APPLICATION NOTE

Atmel AVR156: TWI Master Bit Bang Driver

8-bit Atmel Microcontrollers

Features

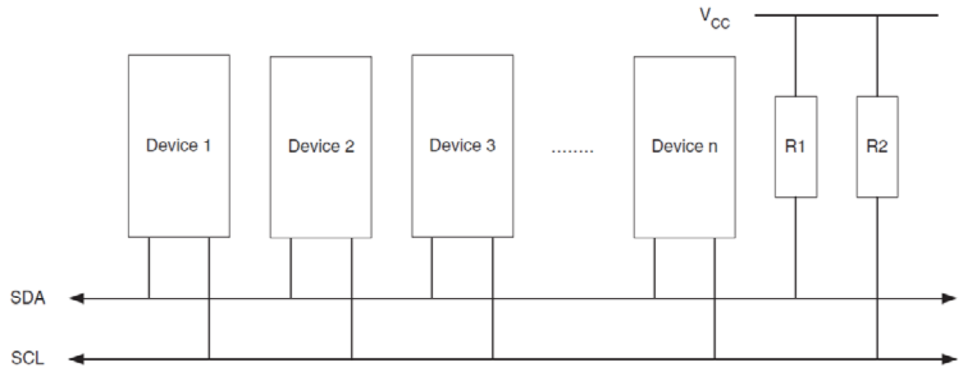
- Tested using Atmel® ATtiny40 and Atmel ATmega2560 microcontrollers
- Easily portable to any other Atmel AVR® family microcontrollers
- Implements bit bang TWI master driver that is compatible with Philips' I^{2}C
- C code that fits into 713 bytes
- Utilizes software polling instead of interrupt
- Supports clock stretching and multiple TWI slaves

Introduction

This application note describes a Two-wire Interface (TWI) master implementation, in the form of a full-featured driver. Many chips feature a hardware TWI module; others have Universal Serial Interface (USI), which can be used in TWI mode. This application note discusses the TWI master driver for devices without any of these hardware modules. This driver provides interfaces to read/write to a TWI slave.

The Two Wire serial Interface (TWI) is compatible with Philips' I^{2}C protocol. The bus was developed to allow simple, robust, and cost effective communication between integrated circuits in electronics. The strengths of the TWI bus includes the capability of addressing up to 128 devices on the same bus, arbitration, and the possibility to have multiple masters on the bus. Figure 1 demonstrates the typical TWI connection in multi slave TWI architecture. This application note does not discuss the theory of TWI interface. More information on TWI protocol can be found in the Atmel AVR311 application note.

Figure 1. TWI Bus interconnection.



1. Theory

This section gives a short description about the driver architecture.

1.1 Design

The TWI master driver implements the protocol by bit banging the SCL and SDA pins. Any GPIO pins can be used for the communication by changing the pin/port definitions in the driver header file.

The driver does not use any interrupts and is based on polling. Since it is for the TWI master, no timeout is required.

2. Prerequisites

This document requires basic familiarity with following:

- Compiling C projects with IAR Embedded Workbench® for Atmel AVR, as this driver is written using this IDE
- General familiarity with TWI interfaces and electrical connection requirements
- A method to debug and test the compiled application, or download the application hex files into the targeted device, such as the Atmel AVR JTAGICE mkII or Atmel AVR JTAGICE 3

3. Limitations

- This driver tested to support up to 206kHz TWI communication at 16MHz system clock of the Atmel ATmega2560. The speed can be improved by running the device at higher clock rates
- This driver uses two GPIO pins of the device. As with any TWI circuit, it requires pull ups on both SCL and SDA pins
- Since it is a software TWI driver, the driver is not able to detect bus contention errors like the hardware TWI module

4. Creating a project

The driver consists of only two files:

1. TWI_Master.c
2. TWI_Master.h

TWI_Master.c contains the prototype implementations for the driver functions. Following interfaces are provided by this driver:

Prototypes	Use
`void twi_init()`	Initializes interface
`void twi_disable()`	Disables interface
`char write_data(char* data, char n)`	Writes ‘n’ number of bytes from buffer ‘data’
`char read_bytes(char* data, char n)`	Reads ‘n’ number of bytes into buffer ‘data’

TWI_Master.h contains the function declarations as well as settable parameters for the TWI interface. These parameters, along with default values, are listed below:

Parameter definitions	Explanation
`#define SCL PC1`	Selects the SCL pin
`#define SDA PC4`	Selects the SDA pin
`#define PORT_SCL PORTC`	Selects the PORT register for SCL
`#define DDR_SCL      DDRC`	Selects the DDR register for SCL

#define PIN_SCL PINC	Selects the PIN register for SCL
#define PORT_SDA PORTC	Selects the PORT register for SDA
#define DDR_SDA DDRC	Selects the DDR register for SDA
#define PIN_SDA PINC	Selects the PIN register for SDA
#define SLAVE_ADDRESS 0xA0	Sets the slave address (Shifted 8 bit)
#define DELAY 2	Used as a fixed delay for generating clock and other delays. Changing this number will change the SCL clock.
#define SCL_SDA_DELAY 1	Delay between SDA and SCL during STOP condition

Note: DELAY and SCL_SDA_DELAY values can be fine tuned to set timing delays accurately and as required by application.

5. Using the driver

To use this driver, both these files should be included in the project and TWI_Master.h should be included in the main source file.

The driver code contains a demo application file named ‘main.c’ which demonstrates the initialization and use of this driver. This project is written for Atmel ATtiny40 device but can be easily used for any Atmel AVR device. Since it is not an interrupt based driver, global interrupt need not be enabled before using this driver.

6. References

[1] AVR TWI for beginners: www.atmel.com/dyn/resources/prod_documents/doc2564.pdf

[2] IAR Embedded Workbench: http://www.iar.com/en/Products/IAR-Embedded-Workbench/AVR/

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