Assignment on TWI Communication

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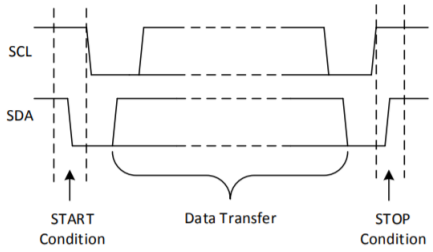
1 Brief Introduction of the Two-Wire Interface

TWI is serial , synchronous , bidirectional , multi-master , and self-reserved communication bus. It has two wire namely SDA and SCL. SDA is serial data line and SCL is serial clock line.

1.1 Properties of TWI

- Both SDA and SCL are connected to power source with pull up resistor. So devices can force voltage of SDA, SCl to low only.
- There are 7 bit for address. So total of $2^7 = 128$ distinct addressable devices can communicate via this interface.



- Start condition is happend when SDA line goes low from high while SCL is high. SDA line going high to low while SCL is high defines STOP condition.

1.2 Sending data from master to slave

Master first send start condition followed by slave devices address and $R/\tilde{W}$ bit which is 0 this time. Then if slave is ready to communicate then it sends acknowledge (ACK) signal. Then Master sends 8 bit data. Then slave sends ACK signal. Again master sends 8 bit data and slave reply with ACK bit. If slave unable to send ACK bit then error happens and master send stop condition and report error.

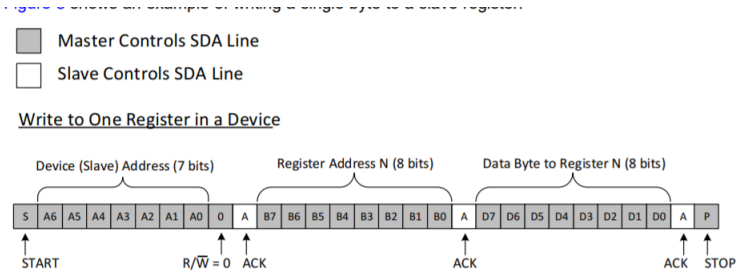


Figure 8. Example I²C Write to Slave Device's Register

1.3 Receiveing data from slave to master

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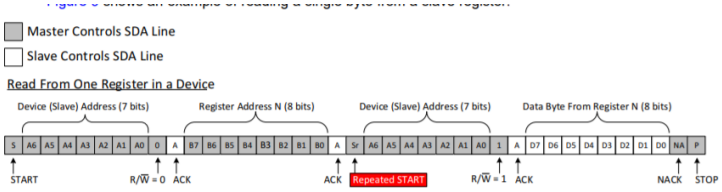

Figure 9. Example I²C Read from Slave Device's Register

Slave cannot send start condition. If slave needs to transmit data to master then master needs to start connection and make $R/\tilde{W}$ bit to 1. Master release control of sda line when data should be written by slave. Master always send clock pulse to SCL line irrespective of $R/\tilde{W}$ bit. After slave write data , then master sends NACK signal to sda line.

2 Advantages of TWI/I2C

- I2C uses only two wires whereas, SPI uses atleast 2 wires for simplex communcation and 3 wires for duplex communication .
- Supports multiple master and multiple slaves. But USART works with only two devices.
- ACK/NACK confirms successful data transfer.
- TWI offers multiple master/slave support which UART does not.
- Faster than UART

3 Disadvantages of TWI/I2C

- Connection is half duplex , SPI or USART is full duplex.
- Size of data frame is only 8 bit and cannot be changed. In USART communcation size of data frame can be choosen from between 8 and 9 bit.
- More complicated hardware needed to implement than SPI
- Slower transfer rate then SPI.

4 Solution to data overrun problem

Master and slave may be works in different frequency. In SCL line master always generates clock pulse. So if clock frequency of slave devices is higher than SCL clock than slave can read bit before another bit comes. Problem arises when salve clock freuqncy is less than SCL ckock. Because of higher clock frequency in SCL line new data may arrive before slave read and process data from SDA line. This phenomena is called data overrun.

To solve data overrun issues I2C uses clock stretching method. Since SDA and SCL are connected to Vcc with pull up registor, devices cannot force voltage to high lavel. So slave can hold down the clock if it didnot complete reading. So naster needs to read back SCL line after releasing control, to check if it went to high state or not.