

Using the USCI I²C Slave

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ABSTRACT

This document is an overview of the use of the I²C slave function set for MSP430 devices with the USCI module. The functions provided in the package can be used for MSP430 slave devices performing I²C communication and can handle both transmit and receive requests from I²C masters.

Note: The USCI I²C slave package includes a demonstration application that can be used on any MSP430 2xx device with the USCI module.

Contents

1	Introduction	2
2	Usage From C	3
	2.1 Initialization	3
3	Compiling the USCI I ² C Slave Code	4
4	Included Files	4
	4.1 Function Description	4
5	Code Size.....	5
6	References	5

1 Introduction

When using the MSP430 with peripheral modules, I²C is often used for communication. There are several MSP430 devices that have an USCI module, which is capable of this communication protocol.

The USCI I²C slave function set offers some functions that make I²C communication easy. Instead of having to configure the different registers of the UCSI module, the user can use the included functions with well-defined parameters to start communication. These functions serve only for setting up the USCI module, and the user is free to include low-power mode functionality to allow the CPU to be turned off at the application level or to continue calculations during I²C communication. Transmitted and received bytes are managed using callback functions.

The USCI I²C slave package includes functions that support both transmit and receive operations:

- Slave receive (the slave is addressed by the master and receives data from it)

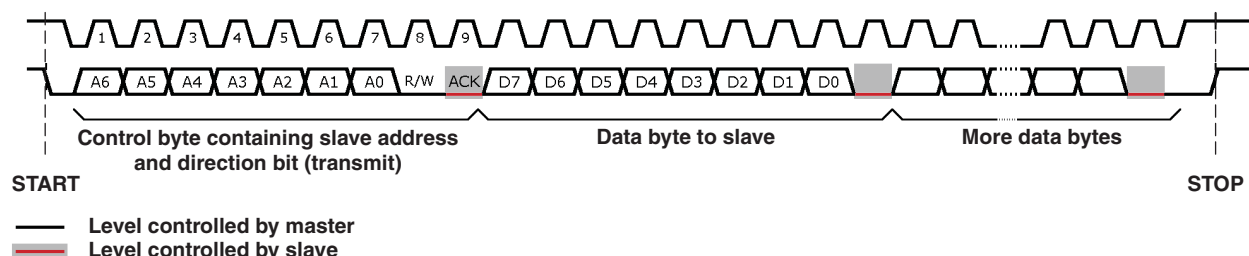


Figure 1. Slave Receive

- Slave transmit (the slave is addressed by the master and transmits data to it)

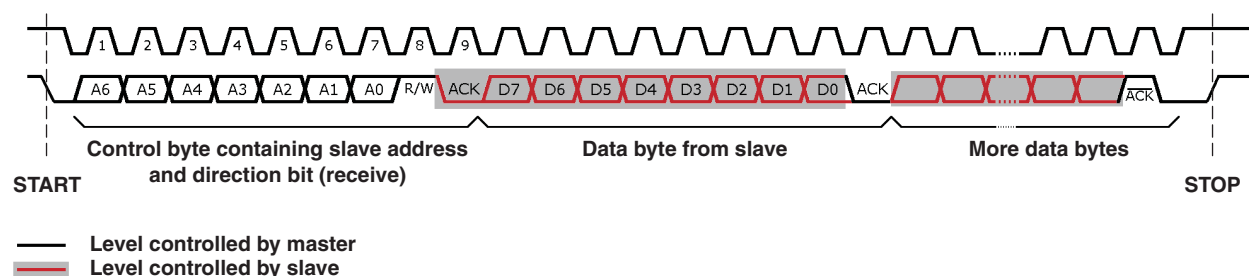


Figure 2. Slave Transmit

Both of these functions support only 7-bit addressing.

2 Usage From C

```
#include "msp430x26x.h"
#include "TI_USCI_I2C_slave.h"

void receive_cb(unsigned char receive);
void transmit_cb(unsigned char volatile *receive);
void start_cb();

unsigned char TXData = 0 ;
unsigned char RXData = 0 ;

void main(void)
{
    WDTCTL = WDTPW + WDTHOLD;           // Stop WDT

    TI_USCI_I2C_slaveinit(start_cb, transmit_cb, receive_cb, 0x50); // init the slave
    _EINT();
    BCSCCTL1 = CALBC1_16MHZ;
    DCOCTL = CALDCO_16MHZ;
    LPM0;                               // Enter LPM0.
}

void start_cb(){
    RXData = 0;
}

void receive_cb(unsigned char receive){
    RXData = receive;
}

void transmit_cb(unsigned char volatile *byte){
    *byte = TXData++;
}
```

The file `TI_USCI_I2C_slave.c` must be added to the project, and the line `#include "TI_USCI_I2C_slave.h"` must be included in the user source code to access to the slave functions.

The slave program `TI_USCI_I2C_slave.c` runs on a slave MSP430 that is connected to an MSP430 master running the program `TI_USCI_I2C_master.c`. [4]

This short program initializes a MSP430F2618 as I²C slave device with the address 0x50. For each data read request from a master, it returns the last byte the master wrote to it, or it returns a zero if the first transaction is a read.

Note: The slave demonstration applications were developed for use with the 2xx family. However, they can be easily modified for use with any MSP430 device with the USCI module.

2.1 Initialization

As shown in the previous example, configuring the device in slave mode requires calling `TI_USCI_I2C_slaveinit` once.

The first parameter is a function pointer, which points to a callback function that is executed each time a Start condition occurs and the slave is addressed. This callback function's return type must be void, and its parameter must be empty.

The second parameter is a callback function for values that are to be transmitted to the master. This callback function's return type must be void, and its parameter list must contain one char pointer as its only parameter. This callback function is called for every byte the master requests from the slave.

The third parameter is a callback function that handles the receiving of data from I²C master devices. For each byte received, the callback is called, and the received byte is available through the parameter *receive*.

The last parameter is the slave address of the MSP430 that acts as a slave.

Note: Receive and transmit callbacks are not called corresponding to the number of bytes actually transmitted and received, but to the number of times the corresponding interrupts occur. In the case of a slave transmit, the transmit callback is called once more than the actual number of transmitted bytes. In the case of heavy CPU loads by different ISRs, the last redundant call of the transmit callback might not occur. Therefore, the data for the communication should be prepared within the Start callback to keep track of the number of frames requested by the master.

3 Compiling the USCI I²C Slave Code

This USCI I²C slave package is distributed as source code and is intended to be compiled with a project. To accomplish this:

- Add TI_USCI_I2C_slave.c to the project.
- Include the necessary header definitions by adding `#include "TI_USCI_I2C_slave.h"` to the user source code.
- Change the MSP430 device-specific include file (MSP430 standard header file) in TI_USCI_I2C_slave.c.
- Adjust the definitions of SDA_PIN and SCL_PIN in TI_USCI_I2C_slave.h.

4 Included Files

TI_USCI_I2C_slave.c	This file contains all functions necessary to perform I ² C slave communication using the USCI module of the MSP430.
TI_USCI_I2C_slave.h	This file includes the definitions of the functions and variables that are used in TI_USCI_I2C_slave.c. It also contains the precompiler variables SDA_PIN and SCL_PIN that define which pins of the MSP430 are used for I ² C communication. This file must be included in any C program that calls the slave function set.

4.1 Function Description

- **void TI_USCI_I2C_slaveinit(void (*SCallback)(), void (*TCallback)(unsigned char volatile *value), void (*RCallback)(unsigned char value), unsigned char slave_address)**

This function initializes the USCI module for I²C slave operation. It has the following parameters:

- **void (*SCallback)()**
This is the function that is called when a Start condition is detected and the slave is addressed.
- **void (*TCallback)(unsigned char volatile *value)**
This is the function that is called for every byte requested by a master. The byte that is to be sent to the master has to be written to *value*.
- **void (*RCallback)(unsigned char value)**
This is the function that is called for every byte that is received from a master. The actual received value is available through the variable *value*.
- **unsigned char slave_address**
This parameter is used to set the slave address of the USCI module.

5 Code Size

Table 1. Code Size (IAR)

Function	Size (Bytes)
Slave initialize	120

6 References

1. *MSP430x2xx Family User's Guide* ([SLAU144](#))
2. MSP430x261x data sheet ([SLAS541](#))
3. *I²C-Bus Specification and User Manual*, NXP Semiconductors, 2007
(http://www.nxp.com/acrobat/usermanuals/UM10204_3.pdf)
4. *Using the USCI I²C Master* ([SLAA382](#))

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