

MSP430 Interface to TPS60250 via I2C Master Software

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ABSTRACT

The TPS60250 is a high-efficiency, constant-frequency charge pump dc/dc converter that can drive up to five white LEDs for a main display and up to two white LEDs for a subdisplay with regulated constant current for uniform intensity.

A microcontroller (MCU) can be used to control the currents for white LEDs via the TPS60250 charge pump through a standard I2C interface, with the MCU acting as the I2C master. This application report describes a simple hardware and software platform to demonstrate a Texas Instruments MSP430 MCU implementing an I2C master interface using two general-purpose I/O pins via I2C software emulation. The MSP430 is an ultra low power microcontroller that is ideal for controlling white LEDs in applications such as PDA, PMP, GPS, and cell phone screens.

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1 Introduction

The TPS60250 is a high-efficiency, constant-frequency charge pump dc/dc converter that uses a dual mode 1 and 1.5 conversion to maximize efficiency over the input voltage range. It drives up to five white LEDs for a main display and up to two white LEDs for a subdisplay with regulated constant current for uniform intensity. By using adaptive 1 and 1.5 charge pump modes and low-dropout current regulators, the TPS60250 achieves high efficiency over the full 1-cell lithium-battery input voltage range.

Four enable inputs, ENmain, ENsub1, ENsub2, and ENaux, available through I2C control, are used for simple on/off controls for the independent main, sub1, sub2, and DM5 displays, respectively. To lower operating current when using one subdisplay LED, the device provides completely separate operation in subdisplay LEDs.

In most applications, a microcontroller can be used to control the currents for white LEDs via the TPS60250 charge pump through an MCU I2C master interface. This application report describes a simple hardware and software platform to demonstrate a Texas Instruments MSP430 microcontroller implementing an I2C master interface using two general-purpose I/O pins via software. The TPS60250 device is an addressable I2C slave device which responds to commands sent by the MSP430 microcontroller. The MSP430 source code can be used as a basic framework for actual systems that are used to control white LEDs for multidisplay handheld applications such as PDA, PMP, GPS, and cell phone screens. The MSP430 software layer which implements the master I2C protocol driver can be used with other devices with an I2C interface configured as uniquely addressed slaves on the common bus. Because this protocol driver layer uses just two general-purpose I/O pins, the software driver works on all MSP430 devices.

2 Hardware Evaluation Platform

2.1 MSP430 Development Board

Several configurations of MSP430 development boards are available. For simplicity, one of the smallest MSP430F2xx devices is used as the example in this application report. The MSP430F20xx is a 14-pin microcontroller with 10 I/O pins. Two of the 10 I/O pins are used to emulate the SCL and SDA lines for the I2C master interface. The part number for this development kit is MSP-FET430U14.

WARNING

The TPS60250 can operate at up to 6 Vdc; however, the MSP430 maximum operating voltage is 3.6 Vdc. Before connecting the MSP430 board to the TPS60250EVM, ensure that the MSP430 never receives more than 3.6 Vdc.

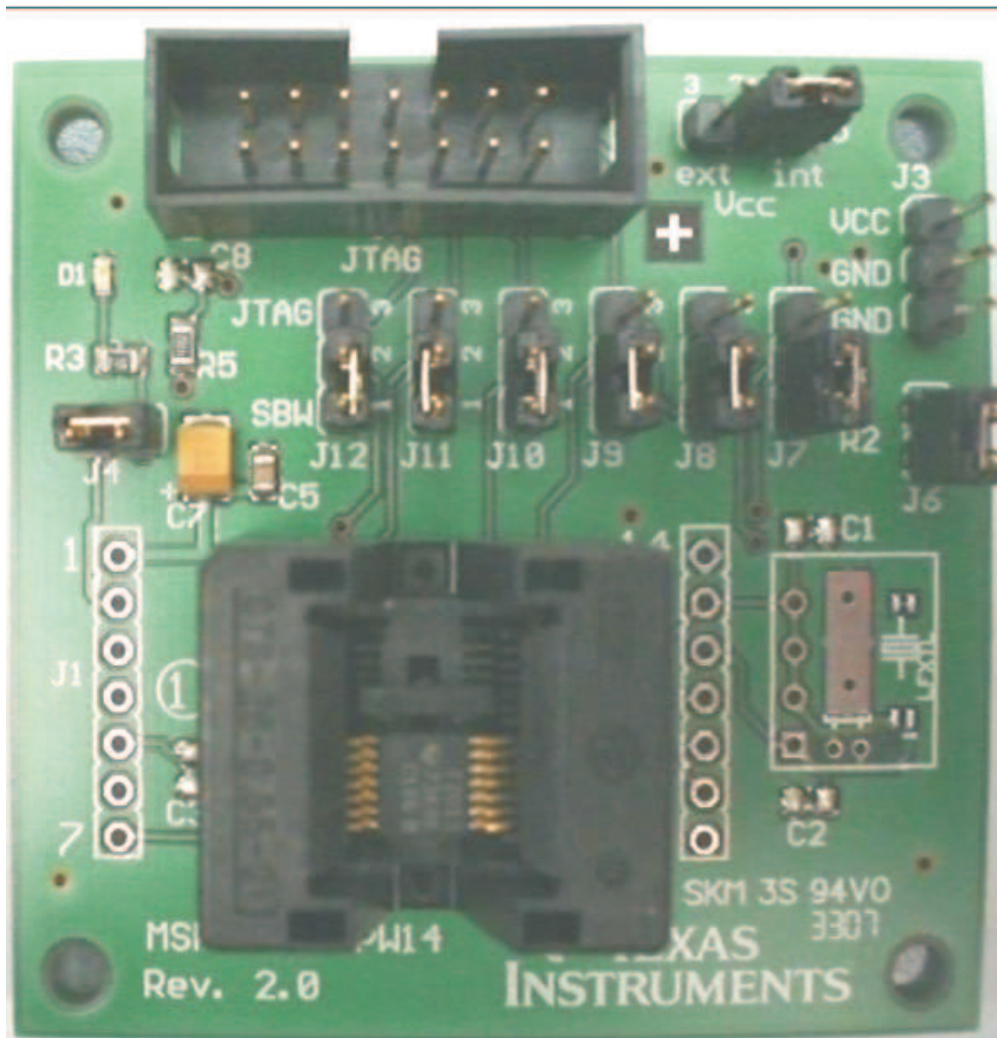


Figure 1. MSP-FET430U14

2.2 TPS60250 Evaluation Module

The Texas Instruments TPS60250EVM-185 evaluation module (EVM) helps designers evaluate the operation and performance of the TPS60250 white LED (WLED) driver for applications that are powered with one Li-ion or Li-polymer cell and require two or three separate banks of WLEDs. The TPS60250 contains a 1×/1.5× charge pump, as well as seven current sinks that are configured into a main display bank of four or five WLEDs and a subdisplay bank of two WLEDs. Additionally, the fifth main display WLED can be configured to drive an auxiliary display at up to 80 mA for backlighting a keypad or a weak camera flash.

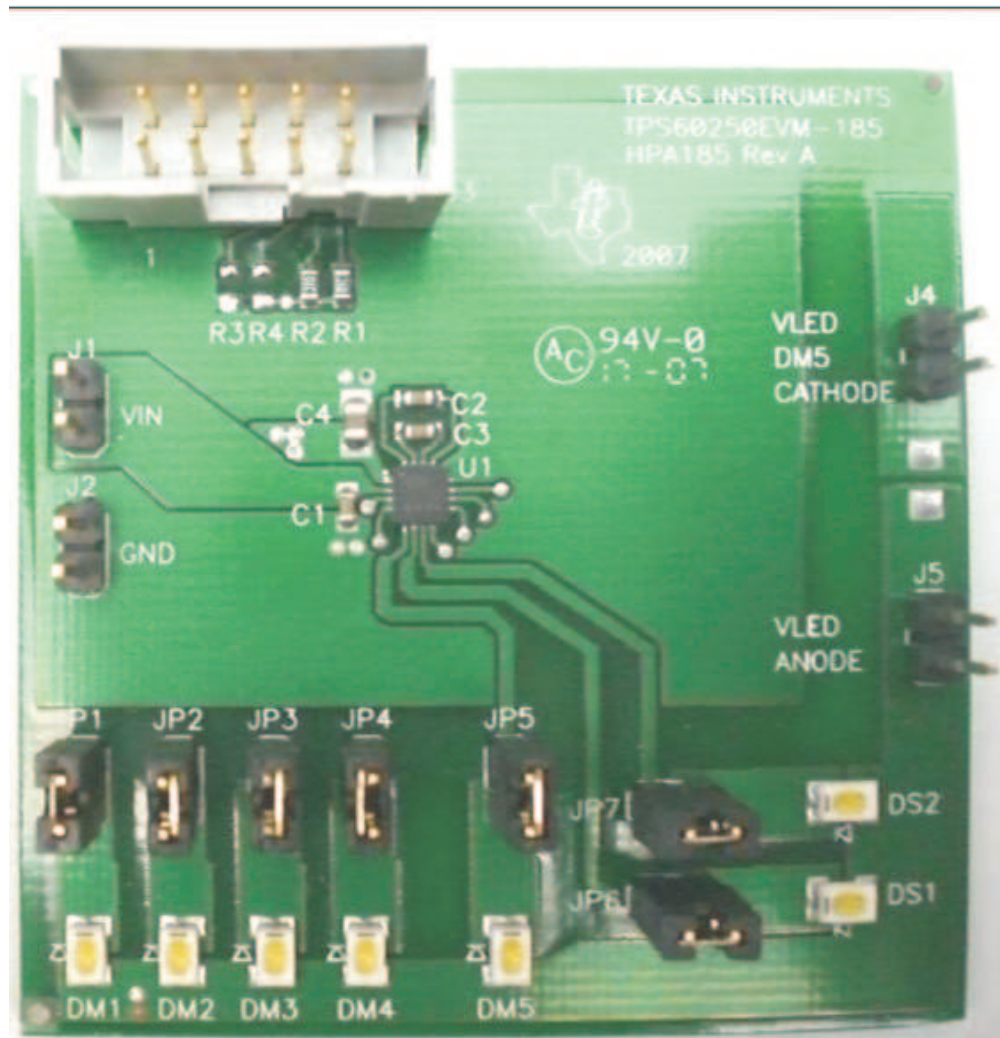


Figure 2. TPS60250EVM-185

2.3 Connecting the MSP430 Development Board to the TPS60250EVM

Four wired connections must be made between the MSP430 and TPS60250 demonstration boards. See [Table 1](#) for the required connections.

Table 1. MSP430 and TPS60250 Connections

MSP430	CONNECT	TPS60250
P2.6	← →	SCLK
P2.7	← →	SDAT
VCC	← →	VIN
GND	← →	GND

3 Demonstration Application Description

The sample application enables each of the four WLED enable inputs, one at a time, cycling through all the possible current settings for each of the independent main, sub1, sub2, and auxiliary DM5 displays. Once each of the four WLED displays goes through each repeated cycle of current settings, the main display WLEDs toggle at an approximately 1-second interval forever, until the MSP430 has been powered down or reset.

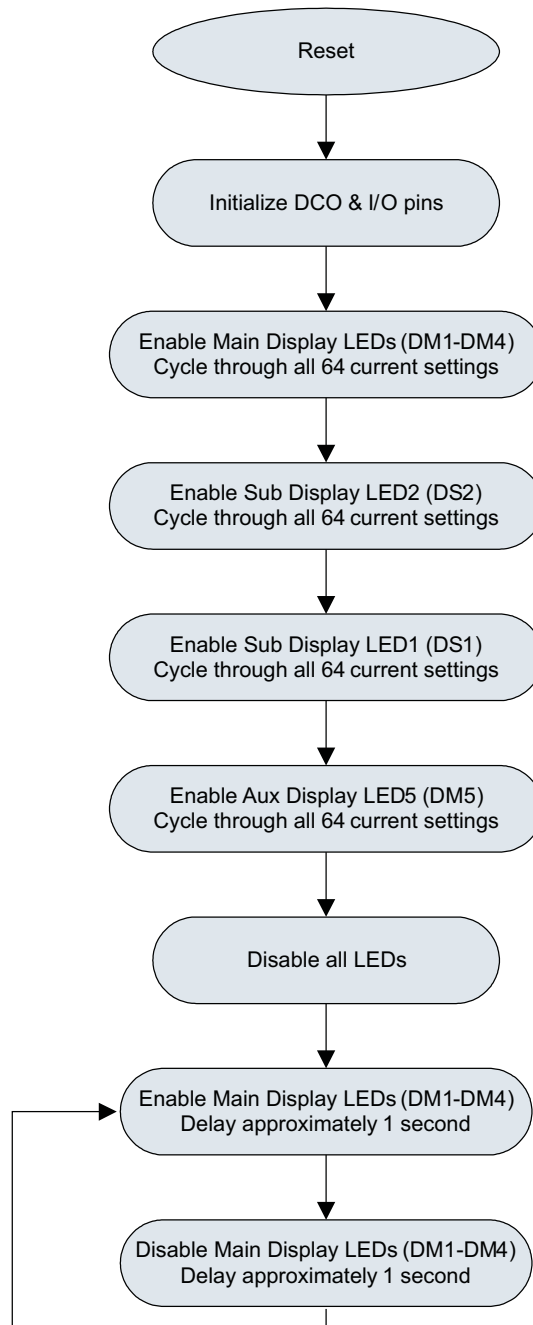


Figure 3. Application Software Flow Chart

4 Software Architecture

4.1 Application Layer

The files *MSP430_TPS60250.c* and *MSP430_TPS60250.h* define the application software layer which deals with all logic and definitions pertaining to the MSP430 and TPS60250 operations.

The *MSP430_TPS60250.h* header file contains the definition of the I2C slave address to be used (a 7-bit slave address plus 1 don't care least significant bit):

```
#define I2CSLAVEADDR 0x77
```

The following function is used to write data to one of the configuration registers:

```
void MSP430_TPS60250_write(unsigned char reg, unsigned char data)
```

The following function is used to read data from one of the configuration registers:

```
unsigned char MSP430_TPS60250_read(unsigned char reg)
```

The following function is used to read data from one of the configuration registers:

The *MSP430_TPS60250.h* header file also contains the definitions of all the configuration register addresses as well as the individual bit fields for each register.

The example application primarily uses these read and write functions to dynamically change the contents of the TPS60250 configuration registers to vary and cycle through the different current settings for each bank of WLEDs to demonstrate changes in brightness. The read and write functions at this application level use the lower-level I2C master driver functions to emulate the I2C master for the general-purpose I/O pins of the MSP430.

4.2 I2C Master Drive

The files *MSP430_SWI2C_Master.c* and *MSP430_SWI2C_Master.h* define the protocol layer for standard I2C master software emulation using general-purpose I/O pins. This layer implements all of the specific I/O operations required for standard I2C master communications with other I2C slave devices.

By default, the I2C master driver code configures I/O pins P2.6 and P2.7 to emulate the SCL and SDA bus lines, respectively. If the I/O pin assignment needs to be changed, it can be modified in the *MSP430_SWI2C_Master.h* file:

```
#define PxSEL P2SEL // Port selection #define PxDIR P2DIR // Port direction #define  
PxOUT P2OUT // Port output #define PxIN P2IN // Port input #define SDA BIT7 //  
Controls SDA line (pull-up used for logic 1) #define SCL BIT6 // Controls SCL line  
(pull-up used for logic 1)
```

The function `MSP430_SWI2CMST_init()` must be called once during the startup sequence to properly initialize the I/O pins used for I2C Master emulation.

In order to write a block of one or more data bytes to the I2C Slave, the following function should be used:

```
MSP430_SWI2CMST_writeBlock(SlaveAddress, numBytes, TxData);
```

Where **SlaveAddress** is the 7-bit address of the slave plus a don't care least significant bit, **numBytes** is the number of 8-bit bytes to transmit, and **TxDATA** is the pointer to the transmit data buffer which holds the data bytes to transmit.

Similarly, in order to read a block of one or more data bytes from the I2C Slave, the following function should be used:

```
MSP430_SWI2CMST_readBlock(SlaveAddress, numBytes, RxData);
```

Where **SlaveAddress** is the 7-bit address of the slave plus a don't care least significant bit, **numBytes** is the number of 8-bit bytes to read back, and **RxDATA** is the pointer to the receive data buffer.

5 Conclusion

In most applications, a microcontroller can be used to control the currents for white LEDs via the TPS60250 charge pump through an MCU I2C Master interface. This application report describes a simple hardware and software platform to demonstrate a Texas Instruments MSP430 microcontroller implementing an I2C master interface using two general-purpose I/O pins via software. The TPS60250 device is an addressable I2C slave device which responds to commands sent by the MSP430 microcontroller. The MSP430 source code can be used as a basic framework for actual systems that are used to control white LEDs for multidisplay handheld applications such as a PDA, PMP, GPS, or a cell phone screen. The MSP430 software layer which implements the master I2C protocol driver can be used with other devices with an I2C interface configured as uniquely addressed slaves on the common bus. Because this protocol driver layer uses just two general-purpose I/O pins, the software driver works on all MSP430 devices

6 References

1. *TPS60250, High Efficiency Charge Pump for 7 WLEDs with I²C Interface* data sheet ([SLVS769](#))
2. *TPS60250EVM-185* user's guide ([SLVU208](#))
3. *MSP430x2xx Family* user's guide ([SLAU144](#))
4. *MSP430x20x1, MSP430x20x2, MSP430x20x3, Mixed Signal Microcontroller* data sheet ([SLAS491](#))

Appendix A I2C Master Software Driver Flow Charts

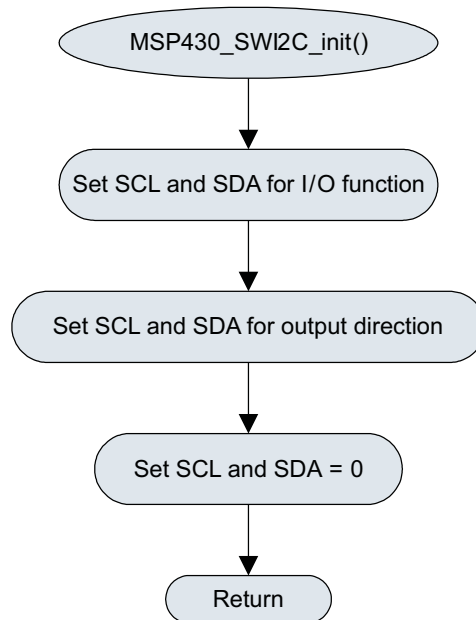


Figure A-1. MSP430_SWI2CMST_init()

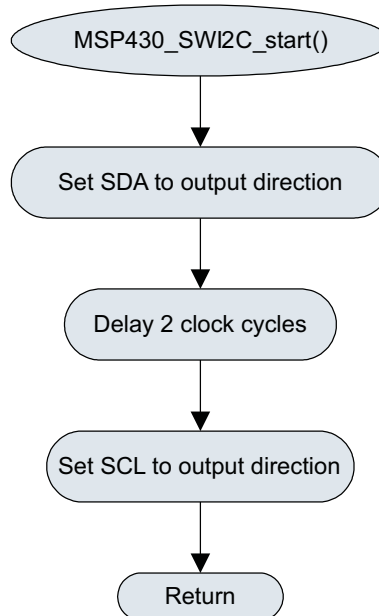


Figure A-2. MSP430_SWI2CMST_start()

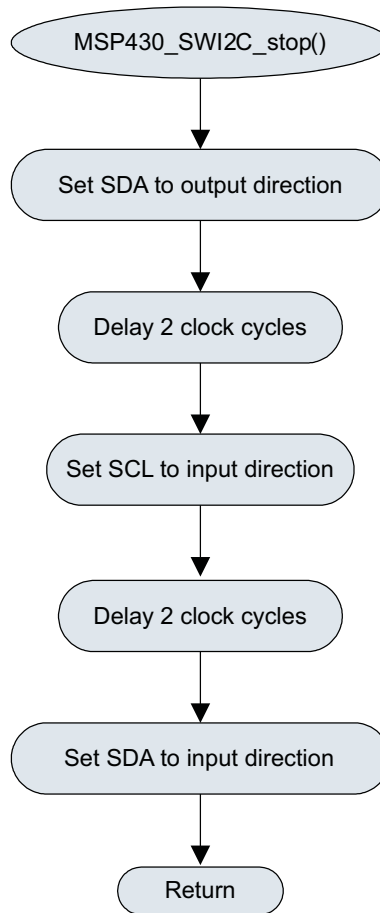


Figure A-3. MSP430_SWI2CMST_stop()

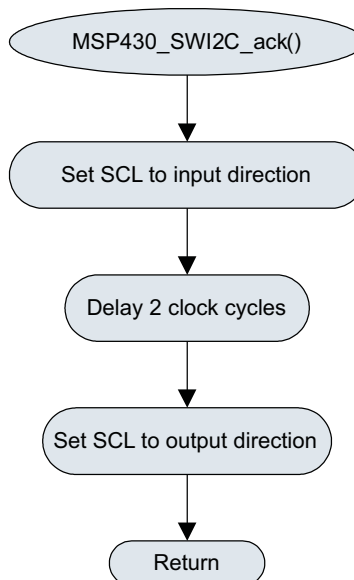


Figure A-4. MSP430_SWI2CMST_ack()

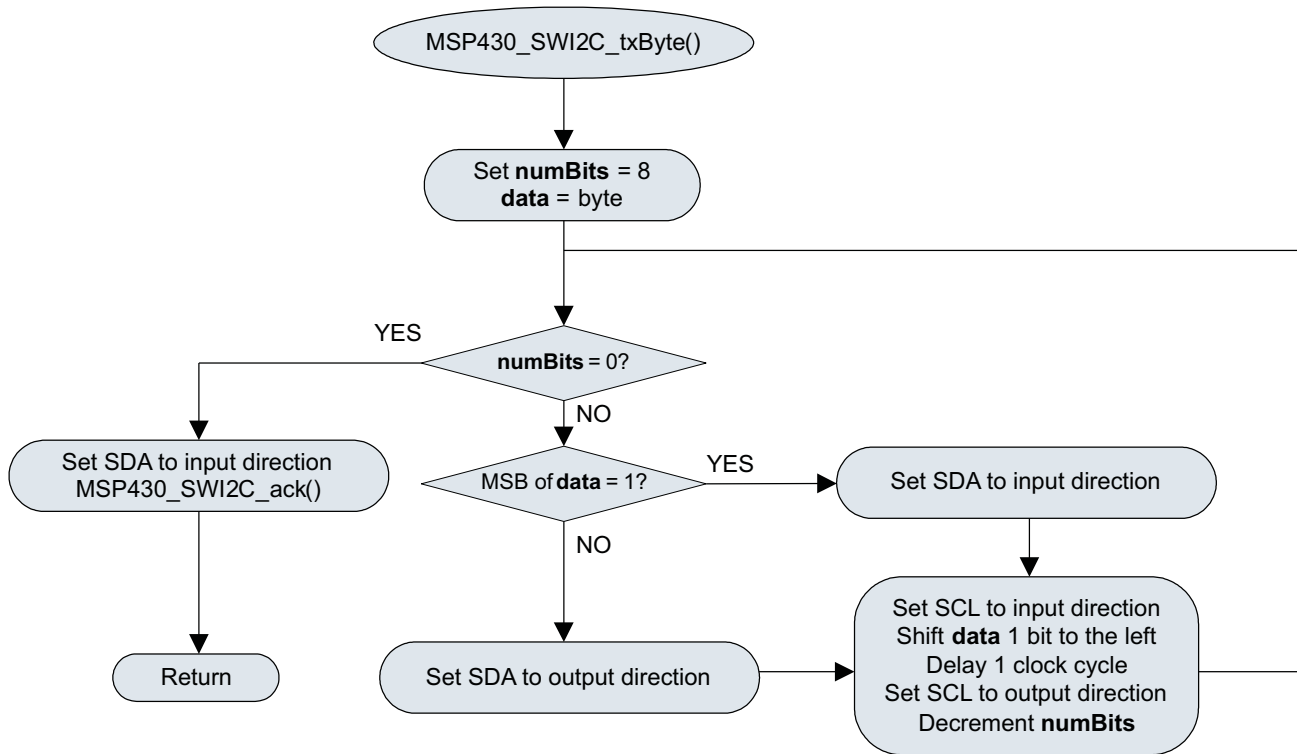


Figure A-5. MSP430_SWI2CMST_txByte()

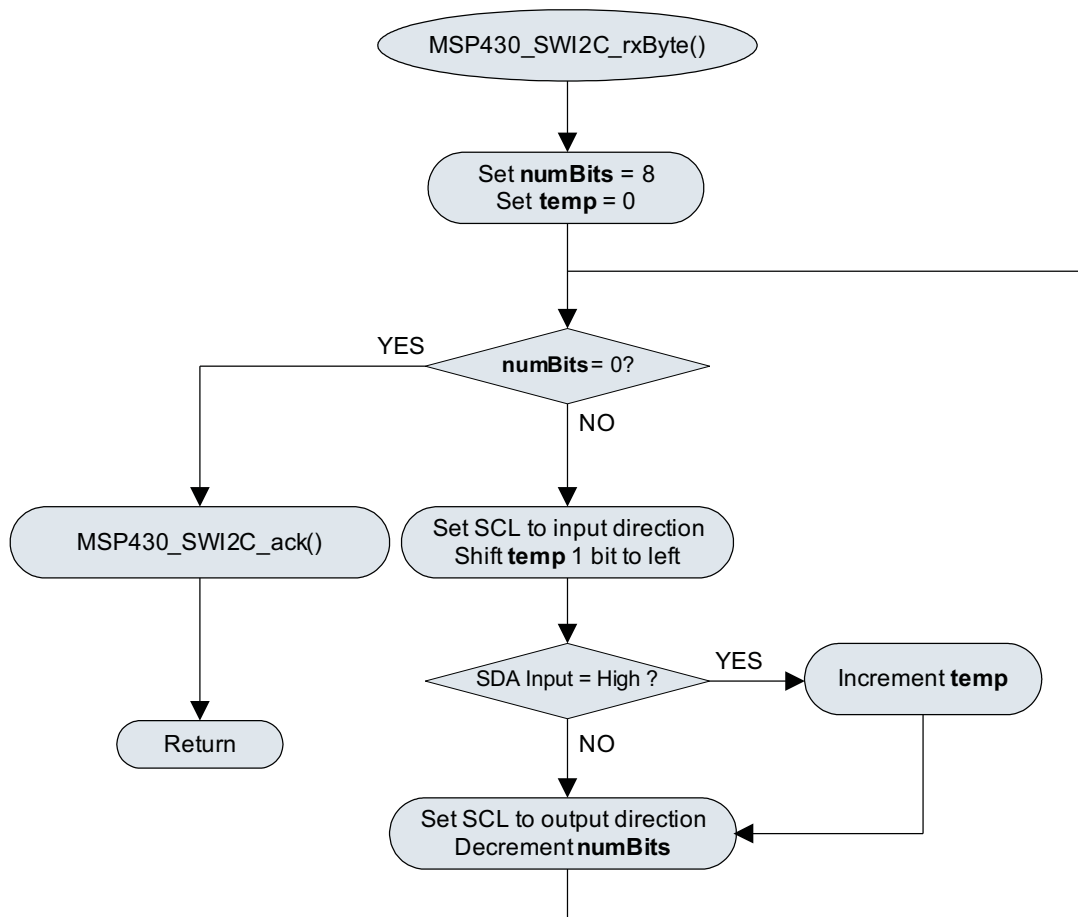


Figure A-6. MSP430_SWI2CMST_rxByte()

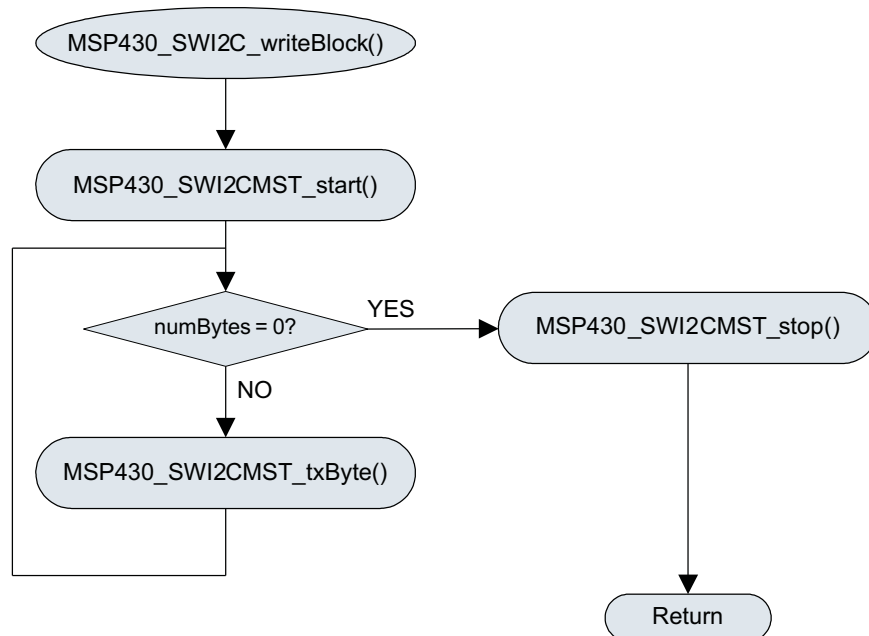


Figure A-7. MSP430_SWI2CMST_writeBlock()

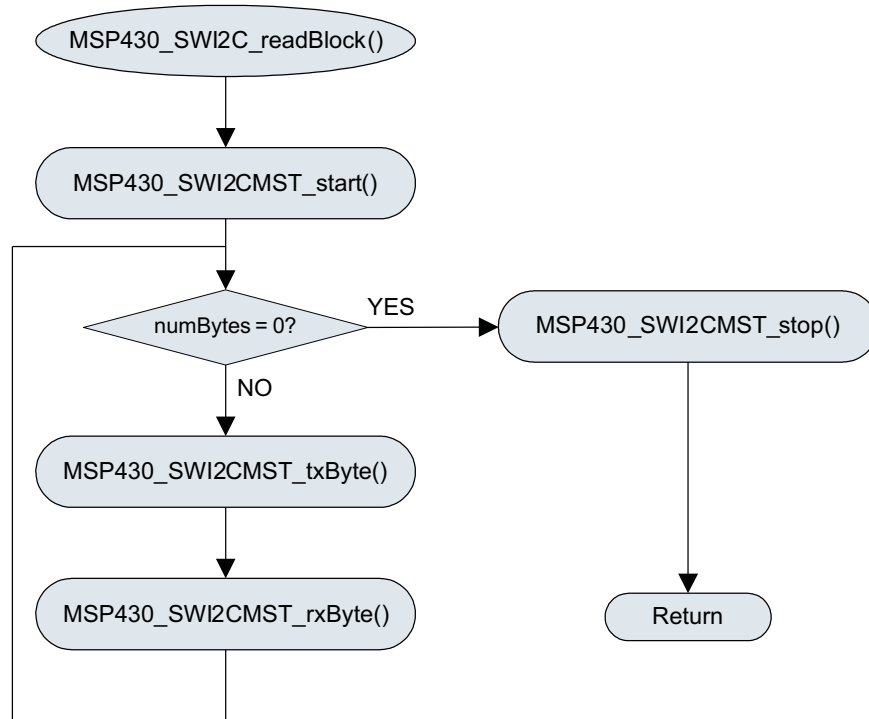


Figure A-8. MSP430_SWI2CMST_readBlock()

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