

ATBTLC1000

ATBTLC1000 BluSDK Example Profiles Application User's Guide

Introduction

This document describes how to set the ATBTLC1000-MR/ZR evaluation boards for various example applications supported by the Advanced Software Framework (ASF). This also provides the list of supported hardware platforms and IDEs to be used in conjunction with the ATBTLC1000-MR/ZR evaluation boards (see Table 2-1). The part number of the BTLC1000-ZR Xplained Pro (XPro) board is ATBTLC1000ZR-XPRO, and the part number of the BTLC1000-MR Xplained Pro board is ATBTLC1000MR-XPRO.

Note: All the example applications are included in BluSDK software package.

Figure 1. ATBTLC1000 Extension Boards



ATBTLC1000-ZR

ATBTLC1000-MR

Features

- Observer application
- Proximity Monitor Application:
 - Device discovery and disconnection
 - Services and characteristics discovery
 - Services Link Loss service, Immediate Alert service, and Tx Power service
 - Setting up Path Loss and Link Loss
 - Received Signal Strength Indicator (RSSI) sampling
- Proximity Reporter Application:
 - Advertisement
 - Pairing/bonding
 - Services Link Loss service (mandatory), Immediate Alert service, and Tx Power service
- Apple[®] Notification Center Service (ANCS) Application
- Scan Parameters Service Application
- Time Information Profile Application:
 - Device discovery and disconnection
 - Pairing/bonding
 - BLE time client
- HID Mouse Device and HID Keyboard Device Applications:
 - Advertisement
 - Pairing
 - Services: HID service and Device Information service
 - Report mode (mouse)/Report mode (keyboard)
- Battery Service Application
- Simple Broadcaster Application
- Device Information Service
 - Custom Serial Chat (CSC) Profile Application:
 - Device discovery and disconnection
 - Pairing/bonding
 - Send and receive messages
 - Heart rate Profile Application:
 - Advertisement
 - Pairing/bonding
 - Heart rate sensor measurements
 - Console display
- Blood Pressure Profile Application:
 - Advertisement
 - Pairing/bonding
 - Blood pressure measurements
 - Find Me Profile Application:
 - Advertisement

- Pairing/bonding
- Find Me alerts
- Phone Alert Status Profile Application:
 - Advertisement
 - Pairing/bonding
 - Phone alert status
- Alert Notification Profile Application:
 - Device discovery and disconnection
 - Pairing/bonding
 - Alert notification service
 - Alert on incoming call
 - Multi-Role Peripheral Multi-Connect Application:
 - Supports eight connections
- L2CAP Throughput Application:
 - L2CAP central

•

- L2CAP peripheral
- Used LE L2CAP connection oriented channel for data communication
- Health Thermometer Profile (HTP) Application:
 - Advertisement
 - Pairing/bonding
 - RSSI sampling
 - Health thermometer service
 - Health thermometer profile app for iOS/Android
- iBeacon Application:
 - RSSI sampling
 - Beacon advertising
 - iBeacon demo app for iOS/Android
- AltBeacon Application:
 - AltBeacon advertising
 - AltBeacon demo app for iOS/Android
- Eddystone Beacon Application:
 - Eddystone UID, URL, and TLM frame types
 - URL configuration service with optional lock
 - Beacon demo application for Android and iOS
- Direct Test Mode (DTM) Application:
 - DTM setup procedure
 - Downloading DTM firmware

Table of Contents

Int	roduc	tion	1
Fe	atures	5	2
1. Functional Overview			
	1.1.	Observer Application	6
	1.2.	Proximity Reporter Application	
	1.3.	Proximity Monitor Application	
	1.4.	ANCS Profile Application	
	1.5.	Scan Parameters Service Application	
	1.6.	Time Information Profile Application	
	1.7.	HID Mouse Device or HID Keyboard Device Application	
	1.8.	Battery Service Application	
	1.9.	Simple Broadcaster Application	
	1.10.	Device Information Service Application	
		Custom Serial Chat Profile Application	
		Heart Rate Profile Application	
		Blood Pressure Profile Application	
		Find Me Profile Application	
		Phone Alert Status Profile Application	
		Alert Notification Profile Application	
		Multi-Role Peripheral Multi-Connect Application	
		L2CAP Throughput Application	
		Health Thermometer Profile Application	
		iBeacon Application	
		AltBeacon Application	
		Eddystone Beacon Application	
		Direct Test Mode Application	
2.	2. Supported Hardware Platforms and IDEs15		15
3.	Hard	ware Setup	16
	3.1.	ATBTLC1000 Board Types	16
	3.2.	SAM L21 Xplained Pro Setup	16
	3.3.	SAM D21 Xplained Pro Setup	17
	3.4.	SAM G55 Xplained Pro Setup	18
	3.5.	SAM 4S Xplained Pro Setup	19
4.	Softv	vare Setup	21
	4.1.	Installation Steps	21
	4.2.	Build Procedure	
5.	Appl	ication Demo	29
	5.1.	Demo Setup	29
	5.2.	Console Logging	

	5.3.	Running the Demo	32		
6.	6. Adding a BLE Standard Service75				
7.	Cust	om Serial Chat Service Specification	78		
	7.1.	Service Declaration			
	7.2. 7.3.	Service Characteristic			
	7.3. 7.4.	Endpoint Characteristic Descriptors			
	7.5.	Sequence Flow Diagram			
8.	BluS	DK Software Architecture	30		
9.	Hard	ware Flow Control for 4-Wire Mode eFuse Write Procedure	31		
10.	10. Document Revision History				
11. Object of Declaration					
The	The Microchip Web Site				
Cu	Customer Change Notification Service86				
Cu	Customer Support				
Microchip Devices Code Protection Feature					
Leg	Legal Notice				
Tra	Trademarks				
Qu	Quality Management System Certified by DNV88				
Wo	Worldwide Sales and Service				

1. Functional Overview

This chapter describes the functional overview of all the applications that are pre-defined in Atmel Studio.

1.1 Observer Application

The Observer application is used for continuously listening to the advertisement data over the air. This application supports the following advertisement data types:

- Incomplete list of 16-bit service class UUIDs
- Complete list of 16-bit service class UUIDs
- Incomplete list of 32-bit service class UUIDs
- Complete list of 32-bit service class UUIDs
- Incomplete list of 128-bit service class UUIDs
- Complete list of 128-bit service class UUIDs
- Shortened local name
- Complete local name
- Appearance
- Manufacturer specific data
- Tx Power
- Advertisement interval

1.2 Proximity Reporter Application

The Proximity profile is defined by the Bluetooth SIG to enable monitoring the proximity between two Bluetooth Low Energy (BLE) devices. The Proximity Monitor (a Generic Attribute (GATT) client) configures the behavior of the peer Proximity Reporter device (a GATT server) based on the link conditions. The configuration includes setting the alert level, which triggers on the Link Loss or based on different threshold of the Path Loss. The Path Loss determines the quality of the connection and it is derived out of the Received Signal Strength Indicator (RSSI) and transmits the power. The Proximity Monitor continuously evaluates the Path Loss and creates an immediate alert in the Proximity Reporter device when the Path Loss crosses threshold values.

On-board LED Status

The on-board LED is configured to notify the user about the alerts received. The different alerts for the Link Loss and Immediate Alert service are explained in the subsections.

Link Loss

On the Link Loss, the LED blinks according to the alert level set by the Proximity Monitor. The alert levels are:

- NO_ALERT for No alert level
- MILD_ALERT for Mild alert level
- HIGH_ALERT for High alert level

Based on the alert level configuration set by the Proximity Monitor, the LED blinks at different rates:

- If the alert level is "HIGH_ALERT" then the LED blinks faster (1 second interval)
- If the alert level is "MILD_ALERT" then the LED blinks moderately (2 second interval)
- If the alert level is "NO_ALERT" the LED must be off

Alert on Path Loss (Immediate Alert)

This alert is applicable when the "Immediate Alert" service is implemented. The example application relies on the Path Loss configuration done by the Proximity Monitor and notifies accordingly. The alert levels are:

- NO_ALERT for No alert level
- MILD_ALERT for Mild alert level
- HIGH_ALERT for High alert level

Based on the alert level configuration set by the Proximity Monitor, the LED blinks at different rates:

- If the alert level is "HIGH_ALERT" then the LED blinks faster (3 second interval)
- If the alert level is "MILD_ALERT" then the LED blinks moderately (5 second interval)
- If the alert level is "NO_ALERT" the LED must be off

1.3 Proximity Monitor Application

The Proximity profile is defined by the Bluetooth SIG to enable proximity monitoring between two BLE devices. The Proximity Monitor (a GATT client) configures the behavior of a peer Proximity Reporter device (a GATT server) based on the link conditions. The Proximity Monitor configures the desired behavior of the peer device through setting alert levels on the Link Loss and the Path Loss. In addition, it also maintains the connection with the Proximity Reporter and monitors the link quality of the connection based on RSSI reporting from the peer device.

1.4 ANCS Profile Application

The Apple[®] Notification Center Service (ANCS) is used to enable a device to access notifications from an iOS device that exposes ANCS.

The ANCS profile defines the following roles:

- Notification Provider (NP) is a device that provides the iOS notification
- Notification Consumer (NC) is a device that receives the iOS notifications and notification related data from Notification Provider

Incoming Call Notification

The programmed SAM L21 or the other supported hardware platforms (Notification Consumer) must be paired with an iPhone[®] to display the received incoming call notification on a console.

The Bluetooth[®] SIG defined Alert Notification profile provides similar functionality for Android devices. ANCS is a variant of the Alert Notification profile customized by Apple. For more details on Alert Notification, refer to the Alert Notification Profile Application.

1.5 Scan Parameters Service Application

The Scan Parameter service is an example application that demonstrates how to retrieve scan interval window information from a peer device. The Scan Parameter service must be implemented on a peer device to retrieve scan interval information. This application implements a GATT server role. This application can be used for obtaining the updated scan interval window value by configuring the scan refresh characteristic for notification.

1.6 Time Information Profile Application

The Time Information Profile is an example application for implementing the BLE time service, such as current time, date, and day, from a compatible Android/iPhone device and displays it on the console.

The profile defines the following roles:

- Time client, a device in a peripheral role to read the time, date, and day information
- Time server, a device to provide the time related information

Note: This application is supported in iOS 7.0 and above or a BLE compatible Android device in which the Microchip SmartConnect mobile application is installed.

1.7 HID Mouse Device or HID Keyboard Device Application

The HID Over GATT Profile (HOGP) is defined by the Bluetooth SIG to enable HID services support over a BLE protocol stack using the GATT profile. This allows devices like a keyboard or mouse to implement HOGP and to connect with a compatible HOGP/BLE host device, such as mobile phone, tablet, TV, and so on.

The HID Mouse device or HID Keyboard device application supports the following characteristics:

- Protocol mode (mouse/keyboard)
- Report (mouse/keyboard)
- Report map (mouse/keyboard)
- HID information (mouse/keyboard)
- HID control point (mouse/keyboard)
- Boot mouse input report (mouse only)
- Boot keyboard input report (keyboard only)
- Boot keyboard output report (keyboard only)

This example application simulates a function of a mouse or keyboard. Once the connection procedure is implemented between a mobile phone and the ATBTLC1000-MR/ZR board, the board can act as a mouse or a keyboard.

In the case of a HID Mouse device application, a mouse cursor, visible in the mobile screen, can be moved as per the predefined pattern by pressing the SW0 button on the board.

In the case of a HID keyboard device application, the predetermined text is sent to the mobile phone by pressing the SW0 button on the board. This can be viewed in any standard text editor in the mobile phone.

1.8 Battery Service Application

The Battery Service application is used for reporting the battery level of the device using the battery characteristics. Any application discovering the database can access the battery service instance during discovery services. This example application simulates the device battery level from 0% to 100%, with the step of 1% every second.

1.9 Simple Broadcaster Application

The Simple Broadcaster application is used for continuously broadcasting the advertisement data over the air. This application supports the following advertisement data types:

- Incomplete list of 16-bit service class UUIDs
- Complete list of 16-bit service class UUIDs
- Incomplete list of 32-bit service class UUIDs
- Complete list of 32-bit service class UUIDs
- Incomplete list of 128-bit service class UUIDs
- Complete list of 128-bit service class UUIDs
- Shortened local name
- Complete local name
- Appearance
- Manufacturer specific data

1.10 Device Information Service Application

The Device Information Service (DIS) application is used for providing a setup to the user to define and use the BLE DIS service. Any application discovering the database can access the DIS service instance during discovery services. This application supports the following characteristics:

- Manufacturer name string
- Model number string
- Serial number string
- Hardware revision string
- Firmware revision string
- Software revision string
- System ID
- IEEE[®] 11073-20601 regulatory certification data list
- PnP ID

1.11 Custom Serial Chat Profile Application

The Custom Serial Chat application is used for sending and receiving data between the boards (see Table 2-1) and the Microchip SmartConnect mobile application. This is a custom profile example application implemented over GATT. The user can send the information to the mobile phone using the console terminal that is configured with the board and vice versa.

Note: For more information on Custom Serial Chat service, refer to Custom Serial Chat Service Specification.

1.12 Heart Rate Profile Application

The Heart Rate Profile application is used for enabling the collector device (GATT client) to connect and interact with a Heart Rate sensor (GATT server) to be used in the fitness applications. The Heart Rate sensor sends the heart rate measurement in bpm (beats per minute), energy expended in kJ (kilojoules), and R-R intervals in seconds. In addition to the Heart Rate service, this profile also implements the Device Information Service, which provides information about the Heart Rate sensor device.

The Heart Rate profile provided by Bluetooth SIG defines three characteristics for the exchange of heart rate parameters between the sensor and monitor. The characteristics of the profile are used to transfer heart rate parameters like bpm, R-R interval measurements, and other parameters like body sensor

location and energy expended values. The optional "Heart Rate Control Point characteristic" is used by the Heart Rate monitor to reset the energy expended in the Heart Rate sensor.

The Heart Rate sensor, which is the GATT server, holds the characteristics and sends the measurement values to the Heart Rate monitor.

- The Heart Rate, R-R interval, and energy expended are sent using the Heart Rate measurement characteristics
- The Heart Rate measurements are sent to the monitor on a value change if the monitor has enabled the notifications
- The body sensor location is read by the monitor by its body sensor location characteristic. The energy expended sent in the heart rate measurement can be reset by the monitor by writing to the Heart Rate control point characteristic

Note: The example application simulates the sensor measurements and sends them to the Heart Rate collector.

1.13 Blood Pressure Profile Application

The Blood Pressure Profile (BLP) application is used for connecting to and interacting with a device with a blood pressure sensor device to be used in consumer and professional health care applications. This application enables the device to obtain blood pressure measurement and other data from a non-invasive blood pressure sensor that exposes the Blood Pressure service. For example, a nurse or doctor could use a non-invasive blood pressure sensor on a patient that sends blood pressure measurements to a laptop or other hand held device.

Blood Pressure Measurements

The blood pressure measurement characteristic can be used to send blood pressure measurements.

- Flags field (containing units of blood pressure and used to show the presence of optional fields)
- Blood pressure measurement compound value field and, depending upon the contents of the Flags field
- Timestamp (time of the measurement)
- Pulse Rate
- User ID
- Measurement status fields

The intermediate cuff pressure characteristic may be sent frequently during the course of a measurement, so that a receiving device can effectively update the display on its user interface during the measurement process.

When the client characteristic configuration descriptor is configured for indications and a blood pressure measurement is available, this characteristic is indicated while in a connection. When the client characteristic configuration descriptor is configured for indications and a blood pressure measurement is available, this characteristic is indicated while in a connection.

- The blood pressure measurement characteristic is used to send blood pressure measurements
- The intermediate cuff pressure characteristic is used to send current cuff pressure values to a device to display, while the measurement is in progress
- The blood pressure feature characteristic is used to describe the supported features of the blood pressure sensor

The ATBTLC1000-MR/ZR together with the host MCU simulates a blood pressure sensor (GATT server role) and sends simulated values to the blood pressure monitor (Microchip SmartConnect mobile application).

1.14 Find Me Profile Application

The Find Me Profile (FMP) application is used to define the device to create an alert signal behavior when a button is pressed on one device to cause an alerting signal on a peer device.

Find Me Target

The FMP defines the behavior when a button is pressed on a device to cause an immediate alert on a peer device. This can be used to allow users to find devices that have been misplaced.

The Find Me Target application, which is the GATT server, holds the alert level characteristics and waits for the Find Me locators alert and performs the following alert level characteristic:

• When the Find Me locator device wishes to cause an alert on the Find Me Target device, it writes the specific alert level (High, Mild and No alert) in the alert level characteristic.

1.15 Phone Alert Status Profile Application

The Phone Alert Status (PAS) profile is used to obtain the phone alert status exposed by the phone alert status service on a mobile phone. The alert status and ringer setting information of a mobile phone can be received and modified by the phone alert status service. The device can also use this profile to configure the ringer status on the mobile phone.

Phone Alert Status Notifications

This profile defines two roles:

- Phone alert server device that originates the alerts
- Phone alert client device that receives the alerts and alerts the user

The phone alert client (a GATT client) configuration is implemented on the ATBTLC1000-MR/ZR along with a few other supported hardware platforms and IDEs (see Table 2-1). The example application utilizes the SW0 button on the supported hardware platform to demonstrate the notification use-cases. A BLE compatible Android device that contains the Microchip SmartConnect mobile application provides the phone alert server functionality in this example. On the application, once the service is discovered and the user can click on the PAS service to enable the notifications.

- 1. After connecting with the mobile phone, press the SW0 button once to set the PAS server to "Silent" mode.
- 2. In the second SW0 button press, the device is set to "Mute" mode.
- 3. In the third SW0 button press, the device is returns to "Normal" mode.
- 4. In the fourth SW0 button press, a "Read Characteristic" request is issued that reads the characteristics of "Alert Status", "Ringer Settings", and "Ringer Control Point".

Note: The PAS profile application is not supported in iOS devices. This example works only with BLE compatible Android devices that contain the Microchip SmartConnect mobile application.

1.16 Alert Notification Profile Application

The Alert Notification Profile allows a device to obtain information from a mobile phone about incoming calls, missed calls, and SMS/MMS messages. The information includes the caller ID for an incoming call

or the sender ID for an email/SMS/MMS, but not the message text. This profile also enables the client device to get information about the number of unread messages on the server device.

Note: This example application only works with BLE compatible Android devices that contain the Microchip SmartConnect mobile application.

The Microchip SmartConnect mobile application is used for implementing the Alert Notification service and can be used for demonstrating an example application. This example application supports missed call alert notification and SMS alert notification.

The device implements the GATT client, which reads (or notifies) about the characteristic values received from the GATT server (the mobile phone). The device must be paired with an Android phone. A missed call or SMS alert notifications can be enabled/disabled, once connection is established. The Microchip SmartConnect application notifies a missed call or SMS alert, which are then displayed on the terminal console on the device side.

The "SW0" user button on the supported platform is programmed in such a way that each successive button press either enables or disables the notifications.

Note: The SAM L21 or supported platforms (see Table 2-1) + ATBTLC1000-MR/ZR is referred as "device".

1.17 Multi-Role Peripheral Multi-Connect Application

The Multi-Role Peripheral Multi-Connect application demonstrates the ATBTLC1000-MR/ZR to have eight simultaneous active connections. The ATBTLC1000-MR/ZR supports multiple roles such as GAP peripheral device with battery service and GAP central device with a Find Me locator profile at the same time. It also supports multiple connection such as a GAP peripheral device with battery service that can connect with seven GAP central devices simultaneously.

The Multi-Role Peripheral Multi-Connect application initially starts advertising using connectable advertisement packets as a GAP peripheral and if any device sends a connection request, the application gets connected to the remote device and exchanges the data on the link established. If the connection request from the device is not sent within a minute, then the application scans the devices and initiates a connection to the peripheral device, which advertises using connectable advertisement packets. The ATBTLC1000-MR/ZR is exchanging the data as a GAP central once the link is established. Again, the Multi-Role application is started to advertise using connectable advertisement packets as a GAP peripheral and gets connected to the remote device, which sends a connection request, and exchanges the data on the new link established. The process continues until the Multi-Connection application reaches eight connections.

1.18 L2CAP Throughput Application

The L2CAP Throughput example application supports the L2CAP central feature and the L2CAP peripheral feature.

1.19 Health Thermometer Profile Application

The Health Thermometer Profile (HTP) enables the data collection device to obtain data from a thermometer sensor that exposes the health thermometer service. The profile defines following roles:

- Thermometer Device to measure temperature
- Collector Device to receive temperature measurement and other data from a thermometer

The thermometer implements only one Health Thermometer service in addition to the Device Information Service to display the information about the thermometer device. The current HTP application implements the following characteristics:

- Temperature measurement
- Intermediate temperature
- Measurement interval

1.20 iBeacon Application

The iBeacon application is used to advertise iBeacon specific packets that include UUID, major and minor numbers. Any beacon scanner application can be used for finding the beacon device. The iOS Microchip SmartConnect app can be used to find the beacon devices in the vicinity.

This profile defines the following roles:

- Monitor Device (iOS/Android) to search for beacon packets
- Reporter Device that continuously advertises the beacon packet as a part of advertisement data

1.21 AltBeacon Application

The AltBeacon application advertises packets that includes MFG ID, Beacon code, Beacon ID, Reference RSSI, and MFG reserved value. Any AltBeacon scanner application can be used to find the AltBeacon device based on the beacon code. The supplied iOS demo app can be used to find the AltBeacon devices in the vicinity. The profile defines the following roles:

- Monitor Device (iOS/Android) to search for AltBeacon packets
- Reporter Device that continuously advertises the AltBeacon packet as part of advertisement data

1.22 Eddystone Beacon Application

The Eddystone[™] is an open Bluetooth Smart beacon format from Google that works across Android and iOS devices. The Microchip SmartConnect BLE BluSDK software solution provides full support for this beacon format on the ATBTLC1000-MR/ZR devices.

The Eddystone beacon application supports UID, URL, and TLM frame types. The application can be configured as follows using the APP TYPE define:

- Set APP_TYPE to EDDYSTONE_UID_APP to send UID and TLM beacon frames at regular beacon intervals
- Set APP_TYPE to EDDYSTONE_URL_APP to send URL and TLM frames. This also supports the URL configuration service that enables the beacon to be configured dynamically from a mobile application

The Eddystone application is completely configurable using the conf_eddystone.h file. The #defines present in the conf_eddystone.h file are supplied with default values, which can be changed by the user to meet the requirements. In addition to this compile time configuration, the frame fields like the UID value, URL, transmit power at 0 meters, and so on can be changed using the APIs provided in eddystone.h file.

1.23 Direct Test Mode Application

The Direct Test Mode (DTM) application is used to establish and test the Direct Test mode between two ATBTLC1000-MR/ZR modules. Windows-based ATBTLC1000-MR/ZR characterization software is used

at both ends. The ATBTLC1000-MR/ZR Xplained Pro extensions are connected to a compatible MCU host device such as the SAM L21, SAM D21, SAM G55 or SAM 4S. The Performance Analyzer (PC tool) communicates with the ATBTLC1000 using a serial bridge application running on the MCU.

Serial Bridge Application

Sends the DTM commands to the ATBTLC1000-MR/ZR to enable the DTM performance analyzer application. The supported hardware platforms (see Table 2-1) can act as a serial bridge between the ATBTLC1000-MR/ZR and Atmel Studio performance analyzer tool. Once the SAM L21 (or other supported hardware platforms) is powered on or Reset, it initializes the Wake-up and Chip Enable to download the patch file into the ATBTLC1000-MR/ZR and completes the initialization procedure of the BLE module. After the ATBTLC1000-MR/ZR initialization, the application initializes the SAM L21 to act as a serial bridge.

2. Supported Hardware Platforms and IDEs

The following table provides the supported hardware platforms and IDEs for the ATBTLC1000-MR/ZR.

Table 2-1. BluSDK – Supported Hardware and IDES				
Platform	МСИ	Supported BLE Device	Supported Evaluation Kits	Supported IDEs
SAM L21	ATSAML21J18B	ATBTLC1000-MR, ATBTLC1000-ZR	ATBTLC1000-XSTK (ATSAML21-XPRO-B + ATBTLC1000-XPRO) or ATBTLC1000ZR-XSTK (ATSAML21-XPRO-B + ATBTLC1000ZR-XPRO)	Atmel Studio v7.0 and IAR
SAM L21	ATSAML21J18A	ATBTLC1000-MR, ATBTLC1000-ZR	ATSAML21-XPRO + ATBTLC1000-XPRO or ATSAML21-XPRO + ATBTLC1000ZR-XPRO	Atmel Studio v7.0 and IAR
SAM D21	ATSAMD21J18A	ATBTLC1000-MR, ATBTLC1000-ZR	ATSAMD21-XPRO + ATBTLC1000-XPRO or ATSAMD21-XPRO + ATBTLC1000ZR-XPRO	Atmel Studio v7.0 and IAR
SAM G55	ATSAMG55J19	ATBTLC1000-MR, ATBTLC1000-ZR	ATSAMG55-XPRO + ATBTLC1000-XPRO or ATSAMG55-XPRO + ATBTLC1000ZR-XPRO	Atmel Studio v7.0 and IAR
SAM 4S	ATSAM4SD32C	ATBTLC1000-MR, ATBTLC1000-ZR	ATSAM4S-XPRO + ATBTLC1000-XPRO or ATSAM4S-XPRO + ATBTLC1000ZR-XPRO	Atmel Studio v7.0 and IAR

Table 2-1. BluSDK – Supported Hardware and IDEs

3. Hardware Setup

3.1 ATBTLC1000 Board Types

The ATBTLC1000 supports the following extension boards:

- 1. ATBTLC1000-MR
- 2. ATBTLC1000-ZR
 - Supports from BluSDK 6.0 release and later

The following figures illustrate samples of ATBTLC1000-MR and ATBTLC1000-ZR kit details displayed in the Atmel Studio.

Figure 3-1. ATBTLC1000-MR

 Kit Details 	
Extension port	EXT1
Extension manufacturer	Atmel
Extension product	ATBTLC1000-XPRO
Extension revision	02
Extension serial number	2528020200005982
Extension minimum voltage	1.8V
Extension maximum voltage	3.6V
Extension current	10mA

Figure 3-2. ATBTLC1000-ZR

∧ Kit Details	
Extension port	EXT1
Extension manufacturer	Atmel
Extension product	ATBTLC1000ZR-XPRO
Extension revision	03
Extension serial number	268903020000068
Extension minimum voltage	1.8V
Extension maximum voltage	3.6V
Extension current	10mA

3.2 SAM L21 Xplained Pro Setup

The following figure illustrates the connection between the ATBTLC1000-MR Xplained Pro Extension Board connected to the SAM L21 Xplained Pro Board.

Figure 3-3. ATBTLC1000-MR Xplained Pro Extension Connected to the SAM L21 Xplained Pro



Note: Refer to the following section for the ATBTLC1000-ZR Xplained Pro Extension Board configuration.

3.3 SAM D21 Xplained Pro Setup

The following figures illustrate the connection between the ATBTLC1000-MR and ATBTLC1000-ZR Xplained Pro Extension Boards connected to the SAM D21 Xplained Pro.

Figure 3-4. ATBTLC1000-MR Xplained Pro Extension Connected to the SAM D21 Xplained Pro



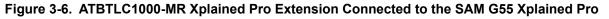
Figure 3-5. ATBTLC1000-ZR Xplained Pro Extension Connected to the SAM D21 Xplained Pro

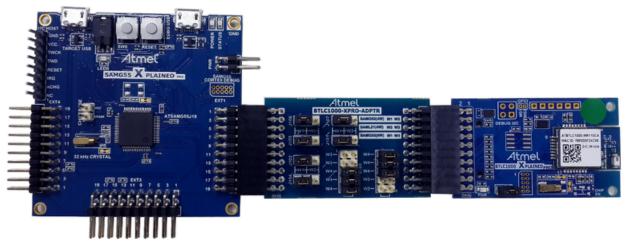


Note: The connection for the SAM L21 Xplained Pro with the ATBTLC1000-ZR Xplained Pro Extension Board is similar to the preceding figure.

3.4 SAM G55 Xplained Pro Setup

The following figures illustrate the connection between the ATBTLC1000-MR and ATBTLC1000-ZR Xplained Pro Extension Boards connected to the SAM G55 Xplained Pro Board.





Note:

1. The SAM G55 Xplained Pro is connected to the ATBTLC1000-MR Xplained Pro through the ATBTLC1000 XPRO adapter board.

2. For a jumper connection on 4-wire and 6-wire connections, refer to the ATBTLC1000-XPRO-ADAPTER marking label.

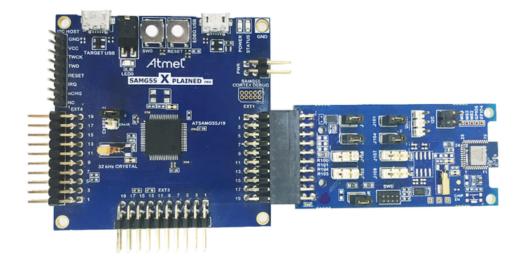


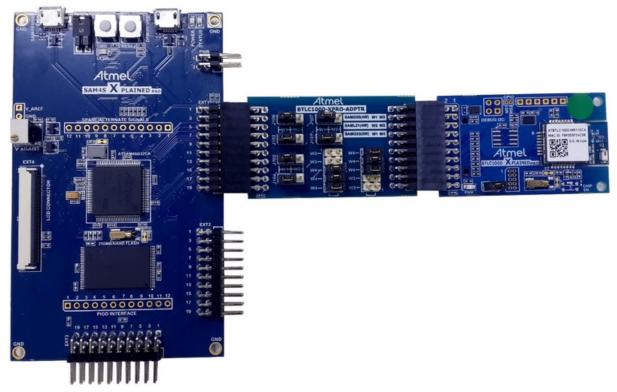
Figure 3-7. ATBTLC1000-ZR Xplained Pro Extension Connected to the SAM G55 Xplained Pro

Note: The connection for the SAM 4S Xplained Pro with the ATBTLC1000-ZR Xplained Pro Extension Board is similar to the preceding figure.

3.5 SAM 4S Xplained Pro Setup

The following figure illustrates the connection between the ATBTLC1000-MR Xplained Pro Extension Board and the SAM 4S Xplained Pro Board. These two devices are connected using the ATBTLC1000-XPRO-ADAPTER Board.

Figure 3-8. ATBTLC1000-MR Xplained Pro Extension Connected to the SAM 4S Xplained Pro



Note: For a jumper connection on 4-wire and 6-wire connections, refer to the ATBTLC1000-XPRO-ADAPTER marking label.

4. Software Setup

4.1 Installation Steps

- 1. Download and install the Atmel Studio software.
- 2. Install the standalone Advanced Software Framework (ASF) package.
- 3. Download and install the Microchip SmartConnect App on the mobile phone, available in the Apple Store[®] for iPhone and in the Google Play[™] Store for Android.

Note: Atmel Studio offers predefined example projects for the SAM L21, SAM D21, SAM G55 and SAM 4S extension boards.

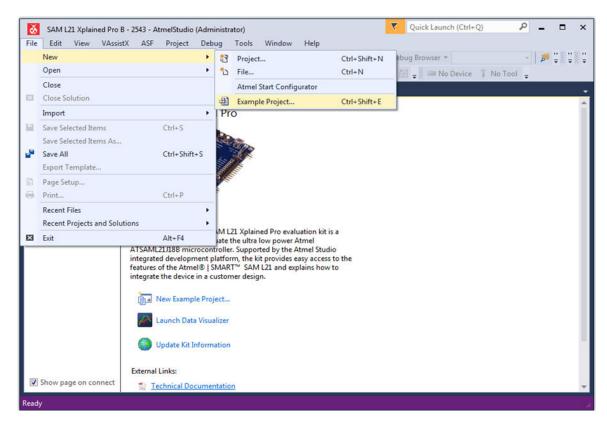
Note: For more information on the previous releases, refer to the *Atmel Studio Release Notes* available on the Microchip web page.

4.2 Build Procedure

Perform the following steps to build an example project. This example build procedure is developed using the SAM L21 Xplained Pro Board, which is also valid for the other supported hardware platforms and IDEs (see Table 2-1).

1. Open Atmel Studio and select File > New > Example Project.

Figure 4-1. Creating a New Project



2. In the New Example Project from ASF or the Extensions window:

- 2.1. Enter the application specific keyword in the search box; for example, Scan Parameter, Battery Service Application, Blood Pressure, etc.
- 2.2. Select the respective example application of theSAM L21 by expanding the "Atmel Atmel Corp." in the **All Projects** tab. This selection automatically populates the Project Name, Location, Solution, Solution Name, and Device.
- 2.3. Click **OK**.

Figure 4-2. Searching for a Specific Application Example

New Example Project from ASF or Extensions					
Device Family:	All Category: All Battery X	Battery Service			
All Projects Kit Category Technology Addon	 Atmel - Atmel Corp. (4) 327.2 Battery Service Application - SAM D21 Xplained Pro Battery Service Application - SAM L21 Xplained Pro Battery Service Application - SAM L21 Xplained Pro Battery Service Application - SAM L21 Xplained Pro 	Dattery Service Application SAML2J18B Battery Service Application for BLE stack. Image: Comparison of the stack			
Project Name:	BATTERY_INFO_SAML21_XPLAINED_PRO_B1				
Location:	C:\Atmel Studio\7.0	Browse			
Solution:	Create New Solution	•			
Solution name:	BATTERY_INFO_SAML21_XPLAINED_PRO_B1				
Device:	ATSAML21/18B				
		OK Cancel			

- 3. Select the "Accept the License Agreement" checkbox and then click **Finish**.
- 4. Atmel Studio generates the project files for the selected application example that can be used in the SAM L21 Xplained Pro board.
- 5. Go to Project > Properties to choose the hardware configuration switches and number of wires:
 - 5.1. Set the appropriate build symbols (see following figure):
 - For ATBTLC1000-MR: "BLE_MODULE = BTLC1000_MR"
 - For ATBTLC1000-ZR: "BLE_MODULE = BTLC1000_ZR"

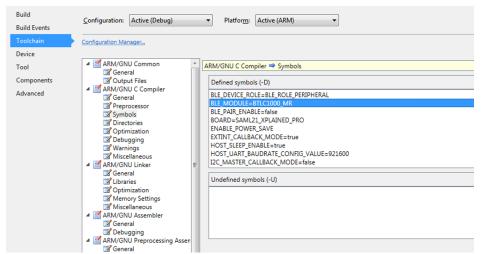


Figure 4-3. Selecting the ATBTLC1000 Board Type

- 5.2. Choose between the 4-wire or 6-wire modes:
 - ATBTLC1000-MR supports both 4-wire and 6-wire UART modes. The ATBTLC1000-XPRO-ADPTR must be with this board in 4-wire mode.
 - ATBTLC1000-ZR supports only 4-wire mode.

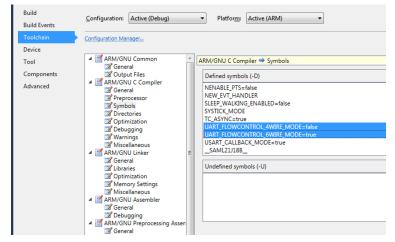
Note: For more information on 4-wire mode, refer to Hardware Flow Control for 4-wire Mode eFuse Write Procedure.

The configurations for 4-wire and 6-wire are as follows:

- 6-wire:
 - UART_FLOWCONTROL_4WIRE_MODE=false
 - UART_FLOWCONTROL_6WIRE_MODE=true
- 4-wire:
 - UART_FLOWCONTROL_4WIRE_MODE=true
 - UART FLOWCONTROL 6WIRE MODE=false

Configure UART_FLOWCONTROL_4WIRE_MODE and UART_FLOWCONTROL_6WIRE_MODE symbols in the project properties as shown in the following figure.

Figure 4-4. Configuring the UART Flow Compiler Symbols



6. For the Time Information Profile application, the user must select the compiler symbol based on the following:

For Android devices: TP_ANDROID

_

For iOS devices: NTP_ANDROID **Note:** This step is applicable only for the Time Information Profile application.

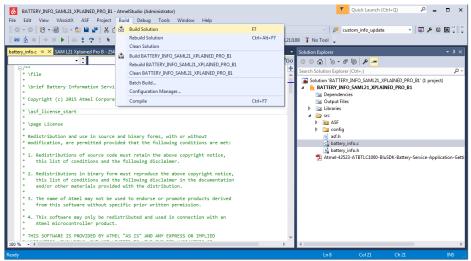
Figure 4-5. Configuring the UART Flow Compiler Symbols for the Time Information Profile



Note: iOS requires a device supporting the Time Information Profile to include the service solicitation advertisement type in the advertisement data. The above setting provides the configuration to build the Time Information Profile for iOS or Android. The iOS natively supports Time Server and does not require a specific mobile application. To enable the devices that are displayed on the iOS BLE devices page, the service solicitation advertisement data type configuration is necessary.

7. To build the solution, go to Build > Build Solution.

Figure 4-6. Building Solution for Selected Application Example



8. The generated solution is downloaded into the SAM L21 XPro board through the USB cable. To program the board, go to Tools > Device Programming.

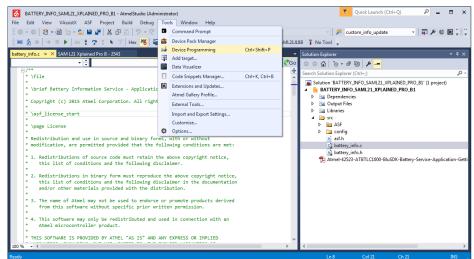


Figure 4-7. Selecting Device Programming

- 9. In the EDBG (XXXXXXX) Device Programming window, perform the following steps:
 - 9.1. Select EDBG in **Tool**.
 - 9.2. Click **Apply** and then click **Read** to read the *Device Signature*.
 - 9.3. After reading the *Device*, click **Program** to program the device.
 - Figure 4-8. Embedded Debugger Device Programming Window

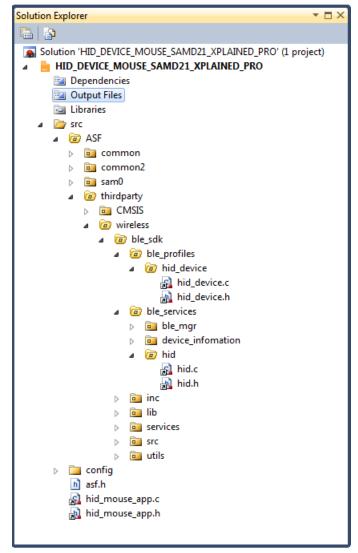
EDBG (ATML2241040200002543) - Device Programming					
Tool Device EDBG TODE ATSAML21J188	Interface Device signature Target Voltage 3 V SWD Apply 0x1081010F Read 3.3 V Read				
Interface settings Tool information	Device Erase Chip 💌 Erase now				
Device information	Flash (264 KB)				
Memories	C:\Atmel Studio\7.0\BATTERY_INFO_SAML21_XPLAINED_PRO_B1\BATTERY_INFO_SAML21_XPLAI				
Fuses Security	✓ Erase Flash before programming ✓ Verify Flash after programming ✓ Advanced Verify Read				
	User Page (256 bytes)				
	 ✓ Im ✓ Erase User Page before programming ✓ Verify User Page after programming ✓ Advanced 				
Reading device IDOK					
С ОК					
	Close				

- After flashing the example application into the SAM L21 Xpro board, it is ready to be used as a BLE device that supports the selected application example.
 Note:
 - 1. To run the profile application, refer to Running the Demo.
 - 2. In the case of HID and Broadcaster applications, refer to the following configuration sections.

4.2.1 HID Mouse and HID Keyboard Application Configuration

The user needs to modify a few macros in hid_device.h (HID profile) for configuring the profile for HID Mouse and HID Keyboard applications as per the desired application use case.

Figure 4-9. HID Mouse Code Hierarchy



Note: Similar to HID Mouse, the hid_device.h file for the HID Keyboard is available in the following directory: \asf\thirdparty\wireless\ble_sdk\ble_profiles\hid_device\

The list of macros that must be modified by the user are:

1. By default, the application supports Report mode. If the application requires only Boot mode support, the user can add the macro BOOT_MODE in the **Compiler/Symbols** tab, as shown in the following screen.

-		7	Ouick Launch (Ctrl+O)	×
HID_DEVICE_MOUSE_SAMIL21_XPLAINED_PRO_B2 - AtmelStu		1	Quick Launch (Ctrl+Q)	- 0 ×
File Edit View VAssistX ASF Project Build Debu		🔎 🔎 custom info update	· . / C	
	C * I C = Debug * Debug Browser *		• #1 \rake @ [# @ [] • -	
	🝓 📲 👷 💷 💷 🐨 🖉 🔛 🔛 🔛 👘 🖓 ATSAMLZIJISS 🁔 No To	ol 🚽		
HID_DEVICE_MOUSXPLAINED_PRO_B2 + ×	· · · · · · · · · · · · · · · · · · ·	Solution Explorer		* # ×
Build Configuration: Active (Debug)	Platform: Active (ARM)	ം പ്ര- ഭതം ,	£	
Build Events	- Part (start)	Search Solution Explorer (Ctrl+;)		ρ.
Toolchain Configuration Manager 3		Solution 'HID DEVICE MOI	USE SAMIL21 XPLAINED PRO 82 (1 proje	
Device		HID_DEVICE_MOUSE_	* 0.00	
Tool ARM/GNU Common	ARM/GNU C Compiler => Symbols	Output Files	Rebuild	
Components OutputFiles	Defined symbols (-D)	Elibraries	Clean	
Advanced ARM/GNU C Compiler	DEBUG	A by sec	Copy Full Path	
C Descoveror	BLE_DEVICE_ROLE=BLE_PERIPHERAL 5	config	 Collapse 	
4 Symbols	DEVICE_INFORMATION_SERVICE	asf.h	Scope to This	
Cotimization	HID_MOUSE_DEVICE ARM_MATH_CMOPLUS=true	hid mouse app	New Solution Explorer View	
ar Debugging ar Warnings	SYSTICK_MODE	1 Atmel-42524-ATBT	Add	•
Miscellaneous	HID_SERVICE ENABLE PTS=false		Add Library	
A MANJGNU Linker			Set as StartUp Project	
Libraries	Undefined symbols (-U)		Re-Configure Atmel Start Project	
Continuation			Launch Atmel Start	
Miscellaneous			ASF Wizard	
ARM/GNU Assembler			Board Wizard	Alt+Z
Comparing Comparing			View Example Project Help	,
ARM/GNU Preprocessing Assemt			Export Project as Extension	
Symbols			👗 Cut	Ctrl+X
Debugging			× Remove	Del
General			Rename	F2
			Unload Project	
			✤ Properties	
×				
		4) b

Figure 4-10. Enabling Boot Mode Support

2. The user must configure the desired number of reports in the application. Currently, a maximum of 10 reports are supported.

#define HID NUM OF REPORT (1)

3. The user must configure the desired number of service instances. Currently, a maximum of two services are supported.

#define HID_SERV_INST (1)

Note: After configuring the profiles for HID Mouse and HID Keyboard, follow the steps mentioned in HID Mouse Device and HID Keyboard Device, respectively.

4.2.2 Configuration of the Simple Broadcaster Application

- Simple Broadcaster application advertises the default configuration provided as follows:
 - Non-connectable undirected advertisement event
 - Broadcasts data in advertisement data packets only
 - Broadcasts the following advertisement data types:
 - Complete list of 16-bit service class UUIDs
 - Complete local name
 - Appearance
- The configuration and advertisement data types listed above can be changed by using the macros provided in the simple_broadcaster_app.h file that is available in the \src\config\ directory.

Note: After configuration, follow the steps mentioned in Simple Broadcaster Application.

4.2.3 Configuration of Observer Application

The default scanning parameters of Observer application are:

MAX SCAN DEVICE	(10)
SCAN INTERVAL	(96)
SCAN WINDOW	(96)
SCAN TIMEOUT	(0x0000)
SCAN_TYPE	(AT_BLE_SCAN_ACTIVE)

These parameters can be modified as per the user requirement. These parameter can be updated in the ble_manager.h file, which is available in the following directory: \asf\thirdparty\wireless \ble_sdk\ble_services\ble_mgr\

Note: After configuration follow the steps in Observer Application.

5. Application Demo

5.1 Demo Setup

The following figure shows how to setup the board and the Microchip SmartConnect App for the purpose of the demo.

Figure 5-1. Demo Setup



Applications (Keywords)	BLE Node 1	BLE Node 2
Observer Application	Any BLE device can be used as Peripherals	Supported by the ATBTLC1000- MR/ZR extension board and microcontroller to act as an Observer application
Proximity Reporter Application	Supported by the Microchip SmartConnect application for iPhone/Android devices to act as a Proximity Monitor	Supported by the ATBTLC1000- MR/ZR extension board and microcontroller to act as a Proximity Reporter
Proximity Monitor Application	Supported by the ATBTLC1000- MR/ZR extension board and microcontroller to act as a Proximity Monitor	Supported by the ATBTLC1000- MR/ZR extension board and microcontroller to acts as a Proximity Reporter
ANCS Profile Application	Supported by the Microchip SmartConnect application for only iPhone devices to act as a Notification Provider	Supported by the ATBTLC1000- MR/ZR extension board and microcontroller to act as a Notification Consumer
Scan Parameters Service Application	Supported by the Microchip SmartConnect application for iPhone/Android devices	Supported by the ATBTLC1000- MR/ZR extension board and microcontrollers to act as Scan Parameter Service
Time Information Profile Application	Supported by the Microchip SmartConnect application for iPhone/Android devices to act as a Time server	Supported by the ATBTLC1000- MR/ZR extension board and microcontroller to act as Time client

ATBTLC1000

Applications (Keywords)	BLE Node 1	BLE Node 2
HID Mouse Device Application	Supported by the Microchip SmartConnect application only for Android devices to act as HOGP host	Supported by the ATBTLC1000- MR/ZR extension board and microcontroller to act as HID Mouse Device application
HID Keyboard Device Application	Supported by the Microchip SmartConnect application only for Android devices to act as Notepad text editor app (HOGP Host role)	Supported by the ATBTLC1000- MR/ZR extension board and microcontroller to act as HID Keyboard Device application
Battery Service Application	Supported by the Microchip SmartConnect application for iPhone/Android devices	Supported by the ATBTLC1000- MR/ZR extension board and microcontroller to act as Battery Service application
Simple Broadcaster Application	Supported by the ATBTLC1000- MR/ZR extension board and microcontroller to act as Simple Broadcaster application	Supported by Scanner application on a mobile phone
Device Information Service	Supported by the Microchip SmartConnect application for iPhone/Android devices	Supported by the ATBTLC1000- MR/ZR extension board and microcontroller to act as Device Information Service application
Custom Serial Chat Profile Application	Supported by Custom Serial Chat (CSC) application for iPhone/ Android to send and receive data	Supported by the ATBTLC1000- MR/ZR extension board and microcontroller with CSC application to send and receive data
Heart Rate Profile Application	Supported by the Microchip SmartConnect application for iPhone/Android devices to act as a Heart Rate Data Collector	Supported by the ATBTLC1000- MR/ZR extension board and microcontroller to act as Heart Rate Sensor
Blood Pressure Profile Application	Supported by the Microchip SmartConnect application for iPhone/Android devices to act as a Blood Pressure Monitor	Supported by the ATBTLC1000- MR/ZR extension board and microcontroller to act as Blood Pressure Sensor
Find Me Profile Application	Supported by the Microchip SmartConnect application for iPhone/Android devices to act as a Find Me Locator	Supported by the ATBTLC1000- MR/ZR extension board and microcontroller to act as Find Me Target
Phone Alert Status Profile Application	Supported by the Microchip SmartConnect application only for Android devices to act as a Phone Alert Status server	Supported by the ATBTLC1000- MR/ZR extension board and microcontroller to act as Phone Alert Status client
Alert Notification Profile Application	Supported by the Microchip SmartConnect application only for	Supported by the ATBTLC1000- MR/ZR extension board and

ATBTLC1000

Applications (Keywords)	BLE Node 1	BLE Node 2	
	Android devices to act as a Notification Provider	microcontroller to act as Notification Consumer	
Multi-Role Peripheral Multi- Connect Application	Supported by the ATBTLC1000-MR/ZR extension board, microcontroller, and Microchip SmartConnect application to act as Peripheral or Central. This supports maximum of eight connections		
L2CAP Throughput Application	Supported by the ATBTLC1000- MR/ZR extension board and microcontroller to act as L2CAP Central	Supported by the ATBTLC1000- MR/ZR extension board and microcontroller to act as L2CAP Peripheral	
Health Thermometer Profile (HTP) Application	Supported by the Microchip SmartConnect application for iPhone/Android devices to act as a Health Thermometer Collector	Supported by the ATBTLC1000- MR/ZR extension board and microcontroller to act as HTP application	
iBeacon Application	Supported by the Microchip SmartConnect application for iPhone/Android devices to act as Beacon Monitor	Supported by the ATBTLC1000- MR/ZR extension board and microcontroller to act as Beacon Reporter	
AltBeacon Application	Supported by the Microchip SmartConnect application for iPhone/Android devices act as a AltBeacon App (Monitor)	Supported by the ATBTLC1000- MR/ZR extension board and microcontroller to act as Reporter	
Eddystone Beacon Application	Supported by the Microchip SmartConnect application for iPhone/Android devices	Supported by the ATBTLC1000- MR/ZR extension board and microcontroller to act as Eddystone Beacon Application	
Direct Test Mode (DTM) Application	Supported by the ATBTLC1000- MR/ZR extension board and microcontroller to act as a Transmitter (Tx) Test Board. BLE performance analyzer tool connected with target board using COM port	Supported by the ATBTLC1000- MR/ZR extension board and microcontroller to act as a Receiver (Rx) Test Board. BLE performance analyzer tool connected with target board using COM port	

5.2 Console Logging

For the purpose of debugging, a logging interface can be implemented in the applications.

The logging interface utilizes the same EDBG port that connects to a supported Xplained Pro (XPro) platform. A serial port monitor application (for example, TeraTerm) is opened and attached to the appropriate COM port enumerated by the device on the PC.

5.3 Running the Demo

Initializing the Device

Perform the following steps to initialize the device:

- 1. Open any Terminal Application (for example, TeraTerm). Select the COM port enumerated on the PC and set the following parameters:
 - Baudrate 115200
 - Parity None
 - One Stop bit
 - One Start bit
 - No Hardware Handshake
- Press the Reset button on the supported Xplained Pro (XPro) platforms (see Table 2-1).
 Note: The device is now ready to be used as selected application and starts to scan or advertise on the button press. This button must be pressed only when the "Press button" is displayed on the console log window. The same button is pressed to stop the device scan or advertise.
- 3. The device is in advertising mode and the device initialization message is displayed on the console window.

```
Initializing Application
BTLC1000 XPro Module: BTLC1000-ZR
BTLC1000 Host Interface UART Mode:4-Wire, Baudrate:921600
Initializing BTLC1000
BTLC1000 Chip ID: 0x2000B1
BD Address:0xF8F005F60515, Address Type:0
BluSDK Firmware Version:6.1.7035
BLE Started Advertisement
```

Pairing Procedure

Perform the following steps to pair the device with the smartphone application:

1. Open the Microchip SmartConnect application and click the **Bluetooth Smart** in an application dashboard as illustrated in the following figure.



Figure 5-2. Dashboard of Microchip SmartConnect Application

To scan for the peripheral devices, click the START SCAN option available in scanning page. The device name (for example, ATMEL-PXP) is displayed among the list of scanned devices.
 Figure 5-3. Scanning for Devices

No SIM 🗢 Home	09:19 BLE Scanner	8 99% → +	No SIM ♀ Home	16:37 BLE Scanner	≁ ≹ 100% 🖚 ୧ 🔳 💠
		START SCAN	$\theta^{\rm star}_{\rm star}$		STOP SCAN
			E.	ATMEL-PXP 3 services	-64 dBm
	Міскоснір		>		
			L.		

3. Select the device name in the scan results, which initiates the pairing procedure. Enter the passkey "123456" on Bluetooth Pairing Request window and click **Pair**. The mobile app displays "Successful connection" upon successful completion of pairing.

Figure 5-4. Pairing Request

	16:39 ATMEL-PXP	7 🐮 100% 🗰	No SIM ♥	09:26 ATMEL-PXP	* 99% 🛶 (
	▲ ▲ [′] Г			▲ [′]	
	Bluetooth Pairing Re	quest	Blu	etooth Pairing Red	quest
Link L Assign This se	"ATMEL-PXP" would like to your iPhone. Enter the code "ATMEL-PXP".			EL-PXP" would like to p Phone. Enter the code s "ATMEL-PXP".	
betwee			betwee	••	
	Cancel	Pair	с	ancel P	air
A REAL PROPERTY AND A REAL	ate Alert Service		Immediate Ale Assigned Nur		
	vice exposes a control point t		This service exp	ooses a control point to	allow a peer
	1 <u>2</u>	3 Def	1	2 ^BC	3 Def
L G	1 5 _{ні JKL}	6 ^{MNO}	4 _{бні}	5 JKL	6 ^{MNO}
PC	7 8 Irs TUV	9 wxyz	7 PORS	8 TUV	9 wxyz
	0	\bigotimes		0	\otimes

- 4. On the device side, the console displays the successful completion of the pairing procedure.
- 5. On the Microchip SmartConnect app, the supported services are displayed for the device.

Figure 5-5. Display of Services Supported by the Application



5.3.1 Observer Application

Perform the following steps to run the Observer application demo:

- 1. Follow the steps (1 and 2) from Initializing the Device.
- 2. The device is now ready to be used as an Observer and starts to scan for nearby BLE devices.
- 3. The following figure shows example logs from the Observer application:
 - Figure 5-6. Observer Console Output

🤐 COM35:115200baud - Tera Term VT	
<u>File Edit Setup Control Window</u>	Help
Initializing BTLC1000 BD Address:0xF8F005F34C98, f Press button to start scann: Scanning,Please wait Scanning process initiated Press button to stop scanning	ing
Advertisement type Device address type Device address RSSI Flags	: ADU_IND : RANDOM_RESOLUABLE_PRIVATE_ADDRESS : Øx588829b1bf11 : -59 : LE_CENERAL_DISCOUERABLE_MODE_LE_BREDR_CAPABLE_CONTROLLER_LE_BREDR_CAPABLE_HOST : DE_CONTROLLER_LE_BREDR_CAPABLE_CONTROLLER_LE_BREDR_CAPABLE_HOST
Complete_16bit_service_uuids	
Advertisement type Device address type Device address RSSI RSSI	: ADU_IND : RANDOM_RESOLUABLE_PRIVATE_ADDRESS : 0x588229515f11 : -58
Flags Complete_16bit_service_uuids	: LE_GENERAL_DISCOUERABLE_MODE LE_BREDR_CAPABLE_CONTROLLER LE_BREDR_CAPABLE_HOST : 0x180a 0x1816
Advertisement type Device address type Device address RSSI Complete Local Name	: ADU_SCAN_RESPONSE : RANDOM_RESOLUABLE_PRIVATE_ADDRESS : Øx588829b1bf11 : -58 : Cycling Speed and Cadence
Advertisement type Device address type Device address RSSI Flags	: ADU_IND : RANDOM_RESOLUABLE_PRIVATE_ADDRESS : Øx588829b1bf11 : -51 : LE_GENERAL_DISCOVERABLE_MODE LE_BREDR_CAPABLE_CONTROLLER LE_BREDR_CAPABLE_HOST
Complete_16bit_service_uuids	: 0x180a 0x1816
Advertisement type Device address type Device address RSSI RSSI	: ADU_SCAN_RESPONSE : RANDOM_RESOLUABLE_PRIVATE_ADDRESS : Øx588829bibf11 : -51
Complete Local Name	: Cycling Speed and Cadence
Device address RSSI	: ADU_IND : RANDOM_RESOLUABLE_PRIVATE_ADDRESS : 0x588829b1bf11 : -45
Flags Complete_16bit_service_uuids	: LE_GENERAL_DISCOUERABLE_MODE_LE_BREDR_CAPABLE_CONTROLLER_LE_BREDR_CAPABLE_HOST : 0x180a_0x1816
Advertisement type Device address type Device address RSSI	: ADU_SCAN_RESPONSE : RANDOM_RESOLUABLE_PRIVATE_ADDRESS : Øx588829blbf11 : -45
Complete Local Name Scanning process terminated Press button to start scann:	: Cycling Speed and Cadence ing

5.3.2 Proximity Reporter Application

Perform the following steps to run the Proximity Reporter application demo:

- 1. Establish the connection between the device and mobile phone using the procedure listed in Running the Demo.
- 2. Select the desired service (Link Loss or Immediate Alert) for alert level characteristics configuration. Choose a value from the following:
 - HIGH ALERT
 - MILD ALERT
 - NO ALERT

No SIM ♀ ← Range Selecto	09:56 Settings or	\$ 100% ••+	No SIM 🗢	16:41 Link Loss Service	⊀ ∦ 100%∎
NO ALE	DANGER	GH ALERT		6	
NO ALE		GH ALERT	\sim		
NO ALE	SAFE	GH ALERT			
			NO	ALERT MILD ALERT HIG	HALERT

Figure 5-7. Configuring Alert Level Settings

3. After configuration of the desired alert levels, click **Immediate Alert** service and then move the mobile phone away from the Proximity reporter. Based on the distance of separation, Path Loss is plotted on the zone radar (using RSSI values received from the Proximity Reporter). Based on the zone, the Proximity Monitor sends the corresponding alert level. The console log on the Proximity Reporter displays the corresponding alerts and on-board status LED behavior.

Figure 5-8. Proximity Reporter Path Loss Plot Across Safe, Mid, and Danger Zone



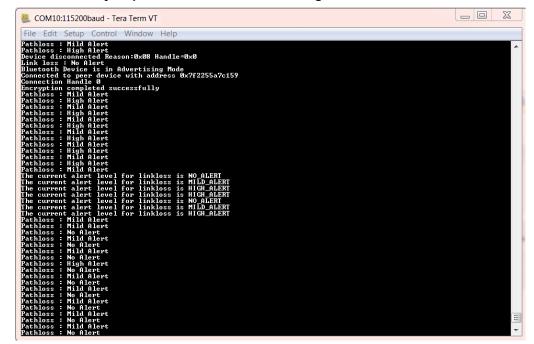


Figure 5-9. Proximity Reporter Path Loss Console Log Alerts Notification

4. After configuration of the desired alert levels, click on the Link Loss service and then move the mobile phone away from the reporter. Based on the distance of separation, the Proximity Reporter receives the path loss notifications based on the alert settings. Keep moving until the "Link Loss" pop-up appears. The console log on the Proximity Reporter displays the corresponding alerts and when Link Loss occurs, it reports the disconnection and the on-board status LED behavior. The lock screen emulates a common use-case application where the Link Loss service is used (for example, key fob). When the user is in close proximity, the lock remains open. Subsequently, the user moving out of range can be triggered to close the lock.

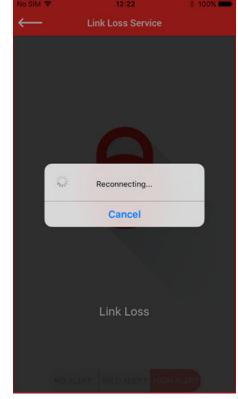
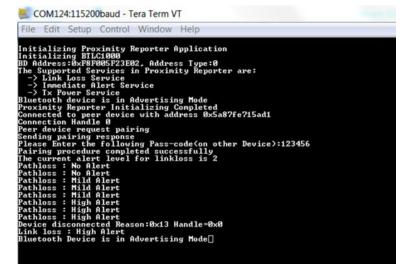


Figure 5-10. Link Loss Pop-up on Proximity Monitor

Figure 5-11. Proximity Reporter Console Log for Link Loss



- 5. After Link Loss, the mobile application attempts to reconnect to the Proximity Reporter. The connection is re-established by moving the mobile phone closer to the reporter.
- 6. The Tx Power service is used to retrieve the Tx Power of the Proximity Reporter. Click **Tx Power** service icon in the services screen. The Proximity Monitor reads the Tx Power value from the Proximity Reporter and displays the TX POWER LEVEL as shown in the following figure.



Figure 5-12. Proximity Monitor – Reading Tx Power Service

5.3.3 Proximity Monitor Application

Perform the following steps to run the Proximity Monitor application demo:

- 1. Connect one ATBTLC1000-MR/ZR device loaded with the Proximity Monitor example application code. Follow the steps (1 and 2) from Initializing the Device.
- 2. Setup another ATBTLC1000-MR/ZR device with the Proximity Reporter application. Follow all the steps from Initializing the Device. The device starts advertising.
- 3. The Proximity Monitor device then starts scanning for available devices in the vicinity and displays its Bluetooth Device Address (BD) in the console window. The Proximity Reporter device found during the scan is displayed in the console log window (refer to the following figure). Select the index number of that device to establish connection with it.

Figure 5-13. Proximity Monitor Connection with a Proximity Reporter

COM112:115200baud - Tera Term VT File Edit Setup Control Window Help	Proximity supported	
Initializing BTLC1000 BD Address: SWxPSF005F23D02, Address Type:0 High Alert KSSI range: -740Bm and above Mild Alert KSSI range: -740Bm to -740Bm No Alert KSSI range: -740Bm and below Initializing Provinity Monitor Application Scanning71Easte udit610 Boc6FB6C686119 Select Index number to Connect or [s] to scan PAP Connect request sent Connection Loger device with address 0x66fb6c6861 Connection Handle 0 Iank Joss service discovered Tx pover service discovered		
Ix Power of device is 06 dBm Starting timer Rx Power(RSSI):-022 dBm——No Alert Rx Power(RSSI):-022 dBm——No Alert Rx Power(RSSI):-022 dBm——No Alert Rx Power(RSSI):-028 dBm——No Alert		

4. When the connection is established, the Proximity Monitor sets the link loss alert value to "HIGH ALERT" at the Proximity Reporter device. The Proximity Monitor also monitors the path loss, if the Proximity Reporter device supports the optional "Immediate Alert" service and "Tx Power" service. The Proximity Reporter example application supports both of these optional services. The default alert settings are as follows:

- For HIGH ALERT, set high alert RSSI to -91dBm and above, alert status is indicated by LED, which must be ON.
- For MILD ALERT, set RSSI to -70dBm to -90dBm, alert status is indicated by LED, which must be toggling.
- For NO ALERT, set RSSI to -69dBm and below, alert status is indicated by LED, which must be OFF.

If the reporter device moves out of the proximity of the monitor device, the path loss crosses the threshold values and the corresponding alert value is set; the alert notification is displayed on the console as shown below.

Figure 5-14. Proximity Monitor Setting Alert Levels

COM112:115200baud - Tera Term VT		
Eile Edit Setup Control Window Help		
nitislising HICLEND 10 Address PartWFFS2122, Address Type:0 High Hart ESSI range: "FidBs and abave Pila Hart ESSI range: Type Address Pila Hart ESSI range: Type Address In tislising Provinity Ponitor Application Scaning Finans wait Interview Finans wait Interview Finans wait Deckel Hade under the Address HI BarPMORT223EF7 Eacher Index under to Concettor Fistes can		
TYP Connect sent Connected to per device with address 0x67915acd291e Connection Handle 0 Link loss service discovered TA publer corvice discovered Interdiale Alex service discovered		
Ix Power of device is 06 dBm Starting timer Rx Power(RSSI):-077 dBmHild Alert!		
Rx Power(R061):-867 dBmNo Rigert		
Rx Power(ISSI):-075 dBmHild flert!		
R: Four(SI):=00 dBn-miid fort R: Four(SI):=072 dBn-miid fort R: Four(SI):=072 dBn-miid fort R: Four(SI):=072 dBn-miid fort R: Four(SI):=072 dBn-miid fort R: Four(SI):=075 dBn-miid fort	Alert Status for Path loss	
Rx Power(\$\$1):-078 dBmHild Flert!		
Rx Power(SSI):-#76 dBmHild flert Rx Power(SSI):-#72 dBmHild flert Rx Power(SSI):-#66 dBmHo Alert		
Rx PowerC SSI):-0661 dBm-→No Alert Rx PowerC SSI):-068 dBm-→No Alert Rx PowerC SSI):-057 dBm-→No Alert Rx PowerC SSI):-071 dBm-→Nild flert?		
Rx Power(1SS1):-0674 dBmHild (lert! Rx Power(RLS1):-060 dBmHo Avert		

5.3.4 ANCS Application

Perform the following steps to run the ANCS application demo:

- 1. Follow the steps from Initializing the Device.
- Enable Bluetooth from the Settings page of iPhone. The phone starts to scan for the devices. ATMEL-ANCS appears among the list of devices scanned. Click the **ATMEL-ANCS** to connect to the device.

Figure 5-15. ANCS Device Discovery in iPhone

+	8:42 pm	🔻 51% 🔳 🔿
Settings	Bluetooth	
Bluetooth		
Now discoverable	e as "iPhone (3)".	
DEVICES		
ATMEL-ANCS	3	
CHELT0172		
To pair an Apple Watch app.	Watch with your iPhone,	go to the Apple

3. When connected, the client side initiates a pairing request with the iPhone. The console log provides guidance for the user to enter the pass-key on the iPhone.

Figure 5-16. Console Display for Pairing in ANCS

COM129:115200baud - Tera Term VT
File Edit Setup Control Window Help
ANCS Application Initializing BTLC1000 BD Address:0xF8F005F35254, Address Type:0 Device is in Advertising Mode Connected to peer device with address 0x5b8a7130cacc Connection Handle 0 Please Enter the following Pass-code(on other Device):123456 Pairing procedure completed successfully]

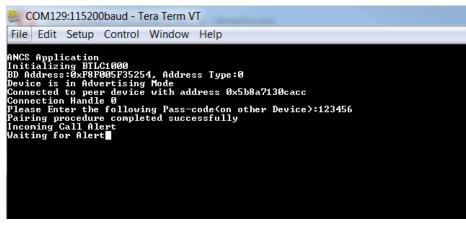
4. Enter the pass-key displayed in the console log on the Bluetooth Pairing Request window of the iPhone and click **Pair**. After the device is connected, "ATMEL-ANCS" appears in the MY DEVICES section on the iPhone.

Figure 5-17. Pairing and Connecting iPhone to ATMEL-ANCS

"ATMEL-ANCS" wor	Bluetooth Pairing Request "ATMEL-ANCS" would like to pair with your iPhone. Enter the code shown on		:43 pm ≵ 50% ■⊃ ietooth
your iPhone. Enter t "ATMEL-		Bluetooth	one (3)".
Cancel	Pair	ATMEL-ANCS	Connected (i)

5. Now, the user can initiate a mobile terminated call to the iPhone. When the iPhone receives a call, the corresponding incoming call alert is indicated on the device side console log window. Once the call is terminated, the device waits for a new alert to occur, as shown in the following screen.

Figure 5-18. Console Display for Notification Received as Incoming Call Alert



5.3.5 Scan Parameters Application

Perform the following steps to run the Scan Parameters application demo:

- 1. Establish the connection between the device and mobile phone using the procedure listed in Running the Demo.
- 2. When paired, the application displays the Scan Parameters and the Generic Information service.
- 3. Click the **Scan Parameters** service. The user receives a notification for the scan refresh characteristic value. The user can disable the notification in the Scan Parameters page, refer the following figure.

Figure 5-19. Scan Refresh Characteristic Notification Options

	Scan Parameters	
	E	
Scan Inte	rval	
13		ms
Scan Win 45	dow	ms

- 4. The user can set appropriate value for the Scan Interval and Scan Window characteristics.
- 5. The newly updated values of Scan Interval and Scan Window must be displayed on the console log of the device side as shown in the following figure.

Figure 5-20. Updated Scan Interval/Window Characteristic Value on Device

Initializing Scan Parameter Application
Initializing BTLC1000
BD Address:0xF8F005F23DED, Address Type:0
BLE Started Adv
Connected to peer device with address 0x4e3cd73c6fcc
Connection Handle Ø
Peer device request pairing
Sending pairing response
Please Enter the following Pass-code(on other Device):123456
Pairing procedure completed successfully
New scan interval window parameter
Scan Interval 3 ms
Scan Window 3 ms
Scan Refresh Characteristic Value: 0
New scan interval window parameter
Scan Interval 3 ms
Scan Window 3 ms
Scan Refresh Characteristic Value: Ø
New scan interval window parameter
Scan Interval 12 ms
Scan Window 3 ms
Scan Refresh Characteristic Value: Ø
New scan interval window parameter
Scan Interval 12 ms
Scan Window 3 ms
Device disconnected Reason:0x13 Handle=0x0
BLE Started Adu

5.3.6 Time Information Profile Application

Perform the following steps to run the Time Information Profile application demo:

- 1. Follow steps 1 through 4 from the ANCS Application.
- 2. Press the SW0 button on the device to read the internally supported characteristic values from the iPhone.

3. The console log on the device side displays the values for all characteristics supported by the iPhone internally.

Figure 5-21. Console Display – Date, Time, and Day Information



5.3.6.1 Running the Demo for Android devices

Perform the following steps to run the Time Information Profile application demo for Android devices:

- 1. Establish the connection between the device and mobile phone using the procedure listed in Running the Demo.
- 2. After the device is connected, the application displays Continuous Time Service, Next DST Change Service, and Reference Time Update Service.
- 3. The user has to click on the services to read the characteristic values.
- 4. Press the SW0 button on the supported platform device to read the internally supported characteristic values from the Android device.
- 5. The console log on the device side displays the values for all the characteristics supported by the device.

Figure 5-22. Console Display - All Supported Characteristic Values

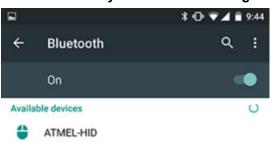
Current Time:[DD:MM:YYYY]: 13-09-2015 [HH:MM:SS]: 04:42:56 Day:SUN	Fraction:00
Time Zone 22	
DST Offset 00 Standard Time	
Time Source = 6 Cellular Network	
Accuracy = 255	
Day Since Update = 255	
Hour Since Update = 255	
DST Time is Îime:[DD:MM:YYYY]: 13-09-2015 [HH:MM:SS]: 04:42:56 DST	Offset is :00
Source = 255	
Result = 00	

5.3.7 HID Mouse Device Application

Perform the following steps to run the HID Mouse Device application demo:

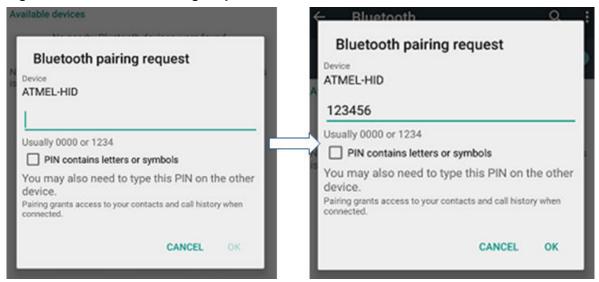
- 1. Follow the steps from Initializing the Device.
- 2. In this demonstration, an Android device supporting HOGP is used. The HOGP profile is natively supported in Android version 4.4 (Android KitKat) and higher. The mobile phone must include a Bluetooth chipset supporting Bluetooth 4.0 or higher. On the mobile phone, enable Bluetooth in the Settings page to scan for the devices. "ATMEL-HID" appears among the list of scanned devices. Select ATMEL-HID to connect to the supported platform device.

Figure 5-23. HID (Mouse) Device Discovery on Bluetooth Settings Page

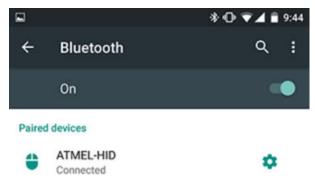


3. Click **ATMEL-HID** to start the pairing procedure. A pop-up requesting the pass-key appears. Enter pass-key "123456" and click **Pair**.

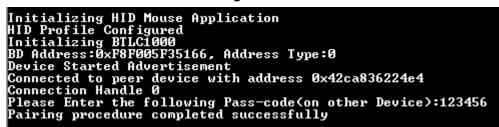
Figure 5-24. Bluetooth Pairing Request



4. After pairing is complete, the connected device is listed under Paired device. **Figure 5-25. Paired Devices**



5. The HID device side for the pairing and connection procedure is shown in the console log. **Figure 5-26. HID Mouse Device Console Log**



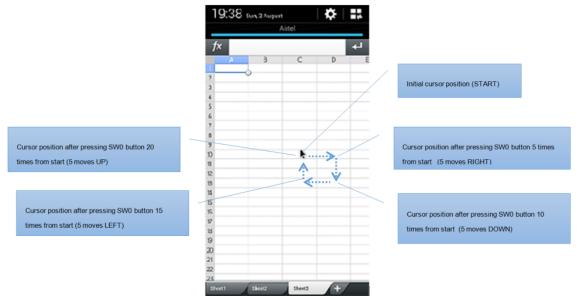
- 6. After the device is connected to the mobile phone, the user can click on the SW0 button to simulate mouse movement.
- 7. For every press of the button, the user can see a corresponding cursor movement on the HID host as described below:
 - First 5 button presses cursor moves right
 - Next 5 button presses cursor moved down
 - Next 5 button presses cursor moves left
 - Next 5 button presses cursor moved up

The same sequence is repeated based on user input. The console log is shown in the following screen.

Figure 5-27	HID Device	Console Log	for Movement
-------------	------------	--------------------	--------------

Mouse	Right	Movement
Mouse	Right	Movement
Mouse	Right	Movement
	Right	
Mouse	Right	Movement
Mouse	Down	
Mouse	Down	Movement
Mouse	Down	Movement
Mouse	Down	Movement
Mouse		Movement
Mouse	Left	Movement
Mouse		Movement
Mouse	UP	Movement
Mouse		Movement
Mouse	UP	Movement
Mouse	UP	Movement



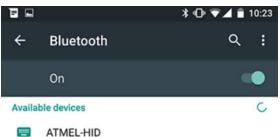


5.3.8 HID Keyboard Device Application

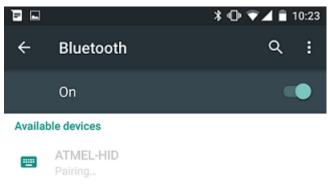
Perform the following steps to run the HID Keyboard device application demo:

- 1. Follow the steps from Initializing the Device.
- 2. In this demonstration, an Android device supporting HOGP is used. The HOGP profile is natively supported in Android version 4.4 (Android KitKat) and higher. The mobile phone must include a Bluetooth chip-set supporting Bluetooth 4.0 or higher. On the mobile phone, enable Bluetooth in the Settings page to scan for the devices. "ATMEL-HID" appears among the list of scanned devices. Select ATMEL-HID to connect to the supported platform device.

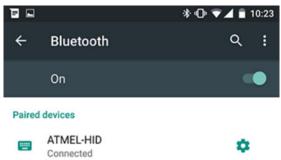
Figure 5-29. HID (Keyboard) Device Discovery on Bluetooth Settings Page



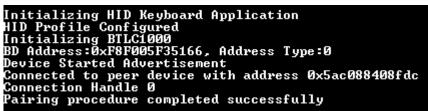
3. Click **ATMEL-HID** to initiate the pairing procedure. **Figure 5-30. Pairing Procedure with HID Device**



After pairing is complete, the connected device is listed under Paired device.
 Figure 5-31. Paired Devices

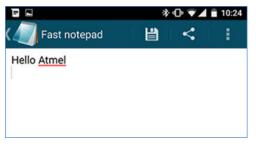


The HID device side for the pairing and connection procedure is shown in the console log.
 Figure 5-32. HID Keyboard Device Console Log



- 6. After the device is connected, start any notepad application on the mobile phone.
- 7. Click the SW0 button on the supported platform device.
- 8. The user can see a letter for each press in the application "Fast notepad".
- 9. The user can see a complete "Hello Atmel" in the application as shown in the following screen.

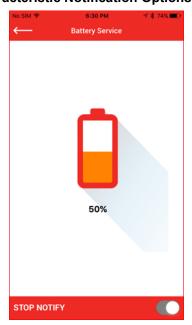
Figure 5-33. Message Displayed in the Application



5.3.9 Battery Service Application

Perform the following steps to run the Battery Service Application demo:

- 1. Establish the connection between the device and mobile phone using the procedure listed in Running the Demo.
- 2. When paired, the application displays the Battery Service and the Generic Information service.
- Select "Battery Service" to receive notifications for the battery level characteristic. The user can stop receiving the notifications by disabling notifications, as shown in the following figure.
 Figure 5-34. Battery Level Characteristic Notification Options



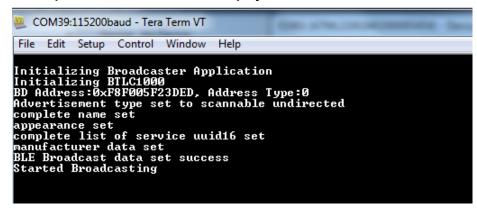
- 4. On the device side, the console log displays the periodic battery level updates.
 - Battery Level:0% Battery Level:1% Battery Level:2% Battery Level:3% Battery Level:4% Battery Level:5%

5.3.10 Simple Broadcaster Application

Perform the following steps to run the Simple Broadcaster application demo:

- 1. Follow the steps (1 and 2) from Initializing the Device.
- 2. The device is in advertising mode.
- 3. The following figure shows example logs from the Simple Broadcaster application.

Figure 5-35. Simple Broadcaster Console Display



5.3.11 Device Information Service Application

Perform the following steps to run the Device Information Service application demo:

- 1. Establish the connection between the device and mobile phone using the procedure listed in Running the Demo.
- 2. When paired, the application displays the Device Information Service.
- 3. When the Device Information Service is selected, the user can view the device information service characteristics as shown in the following screen.

Figure 5-36. Display of Device Information Service Characteristics

No SIM 🗢	10:26 PM	\$ 53% □⊃ •
(Device Information Servic	e
Manufact ATMEL	turer Name	
Model Nu BLE DEVICE	umber	
Serial Nu BTLC1000/S		
Hardware _{Rev A}	e Revision	
Firmware	Revision	
Software	Revision	
<0x0000000	urer Identifier 00 00> ionally Unique Identifier	
Regulato <0x00>	ry Certificate Data	
D		

- 4. The user can refresh the page to get the updated characteristic value of all characteristics.
- 5. On the device side the console log is displayed as:

Updating Firmware to ver:FW_VER-000 Updating Firmware to ver:FW_VER-001 Updating Firmware to ver:FW_VER-002 Updating Firmware to ver:FW_VER-003

5.3.12 Custom Serial Chat Profile Application

Perform the following steps to run the Custom Serial Chat Profile application demo:

- 1. Establish the connection between the device and mobile phone using the procedure listed in Running the Demo.
- 2. Once pairing is complete, the Custom Serial Chat icon appears on the service list page.
- 3. Click the **Custom Serial Chat** icon. The chat screen appears where the user can type the text that is to be sent to the remote device and also see the text coming from the remote device.
- 4. Chat text "Hello Atmel" send to remote device.

Figure 5-37. Sending Data to Device

	¢	C	uston	12:39 n Seri	al Ch	at	/ 🛊 100)% 💼 +
					ŀ	Iello A	tmel	10
Туре	New 1	Text			_			Send
Q W E R T Y U I O P								
Q	NE	E	2	٢Ľ	ſ	וו) Р
Q	N E		F		rц Н		I С К	D P
	s	D	F	h	Н		Å	<u> </u>

5. The user can also write the text on the console for the device and press the ENTER key for transmitting the chat text to the mobile application.

Figure 5-38. Console Log for Sending Data to Remote Device

SCOM28 - Tera Term VT	
File Edit Setup Control Window Help	
Initializing Custom Serial Chat Application Initializing BILC1000 BD Address:0x78F005F3508E, Address Type:0 Device Started Advertisement Connected to peer device with address 0x50562d2140d2 Connection Handle 0 Please Enter the following Pass-code(on other Device):123456 Pairing procedure completed successfully	*
Hello Atmel	
Hello Atmel	

Figure 5-39. Chat Text Received from ATBTLC1000

No SIM	× .			12:23			7 \$ 10	00%
←		С	uston	n Seri	al Ch	at		
						iello A	tmel	9
6	Hello	Atme	el					
•								
Туре	New 1	Text						Send
Туре	New 1	Fext						Senc
		Ŷ	R 1	ΓΥ	7 1	J	ıc	
Q	W	E F						P
-		-	R 1	Γ \ G	r l	J	I C	
Q	w I	E F	F	G	Н	J	к	L
Q	W	E F	F					P
Q	w I	E F	F	G	H	J	к м	D P L

Note: For more information on the Custom Serial Chat service, refer to the Custom Serial Chat Service Specification.

5.3.13 Heart Rate Profile Application

Perform the following steps to run the Heart Rate Profile application demo:

- 1. Establish the connection between the device and mobile phone using the procedure listed in Running the Demo.
- 2. After the device is connected, the application displays the Heart Rate and the Device Information service is displayed.
- 3. When notifications are enabled, the HRM values are displayed, as shown in the console and the corresponding mobile app. The LED on the SAM L21 board starts blinking while sending notifications.

Notif	icatior	ı Eı	nabled		
Heart	Rate:	50	bpm	RR	Values:<100,300>msec User Status:Idle
Heart	Rate:	51	bpm	RR	Values:<500,700>msec User Status:Idle
Heart	Rate:	52	bpm	RR	Values:<900,1100>msec User Status:Idle
Heart	Rate:	53	bpm	RR	Values:<100,300>msec User Status:Idle
Heart	Rate:	54	bpm	RR	Values:<500,700>msec User Status:Idle
Heart	Rate:	55	bpm	RR	Values:<900,1100>msec User Status:Idle
Heart	Rate:	56	bpm	RR	Values:<100,300>msec User Status:Idle
Heart	Rate:	57	bpm	RR	Values:<500,700>msec User Status:Idle
Heart	Rate:	58	bpm	RR	Values:<900,1100>msec User Status:Idle
Heart	Rate:	59	bpm	RR	Values:<100,300>msec User Status:Idle
Energ	y Exper	ndea	d :3KJ		

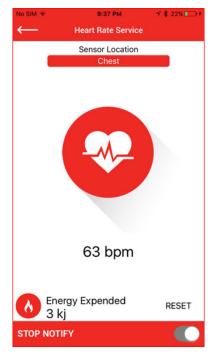


Figure 5-40. Displaying Heart Rate Measurements

- 4. When the user disable on Stop Notify, the notifications are displayed in the console logs as: Notification Disabled
- 5. During the connection, the SW0 button is used to disconnect the connection. If no connection exists, the SW0 button is used to start advertisement.

5.3.14 Blood Pressure Profile Application

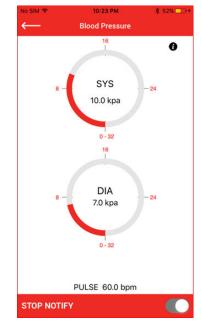
Perform the following steps to run the Blood Pressure Profile application demo:

- 1. Establish the connection between the device and mobile phone using the procedure listed in Running the Demo.
- 2. When the device is connected, the application displays Blood Pressure, Device Information Service and Generic Information.
- 3. On entering the Blood Pressure service page, the mobile application enables the notifications and indications for interim cuff pressure and blood pressure characteristics, respectively. The blood pressure sensor device simulated by the device, sends the current blood pressure values after receiving the indications enabling request. The corresponding console logs and mobile application screen are shown in the following screen.

Figure 5-41. Console Log for Blood Pressure Measurements

COM129:115200baud - Tera Term VT
File Edit Setup Control Window Help
Initializing Blood Pressure Sensor Application Initializing BILC1000 BD Address:0xF8F005F35254, Address Type:0 Bluetooth device is in Advertising Mode Connected to peer device with address 0x585e3bb3e08a Connection Handle 0 Please Enter the following Pass-code(on other Device):123456 Pairing procedure completed successfully Indications enabled by the remote device for blood pressure Systolic 10 kpa Diastolic 07 kpa
Map 08 kpa Pulse rate 60 bpm
Press the button to receive the blood pressure parameters Notifications enabled by the remote device for interim cuff pressure

Figure 5-42. Blood Pressure Service Page after Receiving BP Indications

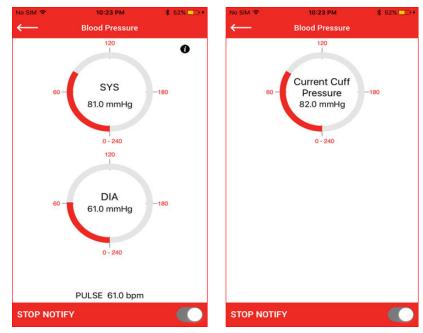


4. The SW0 button can be used on the SAM L21 to receive updated blood pressure measurements. The blood pressure sensor first sends the interim cuff pressure values as notifications and then sends the final blood pressure measurements as indication. The blood pressure measurements sent by the blood pressure sensor are simulated values. The following figures demonstrate the scenario after a SW0 button press.

Figure 5-43. Console Log for Blood Pressure Values after Button Press

Started sending	g Interim Cuff Pressure Values
Cuff pressure	
The Blood Pres	sure Values are:
Systolic	81 mmhg
Diastolic	61 mm/y
Map	
PuÎserate	61 bpm
Press the butt	on to receive the blood pressure parameters

Figure 5-44. Blood Pressure Service Pages after Receiving Measurement Data on Button Press



5.3.15 Find Me Profile Application

Perform the following steps to run the Find Me Profile application demo:

- 1. Establish the connection between the device and mobile phone using the procedure listed in Running the Demo.
- 2. After the device is connected, the application displays a service page that includes Immediate Alert Service and Generic Information.
- 3. Since the service level connection is established, the user can see the notifications based on the alert level settings as depicted in the following figures.

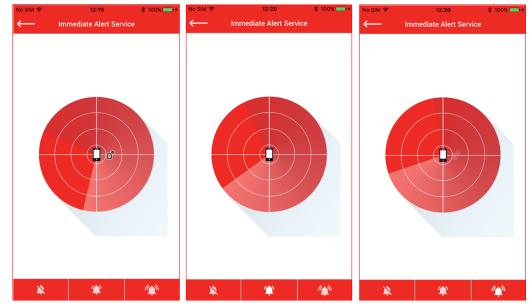


Figure 5-45. Sending Alerts to Find Me Target ATMEL-FMP

4. On the device side, the console log is displayed as:

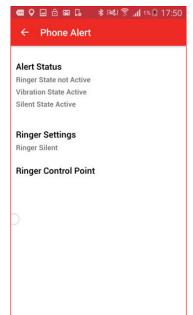
Find Me : Mild Alert Find Me : High Alert Find Me : No Alert

5.3.16 Phone Alert Status Application

Perform the following steps to run the Phone Alert Status application demo:

- 1. Establish the connection between the device and mobile phone using the procedure listed in Running the Demo.
- 2. After connection, the application displays the Phone Alert Status Service page.
- 3. Notifications are automatically enabled and the application reads the values of the "Alert Status", "Ringer Settings", and "Ringer Control Point" characteristics, which are updated on the mobile application, as illustrated in the following figure.

Figure 5-46. Displaying the Characteristics of the Phone Alert Service



4. Press the SW0 button. The device is set to different modes by using the notifications and the corresponding console logs are displayed.

Figure 5-47. Phone Alert Status Console Log

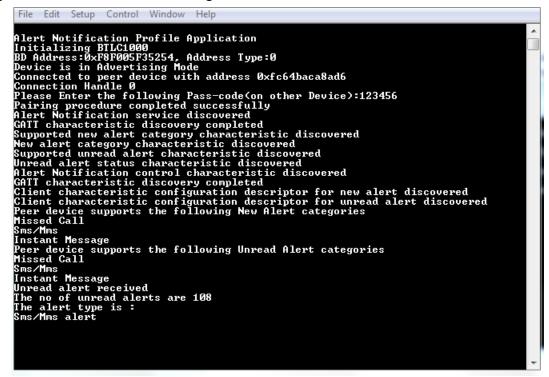
SCOM116:115200baud - Tera Term VT	
File Edit Setup Control Window Help	
	^
Device to silent	
Notified Ringer setting :Ringer Silent	
Device to Mute Once	
Notified Ringer setting :Ringer Silent	
Device to cancel mute	
Notified Ringer setting :Ringer Normal	-
	1
	Ŧ

5.3.17 Alert Notification Profile Application

Perform the following steps to run the Alert Notification Profile application demo:

- 1. Establish the connection between the device and mobile phone using the procedure listed in Running the Demo.
- 2. When connected, the application displays the Alert Notification service page. The console log displays the new and unread alert categories.

Figure 5-48. Alert Notification Categories



3. Enable the notifications by using the SW0 button. The mobile application reflects the status as shown.

Figure 5-49. Alert Notification Screen on Microchip SmartConnect Application

D Ø	🗱 🕾 🗗 🏹 💶 18:5
← Alert No	tification
_	NEW ALERT
	ication Enabled
Category: SMS Number :0 Text :	Category: Missed Call Number :0 Text :
UN	IREAD ALERT
Notif	ication Enabled 😩
Category: SMS Number :1	Category: Missed Call Number :0
đ	∆ ₽

4. The user can trigger a missed call to the Android device or send an SMS. The corresponding notification then gets displayed on the device side in the console logs.

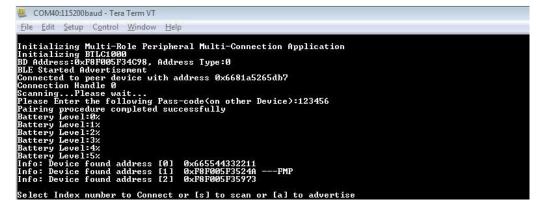
Figure 5-50. Console Display for Missed Call Alert and SMS Alert Notifications

COM:	112:11520	0baud - T	era Term V	Т	- 10 C	eer (J). Nysee	46 No. 17		X
File Edi	it Setup	Control	Window	Help					
he no o he aler issed C nread a he no o ew Aler he no o he aler issed C nread a he no o he Aler he no o nread a he no o	t type Call aler (lert rec of unread t receit all aler lert rec f unread t type Call aler lert receit f new al t receit f new al	lerts are is : rt ceived l alerts ed lerts are is : rt rt rt ved lerts are ved lerts are seived l alerts	are 0 2 are 1 0	-					
he no o he aler	lert red	l alerts is :	are 2						

5.3.18 Multi-Role Peripheral Multi-Connect Application

Perform the following steps to run the Multi-Role Peripheral Multi-Connect application demo:

- 1. Establish the connection between the device and mobile phone using the procedure listed in Running the Demo. The device initially acts as a GAP Peripheral and starts advertisement with Battery Service UUID in the advertisement data. Perform all the steps from Battery Service Application.
- 2. The device starts scanning and displays the devices found, as shown in the following figure.
 - Figure 5-51. Multi-Role Peripheral Multi-Connect Application Scanning Devices



- 3. Setup another ATBTLC1000-MR/ZR device with the Find Me application example loaded. Follow the steps (1 through 3) from Running the Demo. The device starts advertising.
- 4. The GAP Central (Find Me Locator) scans and then displays the list of all BLE devices that are advertising. Find Me Target devices (GATT server role) are indicated with tag "---FMP". Select the appropriate index number for the Find Me Target. GAP Central (Find Me Locator) connects to the selected peer device.

Figure 5-52. Connecting GAP Central (Find Me Locator) with GAP Peripheral (Find Me Target)

📒 COM40:115200baud - Tera Term VT
<u>Eile Edit Setup Control Window H</u> elp
Initializing Multi-Role Peripheral Multi-Connection Application Initializing BILC1000 BD Address:00xF8F005F34C98, Address Type:0 BLE Started Advertisement Connected to peer device with address 0x6681a5265db7 Connection Handle 0 ScanningPlease wait Please Enter the following Pass-code(on other Device):123456 Pairing procedure completed successfully Battery Level:1% Battery Level:1% Battery Level:3% Battery Level:4% Battery Level:5% Info: Device found address [0] 0x665544332211 Info: Device found address [1] 0xF8F005F3524AFMP Info: Device found address [2] 0xF8F005F35973
Select Index number to Connect or [s] to scan or [a] to advertise 1
FMP Connect request sent Battery Level:6%
Battery Level:7% Battery Level:8%
Connected to peer device with address Øxf8f005f3524a Connection Handle 1 central device connected

5. The ATBTLC1000 as a GAP Central pairs with the connected peripheral. The ATBTLC1000-MR/ZR then acts as a GAP Peripheral by advertising with Battery Service UUID in the advertisement data. Now the ATBTLC1000-MR/ZR sends alert levels as a GAP Central, sends battery level notifications to the device connected as a GAP Peripheral and also starts advertising with Connectable advertisement packets.

Figure 5-53. Device acting as Multi-Role to accept connections from GAP Central devices (Mobile)

🚇 COM40:115200baud - Tera Term VT	
<u>File Edit Setup Control Window Help</u>	
Initializing Multi-Role Peripheral Multi-Connection Application Initializing BILC1000 BD Address:0xFR095F34C98, Address Type:0 BLE Started Advertisement Connected to peer device with address 0x6681a5265db7 Connection Handle 0 ScanningPlease wait Please Enter the following Pass-code(on other Device):123456 Pairing procedure completed successfully Battery Level:0% Battery Level:1% Battery Level:2% Battery Level:3%	
Battery Level:4% Battery Level:5%	
Info: Device found address [0] 0x665544332211 Info: Device found address [1] 0xF8F005F3524AFMP Info: Device found address [2] 0xF8F005F35973	
Select Index number to Connect or [s] to scan or [a] to advertise	
1 FMP Connect request sent	
Battery Level:6%	
Battery Level:7%	
Battery Level:8%	
Connected to peer device with address 0xf8f005f3524a	
Connection Handle 1	
central device connected	
BLE Started Advertisement	
Rx Power(RSSI):-041 dBmNo Alert	
Battery Level:9% Rx Power(RSSI):-039 dBmNo Alert	
Enter the Passkey(6-Digit) in Terminal:123456	
Entered Pass-code:123456	
Battery Level:10%	
Rx Power(RSSI):-042 dBmNo Alert	
Battery Level:11%	
Pairing procedure completed successfully Immediate Alert service discovered	
Battery Level:12%	
Rx Power(RSSI):-041 dBmNo Alert	
Battery Level:13%	
Rx Power(RSSI):-041 dBmNo Alert Battery Level:14%	
Rx Power(RSSI):-039 dBmNo Alert	
Battery Level:15%	
Rx Power(RSSI):-038 dBmNo Alert Battery Level:16%	
Rx Power(RSSI):-041 dBmNo Alert	
R = R = R = R = R = R = R = R = R = R =	
INX FUWERNASSIZ. UDWNU HIEFU	

6. The ATBTLC1000-MR/ZR acting as a GAP Peripheral (BAS) can connect to seven GAP central devices (mobile devices through the Microchip SmartConnect application). Now, the ATBTLC1000-MR/ZR continues to behave as Find Me Locator (GAP Central) and Battery Service Application (GAP Peripheral) simultaneously with eight active connections. Continuous data transfer happens on all the links by the ATBTLC1000-MR/ZR and even if one link gets disconnected, the data transfer happens on the other links.

5.3.19 L2CAP Throughput Application

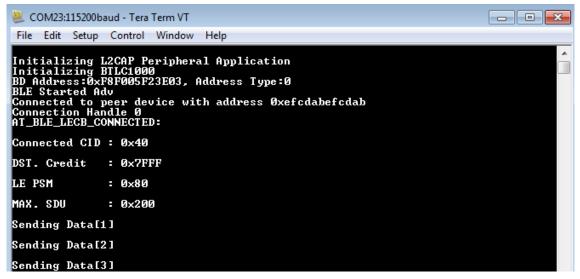
This demonstration requires two ATBTLC1000-MR/ZR devices. Program one ATBTLC1000-MR/ZR device with the L2CAP Peripheral and another one with the L2CAP Central application example. Perform the following steps to run the Throughput application demo:

- 1. Follow the steps (1 and 2) from Initializing the Device for both devices.
- 2. The device initializes and start-up.
- 3. The Central device starts scanning and subsequently connects with the desired peripheral device. The following log shows that both devices connected to confirm the connection status.

Figure 5-54. L2CAP Central Connection with L2CAP Peripheral

📒 COM22:115200	Ibaud - Tera Term VT	- • •
File Edit Setu	o Control Window Help	
Initializing	xF8F005F35166, Address Type:0	Î
Request sent		
Connected to Connection H AT_BLE_CONNE		
AT_BLE_LECB_	CONNECTED =	
Connected CI	D : Ø×40	
DST. Credit	: Øx7FFF	
LE PSM	: Øx80	
MAX. SDU	: 0×200	

Figure 5-55. L2CAP Peripheral Connection with a L2CAP Central



4. Once the connection is established, the peripheral device keeps sending the specified data and the central device receives the same data in a given time. Eventually, calculated Throughput is displayed on the console for both central and peripheral.

🛎 COM22:115200baud - Tera Term VT	
File Edit Setup Control Window Help	
Sending Data[96]	×
Sending Data[97]	
Sending Data[98]	
Sending Data[99]	
Sending Data[100]	
Sending Data[101]	
Sending Data[102]	
Sending Data[103]	
Sending Data[104]	
Sending Data[105]	
Sending Data[106]	_
ThroughPut of Peripheral <mark>:</mark> 51Kbps	~
Throughput	

Figure 5-56. L2CAP Peripheral Final Throughput Value



📒 COM43:	115200baud - Tera	a Term VT			
File Edit	Setup Control	Window H	elp		
Receivin	g data:[95]				
Receivin	g data:[96]				
Receivin	g data:[97]				
Receivin	g data:[98]				
Receivin	g data:[99]				
Receivin	g data:[100]	l			
Receivin	g data:[101]				
Receivin	g data:[102]				
Receivin	g data:[103]	l			
Receivin	g data:[104]				
Receivin	g data:[105]	l			
ThroughP	ut of Centra	1 : 51Kbps			
			Throughp	out	

5.3.20 Health Thermometer Profile Application

Perform the following steps to run the Health Thermometer Profile application demo:

1. Establish the connection between the device and mobile phone using the procedure listed in Running the Demo.

- 2. When paired, the application displays the Health Thermometer Service and the Generic Information service.
- 3. The temperature value, RSSI and the device name are displayed on the mobile application. The console log is shown in the following screen.

No SIM • 8:55 PM 7 \$ 4% -)* Health Thermometer Service TEMPERATURE TYPE Armpit 50.0°C 0.0°C 0.0°C 0.0°C

Figure 5-59. Console Log after Connection, Pairing, and with Notifications

🚇 Tera Term - [disconnected] VT	
File Edit Setup Control Window Help	
Initializing HTP Application Initializing BTLC1000 BD Address:0xF8F005F23E45, Address Type:0 BLE started LE advertisement HTP Initialization completed. Waiting for Event Connected to peer device with address 0x705969f40b7d Connection Handle 0 Device connected to 0x705969f40b7d handle=0x0 Please Enter the following Pass-code(on other Device):123456 Pairing procedure completed successfully Started HTP Temperature Indications Temperature: 0 Deg Celsius, Location: Armpit Temperature: 0 Deg Celsius, Location: Armpit	

- 4. To change the body measurement location, press the user button (SW0) on the SAM L21. The new value is updated in the application.
- 5. On the Microchip SmartConnect application, going back to the scanning screen disconnects the device with mobile application.

5.3.21 iBeacon Application

Perform the following steps to run the iBeacon application demo:

Health T

Figure 5-58. Health Thermometer Connected Services

- 1. Follow the steps (1 and 2) from Initializing the Device.
- 2. Start the Beacon application on the iPhone.
 - Figure 5-60. Beacon Radar Profile App Launch Screen



- 3. Click **Beacon Ranging**. The beacon application is launched to show the positioning of the beacon device with respect to the mobile phone and supports the following modes:
 - Proximity used to display beacon specific information when the mobile device comes in close proximity to a given beacon. This mode also shows the corresponding product related information that is configured for this particular beacon device.
 - Distance used to indicate the distance between the beacon device and the mobile.

Figure 5-61. Beacon Radar Application Initial Screen

No SIM 🗢	08:15	🕇 💲 61% 🔳 🔿
Home	Beacons	Ø To To
		/
Far		
1		
Near		
	Beacon	
Immediate		
Immediate		
	/	2
8 Bluetooth		MICROCHIP Atmel
		SMART
Proximity		Distance

4. Click **iBeacon** to check the Major, Minor and RSSI value. The RSSI value is automatically updated based on the movement of the scanner device, as shown in the following figure.

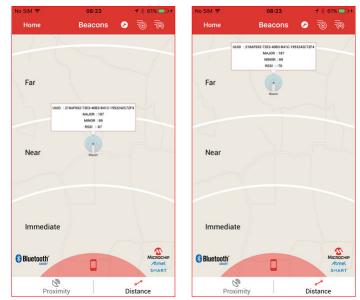


Figure 5-62. Beacon Radar Application in Distance Mode

5. Inside the proximity mode, if the scanner device is very near to the beacon. The user can see the product information when the user is in close proximity to a given beacon device. When the user moves away from the beacon device information content is not shown any more. It is an indication that the user is moved away from the beacon device. The user can optionally close the message by clicking on close.

Figure 5-63. Beacon Radar Application in Proximity Mode



OEMs the flexibility to create low por

5.3.22 AltBeacon Application

Perform the following steps to run the AltBeacon application demo:

- 1. Follow the steps (1 and 2) from Running the Demo.
- 2. The beacon application initialization is displayed in the console.

Initializing AltBeacon Application BLE AltBeacon Advertisement started

- 3. Start the Beacon application on the mobile phone (see Figure 5-50). In this demonstration, an iPhone is used to run the application.
- 4. Tap on the AltBeacon icon for Major, Minor and UUID Value. The RSSI values are automatically updated based on the movement of the scanner device. For more details about the AltBeacon device, the user can tap on the pop-up message (which shows UUID, ID1 and ID2 values), as shown in the following figures.

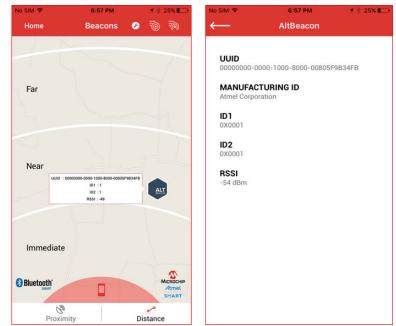
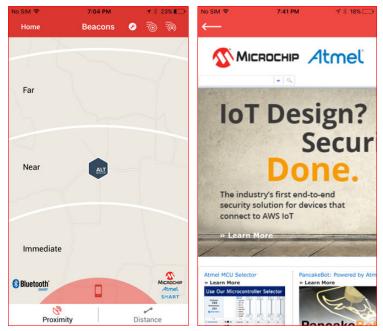


Figure 5-64. AltBeacon Radar Application in Distance Mode

5. In proximity mode, the application opens the configured URL whenever the user comes in close proximity to the configured beacon device. When the user moves away from the beacon device, the configured beacon is not shown. It is just an indication that the user moved away from beacon device.

Figure 5-65. AltBeacon Radar Application in Proximity Mode



6. A new AltBeacon can be added to the Beacon list using the add button, as illustrated in the following figure.

```
Figure 5-66. Adding new beacon
                                                                                                                             ns List
                                       s List
                                                                                                                        Bea
                                                                          Update AltBeacon
                                                                                                                                              ø
                                                                                                                  altbcon
                                                                     Name
                                                                                                          UUID: 0000000-0000-1000-8000-00805F9B34FB
                                                                      altbcor
                                                                                                                            ID2: 1
                                                                                                          ID1: 1
                                                                                                          URL: http://www.atmel.com
                                                                     UUID
                                                                     0000000-0000-1000-8000-
                        Select beacon type
                                                                     ID1
                                                                      1
                              ALT
                                                                     ID2
                                                                     1
                                                                     URL
                                                                      http://www.atmel.com
                                                                               Save
```

7. A new AltBeacon can be added into the Region monitoring list using the add button, as illustrated in the following figure.

Figure 5-67. Adding new beacon in Region Monitoring List

No SIM	₱ 7:02 PM	🕈 🕴 24% 🔛	No SIM 🗢	8:17 PM	9 🖇 14% 🗁	No SIM 🔶	8:12 PM	⊀ ∦ 159	× 🗆
	Region Monitoring List	€	←			~ ~	Region Monitorin	g List	
		$\hat{\mathbf{f}}$		Update AltBeacon Region		ALT	rmlaltbcon		0
				Name		UUID:	0000000-0000-1000-8000-	00805F9B34FB	
				rmlaltbcon		ID1: 1	ID2: 1		
				JUID					
				0000000-0000-1000-8000					
	Select beacon region type			D1					
	ALT ()			1					
	Becon			D2					
		_		1					
			1	s Ranging Enabled?					
				Save					

Note: The Region Monitoring List is supported on iOS, and not on Android devices.

5.3.23 Eddystone Beacon Application

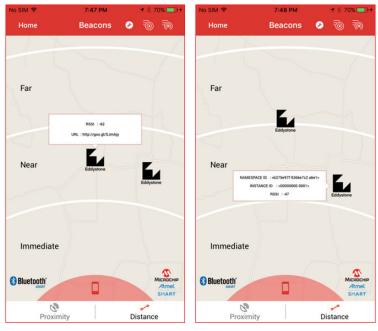
Perform the following steps to run the Eddystone Beacon application demo:

- 1. Follow the steps (1 and 2) from Running the Demo.
- 2. The beacon application initialization is displayed on the console.

```
Initializing BTLC1000
BD Address:0xF8F005F34CC1, Address Type:0
Eddystone beacon started
Adv count: 1
Tx URL
Adv count: 22
Tx TLM
```

- 3. Start the Beacon application on the mobile phone (see Figure 5-50). In this demonstration, an iPhone is used to run the application.
- 4. Open the **Beacons** navigation tab to view the ranging screen. The Eddystone beacon device is shown on the ranging screen with the Eddystone icon. The position of the beacon is based on the strength of the signal received from RSSI. Click the **Beacon** icon to see a pop-up window showing the identity of the frame; in the case of the EDDYSTONE_URL_APP, the shortened URL value is shown and in the case of the EDDYSTONE UID APP, Namespace ID and Instance ID is shown.

Figure 5-68. Eddystone Beacons (both UID and URL beacons) ranged by Microchip SmartConnect Application



5. Click the beacon pop-up window to view detailed information. The detailed view shows UID/URL and telemetric information like battery voltage, beacon temperature, time since power-on, etc.. This telemetric information is obtained from the Eddystone-TLM frames which are interleaved with Eddystone identifying frames (UID/URL).

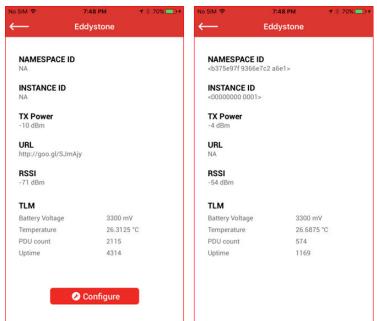


Figure 5-69. Detailed view of the Eddystone URL and UID beacon

- 6. In the EDDYSTONE_URL_APP, the detailed beacon information screen shows a Configure button. Click the **Configure** button. It requests that the user puts the beacon into Configuration mode. The SW0 hardware button present on the SAM L21 Xplained Pro board has to be long pressed (around 3 seconds) to enter into Configuration mode.
- Connect to the beacon in Configuration mode as shown in Figure 5-70. Once connected, the configurable beacon parameters are listed out as shown in Figure 5-71.
 Figure 5-70. Connecting to Beacon in Configuration Mode

← Eddystone NAMESPACE ID INSTANCE ID NA INSTANCE ID NA Atmel-Eddystone TX Power Connect -10 dBm INSTANCE ID WR Press OK button after long pressing SWO button in hardware RS: -73 Cancel OK TLM Battery Voltage 3300 mV Temperature 26.1875 °C PDU count 2276 Uptime 4643	No SIM 🗢		7:49 PM	≠ \$ 70% 💶>+	No SIM 🗢	7:49 PM	1 ∦ 70% 💶 +
NA Atmel-Eddystone Connect NA Atmel-Eddystone Connect NA TX Power -10 dBm UR Press OK button after long pressing SWO button in hardware SWO button in hardware RS: -78 OK TLM Battery Voltage 3300 mV Temperature 26.1875 °C PDU count 2276	~ ~	Ed	dystone		←	Beacons	
Image: Name of the second		IESPACE ID			🁋 01 Beaco	ons found	STOP SCAN
-10 dBm UR Press OK button after long pressing SWO button in hardware RS -78 Cancel OK TLM Battery Voltage 3300 mV Temperature 26.1875 °C PDU count 2276	INST	ANCE ID			Atmel-Eddy:	stone	Connect
Nttp Press OK button after long pressing SW0 button in hardware RS: -78 Cancel OK TLM Battery Voltage 3300 mV Temperature 26.1875 °C PDU count 2276							
-78 Cancel OK TLM Battery Voltage 3300 mV Temperature 26.1875 °C PDU count 2276		Press OK butte SW0 but	on after long pre ton in hardware	ssing			
Battery Voltage 3300 mV Temperature 26.1875 °C PDU count 2276		Cancel	OK				
Temperature 26.1875 °C PDU count 2276	TLM						
PDU count 2276	Batter	ry Voltage	3300 m\	t in the second s			
	Temp	erature	26.1875	°C			
Uptime 4643	PDU o	count	2276				
	Uptim	ne	4643				
			Configure				
Conforma		0	configure				
Configure							

SIM 🗢	7:49 PM	オ ≵ 70% □ >+	No SIM 🗢	7:50 PM	1 🕏 71% 💻
— Edd	lystone Configur	ations	← Eddy	stone Configura	ations
.ock Eddy	stone		Lock Eddys	stone	
URI Data			Advertised T	Tx Power Levels	
		Write	-18	-10	
http://goo.g	l/SJmAjy		Medium	High	Write
	C	_	-4	-1	
JRI Flags			TX Power lev	el [+20dBm to -10	0dBm]
			Tx Power M	odo	
0			TX POwer IM	oue	
			Lower	~	Write
dvertised	Tx Power Levels				inite
Lowest	Low				
-18	-10	Write			_
ledium	High		Beacon Peri	od	
-4	-1	Second to	200	1	Write
X Power le	vel [+20dBm to -10	00dBm]		J	
Tx Power M	lode		Beacon period	d [100ms to 10240	ms]
Lower			Reset eddys defaults	tone values to	Reset
		Write			neset

Figure 5-71. Beacon Configuration Screen

8. Update the URL, Tx Power mode, beacon period, etc. and then save. Now, disconnect from the beacon and enter the ranging screen. Once disconnected, the beacon device (ATBTLC1000-MR/ZR) enters into Beacon mode and start sending Eddystone URL frames with the updated values. The ranging console log screen shows the beacon with new URL value.

Figure 5-72. Eddystone Beacon Console Log

-	- [disconnected] VT	
File Edit S	etup Control Window Help	
lnitializi	ng BTLC1000 :0xF8F005F34CC1, Address Type:0	
BD Haaress Edductope	beacon started	
Adv count:	1	
Tx URL		
Adv count:	22	
T× TLM		
Adv count:	24	
T× URL		
Adv_count:	45	
Tx TLM	40	
Adv count: Tx URL	47	
Adv count:	68	
Tx TLM	00	
Adv count:	70	
T× URL		
Adv_count:	91	
T× TLM		
Adv_count:	93	
Tx URL Adv count:		
Tx TLM	114	
Adv count:	116	
T× URL	110	
Eddystone-	URL config mode	
Connected	to peer device with address 0x08fc88427322	
Connection		
Connected!		
Device dis Disconnect	connected Reason:0x13 Handle=0x0	
	beacon mode	
Adv count:	137	
T× URL		
Adv count:	158	
T× TLM		
Adv_count:	160	
T× URL	101	
Adv count: Tx TLM	181	
Adv count:	183	
T× URL		

9. The beacon configuration page also provides a reset button that can set all the parameters to its default factory settings.

5.3.23.1 Demo with Physical Web Application

Eddystone is the backbone of the Physical Web initiative from Google. For more information on the Physical Web, refer to https://google.github.io/physical-web/.

The following demo shows how the Eddystone application running on an ATBTLC1000-MR/ZR device works seamlessly with the Physical Web Android application.

- 1. Install the Physical Web Android application in a BLE compatible android device.
- 2. Build and run the EDDYSTONE URL APP in the hardware setup.
- 3. Open the Physical Web app to detect the URL emitted by the beacon node, as shown in the following figure.

လ္ ေနတဲ့ ဒို /ျ 58% 🛢 18:35	<u>ග</u> ≱ ඊ <u>දි ∦ 62% ∎ 18:26</u>
Nearby Beacons	Nearby Beacons
\bigcirc	Bluetooth http://www.atmel.com/products/Wireless Bluetooth Low Energy (BLE) or Bluetooth Smart is a new Bluetooth 4.1 standard, allowing 4.1 compliant
Searching for beacons	

Figure 5-73. Physical Web App Detecting Eddystone-URL

- 4. Click the **Menu** button to open the "Edit URL" option; this requests that the user to put the beacon in Configuration mode. Pressing the SW0 button on the Xplained Pro board for 3 seconds (long press) puts the beacon device in Configuration mode.
- 5. The URL configuration window will pop-up once the Android device establishes connection with the beacon's configuration service, as shown in the following figure. Change the URL value to a different one; make sure to use a shortened URL as the size of encoded URL is limited to 17 bytes. Google's URL shortener can be used for this purpose https://goo.gl/.

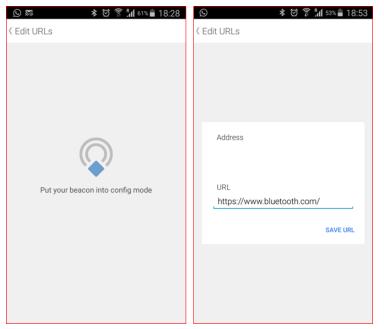
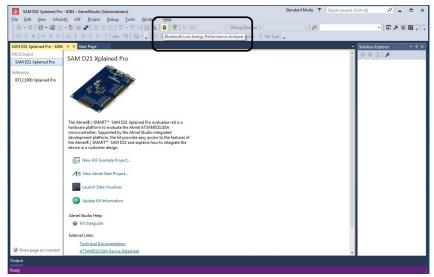


Figure 5-74. URL Configuration on Physical Web App

5.3.24 Direct Test Mode Application

This demonstration requires two ATBTLC1000-MR/ZR devices loaded with the Direct Test Mode example application code. Perform the following steps to run the DTM with the Performance Analyzer tool.

- 1. Start the performance analyzer in Atmel Studio.
 - Figure 5-75. Selecting Studio Performance Analyzer Tool

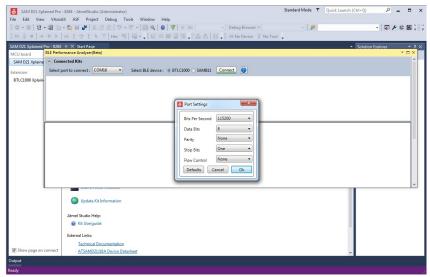


File Edit View	ined Pro - 8284 - AtmelStudio (Administrator) VAsistX ASF Project Debug Tools Window Help		Quick Launch (Ctrl+Q)			
	④ 1 - 4 単 4 2 3 1 3 7 - で、図 4 0 ▼ ト 20 - Debug Browser - UL ト 6 3 7 3 1 4 T Hex 格 号 - 5 面 回 ● 回 回 5 益 杰 図 5 ● NO Device T No Tool			- 51 / 6		-
	n p eos : 2 : 4 : 1 hex 15 km eos i 2 : 4 : 1 hex 15 km eos i 2 i 2 : 1 hex 15 km eos i 2 i 2 : 1 hex 15 km eos i 2 i 1 hex 15 km e	-	- Solutio	- Curlanse	- 1	
	BLE Performance Analyzer(Beta)		• 1501000		Ξ×	Ê
SAM D21 Xplaine	Connected Kits				1	
Estension BTLC1000 Xplein	Select por to connect. [COM49 COM4 COM4 COM4 COM5					
🖉 Show page on r	Update Kit Information Atmed Studio Melp:		*]
Output						

Figure 5-76. BLE Performance Analyzer Tool Window

- 2. Next, initialize the UART. Enter the COM port number and press "Init UART". A successful initialization is indicated by receiving a chip response, as shown in the following figure.
 - **Tip:** Check the COM port number from the Device Manager.

Figure 5-77. Initializing UART



3. Start the Direct Test Mode, configure one board as Tx and the other one as Rx. Make sure to select the same RF Channel for both Rx and Tx during the test and start the Rx test before the Tx test in order not to miss any packets. The user must see non-zero packets received at the Rx side notifying successful transmission and reception.

Note: Any side can be replaced by standard compliant test equipment.

4. Select **Tx Power (dBm)** other than -55 dBm, if the devices are relatively far from each other.

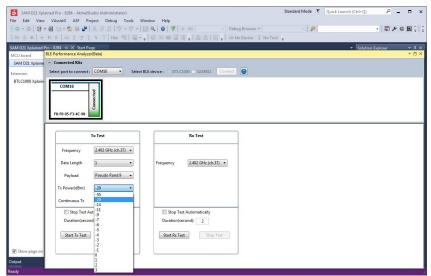


Figure 5-78. Tx Power Configuration



SAM D21 Xplained Pro - 8284 - AtmelStudio (Administrator)	Standard Mode 🔻	Quick Launch (Ctrl+Q)	۶ – 🗆 ×
File Edit View VAssistX ASF Project Debug Tools Window Help			
0 - 0 間 - 型 日 - 🖕 目 🔐 🐰 🖓 合 🤊 - ୯ - 🔠 🔍 😆 🌹 🕨 👘 - Debug Browser -	- 📁		
※HI 函 = → H ▶ ⇔ \$? \$ ★ T Hex 符 圖 + _ ◎ 屈 回 曲 回 回 _ ◎ 函 函 函 _ ◎ = No Device 『 No Tool			
SAM D21 Xplained Pro - 8284 👳 🗙 Start Page		✓ Solution	
MCU board BLE Performance Analyzer(Beta)			+ ⊡ ×
SAM D21 Xplaine Oconnected Kits			
Extension Select port to connect: COML6 Select BLE device: BTLC1000 SAMB11 Connect			
5TLC.000 /plan			
Frequency 2.402 GHz (ch.37) +			
Data Length			
Payload Pseudo Rand 9 +			
Tx Power(dBm) -20 *			
Continuous Tx Disable -			
Stop Test Automatically Duration(second): 2 Start Tu Test Stop Test			
Show page on Transmitting			
Output			
Ready			

5. On the Rx side, select the appropriate COM port with the same default settings. Open the window having both Tx and Rx options. Click **Start Rx Test** and ensure that the packets are transferred for a certain time period from the Tx device.

Figure 5-80. Starting Rx Test

BLE Performance Analyzer(Beta)		* = >
Connected Kits		
Select port to connect : COM17 -	Select BLE device : O BTLC1000 O SAMB11 Connect	
COM17 P3 58-F0-05-F3-48-18		
	Rx Test	
	Frequency 2402 GHz (ch.37) *	
	Stop Test Automatically Duration(second): 2 Start Ra Test Stop Test	
	Receiving	

6. Click **Stop Test** to display the number of successful received packets. **Figure 5-81. Number of Packets Received**

	Standard Mode 🔻 Quick Launch (Ctrl+Q)
SAM D21 Xplained Pro - 3758 - AtmelStudio (Administrator)	Standard Wide (Quee cauter (carry)
File Edit View VAssistX ASF Project Debug Iools Window Help	owser - 👘 - 🗊 🖉 🕼 🗰 👬
◎ - O 哲 - 创 台 - 입 目 計 X 라 쉽 ヴ - ペ - 図 Q Ø ♥ > MI - Oebug B	owser * 👘 👘 👘 👘 👘 👘 👘 👘
※川 函 = → Ⅱ ▶ ⇔ ‡ ? ‡ № 王 Hex 答 遍	vice 👔 No Tool 🖕
SAM D21 Xplained Pro - 3758 + × SAM D21 Xplained Pro - 8284 Start Page	▼ I Solution Explorer ▼ I ×
MC BLE Performance Analyzer(Beta)	* 🗆 ×
SA Connected Kits	
Ette Select port to connect: COM17 Select BLE device: OBTLC1000 SAMB11 Connect 🔞	
6T T T T T T T T T T T T T T T T T T T	
Tx Test Rx Test	
	of packets received: 15100
Frequency 2.402 GHz (ch.37) +	
Data Length 1 Frequency 2.402 GHz (ch.37)	
Payload Pseudo Rand 9 -	
Payload Paedo Nano 9	
Tx Power(dBm)	
Continuous Tx Disable •	
Stop Test Automatically	
Duration(second): 2 Duration(second): 2	
Start Tx Test Stop Test Start Rx Test Stop Test	
Show page on connect	
Output	· · · · · · · · · · · · · · · · · · ·
Ready	
webby	· · · · · · · · · · · · · · · · · · ·

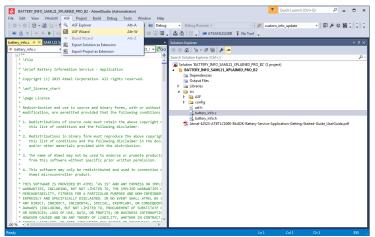
 \rightarrow

Important: The PER is calculated assuming that the transmitter side sends 1500 packets for testing using R&S CBT equipment. For peer testing, ignore the PER reading.

6. Adding a BLE Standard Service

The user can add another service such as the "Device Information Service" or "Battery Service" to the application by using the ASF wizard as mentioned in the following screen:

- 1. Go to the Atmel Studio ASF > ASF Wizard as shown in the following figure.
 - Figure 6-1. Invoking ASF Wizard



2. In the *ASF Wizard* window, enter "BLE" in the search box, as shown in the following figure. **Figure 6-2. ASF BLE Services and Components Window**

BATTERY_INFO_SAML21_XPLAINED_PRO_B2 - AtmetStudio (Administrator) File Edit View VAssistX ASF Project Build Debug Tools Window Help Image: State of the state	▼ Quick Launch (Ctrl+Q) P ■ × → # custom_info_update + III P III III IIII IIII IIIII IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII
	Solution Explorer
Info Actions Details BLE-Battery Services Add >> Apply Revert << Remove Summary	<>

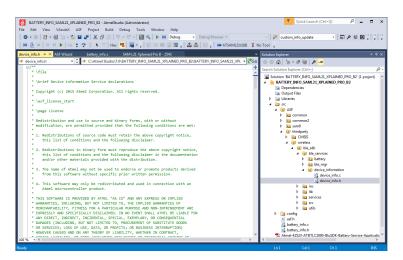
- 3. Select the required BLE Services/Profiles Component, as shown in the following figure.
 - 3.1. Select **Device Information Services**.
 - 3.2. Click Add > Apply > OK.

Mattern (Marc) SAM 21, 3PLANED (PRO, 22 - Ametibadio (Administrator) File Eat View Vietacit ASP Project Build Debag Tools Window Mattern (Marc) (Match (Mattern (Mattetn (Mattern (Mattern (Mattern (Mattern (Mattetn (Mattern	Debug Debug Browser		× ם _ ۹ ۵ : : : : : : : : : ۰ : ۰ : ۰
Encode Version Version Extension: Annu ASF0272 D BL2 Annu ASF0272 Show: A BL4 ANCS Services (component) BL4 D BL2 Annu ASF0272 Show: D BL2 Annu ASF02743 Show: D BL2 Annu ASF0	Selected Modules Generic board support (driver) BCHTT - Extend Interrupt (driver) BCHT - General Interrupt (driver) BCE-Oncice Information Services (component)	Isolation BATTERY (MPC_SAMEL2_SPALMED_PRO; B2 Intervention BATTERY (MPC_SAMEL2_SPALMED_PRO; B2 Intervention BATTERY (MPC_SAMEL2_SPALMED_PRO; B2 Intervention BATTERY (MPC_SAMEL2_SPALMED_PRO; B2 Intervention BATTERY (MPC_SAMEL2_SPALMED_PRO; B3 Intervention BATTERY (MPC_SAME	
BLE Alert Notification Services Add>> Apply Revent	<< Remove Summary	4	•

Figure 6-3. Adding BLE-Device Information Service and its Component

4. Newly added BLE service component must be available in the following directory: src \thirdparty\wireless\ble_sdk\ble_services\device_information, as shown in the following figure.

Figure 6-4. Hierarchy of Newly Added Service Component



5. Use the APIs, as mentioned in the Device Information Service (device_info.h), for incorporating this functionality, if required in the application.

```
/**@brief Update the DIS characteristic value after defining the services using
dis_primary_service_define
*
 * @param[in] dis_serv dis service instance
 * @param[in] info_type dis characteristic type to be updated
 * @param[in] info_data data need to be updated
 * @return @ref AT_BLE_SUCCESS operation completed successfully.
 * @return @ref AT_BLE_FAILURE Generic error.
 */
at_ble_status_t dis_info_update(dis_gatt_service_handler_t *dis_serv , dis_info_type
 info_type,
 dis_info_data* info_data, at_ble_handle_t conn_handle);
/**@brief DIS service and characteristic initialization (Called only once by user).
 *
 * @return none
 */
void dis_init_service(dis_gatt_service_handler_t *device_info_serv );
/**@brief Register a dis service instance inside stack.
```

* * @param[in] dis_primary_service dis service instance
*

* @return @ref AT_BLE_SUCCESS operation completed successfully * @return @ref AT_BLE_FAILURE Generic error. */

at_ble_status_t dis_primary_service_define(dis_gatt_service_handler_t *dis_primary service);

7. Custom Serial Chat Service Specification

7.1 Service Declaration

The Custom Serial Chat profile consists of a custom serial chat service. Both the mobile app and the host (HOST MCU + ATBTLC1000-MR/ZR) need to expose this service. The custom serial chat service is instantiated as a primary service.

The UUID value assigned to custom serial chat service is: fd5abba0-3935-11e5-85a6-0002a5d5c51b.

7.2 Service Characteristic

The following characteristics are exposed in the Custom Serial Chat service. Only one instance of each characteristic is permitted within this service.

Table 7-1. Custom Serial Chat Service Characteristics

Characteristic Name	Requireme nt	Mandatory Properties	Security Permission
Endpoint	М	Notify	Depend on BLE_PAIR_ENABLE macro
Client characteristic configuration descriptor	М	Read, Write	None

Note:

- 1. The security permission depends on BLE_PAIR_ENABLE macro, defined inside the ble_manager.h.
- 2. If **BLE_PAIR_ENABLE** is set true, then the security permission of Endpoint characteristic is readable with authentication and writable with authentication.
- 3. If **BLE_PAIR_ENABLE** is set false, then the security permission of Endpoint characteristic is none.

7.3 Endpoint

The Endpoint characteristic is used to transmit the chat data provided by the user on the terminal (device side) and on the mobile chat screen (mobile side).

The UUID value assigned to Endpoint characteristic is fd5abba1-3935-11e5-85a6-0002a5d5c51b.

7.3.1 Characteristic Behavior

When the client characteristic configuration descriptor is configured for the notification by a remote device, the user can send chat text message to the remote device.

Note: The chat text is sent as a notification from the sender (mobile app or ATBTLC1000-MR/ZR based device). Hence, the client characteristic configuration descriptor is always configured for notifications (in the Custom Serial Chat service instance on the mobile application and host).

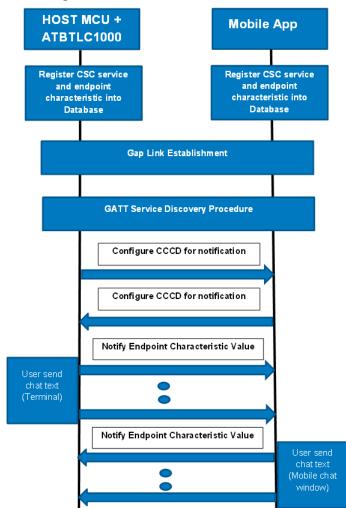
7.4 Characteristic Descriptors

7.4.1 Client Characteristic Configuration Descriptor

The client characteristic configuration descriptor is included in the Endpoint characteristic.

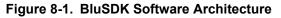
7.5 Sequence Flow Diagram

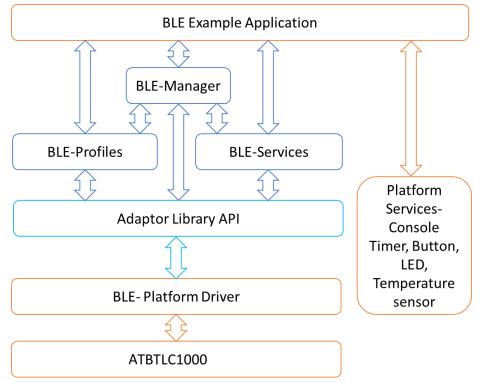
The following figure illustrates the sequence flow diagram of Custom Serial Chat profile. **Figure 7-1. Sequence Flow Diagram**



8. BluSDK Software Architecture

The following diagram illustrates the various layers in the BluSDK Architecture for implementing various applications. The External host can be supported hardware platforms and IDEs (see Supported Hardware Platforms and IDEs).





9. Hardware Flow Control for 4-Wire Mode eFuse Write Procedure

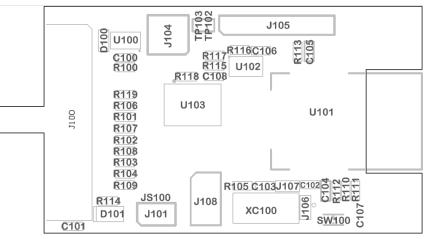
This procedure is applicable only for the MR/CSP/QFN packages. The ATBTLC1000-ZR module comes with a 4-wire mode eFuse by default from the factory.



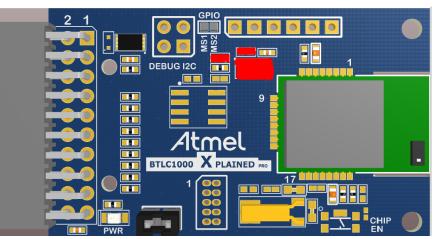
Caution: While writing data to the eFuse, the data written can never be changed (that is, if a value of '1' is written to a specific eFuse, those contents can never be reverted back to its original value). To configure the eFuse controller for accessing the eFuse contents, the user must enter the valid arguments for eFuse configuration.

1. Connect the SAM-ICE to the J108 header and the ATBTLC1000 XPRO to any MCU board to power it up. For the J108 location, refer to the following assembly drawing. Ensure that the "ATBTLC1000 chip enable" and "Wakeup pin" are driven high throughout the eFuse process.





 Remove pins U102, R116, and R117 on the ATBTLC1000 XPRO to disconnect the temperature sensor chip from the GPIOs used for flow control, as shown in following figure (highlighted in red).
 Figure 9-2. ATBTLC1000 3D View XPRO Board



- 3. The supplied command line tool (EfuseBlockProgram.exe) is used to write the ATBTLC1000 eFuse to configure the flow control signals.
- 4. To invoke the help information from the EfuseBlockProgram, enter EfuseBlockProgram.exe -h in the command line.



Administrator: C:\Windows\System32\cmd.exe	
D:\test\eFuse>EfuseBlockProgram.exe	^
Command format is as :	=
 For Programming eFuse Block and Verification: 	
EfuseBlockProgrammang eruse block and derfrication: EfuseBlockProgram.exe <bank no=""> <block no=""> <reg hex="" in="" ualue=""> -υ Example :- EfuseBlockProgram.exe 2 3 f0 -υ 2 - Bank No</reg></block></bank>	
3 - Block No f0 - eFuse Reg Value to be configure '-v' - To start verify and print logs	
2. For Verification of Efuse Block: EfuseBlockProgram.exe –v <bank no=""> <block no=""> Example :- EfuseBlockProgram.exe –v 2 3 '–v' – To start verify 2 – Bank No 3 – Block No</block></bank>	
1. For Programming eFuse Block only: EfuseBlockProgram.exe <bank no=""> <block no=""> <reg hex="" in="" ualue=""> Example :- EfuseBlockProgram.exe 2 3 f0 2 - Bank No 3 - Block No f0 - eFuse Reg Ualue to be configure</reg></block></bank>	
<pre><bank no=""> - Range from 0 to 5 <block no=""> - Range from 0 to 3 <reg hex="" in="" value=""> = Value in Hex '-v' - To verify and print Logs</reg></block></bank></pre>	
D:\test\eFuse>	~

- 5. Reading eFuse value:
 - 5.1. Command Syntax: EfuseBlockProgram.exe -v <Bank No> <Block No>.
 - Bank No: Range from 0 to 5
 - Block No: Range from 0 to 3
 - -v: For verification of a programmed block

Note: For the ATBTLC1000 UART hardware flow control 4-wire mode, Bank-5 and Block-3 are configured.

5.2. To enable the ATBTLC1000 UART hardware flow control eFuse configuration, use command EfuseBlockProgram.exe -v 5 3. The example output shown in following figure is for reading the eFuse.

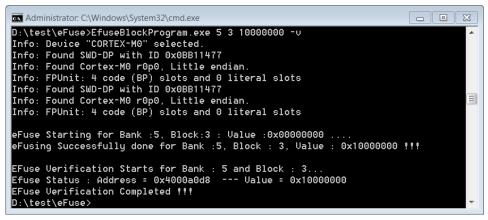
Figure 9-4. Reading eFuse Values

Administrator: C:\Windows\System32\cmd.exe	×
D:\test\eFuse>EfuseBlockProgram.exe =v 5 3	*
Info: Device "CORTEX-MO" selected.	
Info: Found SWD-DP with ID 0x0BB11477	=
Info: Found Cortex-M0 r0p0, Little endian.	
Info: FPUnit: 4 code (BP) slots and 0 literal slots	
Info: Found SWD-DP with ID 0x0BB11477	
Info: Found Cortex-M0 r0p0, Little endian.	
Info: FPUnit: 4 code (BP) slots and 0 literal slots	
EFuse Verification Starts for Bank : 5 and Block : 3	
Efuse Status : Address = 0x4000a0d8 Value = 0x00000000	
EFuse Verification Completed !!!	
D:\test\eFuse>	Ψ.

6. Writing and verifying the ATBTLC1000 eFuse value:

- 6.1. When writing the data to eFuse, the data written can never be changed (that is, if a value '1' is written to a specific eFuse, those contents can never be reverted back to its original value. To configure the eFuse controller for accessing the eFuse contents, the user must enter the valid arguments for eFuse configuration.
- 6.2. Command Syntax: EfuseBlockProgram.exe <Bank No> <Block No> <Reg Value in HEX> -v.
 - Bank No: Range from 0 to 5
 - Block No: Range from 0 to 3
 - Reg Value: eFuse to be configured in Hex
 - -v: For verification of a programmed block
- 6.3. To enable the ATBTLC1000 UART hardware flow control 4-wire mode, Bank-5 and Block-3 must be written as "10000000" (inputs are in hex). The example write configuration to enable the hardware flow control is shown in following figure.

Figure 9-5. Writing eFuse Values



10. Document Revision History

Rev A - 07/2017

Section	Changes
Document	Initial Release

11. Object of Declaration

EU Declaration of Conformity for ATBTLC1000-MR/ZR Evaluation Boards

This declaration of conformity is issued by the manufacturer.

The development/evaluation tool is designed to be used for research and development in a laboratory environment. This development/evaluation tool is not intended to be a finished appliance, nor is it intended for incorporation into finished appliances that are made commercially available as single functional units to end users. This development/evaluation tool complies with EU EMC Directive 2004/108/EC and as supported by the European Commission's Guide for the EMC Directive 2004/108/EC (8th February 2010).

This development/evaluation tool complies with EU RoHS2 Directive 2011/65/EU.

This development/evaluation tool, when incorporating wireless and radio-telecom functionality, is in compliance with the essential requirement and other relevant provisions of the R&TTE Directive 1999/5/EC and the FCC rules as stated in the declaration of conformity provided in the module datasheet and the module product page available at www.microchip.com.

For information regarding the exclusive, limited warranties applicable to Microchip products, please see Microchip's standard terms and conditions of sale, which are printed on our sales documentation and available at www.microchip.com.

Signed for and on behalf of Microchip Technology Inc. at Chandler, Arizona, USA.

Will

4/4/17

Date

Rodger Richey Director of Development Tools

The Microchip Web Site

Microchip provides online support via our web site at http://www.microchip.com/. This web site is used as a means to make files and information easily available to customers. Accessible by using your favorite Internet browser, the web site contains the following information:

- Product Support Data sheets and errata, application notes and sample programs, design resources, user's guides and hardware support documents, latest software releases and archived software
- **General Technical Support** Frequently Asked Questions (FAQ), technical support requests, online discussion groups, Microchip consultant program member listing
- Business of Microchip Product selector and ordering guides, latest Microchip press releases, listing of seminars and events, listings of Microchip sales offices, distributors and factory representatives

Customer Change Notification Service

Microchip's customer notification service helps keep customers current on Microchip products. Subscribers will receive e-mail notification whenever there are changes, updates, revisions or errata related to a specified product family or development tool of interest.

To register, access the Microchip web site at http://www.microchip.com/. Under "Support", click on "Customer Change Notification" and follow the registration instructions.

Customer Support

Users of Microchip products can receive assistance through several channels:

- Distributor or Representative
- Local Sales Office
- Field Application Engineer (FAE)
- Technical Support

Customers should contact their distributor, representative or Field Application Engineer (FAE) for support. Local sales offices are also available to help customers. A listing of sales offices and locations is included in the back of this document.

Technical support is available through the web site at: http://www.microchip.com/support

Microchip Devices Code Protection Feature

Note the following details of the code protection feature on Microchip devices:

- Microchip products meet the specification contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.
- There are dishonest and possibly illegal methods used to breach the code protection feature. All of these methods, to our knowledge, require using the Microchip products in a manner outside the operating specifications contained in Microchip's Data Sheets. Most likely, the person doing so is engaged in theft of intellectual property.
- Microchip is willing to work with the customer who is concerned about the integrity of their code.

• Neither Microchip nor any other semiconductor manufacturer can guarantee the security of their code. Code protection does not mean that we are guaranteeing the product as "unbreakable."

Code protection is constantly evolving. We at Microchip are committed to continuously improving the code protection features of our products. Attempts to break Microchip's code protection feature may be a violation of the Digital Millennium Copyright Act. If such acts allow unauthorized access to your software or other copyrighted work, you may have a right to sue for relief under that Act.

Legal Notice

Information contained in this publication regarding device applications and the like is provided only for your convenience and may be superseded by updates. It is your responsibility to ensure that your application meets with your specifications. MICROCHIP MAKES NO REPRESENTATIONS OR WARRANTIES OF ANY KIND WHETHER EXPRESS OR IMPLIED, WRITTEN OR ORAL, STATUTORY OR OTHERWISE, RELATED TO THE INFORMATION, INCLUDING BUT NOT LIMITED TO ITS CONDITION, QUALITY, PERFORMANCE, MERCHANTABILITY OR FITNESS FOR PURPOSE. Microchip disclaims all liability arising from this information and its use. Use of Microchip devices in life support and/or safety applications is entirely at the buyer's risk, and the buyer agrees to defend, indemnify and hold harmless Microchip from any and all damages, claims, suits, or expenses resulting from such use. No licenses are conveyed, implicitly or otherwise, under any Microchip intellectual property rights unless otherwise stated.

Trademarks

The Microchip name and logo, the Microchip logo, AnyRate, AVR, AVR logo, AVR Freaks, BeaconThings, BitCloud, CryptoMemory, CryptoRF, dsPIC, FlashFlex, flexPWR, Heldo, JukeBlox, KeeLoq, KeeLoq logo, Kleer, LANCheck, LINK MD, maXStylus, maXTouch, MediaLB, megaAVR, MOST, MOST logo, MPLAB, OptoLyzer, PIC, picoPower, PICSTART, PIC32 logo, Prochip Designer, QTouch, RightTouch, SAM-BA, SpyNIC, SST, SST Logo, SuperFlash, tinyAVR, UNI/O, and XMEGA are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

ClockWorks, The Embedded Control Solutions Company, EtherSynch, Hyper Speed Control, HyperLight Load, IntelliMOS, mTouch, Precision Edge, and Quiet-Wire are registered trademarks of Microchip Technology Incorporated in the U.S.A.

Adjacent Key Suppression, AKS, Analog-for-the-Digital Age, Any Capacitor, AnyIn, AnyOut, BodyCom, chipKIT, chipKIT logo, CodeGuard, CryptoAuthentication, CryptoCompanion, CryptoController, dsPICDEM, dsPICDEM.net, Dynamic Average Matching, DAM, ECAN, EtherGREEN, In-Circuit Serial Programming, ICSP, Inter-Chip Connectivity, JitterBlocker, KleerNet, KleerNet logo, Mindi, MiWi, motorBench, MPASM, MPF, MPLAB Certified logo, MPLIB, MPLINK, MultiTRAK, NetDetach, Omniscient Code Generation, PICDEM, PICDEM.net, PICkit, PICtail, PureSilicon, QMatrix, RightTouch logo, REAL ICE, Ripple Blocker, SAM-ICE, Serial Quad I/O, SMART-I.S., SQI, SuperSwitcher, SuperSwitcher II, Total Endurance, TSHARC, USBCheck, VariSense, ViewSpan, WiperLock, Wireless DNA, and ZENA are trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

SQTP is a service mark of Microchip Technology Incorporated in the U.S.A.

Silicon Storage Technology is a registered trademark of Microchip Technology Inc. in other countries.

GestIC is a registered trademark of Microchip Technology Germany II GmbH & Co. KG, a subsidiary of Microchip Technology Inc., in other countries.

All other trademarks mentioned herein are property of their respective companies.

[©] 2017, Microchip Technology Incorporated, Printed in the U.S.A., All Rights Reserved.

ISBN: 978-1-5224-1882-5

Quality Management System Certified by DNV

ISO/TS 16949

Microchip received ISO/TS-16949:2009 certification for its worldwide headquarters, design and wafer fabrication facilities in Chandler and Tempe, Arizona; Gresham, Oregon and design centers in California and India. The Company's quality system processes and procedures are for its PIC[®] MCUs and dsPIC[®] DSCs, KEELOQ[®] code hopping devices, Serial EEPROMs, microperipherals, nonvolatile memory and analog products. In addition, Microchip's quality system for the design and manufacture of development systems is ISO 9001:2000 certified.



Worldwide Sales and Service

Corporate Office 2355 West Chandler Blvd. Chandler, AZ 85224-6199 Tel: 480-792-7200 Fax: 480-792-7277	Asia Pacific Office Suites 3707-14, 37th Floor	China - Xiamen	Austria - Wels
2355 West Chandler Blvd. Chandler, AZ 85224-6199 Tel: 480-792-7200	Suites 3707-14, 37th Floor		
Tel: 480-792-7200		Tel: 86-592-2388138	Tel: 43-7242-2244-39
	Tower 6, The Gateway	Fax: 86-592-2388130	Fax: 43-7242-2244-393
⁻ ax: 480-792-7277	Harbour City, Kowloon	China - Zhuhai	Denmark - Copenhagen
	Hong Kong	Tel: 86-756-3210040	Tel: 45-4450-2828
Technical Support:	Tel: 852-2943-5100	Fax: 86-756-3210049	Fax: 45-4485-2829
http://www.microchip.com/	Fax: 852-2401-3431	India - Bangalore	Finland - Espoo
support	Australia - Sydney	Tel: 91-80-3090-4444	Tel: 358-9-4520-820
Web Address:	Tel: 61-2-9868-6733	Fax: 91-80-3090-4123	France - Paris
www.microchip.com	Fax: 61-2-9868-6755	India - New Delhi	Tel: 33-1-69-53-63-20
Atlanta	China - Beijing	Tel: 91-11-4160-8631	Fax: 33-1-69-30-90-79
Duluth, GA	Tel: 86-10-8569-7000	Fax: 91-11-4160-8632	France - Saint Cloud
Tel: 678-957-9614	Fax: 86-10-8528-2104	India - Pune	Tel: 33-1-30-60-70-00
Fax: 678-957-1455	China - Chengdu	Tel: 91-20-3019-1500	Germany - Garching
Austin, TX	Tel: 86-28-8665-5511	Japan - Osaka	Tel: 49-8931-9700
Tel: 512-257-3370	Fax: 86-28-8665-7889	Tel: 81-6-6152-7160	Germany - Haan
Boston	China - Chongging	Fax: 81-6-6152-9310	Tel: 49-2129-3766400
Westborough, MA	Tel: 86-23-8980-9588	Japan - Tokyo	Germany - Heilbronn
Tel: 774-760-0087	Fax: 86-23-8980-9500	Tel: 81-3-6880- 3770	Tel: 49-7131-67-3636
Fax: 774-760-0088	China - Dongguan	Fax: 81-3-6880-3771	Germany - Karlsruhe
Chicago	Tel: 86-769-8702-9880	Korea - Daegu	Tel: 49-721-625370
Itasca, IL	China - Guangzhou	Tel: 82-53-744-4301	Germany - Munich
Tel: 630-285-0071	Tel: 86-20-8755-8029	Fax: 82-53-744-4302	Tel: 49-89-627-144-0
Fax: 630-285-0075	China - Hangzhou	Korea - Seoul	Fax: 49-89-627-144-44
Dallas	Tel: 86-571-8792-8115	Tel: 82-2-554-7200	Germany - Rosenheim
Addison, TX	Fax: 86-571-8792-8116	Fax: 82-2-558-5932 or	Tel: 49-8031-354-560
Tel: 972-818-7423	China - Hong Kong SAR	82-2-558-5934	Israel - Ra'anana
Fax: 972-818-2924	Tel: 852-2943-5100	Malaysia - Kuala Lumpur	Tel: 972-9-744-7705
Detroit	Fax: 852-2401-3431	Tel: 60-3-6201-9857	Italy - Milan
Novi, MI		Fax: 60-3-6201-9859	Tel: 39-0331-742611
Tel: 248-848-4000	China - Nanjing Tel: 86-25-8473-2460	Malaysia - Penang	Fax: 39-0331-466781
	Fax: 86-25-8473-2470	Tel: 60-4-227-8870	Italy - Padova
Houston, TX Tel: 281-894-5983		Fax: 60-4-227-4068	Tel: 39-049-7625286
	China - Qingdao Tel: 86-532-8502-7355		Netherlands - Drunen
ndianapolis	Fax: 86-532-8502-7205	Philippines - Manila Tel: 63-2-634-9065	Tel: 31-416-690399
Noblesville, IN	China - Shanghai	Fax: 63-2-634-9069	Fax: 31-416-690340
Tel: 317-773-8323 Fax: 317-773-5453	Tel: 86-21-3326-8000		
Fax: 317-773-5453 Tel: 317-536-2380	Fax: 86-21-3326-8021	Singapore Tel: 65-6334-8870	Norway - Trondheim Tel: 47-7289-7561
		Fax: 65-6334-8850	Poland - Warsaw
Los Angeles	China - Shenyang		
Mission Viejo, CA	Tel: 86-24-2334-2829	Taiwan - Hsin Chu	Tel: 48-22-3325737
Tel: 949-462-9523	Fax: 86-24-2334-2393	Tel: 886-3-5778-366	Romania - Bucharest
Fax: 949-462-9608	China - Shenzhen	Fax: 886-3-5770-955	Tel: 40-21-407-87-50
Tel: 951-273-7800	Tel: 86-755-8864-2200	Taiwan - Kaohsiung	Spain - Madrid
Raleigh, NC	Fax: 86-755-8203-1760	Tel: 886-7-213-7830	Tel: 34-91-708-08-90
Tel: 919-844-7510	China - Wuhan	Taiwan - Taipei	Fax: 34-91-708-08-91
New York, NY	Tel: 86-27-5980-5300	Tel: 886-2-2508-8600	Sweden - Gothenberg
Tel: 631-435-6000	Fax: 86-27-5980-5118	Fax: 886-2-2508-0102	Tel: 46-31-704-60-40
San Jose, CA	China - Xian	Thailand - Bangkok	Sweden - Stockholm
Tel: 408-735-9110	Tel: 86-29-8833-7252	Tel: 66-2-694-1351	Tel: 46-8-5090-4654
Tel: 408-436-4270	Fax: 86-29-8833-7256	Fax: 66-2-694-1350	UK - Wokingham
Canada - Toronto			Tel: 44-118-921-5800
Tel: 905-695-1980 Fax: 905-695-2078			Fax: 44-118-921-5820