

Ver. 310807 s. 1

Bilag 3

Valgfri specialefagskatalog

Data- og kommunikationsuddannelsen

Undervisningsministeriet

September 2007

/Steen Albertsen

Ver. 310807 s. 2

Embedded controller, almen.

Varighed 1 uge.

Mål og øvrige rammer

Forudsætning: Gennemført ”Programmering i sproget C”, eller tilsvarende viden.

Beskrivelsen er en paraplybeskrivelse, der f.eks. kan benyttes til en af følgende kendte platforme:

- 8051

- PIC

Målet er at:

Eleven kan beskrive controllerens arkitektur, ud fra et blokdiagram.

Eleven kan beskrive memory-maps internt og eksternt.

Eleven kan anvende Special Function Register.

Eleven kan indsamle information fra datablade til interne perifære enheder og kan lave små programmer i C, til styring af disse.

Eleven kan benytte udviklingssystemet, til lave små programmer i C.

Eleven kan benytte simpel debug/emulering/simulering til debugging.

Praktikregler Eleven kan udføre følgende arbejdsopgaver:

Programmere embeddede systemer

Skrive mindre programmer. f.eks. i C til controlleren

Deltage i fejlfinding, test og optimering.

PIC18FXX2 Data Sheet

High-Performance, Enhanced Flash Microcontrollers with 10-Bit A/D

High Performance RISC CPU:

- C compiler optimized architecture/instruction set
 - Source code compatible with the PIC16 and PIC17 instruction sets
- Linear program memory addressing to 32 Kbytes
- Linear data memory addressing to 1.5 Kbytes

| Device | On-Chip Program Memory | | On-Chip RAM (bytes) | Data EEPROM (bytes) |
|-----------|------------------------|----------------------------|---------------------|---------------------|
| | FLASH (bytes) | # Single Word Instructions | | |
| PIC18F242 | 16K | 8192 | 768 | 256 |
| PIC18F252 | 32K | 16384 | 1536 | 256 |
| PIC18F442 | 16K | 8192 | 768 | 256 |
| PIC18F452 | 32K | 16384 | 1536 | 256 |

- Up to 10 MIPS operation:
 - DC - 40 MHz osc./clock input
 - 4 MHz - 10 MHz osc./clock input with PLL active
- 16-bit wide instructions, 8-bit wide data path
- Priority levels for interrupts
- 8 x 8 Single Cycle Hardware Multiplier

Peripheral Features:

- High current sink/source 25 mA/25 mA
- Three external interrupt pins
- Timer0 module: 8-bit/16-bit timer/counter with 8-bit programmable prescaler
- Timer1 module: 16-bit timer/counter
- Timer2 module: 8-bit timer/counter with 8-bit period register (time-base for PWM)
- Timer3 module: 16-bit timer/counter
- Secondary oscillator clock option - Timer1/Timer3
- Two Capture/Compare/PWM (CCP) modules. CCP pins that can be configured as:
 - Capture input: capture is 16-bit, max. resolution 6.25 ns (TCY/16)
 - Compare is 16-bit, max. resolution 100 ns (TCY)
 - PWM output: PWM resolution is 1- to 10-bit, max. PWM freq. @: 8-bit resolution = 156 kHz
10-bit resolution = 39 kHz
- Master Synchronous Serial Port (MSSP) module, Two modes of operation:
 - 3-wire SPI™ (supports all 4 SPI modes)
 - I²C™ Master and Slave mode

Peripheral Features (Continued):

- Addressable USART module:
 - Supports RS-485 and RS-232
- Parallel Slave Port (PSP) module

Analog Features:

- Compatible 10-bit Analog-to-Digital Converter module (A/D) with:
 - Fast sampling rate
 - Conversion available during SLEEP
 - Linearity ≤ 1 LSB
- Programmable Low Voltage Detection (PLVD)
 - Supports interrupt on-Low Voltage Detection
- Programmable Brown-out Reset (BOR)

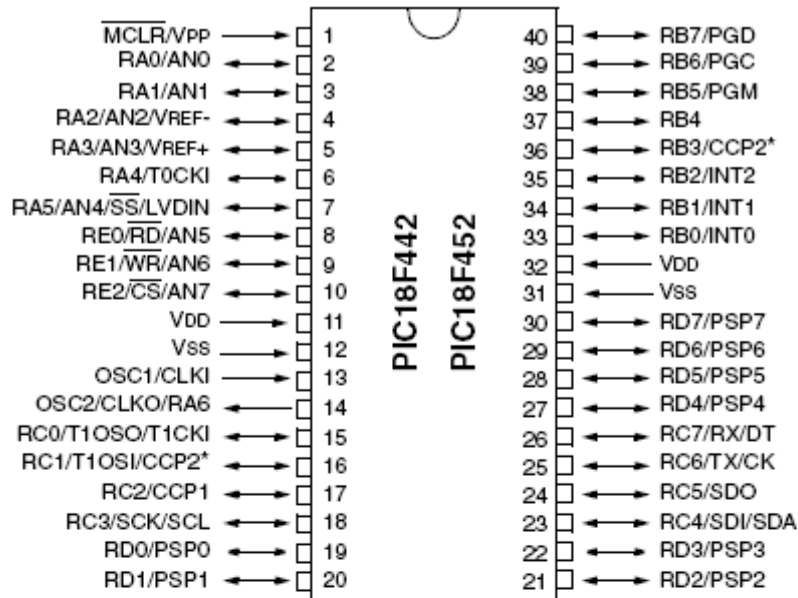
Special Microcontroller Features:

- 100,000 erase/write cycle Enhanced FLASH program memory typical
- 1,000,000 erase/write cycle Data EEPROM memory
- FLASH/Data EEPROM Retention: > 40 years
- Self-reprogrammable under software control
- Power-on Reset (POR), Power-up Timer (PWRT) and Oscillator Start-up Timer (OST)
- Watchdog Timer (WDT) with its own On-Chip RC Oscillator for reliable operation
- Programmable code protection
- Power saving SLEEP mode
- Selectable oscillator options including:
 - 4X Phase Lock Loop (of primary oscillator)
 - Secondary Oscillator (32 kHz) clock input
- Single supply 5V In-Circuit Serial Programming™ (ICSP™) via two pins
- In-Circuit Debug (ICD) via two pins

CMOS Technology:

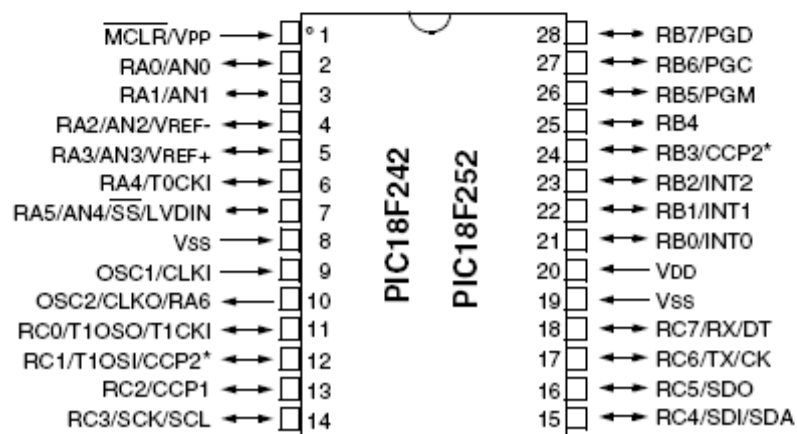
- Low power, high speed FLASH/EEPROM technology
- Fully static design
- Wide operating voltage range (2.0V to 5.5V)
- Industrial and Extended temperature ranges
- Low power consumption:
 - < 1.6 mA typical @ 5V, 4 MHz
 - 25 μ A typical @ 3V, 32 kHz
 - < 0.2 μ A typical standby current

DIP



Note: Pin compatible with 40-pin PIC16C7X devices.

DIP, SOIC



* RB3 is the alternate pin for the CCP2 pin multiplexing.

1.0 DEVICE OVERVIEW

This document contains device specific information for the following devices:

- PIC18F242
- PIC18F252
- PIC18F442
- PIC18F452

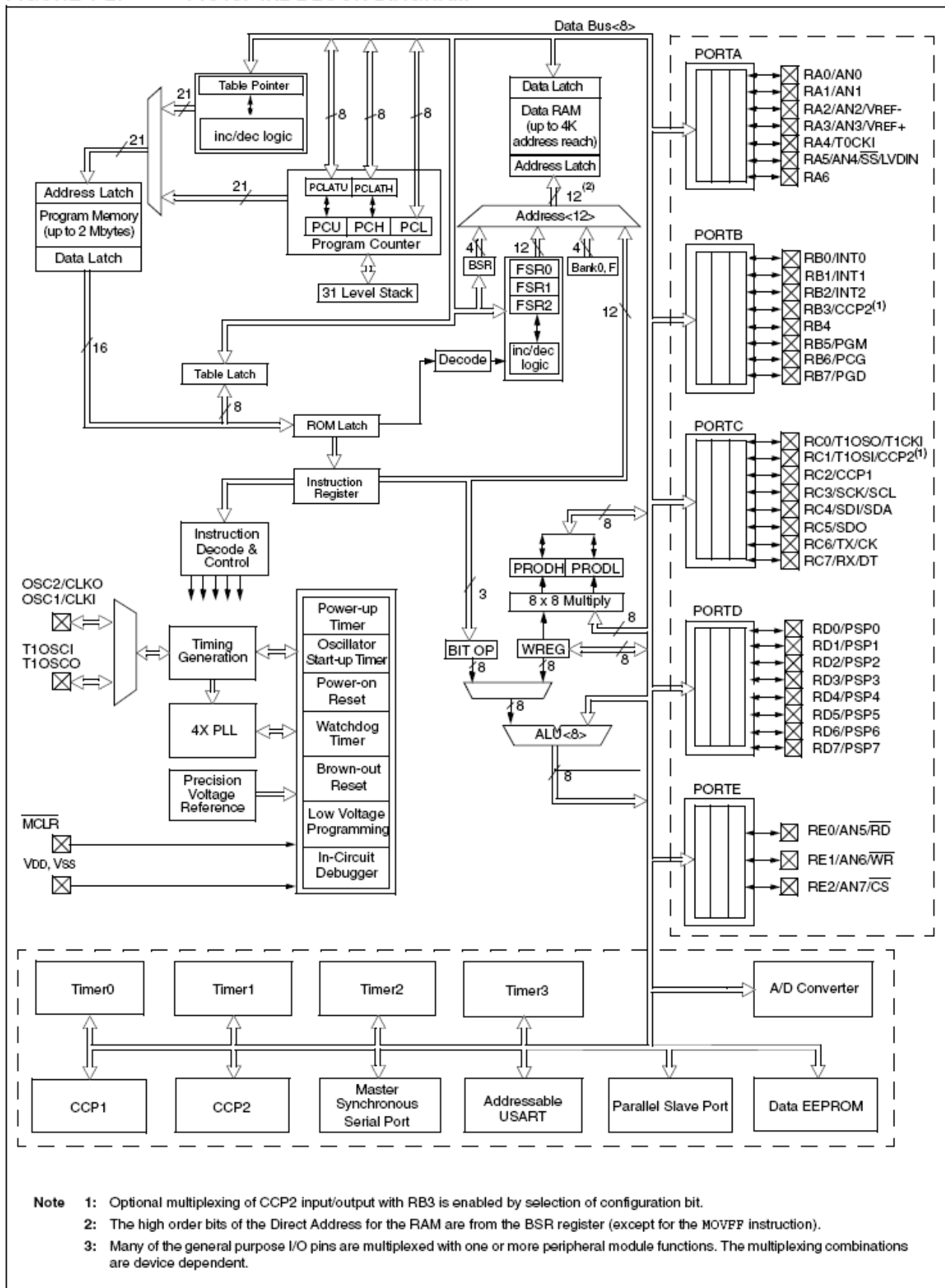
These devices come in 28-pin and 40/44-pin packages. The 28-pin devices do not have a Parallel Slave Port (PSP) implemented and the number of Analog-to-Digital (A/D) converter input channels is reduced to 5. An overview of features is shown in Table 1-1.

The following two figures are device block diagrams sorted by pin count: 28-pin for Figure 1-1 and 40/44-pin for Figure 1-2. The 28-pin and 40/44-pin pinouts are listed in Table 1-2 and Table 1-3, respectively.

TABLE 1-1: DEVICE FEATURES

| Features | PIC18F242 | PIC18F252 | PIC18F442 | PIC18F452 |
|---------------------------------|--|--|--|--|
| Operating Frequency | DC - 40 MHz | DC - 40 MHz | DC - 40 MHz | DC - 40 MHz |
| Program Memory (Bytes) | 16K | 32K | 16K | 32K |
| Program Memory (Instructions) | 8192 | 16384 | 8192 | 16384 |
| Data Memory (Bytes) | 768 | 1536 | 768 | 1536 |
| Data EEPROM Memory (Bytes) | 256 | 256 | 256 | 256 |
| Interrupt Sources | 17 | 17 | 18 | 18 |
| I/O Ports | Ports A, B, C | Ports A, B, C | Ports A, B, C, D, E | Ports A, B, C, D, E |
| Timers | 4 | 4 | 4 | 4 |
| Capture/Compare/PWM Modules | 2 | 2 | 2 | 2 |
| Serial Communications | MSSP, Addressable USART | MSSP, Addressable USART | MSSP, Addressable USART | MSSP, Addressable USART |
| Parallel Communications | — | — | PSP | PSP |
| 10-bit Analog-to-Digital Module | 5 input channels | 5 input channels | 8 input channels | 8 input channels |
| RESETS (and Delays) | POR, BOR, RESET Instruction, Stack Full, Stack Underflow (PWRT, OST) | POR, BOR, RESET Instruction, Stack Full, Stack Underflow (PWRT, OST) | POR, BOR, RESET Instruction, Stack Full, Stack Underflow (PWRT, OST) | POR, BOR, RESET Instruction, Stack Full, Stack Underflow (PWRT, OST) |
| Programmable Low Voltage Detect | Yes | Yes | Yes | Yes |
| Programmable Brown-out Reset | Yes | Yes | Yes | Yes |
| Instruction Set | 75 Instructions | 75 Instructions | 75 Instructions | 75 Instructions |
| Packages | 28-pin DIP 28-pin SOIC | 28-pin DIP 28-pin SOIC | 40-pin DIP 44-pin PLCC 44-pin TQFP | 40-pin DIP 44-pin PLCC 44-pin TQFP |

FIGURE 1-2: PIC18F4X2 BLOCK DIAGRAM



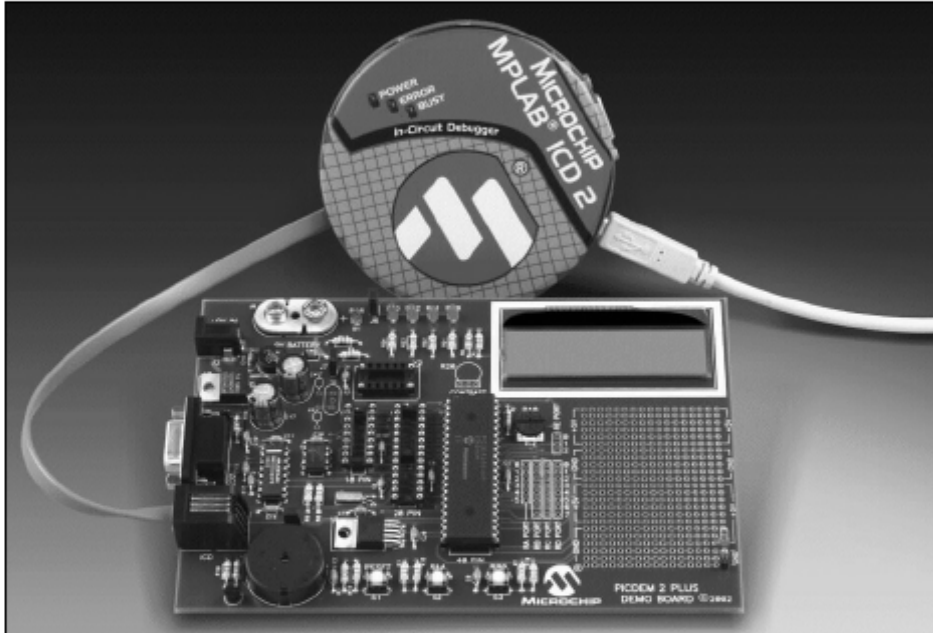


PICDEM™ 2 PLUS USED WITH AN IN-CIRCUIT EMULATOR OR IN-CIRCUIT DEBUGGER

To use PICDEM 2 Plus with an In-Circuit Emulator (ICE) or In-Circuit Debugger (ICD), refer to the tool's user guide for instructions to learn how to:

- Power-up and configure the ICE/ICD
- Connect to target boards (such as in Figure 2-1)

FIGURE 2-1: PICDEM™ 2 PLUS CONNECTED TO MPLAB® ICD 2 USING USB



Configure the PICDEM 2 Plus for the desired oscillator as described in Table 2-1. Refer to the ICE/ICD user's guide for any oscillator configuration requirements.

TABLE 2-1: OSCILLATOR SELECTION

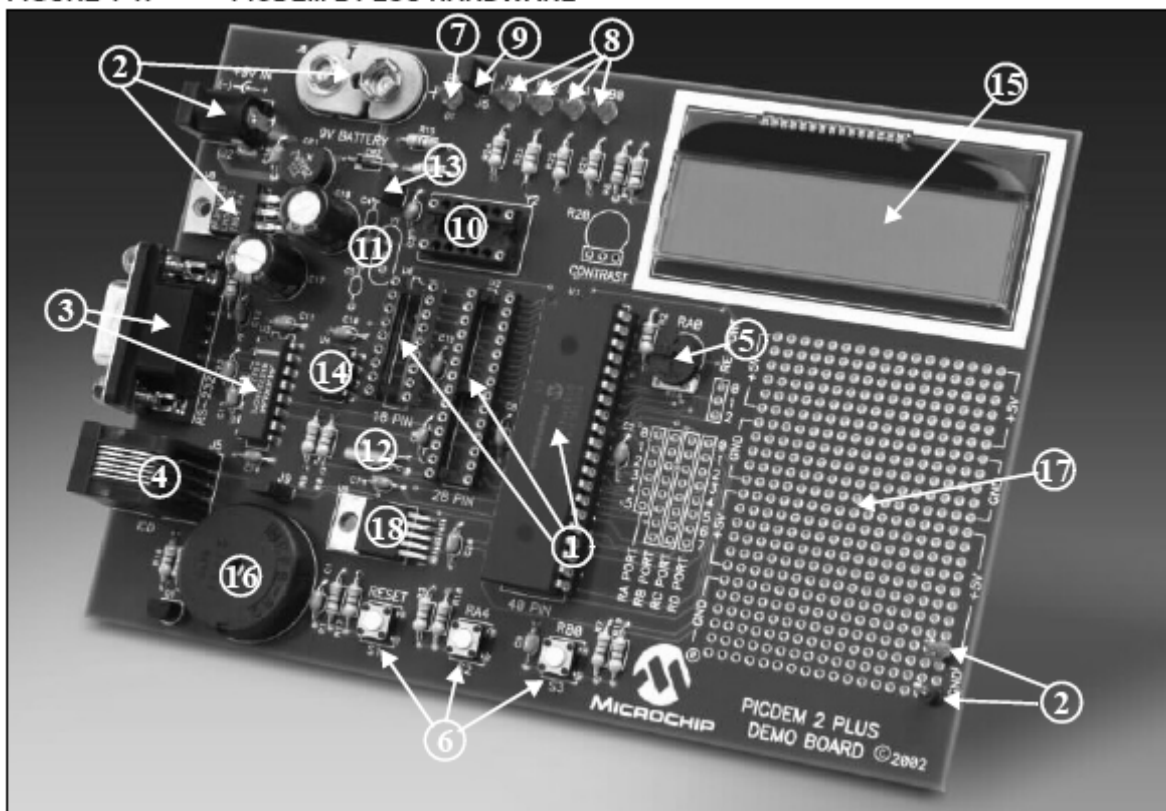
| Oscillator Selection on PICDEM™ 2 Plus | Modification on PICDEM 2 Plus |
|--|--|
| RC | J7 installed, Y2 empty, Y1 empty |
| Crystal | J7 removed, Y2 empty, crystal in Y1, caps in C4 and C5 |
| Canned Oscillator | J7 removed, oscillator in Y2 (Y1, C4, C5 empty) |
| Resonator – no internal caps | J7 removed, Y2 empty, resonator in Y1, caps in C4 and C5 |
| Resonator – with internal caps | J7 removed, Y2 empty, resonator in Y1, C4 and C5 empty |

1.2 PICDEM 2 PLUS DEMONSTRATION BOARD

The PICDEM 2 Plus demonstration board has the following hardware features:

1. 18, 28 and 40-pin DIP sockets. (Although three sockets are provided, only one device may be used at a time.)
2. On-board +5V regulator for direct input from 9V, 100 mA AC/DC wall adapter or 9V battery, or hooks for a +5V, 100 mA regulated DC supply.
3. RS-232 socket and associated hardware for direct connection to an RS-232 interface.
4. In-Circuit Debugger (ICD) connector.
5. 5 K Ω pot for devices with analog inputs.
6. Three push button switches for external stimulus and Reset.
7. Green power-on indicator LED.
8. Four red LEDs connected to PORTB.
9. Jumper J6 to disconnect LEDs from PORTB.
10. 4 MHz canned crystal oscillator.
11. Unpopulated holes provided for crystal connection.
12. 32.768 kHz crystal for Timer1 clock operation.
13. Jumper J7 to disconnect on-board RC oscillator (approximately 2 MHz).
14. 32K x 8 Serial EEPROM.
15. LCD display.
16. Piezo buzzer.
17. Prototype area for user hardware.
18. Microchip TC74 thermal sensor.

FIGURE 1-1: PICDEM 2 PLUS HARDWARE



Appendix A. Hardware Detail

The PICDEM 2 Plus hardware is extremely simple and illustrates the ease of use of various PIC MCUs. This section describes the PICDEM 2 Plus hardware elements.

A.1 PROCESSOR SOCKETS

Although three sockets are provided, only one device may be used at a time.

- 18-pin socket
- 28-pin socket
- 40-pin socket

A.2 DISPLAY

- Four red LEDs are connected to PORTB of each processor type. The PORTB pins are set high to light the LEDs. These LEDs may be disconnected from PORTB by removing jumper J6.
- One green LED is provided to indicate whether there is power to the PICDEM 2 Plus demonstration board.
LED On = Powered. LED Off = Not Powered.

A.3 POWER SUPPLY

There are three ways to supply power to the PICDEM 2 Plus:

- A 9V battery can be plugged into J8.
- A 9V, 100 mA unregulated AC or DC supply can be plugged into J2. A power supply can be purchased through Microchip, part #AC162039.
- A +5V, 100 mA regulated DC supply can be connected to the hooks provided.

Note: The PICDEM 2 Plus kit does not include a power supply.

MPLAB ICE 2000 users have a regulated +5V power supply available in the logic probe connector and can easily connect to the hooks on PICDEM 2 Plus. (Red probe to +5V and Black probe to GND.)

MPLAB ICD 2 users may use the ICD to power the target board to 5V, up to 200 mA, if the MPLAB ICD 2 is connected to the PC with a serial cable.

A.4 RS-232 SERIAL PORT

An RS-232, level-shifting IC has been provided with all the necessary hardware to support connection of an RS-232 host through the DB9 connector. The port is configured as DCE and can be connected to a PC using a straight-through cable.

The PIC16/PIC18 RX and TX pins are tied to the RX and TX lines of the MAX232A.

A.5 SWITCHES

Three switches provide the following functions:

- S1 – \overline{MCLR} to hard reset the processor
- S2 – Active-low switch connected to RA4
- S3 – Active-low switch connected to RB0

Switches, S1 and S3, have debounce capacitors, whereas S2 does not, allowing the user to investigate debounce techniques.

When pressed, the switches are grounded. When Idle, they are pulled high (+5V).

A.6 OSCILLATOR OPTIONS

- RC oscillator (2 MHz approximately) supplied. This oscillator may be disabled by removing jumper J7.
- Pads provided for user-furnished crystal and two capacitors.
- Removable, 4 MHz, canned oscillator.
- 32.768 kHz (watch-type) crystal for Timer1.

A.7 ANALOG INPUT

A 5 k Ω potentiometer is connected through a series 470 Ω resistor to AN0.

The pot can be adjusted from V_{DD} to GND to provide an analog input to the parts with an A/D module.

A.8 ICD CONNECTOR

By way of the modular connector (J5), the MPLAB ICD 2 can be connected for low-cost debugging. The ICD connector utilizes RB6 and RB7 of the microcontroller for in-circuit debugging.

A.9 TEMPERATURE SENSOR

This is a serial digital thermal sensor (TC74) connected to the 28 and 40-pin microcontrollers via RC3 and RC4.

Communication is accomplished with the TC74 via its 2-wire I²C™ compatible serial port. This device has an address of `'b1001101`.

A.10 SERIAL EEPROM

A 24L256 256K (32K x 8) serial EEPROM is included on the board to illustrate I²C bus concepts.

A.11 LCD

An LCD display with two lines, 16 characters each, is connected to the 28 and 40-pin sockets. There are three control lines (RA3:RA1) and four data lines (RD3:RD0).

A 5 k Ω pot may be installed into R20 to adjust contrast on the LCD. If this is done, R5 and R6 need to be removed.

A.12 SAMPLE DEVICES

A sample part programmed with a simple program is included in the PICDEM 2 Plus kit.

Table A-1 lists the I/O features and port connections for each processor type.

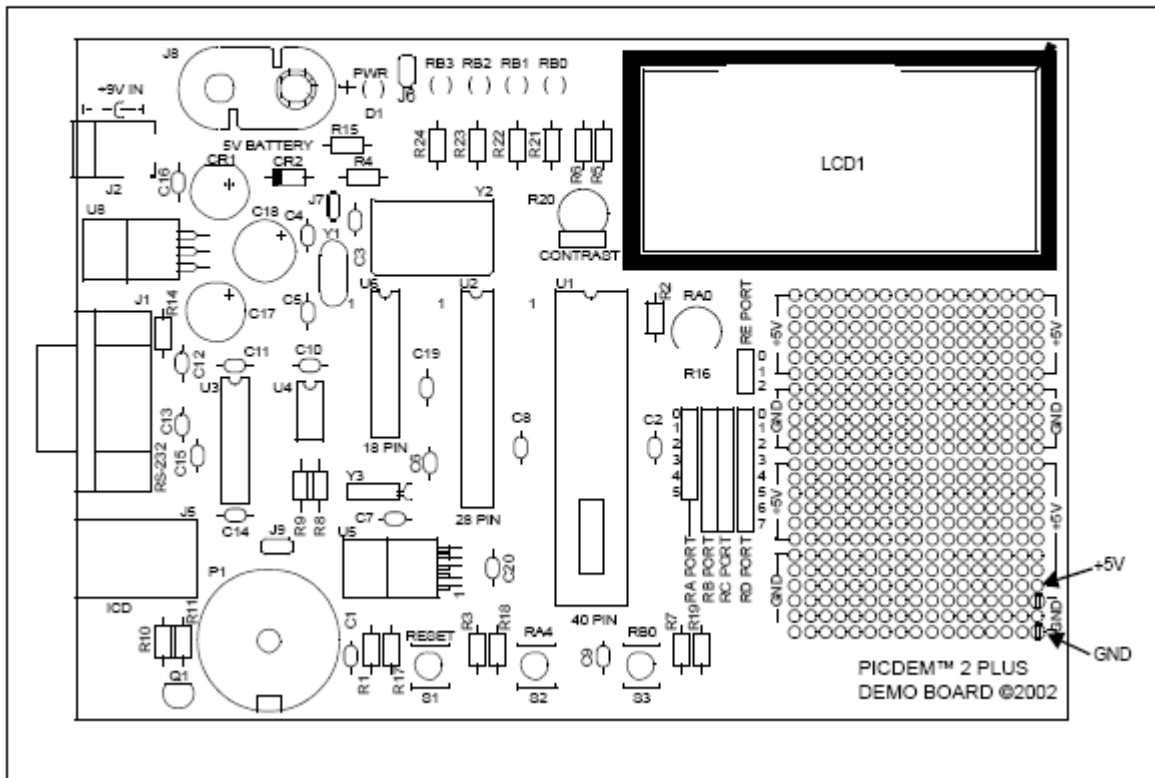
TABLE A-1: PORT CONNECTIONS

| Device | LEDs | RS-232 | S1 | S2 | S3 | Pot R16 | LCD | EEPROM | Buzzer | ICD | Temp Sensor | Y1/Y2 |
|--------|---------|---------|------|-----|-----|------------|--------------------|---------|--------|---------|----------------|-------|
| 18-pin | RB3:RB0 | N/A | MCLR | RA4 | RB0 | RA0 | N/A | N/A | N/A | RB6/RB7 | N/A | Yes |
| 28-pin | RB3:RB0 | RC6/RC7 | MCLR | RA4 | RB0 | RA0 | RA3:RA1 | RC3/RC4 | RC2 | RB6/RB7 | RC3/RC4 | Yes |
| 40-pin | RB3:RB0 | RC6/RC7 | MCLR | RA4 | RB0 | RA0 | RA3:RA1 RD3:RD0 | RC3/RC4 | RC2 | RB6/RB7 | RC3/RC4 | Yes |

A.13 BOARD LAYOUT AND SCHEMATICS

The following figures show the parts layout (silkscreen) and schematics for the PICDEM 2 Plus demonstration board.

FIGURE A-1: PICDEM™ 2 PLUS PARTS LAYOUT



Test af PICDEM 2 PLUS DEMO BOARD

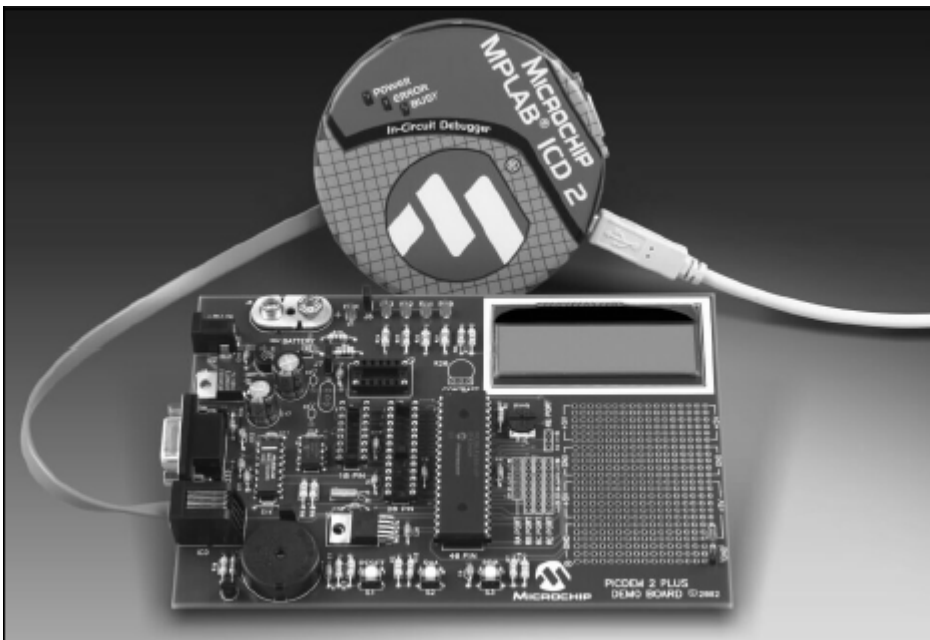
Vi skriver et program i C. programmet compileres (oversættes) med C kompileren fra HI-TECH



.Pogrammet skrives i MPLAB IDE der sammen med et PICDEM 2 PLUS BOARD og MPLAB ICD 2 udgør udviklingssystemet. Det forventes at MPLAB IDE og HI-TECH kompileren er installerede og PICDEM 2 PLUS BOARD og MPLAB ICD 2 er i nærheden. Hvis du ikke selv har et må du se ved sidemanden.

IDE: Integrated Development Environment.

ICD: In-Circuit Debugger.



PICDEM 2 PLUS
BOARD

Nyere udgaver er i
farver!

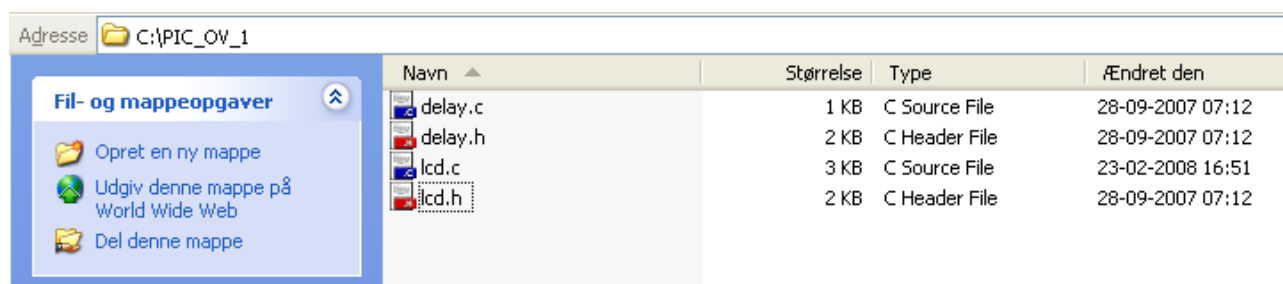
Opret et projekt.

Opret en mappe under c:\ > "roden" med navnet. PIC_OV_1, kopier ovenstående files til mappen. Nomenklaturen for fil og sti navne skal overholde konventionerne fra DOS da compileren ellers ikke kan læse dem. Den mappe der arbejdes i må heller ikke ligge langt fra roden.

Du skal kopiere følgende files til mappen PIC_OV_1.

lcd.h
lcd.c
delay.h
delay.c

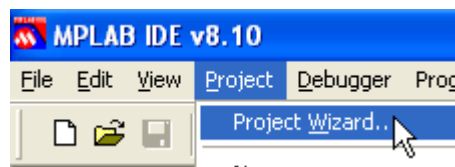
disse files finder du under: C:\Programmer\HI-TECH Software\PICC-18\9.50\samples\delay og C:\Programmer\HI-TECH Software\PICC-18\9.50\samples\lcd



Du kan nu starte MPLAB-IDE

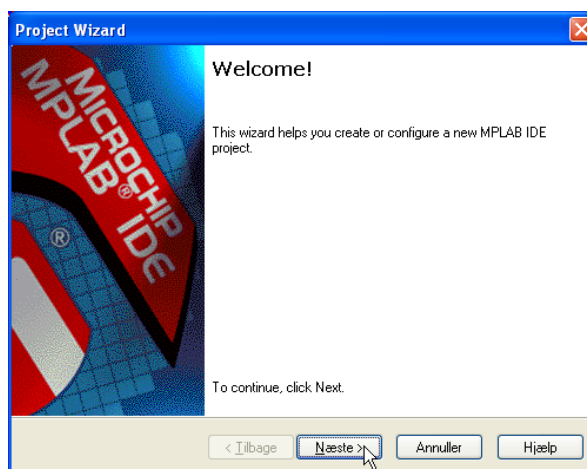


. For at oprette et nyt projekt gør du nu følgende.

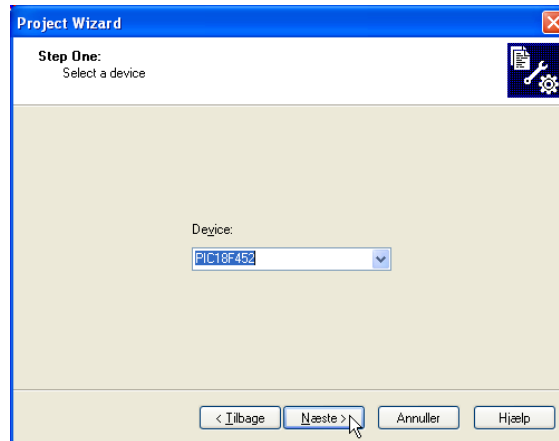


Du bruger projekt Wizard til at oprette projektet med.

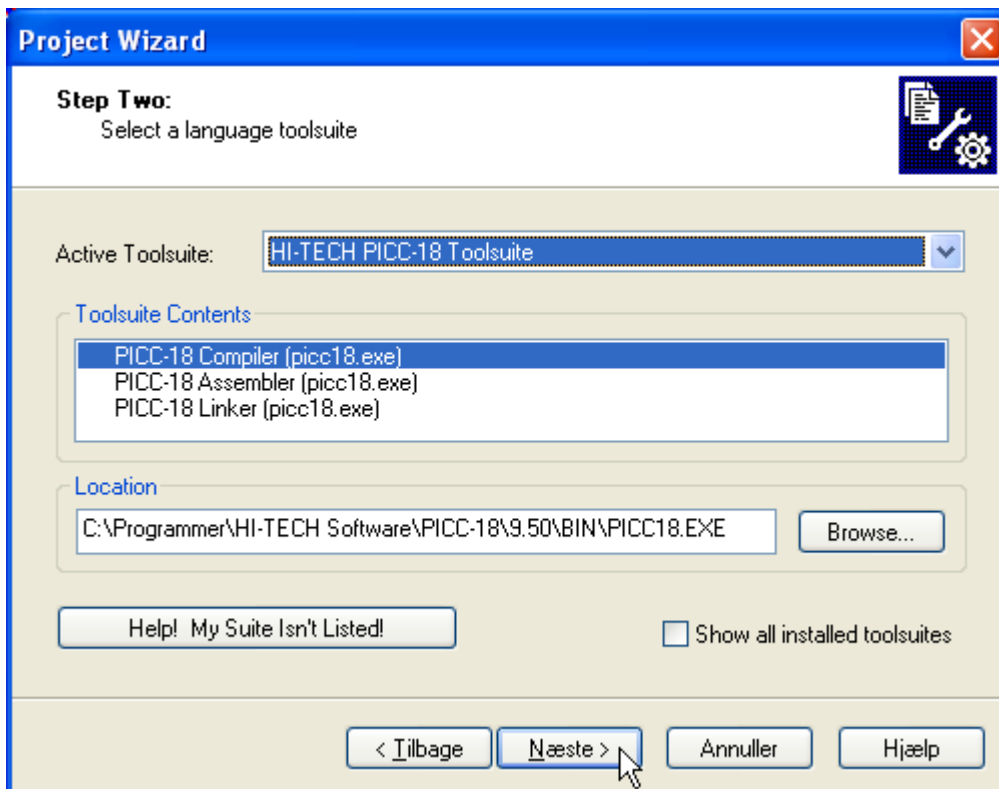
og trykker næste.



Du skal nu vælge de processor du vil med. PIC18F452, og <næste>

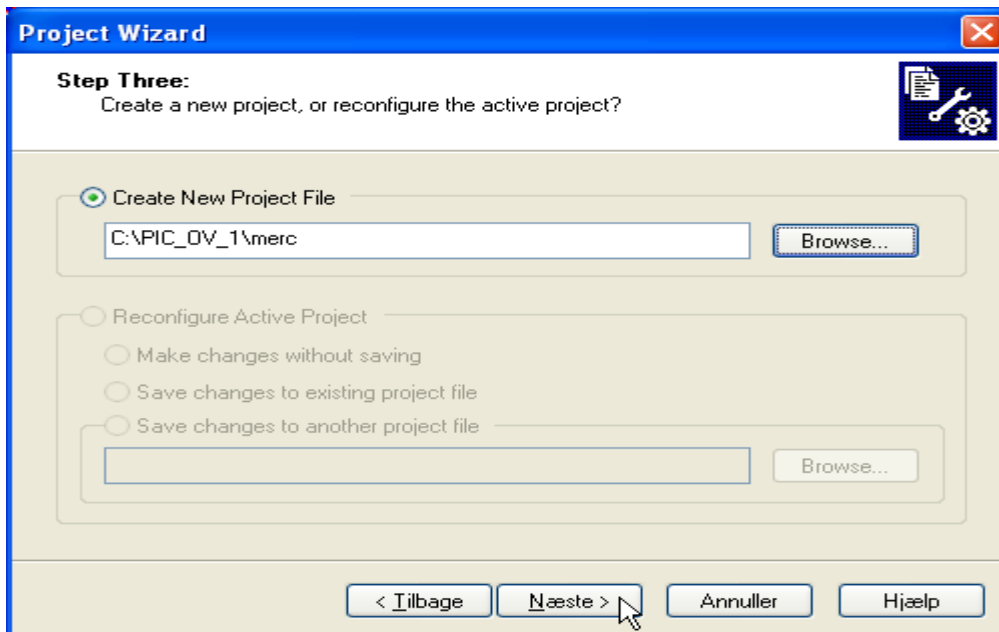


arbejde

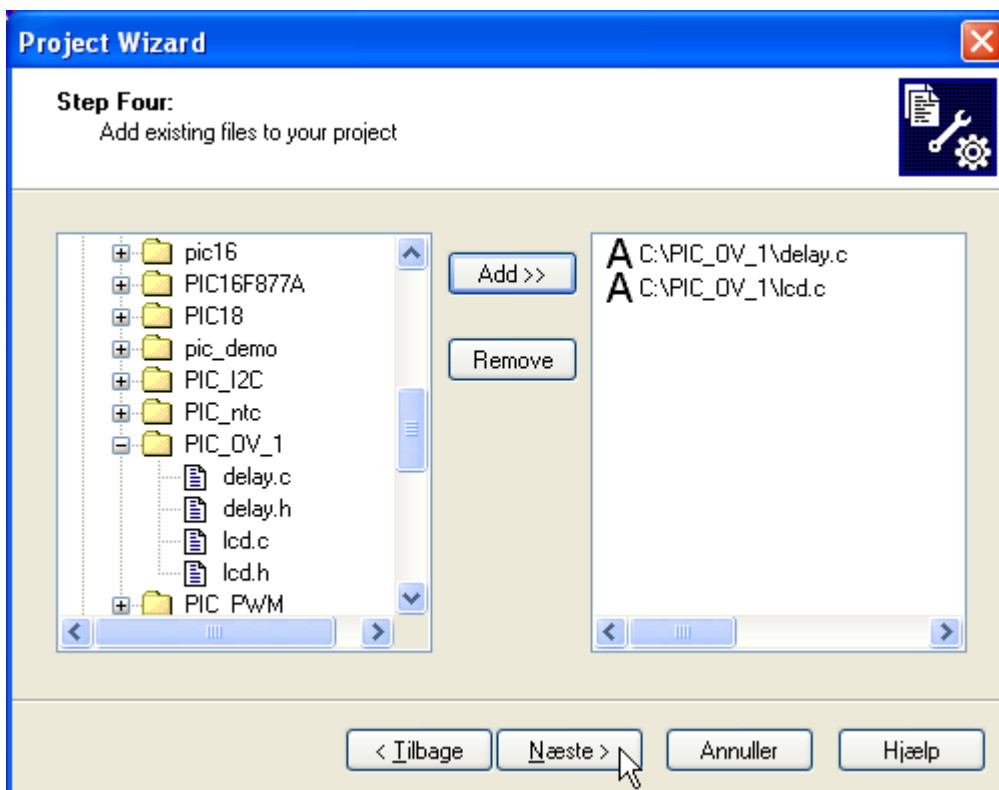


Gør som vist oven for og tryk <Næste>

Du skal nu navngive projektet.

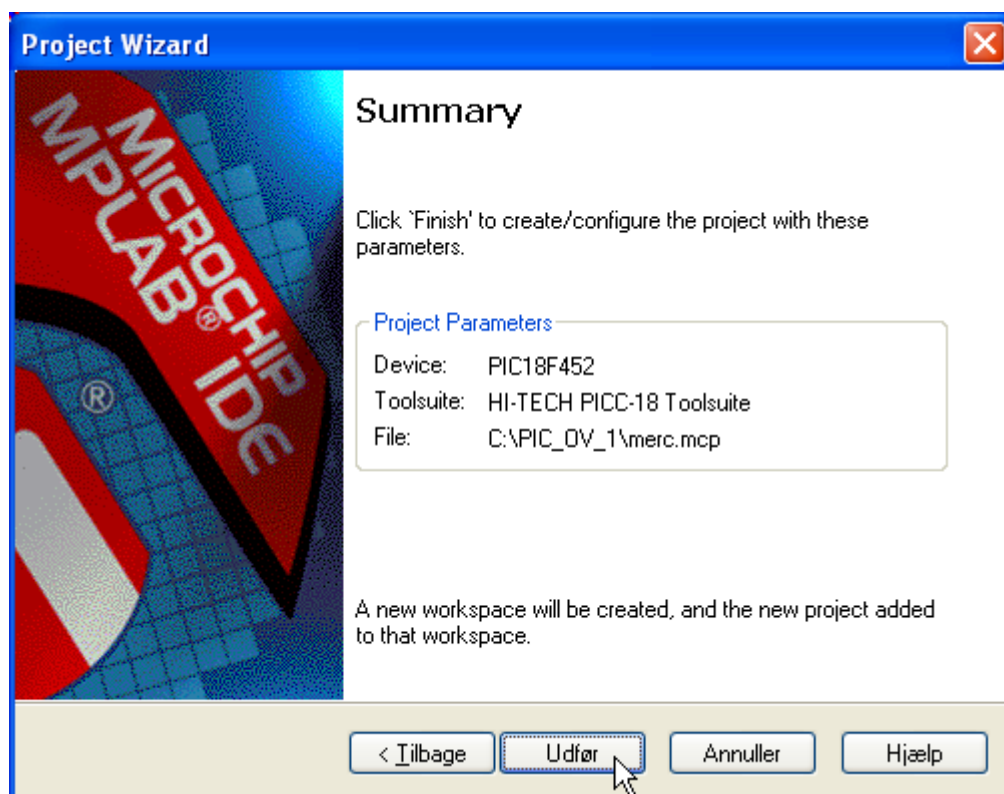


<Næste>



Gør som vist og tryk <Næste>

Du er nu næsten færdig.



Tryk <Udfør>

Du skal nu oprette din egen kildetekst, gemme den og inkludere den i projektet.



Klik på New file og kopier nedenstående kildetekst ind i den unavngivne file og gem den med file navnet: "mercan.c" i mappen C:\PICC_OV_1\

Kildeteksten starter lige under denne linje.

```
/* This is a simple demo project written for use with
 * the HI-TECH Software PICC18 compiler. It may be compiled
 * and run on the Microchip PICDEM 2 PLUS DEMO BOARD.
 * Features demonstrated include driving the LCD display
```

Additional files required for this demo are included in the
PIC18\SAMPLES directories:

DELAY\delay.c

DELAY\delay.h

LCD\lcd.c

LCD\lcd.h

*/

```
#include <pic18.h>
```

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

```
#include "lcd.h"
```

```
#include "delay.h"
```

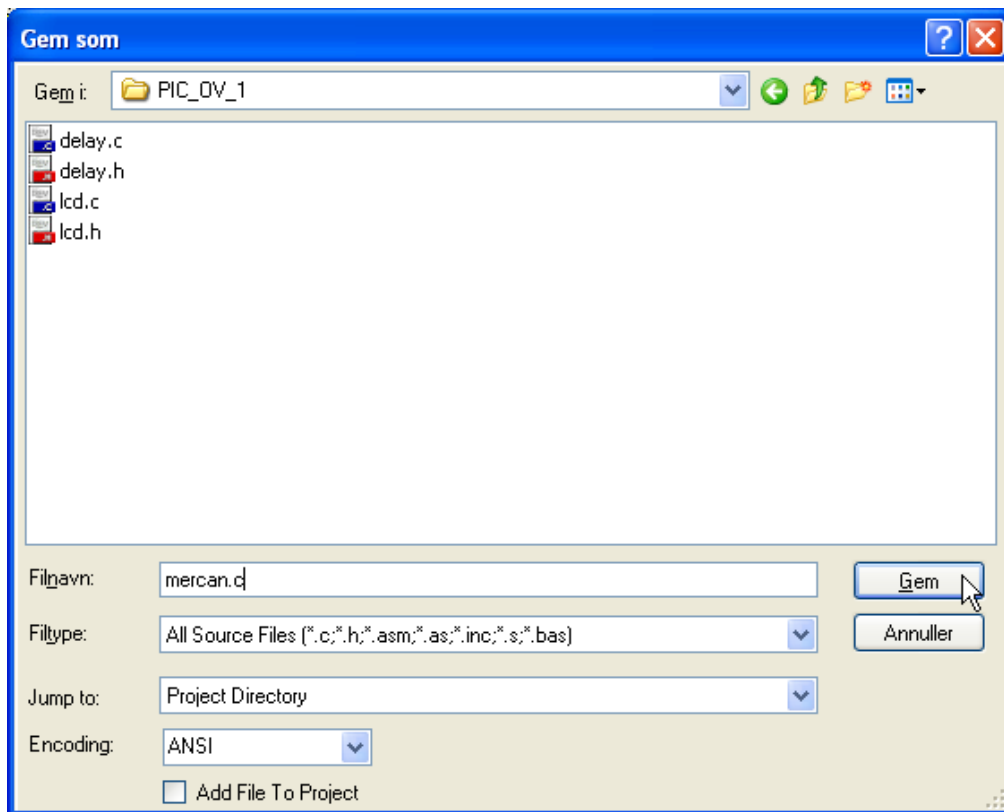
```
void init(void){
    lcd_init(FOURBIT_MODE);
}
```

```
void main(void){

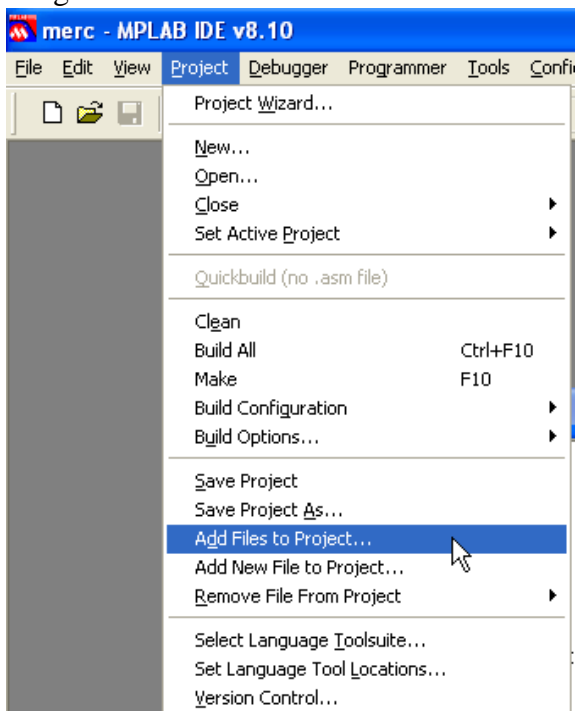
    init();
    lcd_puts(" Mercantec ");
    while(1);
```

```
}
```

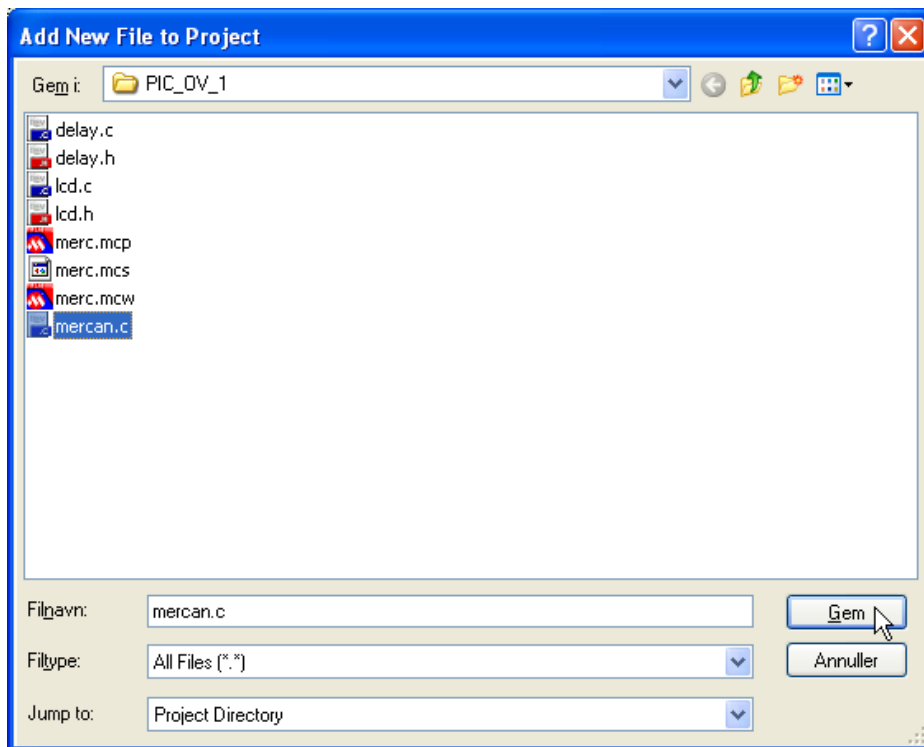
Kildeteksten stoppede lige før denne linje.



Du gemmer nu filen som vist oven for. <Gem>

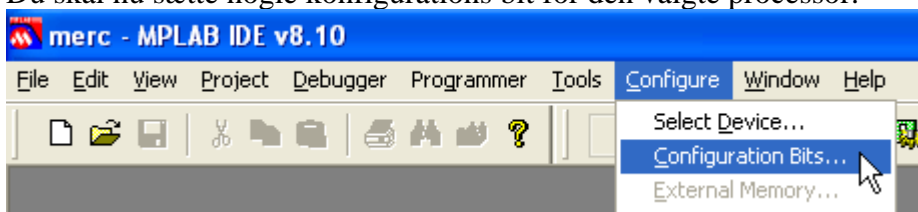


Den nye file skal nu gøres til en del af dit projekt.

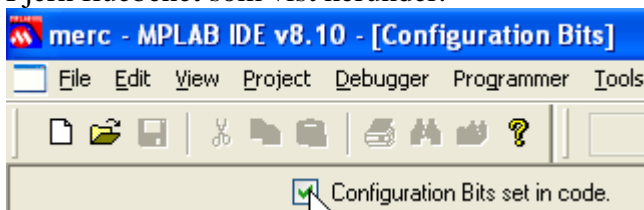


Gør som vist ovenfor og tryk <GEM>

Du skal nu sætte nogle konfigurations bit for den valgte processor.



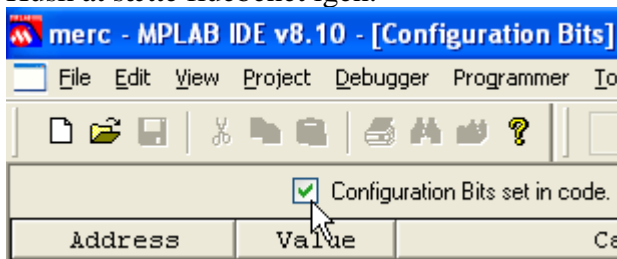
Fjern fluebenet som vist herunder.



Du kan nu rette på fire ting så resultatet bliver som neden for.

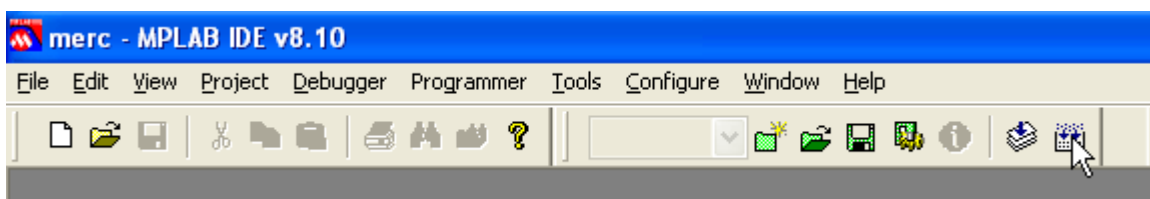
| Address | Value | Category | Setting |
|---------|-------|---------------------------------|-------------------------------------|
| 300001 | 22 | Oscillator | HS |
| | | Osc. Switch Enable | Disabled |
| 300002 | 0F | Power Up Timer | Disabled |
| | | Brown Out Detect | Enabled |
| | | Brown Out Voltage | 2.0V |
| 300003 | 0E | Watchdog Timer | Disabled - Controlled by SWDTEN bit |
| | | Watchdog Postscaler | 1:128 |
| 300005 | 01 | CCP2 Mux | RC1 |
| 300006 | 81 | Stack Overflow Reset | Enabled |
| | | Low Voltage Program | Disabled |
| 300008 | 0F | Code Protect 00200-01FFF | Disabled |
| | | Code Protect 02000-03FFF | Disabled |
| | | Code Protect 04000-05FFF | Disabled |
| | | Code Protect 06000-07FFF | Disabled |
| 300009 | C0 | Code Protect Boot | Disabled |
| | | Data EE Read Protect | Disabled |
| 30000A | 0F | Table Write Protect 00200-01FFF | Disabled |
| | | Table Write Protect 02000-03FFF | Disabled |
| | | Table Write Protect 04000-05FFF | Disabled |
| | | Table Write Protect 06000-07FFF | Disabled |
| 30000B | E0 | Config. Write Protect | Disabled |
| | | Table Write Protect Boot | Disabled |
| | | Data EE Write Protect | Disabled |
| 30000C | 0F | Table Read Protect 00200-01FFF | Disabled |
| | | Table Read Protect 02000-03FFF | Disabled |
| | | Table Read Protect 04000-05FFF | Disabled |
| | | Table Read Protect 06000-07FFF | Disabled |
| 30000D | 40 | Table Read Protect Boot | Disabled |

Husk at sætte fluebenet igen.

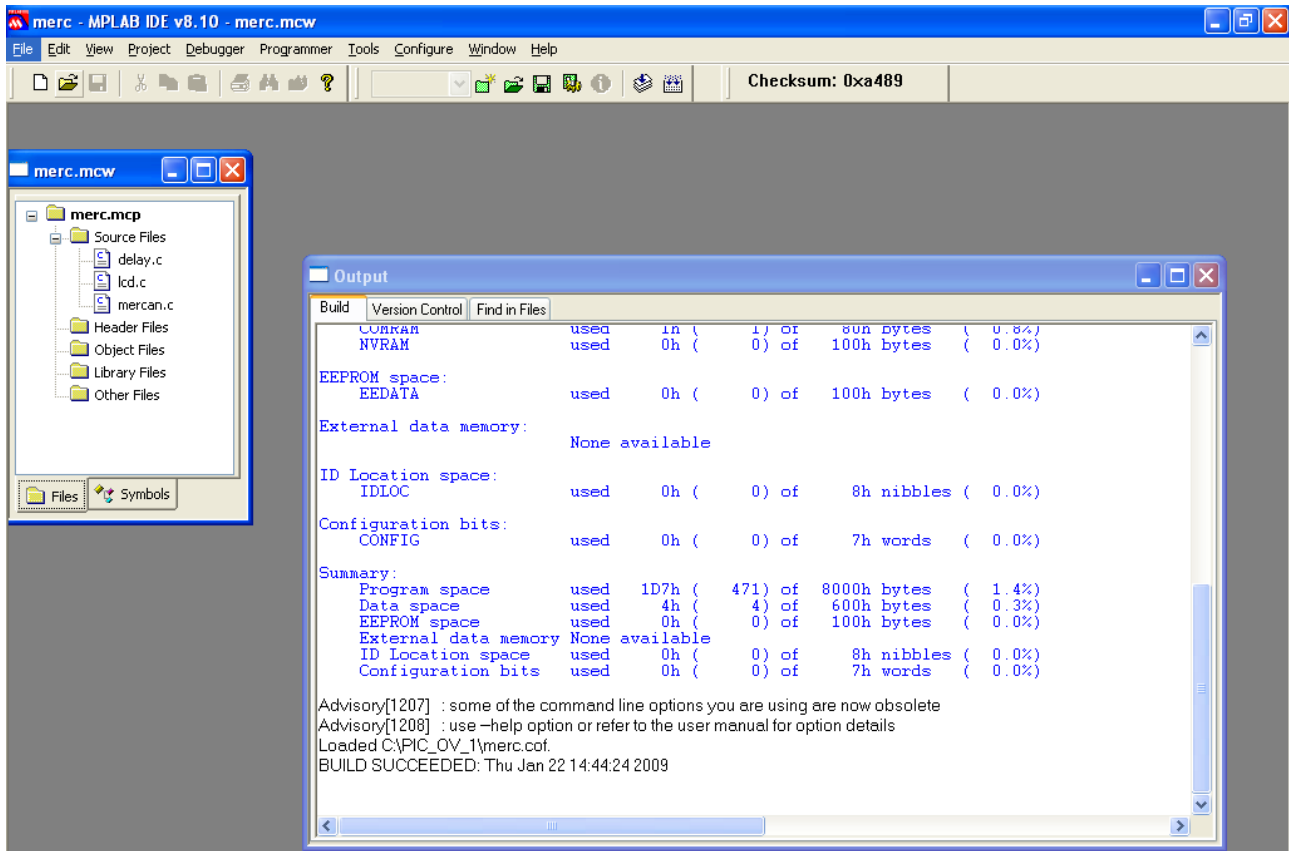


Luk "Configuration Bits" vinduet igen.

Nu skulle kildeteksten kunne oversættes. Gør som vist neden for.



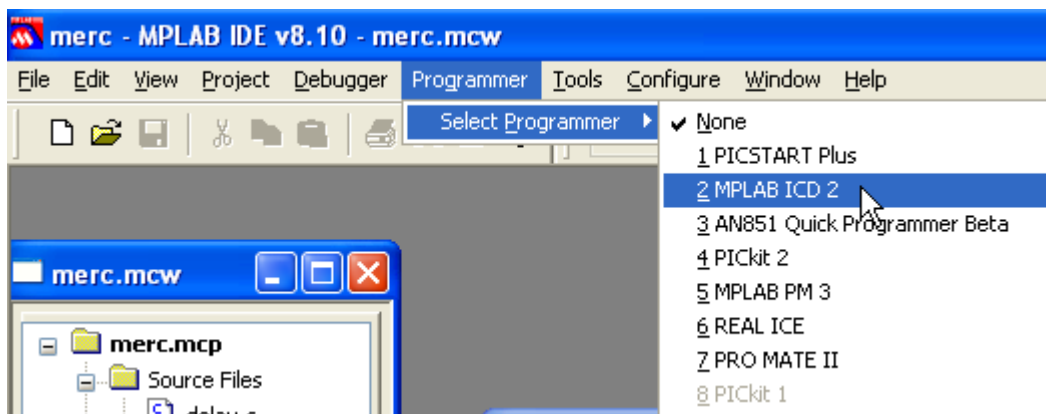
Det skulle gerne se ud som vist neden for.



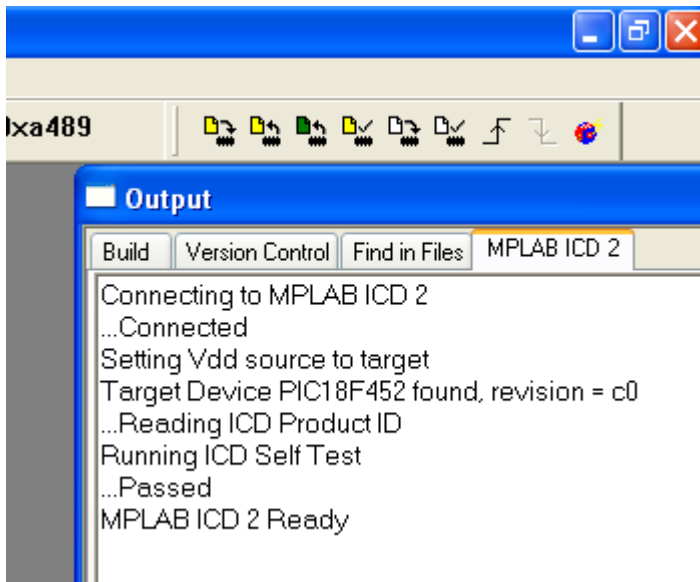
Ellers har DU lavet en fejl (måske).

Der skal nu vælges en måde at teste programmet på. Du vælger at lægge programmet over i PICDEM 2 PLUS DEMO BOARDED og teste det der. Der er en indbygget simulator i MPLAB IDE men da du skal bruge et stykke eksternt hardware er det fornuftigt at lægge programmet over i PICDEM 2 PLUS DEMO BOARDED og teste det der.

HUSK AT SLÅ RC OSC. FRA, på PICDEM2 BOARDED, se dokumentationen over boarded.
Punkt 13. Jumper J7 to disconnect on-board RC oscillator (approximately 2 MHz).

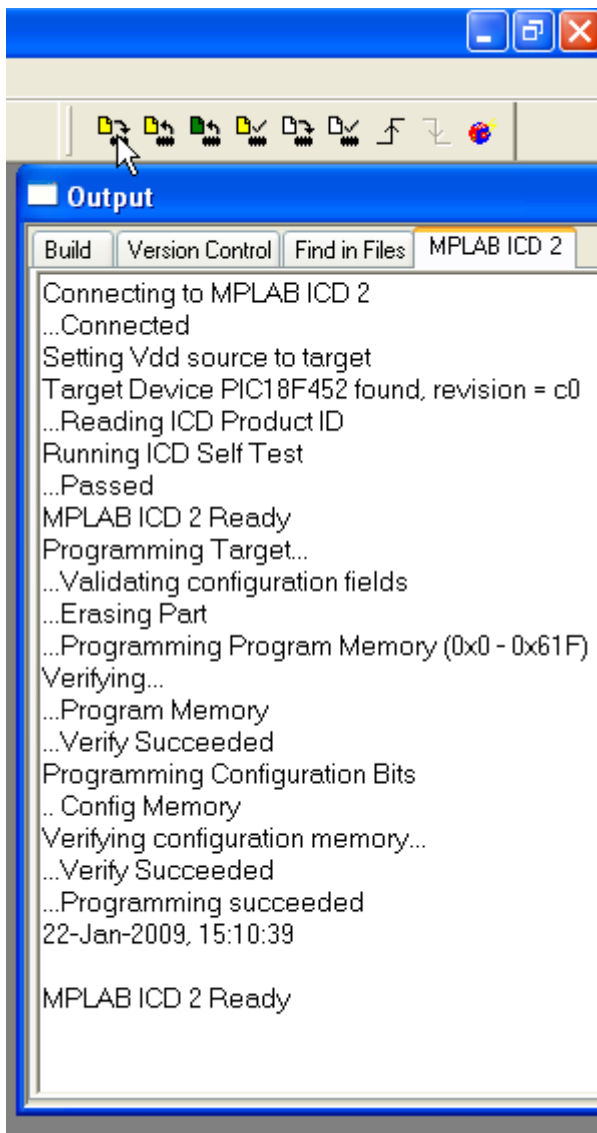


Gør som vist ovenfor.



og hvis alt ellers er tilsluttet korrekt fremkommer følgende.

Du kan nu overføre programmet til PICDEM 2 BOARDED som vist neden for.



Tryk nu på "Release from Reset" og se hvad der sker ude på PICDEM 2 BOARDED.

