I^2C Communication Sample Code for the bq76940 with a CRC Option Based on the MSP430G2553

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ABSTRACT

This application note describes how to communicate with the bq76940 family devices over I^2C. The code is based on the TI MSP430G2553. The code shows how to write the CRC function which is used to verify the transaction integrity over the I^2C and how to initialize the I^2C engine of the G2553 and bq76940 registers as well as how to read binary data from the AFE registers and transfer the data to voltages.

Contents

1 Introduction

The bq76940 is a new Analog Front End (AFE) device which targets at the battery management solutions for the applications like energy storage station, batteries for E-Motor, E-Bike, scooter or E-Tool, and so on. It typically works with an MCU with an I^2C interface. The MCU can directly read digital information for individual cell voltages, battery current, and temperatures via the I^2C bus. The basic protect actions like overvoltage protection, undervoltage protection, overcurrent protection and short-circuit protection can be performed by the bq76940 according the threshold programmed by the MCU during initialization of the battery management system. The MCU is also responsible for the release of protections. The bq76940 device name is used in the document, but the communication methods described also apply to the bq76930 and bq76920.

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2 Hardware Connection

The I²C communication sample code is based on the bq76940 EVM and MSP430 value line LaunchPad™ development tool, Figure 1 is the simplified connection diagram.

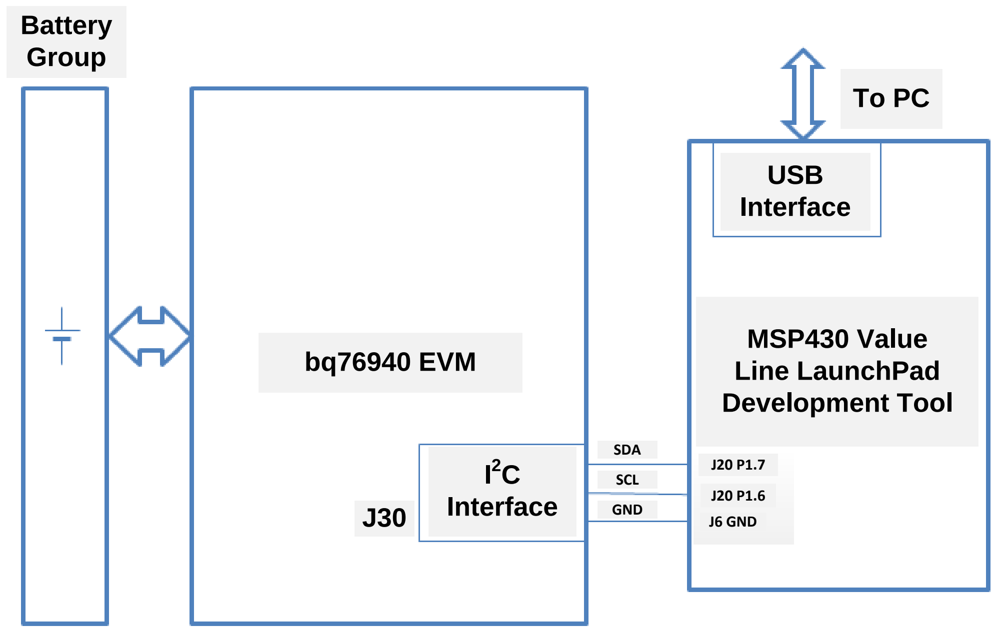

Figure 1. Simplified Connection Diagram

For the MSP430 Value Line LaunchPad Development tool, short all the jumpers of J3 (Figure 2), and leave the jumpers for J5 open.

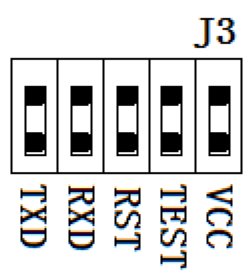

Figure 2. LaunchPad J3 Jumper Settings

For the bq76940 EVM, there are more than one versions in the field, refer to the documentation for the board you are using. Figure 3 illustrates how to connect the J31 jumper in the EVM PR2019 REVB.

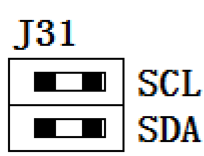

Figure 3. J31 Jumper Connections in PR2019 RevB

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For jumper J27, connect REGOUT and PULL-UP, connect CELL1 and BOOT on J22. Figure 4 illustrates how to connect the J32 jumper.

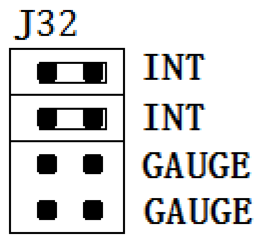

Figure 4. J32 Jumper Connections

Figure 5 illustrates the selection of FET SRC on the jumper for REGSRC.

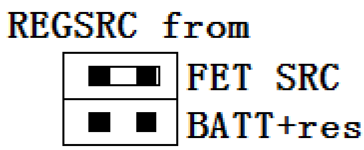

Figure 5. REGSRC Jumper Connection

Short jumpers J7 and J51 if there is no need to test the current for VC10x and VC5X.

All other jumpers can be left open except for J43, J49, J5, J46, J53, and J6. Refer to the bq76940 EVM user guide for instructions on how to connect these jumpers.

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3 Sample Code

The sample code is composed of three types of functions: MSP430 initializing functions, I^2C communication functions, and CRC generating functions. The sample code provides a demonstration of how to communicate with the bq76940 I^2C engine. The MSP430 initializing is relatively simple. Watchdog and all interrupts are disabled by the lines of:

```
WDTCTL = WDTPW | WDTHOLD;
And
DISABLE_INT;
```

The clock module are initialized by the function of ***ClockInitialise()***. The highest frequency is selected by setting DCOx to 7 and RSELx to 15. The frequency is about 20 MHz. The DCOCLK is selected as MCLK by setting SELMx to 0, the divider is set to 1 by setting DIVMx to 00, the DCO is selected as SMCLK by setting SELS to 0, the divider is set to 1 by setting DIVSx to 0. The internal resistor is selected for DCO.

The I^2C module is initialized by the ***I2CInitialise()*** function. The pins for P1.6 and P1.7 are set as SCL and SDA, the basic input clock for the I^2C module is SMCLK which is sourced from DCO at the frequency of about 20 MHz. By setting the UCB0BR0 to 20 and UCB0BR1 to 0, the I^2C clock is 100 kHz. All functions with names beginning I^2C are for I^2C communication operation. The major functions are listed as follows:

```
I2CWriteRegisterByte
I2CWriteRegisterByteWithCRC
I2CWriteRegisterWordWithCRC
I2CWriteBlockWithCRC
I2CReadRegisterByte
I2CReadRegisterByteWithCRC
I2CReadRegisterWordWithCRC
I2CReadBlockWithCRC
```

These functions are used for reading or writing bq76940 registers in Byte, word or Block operations. For robustness and reliability of the system, bq76940 devices are offered with CRC options. It can be ordered with specific postfix for information described in the “ORDER INFO” section in the data sheet (SLUSBK2). Functions supporting CRC option devices in this application note are in the format I2Cxxx…xxxWithCRC.

The bq76940 uses 8-bit CRC. The CRC polynomial is $X^8 + X^2 + X + 1$. A function CRC8() is used in the sample code. The prototype of the function is:

```
unsigned char CRC8(unsigned char *ptr, unsigned char len,unsigned char key)
```

The 8-bit CRC value is returned as an unsigned char value by this function, the input parameter ptr, is a pointer to an input string containing the byte(s) that should be involved for CRC calculation. The parameter len is the number of bytes of the string pointed by ptr, the parameter key is derived from the CRC polynomial. This value can be acquired by replacing the X with 2 in the CRC polynomial with first item (the item with highest power index) excluded. For the polynomial used by the bq76940, the key should be 0x7. For a single write operation, the byte transmission sequence is illustrated in Figure 6. In Figure 6, the 8-bit CRC is calculated with the string composed of the data of Byte1, Byte2, and Byte3; note that Byte1 is an 8-bit address with R/W included.

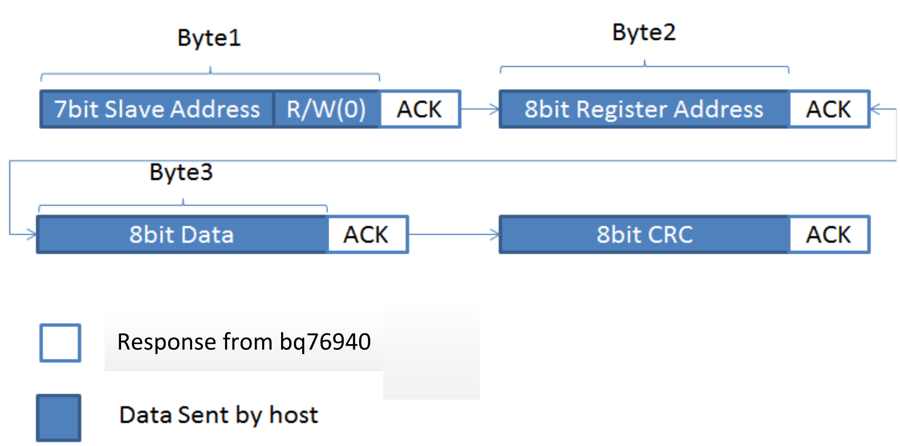

Figure 6. Single Write, Byte Transmission Sequence

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For a multi byte transaction, the CRC bytes are interlaced between each 8-bit data item.

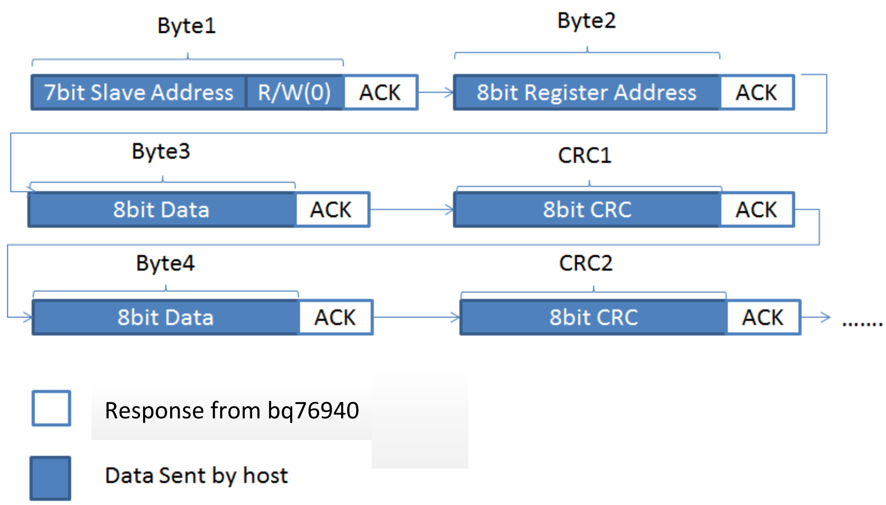

Figure 7. Multiple Bytes Sent to the bq76940 Target Device

In Figure 7, multi bytes are sent to the bq76940 target device, as in single byte transaction, CRC1 is calculated over the byte string from Byte1 to Byte3, afterwards, each CRC byte is only calculated over its successive byte data, that is, CRC2 in Figure 7 is only calculated from Byte4. For a single byte read transaction, the transaction with CRC is like Figure 8. The first CRC1 returned from bq76940 is calculated over Byte3 and Byte4.

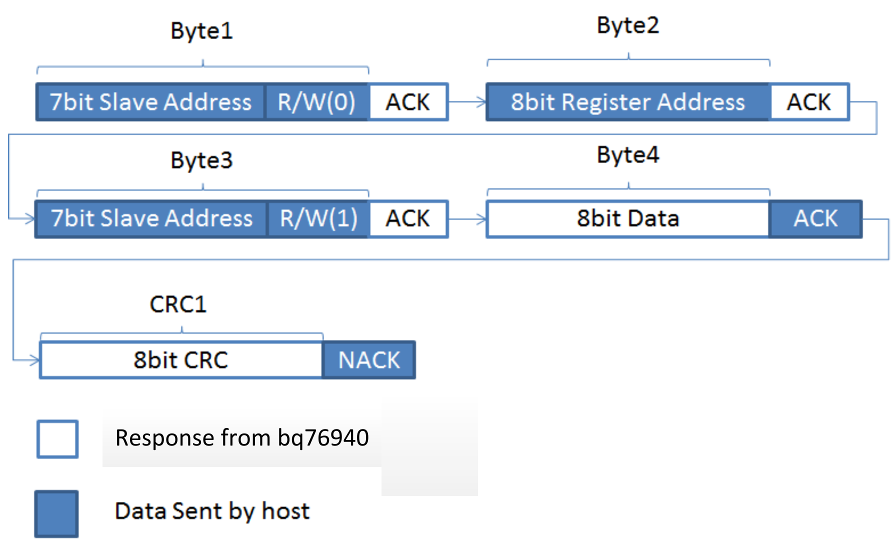

Figure 8. Single Byte Read Transaction with CRC

For the multiple byte reading, the CRC and data returned from bq76940 are also interlaced like multiple byte write.

In Figure 9, CRC1 is just the same as a single byte reading transaction, it is calculated over Byte3 and Byte4, for the following CRCs, like CRC2, it is calculated only over Byte5. Each CRC byte is only calculated over its successive byte.

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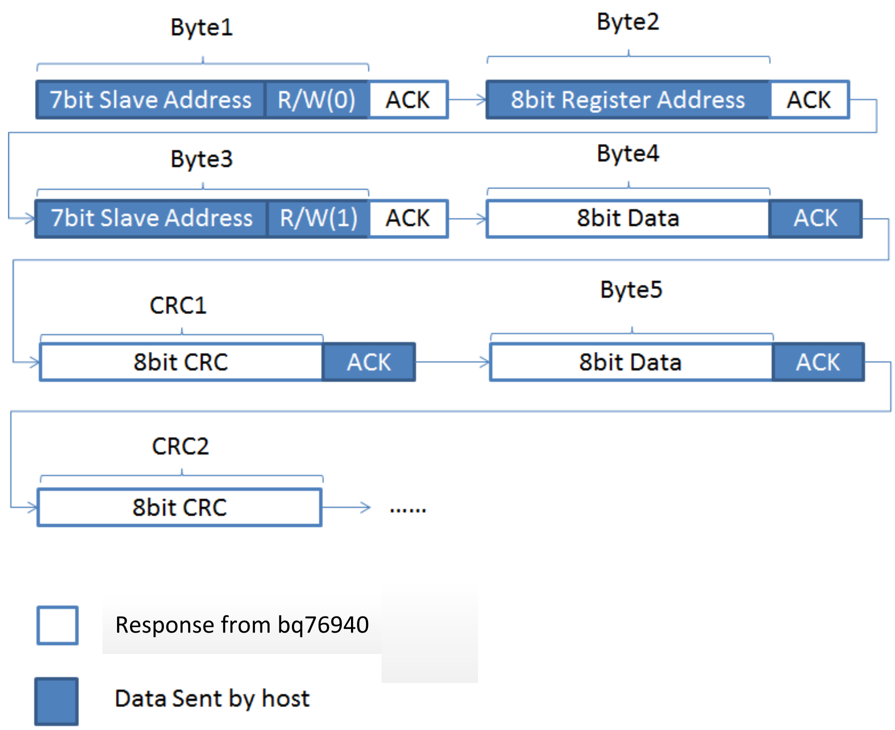

Figure 9. Multiple Byte Reading

4 Conclusion

This application note describes sample code for MCU and bq76940 communication over I^{2}C, especially on how to generate CRC and how to verify the CRC from the target device. The sample code is written under CCS5.4.0 environment*. It can be directly built and downloaded into MSP430G2553, CRC is helpful with communication robustness. The sample code can be referred for actual communication programming.

*The Stack size and Heap size must be set to greater than 100.

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Revision History

Changes from Original (November 2013) to A Revision	Page
• Added paragraph after Figure 5.	3

Revision History

Changes from A Revision (December 2013) to B Revision	Page
• Changed title of document to *I^2C Communication Sample Code for the bq76940 with a CRC Option Based on the MSP430G2553*	1
• Changed content of the abstract.	1
• Changed *Introduction* section.	1
• Changed device name to bq76940 in first and third paragraphs in *Hardware Connection* section.	2
• Changed device name to bq76940 in Figure 1.	2
• Changed device name to bq76940 in second paragraph under Figure 5.	3
• Changed device name to bq76940 in all of *Sample Code* section.	4
• Changed device name to bq76940 in Figure 6.	4
• Changed device name to bq76940 in Figure 7.	5
• Changed device name to bq76940 in Figure 8.	5
• Changed device name to bq76940 in Figure 9.	6

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