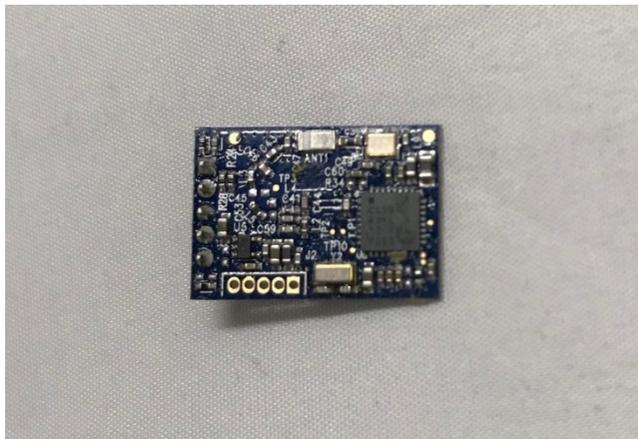
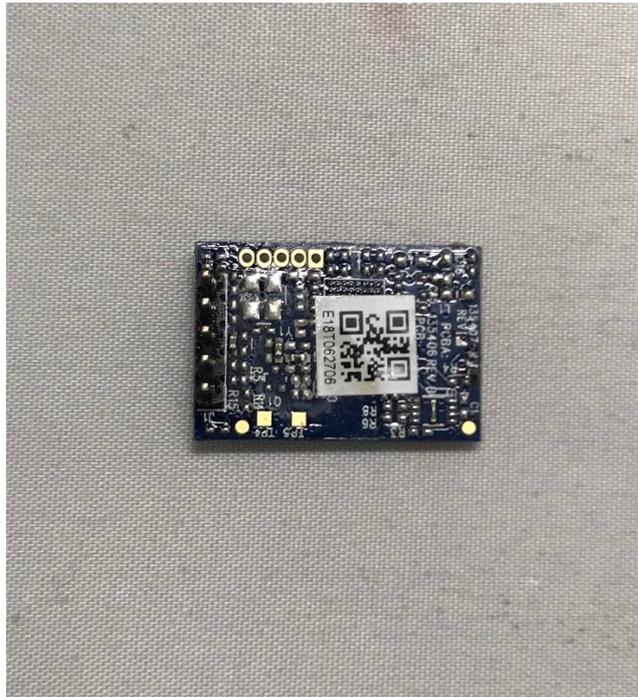


CalAmp BlueBoard User Manual

FCC ID: APV-BLD01

IC: 5843A-BLD01



Author	Version	Date	Note of changes
Boris Velv	1.0		
Imad Rizk	1.1	4/16/2018	

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1 Introduction

This application note documents the use of Bluetooth chipset device based on TI MSP430F5438A microcontroller and CC2564 RF processor. And the module based on TI2640 chipset.

The BTCS device has Bluetooth LE4.0 dual mode capabilities. The firmware is based on Stonestreet One Bluetopia protocol stack. The document uses as an example the Texas Instruments CC 2541 Sensor Tag with the purpose of reading the temperature from TI TMP006 temperature sensor. A “KeyFob” device which broadcasts “Button xx press” events together with “battery charge state as percentage” information is used as another example. It is a Bluetooth LE only.

2 Description

The BTCS device is connected to a LMU serial port. The BTCS unit supports Bluetooth SPP mode of operation. BTCS plays a server slave device which upon connection with a Remote Bluetooth client master device can exchange data. There are two Bluetooth low energy (BLE) modes of operation: “Connection” based and an “Advert Broadcast Scanning” mode. In “Connection” mode, the LMU firmware starts the discovery process of all BLE remote devices. If a match is found based on the remote address stored as an “APP PARAM 2082”, the discovery sequence is ended and the connection process starts. Upon the reception of “CONNECTED_OK” event, the user will be able to send setup commands to the remote device, and consequently receive the sensor data.

In “Advert Broadcast scanning” mode BT driver simply receives the broadcast advertisements from all remote BLE devices.

The block diagram is presented in Figure 1 below.

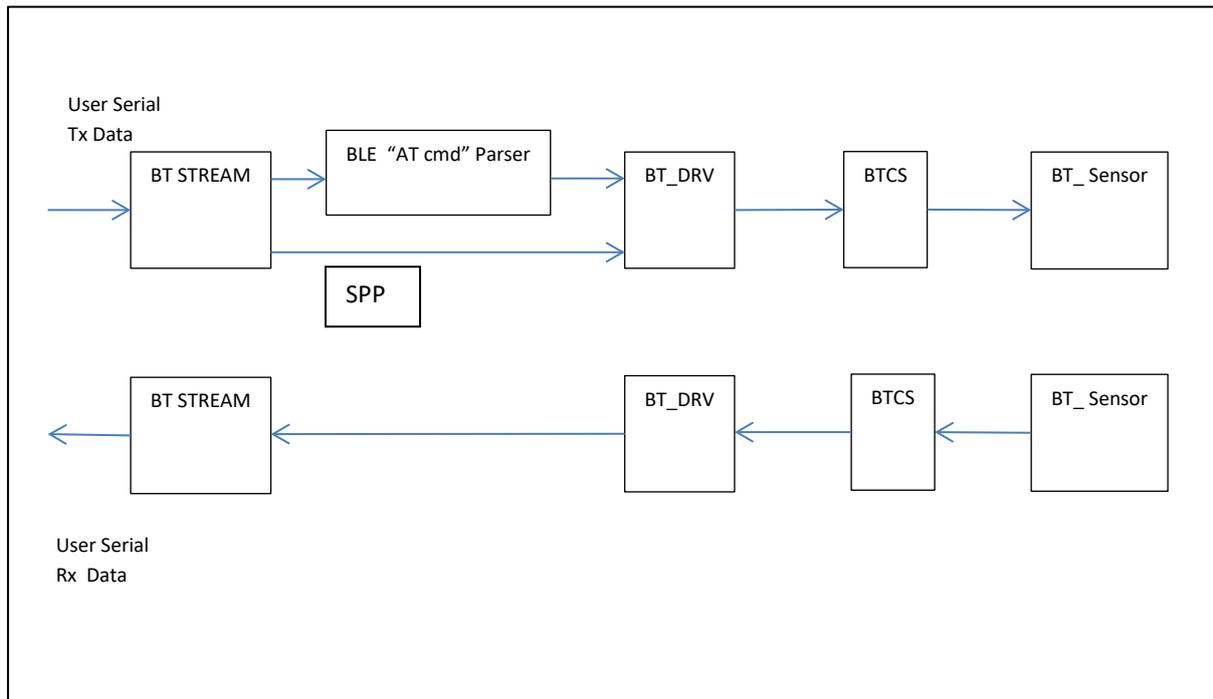


Figure 1

3 Setup

3.1 LMU BT LE driver streams and serial port configuration parameters setup example.

- Map debug stream to Aux1 port.
AT\$APP PARAM 3072,3,0
- Bluetooth stream to AUX 2.
AT\$APP PARAM 3072,14,1
- A Bluetooth stream baud rate set to 115200
AT\$APP PARAM 3073,14,12
- A Bluetooth stream set to 8, n, 1
AT\$APP PARAM 3074,14,3
- User0 Stream to Bluetooth Port
AT\$APP PARAM 3072,0,8

3.2 LMU BTST SPP driver streams and serial port configuration parameters setup example.

- LMU BT driver SPP mode setup:
at\$app param 2083,0,0

- Turn off stream for User 0:
at\$app param 3072,0,255
- Map Debug stream to BT_port:
at\$app param 3072,3,8
- Reset LMU :
ATRESET
LMU debug log will be visible on BT remote Android device console upon connection.
The connection process is initiated by Android master device.

3.3 LMU Bluetooth driver configuration parameters setup.

- PID 2082 holds up to 8 remote device addresses 6 Bytes long.
at\$app param 2082,0,144,89,175,10,169,169 corresponding to remote device MAC address: 0x9059AF0AA9A9
The first location in the array of addresses above is used to establish a BLE connection to a remote BLE device in BLE" Connected" mode.
All unused addresses must contain 255,255,255,255,255,255.
- PID 2083 holds the mode of operation and it is 2 Bytes long. Bit 0 is used for mode selection 0- standard-SPP, and 1- Low Energy.
For instance to configure BT driver in SPP mode use the following:
at\$app param 2083,0,0
For example in order to configure BT driver in BLE "Connection" mode use:
at\$app param 2083,0,1
Bit 1 defines if broadcast scanning is enabled 0 – disabled , 1 – enabled.
Bit 2: 0- whitelist should be used to filter out the remote devices with MAC addresses which are not found in the list of the remote addresses. BTCS ignores the whitelist functionality at present.
1: scan all advert broadcasts, no whitelist.
For instance in order to configure BT driver in "LE advert broadcast scan all" mode use:
at\$app param 2083,0,7
- To disable Bluetooth driver use:
at\$app param 2083,0,65535
- The above commands allow the LMU to switch from one mode to another without the necessity of AT reset command, given that the data stream configuration is not changed. It could take up to 40s to complete the switch.

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3.4 LMU user serial message configuration parameters setup example.

- If user data packets from the remote device are required to be transmitted to the backend server at a rate above one per five seconds, the User Message Disposition S-Register must be set to unacknowledged Message:

```
S-137< VALUE = 5>
ats137=5
```

- Configure serial message filters:

```
at$app param 2178,0,""
at$app param 2178,1,""
at$app param 2178,2,""
at$app param 2178,3,""
at$app param 2178,4,""
at$app param 2178,5,""
at$app param 2178,6,""
at$app param 2178,7,""
```

Use the same as above for 2176 app param:

```
at$app param 2176,0,""
at$app param 2176,1,""
at$app param 2176,2,""
at$app param 2176,3,""
at$app param 2176,4,""
at$app param 2176,5,""
at$app param 2176,6,""
at$app param 2176,7,""
```

- Ensure that these new configurations do not cause any stream conflicts. Send the query:

```
at$app stream?
```

Below is an example of a stream conflict:

```
at$app stream?
```

Stream	Port	Rate	Word
0:User0	8:BTPort	9600	8/N/1
1:Modem	4:Radio	115200	8/N/1
2:User1	--		
3:Debug	0:Aux1	115200	8/N/1 PREEMPT
4:NMEA Out	--		
5:DUN	--		

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```

6:PEG Serial --
7:VBUS --
8:GPS Rcvr 5:GPS 115200 8/N/1
9:AltMdm 1:Aux2 115200 8/N/1
10:HostApp0 --
11:HostApp1 --
12:HostApp2 --
13:Undef. --
14:BlueTooth 1:Aux2 115200 8/N/1
15:Undef. --
16:Undef. --
17:Undef. --
18:Undef. --
19:Undef. --

```

OK

AUX2 must only have one stream assigned to it, so the AltMdm stream must be moved:

at\$app param 3072,9,3

This command will move the AltMdm stream to the daughterboard port.

at\$app param 3072,9,255 will disable it.

- Finally reset the LMU by executing: at\$app reboot

3.5 BTCS version format.

Upon RESET BTCS firmware reports its version as follows:

BT: Rcv: VERSION,4.1.1.1CBA8C2A9539 with format: dcs.bts.ver.macaddr , where dcs is Device chipset version, bts is the bluetopia stack id, ver is BTCS firmware version and macaddr is the local device MAC address.

3.6 BTCS default Pass key.

The default Pass Key is "0000".

3.7 Verification of LMU BTST SPP mode "Data" state example.

LMU debug log will contain:

BT: Rcv: SPP,0,1

BT: Connected

From this point data exchange is possible.

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3.8 Verification of LMU configuration for BLE “connection” mode example.

LMU BT driver “DISCOVERED” state can be verified by observing the following debug log lines:

“BLE rx cmd:DISCOVERY,2,9059AF0AA9A9,0,-67,1,020105”

LMU BT driver “CONNECTED” state can be verified by observing the following debug log lines: “BLE rx cmd:CONNECT,1,1,0,9059AF0AA9A9” , where 1 is the connection handler index, 1-Low Energy mode, 0 – not paired, 9059AF0AA9A9 – remote device address.

The line: “BLE: Connected” indicates that the connection is achieved.

It is important to note that the connection handler index is returned by BTCS and is arbitrary number ranging from 0 to 65535. The same connection handler index must be used to send the user messages as explained in 4.1.

ATCS? Command will return the connection handler index:

SERMSG: Rcvd Msg:

41 54 43 53 2C 31 2C 31 2C 30 2C 39 30 35 39 41 46 30 41 41 39 41 39 0D

The above debug log line when converted to ASCII format is: ATCS,1,1,0,9059AF0AA9A9 where 1: connection handler index, 1: BLE mode, 0-not paired, 9059AF0AA9A9 is the BLE remote device MAC address.

3.9 Verification of LMU BLE “Advert broadcast scanning” mode configuration example.

The debug log indicates when the final LMU BLE “Scanning” state is reached by:

BLE: Scanning

The KeyFob “Button 1 Press” event user message looks like the following:

SERMSG: Rcvd Msg:

44 49 53 43 4F 56 45 52 59 2C 32 2C 30 30 30 37 38 30 36 37 41 33 35 44 2C 30 2C 2D 36 36 2C 33 2C 30 32 30 31 30 36 2D 30 32 30 41 30 33 2D 30 35 30 31 46 46 46 46 35 42 30 31 0D

The above message when converted to ASCII format looks like the following:

DISCOVERY,2,00078067A35D,0,-66,3,020106-020A03-0501FFFF5B01, where

- 2 is the GAP advertising report type: LE Connectable and undirected, Connectable and Scannable, 3 – LE Connectable Direct Advertisement, Connectable only, 4- LE Scannable Indirect Advertisement, Scannable only, 5- LE Non-connectable Indirect Advertisement, Not connectable or scannable, 6- LE Scan Response.
- 00078067CD72 is the MAC address.
- 0-public, 1- Random LE address type.
- -66 is RSSI Received Signal Strength indication value of the last packet received in dBm.

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- 3 is number of advertising report data entries.
- 02 is the first advertisement report data length in Bytes.
- 01 is the first report advertisement type.
- 06 is the first report advertising data byte.
- 020A03 is the second AD report.
- 0501FFFF5B01 is the third AD report.
- The user data is in the third AD report-5B: 91% battery charge remaining, 01 :Button 1 is pressed.

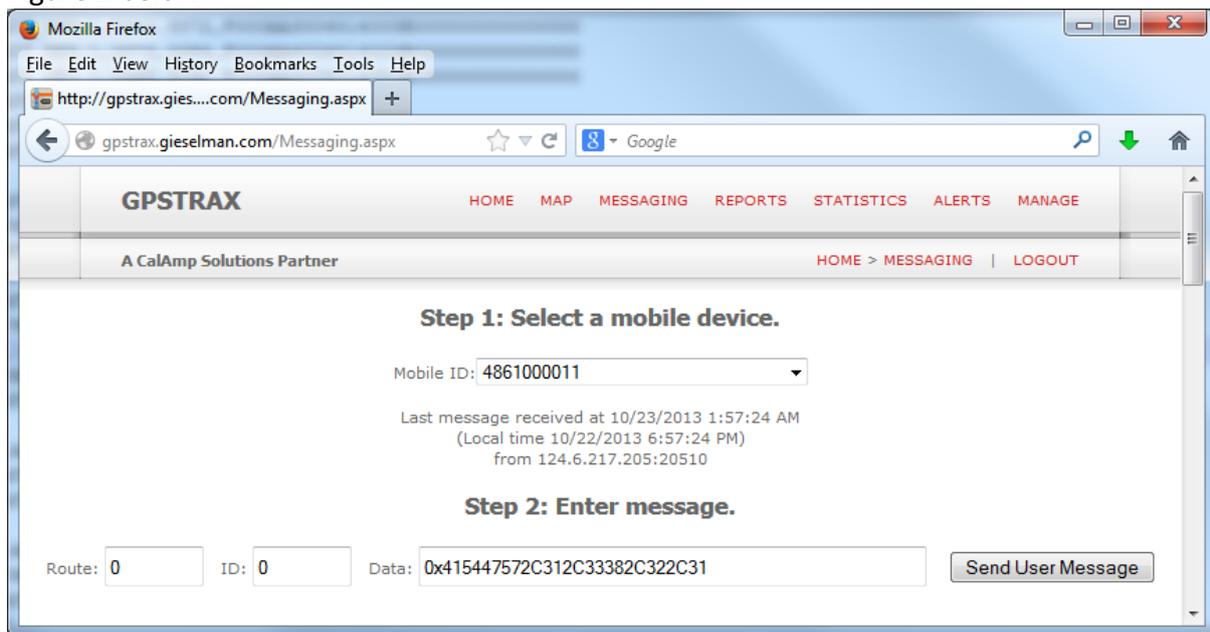
4 Usage

4.1 Demonstration of LMU BT SPP mode.

Follow the instructions in 3.2. Android Bluetooth SPP application starts the process of connection with BTCS and upon completion all LMU debug log data will be visible in Android device console. All Android input keyboard messages ending with 'CR' will be visible in its console.

4.2 Demonstration of BLE "connection" mode based remote temperature sensor device.

"GPSTRAX" server is used to send User0 messages. Select route: 0 and ID: 0 as shown in Figure 2 below



The screenshot shows the GPSTRAX web application interface. The browser is Mozilla Firefox. The URL is http://gpstrax.gieselman.com/Messaging.aspx. The page has a navigation menu with links: HOME, MAP, MESSAGING, REPORTS, STATISTICS, ALERTS, MANAGE. Below the menu, it says "A CalAmp Solutions Partner" and "HOME > MESSAGING | LOGOUT". The main content area is titled "Step 1: Select a mobile device." and shows a dropdown menu for "Mobile ID" with the value "4861000011". Below this, it says "Last message received at 10/23/2013 1:57:24 AM (Local time 10/22/2013 6:57:24 PM) from 124.6.217.205:20510". The next section is "Step 2: Enter message." and shows input fields for "Route" (0), "ID" (0), and "Data" (0x415447572C312C33382C322C31), along with a "Send User Message" button.

Figure 2

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There is a limitation of the length of the command which has to be less than 32 BYTES.

4.2.1 Send command “Enable notifications on Temperature sensor attribute profile”.

Populate the “Data” field in Figure 2 with the hexadecimal representation of ATGW,1,38,2,1 - 0x415447572C312C33382C322C31.

Where ATGW is the BTCS API for characteristic “WRITE” (GATT WRITE). It is used to write the characteristic value or descriptor from a server when the attribute handle of the characteristic value is known. 1 is the BTCS connection handler, and can be an arbitrary number.

Use ATCS command to get the correct connection handler index as explained in 3.6. The rest of the command is “SensorTag” temperature sensor specific. 38 is the SensorTag board temperature sensor “Notification settings” handler index. 2 is the “Notifications” configuration parameter byte length. The last field is the parameter value - 1 stands for “Turn ON” operation , 0 for “Turn OFF”.

4.2.2 Send command “Start temperature conversion”.

Populate the “Data” field in Figure 2 with the hexadecimal representation of ATGW,1,41,1,1 - 0x415447572C312C34312C312C31

The command fields description is the same as 4.1.

4.2.3 Observe the GPSTRAX server User 0 temperature data.

474154545F56414C2C312C303033372C312C342C44394646313030430D

In LMU debug log the same message can be observed:

SERMSG: RcvMsg:

474154545F56414C2C312C303033372C312C342C44394646313030430D

Converted to ASCII format the same message is: GATT_VAL,1,37,1,4,D9FF100C0D, where 1 corresponds to the connection ID ranging from 1 to 65535, 37 corresponds to the GATT characteristic handler index specific to TI temperature sensor, 1 is GATT notification, 4 is data length in Bytes, D9FF100C0D represents the sensor data.

The data colored in yellow represent the temperature, where 0xD9 is the lowest significant byte of the Object temperature, 0xFF- MSB of object temperature, 0x10 – LSB of the ambient temperature, 0x0C – MSB of the ambient temperature.

4.2.4 Disable BLE sensor “notifications”.

Populate the data field in Figure 2 with the hexadecimal representation of ATGW,1,38,2,0 - 0x415447572C312C33382C322C30

4.2.5 Send command “Stop” temperature conversion.

Populate the data field in Figure 2 with the hexadecimal representation of ATGW,1,41,1,0 - 0x415447572C312C34312C312C30

4.2.6 “GPSTRAX” server report contains temperature sensor data.

10/22/2013	486100	36.7	0	0	0A474154545F56414C2C312C303033372C312C3
20:21:45	0011	926			42C43444646463430420D

4.3 Demonstration of BLE “broadcast scanning” mode based remote KeyFob DriverID device.

The GPSTRAX server report will contain the following User0 messages:

```
0A444953434F564552592C322C3030303738303637434437322C302C2D35352C332C30323
03130362D3032304130332D3035303146464646353430310D
```

Which converted into ASCII representing “Button1 press” event:

```
DISCOVERY,2,00078067CD72,0,-55,3,020106-020A03-0501FFFF5401
```

The user payload content description is given in 3.3.

The Raw message type 4 is presented below:

```
830548610000110101000415A25295086652950866EA11DA4C682ABBA700000000000000
000AE0B020001FFCD4F09DD000000003D0A444953434F564552592C322C30303037383036
37434437322C302C2D35352C332C3032303130362D3032304130332D30353031464646463
53430310D
```

5 PWA Label



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6 Integration Instructions

A label containing the BLE Board FCC ID and Industry Canada certification number must be permanently affixed to the exterior of the host device into which the BlueBoard transmitter is installed. The label may also be in a user accessible location such as under a panel or battery pack if it is a handheld device, readily accessible, not placed on a removable part and the FCC ID and Industry Canada certification number are visible at the time of purchase. The label must contain a statement similar to the following:

- o This device contains FCC ID: APV-BLD01
- o This device contains IC: 5843A-BLD01

If the BLE Daughter board is certified transmitter is intended for use in a portable use device, the OEM integrator is responsible to design the product to comply with RF exposure requirements, and must work with CalAmp to satisfy FCC/IC SAR requirements. Refer to Industry Canada RSS-102 and FCC KDB publication 447498 D01 and the applicable SAR/RF Exposure KDB publications available at:

<https://apps.fcc.gov/oetcf/kdb/reports/GuidedPublicationList.cfm>. 1

The system user manuals and other documentation must clearly indicate operating conditions that must be observed to ensure compliance with FCC/IC RF exposure guidelines and also include appropriate caution and warning statements and information.

The host device containing the BlueBoard certified transmitter may also require compliance to FCC Part 15 Subpart B – Unintentional Radiator rule part as well as Industry Canada ICES-003.

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9 Regulatory Information

Human Exposure Compliance Statement

Pursuant to 47 CFR § 24.52 of the FCC Rules and Regulations, personal communications services (PCS) equipment is subject to the radio frequency radiation exposure requirements specified in § 1.1307(b), § 2.1091 and § 2.1093, as appropriate.

CalAmp Wireless Networks Corp. certifies that it has determined that the module complies with the RF hazard requirements applicable to broadband PCS equipment operating under the authority of 47 CFR Part 24, Subpart E of the FCC Rules and Regulations. This determination is dependent upon installation, operation and use of the equipment in accordance with all instructions provided.

The module is designed for and intended to be used in fixed and mobile applications. “Fixed” means that the device is physically secured at one location and is not able to be easily moved to another location. “Mobile” means that the device is designed to be used in other than fixed locations and generally in such a way that a separation distance of at least 20 cm is normally maintained between the transmitter’s antenna and the body of the user or nearby persons. The LMU-5000™ is not designed for or intended to be used in mobile applications (within 20 cm of the body of the user) and such uses are strictly prohibited.

To ensure that the module complies with current FCC regulations limiting both maximum RF output power and human exposure to radio frequency radiation, a separation distance of at least 20 cm must be maintained between the unit’s antenna and the body of the user and any nearby persons at all times and in all applications and uses. Additionally, in mobile applications, maximum antenna gain must not exceed 3.2 dBi.

FCC Rules and Industry Canada (IC) regulatory information Compliance Statement (Part 15.19)

The equipment device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) This device must accept any interference received including interference that may cause undesired operation.

Warning (Part 15.21)

Changes or modifications not expressly approved by CalAmp Wireless Networks Corp could void the user's authority to operate the equipment. Manufacturer is not responsible for any radio or TV interference caused by unauthorized modifications to this equipment.

Compliance Statement (Part 15.105(b))

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

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

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Class B digital device notice

“CAN ICES-3 (B)/NMB-3(B)”

RF Radiation Exposure Statement

This equipment complies with the FCC/IC radiation exposure limits set fourth for mobile transmitting devices operation in an uncontrolled environment. End users must follow the specific operating instructions to satisfy RF exposure compliance.

The equipment should only be used where there is normally at least 20cm separation between the antenna and all person/user.

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