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# H8S/2117

## Smart Battery Communications

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### Introduction

This application note accompanies the Smart battery sample code developed for the H8S/2117. The sample program demonstrates how to communicate with a smart battery. Charging and discharging circuits and algorithms are not included in this application note. The software was developed and tested on the YTD08EV211701 and the HP HSTNN-CB69 standard laptop battery

### Target Device

H8S/2117 (YTD08EV211701 Common KBC Board)

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## 1. Overview

The Smart Battery sample code provides an example of Smart Battery communications. The program sends out commands and populates the Smart battery data structure with information about the smart battery. In a real application this information can then be used by higher layers to determine charging algorithms and other parameters.

## 2. Running the program

To run the program, download the code to the H8S2117. Connect a smart battery to the I2C channel 0. The program will then send out the series of commands and populate the smart battery data structure with responses received from the battery. Connecting a secondary battery to channel 2 and changing arguments to the battery interrogation functions will allow communication with the secondary battery.

## 3. The Smart Battery Standard

The Smart Battery Specification was written primarily with the intent to provide a communications interface between a battery and the user system. The specification was written to provide a better user experience when using such a system. Aspects of the user experience including regular updates on battery status like remaining charge and estimated usage time, selection of proper algorithms for charging and discharging etc which are better served by this specification. Based on this information, the system is able to regulate performance to maximize battery life or maximize performance or any other user defined performance specification.

The Smart Battery Specification specifies a set of commands that the battery controller can decode and respond to. The spec also defines how to interpret battery responses to a particular command, as well as commands that let the system control certain aspects of battery operation.

### 3.1 Communication Protocol

At the communications layer, the Smart Battery Specification uses the SMBUS protocol. All smart batteries are equipped with microcontroller that operates as an SMBUS slave device. This device takes care of obtaining and keeping track of all the information regarding the battery like charge state, temperature, estimated charge time etc. In addition to this operational information, the microcontroller also holds static information about the battery like battery address (0x16), manufacturer information, serial number, battery chemistry etc.

The specification [0] is available for download on the smartbattery.org website.

## 4. Program Description

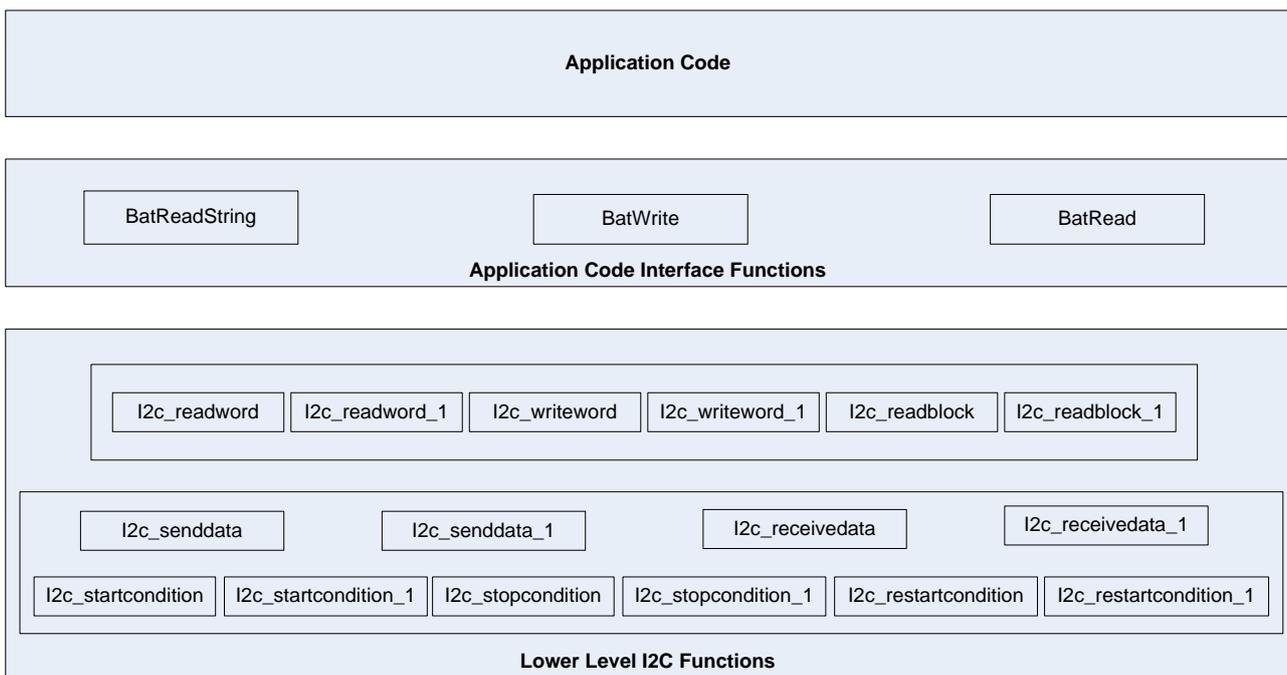


Figure 1: Sample Program Layout

The Main layers in the sample program are

a. Main (Application code)

b. Application Interface Functions: These functions take as arguments Battery-number, command and pointers to response buffers

```
uchar BatReadString (uchar command, uchar* ResponseString,uchar PolledBattery)
uchar BatRead (uchar command, uint* Resp, uchar PolledBattery)
uchar BatWrite(uchar command, uint Mesg, uchar PolledBattery)
```

c. Lower Level I2C functions: These functions are written for individual I2C Channels and are invoked depending on the Battery-number parameter passed to higher level functions.

```
uchar i2c_senddata(uchar sendingdata)
uchar i2c_receivedata(uchar * receivedata)
uchar i2c_senddata_1(uchar sendingdata)
uchar i2c_receivedata_1(uchar * receivedata)
```

The program is configured to work with I2C channels 0 and 1, although it can be easily ported to work with channel 2 as well. The lower level functions use a timeout function for a non-blocking implementation. Timer0 is used as the system tick timer and generates a 1 millisecond system tick. The timeout routine alarm() uses this as its time base.

The sample application uses the Application Interface functions to interrogate a smart battery and populate the battery structure based on the responses received from the battery. The program currently supports the following Smart Battery commands although more can be added easily.

```
#define TEMPERATURE           0x08 // Get cell temperature (word 0.1 degK)
#define VOLTAGE                0x09 // Get cell pack voltage (word mV)
#define CURRENT                0x0A // Get cell pack current (word mA)
#define AVERAGE_CURRENT      0x0B // Get cell avg current (word mA)
#define PERCENT_FULL          0x0D // Get cell relative state of charge
#define REMAINING_CAPACITY    0x0F // Get remaining capacity (word mAh)
#define RUNTIME_TO_EMPTY      0x11 // Runtime remaining to drain battery (word minutes)
#define BATTERY_STATUS        0x16 // Battery status flags (word)
#define DESIGN_CAPACITY       0x18 // Designed capacity (word mAh)
#define DESIGN_VOLTAGE        0x19 // Designed voltage (word mV)
#define MFG_DATE              0x1B // Manufacture date
#define SERIAL_NUMBER         0x1C // Serial number
#define MFG_NAME              0x20 // Manufacturer name
#define DEVICE_NAME           0x21 // Device name
#define CHEMISTRY              0x22 // Device chemistry (4 character string)
```

**Figure 2: Supported Smart Battery commands**

The smart battery structure listed below is not an exhaustive one, only a sample of data that can be obtained from the battery. The I2C layer uses the i2c\_data structure listed below to store data sent and received during a particular transaction. The higher layers transfer this data to the battery structure.

```
struct i2c_data {
    unsigned char  Slave_ID;      // Slave address
    unsigned char  Byte_count;    // Byte count
    unsigned char  buffer[I2C_BUFFSIZE]; // Received data or send data
    unsigned char  PolledBattery; // Battery number (Primary or Secondary)
} I2C_DATA;
```

**Figure 3: i2c\_data data structure**

```

Battery_struct
{
  uint   Temperature;           // Battery temperature (command 0x08)
  uint   Current;              // Current (abs value command 0x0A)
  uint   Voltage;              // Battery voltage (command 0x09)
  uint   AverageCurrent;       // Average current (abs value command 0x0B)
  uint   PercentFull;          // Percent full (command 0x0D)
  uint   RemainingCapacity;     // Battery capacity (command 0x0F)
  uint   RunTimeToEmpty;       // Time remaining until empty (command 0x11)
  // Status word read from battery (command 0x16)
  union
  {
    uint   Word;
    struct
    {
      // Smart Battery Status bits
      uint   ErrorCode          :4; // Error code
      uint   FullyDischarged    :1; // Battery discharged
      uint   FullyCharged       :1; // Battery charged
      uint   Discharging        :1; // Battery currently discharging
      uint   Initialized        :1; // 1=Battery calibrated and working
      uint   TimeAlarm          :1; // 1=Time to Empty less than Remaining Time
      uint   CapacityAlarm      :1; // 1=Capacity less than Capacity alarm
      uint   Reserve10         :1; // Reserved in SBS spec
      uint   DischargeAlarm     :1; // 1=Battery is depleted: stop discharging
      uint   OverTempAlarm     :1; // 1=High temperature: stop charging
      uint   Reserve13         :1; // Reserved in SBS spec
      uint   ChargeAlarm       :1; // 1=Charging must be suspended
      uint   OverChargeAlarm   :1; // 1=Battery is fully charged: stop charging
    } Bit;
  } Status;

  uint   DesignCapacity;       // Design capacity (command 0x18)
  uint   DesignVoltage;        // Design voltage (command 0x19)
  uint   MfgDate;              // Manufacture date (command 0x1B)
  uint   SerialNumber;         // Serial number (command 0x1C)
  uchar  MfgName[MFG_NAME_LENGTH]; // Manufacturer Name
  uchar  DeviceName[DEVICE_NAME_LENGTH]; // Device Name
  uchar  Chemistry[CHEMISTRY_NAME_LENGTH]; // Device chemistry ('LION')
} BATTERY_STRUCT;

```

**Figure 4: Battery\_struct data structure**

## 5. Using the Program in your application

To use the program in a separate application, include the `I2C_functions.c` and `I2C_functions.h` in the application. The tick timer ISR in `intprg.c` should be included as well.

Initialize the proper I2c channel by calling `I2C_init()` with the proper argument. Since the I2C function calls use `timer0` to determine timeouts, the timer has to be initialized at this point as well by calling the `Init_timer()` function. The main program can be used as a template on how to use the provided functions. The `BatRead()`, `BatWrite()` and `BatReadString()` functions can now be called with proper arguments to retrieve/send data to the smart battery system. The provided main application can be used as a template.

To port the program to work with channel 2, simply reconfigure the corresponding registers from channel 0 or 1 to channel 2. The module stop bit for the individual channel needs to be cleared as well to enable configuring the I2C registers.

## Reference

1. <http://smartbattery.org/specs/sbdata10.pdf>

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## Revision Record

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