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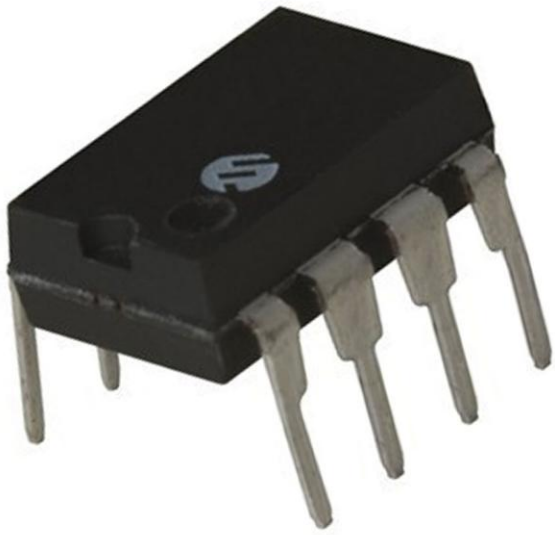
PIC HOW-TO GUIDE

Interfacing I2C-EEPROM with PIC16F



Contents at a Glance

PIC16F/18F Slicker Board

The PIC16F/18F Slicker board is specifically designed to help students to master the required skills in the area of embedded systems. The kit is designed in such way that all the possible features of the microcontroller will be easily used by the students. The kit supports in system programming (ISP) which is done through USB port.

Microchip's PIC (PIC16F877A), PIC16F/18F Slicker Kit is proposed to smooth the progress of developing and debugging of various designs encompassing of High speed 8-bit Microcontrollers.

I2C (Inter Integrated Circuit)

The I2C (Inter-IC) bus is a bi-directional two-wire serial bus that provides a communication link between integrated circuits (ICs).I2C is a synchronous protocol that allows a master device to initiate communication with a slave device. Data is exchanged between these devices.

EEPROM

EEPROM (electrically erasable programmable read-only memory) is user-modifiable read-only memory (ROM) that can be erased and reprogrammed (written to) repeatedly through the application of higher than normal electrical voltage. It is a type of non-volatile memory used in computers and other electronic devices to store small amounts of data that must be saved when power is removed, e.g., calibration tables or device configuration.

Interfacing I2C - EEPROM

Fig. 1 shows how to interface the EEPROM with microcontroller through I2C. I2C is a Master-Slave protocol. I2C has a clock pulse along with the data. Normally, the master device controls the clock line, SCL. This line dictates the timing of all transfers on the I2C bus. No data will be transferred unless the clock is manipulated. All slaves are controlled by the same clock, SCL.

I2c bus supports many devices, each device is recognized by a unique address—whether it's a micro-controller, LCD Driver, memory or keyboard interface and can operate as transmitter or receiver based on the functioning of the device. The controller designed controls the EEPROM device through I2C protocol. The I2C Controller here acts as a master device and controls EEPROM which acts as a slave. The read-write operations are accomplished by sending a set of control signals including the address and/or data bits. The control signals must be accompanied with proper clock signals.

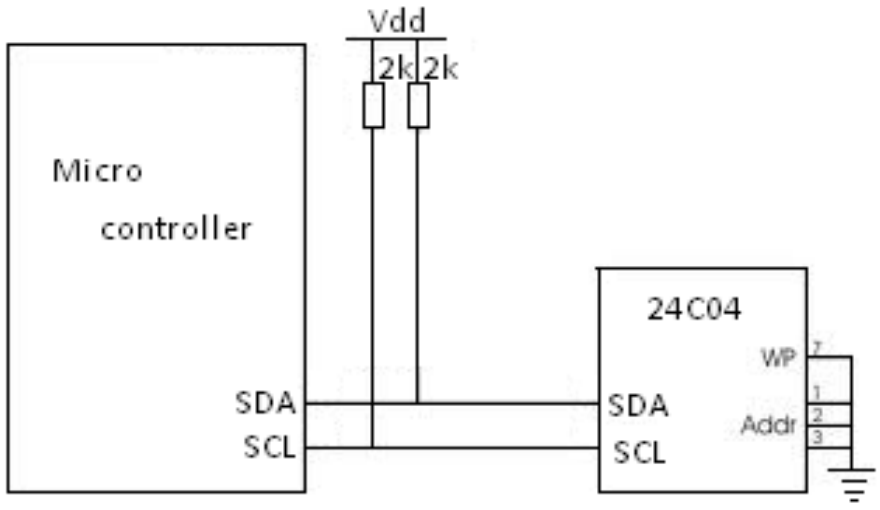


Fig. 1 Interfacing I2C - EEPROM to Microcontroller

Interfacing I2C – EEPROM with PIC16F877A

We now want to Read, write and Erase EEPROM by using I2C in PIC16F/18F Slicker Board. Wiring up an I2C based EEPROM to the I2C port is relatively simple. The basic operation of the I2C based EEPROM's is to send a command, such as WRITE, followed by an address and the data. In WRITE operation, the EEPROM to store the data.

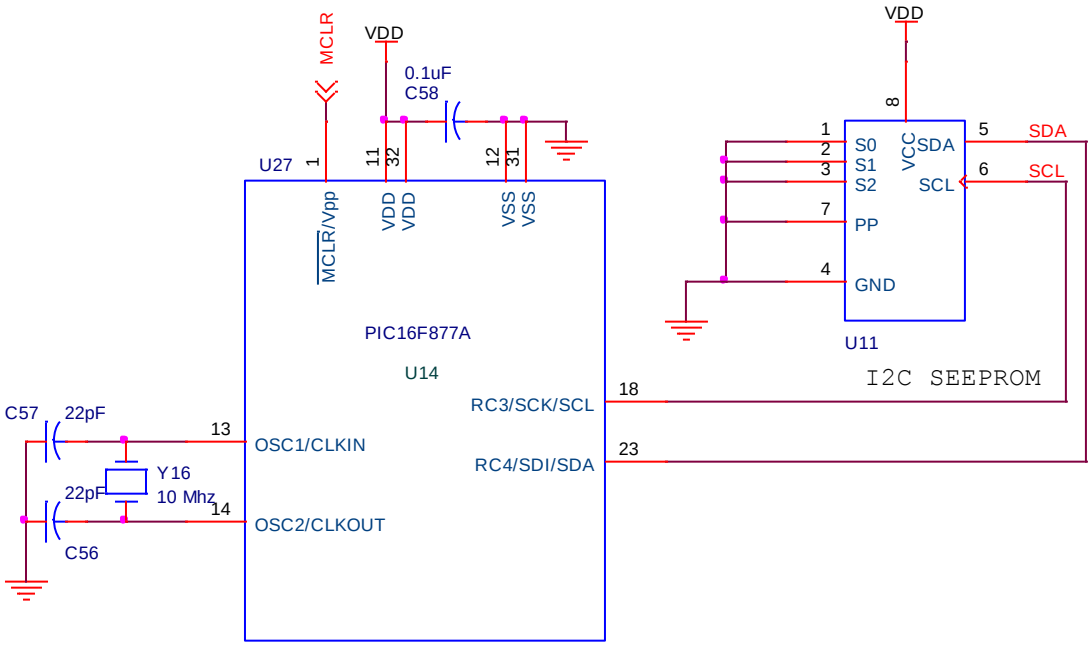
In **PIC16F/18F Slicker Kit**, 2 nos. of EEPROM lines are controlled by I2C Enabled drivers. I2C Lines serial clock of **CLK (PORTC.3)**, serial data of **DATA (PORTC.4)** connected to the I2C based serial EEPROM IC. The EEPROM read & write operations are done in PIC16F/18F Slicker Kit by using these SCK & DATA I2C lines.

Pin Assignment with PIC16F877A

	I2C EEPROM	PIC16F/18F Lines	Serial EEPROM	Connections
AT 24xx	CLK	PORTC.3	PIC ⇄ AT24XX EEPROM	*Turn ON TXD, RXD, SCL and MISO Pins of CONFIG switch SW1. *Connect Serial cable between USART Section in the Board and PC.
	DATA	PORTC.4		

Output: **The string "I2C Test Program" will be displayed in Hyper- Terminal**

Circuit Diagram to Interface I2C–EEPROM with PIC16F



Source Code

The Interfacing I2C – EEPROM with PIC16F877A program is very simple and straight forward that read, write and erase operations in EEPROM by using I2C & the value is displayed in serial port. A delay is occurring in every single data read or write in EEPROM. The delay depends on compiler how it optimizes the loops as soon as you make changes in the options the delay changes.

C Program with I2C – EEPROM using PIC16F877A

```
*************************************************************************************
                Title        : Program to read, write & erase of I2C - EEPROM
*************************************************************************************
```

```
#include<pic.h>
#include<stdio.h>

__CONFIG(0x3f72);
//Select HS oscillator, BODEN, PWRT and disable others

#define EEPROM_CNTRL_IN  0xa0      // EEPROM address+write
#define EEPROM_CNTRL_OUT 0xa1      // EEPROM address+read
#define I2C_FREQ    100            // 100khz at 4Mhz

#define FOSC        10000          // 10Mhz==>10000Khz
#define BAUD_RATE   9.6            // 9600 Baudrate

#define BAUD_VAL    (char)(FOSC/ (16 * BAUD_RATE )) - 1;
//Calculation For 9600 Baudrate @10Mhz

unsigned char data[17]={"I2C Test Program"},i;

void I2CWrite(void);
void WaitMSSP(void);
void I2CRead(void);
void i2c_init(void);
void serial_init(void);
void DelayMs(unsigned int);

void main()
{
   DelayMs(100);           // Give delay for power up
   i2c_init();             // Initialize I2C
   serial_init();          // Setup serial port
   printf("\033[2J");
   DelayMs(20);
```

```
    I2CWrite();           // Sends the data to I2C EEPROM
    DelayMs(50);
    while(1)
    {
        I2CRead();        // Read back the data's
        TXREG='\n';
        while(TXIF==0);
        TXREG='\r';
        DelayMs(500);
    }
}

void I2CWrite()
{
    SEN=1;          // Send start bit
    WaitMSSP();     // wait for the operation to be finished
    SSPBUF=EEPROM_CNTRL_IN;//Send Slave address write command
    WaitMSSP();
    SSPBUF=0x00;    // Send the starting address to write
    WaitMSSP();

    for(i=0;i<16;i++)
    {
        SSPBUF=data[i];
        // A page contains 16 locations then 16 data's are sent
        WaitMSSP();
    }
    PEN=1;          // Send stop bit
    WaitMSSP();
}


void I2CRead()
{
    int y;
    SEN=1;          //Send start bit
    WaitMSSP();     //wait for the operation to be finished
    SSPBUF=EEPROM_CNTRL_IN;//Send Slave address write command
    WaitMSSP();
```

```
    SSPBUF=0x00;    // Send the starting address to write
    WaitMSSP();

    for(y=0;y<16;y++)
    {
        RSEN=1;       // Send re-start bit
        WaitMSSP();
        SSPBUF=EEPROM_CNTRL_OUT; // Slave address read command
        WaitMSSP();
        RCEN=1;       // Enable receive
        WaitMSSP();
        ACKDT=1;      // Acknowledge data 1: NACK, 0: ACK
        ACKEN=1;      // Enable ACK to send
        PEN=1;        // Stop condition
        WaitMSSP();
        putch(SSPBUF);  // Send the received data to PC
        DelayMs(30);
    }
    PEN=1;
    WaitMSSP();
}


void WaitMSSP()
{
    while(!SSPIF); // while SSPIF=0 stay here else exit the loop
    SSPIF=0;       // operation completed clear the flag
}

void i2c_init()
{
    TRISC3=1;      // Set up I2C lines by setting as input
    TRISC4=1;
    SSPCON=0x28;
// SSP port, Master mode, clock = FOSC / (4 * (SSPADD+1))
    SSPADD=(FOSC / (4 * I2C_FREQ)) - 1; //clock 100khz
    SSPSTAT=80;    // Slew rate control disabled
}
```

```
void serial_init()
{
   TRISC6=1;        // Enable TX and RX pin for Serial port
   TRISC7=1;
   TXSTA=0x24;      // Transmit Enable
   SPBRG=BAUD_VAL; // 9600 baud at 10 MHz
   RCSTA=0x90;      // Usart Enable, Continus receive enable
   TXIF=1;          // Make TXREG register empty
}

void putch(unsigned char Data)  // transmit data
{
   while(TXIF==0);
   TXREG = Data;
}

void DelayMs(unsigned int Ms)
{
   int delay_cnst;
   while(Ms>0)
   {
      Ms--;
      for(delay_cnst = 0;delay_cnst <220;delay_cnst++);
   }
}
```

To compile the above C code you need the Mplab software & Hi-Tech Compiler. They must be properly set up and a project with correct settings must be created in order to compile the code. To compile the above code, the C file must be added to the project.

In Mplab, you want to develop or debug the project without any hardware setup. You must compile the code for generating HEX file. In debugging Mode, you want to check the port output without PIC16F/18F Slicker Board.

The PICKIT2 software is used to download the hex file into your microcontroller IC PIC16F877A through USB port.

Testing the I2C – EEPROM with PIC16F877A

Give +12V power supply to PIC16F/18F Slicker Board; the EEPROM device is connected with the PIC16F/18F Slicker Board. First check the entire EEPROM device fixed properly. A serial cable is connected between the microcontroller and PC. In PC, open the Hyper Terminal for displaying the values from EEPROM through I2C.

The Read & Write operations are performed in EEPROM with EEPROM address. When the EEPROM address is correct, then only you can write, read, and erase data's correctly in EEPROM.

If any data is not coming in Hyper Terminal, then you just check the serial cable is working or not. Otherwise you just check the code with debugging mode in Mplab. If you want to see more details about debugging just see the videos in below link.

- How to create & Debug a Project in Mplab using PIC16F using Hi-Tech Compiler.

General Information

- For proper working use the components of exact values as shown in Circuit file.
- Solder everything in a clean way. A major problem arises due to improper soldering, solder jumps and loose joints. Use the exact value crystal shown in schematic.
- More instructions are available in following articles,
  - User Manual of PIC16F/18F Slicker Board.
  - Create & Debug a project in Mplab using PIC16F877A.

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