EC336: Embedded Systems

Interfacing Display Devices

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1   Goal of the Lab

The aim of this lab was to interface the chosen microcontroller with input devices such as the Hex keypad and the Keyboard. The microcontroller chosen by our group is TI's MSP430G2.

2   Components Used

For this lab the components used are :

- MSP430 microcontroller

- LEDs

- 220 Ω resistors

- Hex Keypad

- Keyboard

3   Board Details

Some of the features of the MSP430 are - (Refer Figure 1 and Figure 2 for more information)

- 16-bit RISC architecture

- Von-Neumann architecture

- Upto 16 MHz clock frequency

- Low power consumption and five power saving modes
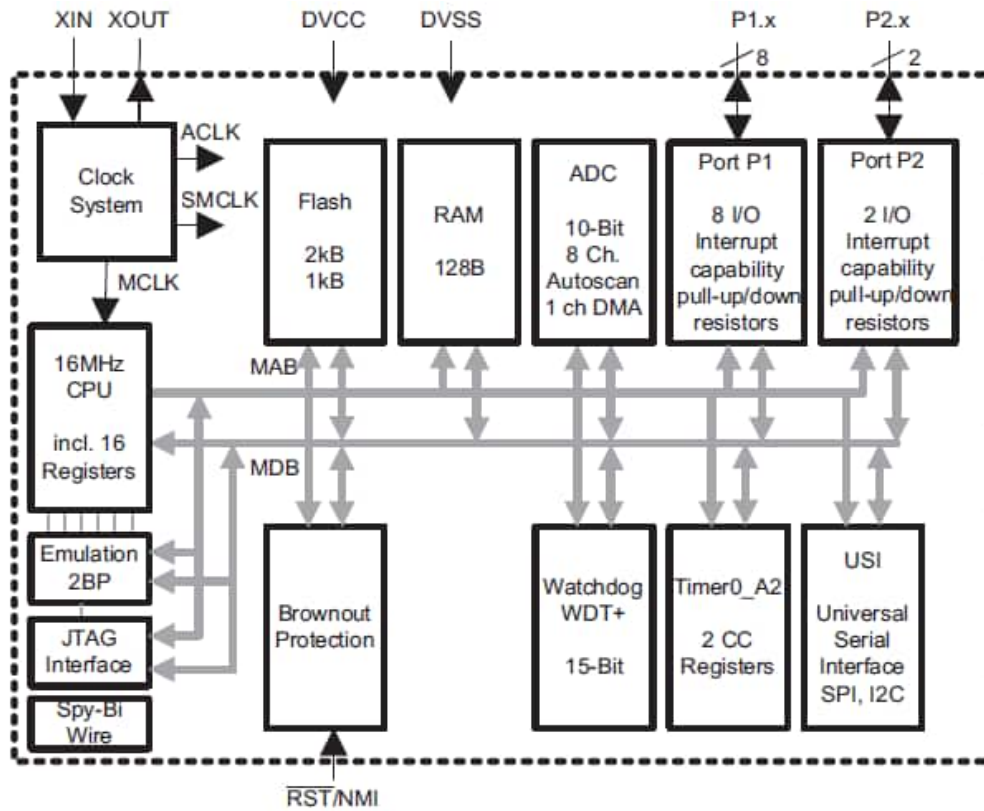
- 16 general purpose registers

XIN XOUT DVCC DVSS P1.x P2.x

Clock System

ACLK

SMCLK

MCLK

Flash
2kB
1kB

RAM
128B

ADC
10-Bit
8 Ch.
Autoscan
1 ch DMA

Port P1
8 I/O
Interrupt capability
pull-up/down resistors

Port P2
2 I/O
Interrupt capability
pull-up/down resistors

16MHz CPU
incl. 16 Registers

MAB

MDB

Emulation 2BP

JTAG Interface

Spy-Bi Wire

Brownout Protection

Watchdog WDT+
15-Bit

Timer0_A2
2 CC Registers

USI
Universal Serial Interface
SPI, I2C

RST/NMI

Figure 1: MSP430 Architecture

- 10-bit ADC

- Supports SPI, I2C, UART and USB interfaces

- Has 16 GPIO pins divided as two ports (8-bit each)

4   Interfacing Details

Two input devices - the Hex Keypad and the Keyboard were interfaced. Both
the devices were manufactured by Electro Systems, Bangalore and datasheets
for the devices are available at the Embedded Lab. In order to observe
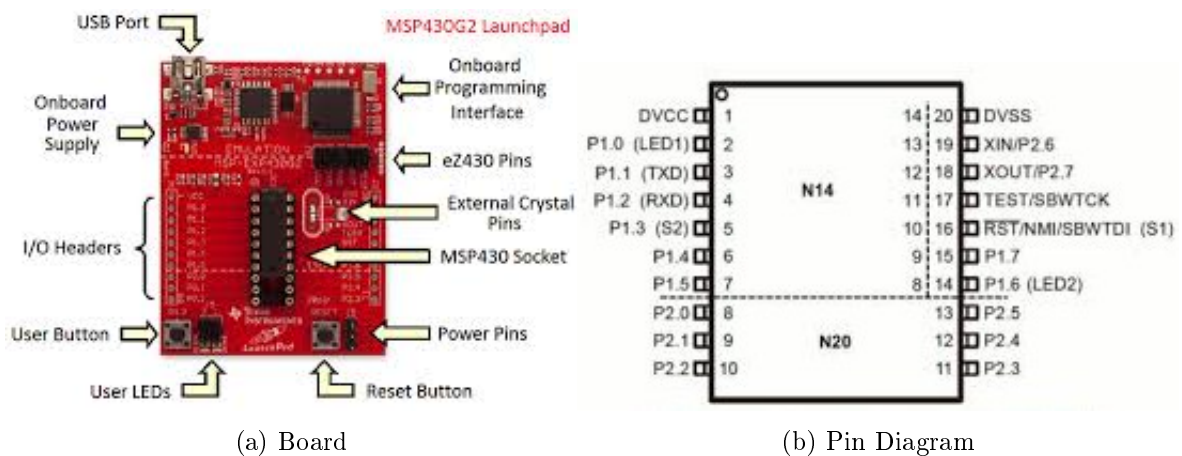
(a) Board　　　　　　　　　(b) Pin Diagram

Figure 2: Board details

the outputs of these devices, we also connected LEDs to the MSP430 and programmed a software decoder to translate key presses to a 4-bit binary value that were displayed using LEDs.

4.1　General layout

The internal schematic for each of the devices discussed here will be elaborated in the respective sections. The general structure, however, is the same. Each of the keys act like push-buttons in the circuit. There are two controlling lines that help the user detect which key was pressed. The lines and the keys form a matrix. Each line controlling the rows are inputs and line controlling the columns are outputs from the peripheral.

Initially, all the rows are enabled and the MSP waits for a key press. As soon as a key is pressed, the column is detected and to detect the row, the rows are enabled one by one and the column is monitored. The enabled row for which the column is also enabled, gives us the exact location of the key pressed.

VCC = 5V and GND are connected to the MSP 5V output (TP1) and

3

GND respectively.

4.2 Hex Keypad

The hex keypad is a 4x4 keypad with numbers from 0-9 and the hex digits A-F. Internally it is structured as 4x4 matrix. The rows are connected to Port 2 of the MSP and the columns are connected to Port 1 of the MSP. 4 LEDs are connected to Port 2 to display the decoded output. Port 2 is set to output and Port 1 to input.

4.3 Keyboard

The keyboard is a 4x6 keyboard with numbers from 0-9, basic math operators - $=, ., +, -, *, /$ and $\%$ and some basic calculator operators M+, M-, MR, MC, AC, CE and CHK. Internally it is structured as 3x8 matrix. The rows are connected to Port 2 of the MSP and the columns are connected to Port 1 of the MSP. 4 LEDs are connected to Port 2 to display the decoded output. Port 2 is set to output and Port 1 to input.

For ease of display and due to less number of pins available, the row controlling the calculator functions are disabled.

The internal structure of the keyboard is as shown in Fig 3.
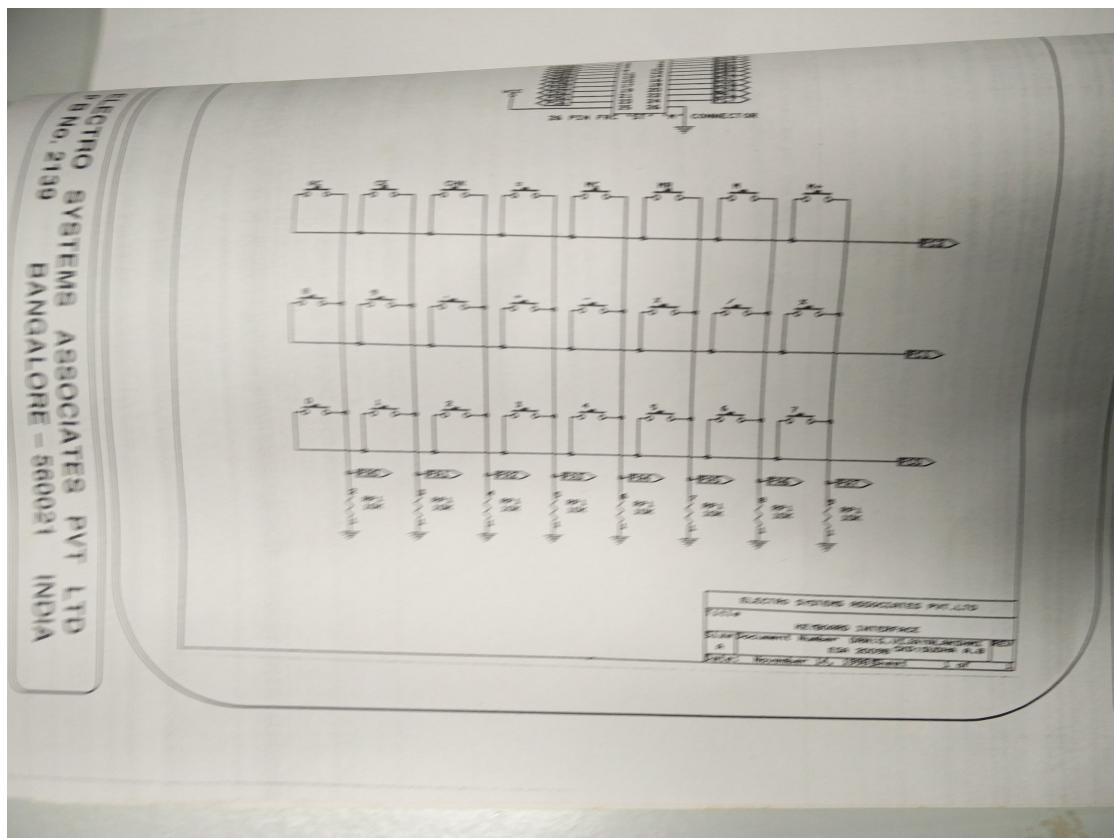
5 Program

6 Knowledge gained

Figure 3: Keyboard