Introduction

Our kcEnergy firmware provides an embedded Bluetooth Low Energy (BLE) system on a small footprint pre-engineered module. The firmware is written for the CSR1010 chipset.

kcEnergy provides the required BLE profiles including GATT and GAP, along with several optional profiles, and custom KC Wirefree profiles. kcEnergy can function as BLE client and/or server.

It can provide iBeacon advertisements, GATT client and server features, as well as over-the-air updates. It is typically used to provide data to host devices through GATT server characteristics or beacon advertisements. The firmware can expose both server and client functionality, although it exposes only server functionality by default. The AT SetMode command may be used to change this.

Serial port functionality is available. This service can transmit data to and from the UART interface wirelessly to remote devices. Bandwidth is more limited than a dedicated SPP module and is not expected to exceed 20 kb/s. The data exchange can operating in either CommandMode or DataMode. In CommandMode, the data received will have a [coms]=n<LF> prefix, where n is an ASCII number string indicating the number of bytes received, followed by the data payload, and closed with a <LF> suffix. In DataMode, all Uart activity is transparent data streaming. Entering the ~~~ string will escape from DataMode.

Hardware

This User Guide covers device operations specific to this firmware edition. Hardware features and capabilities are outlined in the module Datasheets.

Supported Bluetooth Profiles

Profile	Name	Version	Dependencies
GAP	Generic Access Profile	1.0	None
GATT	Generic Attribute Profile	1.0	None
FMP	Find Me Profile	1.0	IAS
PXP	Proximity Profile	1.0	LLS, IAS, TXP

Included Bluetooth Low Energy Services

Services are organized collections of attributes that expose data fields for wireless input and output on the BLE device to remote devices.

Note: The 16-bit Bluetooth Service UUIDs are shorthand for 0000XXXX-0000-1000-8000-00805F9B34FB.

Profile	Name	UUID	Configure
GAP	Generic Access Service	0x1800	Enabled
GATT	Generic Attribute Service	0x1801	Enabled
DIS	Device Information Service	0x180A	Enabled
BATT	Battery Service	0x180F	Enabled
TPS	Tx Power Service	0x1804	Enabled
LLS	Link Loss Service	0x1803	Enabled
IAS	Immediate Alert Service	0x1802	Enabled

Included Custom Services

kcEnergy firmware provides the following custom services and characteristics by default:

Service – COMS

Service			UUID
COMS			0000F100-0000-AAAA-BBBB-CCCCDDDDEEEE
Characteristic	**Bytes**	**Type**	**UUID**
Data Transfer	20	String	0000F101-0000-AAAA-BBBB-CCCCDDDDEEEE

The COMS Service allows the transfer of serial data between a host and the kcEnergy Uart. The Data Transfer characteristic is used to send and receive data.

In order to automatically receive data from the COMS Service, the client device (phone) must send a Notification request for the kcEnergy Data Transfer Characteristic. With the server notification enabled, kcEnergy will automatically send any new data (received from the Uart).

> Android API call is `setCharacteristicNotification(characteristic, enable)`
> iOS API call is `setNotifyValue(enable, characteristic)`

Service – PIOS

Service			UUID
PIOS			0000F200-0000-AAAA-BBBB-CCCCDDDDEEEE
Characteristic	**Bytes**	**Type**	**UUID**
Aio State	2	Value	0000F201-0000-AAAA-BBBB-CCCCDDDDEEEE
Aio Notify	1	Value	0000F202-0000-AAAA-BBBB-CCCCDDDDEEEE
Pio State	2	Value	0000F203-0000-AAAA-BBBB-CCCCDDDDEEEE

The PIOS Service reports the Aio and Pio values of the module to client devices. Reading the Pio state will obtain the current Pio state while writing the Pio state will set the Pio state. The Aio state characteristic will read from Aio 1 and write to Aio 2.

Notifications using the AT Notf command must be enabled on the client side and will send periodic notifications from Aio 0 thereafter.

Service – MEAS

Service			UUID
MEAS			0000F300-0000-AAAA-BBBB-CCCCDDDDEEEE
Characteristic	**Bytes**	**Type**	**UUID**
Measure 0	2	Value	0000F301-0000-AAAA-BBBB-CCCCDDDDEEEE
Measure 1	2	Value	0000F302-0000-AAAA-BBBB-CCCCDDDDEEEE
Measure 2	2	Value	0000F303-0000-AAAA-BBBB-CCCCDDDDEEEE
Measure 3	4	Value	0000F304-0000-AAAA-BBBB-CCCCDDDDEEEE
Measure Str	21	String	0000F305-0000-AAAA-BBBB-CCCCDDDDEEEE

The MEAS Service provides a convenient way to send and receive structured numerical data, such as Temperatures, Lengths, and Time. Measurement characteristics 0 - 2 are each 16 bit values, while the Measurement 3 characteristic is a 32 bit value. The Measurement String characteristic is string up to 21 characters/bytes.

If notifications are requested by the client device (phone), then all updates to these characteristics are automatically transmitted to the phone. Otherwise, they can be read manually anytime.

Service - OTAU

Service			UUID
OTAU			00001016-D102-11E1-9B23-00025B00A5A5

The OTAU (Over The Air Update) Service permits the device to be wirelessly updated to newer versions of firmware. This is a CSR implementation, and requires the CSR OTA application to run on a PC (and requires a CSR Low Energy Bluetooth device - built in or USB dongle).

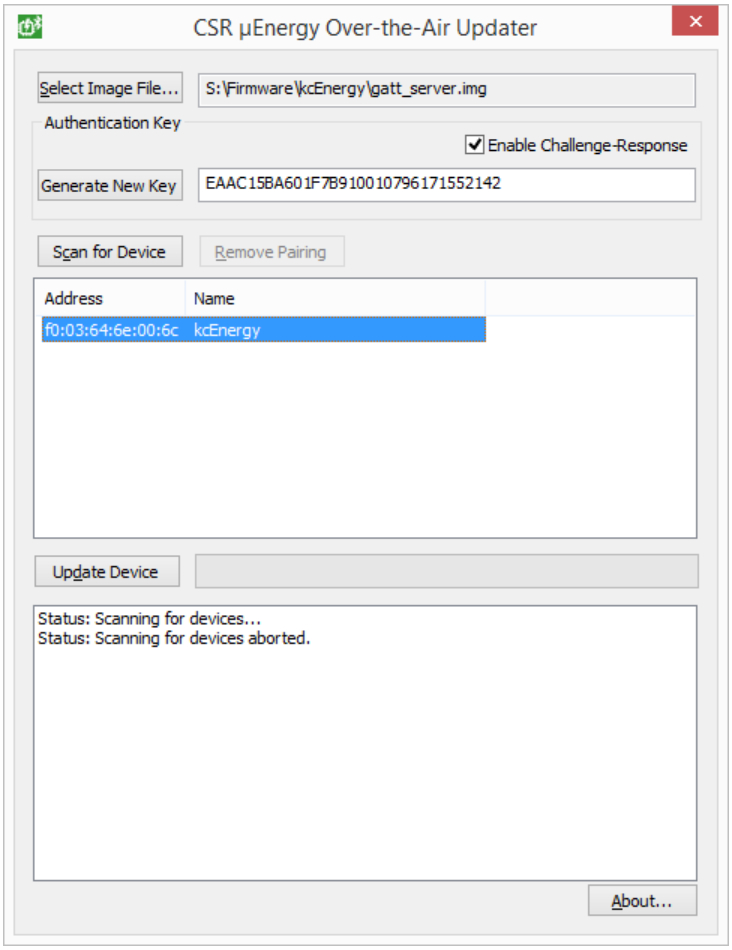
Wireless Firmware Update

The system firmware can be updated wirelessly. Requirements are: Microsoft Windows 8 (or higher), Bluetooth Low Energy device (internal or dongle), the CSR µEnergy Over-the-Air Updater application, the new firmware image file.

http://www.kcwirefree.com/docs/CSR_OTA_Installer.zip

Instructions

- Install CSR_OTA application.
- Turn on computer Bluetooth Low Energy (internal or dongle)
- Open µEnergyOTAUpdater
- Select kcEnergy firmware image file
- Select Enable Challenge Response
- Insert the KC Wirefree authentication key: EAAC15BA601F7B910010796171552142
- Power up KC Wirefree BlueEnergy demo board or module
- Press the “Scan for Device” button to find BlueEnergy device
- Select the device then press the “Update Device” button



BLE Phone Utility Apps

BLE Scanner	Free	Android	Does not handle notifications or PNP ID's.
nRF Master Control Panel	Free	Android/IOS	Status indicators do not update, DFU not avail.
iBeaconDetector	Free	Android	RSSI values may be erroneous.
LightBlue	Free	IOS	No known issues.
Locate Beacon	Free	IOS	No known issues.

Device States

Idle

Idle is the default device state. It disables discovery advertising and disconnects any currently active connections. Bypass and Notification functions will have no effect when the device is idle. The UART will be active

Fast Discovery

The device will send out advertising packets every 60 ms for up to 30 seconds, after which it will transition to Slow Discovery to save power. In other respects, discovery is identical to Idle.

Slow Discovery

The device will advertise once every 1280ms for up to 60 seconds.

Scanning

Scanning is only available when the device is acting in a client role. This state is used to indicate passive listening for discoverable devices.

Connected

Connected state enables the connection-specific commands, including AT Notf, Meas, and UART Bypass. Upon entering this state, the message "ConnUp" will be printed to UART.

Disconnecting

This temporary state indicates that a disconnection is in progress. When the disconnection is completed, the message "ConnDn" will be printed to UART.

Pio Assignments on KC-4014/4114 Modules

PIN	I/O	Default Firmware Feature
AIO 0		
AIO 1	Input	Demo Reader
AIO 2	Output	Demo Controller
TXD	Output	Uart Transmit
RXD	Input	Uart Receive
PIO 2	Input	Factory Reset (HIGH during boot)
PIO 3	Input	Command Button
PIO 4	Input	Aux Button
PIO 5 [CLK]	Input	Unassigned (Optional SPI CLK, I2C SCL)
PIO 6 [CSB]	Input	Unassigned (Optional SPI CSB, I2C SDA)
PIO 7 [MOSI]	Input	Unassigned (Optional SPI MOSI)
PIO 8 [MISO]	Input	Unassigned (Optional SPI MISO)
PIO 9	Output	Activity Output
PIO 10	Output	Aux Output
PIO 11	Input	Unassigned
SPI	Input	Enables SPI feature
WAKE	Input	Wake from Deep Sleep when HIGH

Low Energy UART

The onboard UART is the primary interface for configuring and communicating with the device. The UART operates in one of two modes: Bypass and Command mode

Bypass Mode

Bypass mode remains similar to the bypass mode found on previous

Command Mode

AT Commands on the KC4014 and KC4114 use a new command format that differs from our commands on other kcWirefree modules. All commands now require either a *get* or a *set* parameter following the command. *Get* parameters return the value of the current setting while *set* will modify the device state as appropriate.

- Default UART setting is 115200-8-N-1, without hardware flow control.
- Enter AT Commands via UART as standard strings, terminated with the LF character (0x0A).
- Command lines parsed and executed when the LF character is received.
- All AT Commands accept either a Get or Set parameter. The Get parameter will return the value of the current setting. The Set parameter will save the following parameters as appropriate.
- Output messages are terminated with LF (0x0A).
- While in a remote connected Bypass mode, using the escape sequence "~~~" can escape bypass mode

AT Command List

```
Addr            Hid             Name
Aio             I2c             Pair
Bat             Idle            Pio
Bcon            Info            Role
Coms            Link            Rset
Conn            Mem             Rssi
Dbug            Meas            Uart
Dtim            Mode
```

AT Commands

AT Addr

The Addr command prints the Bluetooth device address.

Get	`AT Addr Get`
Example	`AT Addr Get` `Addr 646E:6C:F003`

AT Aio

The Aio command provides the interface to the Analogue I/O pins on the kcEnergy BLE module. There are 3 available Aio pins, numbered 0-2. The Aios may be driven from 0-1350mV. The available notification timer may be configured to report the voltage on Aio pin 0 to a remote device at periodic intervals.

Get	AT Aio Get <aio>
Set	AT Aio Set <aio> <e/d> <level>
Notify Cmd	At Aio Notf <e/d> <period>
<aio>	Aio pins 0-2
<e/d>	E/D (enable or disable)
<level>	Voltage in mV at which to drive the Aio (optional)
<period>	Reporting interval in milliseconds
Example	AT Aio Get 1 475 mV

AT Bat

The Battery command may be used to read the current battery level. The command will return the battery level in both percent and millivolts.

Get	AT Bat Get
Example	AT Bat Get 100% 3327mV

AT Bcon

This command can be used to configure the settings for iBeacon and altbeacon setups. The Major and Minor parameters refer to customer installation information. The TX power parameter is an index into the power table and should be omitted.

Get	AT Bcon Get
Set	AT Bcon Set <minor> <major> <UUID minor> <UUID major> <TX power>
<minor>	The minor version of the beacon to be advertised in hexadecimal format
<major>	The major version of the Beacon to be advertised in hexadecimal format
<UUID minor>	Minor 16 bit word of the UUID in hexadecimal format
<UUID major>	Major 16 bit word of the UUID in hexadecimal format
<TX power>	The TX Power parameter should be normally omitted.
Example	AT Bcon Set 0123 4567 89ab cdef 6 0123-4567-89AB-CDEF-6

AT Coms

The Coms (Com Port Transfer) command sends data using the COMS Service, for transmission to the remote device. The bytes parameter is the payload size. Must include a LineFeed between the AT Command and the data payload. There is no additional LineFeed or other End Of Line marker following the payload data. The Coms command will transmit the subsequent <bytes> of data when received, until completed.

Issuing the Coms command with 0 bytes, will cause the

The remote device must have enabled notifications on the COMS Service Data Transfer Characteristic, otherwise unsolicited data cannot be sent, and the command will fail.

Command	AT Coms <bytes><lf><data>
<bytes>	0=DataMode, 1-64 bytes to transmit (ASCII number string)
<lf>	LineFeed character
<data>	Data payload
Example	AT Coms 10<lf>HelloWorld Coms Ok
Example not connected	AT Coms 12<lf>HelloWorld!! Coms Failed
Example	AT Coms 0 [datamode]

AT Conn

The Conn (Connection) command reconnects to the last connected device. This functionality will be expanded in future releases.

Set	AT Conn Set
Example	AT Conn Set Conn 00163EE366AF

AT Dbug

The Dbug (Debug) command is designed for internal purposes only. Use only under direction from kcWirefree support. Debug output is not human-readable without additional direction.

Get	AT Dbug Get
Set	AT Dbug Set <flags>
<flags>	Hex16 flag to enable debugging modules
Example	AT Dbug Set 111 0-1-1-0-1-1-1-1

AT Hid

The HID command may be used to send HID packets if the appropriate HID profile is enabled in firmware. The report IDs must be in the range 1-3. Report ID 1 corresponds to HID Input/Keyboard keys while report ID 3 corresponds to Consumer/Media keys.

Set	AT Hid Set <id> <data>
<id>	Hid report ID (1-3)
<data>	The packet in hexadecimal format
Example	AT Hid Set 3 200000 [20:00:00]

AT I2c

The I2c command may be used to communicate with I2c devices manually. For I2c configuration, all values except the enable flag are optional.

Get	AT I2c Get <device> <addr> <length>
Set	AT I2c Set <device> <addr> <data>
Get	AT I2c Get config
Set	AT I2c Set config <e/d> <sda> <scl> <power> <on period> <off period> <pull mode>
<device>	I2c device address in hexadecimal format
<addr>	I2c memory address to read or write in hexadecimal format
<length>	Length of data to be read in hexadecimal format
<data>	Hexadecimal data to be written
<e/d>	E/D (enable or disable)
<sda>	SDA line Pio (2-9). Default Pio is 5
<scl>	SCL line Pio (2-9). Default Pio is 6
<power>	Power rail Pio (2-9). Default Pio is the onboard power rail
<on period>	The clock Settings default to I2c Fast Mode.
<off period>	The clock settings default to I2c Fast Mode.
<pull mode>	Please contact KC Wirefree for help modifying this value.
Example	At I2C Get 50 1200 4 [4A:00:32:FF:]

AT Idle

The Idle command may be used to change the sleep mode of the device. The Uart is disabled when the device is in Deep Sleep, except when using the special 2400 baud rate setting.

Get	AT Idle Get
Set	AT Idle Set <mode>
<mode>	Sleep mode 0-2 0=Never, 1=Deep Sleep, 2=Shallow Sleep (default)
Example	AT Idle Set 2 Idle 2

AT Info

The Info command prints out the information regarding the current firmware version.

Get	AT Info Get
Example	AT Info Get kcEnergy v0.6 by KC Wirefree HW v1.0 SW v0.6 Date Jun 3 2015

AT Meas

The AT Meas (Measurement) command provides an interface to KC Wirefree's custom measurements profile. All characteristics and notifications available in the profile are accessible through this command. It is only accessible in firmware in which the measures measurements profile is enabled. When a characteristic is set, notifications will be sent to connected devices if they have elected to receive notifications on that characteristic.

Get	AT Meas Get <index>
Set	AT Meas Set <index> <value>
Get Str	AT Meas Get str
Set Str	AT Meas Set str <string>
<index>	0-3 (measurement characteristic variable 0-3)
<value>	16-bit value (measurement characteristic variable 0-2) 32-bit value (measurement characteristic variable 3)
<string>	ASCII string (measurement characteristic variable str)
Example	At Meas Set str TestStr

	Meas “TestStr”

AT Mode

The AT Mode command is used to print out the device state. These states will also be printed automatically when the device state changes. The device states include:

- [init] This is a very brief power-up state
- [idle] No discovery or connection
- [fast] Fast discovery (advertising every 60ms)
- [slow] Slow discovery (advertising every 1280ms)
- [scan] Listening for discoverable/advertising BLE devices
- [conn] Device is connected to a host
- [dcon] Device is currently disconnecting, very brief state

Get	AT Mode Get
Example	AT Mode Get [conn]

AT Notf

The Notf (Notify) command is used to send notifications on any characteristic for which notifications have been enabled. This command should not be used without specific direction from kcWirefree.

Set	AT Notf Set <handle> <data>
<handle>	GATT characteristic ID in hexadecimal
<data>	The data as a stream of non-zero bytes
Example	AT Notf Set 2816 5658

AT Pair

The AT Pair command may only be used to delete pairing in the present iteration.

Set	AT Pair Set del
Example	AT pair Set del Pair del 0

AT Pio

The Pio command may be used to read and set the Pio lines.

Get	AT Pio Get <pio>
Set	AT Pio Set <e/d> <pio>
<pio>	Pio pin 2-11

<enable>	E/D (enable or disable)
Example	AT Pio Set 9 E Pio 9 E

AT Rset

The Rset (Reset) command may be used to reset the device.

Set	AT Rset Set
Example	AT Rset Set kcEnergy v0.8 by KC Wirefree HW v1.0 SW v0.8 Date Jun 3 2015

AT Role

This command is used to switch the device between operating modes. It should be followed by AT Reset. Server mode is the factory default and will expose GATT services to remote hosts. Client mode is currently limited to discovery procedures, RSSI, and reading advertisement data. Additional functionality for this mode available upon request. Beacon mode can be used to enable iBeacon functionality. The AT Bcon command may be used to configure Beacon data to your requirements.

Get	AT Role Get
Set	AT Role Set <role>
<role>	Only role 0 is currently available
Example	AT Role Get Role 0

AT Rssi

The Rssi command returns the Rssi reading of the active connection.

Get	AT Rssi Get
Example	AT Rssi Get dBm -49

AT Uart

The Uart command is used to configure the UART interface to customer requirements.

Get	AT Uart Get

Set	AT Uart Set <enable> <baud rate> <config> <blocking> <flow ctrl> <rts> <cts>
Set Bypass	AT Uart Set bypass <enable>
<enable>	E/D (enable or disable)
<baud rate>	Useful values for this parameter can be found in the following table 12C0 (2400 baud works in Deep Sleep), 0028 (9600 baud), 004E (19200 baud), 009E (38400 baud), 00EB (57600 baud), 01D9 (115200 baud), 0760 (460800 baud), 0EBF (921600 baud)
<config>	This parameter is optional
<blocking>	This parameter is optional
<flow ctrl>	E/D (enable or disable)
<rts>	RTS pio assignment (2-11)
<cts>	CTS pio assignment (2-11)
Example	AT Uart Set E 01d9 E-D-D-01D9-0

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