<cr>**
MBS: **<cr_lf>:OK<cr_lf>**

<cr_lf>:-3<cr_lf>

4.13.2 UART Data Duplication

ATMSSW1

SET SWITCH 1

Function: Use this command to turn data duplication mode on and off. When duplication is on, a duplicate of every reading sent over the Bluetooth link will be sent over the local UART.

Format: ATMSSW1,<Enable/Disable><cr>

Parameters:
- ***Enable/Disable:*** 0 = Disabled, 1 = Enabled

Factory Default: 0

Example:
USER: **ATMSSW1,1<cr>**
MBS: **<cr_lf>:OK<cr_lf>**

ATMRSW1

READ SWITCH 1

Function: Reads the uart data duplication register state.

Format: ATMRSW1<cr>

Return Parameters: <Enable/Disable>

EXAMPLE:
USER: **ATMRSW1<cr>**
MBS: **<cr_lf>:OK<cr_lf>**
<cr_lf>:1<cr_lf>

4.13.3 Bypassing the Hardware Factory Reset

ATMSSW2

SET SWITCH 2

Function: Use this command to disable the hardware factory reset jumper to prevent an inadvertent factory configuration reset.

Format: ATMSSW2,<Enable/Disable><cr>

Parameters:
- ***Enable/Disable:*** 0 = Disabled, 1 = Enabled

Factory Default: 0

Example:
USER: **ATMSSW2,1<cr>**
MBS: **<cr_lf>:OK<cr_lf>**

ATMRSW2

READ SWITCH 2

Function: Reads the hardware factory reset enable/disable register state.

Format: ATMRSW2

Return Parameters: <Enable/Disable>

Example:
USER: **ATMRSW2<cr>**
MBS: **<cr_lf>:OK<cr_lf>**
<cr_lf>:1<cr_lf>

4.13.4 Setting the Clock LED Pulse Rate

ATMSSW3

SET SWITCH 3

Function: Use this command to configure the pulse rate of the clock LED. The duty cycle of the LED will be 1/Period.

Format: ATMSSW3,<Period><cr>

Parameters:
- *Interval:* 2s – 32768s Ex: When set to 5 the frequency of the Clock LED will be .2Hz and the duty cycle will be 20%. It will turn on for one second and then be off for four before turning on again for one second.

Factory Default: 2

EXAMPLE:

USER: **ATMSSW3,1<cr>**
MBS: **<cr_lf>:OK<cr_lf>**

ATMRSW3

READ SWITCH 3

Function: Reads the clock LED pulse rate period.

Format: ATMRSW3<cr>

Return Parameters: <Period>

EXAMPLE:
USER: **ATMRSW3<cr>**
MBS: **<cr_lf>:OK<cr_lf>**
<cr_lf>:1<cr_lf>

4.13.5 Flushing Stored Data at Power Up

ATMSSW5

SET SWITCH 5

Function: Enabling this switch will cause the MBS to flush any stored data at power up. By default the MBS will save all unreported data when it loses power, so data will not be lost if power goes down unexpectedly. The next time the module is powered up it will be in the same state as it was at power down, and will eventually report all of the saved data when the reporting interval is reached.

Format: ATMSSW5,<Enable/Disable><cr>

Parameters:
Enable/Disable: 0 = Disabled, 1 = Enabled

Factory Default: Disabled

Example:
USER: **ATMSSW5,1<cr>**
MBS: **<cr_lf>:OK<cr_lf>**

ATMRSW5

READ SWITCH 5

Function: Reads the flush data at power up switch state.

Format: ATMRSW5<cr>

Return Parameters: <Enable/Disable>

Example:
USER: **ATMRSW5<cr>**
MBS: **<cr_lf>:OK<cr_lf>**
<cr_lf>:1<cr_lf>

4.13.6 Setting a Specific SPP RFCOMM ID

ATMSSW7

SET SWITCH 7

Function: Use this command to set a specific RFCOMM ID for the MBS to connect to on a slave device. Specifying an RFCOMM ID will decrease connection times as the MBS will not have to inquire the slave for available services. This command will only have an effect when the radio is in Master Mode (OpMode 3), and the transport mode is SPP or SPP ACK.

Format: ATMSSW7,<RFCOMM ID><cr>

Parameters:
- ***RFCOMMID**: 0-255, 0 = RFCOMM ID not specified*

Factory Default: 0

Example:
USER: **ATMSSW7,1<cr>**
MBS: **<cr_lf>:OK<cr_lf>**

Note: *If multiple MBS devices are reporting in to the same slave device, a different RFCOMM ID must be specified for each device to avoid connection conflicts.*

ATMRSW7

READ SWITCH 7

Function: Reads the set specific RFCOMM ID.

Format: ATMRSW7<cr>

Return Parameters: <RFCOMM ID>

Example:
USER: **ATMRSW7<cr>**
MBS: **<cr_lf>:OK<cr_lf>**
<cr_lf>:1<cr_lf>

4.14 Reading MBS Configuration

ATMRCFG

READ CONFIGURATION

Function: Use this command to read the current configuration of all MBS parameters. The data will be in XML format - see Appendix B for the XML Schema. This command can only be executed if the unit is paused or in Passive Mode.

Format: ATMRCFG<cr>

Example:

USER: **ATMRCFG<cr>**

MBS: **<cr_lf>:OK<cr_lf>**

```
<cr_lf><mbsConfig createDateTime="2006-01-01T00:01:00"
sensorType="Temperature"><cr_lf>
<cr_lf><ht><operationalMode><cr_lf>
<cr_lf><ht><ht><modeNumber>3</modeNumber><cr_lf>
<cr_lf><ht><ht><samplingInterval>1</samplingInterval><cr_lf>
<cr_lf><ht><ht><reportingInterval>10</reportingInterval><cr_lf>
<cr_lf><ht><ht><transportMode>0</transportMode><cr_lf>
<cr_lf><ht><ht><fallBackRetryInterval>30</fallBackRetryInterval><cr_lf>
<cr_lf><ht><ht><slaveBTAddress>001638C16035</slaveBTAddress><cr_lf>
<cr_lf><ht></operationalMode><cr_lf>
<cr_lf><ht><powerMode><cr_lf>
<cr_lf><ht><ht><current>0</current><cr_lf>
<cr_lf><ht><ht><stored>0</stored><cr_lf>
<cr_lf><ht></powerMode><cr_lf>
<cr_lf><ht><uart><cr_lf>
<cr_lf><ht><ht><baudRateDivisor>47</baudRateDivisor><cr_lf>
<cr_lf><ht><ht><parityMode>0</parityMode><cr_lf>
<cr_lf><ht><ht><stopBitSelect>0</stopBitSelect><cr_lf>
<cr_lf><ht></uart><cr_lf>
<cr_lf><ht><format><cr_lf>
<cr_lf><ht><ht><units>2</units><cr_lf>
<cr_lf><ht><ht><timeStamp>1</timeStamp><cr_lf>
<cr_lf><ht><ht><supplyVoltage>1</supplyVoltage><cr_lf>
<cr_lf><ht><ht><readingCount>1</readingCount><cr_lf>
<cr_lf><ht><ht><outputMode>2</outputMode><cr_lf>
<cr_lf><ht></format><cr_lf>
<cr_lf><ht><limits><cr_lf>
<cr_lf><ht><ht><minLimit>0</minLimit><cr_lf>
<cr_lf><ht><ht><maxLimit>0</maxLimit><cr_lf>
<cr_lf><ht><ht><alarmSignal>0</alarmSignal><cr_lf>
<cr_lf><ht></limits><cr_lf>
<cr_lf><ht><leds><cr_lf>
<cr_lf><ht><connectionLed>1</connectionLed><cr_lf>
<cr_lf><ht><ht><clockLed>1</clockLed><cr_lf>
<cr_lf><ht><ht><alarmSignalLed>1</alarmSignalLed><cr_lf>
<cr_lf><ht><ht><pauseLed>1</pauseLed><cr_lf>
<cr_lf><ht></leds><cr_lf>
```

```
<cr_lf><ht><swtiches><cr_lf>
<cr_lf><ht><ht><adcOffset>0</adcOffset><cr_lf>
<cr_lf><ht><ht><dataDuplication>0</dataDuplication><cr_lf>
<cr_lf><ht><ht><disableHwReset>0</disableHwReset><cr_lf>
<cr_lf><ht><ht><clockLedRate>1</clockLedRate><cr_lf>
<cr_lf><ht><ht><dataAckTimeout>5000</dataAckTimeout><cr_lf>
<cr_lf><ht><ht><flushDataAtPowerUp>0</flushDataAtPowerUp><cr_lf>
<cr_lf><ht><ht><escapeChar>42</escapeChar><cr_lf>
<cr_lf><ht><ht><rfCommID>0</rfCommID><cr_lf>
<cr_lf><ht><ht><supplyScalingFactor>0</supplyScalingFactor><cr_lf>
<cr_lf><ht></switches><cr_lf>
<cr_lf></mbsConfig><cr_lf>
```

ATMFTPCFG

FTP CONFIGURATION

Function: Use this command to read the current configuration of all MBS parameters. The data will be in XML format - see Appendix B for the XML Schema. This command can only be executed if the unit is paused or in Passive Mode.

The first time the MBS sends data using the FTP protocol, it will create a folder in the master radio's default FTP directory (Bluetooth Exchange Folder) named after the MBS's friendly name. By default this is BlueRadiosMS####, the last four characters being the last 4 digits of the MBS's Bluetooth address.

Example File Path:
Bluetooth Exchange Folder\BlueRadiosMS1234\

The config will be named "Cfg", followed by the abbreviated timestamp of the time when the file was created.

Example File Name:
Cfg_20060101000001_0.xml

(Both the friendly name and the service name can be changed using the ATMPT command.)

Format: ATMFTPCFG,<BT Address><cr>

Parameters:

- ***BT Address:*** The 12 character Bluetooth address of the radio the MBS will connect to.

Example:

USER: **ATMFTPCFG<cr>**
MBS: **<cr_lf>:OK<cr_lf>**
<cr_lf>:FTP COMPLETE<cr_lf>
OR
<cr_lf>:SLAVE NOT FOUND<cr_lf>

File Contents: SEE EXAMPLE ABOVE IN ATMCFG

4.15 Radio Pass Through Mode

4.15.1 Enabling Pass Through Mode

ATMPT

PASS THROUGH

Function: Allows BlueRadios AT commands to be directly passed to the BlueRadios module. This command can only be executed if the unit is paused or in passive mode.

See the BlueRadios_ATMP_Commands document for more information on radio specific commands.

WARNING: Changing some radio settings will cause the MBS to stop functioning correctly. Do not use the following AT commands: ATFRST, ATSW20, ATSW25, ATSW28. Altering other commands may also cause unknown behavior, but factory settings can always be restored using the ATMFRST command or by using the factory reset jumper.

To exit pass through mode the user must send an escape sequence to the MBS consisting of three identical characters and a carriage return. By default the escape character is '*', so to exit send the sequence "***<cr>" to the MBS. The escape character can be changed using the ATSSW6 command.

When using pass through mode over a Bluetooth connection the user will need to put the radio into command mode after executing the ATMPT command. To do this wait until the PT ENABLED response has been received, then send the string "+++". To exit pass through mode over the Bluetooth connection put the radio back into data mode by executing an ATMD, then send the escape sequence.

The MBS will retain the radio response mode selection after exiting pass through mode. So if the module response mode is switched from long response mode to short response mode, it will be in short response mode the next time pass through mode is used.

Format: ATMPT<cr>

Examples:

- ***Local Pass Through***

  USER: **ATMPT<cr>**
  MBS: **<cr_lf>:OK<cr_lf>**
  <cr_lf>:PT ENABLED<cr_lf>

  USER: **AT<cr>**
  RADIO MODULE: **<cr_lf>OK<cr_lf>**

  USER: ***<cr>**
  MBS: **<cr_lf>:PT DISABLED<cr_lf>**

- ***Bluetooth Pass Through***

  USER: ***<cr>**

```
      MBS:  <cr_lf>:OK<cr_lf>
            <cr_lf>:PT ENABLED<cr_lf>

      USER: +++<cr>  //Put radio into command mode
      RADIO MODULE: <cr_lf>OK<cr_lf>  //Radio response

      USER: AT<cr>
      RADIO MODULE: <cr_lf>OK<cr_lf>  //Radio response

      USER: ATMD<cr> //Put radio into data mode
      USER: ***<cr>
      MBS:  <cr_lf>:PT DISABLED<cr_lf>
```

4.15.2 Setting the Pass Through Escape Character

ATMSSW6

SET SWITCH 6

Function: Use this command to change the pass through mode escape character.

Format: ATMSSW5,<Escape Char><cr>

Parameters:

- ***Escape Char**: 0-255*

Factory Default: 42 (*)

Example:

```
      USER: ATMSSW6,42<cr>
      MBS:  <cr_lf>:OK<cr_lf>
```

ATMRSW6

READ SWITCH 6

Function: Reads the pass through mode escape character.

Format: ATMRSW6<cr>

Return Parameters: <Escape Char>

Example:

```
      USER: ATMRSW6<cr>
      MBS:  <cr_lf>:OK<cr_lf>
            <cr_lf>:42<cr_lf>
```

5 Sensor Component Specific ATM Commands

5.1 Generic Sensor Commands

5.1.1 Configuring the Data Format

ATMSR1

SET REGISTER 1

Function: This command sets the data format. Data will be padded with leading zeroes in order to keep the length of each reading constant.

Format: ATMSR1,<Units>,<Timestamp>,<Supply Voltage>,<Reading Count>,<Output Mode><cr>

Parameters:

Units	Timestamp	Supply Voltage	Reading Count	Output Mode
0: Raw ADC Value	0: Disabled	0: Disabled	0: Disabled	0: Text
1: Digital	1: Enabled	1: Enabled	1: Enabled	1: Text + EOD
2: Volts				2: XML

Parameter Details:

- ***Units:*** This parameter determines what units the MBS will output data in.
  - **Raw ADC Value:** In Raw ADC mode all data will be reported as a value from 0 to 1023, which represents an analog value between 0 and 3.33 Volts. Data will be in the following format: "####r"
  - **Digital:** All data will be reported as a 0, 1, or X, which indicates an indefinite value. A 0 will be any value below .666 (.2 * 3.33), a 1 will be any value greater than 2.331 (.7 * 3.33), and an X will represent any value in between. Data will be in the following format: "#d"
  - **Volts:** All data will be reported as a voltage between 0 and 3.33 Volts. Data will be in the following format: "#.###V"
- ***Timestamp:*** If Timestamp is enabled the MBS will store a timestamp with every reading, if disabled the MBS will not store timestamps. Timestamp data will be in the following format: "YYYY-MM-DDTHH:MM:SS"

  The value of this parameter effects the reporting interval and maximum storage of the MBS as follows:

Timestamp	Max Reporting Interval	Max Storage
0: Disabled	7000 Readings	8000 Readings
1: Enabled	1500 Readings	1750 Readings

- ***Supply Voltage:*** If this parameter is enabled the MBS will append the voltage on the SUPPLY_VOLTAGE pin in Volts to the end of every report. This allows the user to monitor the battery level of battery powered applications. Input

voltage data will be in the following format: "##.##V"

- ***Reading Count:*** When enabled the MBS will attach the number of readings in a report to the beginning of the report. Reading count data will be in the following format: ":RC=####" In XML output mode the reading count will be part of the file header.

- ***Output Mode:***

0: Text	The MBS will report data in standard text format.
1: Text + EOD	The MBS will report data in standard text format, but will attach an End of Data string (":EOD") to the end of every report.
2: XML	The MBS will report data as an XML file. See Appendix B for the XML Schema.

Factory Default: 2,1,0,0,0

Examples:

- **0,0,0,0,0**
  USER: **ATMSR1,0,0,0,0,0<cr>**
  ATMTR<cr>
  MBS: **<cr_lf>:OK<cr_lf>**
  <cr_lf>:768r<cr_lf>

- **1,1,0,0,0**
  USER: **ATMSR1,1,1,0,0,0<cr>**
  ATMTR<cr>
  MBS: **<cr_lf>:OK<cr_lf>**
  <cr_lf>:1d 2006-01-01T00:00:01<cr_lf>

- **2,1,1,0,0**
  USER: **ATMSR1,2,1,1,0,0<cr>**
  ATMTR<cr>
  MBS: **<cr_lf>:OK<cr_lf>**
  <cr_lf>:2.500V 2006-01-01T00:00:01<cr_lf>
  <cr_lf>:03.33V<cr_lf>

- **2,1,1,1,0**
  USER: **ATMSR1,2,1,1,1,0<cr>**
  ATMTR<cr>
  MBS: **<cr_lf>:OK<cr_lf>**
  <cr_lf>:RC=0001<cr_lf>
  <cr_lf>:2.500V 2006-01-01T00:00:01<cr_lf>
  <cr_lf>:03.33V<cr_lf>

- **2,1,1,1,1**
  USER: **ATMSR1,2,1,1,1,1<cr>**
  ATMTR<cr>
  MBS: **<cr_lf>:OK<cr_lf>**

```
<cr_lf>:RC=0001<cr_lf>
<cr_lf>:2.500V 2006-01-01T00:00:01<cr_lf>
<cr_lf>:03.33V<cr_lf>
<cr_lf>:EOD<cr_lf>
```

- **2,1,1,1,2**

USER: **ATMSR1,2,1,1,1,1<cr>**
ATMTR<cr>

MBS:
```
<cr_lf>:OK<cr_lf>
<cr_lf><megaStampData createDateTime="2006-01-01T00:11:26"
sensorType="Temperature" readingCount="0001"><cr_lf>
<cr_lf><ht><reading><cr_lf>
<cr_lf><ht><ht><value>2.500V</value><cr_lf>
<cr_lf><ht><ht><units>F</units><cr_lf>
<cr_lf><ht><ht><timeStamp>2006-01-01T00:00:01</timeStamp><cr_lf>
<cr_lf><ht></reading><cr_lf>
<cr_lf><ht><supplyVoltage>03.33V</supplyVoltage><cr_lf>
</megaStampData><cr_lf>
```

5.1.2 Configuring Data Limits

ATMSR2

SET REGISTER 2

Function: Configures the MBS data limits. If the minimum reading is enabled the MBS will only store values less than or equal to the set limit. If the maximum reading is enabled the MBS will only store values greater than or equal to the set limit.

The minimum and maximum limits can be used simultaneously. Set the minimum limit lower than the maximum limit to create a bandstop filter – causing the MBS to only reporting readings outside of the two limits. Set the minimum limit greater than the maximum limit to create a bandpass filter – causing the MBS to only report readings between the two limits.

Format: ATMSR2,<Minimum Limit>,<Maximum Limit>,<Alarm Signal><cr>

Parameters:

Minimum Limit (ADC Value)	Maximum Limit (ADC Value)	Alarm Signal
0: Disabled	0: Disabled	0: Disabled
1-1023: Enabled	1-1023: Enabled	1: Active Low
		2: Active High
		3: Latch Active Low
		4: Latch Active High

Parameter Details:

- ***Minimum Reading:*** 0 or 1 – 1023 **ADC Value**. See Appendix C: ADC Conversion Chart for help converting between units.

- ***Maximum Reading:*** 0 or 1 – 1023 **ADC Value**. See Appendix C: ADC Conversion Chart for help converting between units.

- ***Alarm Signal:*** By setting this parameter to a non-zero value the user can enable a digital output signal the ALARM pin that can be used to trigger an event when readings surpass the set limits. An alarm led can also be enabled – See Led Configuration Register for more information.

0: Disabled	The alarm signal will be disabled and ALARM will be held at 0V.
1: Active Low	The alarm signal will be enabled and active high. When readings surpass the set limits ALARM will toggle from 3.33V down to 0V, as soon as the readings go back within the limits ALARM will be set to 3.33V.
2: Active High	The alarm signal will be enabled and active high. When readings surpass the set limits ALARM will toggle from 0V to 3.33V, as soon as the readings go back within the limits ALARM will be set to 0V.
3: Latch Active Low	The alarm signal will be enabled and active high. When readings surpass the set limits ALARM will toggle from 3.33V to 0V and be latched at 0V until the alarm signal is reset using the ATMRA command. (See next Command.)
4: Latch Active High	The alarm signal will be enabled and active low. When readings surpass the set limits ALARM will toggle from 0V to 3.33V and be latched at 3.33V until the alarm signal is reset using the ATMRA command. (See next Command.)

Factory Default: *Minimum Limit = 0, Maximum Limit = 0, Alarm Signal = 0*

Example:

USER: **ATMSR2,300,750,2<cr>**
MBS: **<cr_lf>:OK<cr_lf>**

5.2 Temperature Sensor Commands

5.2.1 Configuring the Data Format

ATMSR1

SET REGISTER 1

Function: This command sets the data format. Data will be padded with leading zeroes in order to keep the length of each reading constant.

Format: ATMSR1,<Units>,<Timestamp>,<Supply Voltage>,<Reading Count>,<Output Mode><cr>

Parameters:

Units	Timestamp	Supply Voltage	Reading Count	Output Mode
0: Kelvin	0: Disabled	0: Disabled	0: Disabled	0: Text
1: Celsius	1: Enabled	1: Enabled	1: Enabled	1: Text + EOD
2: Fahrenheit				2: XML

Parameter Details:

- ***Units:*** This parameter determines what units the MBS will output data in. Reading data will be in the following format: "###.#<Unit>"

  Any reading out of the range of the sensor will read out: "XXX.X<Unit>" Unless the MBS is being used in very extreme temperature this indicates that there is a problem with the sensor – most likely one of the thermistor leads has come loose.

- ***Timestamp:*** If Timestamp is enabled the MBS will store a timestamp with every reading, if disabled the MBS will not store timestamps. Timestamp data will be in the following format: "YYYY-MM-DDTHH:MM:SS"

  The value of this parameter effects the reporting interval and maximum storage of the MBS as follows:

Timestamp	Max Reporting Interval	Max Storage
0: Disabled	7000 Readings	8000 Readings
1: Enabled	1500 Readings	1750 Readings

- ***Supply Voltage:*** If this parameter is enabled the MBS will append the voltage on the SUPPLY_VOLTAGE pin in Volts to the end of every report. This allows the user to monitor the battery level of battery powered applications. Input voltage data will be in the following format: "##.##V"

- ***Reading Count:*** When enabled the MBS will attach the number of readings in a report to the beginning of the report. Reading count data will be in the following format: ":RC=####" In XML output mode the reading count will be part of the file header.

- ***Output Mode:***

0: Text	The MBS will report data in standard text format.
1: Text + EOD	The MBS will report data in standard text format, but will attach an End of Data string (":EOD") to the end of every report.
2: XML	The MBS will report data as an XML file. See Appendix B for the XML Schema.

Factory Default: 2,1,0,0,0

Examples:

- **0,0,0,0,0**
  USER: **ATMSR1,0,0,0,0,0<cr>**
  ATMTR<cr>
  MBS: **<cr_lf>:OK<cr_lf>**
  <cr_lf>:297.0K<cr_lf>

- **1,1,0,0,0**
  USER: **ATMSR1,1,1,0,0,0<cr>**
  ATMTR<cr>
  MBS: **<cr_lf>:OK<cr_lf>**
  <cr_lf>:025.0F 2006-01-01T00:00:01<cr_lf>

- **2,1,1,0,0**
  USER: **ATMSR1,2,1,1,0,0<cr>**
  ATMTR<cr>
  MBS: **<cr_lf>:OK<cr_lf>**
  <cr_lf>:075.0F 2006-01-01T00:00:01<cr_lf>
  <cr_lf>:03.33V<cr_lf>

- **2,1,1,1,0**
  USER: **ATMSR1,2,1,1,1,0<cr>**
  ATMTR<cr>
  MBS: **<cr_lf>:OK<cr_lf>**
  <cr_lf>:RC=0001<cr_lf>
  <cr_lf>:075.0F 2006-01-01T00:00:01<cr_lf>
  <cr_lf>:03.33V<cr_lf>

- **2,1,1,1,1**
  USER: **ATMSR1,2,1,1,1,1<cr>**
  ATMTR<cr>
  MBS: **<cr_lf>:OK<cr_lf>**
  <cr_lf>:RC=0001<cr_lf>
  <cr_lf>:075.0F 2006-01-01T00:00:01<cr_lf>
  <cr_lf>:03.33V<cr_lf>
  <cr_lf>:EOD<cr_lf>

- **2,1,1,1,2**
  USER: **ATMSR1,2,1,1,1,1<cr>**
  ATMTR<cr>
  MBS: **<cr_lf>:OK<cr_lf>**

```
<cr_lf><megaStampData createDateTime="2006-01-01T00:11:26"
sensorType="Temperature" readingCount="0001"><cr_lf>
<cr_lf><ht><reading><cr_lf>
<cr_lf><ht><ht><value>075.0</value><cr_lf>
<cr_lf><ht><ht><units>F</units><cr_lf>
<cr_lf><ht><ht><timeStamp>2006-01-01T00:00:01</timeStamp><cr_lf>
<cr_lf><ht></reading><cr_lf>
<cr_lf><ht><supplyVoltage>03.33V</supplyVoltage><cr_lf>
</megaStampData><cr_lf>
```

5.2.2 Configuring Data Limits

See Appendix C: ADC Conversion Chart for help with selecting limit values.

ATMSR2

SET REGISTER 2

Function: Configures the MBS data limits. If the minimum reading is enabled the MBS will only store values less than or equal to the set limit. If the maximum reading is enabled the MBS will only store values greater than or equal to the set limit.

The minimum and maximum limits can be used simultaneously. Set the minimum limit lower than the maximum limit to create a bandstop filter – causing the MBS to only reporting readings outside of the two limits. Set the minimum limit greater than the maximum limit to create a bandpass filter – causing the MBS to only report readings between the two limits.

Format: ATMSR2,<Minimum Limit>,<Maximum Limit>,<Alarm Signal><cr>

Parameters:

Minimum Limit (Kelvin)	Maximum Limit (Kelvin)	Alarm Signal
0: Disabled	0: Disabled	0: Disabled
1-4227: Enabled	1-4227: Enabled	1: Active Low
		2: Active High
		3: Latch Active Low
		4: Latch Active High

Parameter Details:

- ***Minimum Reading:*** 0 or 1 – 422.7 **Degrees Kelvin**. Must be entered as (Kelvin * 10), so 442.7 would be entered as 4227. See Appendix C: ADC Conversion Chart for help converting between units.

- ***Maximum Reading:*** 0 or 1 – 422.7 **Degrees Kelvin**. Must be entered as (Kelvin * 10), so 442.7 would be entered as 4227. See Appendix C: ADC Conversion Chart for help converting between units.

- ***Alarm Signal:*** By setting this parameter to a non-zero value the user can enable a digital output signal the ALARM pin that can be used to trigger an event when

readings surpass the set limits. An alarm led can also be enabled – See Led Configuration Register for more information.

0: Disabled	The alarm signal will be disabled and ALARM will be held at 0V.
1: Active Low	The alarm signal will be enabled and active high. When readings surpass the set limits ALARM will toggle from 3.33V down to 0V, as soon as the readings go back within the limits ALARM will be set to 3.33V.
2: Active High	The alarm signal will be enabled and active high. When readings surpass the set limits ALARM will toggle from 0V to 3.33V, as soon as the readings go back within the limits ALARM will be set to 0V.
3: Latch Active Low	The alarm signal will be enabled and active high. When readings surpass the set limits ALARM will toggle from 3.33V to 0V and be latched at 0V until the alarm signal is reset using the ATMRA command. (See next Command.)
4: Latch Active High	The alarm signal will be enabled and active low. When readings surpass the set limits ALARM will toggle from 0V to 3.33V and be latched at 3.33V until the alarm signal is reset using the ATMRA command. (See next Command.)

Factory Default: *Minimum Limit = 0, Maximum Limit = 0, Alarm Signal = 0*

Example:

USER: **ATMSR2,2800,3000,2<cr>**

MBS: **<cr_lf>:OK<cr_lf>**

6 Factory Default Settings

- Unpaused
- Operational Mode = 0 (Passive Mode)
- Power Mode = 0 (uC = Always On / Radio = Always On)
- UART Register = 47,0,0 (9600 Baud, 8 Data Bits, No Parity, 1 Stop Bit)
- Format Register = 2,1,0,0,0 (Unit 2, Timestamp On, Input Voltage Off, Reading Count Off, Text Output)
- Data Limit Register = 0,0,0 (No Limits, No Alarm Signal)
- Led Register = 1,1,1,1 (All LEDs enabled)
- ADC Offset = 0
- UART Data Duplication = 0 (Disabled)
- Acknowledgement Timeout Period = 5000ms
- Disable HW Factory Reset = 0 (Disabled)
- Clock LED Rate Interval = 1s
- Flush Data at Power Up = 0 (Disabled)
- Pass Through Escape Character = '*'
- RFCOMM ID = 0
- Supply Voltage Scaling Factor = 1000 (1.0 * SUPPLY_VOLTAGE)
- Bluetooth Passkey = default

7 Typical Characteristics

WARNING: Due to a part selection error a clock that draws approximately 1mA steady state was used in place of a crystal for the module's oscillator. Because of this error the module will not draw less than 1mA in the low power modes. This error will be fixed in the next board revision.

7.1 Supply Current

All measurements were taken with the leds disabled, see the table below for typical led current consumption. The active current is the current seen when the MBS's microcontroller is awake, for instance when the MBS has been paused, or when it wakes up to update its internal clock or take a reading. The sleep current is the current seen in between these periods. The connected current can vary based on the distance between connected devices and the quality of the RF environment, our testing was done at a range of 1m in an ideal environment.

Power Mode	Connected Current	Active Current	Sleep Current
0: Always On	~12 mA	~48 mA	N/A
1: Power Save – Radio = Connectable Deep Sleep	~12 mA	~5.5 mA	~375 µA
2: Power Save – Radio = Not Connectable Deep Sleep	~12 mA	~5.4 mA	~55 µA
3: Power Save – Radio = Off	~12 mA	~5.4 mA	~21 µA

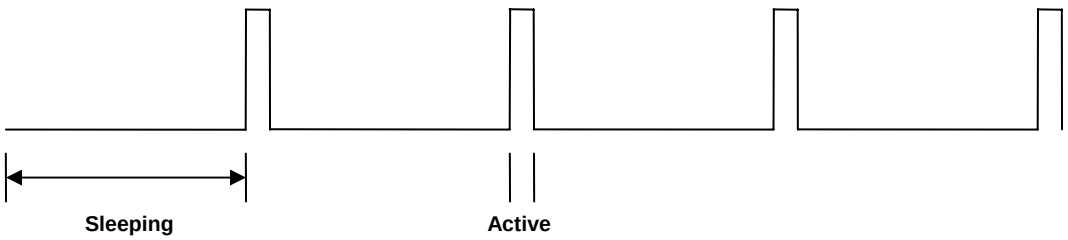
7.2 Led Current

Led	Minimum	Maximum
Connection Led (CR1 - BLUE)	1.8 mA	3.8 mA
Clock Led (CR2 – GREEN)	6.3 mA	10 mA
Alarm Led (CR3 – RED)	7.2 mA	11.8 mA
Power Mode Led (CR4 – YELLOW)	7.2 mA	10.9 mA

7.3 Timing Information

The internal RTC is updated every second and readings are stored at your specified sampling interval at the same time the clock is updated. The following data can be useful in estimating average current consumption.

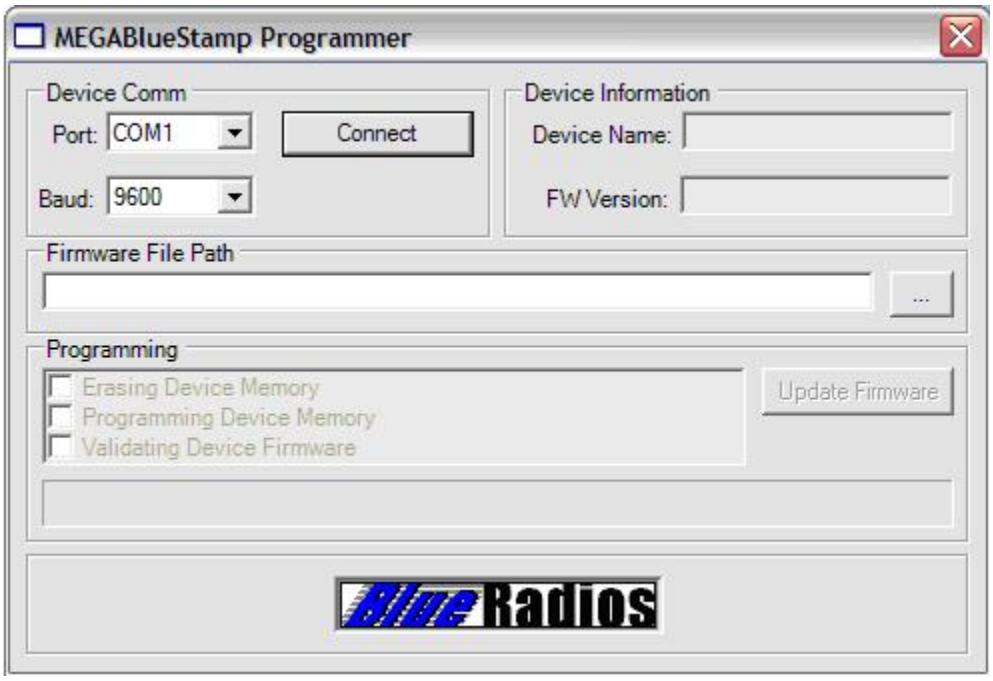
Parameter	Active Period
RTC Update (Freq = 1Hz)	80 µs
RTC Update w/ Reading Store	2.75 ms
RTC Update w/ Reading Store and Limits Enabled	5.4 ms



8 Loading New Firmware

IMPORTANT NOTE: After loading new firmware the MBS will be factory reset back to its default configuration. Allow the unit 5-7 seconds to perform the reset.

The MBS firmware contains a bootloader which allows the user to load firmware updates and custom firmware builds over the local UART using a PC. Firmware updates can be downloaded using the MBS Programmer application, which can be found on www.blueradios.com. This program requires a PC with .NET Framework Version 1.1.



8.1 Putting the MBS into Update Mode

Before the firmware of the MBS can be loaded using the programmer, the MBS must be put into update mode. If the local UART of the MBS is configured at one of the following standard PC baud rates the programmer can automatically command the MBS into update mode upon connecting:

2400, 4800, 9600, 14400, 19200, 28800, 38400, 57600, 76800, 115200, 230400

If the MBS is not configured at one of the above baud rates, the user must manually put the device into update mode using the Multi-Purpose Jumper (J2). If pins 1 & 2 of J2 are jumped together at power up the MBS will enter update mode. Be sure to remove the jumper after updating the firmware to boot up to allow the MBS to run normally on the next power up.

Note: The alarm led (CR3) will be on at all times when the MBS is in update mode.

8.2 Updating the MBS Firmware

Follow these steps to upgrade the firmware on your MBS module using the MBS Programmer.

1. Download the appropriate .a90 firmware build from www.blueradios.com. **Do not change the name or extension of the file or the programmer will not accept the file.**

2. Enter the file path of the firmware build in the "Firmware File Path" text box either manually or by clicking the "…" button to browse for the file using Windows Explorer.

3. Connect your PC to the local UART of the MBS and power up the MBS. (Use the multi-purpose jumper to enter update mode at power up if a standard baud rate is not being used.)

4. Select the appropriate COM port using the combo box labeled "Port." If the MBS is not already in update mode select the baud rate of the local UART using the combo box labeled "Baud." (If the MBS is already in update mode the baud rate selection will not be used.)

5. Click the Connect button. If the connection is successful the "Device Name" and "FW Version" fields of the Device Information section will be updated.

6. Once the firmware has been selected and the device has successfully connected click the "Update Firmware" button. The file will be validated and programming will begin. Programming the MBS will take place in a three step process: first the device will be erased, then the new firmware will be loaded, and finally a CRC will be calculated on the MBS and compared to the CRC of the input file on the PC to validate that the update has been successful.

   Overall progress can be tracked using "Programming" status box. The current step of the process will be highlighted, and each step will be checked off after successfully completing. The progress of each individual step will be displayed in the progress bar.

   During the erase and verification stages of the process the power mode led (CR4) will be on. While the device is being programmed the power mode led will strobe on and off.

7. Once programming has completed the programmer will reset the MBS and automatically disconnect the COM port. If programming successfully completed all three check boxes will be checked, indicating each step was executed successfully and the MBS will now be running the new firmware.

   In the event of a failure a message box describing the error will pop up. The MBS will remain in update mode upon reset until it has been programmed successfully. See below for more information on errors.

8.3 Programming Errors

The MBS will automatically enter update mode upon being reset unless a valid firmware build has successfully been loaded. Two possible errors can occur during programming: communication could be lost or the firmware verification could fail.

1. **Communication Loss** – In the event of communication loss due to a faulty cable or loss of power to the device the programmer will abort the programming process and disconnect the com port. After repairing the connection, reconnect to the MBS using the programmer and attempt the update again. The MBS may need to be reset in order to reestablish communication with the programmer depending on its state when the process failed.

2. **Failed Verification** – If verification of the firmware should fail there may have been an error either in the data transfer or writing to the flash memory. Retry the update, if it continues to fail there may be a problem with the internal memory of the MBS.

9 Acronyms/Abbreviations

AT – Attention
ATM – Attention MegaBlueStamp
ASCII - American Standard Code for Information Interchange
BR - BlueRadios
BT - Bluetooth
BTW - Bluetooth Windows Stack
COD - Class Of Device
COM - Communications
CR - Carriage Return
CTS - Clear To Send
DSR - Data Sent Receive
FTP – File Transfer Protocol
GND - Ground
LF - Line Feed
MBS - MegaBlueStamp
MCU - Microcontroller Unit
MISO - Master In Slave Out
MOSI – Master Out Slave In
NC - Not Connected
PC - Personal Computer
PCB - Printed Circuit Board
PIN - Personal Identification Number
RF - Radio Frequency
PIO - Pin Input/Output
RST - Reset
RTS - Ready To Send
RX - Receive
SCO - Synchronous Connection-Oriented: the links used by BT to send audio.
SMT - Surface Mount Technology
SPI - Serial Protocol Interface
SPICK - SPI Clock
SPICS - SPI Chip Select
TTL - Transistor Transistor Logic
TX - Transmit
UART - Universal Asynchronous Receiver/Transmitter
USB - Universal Serial Bus
UUID - Universal Unique Identifier – maintainedd by Bluetooth SIG.
VCC - DC Power
VDD - DC Power
VM – Virtual Machine

Go to www.blueradios.com and look on the left hand column to download *Bluetooth* Glossary of Terms PDF and other materials.

APPENDIX A: ATM Command Summary Table

AT Command	Description
Attention MBS	
ATM	Used to check communication, responds with OK
Firmware Version	
ATMVER	Reads the MBS and radio module FW versions
Resettting	
ATMURST	Resets the MBS
ATMFRST	Factory resets the MBS to its default settings
Status	
ATMGS	Gets MBS status
Pausing	
ATMPS	Pauses and unpauses the MBS
Clock	
ATMSC	Sets the clock
ATMRC	Reads the clock
Power Modes	
ATMSPM	Sets the power mode
ATMRPM	Reads the power mode
Operational Modes	
ATMSM0	Passive Mode
ATMSM1	Local Mode
ATMSM2	Slave Mode
ATMSM3	Master Mode
ATMRM	Reads the operational mode
Manually Reading Data	
ATMTR	Takes a readings
ATMGSC	Gets the number of stored readings
ATMGSR	Gets stored readings
ATMFTPGSR	FTPs stored readings
ATMFSR	Flushes stored readings
Reading Supply Voltage	
ATMRV	Reads the input voltage
ATMSSW8	Sets the supply voltage scaling factor
ATMRSW8	Reads the supply voltage scaling factor
Data Acknowledgement	
ATMACK	Acknowledges to the MBS that data was received
ATMSSW4	Sets the data acknowledgement timeout period

ATMRSW4	Reads the data acknowledgement timeout period
Configuration Registers	
ATMSR0	Sets the local UART configuration register
ATMRR0	Reads the local UART configuration register
ATMSR1	Sets the data format register
ATMRR1	Reads the data format register
ATMSR2	Sets the data limit register
ATMRR2	Reads the data limit register
ATMRA	Resets the alarm signal
ATMSR3	Sets the led configuration register
ATMRR3	Sets the led configuration register
Utilities	
ATMSSW0	Sets the adc offset
ATMRSW0	Reads the adc offset
ATMSSW1	Configures the data duplication utility
ATMRSW1	Reads the data duplication utility
ATMSSW2	Configures the bypass hardware factory reset utility
ATMRSW2	Reads the bypass hardware factory reset utility
ATMSSW3	Sets the clock led pulse rate
ATMRSW3	Reads the the clock led pulse rate
ATMSSW5	Configures the flush data on power up switch
ATMRSW5	Reads the flush data on power up switch
ATMSSW7	Sets the specific SPP RFCOMM ID
ATMRSW7	Sets the specific SPP RFCOMM ID
Reading Configuration	
ATMRCFG	Reads the MBS configuration
ATMFTPCFG	FTPs the MBS configuration
Radio Pass Through Mode	
ATMPT	Enables radio pass through mode
ATMSSW6	Sets the pass through escape character
ATMRSW6	Sets the pass through escape character

APPENDIX B: XML Schemas

Report Schema:

```
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema">
  <xs:element name="mbsReport">
    <xs:complexType>
      <xs:attribute name="createDateTime" type="xs:string" />
      <xs:attribute name="sensorType" type="xs:string" />
      <xs:attribute name="readingCount" type="xs:string" />
      <xs:sequence>
        <xs:element name="reading" maxOccurs="unbounded">
          <xs:complexType>
            <xs:sequence>
              <xs:element name="value" type="xs:string" />
              <xs:element name="units" type="xs:string" />
              <xs:element name="timeStamp" type="xs:string" minOccurs="0" />
            </xs:sequence>
          </xs:complexType>
        </xs:element>
        <xs:element name="inputVoltage" type="xs:string" minOccurs="0" />
      </xs:sequence>
    </xs:complexType>
  </xs:element>
</xs:schema>
```

Config Schema:

```
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema">
  <xs:element name="mbsConfig">
    <xs:complexType>
      <xs:attribute name="createDateTime" form="unqualified" type="xs:string" />
      <xs:attribute name="sensorType" form="unqualified" type="xs:string" />
      <xs:sequence>
        <xs:element name="operationalMode">
          <xs:complexType>
            <xs:sequence>
              <xs:element name="modeNumber" type="xs:string" />
              <xs:element name="samplingInterval" type="xs:string" minOccurs="0" />
              <xs:element name="reportingInterval" type="xs:string" minOccurs="0" />
              <xs:element name="transportMode" type="xs:string" minOccurs="0" />
              <xs:element name="fallBackRetryInterval" type="xs:string"
minOccurs="0" />
              <xs:element name="slaveBTAddress" type="xs:string" minOccurs="0" />
            </xs:sequence>
          </xs:complexType>
        </xs:element>
        <xs:element name="powerMode">
          <xs:complexType>
            <xs:sequence>
              <xs:element name="current" type="xs:string" />
              <xs:element name="stored" type="xs:string" />
            </xs:sequence>
```

```
  </xs:complexType>
</xs:element>
<xs:element name="localUART" minOccurs="0" maxOccurs="unbounded">
  <xs:complexType>
    <xs:sequence>
      <xs:element name="baudRateDivisor" type="xs:string" />
      <xs:element name="parityMode" type="xs:string" />
      <xs:element name="stopBitSelect" type="xs:string" />
    </xs:sequence>
  </xs:complexType>
</xs:element>
<xs:element name="format">
  <xs:complexType>
    <xs:sequence>
      <xs:element name="units" type="xs:string" />
      <xs:element name="timeStamp" type="xs:string" />
      <xs:element name="supplyVoltage" type="xs:string" />
      <xs:element name="readingCount" type="xs:string" />
      <xs:element name="outputMode" type="xs:string" />
    </xs:sequence>
  </xs:complexType>
</xs:element>
<xs:element name="limits">
  <xs:complexType>
    <xs:sequence>
      <xs:element name="minLimit" type="xs:string" />
      <xs:element name="maxLimit" type="xs:string" />
      <xs:element name="alarmSignal" type="xs:string" />
    </xs:sequence>
  </xs:complexType>
</xs:element>
<xs:element name="leds">
  <xs:complexType>
    <xs:sequence>
      <xs:element name="connectionLed" type="xs:string" />
      <xs:element name="clockLed" type="xs:string" />
      <xs:element name="alarmSignalLed" type="xs:string" />
      <xs:element name="powerModeLed" type="xs:string" />
    </xs:sequence>
  </xs:complexType>
</xs:element>
<xs:element name="switches">
  <xs:complexType>
    <xs:sequence>
      <xs:element name="adcOffset" type="xs:string" />
      <xs:element name="dataDuplication" type="xs:string" />
      <xs:element name="disableHwReset" type="xs:string" />
      <xs:element name="clockLedRate" type="xs:string" />
      <xs:element name="dataAckTimeout" type="xs:string" />
      <xs:element name="flushDataAtPowerUp" type="xs:string" />
      <xs:element name="escapeChar" type="xs:string" />
      <xs:element name="rfCommID" type="xs:string" />
      <xs:element name="supplyScalingFactor" type="xs:string" />
```

```
            </xs:sequence>
          </xs:complexType>
        </xs:element>
      </xs:sequence>
    </xs:complexType>
  </xs:element>
</xs:schema>
```

APPENDIX C: ADC Conversion Chart

ADC Output	Voltage	Kelvin	Celsius	Fahrenheit
0	0	XXX.X	XXX.X	XXX.X
1	0.003	XXX.X	XXX.X	XXX.X
2	0.007	XXX.X	XXX.X	XXX.X
3	0.01	XXX.X	XXX.X	XXX.X
4	0.013	XXX.X	XXX.X	XXX.X
5	0.016	XXX.X	XXX.X	XXX.X
6	0.02	XXX.X	XXX.X	XXX.X
7	0.023	XXX.X	XXX.X	XXX.X
8	0.026	XXX.X	XXX.X	XXX.X
9	0.029	XXX.X	XXX.X	XXX.X
10	0.033	XXX.X	XXX.X	XXX.X
11	0.036	XXX.X	XXX.X	XXX.X
12	0.039	XXX.X	XXX.X	XXX.X
13	0.042	XXX.X	XXX.X	XXX.X
14	0.046	XXX.X	XXX.X	XXX.X
15	0.049	223.6	-49.5	-57.1
16	0.052	224.5	-48.6	-55.5
17	0.055	225.3	-47.7	-54
18	0.059	226.2	-46.9	-52.5
19	0.062	226.9	-46.1	-51.1
20	0.065	227.7	-45.4	-49.7
21	0.068	228.4	-44.7	-48.5
22	0.072	229.1	-44	-47.2
23	0.075	229.7	-43.3	-46
24	0.078	230.4	-42.7	-44.9
25	0.081	231	-42.1	-43.8
26	0.085	231.6	-41.5	-42.7
27	0.088	232.1	-40.9	-41.7
28	0.091	232.7	-40.4	-40.7
29	0.094	233.2	-39.8	-39.7
30	0.098	233.8	-39.3	-38.8
31	0.101	234.3	-38.8	-37.9
32	0.104	234.8	-38.3	-37
33	0.107	235.2	-37.8	-36.2
34	0.111	235.7	-37.4	-35.3
35	0.114	236.2	-36.9	-34.5
36	0.117	236.6	-36.5	-33.7
37	0.12	237	-36	-32.9
38	0.124	237.5	-35.6	-32.1
39	0.127	237.9	-35.2	-31.4
40	0.13	238.3	-34.8	-30.7
41	0.133	238.7	-34.4	-30
42	0.137	239.1	-34	-29.3
43	0.14	239.4	-33.6	-28.6
44	0.143	239.8	-33.2	-27.9
45	0.146	240.2	-32.9	-27.2
46	0.15	240.5	-32.5	-26.6
47	0.153	240.9	-32.2	-26
48	0.156	241.2	-31.8	-25.3

49	0.16	241.6	-31.5	-24.7
50	0.163	241.9	-31.1	-24.1
51	0.166	242.3	-30.8	-23.5
52	0.169	242.6	-30.5	-22.9
53	0.173	242.9	-30.2	-22.4
54	0.176	243.2	-29.8	-21.8
55	0.179	243.5	-29.5	-21.2
56	0.182	243.8	-29.2	-20.7
57	0.186	244.1	-28.9	-20.1
58	0.189	244.4	-28.6	-19.6
59	0.192	244.7	-28.3	-19.1
60	0.195	245	-28	-18.6
61	0.199	245.3	-27.8	-18
62	0.202	245.6	-27.5	-17.5
63	0.205	245.8	-27.2	-17
64	0.208	246.1	-26.9	-16.6
65	0.212	246.4	-26.7	-16.1
66	0.215	246.7	-26.4	-15.6
67	0.218	246.9	-26.1	-15.1
68	0.221	247.2	-25.9	-14.6
69	0.225	247.4	-25.6	-14.2
70	0.228	247.7	-25.4	-13.7
71	0.231	247.9	-25.1	-13.3
72	0.234	248.2	-24.9	-12.8
73	0.238	248.4	-24.6	-12.4
74	0.241	248.7	-24.4	-11.9
75	0.244	248.9	-24.1	-11.5
76	0.247	249.2	-23.9	-11.1
77	0.251	249.4	-23.7	-10.7
78	0.254	249.6	-23.4	-10.2
79	0.257	249.9	-23.2	-9.8
80	0.26	250.1	-23	-9.4
81	0.264	250.3	-22.7	-9
82	0.267	250.5	-22.5	-8.6
83	0.27	250.8	-22.3	-8.2
84	0.273	251	-22.1	-7.8
85	0.277	251.2	-21.9	-7.4
86	0.28	251.4	-21.6	-7
87	0.283	251.6	-21.4	-6.7
88	0.286	251.8	-21.2	-6.3
89	0.29	252	-21	-5.9
90	0.293	252.2	-20.8	-5.5
91	0.296	252.5	-20.6	-5.2
92	0.299	252.7	-20.4	-4.8
93	0.303	252.9	-20.2	-4.4
94	0.306	253.1	-20	-4.1
95	0.309	253.3	-19.8	-3.7
96	0.312	253.5	-19.6	-3.3
97	0.316	253.7	-19.4	-3
98	0.319	253.8	-19.2	-2.6
99	0.322	254	-19	-2.3
100	0.326	254.2	-18.8	-1.9

101	0.329	254.4	-18.6	-1.6
102	0.332	254.6	-18.4	-1.3
103	0.335	254.8	-18.3	-0.9
104	0.339	255	-18.1	-0.6
105	0.342	255.2	-17.9	-0.3
106	0.345	255.4	-17.7	0
107	0.348	255.5	-17.5	0.3
108	0.352	255.7	-17.3	0.6
109	0.355	255.9	-17.2	0.9
110	0.358	256.1	-17	1.3
111	0.361	256.2	-16.8	1.6
112	0.365	256.4	-16.6	1.9
113	0.368	256.6	-16.5	2.2
114	0.371	256.8	-16.3	2.5
115	0.374	256.9	-16.1	2.8
116	0.378	257.1	-15.9	3.1
117	0.381	257.3	-15.8	3.4
118	0.384	257.5	-15.6	3.7
119	0.387	257.6	-15.4	4
120	0.391	257.8	-15.3	4.3
121	0.394	258	-15.1	4.6
122	0.397	258.1	-14.9	4.9
123	0.4	258.3	-14.8	5.2
124	0.404	258.4	-14.6	5.5
125	0.407	258.6	-14.4	5.8
126	0.41	258.8	-14.3	6.1
127	0.413	258.9	-14.1	6.4
128	0.417	259.1	-14	6.7
129	0.42	259.2	-13.8	7
130	0.423	259.4	-13.6	7.3
131	0.426	259.6	-13.5	7.5
132	0.43	259.7	-13.3	7.8
133	0.433	259.9	-13.2	8.1
134	0.436	260	-13	8.4
135	0.439	260.2	-12.9	8.6
136	0.443	260.3	-12.7	8.9
137	0.446	260.5	-12.6	9.2
138	0.449	260.6	-12.4	9.5
139	0.452	260.8	-12.3	9.7
140	0.456	260.9	-12.1	10
141	0.459	261.1	-12	10.3
142	0.462	261.2	-11.8	10.5
143	0.465	261.4	-11.7	10.8
144	0.469	261.5	-11.5	11.1
145	0.472	261.7	-11.4	11.3
146	0.475	261.8	-11.2	11.6
147	0.479	262	-11.1	11.8
148	0.482	262.1	-11	12.1
149	0.485	262.2	-10.8	12.4
150	0.488	262.4	-10.7	12.6
151	0.492	262.5	-10.5	12.9
152	0.495	262.7	-10.4	13.1

153	0.498	262.8	-10.2	13.4
154	0.501	262.9	-10.1	13.6
155	0.505	263.1	-10	13.9
156	0.508	263.2	-9.8	14.1
157	0.511	263.4	-9.7	14.4
158	0.514	263.5	-9.6	14.6
159	0.518	263.6	-9.4	14.9
160	0.521	263.8	-9.3	15.1
161	0.524	263.9	-9.1	15.4
162	0.527	264	-9	15.6
163	0.531	264.2	-8.9	15.8
164	0.534	264.3	-8.7	16.1
165	0.537	264.4	-8.6	16.3
166	0.54	264.6	-8.5	16.6
167	0.544	264.7	-8.3	16.8
168	0.547	264.8	-8.2	17
169	0.55	265	-8.1	17.3
170	0.553	265.1	-8	17.5
171	0.557	265.2	-7.8	17.7
172	0.56	265.4	-7.7	18
173	0.563	265.5	-7.6	18.2
174	0.566	265.6	-7.4	18.4
175	0.57	265.7	-7.3	18.7
176	0.573	265.9	-7.2	18.9
177	0.576	266	-7.1	19.1
178	0.579	266.1	-6.9	19.3
179	0.583	266.2	-6.8	19.6
180	0.586	266.4	-6.7	19.8
181	0.589	266.5	-6.6	20
182	0.592	266.6	-6.4	20.2
183	0.596	266.7	-6.3	20.5
184	0.599	266.9	-6.2	20.7
185	0.602	267	-6.1	20.9
186	0.605	267.1	-5.9	21.1
187	0.609	267.2	-5.8	21.4
188	0.612	267.4	-5.7	21.6
189	0.615	267.5	-5.6	21.8
190	0.618	267.6	-5.4	22
191	0.622	267.7	-5.3	22.2
192	0.625	267.8	-5.2	22.4
193	0.628	268	-5.1	22.7
194	0.631	268.1	-5	22.9
195	0.635	268.2	-4.8	23.1
196	0.638	268.3	-4.7	23.3
197	0.641	268.4	-4.6	23.5
198	0.645	268.6	-4.5	23.7
199	0.648	268.7	-4.4	23.9
200	0.651	268.8	-4.3	24.2
201	0.654	268.9	-4.1	24.4
202	0.658	269	-4	24.6
203	0.661	269.1	-3.9	24.8
204	0.664	269.3	-3.8	25

205	0.667	269.4	-3.7	25.2
206	0.671	269.5	-3.6	25.4
207	0.674	269.6	-3.4	25.6
208	0.677	269.7	-3.3	25.8
209	0.68	269.8	-3.2	26
210	0.684	270	-3.1	26.2
211	0.687	270.1	-3	26.4
212	0.69	270.2	-2.9	26.7
213	0.693	270.3	-2.8	26.9
214	0.697	270.4	-2.6	27.1
215	0.7	270.5	-2.5	27.3
216	0.703	270.6	-2.4	27.5
217	0.706	270.7	-2.3	27.7
218	0.71	270.9	-2.2	27.9
219	0.713	271	-2.1	28.1
220	0.716	271.1	-2	28.3
221	0.719	271.2	-1.9	28.5
222	0.723	271.3	-1.8	28.7
223	0.726	271.4	-1.6	28.9
224	0.729	271.5	-1.5	29.1
225	0.732	271.6	-1.4	29.3
226	0.736	271.7	-1.3	29.5
227	0.739	271.8	-1.2	29.6
228	0.742	272	-1.1	29.8
229	0.745	272.1	-1	30
230	0.749	272.2	-0.9	30.2
231	0.752	272.3	-0.8	30.4
232	0.755	272.4	-0.7	30.6
233	0.758	272.5	-0.6	30.8
234	0.762	272.6	-0.5	31
235	0.765	272.7	-0.3	31.2
236	0.768	272.8	-0.2	31.4
237	0.771	272.9	-0.1	31.6
238	0.775	273	0	31.8
239	0.778	273.1	0	32
240	0.781	273.2	0.1	32.2
241	0.784	273.3	0.2	32.3
242	0.788	273.4	0.3	32.5
243	0.791	273.6	0.4	32.7
244	0.794	273.7	0.5	32.9
245	0.798	273.8	0.6	33.1
246	0.801	273.9	0.7	33.3
247	0.804	274	0.8	33.5
248	0.807	274.1	0.9	33.7
249	0.811	274.2	1	33.9
250	0.814	274.3	1.1	34
251	0.817	274.4	1.2	34.2
252	0.82	274.5	1.3	34.4
253	0.824	274.6	1.4	34.6
254	0.827	274.7	1.6	34.8
255	0.83	274.8	1.7	35
256	0.833	274.9	1.8	35.2

257	0.837	275	1.9	35.3
258	0.84	275.1	2	35.5
259	0.843	275.2	2.1	35.7
260	0.846	275.3	2.2	35.9
261	0.85	275.4	2.3	36.1
262	0.853	275.5	2.4	36.3
263	0.856	275.6	2.5	36.4
264	0.859	275.7	2.6	36.6
265	0.863	275.8	2.7	36.8
266	0.866	275.9	2.8	37
267	0.869	276	2.9	37.2
268	0.872	276.1	3	37.4
269	0.876	276.2	3.1	37.5
270	0.879	276.3	3.2	37.7
271	0.882	276.4	3.3	37.9
272	0.885	276.5	3.4	38.1
273	0.889	276.6	3.5	38.3
274	0.892	276.7	3.6	38.4
275	0.895	276.8	3.7	38.6
276	0.898	276.9	3.8	38.8
277	0.902	277	3.9	39
278	0.905	277.1	4	39.1
279	0.908	277.2	4.1	39.3
280	0.911	277.3	4.2	39.5
281	0.915	277.4	4.3	39.7
282	0.918	277.5	4.4	39.9
283	0.921	277.6	4.5	40
284	0.924	277.7	4.6	40.2
285	0.928	277.8	4.7	40.4
286	0.931	277.9	4.8	40.6
287	0.934	278	4.9	40.7
288	0.937	278.1	4.9	40.9
289	0.941	278.2	5	41.1
290	0.944	278.3	5.1	41.3
291	0.947	278.4	5.2	41.4
292	0.95	278.5	5.3	41.6
293	0.954	278.6	5.4	41.8
294	0.957	278.7	5.5	42
295	0.96	278.8	5.6	42.1
296	0.964	278.9	5.7	42.3
297	0.967	279	5.8	42.5
298	0.97	279.1	5.9	42.6
299	0.973	279.2	6	42.8
300	0.977	279.3	6.1	43
301	0.98	279.4	6.2	43.2
302	0.983	279.4	6.3	43.3
303	0.986	279.5	6.4	43.5
304	0.99	279.6	6.5	43.7
305	0.993	279.7	6.6	43.8
306	0.996	279.8	6.7	44
307	0.999	279.9	6.8	44.2
308	1.003	280	6.9	44.4

309	1.006	280.1	7	44.5
310	1.009	280.2	7.1	44.7
311	1.012	280.3	7.1	44.9
312	1.016	280.4	7.2	45
313	1.019	280.5	7.3	45.2
314	1.022	280.6	7.4	45.4
315	1.025	280.7	7.5	45.5
316	1.029	280.8	7.6	45.7
317	1.032	280.9	7.7	45.9
318	1.035	281	7.8	46
319	1.038	281	7.9	46.2
320	1.042	281.1	8	46.4
321	1.045	281.2	8.1	46.6
322	1.048	281.3	8.2	46.7
323	1.051	281.4	8.3	46.9
324	1.055	281.5	8.4	47.1
325	1.058	281.6	8.5	47.2
326	1.061	281.7	8.5	47.4
327	1.064	281.8	8.6	47.6
328	1.068	281.9	8.7	47.7
329	1.071	282	8.8	47.9
330	1.074	282.1	8.9	48.1
331	1.077	282.2	9	48.2
332	1.081	282.3	9.1	48.4
333	1.084	282.3	9.2	48.6
334	1.087	282.4	9.3	48.7
335	1.09	282.5	9.4	48.9
336	1.094	282.6	9.5	49
337	1.097	282.7	9.6	49.2
338	1.1	282.8	9.7	49.4
339	1.103	282.9	9.7	49.5
340	1.107	283	9.8	49.7
341	1.11	283.1	9.9	49.9
342	1.113	283.2	10	50
343	1.117	283.3	10.1	50.2
344	1.12	283.4	10.2	50.4
345	1.123	283.4	10.3	50.5
346	1.126	283.5	10.4	50.7
347	1.13	283.6	10.5	50.9
348	1.133	283.7	10.6	51
349	1.136	283.8	10.7	51.2
350	1.139	283.9	10.7	51.3
351	1.143	284	10.8	51.5
352	1.146	284.1	10.9	51.7
353	1.149	284.2	11	51.8
354	1.152	284.3	11.1	52
355	1.156	284.3	11.2	52.2
356	1.159	284.4	11.3	52.3
357	1.162	284.5	11.4	52.5
358	1.165	284.6	11.5	52.6
359	1.169	284.7	11.6	52.8
360	1.172	284.8	11.7	53

361	1.175	284.9	11.7	53.1
362	1.178	285	11.8	53.3
363	1.182	285.1	11.9	53.5
364	1.185	285.2	12	53.6
365	1.188	285.2	12.1	53.8
366	1.191	285.3	12.2	53.9
367	1.195	285.4	12.3	54.1
368	1.198	285.5	12.4	54.3
369	1.201	285.6	12.5	54.4
370	1.204	285.7	12.5	54.6
371	1.208	285.8	12.6	54.7
372	1.211	285.9	12.7	54.9
373	1.214	286	12.8	55.1
374	1.217	286.1	12.9	55.2
375	1.221	286.1	13	55.4
376	1.224	286.2	13.1	55.5
377	1.227	286.3	13.2	55.7
378	1.23	286.4	13.3	55.9
379	1.234	286.5	13.3	56
380	1.237	286.6	13.4	56.2
381	1.24	286.7	13.5	56.3
382	1.243	286.8	13.6	56.5
383	1.247	286.9	13.7	56.7
384	1.25	286.9	13.8	56.8
385	1.253	287	13.9	57
386	1.256	287.1	14	57.1
387	1.26	287.2	14.1	57.3
388	1.263	287.3	14.1	57.5
389	1.266	287.4	14.2	57.6
390	1.27	287.5	14.3	57.8
391	1.273	287.6	14.4	57.9
392	1.276	287.7	14.5	58.1
393	1.279	287.7	14.6	58.3
394	1.283	287.8	14.7	58.4
395	1.286	287.9	14.8	58.6
396	1.289	288	14.9	58.7
397	1.292	288.1	14.9	58.9
398	1.296	288.2	15	59.1
399	1.299	288.3	15.1	59.2
400	1.302	288.4	15.2	59.4
401	1.305	288.4	15.3	59.5
402	1.309	288.5	15.4	59.7
403	1.312	288.6	15.5	59.8
404	1.315	288.7	15.6	60
405	1.318	288.8	15.6	60.2
406	1.322	288.9	15.7	60.3
407	1.325	289	15.8	60.5
408	1.328	289.1	15.9	60.6
409	1.331	289.1	16	60.8
410	1.335	289.2	16.1	61
411	1.338	289.3	16.2	61.1
412	1.341	289.4	16.3	61.3

413	1.344	289.5	16.3	61.4
414	1.348	289.6	16.4	61.6
415	1.351	289.7	16.5	61.7
416	1.354	289.8	16.6	61.9
417	1.357	289.8	16.7	62.1
418	1.361	289.9	16.8	62.2
419	1.364	290	16.9	62.4
420	1.367	290.1	17	62.5
421	1.37	290.2	17	62.7
422	1.374	290.3	17.1	62.8
423	1.377	290.4	17.2	63
424	1.38	290.5	17.3	63.2
425	1.383	290.6	17.4	63.3
426	1.387	290.6	17.5	63.5
427	1.39	290.7	17.6	63.6
428	1.393	290.8	17.7	63.8
429	1.396	290.9	17.8	64
430	1.4	291	17.8	64.1
431	1.403	291.1	17.9	64.3
432	1.406	291.2	18	64.4
433	1.409	291.3	18.1	64.6
434	1.413	291.3	18.2	64.7
435	1.416	291.4	18.3	64.9
436	1.419	291.5	18.4	65.1
437	1.422	291.6	18.4	65.2
438	1.426	291.7	18.5	65.4
439	1.429	291.8	18.6	65.5
440	1.432	291.9	18.7	65.7
441	1.436	291.9	18.8	65.8
442	1.439	292	18.9	66
443	1.442	292.1	19	66.2
444	1.445	292.2	19.1	66.3
445	1.449	292.3	19.1	66.5
446	1.452	292.4	19.2	66.6
447	1.455	292.5	19.3	66.8
448	1.458	292.6	19.4	66.9
449	1.462	292.6	19.5	67.1
450	1.465	292.7	19.6	67.3
451	1.468	292.8	19.7	67.4
452	1.471	292.9	19.8	67.6
453	1.475	293	19.8	67.7
454	1.478	293.1	19.9	67.9
455	1.481	293.2	20	68
456	1.484	293.3	20.1	68.2
457	1.488	293.3	20.2	68.4
458	1.491	293.4	20.3	68.5
459	1.494	293.5	20.4	68.7
460	1.497	293.6	20.5	68.8
461	1.501	293.7	20.5	69
462	1.504	293.8	20.6	69.1
463	1.507	293.9	20.7	69.3
464	1.51	294	20.8	69.5

465	1.514	294	20.9	69.6
466	1.517	294.1	21	69.8
467	1.52	294.2	21.1	69.9
468	1.523	294.3	21.2	70.1
469	1.527	294.4	21.2	70.2
470	1.53	294.5	21.3	70.4
471	1.533	294.6	21.4	70.6
472	1.536	294.7	21.5	70.7
473	1.54	294.8	21.6	70.9
474	1.543	294.8	21.7	71
475	1.546	294.9	21.8	71.2
476	1.549	295	21.9	71.4
477	1.553	295.1	22	71.5
478	1.556	295.2	22	71.7
479	1.559	295.3	22.1	71.8
480	1.562	295.4	22.2	72
481	1.566	295.5	22.3	72.1
482	1.569	295.5	22.4	72.3
483	1.572	295.6	22.5	72.5
484	1.575	295.7	22.6	72.6
485	1.579	295.8	22.7	72.8
486	1.582	295.9	22.7	72.9
487	1.585	296	22.8	73.1
488	1.589	296.1	22.9	73.3
489	1.592	296.2	23	73.4
490	1.595	296.2	23.1	73.6
491	1.598	296.3	23.2	73.7
492	1.602	296.4	23.3	73.9
493	1.605	296.5	23.4	74
494	1.608	296.6	23.4	74.2
495	1.611	296.7	23.5	74.4
496	1.615	296.8	23.6	74.5
497	1.618	296.9	23.7	74.7
498	1.621	297	23.8	74.8
499	1.624	297	23.9	75
500	1.628	297.1	24	75.2
501	1.631	297.2	24.1	75.3
502	1.634	297.3	24.2	75.5
503	1.637	297.4	24.2	75.6
504	1.641	297.5	24.3	75.8
505	1.644	297.6	24.4	76
506	1.647	297.7	24.5	76.1
507	1.65	297.7	24.6	76.3
508	1.654	297.8	24.7	76.4
509	1.657	297.9	24.8	76.6
510	1.66	298	24.9	76.8
511	1.663	298.1	25	76.9
512	1.667	298.2	25	77.1
513	1.67	298.3	25.1	77.2
514	1.673	298.4	25.2	77.4
515	1.676	298.5	25.3	77.6
516	1.68	298.6	25.4	77.7

517	1.683	298.6	25.5	77.9
518	1.686	298.7	25.6	78
519	1.689	298.8	25.7	78.2
520	1.693	298.9	25.8	78.4
521	1.696	299	25.8	78.5
522	1.699	299.1	25.9	78.7
523	1.702	299.2	26	78.8
524	1.706	299.3	26.1	79
525	1.709	299.4	26.2	79.2
526	1.712	299.4	26.3	79.3
527	1.715	299.5	26.4	79.5
528	1.719	299.6	26.5	79.7
529	1.722	299.7	26.6	79.8
530	1.725	299.8	26.7	80
531	1.728	299.9	26.7	80.1
532	1.732	300	26.8	80.3
533	1.735	300.1	26.9	80.5
534	1.738	300.2	27	80.6
535	1.741	300.3	27.1	80.8
536	1.745	300.3	27.2	81
537	1.748	300.4	27.3	81.1
538	1.751	300.5	27.4	81.3
539	1.755	300.6	27.5	81.4
540	1.758	300.7	27.6	81.6
541	1.761	300.8	27.7	81.8
542	1.764	300.9	27.7	81.9
543	1.768	301	27.8	82.1
544	1.771	301.1	27.9	82.3
545	1.774	301.2	28	82.4
546	1.777	301.3	28.1	82.6
547	1.781	301.3	28.2	82.8
548	1.784	301.4	28.3	82.9
549	1.787	301.5	28.4	83.1
550	1.79	301.6	28.5	83.2
551	1.794	301.7	28.6	83.4
552	1.797	301.8	28.7	83.6
553	1.8	301.9	28.7	83.7
554	1.803	302	28.8	83.9
555	1.807	302.1	28.9	84.1
556	1.81	302.2	29	84.2
557	1.813	302.3	29.1	84.4
558	1.816	302.4	29.2	84.6
559	1.82	302.4	29.3	84.7
560	1.823	302.5	29.4	84.9
561	1.826	302.6	29.5	85.1
562	1.829	302.7	29.6	85.2
563	1.833	302.8	29.7	85.4
564	1.836	302.9	29.8	85.6
565	1.839	303	29.9	85.7
566	1.842	303.1	29.9	85.9
567	1.846	303.2	30	86.1
568	1.849	303.3	30.1	86.2

569	1.852	303.4	30.2	86.4
570	1.855	303.5	30.3	86.6
571	1.859	303.6	30.4	86.7
572	1.862	303.7	30.5	86.9
573	1.865	303.7	30.6	87.1
574	1.868	303.8	30.7	87.2
575	1.872	303.9	30.8	87.4
576	1.875	304	30.9	87.6
577	1.878	304.1	31	87.7
578	1.881	304.2	31.1	87.9
579	1.885	304.3	31.2	88.1
580	1.888	304.4	31.3	88.3
581	1.891	304.5	31.3	88.4
582	1.894	304.6	31.4	88.6
583	1.898	304.7	31.5	88.8
584	1.901	304.8	31.6	88.9
585	1.904	304.9	31.7	89.1
586	1.908	305	31.8	89.3
587	1.911	305.1	31.9	89.4
588	1.914	305.2	32	89.6
589	1.917	305.3	32.1	89.8
590	1.921	305.3	32.2	90
591	1.924	305.4	32.3	90.1
592	1.927	305.5	32.4	90.3
593	1.93	305.6	32.5	90.5
594	1.934	305.7	32.6	90.6
595	1.937	305.8	32.7	90.8
596	1.94	305.9	32.8	91
597	1.943	306	32.9	91.2
598	1.947	306.1	33	91.3
599	1.95	306.2	33.1	91.5
600	1.953	306.3	33.2	91.7
601	1.956	306.4	33.2	91.9
602	1.96	306.5	33.3	92
603	1.963	306.6	33.4	92.2
604	1.966	306.7	33.5	92.4
605	1.969	306.8	33.6	92.5
606	1.973	306.9	33.7	92.7
607	1.976	307	33.8	92.9
608	1.979	307.1	33.9	93.1
609	1.982	307.2	34	93.2
610	1.986	307.3	34.1	93.4
611	1.989	307.4	34.2	93.6
612	1.992	307.5	34.3	93.8
613	1.995	307.6	34.4	93.9
614	1.999	307.7	34.5	94.1
615	2.002	307.8	34.6	94.3
616	2.005	307.9	34.7	94.5
617	2.008	308	34.8	94.7
618	2.012	308.1	34.9	94.8
619	2.015	308.2	35	95
620	2.018	308.3	35.1	95.2

621	2.021	308.4	35.2	95.4
622	2.025	308.5	35.3	95.5
623	2.028	308.6	35.4	95.7
624	2.031	308.7	35.5	95.9
625	2.034	308.8	35.6	96.1
626	2.038	308.9	35.7	96.3
627	2.041	309	35.8	96.4
628	2.044	309.1	35.9	96.6
629	2.047	309.2	36	96.8
630	2.051	309.3	36.1	97
631	2.054	309.4	36.2	97.2
632	2.057	309.5	36.3	97.3
633	2.06	309.6	36.4	97.5
634	2.064	309.7	36.5	97.7
635	2.067	309.8	36.6	97.9
636	2.07	309.9	36.7	98.1
637	2.074	310	36.8	98.3
638	2.077	310.1	36.9	98.4
639	2.08	310.2	37	98.6
640	2.083	310.3	37.1	98.8
641	2.087	310.4	37.2	99
642	2.09	310.5	37.3	99.2
643	2.093	310.6	37.4	99.4
644	2.096	310.7	37.5	99.5
645	2.1	310.8	37.6	99.7
646	2.103	310.9	37.7	99.9
647	2.106	311	37.8	100.1
648	2.109	311.1	37.9	100.3
649	2.113	311.2	38	100.5
650	2.116	311.3	38.1	100.7
651	2.119	311.4	38.2	100.8
652	2.122	311.5	38.4	101
653	2.126	311.6	38.5	101.2
654	2.129	311.7	38.6	101.4
655	2.132	311.8	38.7	101.6
656	2.135	311.9	38.8	101.8
657	2.139	312	38.9	102
658	2.142	312.1	39	102.2
659	2.145	312.2	39.1	102.4
660	2.148	312.3	39.2	102.5
661	2.152	312.4	39.3	102.7
662	2.155	312.6	39.4	102.9
663	2.158	312.7	39.5	103.1
664	2.161	312.8	39.6	103.3
665	2.165	312.9	39.7	103.5
666	2.168	313	39.8	103.7
667	2.171	313.1	39.9	103.9
668	2.174	313.2	40	104.1
669	2.178	313.3	40.1	104.3
670	2.181	313.4	40.3	104.5
671	2.184	313.5	40.4	104.7
672	2.187	313.6	40.5	104.8

673	2.191	313.7	40.6	105
674	2.194	313.8	40.7	105.2
675	2.197	313.9	40.8	105.4
676	2.2	314.1	40.9	105.6
677	2.204	314.2	41	105.8
678	2.207	314.3	41.1	106
679	2.21	314.4	41.2	106.2
680	2.213	314.5	41.3	106.4
681	2.217	314.6	41.5	106.6
682	2.22	314.7	41.6	106.8
683	2.223	314.8	41.7	107
684	2.227	314.9	41.8	107.2
685	2.23	315	41.9	107.4
686	2.233	315.2	42	107.6
687	2.236	315.3	42.1	107.8
688	2.24	315.4	42.2	108
689	2.243	315.5	42.3	108.2
690	2.246	315.6	42.5	108.4
691	2.249	315.7	42.6	108.6
692	2.253	315.8	42.7	108.8
693	2.256	315.9	42.8	109
694	2.259	316.1	42.9	109.2
695	2.262	316.2	43	109.4
696	2.266	316.3	43.1	109.6
697	2.269	316.4	43.2	109.8
698	2.272	316.5	43.4	110
699	2.275	316.6	43.5	110.2
700	2.279	316.7	43.6	110.5
701	2.282	316.9	43.7	110.7
702	2.285	317	43.8	110.9
703	2.288	317.1	43.9	111.1
704	2.292	317.2	44	111.3
705	2.295	317.3	44.2	111.5
706	2.298	317.4	44.3	111.7
707	2.301	317.5	44.4	111.9
708	2.305	317.7	44.5	112.1
709	2.308	317.8	44.6	112.3
710	2.311	317.9	44.7	112.5
711	2.314	318	44.9	112.8
712	2.318	318.1	45	113
713	2.321	318.3	45.1	113.2
714	2.324	318.4	45.2	113.4
715	2.327	318.5	45.3	113.6
716	2.331	318.6	45.5	113.8
717	2.334	318.7	45.6	114
718	2.337	318.8	45.7	114.3
719	2.34	319	45.8	114.5
720	2.344	319.1	45.9	114.7
721	2.347	319.2	46.1	114.9
722	2.35	319.3	46.2	115.1
723	2.353	319.4	46.3	115.3
724	2.357	319.6	46.4	115.6

725	2.36	319.7	46.5	115.8
726	2.363	319.8	46.7	116
727	2.366	319.9	46.8	116.2
728	2.37	320.1	46.9	116.4
729	2.373	320.2	47	116.7
730	2.376	320.3	47.2	116.9
731	2.38	320.4	47.3	117.1
732	2.383	320.6	47.4	117.3
733	2.386	320.7	47.5	117.6
734	2.389	320.8	47.7	117.8
735	2.393	320.9	47.8	118
736	2.396	321.1	47.9	118.2
737	2.399	321.2	48	118.5
738	2.402	321.3	48.2	118.7
739	2.406	321.4	48.3	118.9
740	2.409	321.6	48.4	119.1
741	2.412	321.7	48.5	119.4
742	2.415	321.8	48.7	119.6
743	2.419	321.9	48.8	119.8
744	2.422	322.1	48.9	120.1
745	2.425	322.2	49.1	120.3
746	2.428	322.3	49.2	120.5
747	2.432	322.5	49.3	120.8
748	2.435	322.6	49.4	121
749	2.438	322.7	49.6	121.2
750	2.441	322.9	49.7	121.5
751	2.445	323	49.8	121.7
752	2.448	323.1	50	121.9
753	2.451	323.2	50.1	122.2
754	2.454	323.4	50.2	122.4
755	2.458	323.5	50.4	122.7
756	2.461	323.6	50.5	122.9
757	2.464	323.8	50.6	123.1
758	2.467	323.9	50.8	123.4
759	2.471	324	50.9	123.6
760	2.474	324.2	51	123.9
761	2.477	324.3	51.2	124.1
762	2.48	324.5	51.3	124.3
763	2.484	324.6	51.4	124.6
764	2.487	324.7	51.6	124.8
765	2.49	324.9	51.7	125.1
766	2.493	325	51.9	125.3
767	2.497	325.1	52	125.6
768	2.5	325.3	52.1	125.8
769	2.503	325.4	52.3	126.1
770	2.506	325.6	52.4	126.3
771	2.51	325.7	52.5	126.6
772	2.513	325.8	52.7	126.8
773	2.516	326	52.8	127.1
774	2.519	326.1	53	127.4
775	2.523	326.3	53.1	127.6
776	2.526	326.4	53.3	127.9

777	2.529	326.6	53.4	128.1
778	2.532	326.7	53.5	128.4
779	2.536	326.8	53.7	128.6
780	2.539	327	53.8	128.9
781	2.542	327.1	54	129.2
782	2.546	327.3	54.1	129.4
783	2.549	327.4	54.3	129.7
784	2.552	327.6	54.4	130
785	2.555	327.7	54.6	130.2
786	2.559	327.9	54.7	130.5
787	2.562	328	54.9	130.8
788	2.565	328.2	55	131
789	2.568	328.3	55.2	131.3
790	2.572	328.5	55.3	131.6
791	2.575	328.6	55.5	131.8
792	2.578	328.8	55.6	132.1
793	2.581	328.9	55.8	132.4
794	2.585	329.1	55.9	132.7
795	2.588	329.2	56.1	132.9
796	2.591	329.4	56.2	133.2
797	2.594	329.5	56.4	133.5
798	2.598	329.7	56.5	133.8
799	2.601	329.8	56.7	134
800	2.604	330	56.8	134.3
801	2.607	330.2	57	134.6
802	2.611	330.3	57.2	134.9
803	2.614	330.5	57.3	135.2
804	2.617	330.6	57.5	135.5
805	2.62	330.8	57.6	135.7
806	2.624	330.9	57.8	136
807	2.627	331.1	58	136.3
808	2.63	331.3	58.1	136.6
809	2.633	331.4	58.3	136.9
810	2.637	331.6	58.4	137.2
811	2.64	331.8	58.6	137.5
812	2.643	331.9	58.8	137.8
813	2.646	332.1	58.9	138.1
814	2.65	332.3	59.1	138.4
815	2.653	332.4	59.3	138.7
816	2.656	332.6	59.4	139
817	2.659	332.8	59.6	139.3
818	2.663	332.9	59.8	139.6
819	2.666	333.1	59.9	139.9
820	2.669	333.3	60.1	140.2
821	2.672	333.4	60.3	140.5
822	2.676	333.6	60.5	140.8
823	2.679	333.8	60.6	141.1
824	2.682	334	60.8	141.5
825	2.685	334.1	61	141.8
826	2.689	334.3	61.2	142.1
827	2.692	334.5	61.3	142.4
828	2.695	334.7	61.5	142.7

829	2.699	334.8	61.7	143
830	2.702	335	61.9	143.4
831	2.705	335.2	62.1	143.7
832	2.708	335.4	62.2	144
833	2.712	335.6	62.4	144.3
834	2.715	335.7	62.6	144.7
835	2.718	335.9	62.8	145
836	2.721	336.1	63	145.3
837	2.725	336.3	63.2	145.7
838	2.728	336.5	63.3	146
839	2.731	336.7	63.5	146.3
840	2.734	336.9	63.7	146.7
841	2.738	337.1	63.9	147
842	2.741	337.2	64.1	147.4
843	2.744	337.4	64.3	147.7
844	2.747	337.6	64.5	148.1
845	2.751	337.8	64.7	148.4
846	2.754	338	64.9	148.8
847	2.757	338.2	65.1	149.1
848	2.76	338.4	65.3	149.5
849	2.764	338.6	65.5	149.8
850	2.767	338.8	65.7	150.2
851	2.77	339	65.9	150.5
852	2.773	339.2	66.1	150.9
853	2.777	339.4	66.3	151.3
854	2.78	339.6	66.5	151.6
855	2.783	339.8	66.7	152
856	2.786	340	66.9	152.4
857	2.79	340.2	67.1	152.7
858	2.793	340.4	67.3	153.1
859	2.796	340.7	67.5	153.5
860	2.799	340.9	67.7	153.9
861	2.803	341.1	67.9	154.3
862	2.806	341.3	68.1	154.6
863	2.809	341.5	68.4	155
864	2.812	341.7	68.6	155.4
865	2.816	341.9	68.8	155.8
866	2.819	342.2	69	156.2
867	2.822	342.4	69.2	156.6
868	2.825	342.6	69.4	157
869	2.829	342.8	69.7	157.4
870	2.832	343	69.9	157.8
871	2.835	343.3	70.1	158.2
872	2.838	343.5	70.4	158.6
873	2.842	343.7	70.6	159
874	2.845	344	70.8	159.5
875	2.848	344.2	71	159.9
876	2.851	344.4	71.3	160.3
877	2.855	344.7	71.5	160.7
878	2.858	344.9	71.8	161.2
879	2.861	345.1	72	161.6
880	2.865	345.4	72.2	162

881	2.868	345.6	72.5	162.5
882	2.871	345.9	72.7	162.9
883	2.874	346.1	73	163.3
884	2.878	346.4	73.2	163.8
885	2.881	346.6	73.5	164.2
886	2.884	346.9	73.7	164.7
887	2.887	347.1	74	165.1
888	2.891	347.4	74.2	165.6
889	2.894	347.6	74.5	166.1
890	2.897	347.9	74.7	166.5
891	2.9	348.2	75	167
892	2.904	348.4	75.3	167.5
893	2.907	348.7	75.5	168
894	2.91	349	75.8	168.4
895	2.913	349.2	76.1	168.9
896	2.917	349.5	76.3	169.4
897	2.92	349.8	76.6	169.9
898	2.923	350	76.9	170.4
899	2.926	350.3	77.2	170.9
900	2.93	350.6	77.5	171.4
901	2.933	350.9	77.7	171.9
902	2.936	351.2	78	172.4
903	2.939	351.5	78.3	173
904	2.943	351.8	78.6	173.5
905	2.946	352	78.9	174
906	2.949	352.3	79.2	174.6
907	2.952	352.6	79.5	175.1
908	2.956	352.9	79.8	175.6
909	2.959	353.3	80.1	176.2
910	2.962	353.6	80.4	176.7
911	2.965	353.9	80.7	177.3
912	2.969	354.2	81	177.9
913	2.972	354.5	81.4	178.4
914	2.975	354.8	81.7	179
915	2.978	355.1	82	179.6
916	2.982	355.5	82.3	180.2
917	2.985	355.8	82.6	180.8
918	2.988	356.1	83	181.4
919	2.991	356.5	83.3	182
920	2.995	356.8	83.7	182.6
921	2.998	357.1	84	183.2
922	3.001	357.5	84.3	183.8
923	3.004	357.8	84.7	184.5
924	3.008	358.2	85	185.1
925	3.011	358.6	85.4	185.7
926	3.014	358.9	85.8	186.4
927	3.018	359.3	86.1	187
928	3.021	359.7	86.5	187.7
929	3.024	360	86.9	188.4
930	3.027	360.4	87.3	189.1
931	3.031	360.8	87.6	189.8
932	3.034	361.2	88	190.5

933	3.037	361.6	88.4	191.2
934	3.04	362	88.8	191.9
935	3.044	362.4	89.2	192.6
936	3.047	362.8	89.6	193.3
937	3.05	363.2	90	194.1
938	3.053	363.6	90.5	194.8
939	3.057	364	90.9	195.6
940	3.06	364.5	91.3	196.4
941	3.063	364.9	91.7	197.1
942	3.066	365.3	92.2	197.9
943	3.07	365.8	92.6	198.7
944	3.073	366.2	93.1	199.5
945	3.076	366.7	93.5	200.4
946	3.079	367.1	94	201.2
947	3.083	367.6	94.5	202
948	3.086	368.1	94.9	202.9
949	3.089	368.6	95.4	203.8
950	3.092	369.1	95.9	204.7
951	3.096	369.6	96.4	205.6
952	3.099	370.1	96.9	206.5
953	3.102	370.6	97.5	207.4
954	3.105	371.1	98	208.4
955	3.109	371.7	98.5	209.3
956	3.112	372.2	99	210.3
957	3.115	372.7	99.6	211.3
958	3.118	373.3	100.2	212.3
959	3.122	373.9	100.7	213.3
960	3.125	374.5	101.3	214.4
961	3.128	375.1	101.9	215.4
962	3.131	375.7	102.5	216.5
963	3.135	376.3	103.1	217.6
964	3.138	376.9	103.7	218.7
965	3.141	377.5	104.4	219.9
966	3.144	378.2	105	221.1
967	3.148	378.8	105.7	222.2
968	3.151	379.5	106.4	223.5
969	3.154	380.2	107.1	224.7
970	3.157	380.9	107.8	226
971	3.161	381.6	108.5	227.3
972	3.164	382.4	109.2	228.6
973	3.167	383.1	110	229.9
974	3.17	383.9	110.7	231.3
975	3.174	384.7	111.5	232.7
976	3.177	385.5	112.3	234.2
977	3.18	386.3	113.2	235.7
978	3.184	387.2	114	237.2
979	3.187	388	114.9	238.8
980	3.19	388.9	115.8	240.4
981	3.193	389.8	116.7	242
982	3.197	390.8	117.6	243.7
983	3.2	391.7	118.6	245.5
984	3.203	392.7	119.6	247.2

985	3.206	393.8	120.6	249.1
986	3.21	394.8	121.7	251
987	3.213	395.9	122.7	252.9
988	3.216	397	123.9	255
989	3.219	398.2	125	257.1
990	3.223	399.4	126.2	259.2
991	3.226	400.6	127.5	261.5
992	3.229	401.9	128.8	263.8
993	3.232	403.3	130.1	266.2
994	3.236	404.7	131.5	268.7
995	3.239	406.1	133	271.3
996	3.242	407.6	134.5	274
997	3.245	409.2	136	276.9
998	3.249	410.8	137.7	279.9
999	3.252	412.6	139.4	283
1000	3.255	414.4	141.2	286.2
1001	3.258	416.3	143.1	289.7
1002	3.262	418.3	145.2	293.3
1003	3.265	420.4	147.3	297.1
1004	3.268	422.7	149.5	301.2
1005	3.271	XXX.X	XXX.X	XXX.X
1006	3.275	XXX.X	XXX.X	XXX.X
1007	3.278	XXX.X	XXX.X	XXX.X
1008	3.281	XXX.X	XXX.X	XXX.X
1009	3.284	XXX.X	XXX.X	XXX.X
1010	3.288	XXX.X	XXX.X	XXX.X
1011	3.291	XXX.X	XXX.X	XXX.X
1012	3.294	XXX.X	XXX.X	XXX.X
1013	3.297	XXX.X	XXX.X	XXX.X
1014	3.301	XXX.X	XXX.X	XXX.X
1015	3.304	XXX.X	XXX.X	XXX.X
1016	3.307	XXX.X	XXX.X	XXX.X
1017	3.31	XXX.X	XXX.X	XXX.X
1018	3.314	XXX.X	XXX.X	XXX.X
1019	3.317	XXX.X	XXX.X	XXX.X
1020	3.32	XXX.X	XXX.X	XXX.X
1021	3.323	XXX.X	XXX.X	XXX.X
1022	3.327	XXX.X	XXX.X	XXX.X
1023	3.33	XXX.X	XXX.X	XXX.X