SMBus Library for MSP430FR5xx_6xx Devices

User's Guide

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1 Introduction

1.1 Introduction

Ths SMBus (Sytem Management Bus) API (application programming interface) stack for MSP430™ microcontrollers is a turnkey API. It includes support for applications where the MSP430™ microcontroller is acting as the master or a slave.

The API is designed to minimize the SMBus knowledge required to write an application:

- All SMBus protocol is handled automatically by the API
- The data interface presented to the application is simple to use, abstracting the application from SMBus protocol

The user should not need to modify the API source. However, for experienced developers, the source is open and available for editing. Accessing the API's source can also be useful for system debug.

Application examples are included in the MSP430™ SMBus Library Package.

1.2 SMBus

The System Management Bus (SMBus) is a lightweight two-wire interface based on the principles of I2C, commonly used as a control bus and for power management tasks in computing, mobile computing and battery operated applications. A device performing data transfers on the bus can be considered a master, which is the device which initiates a transaction and drives the clock, or a slave, which is the target of a SMBus transaction driven by the master. Both the master and the slave can act as transmitters or as receivers.

SMBus 2.0 shares a lot of similarities with I2C, but some of the most relevant differences include:

- Time-out detection when a device stretches the clock for too long
- Packet Error Checking (PEC) can be optionally appended at the end of each transaction, allowing the bus to automatically validate packets
- I2C only defines a PHY and Data-Link layers, but SMBus defines a network layer with different SMBus protocols which can be used to exchange data between devices
- Optional use of additional lines such as SMBAlert# and SMBSUS#.

For more information about SMBus, please refer to the SMBus 2.0 specification: `http://smbus.org/specs/`. For more information about I2C, please refer to `http://www.nxp.com/documents/user_manual/UM10204.pdf`

1.2.1 Supported Features

The following table details the SMBus features supported in the MSP430™ SMBus library.

| SMBus Feature | MSP430FR5xx‑6xx | | MSP430G2xx3 | | Applicable SMBus 2.0 |
	Master	Slave	Master	Slave	specification section
Clock Timeout detection[1]	Yes	Yes	Yes[1]	Yes[1]	3.1.1.2
Manual NACK on invalid address/data	N/A	Yes[2]	N/A	No	4.2
Arbitration	Yes	N/A	Yes	N/A	4.3.2
Clock stretching	Yes	Yes	Yes	Yes	4.3.3
Multiple Slave address	N/A	No	N/A	No	5.2
General Call address	N/A	No	N/A	No	5.2
PEC	Yes	Yes	Yes	Yes	5.4
Quick Command	Partial[3]	Partial[3]	Parial[3]	Partial[3]	5.5.1
Send Byte	Yes	Yes	Yes	Yes	5.5.2
Receive Byte	Yes	Yes	Yes	Yes	5.5.3
Write Byte/Word	Yes	Yes	Yes	Yes	5.5.4
Read Byte/Word	Yes	Yes	Yes	Yes	5.5.5
Process Call	Yes	Yes	Yes	Yes	5.5.6
Block Write/Read	Yes	Yes	Yes	Yes	5.5.7
Block write-block read process call	Yes	Yes	Yes	Yes	5.5.8
Host notify protocol	No	No	No	No	5.5.9
ARP	No	No	No	No	5.6
SMBAlert#	No	No	No	No	Appendix A
SMBSUS#	No	No	No	No	Appendix A

Notes:

1. MSP430G2xx3 USCI doesn't have integrated timeout detection and requires a timer

2. MSP430FR5x/6xx can optionally- use DMA to stretch SCL while deciding to ACK/NACK the current byte

3. Only QuickCommand Write is supported, not QuickCommand Read

1.3   The MSP430™ SMBus Library Package

This User's Guide documents the SMBus API and examples. The contents of the package is described below:

- smbuslib: Top level directory. Contains release notes and the manifest file related to licensing.
  - docs: Contains the API and User's Guides for the supported MSP430™ devices
  - driverlib: Contains the standard MSP430™ driverlib which is used in the library implementation for device families that support driverlib (for example, MSP430FR5xx‑6xx)
  - examples: Contains the example projects for each of the supported MSP430™ devices
  - src: Contains the source code for the SMBus Library stack

2   Introduction to the MSP430™SMBus API

2.1   Overview

The MSP430™ SMBus API stack allows easy creation of MSP430™ applications that communicate with other system components over a SMBus interface.

This API supports using the MSP430™ microcontroller as the SMBus master or as a SMBus slave.

2.2   Supported Device Families

The SMBus API stack is supported on the following MSP430™ device families:

- MSP430FR5xx_6xx
- MSP430G2xx3

2.3   Supported Development Environments

The SMBus API stack and examples build and run on both the IAR and CCS environments for MSP430™ microcontrollers. See the Release Notes HTML file in the SMBus Library Package for specific IAR/CCS version information.

IAR and CCS are both available in free, code-size-limited versions (8K and 16K, respectively, of object code). Applications that fit under 8K of memory can be run on both free versions. Applications that are greater than 8K cannot be built using the free IAR Kickstart tool. Instead, the free version of CCS can be used; or a licensed version of either environment.

See the Release Notes within the SMBus Library Package zip file for additional information specific to a given release.

2.4   Stack Organization

The software stack is organized into three layers:

- The public API layer defines the API's that should be called by application programs. These functions are defined in smbus.h.
- The network layer manages the SMBus protocol state machine and interfaces with the physical layer. These functions are defined in smbus_nwk.h and should not be called directly from application programs.
- The physical layer contain all the device specific code to interact with the MSP430™ microcontroller. These functions are defined in smbus_phy.h and should not be called directly from application programs.

2.5   Usage of MCU Peripheral Resources

Within the SMBus API, the resources shown below are considered owned by the API. If the application accesses them, it should be aware of how the API uses them.

Resource	Owned by API When	How it's Used
eUSCIB0	Always	I2C communication
DMA0	When "MANUAL_ACK_ENABLE" is defined	This is an opitonal feature. See smbus.h for documentation.

2.6   Release Notes and Migration from Previous Versions

A Release Notes HTML file accompanies each release of the SMBus Library Package. Reference this file for any information specific to this release, including:

- All changes from the previous versions
- Instructions for migration from previous versions
- Updated IDE configuration information
- Known issues

3 SMBus API Usage

3.1 Introduction

This chapter contains the detailed documentation for the application API functions and descriptions on using the API to create a SMBus master or slave application.

3.2 Usage

This section illustrates the basic application template for master and slave applications. See the examples for complete applications, and the `HTML API documentation` for details on the individual APIs.

3.2.1 Master Usage Outline

```
// Declare master SMBus structure
SMBus SMB;

// Initialize GPIOs and clocks
...
// Initialize GPIO I2C pins
...

// Initialize SMBus Master using eUSCI_B0 always at 100kbps per SMBus spec
SMBus_masterInit(&SMB, EUSCI_B0_BASE, (MCLK_MHZ*1000000));

// Initialize I2C and enable SMBus Interrupts
SMBus_masterEnableInt(&SMB);

// Send SMBus Sendbyte command (0x33)
uint8_t ret = SMBus_masterSendByte(&SMB,  // SMB struct
                                   0x40,  // Slave Addr
                                   0x33); // SMB Command
...
```

3.2.2 Slave Usage Outline

```
main()
{
    // Declare slave SMBus structure
    SMBus SMB;

    // SMBus receive and transmit buffers
    uint8_t au8RxBuff[SMB_MAX_PACKET_SIZE];
    uint8_t au8TxBuff[SMB_MAX_PACKET_SIZE];

    // Initialize GPIOs and clocks
    ...
    // Initialize GPIO I2C pins
    ...

    // Initialize SMBus Slave using eUSCI_B0
    SMBus_slaveInit(&SMB, EUSCI_B0_BASE);

    // Set the slave's address
    SMBus_slaveSetAddress(&SMB, 0x40);

    // Set the RX and TX buffers for SMBus
    SMBus_slaveSetRxBuffer(&SMB, au8RxBuff, sizeof(au8RxBuff));
```

```
        SMBus_slaveSetTxBuffer(&SMB, au8TxBuff, sizeof(au8TxBuff));

        // Initialize I2C and enable SMBus Interrupts
        SMBus_slaveEnableInt(&SMB);

        ...
        while (1)
        {
            __disable_interrupt();
            {
                _BIS_SR(LPM3_bits+GIE); // Go to sleep
            }
            __enable_interrupt();
        } // While (1)

}
#pragma vector=USCI_B0_VECTOR
__interrupt void eUSCI_ISR (void)
{
    // Check the state of SMBus
    switch (SMBus_slaveProcessInt(&SMB))
    {
        case SMBus_State_Slave_QCMD:
            // If a Quick command was detected, execute function (if any)
        break;
        case SMBus_State_Slave_CmdComplete:
            // Get command using SMBus_slaveGetCommand(&SMB) and process command

            // if command is not valid/supported
            //    SMBus_slaveReportError(&SMB, SMBUS_ErrorCode_Cmd);

            LPM3_EXIT;      // Exit to main loop if required
        break;
        default:
        break;
    }
    // Clear flags to be ready for next packet
    SMBus_processDone(&SMB);
}
```

3.3   Examples

Several examples are provided with the release package that illustrate using the library to implement both SMBus master and slave application.

For each example, matching master and slave implementations are provided.

- ReadByte_Echo - sends and echoes back a ReadByte command
- WriteWord_Dimmer - sends and echoes back a WriteWord command
- AllProtocols - sequences through all the SMBus protocols

Examples are configured for the MSP-EXP430G2 and MSP-EXP430FR5969 launch pad boards and CCS and IAR projects are provided.

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