ADVANCED ELECTRONIC SYSTEMS

ARM7 LPC2148 EVALUATION BOARD

USER MANUAL

ALS-SDA-ARM7-07

ADVANCED ELECTRONIC SYSTEMS
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CHAPTER 1

INTRODUCTION:

The **ALS/EVBRD/ARM7T7** Evaluation board is a study Board which includes LPC2148 ARM7TDMI-S micro-controller with USB 2.0 Full speed device, multiple UARTs, SPI, I2C & on-chip 512K Flash and SRAM up to 40kB, produced by NXP Semiconductors.

The **ARM7TDMI-S** is a general-purpose **32-bit** microprocessor, which offers high performance and very low power consumption. The ARM processor is based on Reduced Instruction Set (**RISC**) architecture, And the instruction set and related decode mechanism are much simpler than those of micro programmed Complex Instruction Set Computers. This simplicity results in a high instruction throughput and impressive real-time interrupt response from a small and cost-effective processor Core.

Pipeline techniques are employed so that all parts of the processing and memory systems can operate continuously. Typically, while one instruction is being executed, its successor is being decoded, and a third instruction is being fetched from memory.

The ARM7TDMI-S processor also employs a unique architectural strategy known as THUMB, which makes it ideally suited to high-volume applications with memory restrictions, or applications where code density is an issue. The key idea behind THUMB is that of a super-reduced instruction set. Essentially, the ARM7TDMI-S processor has two Instruction sets:

- The standard **32-bit** ARM instruction set.
- A **16-bit** THUMB instruction set.

The THUMB set's 16-bit instruction length allows it to approach twice the density of standard ARM code while retaining most of the Arm's performance advantage over a traditional 16-bit processor using 16-bit registers. This is possible because THUMB code operates on the same 32-bit register set as ARM code. THUMB code is able to provide up to 65% of the code size of ARM, and 160% of the performance of an equivalent ARM Processor connected to a 16-bit memory system.

1.1 MICROCONTROLLER FEATURES

Following are the features of 16 bit /32 bit LPC2148 Arm Micro-controller:

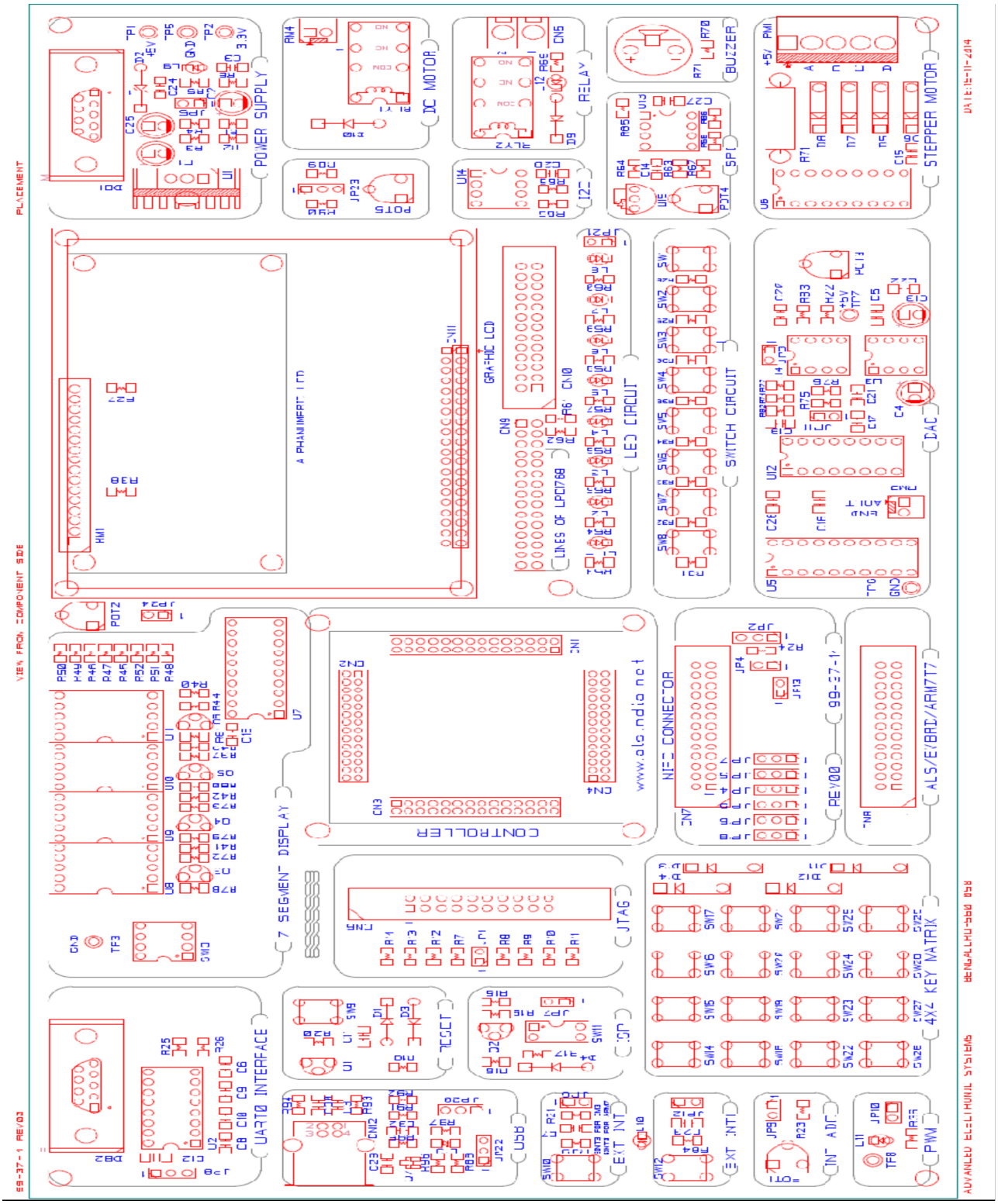
- **PHILIPS LPC2148** is a 16-bit or 32-bit Micro-controller in a LQFP64-pin Package.
- 40 kB of on-chip static RAM and 512 kB of on-chip flash memory. 128-bit wide interface/accelerator enables high-speed 60 MHz operation.
- The LPC2148 provides 100000 erase/write cycles and 20 years of Data-retention.
- In-System Programming/In-Application Programming (ISP/IAP) via on-chip boot loader software. Single flash sector or full chip erase takes 400ms and Flash programming takes 1ms per 256-byte line.
- USB 2.0 Full speed compliant device controller with 2 kB of endpoint RAM. In addition, the LPC2148 provides 8 kB of on-chip RAM accessible to USB by DMA.
- Embedded ICE-RT and Embedded Trace Macro cell (**ETM**) interfaces offer real time debugging with on-chip Real Monitor software and high-speed real-time tracing of instruction execution.
- Two 10-bit ADCs provide a total of 14 analog inputs, with conversion times as low as 2.44µs per channel.
- Single 10-bit DAC provides variable analog output.
- Two 32-bit Timers/External event Counters (with four Capture and four Compare channels each), PWM unit (six outputs) and watchdog.
- Low power Real-Time Clock (RTC) with independent power and 32 kHz clock input.
- Multiple serial interfaces including two UARTs (16C550 equivalent), two Fast I2C-bus (400 kbit/s), SPI and SSP with buffering and variable data length capabilities.
- Vectored interrupt controller (VIC) with configurable priorities and vector addresses.
- Up to 45 numbers of 5 V tolerant fast general purpose I/O pins in a tiny LQFP64 package.
- Up to nine edge or level sensitive external interrupt pins available.
- 60 MHz maximum CPU clock available from programmable on-chip PLL with settling time of 100 µs.
- On-chip integrated oscillator operates with an external crystal in range from 1 MHz to 30 MHz and with an external oscillator up to 50 MHz.
- Power saving modes include Idle and Power-down.
- Individual power enable/disable of peripheral functions as well as peripheral clock scaling for additional power optimization.
- Processor wake-up from Power-down mode via external interrupt, USB, Brown-Out Detect (BOD) or Real-Time Clock (RTC).
- Single power supply chip with Power-On Reset (POR) and BOD circuits:CPU operating voltage range of 3.0 V to 3.6 V (3.3 V ± 10 %) with 5 V tolerant I/O pads.

1.2 BOARD SPECIFICATIONS:

- **LPC2148** 16/32 BIT ARM7TDMI-S with 512K bytes Program Flash, 42K bytes RAM.
- 12MHz Crystal allows easy communication setup.
- One on board voltage regulator for generating 3.3V. Input to this will be from External +5V DC Power supply through a 9-pin DSUB connector.
- One RS232 interface circuits with 9 pin DSUB connector: this is used by the Boot loader program, to program **LPC2148** Flash memory without external Programmer.
- Piggy Back module containing **LPC2148** controller.
- Standard JTAG connector with ARM 2×10 pin layout for programming/ debugging with ARM-JTAG.
- Standard 26-pin FRC connectors to connect to **on-board interface** or some of **ALS standard External Interfaces.**
- Reset push-button for resetting the controller.
- SPI Interface: 2 channel ADC IC with POT and Temperature sensor.
- I2C Interface: NVROM IC.
- On chip ADC interface circuit.
- Two External interrupt circuits with LED indication.
- 16×2 alphanumeric LCD and 128×64 Graphic LCD display are provided – one of them can be used at a time.
- On-board eight push-button switches.
- 4×4 Key-Matrix connected to the port lines of the controller.
- Eight general purpose LED's.
- Four-digit multiplexed 7-segment display interface.
- 8-bit DAC interface.
- Stepper motor interface with direction and speed control.
- DC motor interface with direction and speed control.
- Interface circuit for on board Buzzer and Relay.
- USB device 2.0 full-speed controller.
- A number of software examples in 'C-language' to illustrate the functioning of the interfaces. The software examples are compiled using an evaluation version of KEIL4 'C' compiler for ARM.
- Compact elegant plastic enclosure.
- Serial RS232 cable is included.
- Operates off 5V DC.

CHAPTER 2

2.1 COMPONENT LAYOUT:



CHAPTER 3

HARDWARE DETAILS

3.1 CONNECTOR DETAILS:

1. **CN1 CONNECTOR**: 28 pin 14 X 2 HEADER is connected to the controller.

PIN #	DESCRIPTION	PIN #	DESCRIPTION
1	TDO-JTAG	15	GND
2	TDI-JTAG	16	RTCX1
3	TMS-JTAG	17	RESET
4	TRST-JTAG	18	RTCX2
5	TCK-JTAG	19	VBAT
6	PC3	20	ADC
7	PC2	21	NC
8	PC1	22	NC
9	PC0	23	NC
10	3.3V	24	NC
11	GND	25	NC
12	3.3V	26	P1.24(2148)
13	NC	27	NC
14	NC	28	NC

2. **CN2 CONNECTOR**: 28 pin 14 X 2 HEADER is connected to the controller.

PIN #	DESCRIPTION	PIN#	DESCRIPTION
1	NC	15	NC
2	NC	16	NC
3	NC	17	NC
4	PWM(P0.8)	18	GND
5	3.3V	19	3.3V
6	D+	20	NC
7	D-	21	NC
8	GND	22	NC
9	NC	23	NC
10	NC	24	NC
11	ROW0	25	PB6
12	ROW1	26	PB7
13	ROW2	27	EINT
14	ROW3	28	NC

3. **CN3 CONNECTOR**: 28 pin 14 X 2 HEADER is connected to the controller.

PIN #	DESCRIPTION	PIN #	DESCRIPTION
1	NC	15	PA1
2	NC	16	LD7/CON
3	ILED	17	LD6
4	EINT1	18	LD5
5	ISP	19	LD4
6	3.3V	20	LEN
7	GND	21	LRS
8	PA7*	22	PC7
9	PA6	23	3.3V
10	PA5	24	GND
11	PA4	25	PC6

12	PA3	26	PC5
13	PA2	27	PC4
14	PA0	28	NC

4. **CN4 CONNECTOR**: 28 pin 14 X 2 HEADER is connected to the controller.

PIN #	DESCRIPTION	PIN #	DESCRIPTION
1	PB5	15	NC
2	PB4	16	NC
3	PB3	17	NC
4	PB2	18	NC
5	PB1	19	NC
6	PB0	20	NC
7	NC	21	3.3V
8	GND	22	GND
9	3.3V	23	TXD0
10	NC	24	RXD0
11	NC	25	RTCK-JTAG
12	NC	26	NC
13	NC	27	NC
14	NC	28	NC

5. **CN5 CONNECTOR**: 2 pin MKDSN connector for RELAY interface

PIN NUMBER	DESCRIPTION
1	Connected to POL1 of Rly2.
2	Connected to NO contact of Rly2.

6. **CN6 CONNECTOR**: 20 pin FRC connected to the controller, Standard JTAG connector for programming/debugging with ARM-JTAG debugger. SHORT jumper JP1 for JTAG to work.

PIN #	DESCRIPTION	PIN #	DESCRIPTION
1	+3.3V	11	RTCK
2	+3.3V	12	GND
3	TRST	13	TDO
4	GND	14	GND
5	TDI	15	RST
6	GND	16	GND
7	TMS	17	R10 ONE END
8	GND	18	GND
9	TCK	19	R11 ONE END
10	GND	20	GND

7. **CN7 CONNECTOR**: 26 pin FRC connected to the controller, which is compatible with **ALS Standard External Interfaces**. SHORT jumper JP4 to connect On Board Interfaces.

PIN #	DESCRIPTION	PIN #	DESCRIPTION
1	PC4	14	PB1
2	PC5	15	PA6
3	PC2	16	PA7
4	PC3	17	PA4
5	PC0	18	PA5

6	PC1	19	PA2
7	PB6	20	PA3
8	PB7	21	PA0
9	PB4	22	PA1
10	PB5	23	PC6*
11	PB2	24	PC7
12	PB3	25	+5V THROUGH JP4
13	PB0	26	GND

8. **CN8 CONNECTOR**: 26 pin FRC connected to the controller, which is compatible with **ALS Standard External Interfaces**.

PIN #	DESCRIPTION	PIN #	DESCRIPTION
1	*PC4	14	*PB1
2	*PC5	15	*PA6
3	*PC2	16	*PA7
4	*PC3	17	*PA4
5	*PC0	18	*PA5
6	*PC1	19	*PA2
7	*PB6	20	*PA3
8	*PB7	21	*PA0
9	*PB4	22	*PA1
10	*PB5	23	*PC6
11	*PB2	24	*PC7
12	*PB3	25	+5V THROUGH JP4
13	*PB0	26	GND

3.2 DSUB CONNECTOR DETAILS:

1. **DB1 CONNECTOR**: 9-Pin D-type Male Power connector.

Pin Number	Description
1,2,3,6,7,8	No Connection
4	GND
5	GND
9	+5V

2. **DB2 CONNECTOR**: **(UART0)** 9-Pin D-type Female connector connects to the COM port of host PC for In System Programming (ISP) application and transferring the data between controller device and host computer. Use a cross cable to connect to PC. NOTE: DTR and RTS lines are required.

Pin Number	Description
1,4,7,9	NC
2	R0IN
3	T0OUT
5	GND
6	DTR
8	RTS

3.3 JUMPER DETAILS:

JUMPERS	CONNECTION	DESCRIPTION
JP1 (1,2)	Closed	To enable JTAG Programming.
JP2 (1,2)	Closed	To output the data to CN7 16 through P0.31.

JP2 (2,3)	Closed	To read the data from CN7.16 through P1.24.
JP3 (1,2)	Closed	Ref Volt applied to DAC
JP4(1,2)	Closed	5V supply to connector
JP5 (1,2)	Closed	Connects 3.3v to board
JP6 (1,2)	Closed	External Interrupt (INT0) is given through SW10.
JP7 (1,2)	Closed	ISP signal to the controller
JP8 (1,2)	Closed	Connects 5v to MAX3232 IC
JP8 (2,3)	Closed	Connects 3.3v to MAX3232 IC
JP9 (1,2)	Closed	Enable internal ADC circuit
JP10 (1,2)	Closed	Enable PWM circuit
JP11(1,2)	Closed	The output wave form is Uni Polar
JP12(1,2)	Closed	External Interrupt (INT1) is given through SW12.
JP13(1,2)	Closed	To connect CN3.25 to CN7.23.(Stepper Motor)
JP14(1,2)	Closed	To connect SCK to CN7.14.
JP15(1,2)	Closed	To connect MISO to CN7.11.
JP16(1,2)	Closed	To connect MOSI to CN7.12.
Jp17(1,2)	Closed	To connect SSEL to CN7.9.
Jp18(1,2)	Closed	To connect SCL to CN7.4.
Jp19(1,2)	Closed	To connect SDA to CN3.25.
Jp20(1,2)	Closed	To connect VBUS to CN7.8.
Jp21(1,2)	Closed	To connect +5V to LED'S anode through resistor.
Jp22(2,3)	Closed	To connect USB_CON to CN3.16
Jp23(1,2)	Closed	To connect SIG1 to GND.
Jp23(2,3)	Closed	To connect SIG1 to +5V.
Jp24(1,2)	Closed	To connect LD7 to CN3.16

3.4 TEST POINTS:

TEST POINTS	DESCRIPTION
TP1,TP7	+5V
TP2, TP4	+3.3V
TP3, TP5, TP6	GND

3.5 POT DETAILS:

1. POT1: 10K ANVI POT for testing **INTERNAL ADC** of CONTROLLER.
2. POT2: 50K ANVI POT for **LCD** Contrast.
3. POT3: 5K ANVI POT for **DAC0800** interface circuit (To vary amplitude).
4. POT4: 10K ANVI POT for SPI ADC Circuit
5. POT5: 10K ANVI POT for contrast adjustment of GLCD.

3.6 IC DETAILS:

IC's	DESCRIPTION
U1	**LM317** VOLTAGE REGULATOR (3 PIN)
U2	**MAX3232** RS232 LINE DRIVER(16 PIN)
U3	**ICL7660S** SUPER VOLTAGE Converter (8 PIN)
U4	**LM358** DUAL OP AMP (8 PIN)
U5,U7	**74HCT244** OCTAL BUFFER (20 PIN)
U6	**ULN2803** DRIVER 8 Darlington array(18 PIN)
U8,U9,U10,U11	**LT543** SEVEN SEGMENT DISPLAY (10 PIN)
U12	**DAC0800** Digital to Analog (16 PIN)
U13	**MCP3202** Two channel SPI ADC

U14	**AT24C16** I2C NVROM IC
U15	**LM335** Temperature sensor

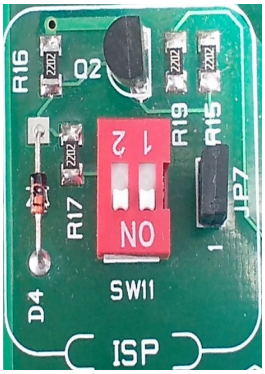
3.7 SWITCH DETAILS:

1. SW1-SW8: General Purpose switches

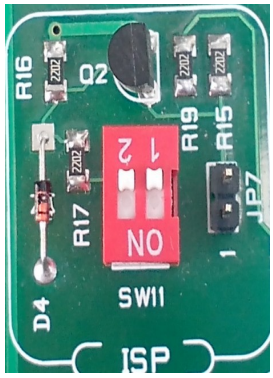
SWITCH	CONTROLLER PORT LINE
SW1	P1.23
SW2	P1.22
SW3	P1.21
SW4	P1.20
SW5	P1.19
SW6	P1.18
SW7	P1.17
SW8	P1.16

2. SW9: Reset Switch
3. SW10: External Interrupt connected to P0.16 of Controller.
4. SW11: 2-WAY dip switch to control RTS & DTR lines for ISP. During programming the switches are kept ON and JP7 is also shorted. In RUN mode the switches are OFF and JP7 is open.

Programming Mode:



Run Mode:



5. SW12: External interrupt to P0.3 pin of Controller.
6. SW13: 4-WAY dip switch to enable each 7-segment display.
7. SW14 to SW29: 4×4 Keypad switches.

3.8 POWERMATE DETAILS:

1. **PM1**:5 Pin Power mate (High Current Output Lines for Stepper Motor).

Pin Number	Description
1	+5V
2	OUT1(A)
3	OUT2(B)
4	OUT3(C)
5	OUT4(D)

3.9 RELIAMATE DETAILS:

1. RM1: 16 pin Single female Berg for LCD Interface.

PIN #	DESCRIPTION	PIN #	DESCRIPTION
1	GND	9,10	NO CONNECTION
2	+5V	11	DATA LINE D4(P0.4)
3	50K ANVI POT (POT2)	12	DATA LINE D5(P0.5)
4	RS(P0.2)	13	DATA LINE D6(P0.6)

5	GND	14	DATA LINE D7(P0.7)
6	CSE(P0.3)	15	+5V(Backlight)
7,8	NO CONNECTION	16	GND

2. RM2: UART1 Interface

Pin Number	Description
1	RX
2	TX
3	GND

3. RM3: DAC 0800 Interface

Pin Number	Description
1	Connected to DAC O/P
2	GND

4. RM4: DC MOTOR

Pin Number	Description
1	Connected to POLE1 of Rly1
2	Connected to POLE2 of Rly1

CHAPTER 4

CABLE DETAILS:

4.1 APPLYING POWER:

Use the following procedure to apply power. Connect a 9-pin DSUB Female Connector to a 9-pin DSUB Male connector **DB1** provided on the Evaluation Board. The color code for the supply is shown in table below:

PIN NUMBERS	POWER	COLOUR CODE
9	+5V	BLUE/ORANGE/WHITE
4,5	GND	YELLOW / BLACK

4.2 SERIAL COMMUNICATION:

The RS232 Cross cable connections required for establishing communication between Evaluation Board and a display terminal/host computer system is given below (ON BOARD it is DB2).

Open the Hyper Terminal & set the host computer system baud rate to **9600**, data length to **8 bit**, parity bit to **none** and stop bits to **1**.

ARM7 LPC2148 PROJECT BOARD (**DB2**) **PIN NO.** (9 PIN MALE)	**COMPUTER** (COM PORT) **PIN NO.** (9-PIN FEMALE)
3-TXD	2-RXD
2-RXD	3-TXD
6-DTR	4-DTR
8-RTS	7-RTS
5-SIGNAL GND	5-SIGNAL GND
1,4,7,9	NC

CHAPTER 5

INSTALLATION:

5.1 KEIL UVISION4 IDE INSTALLATION:

1. **Installation of keiluVision4 as follows.**
2. Go to **Software** folder in the CD and run **Keil4 Arm.exe** file.
3. **Next**
4. Click on the option "I agree to all the terms of..." and then give **Next**
5. **Next**
6. Give some name and the mail id and then **Next**
7. Click **Finish** to complete the installation.

5.2 PROJECT CREATION IN KEILUV4 IDE:

1. Create a project folder before creating NEW project.
2. Open **Keil uVision4 IDE** software by double clicking on "Keil Uvision4" icon.
3. Go to **"Project"** then to **"New Project"** and save it with a name in the Respective project folder, already you created.
4. Select the device as **"NXP (founded by Philips)"** In that **"LPC2148"** then press **OK** and then press "**YES"** button to add "**startup.s"** file.
5. In **startup** file go to **Configuration Wizard**. In **Configuration Wizard** window disable **PLL Setup** and enable **VPBDIV Setup.**
6. Go to "File" In that **"New"** to open an editor window. Create your source file And use the header file **"lpc21xx.h"** in the source file and save the file. **Colour syntax highlighting** will be enabled once the file is saved with a Recognized extension such as "**.C** ".
7. Right click on **"Source Group 1"** and select the option **"Add Files to Group 'Source Group 1' "**add the **.C source file**(s) to the group.
8. After adding the source file you can see the file in Project Window.
9. Then go to **"Project"** in that "Translate" to compile the File (s).
10. Go to "Project" in that "Build Target" for building all source files such as ".C", ".ASM", ".h", files, etc…This will create the .HEX file if no warnings & no Errors.

Some Settings to be done in KEILUV4 for Executing C programs:

1. In Project Window Right click "TARGET1" and select "options for target 'TARGET1'
   - Then go to option "Target" in that
     1. Xtal 12.0MHz
     2. Select "Use MicroLIB".
     3. Select IROM1 (starting 0x0 size 0x80000).
     4. Select IRAM1 (starting 0x40000000 size 0x8000).
   - Then go to option "Output"
     1. Select "Create Hex file".
   - Then go to option "Linker"
     1. Select "Use Memory Layout for Target Dialog".

5.3 FLASH MAGIC VERSION 6.01.2547:

Installation of Flash Magic as follows.

1. Go to **Software** folder in the CD and run **FlashMagic.exe** file.
2. **Next**
3. Click on the option "I Accept the Agreement" and then give **Next**
4. Then it asks the **Destination** location**,** Click **Next.**
5. Further Select start menu folder**,** Click **Next.**
6. Select **"Create a desktop icon"** then **Next**
7. It asks **"Ready to Install"** Click **INSTALL.**
8. Click **Finish** to complete the installation.

5.4 ISP PROGRAMMING:

FLASH MAGIC software can be used to download the HEX files to the Flash memory of controller.

How to Download?

Connect the serial cross cable from 9-pin DSUB Female connector (DB2) to the PC COM port. Switch on both Switches of SW11. SW11(1-RTS), SW11(2-DTR). Connect DC +5V Power, through the 9-pin DSUB FEMALE connector (DB1) applied from an external source. Switch ON the power. Remove JP13 while downloading the software.

Some Settings in FLASH MAGIC:

Options -> Advanced options -> Hardware Config

Enable these options only

Use DTR and RTS to control RST and ISP pin

Keep RTS asserted while COM port open

Press OK then do the below settings

Step1. Communications:

1. Device : LPC2148

2. Com Port : COM1
3. Baud Rate : 9600
4. Interface : None(ISP)
5. Oscillator : 12MHz

Step2. ERASE:

1. Select "Erase Blocks Used By Hex File".

Step3. Hex file:

Browse and select the Hex file which you want to Download.

Step4. Start:

1. Click Start to download the hex file to the controller.

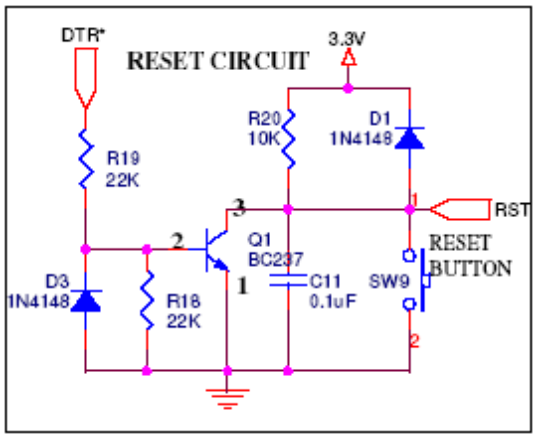
After downloading the code the program starts executing in the hardware, then remove the ISP jumper JP7.

CHAPTER 6

ONBOARD INTERFACES:

6.1 Push Button Switch (RESET)

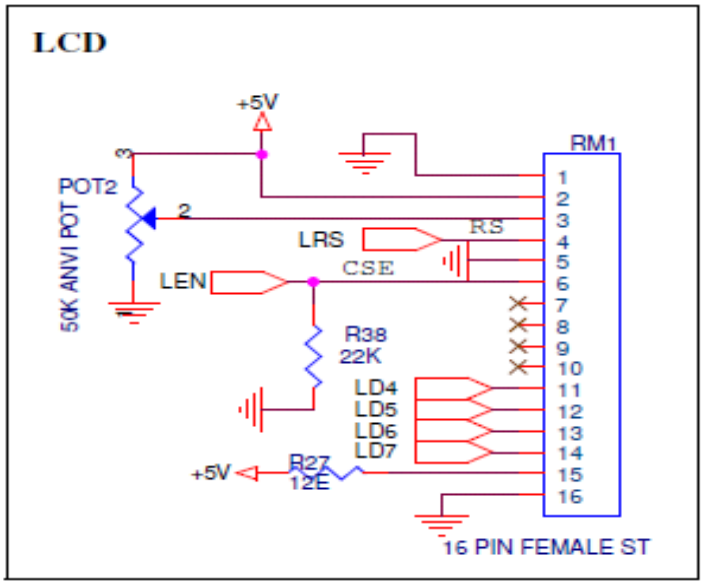
SW9: This push button is connected to the RST (pin-57) of the Micro controller. It is used to reset the controller**.**



6.2 16X2 LCD Interface

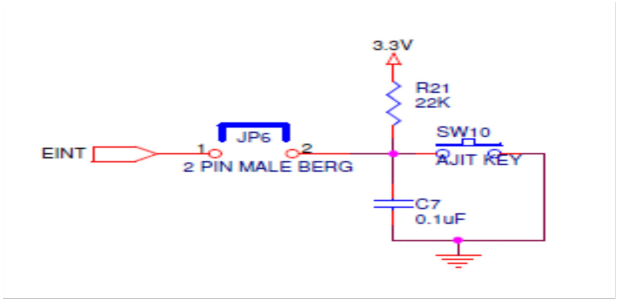
A 16X2 Alphanumeric LCD Display with back light is provided along with the Evaluation Board. The LCD is interfaced using 4 – bit mode.

RS = 0 for sending Command to the LCD, controlled by port P0.2
RS = 1 for sending Data to the LCD, controlled by port P0.2
R/W = 1 for reading from the LCD
R/W = 0 for writing to the LCD, normally it is grounded
EN = 0 for disabling the LCD
EN = 1 for enabling the LCD, controlled by port P0.3
D4= P0.4
D5= P0.5
D6= P0.6
D7= P0.7



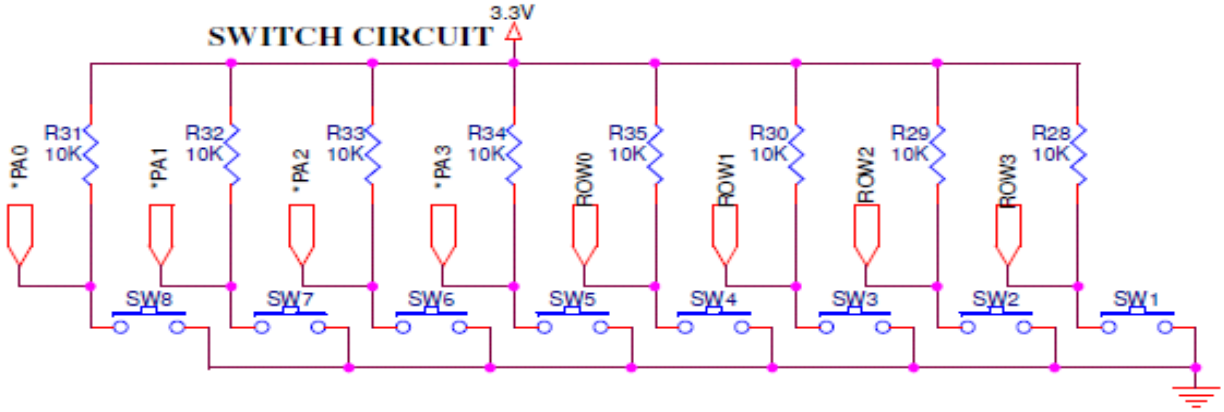
6.3 External Interrupt

By using P0.16 port line we are generating external interrupt (EINT0).Short JP6, when we press the switch SW10 the port line goes low & the external interrupt occurs at port line P0.16.



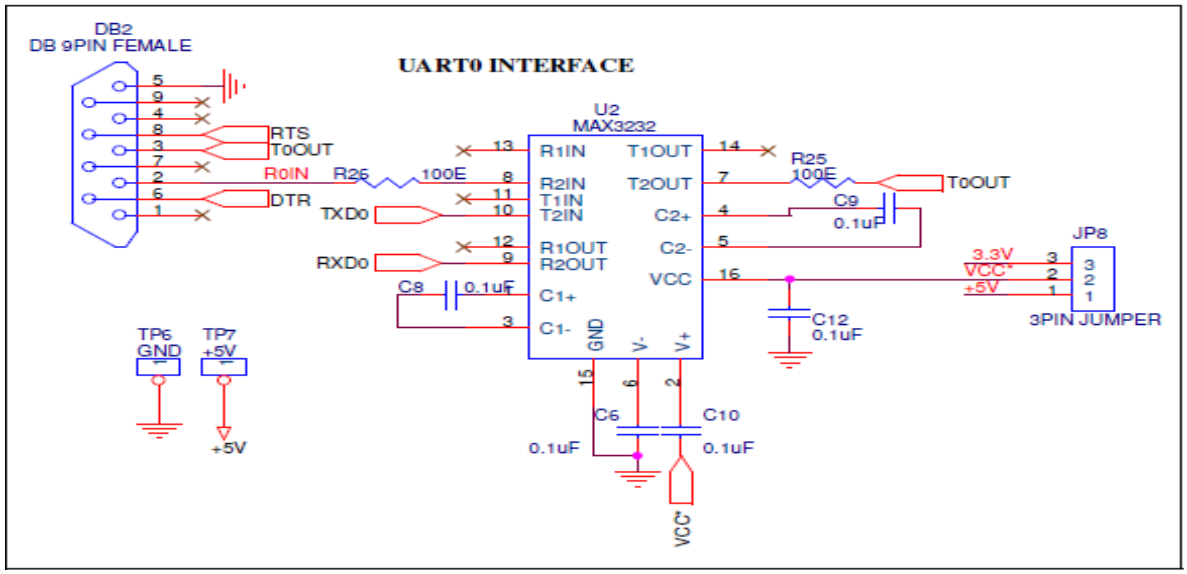
6.4 General Purpose Switches

The switches **SW1** to **SW8** are organized. One end of all the switches are connected to port lines P1.16 – P1.23 and other ends are Ground.



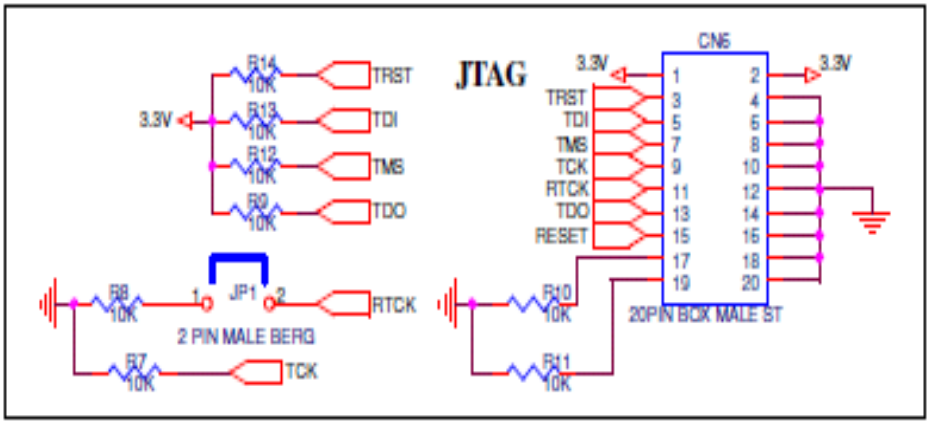
6.5 UART0

The board has an RS-232 serial communication port. The RS-232 transmits and receives signals that appear on the female 9-pin DB connectors (DB2). Use a standard RS-232 cross cable to connect the board to the computer's serial port. The controller U1 provides serial I/O data at TTL levels to the MAX3232 (U2) device, which in turn converts the logic value to the appropriate RS-232 voltage level.



6.6 JTAG

The JTAG connector allows the software debugger to talk via a JTAG **(Joint Test Action Group)** port directly to the core. Instructions may be inserted and executed by the core thus allowing LPC2148 memory to be programmed with code and executed step by step by the host software. The debug communication channel allows the JTAG port to be used for sending and receiving data without affecting the normal program flow. Short the jumper JP1 (1, 2) in the target board to enable JTAG programming.

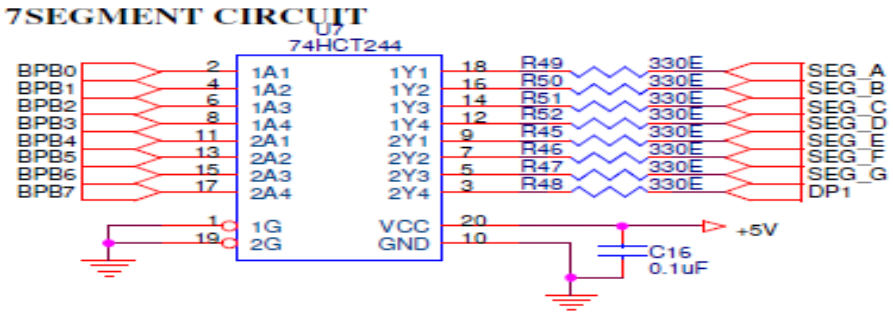


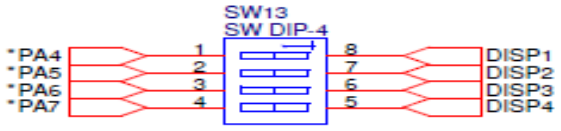
6.7 Four Digit Multiplexed 7- Segment Displays:

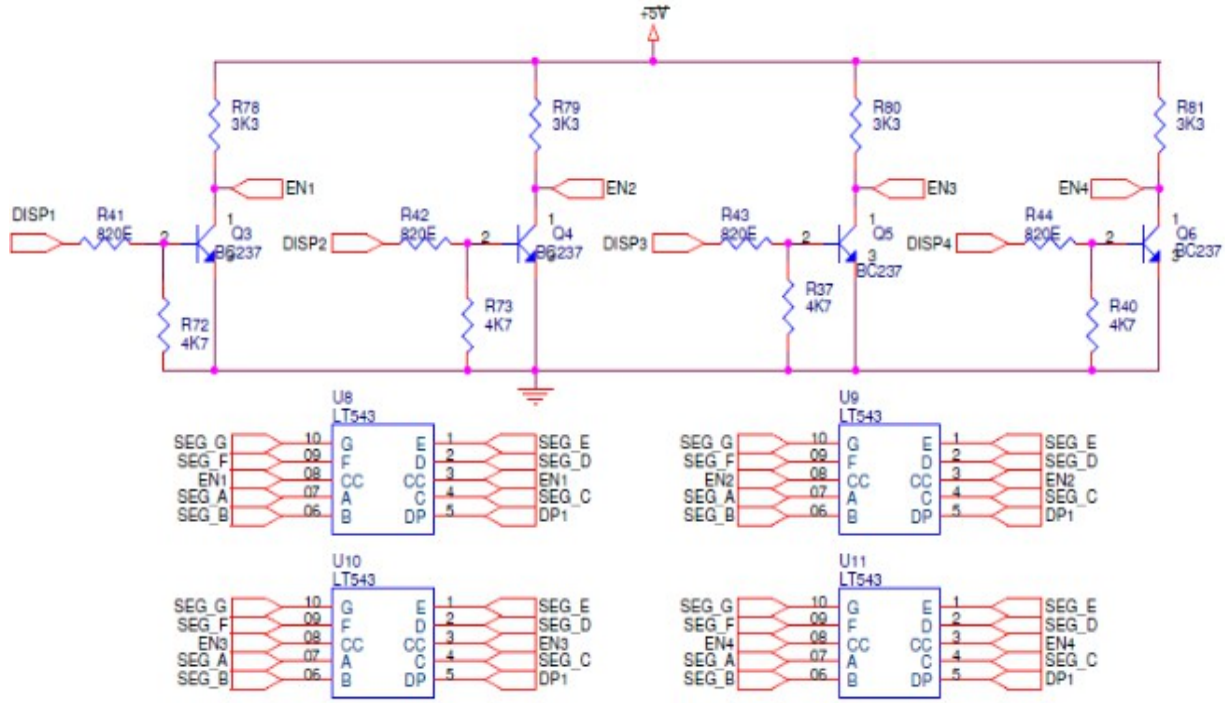
There are four multiplexed 7-segment displays (**U8, U9, U10 and U11**) on the board. Each display has 8-inputs SEG_A (Pin-7), SEG_B (Pin-6), SEG_C (Pin-4), SEG_D (Pin-2), SEG_E (Pin-1), SEG_F (Pin-9), SEG_G (Pin-10) and SEG_H (Pin-5) and the remaining pins pin-3 & pin-8 are Common Cathode. The port lines P0.28 to P0.31 are used to select one of the FOUR digits as shown in the table below. The port lines P0.16 to P0.23 are used as segment lines for the EIGHT digits through the 74HCT244 buffer (**U6**).

Selection Of seven segment displays:

P0.28	P0.29	P0.30	P0.31	Display unit selected
1	0	0	0	U8
0	1	0	0	U9
0	0	1	0	U10
0	0	0	1	U11

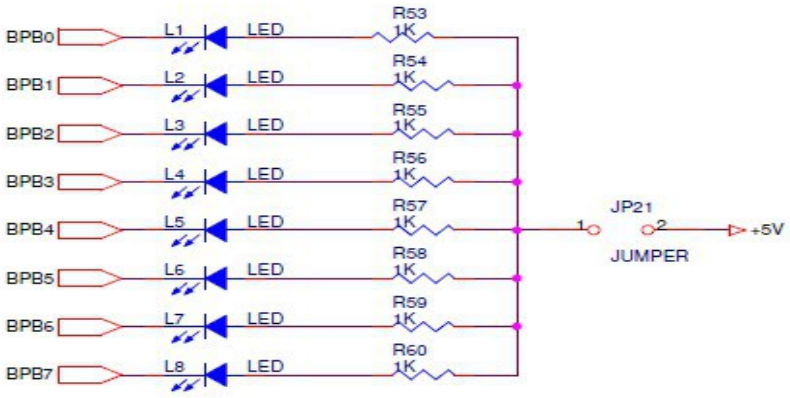






6.8 General Purpose LED's:

Light Emitting Diodes (LED's) are components most commonly used for displaying the port line status. There are 8 LEDs on the board; these lines are connected to the Port lines P0.16 (PB0) to P0.23 (PB7) through buffer.



6.9 High Current Output Lines and Relay Interface:

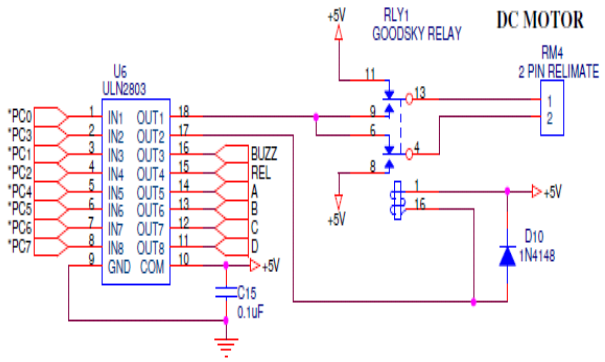
CN1 can be used for High Current applications where a stepper motor, a DC motor, Buzzer and a relay are interfaced through the high current driver ULN2803. These lines will have high current (max 300 mA) with low voltage level of 0.7V.

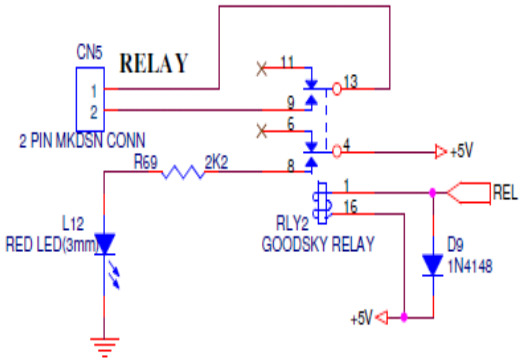
The **Stepper motor** can be interfaced to the board by connecting it into the Power Mate PM1. The rotating direction of the stepper motor can be changed through software. Port lines used for Stepper motor are P0.12 – P0.15.

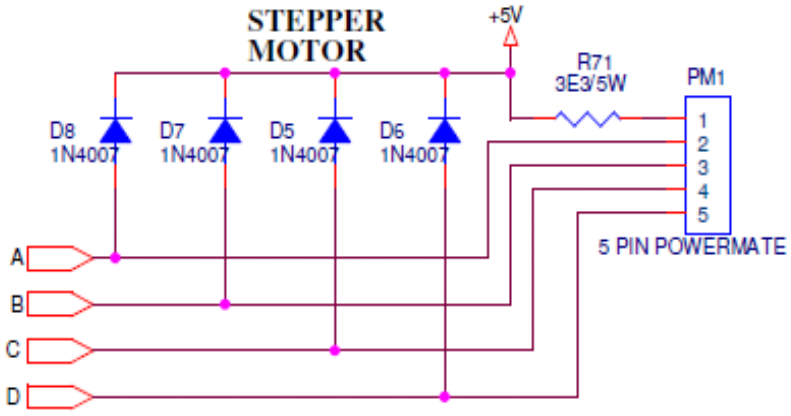
The **DC Motor** can also be interfaced to the board by connecting it to the Reliamate RM4. The direction of the rotation can be changed through software using Relay **RLY1**. Port lines used for DC motor are P0.8 and P0.11.

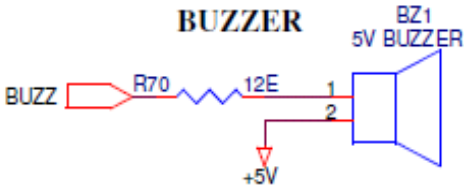
The **BUZZER** is connected through port line P0.9.

The Relay **RLY2** is switched ON and OFF. The LED **L12** will toggle while relay turns on and off. The NO contacts of the relay can be checked at the MKDSN connector **CN5 pins 1 & 2** using a DMM, a click sound will be heard when the relay contact closes (check connectivity). The port line P0.10 is used for relay interface.



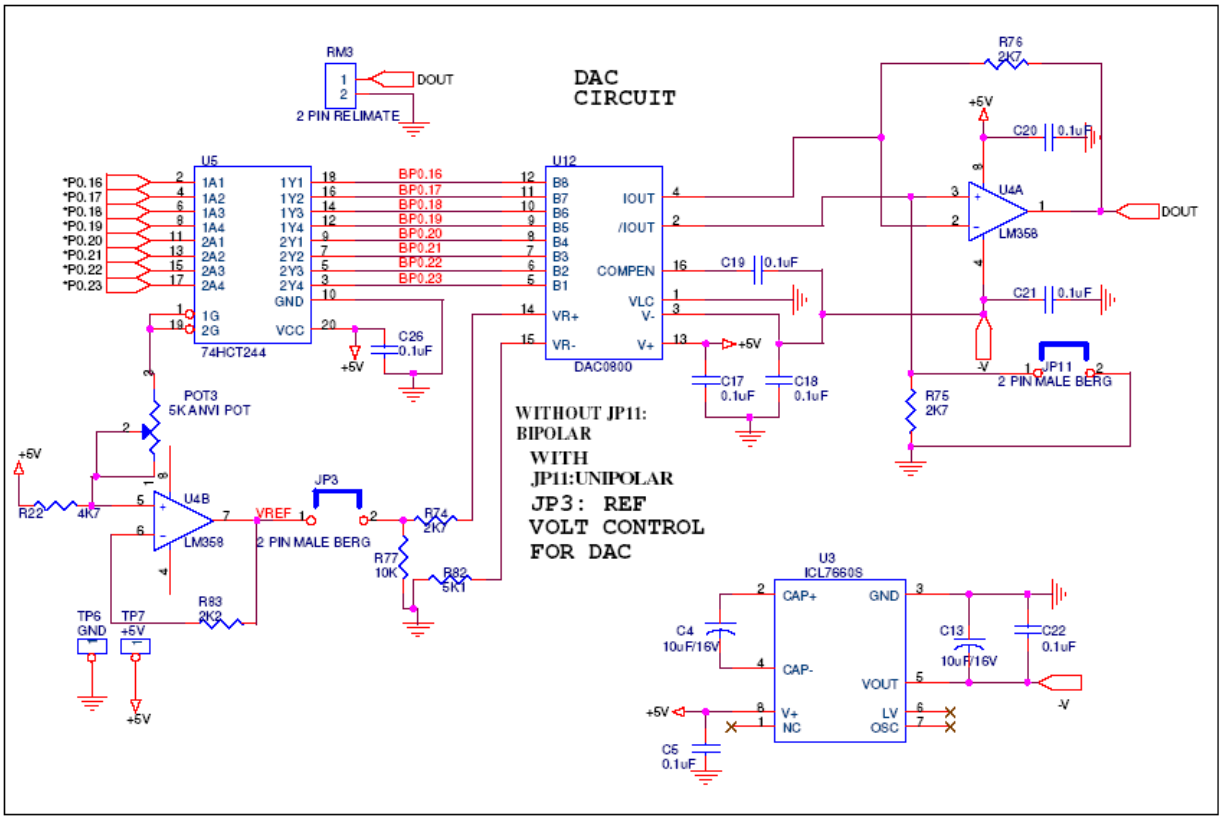






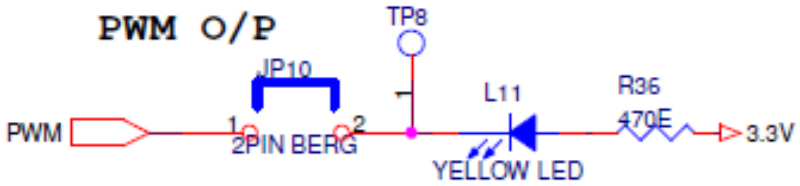
6.10 DAC 0800 INTERFACE

DAC0800 is used to convert the digital data into analog signals. Digital data from specified port lines is given to DAC input. Amplitude of output waveform can be varied by varying POT3 (5K Pot) that is by varying the reference voltage of DAC0800 when JP3 is closed. For Bipolar mode open jumper JP11. To test DAC in Unipolar mode short jumper JP11. Port lines used for DAC are P0.16, P0.23.



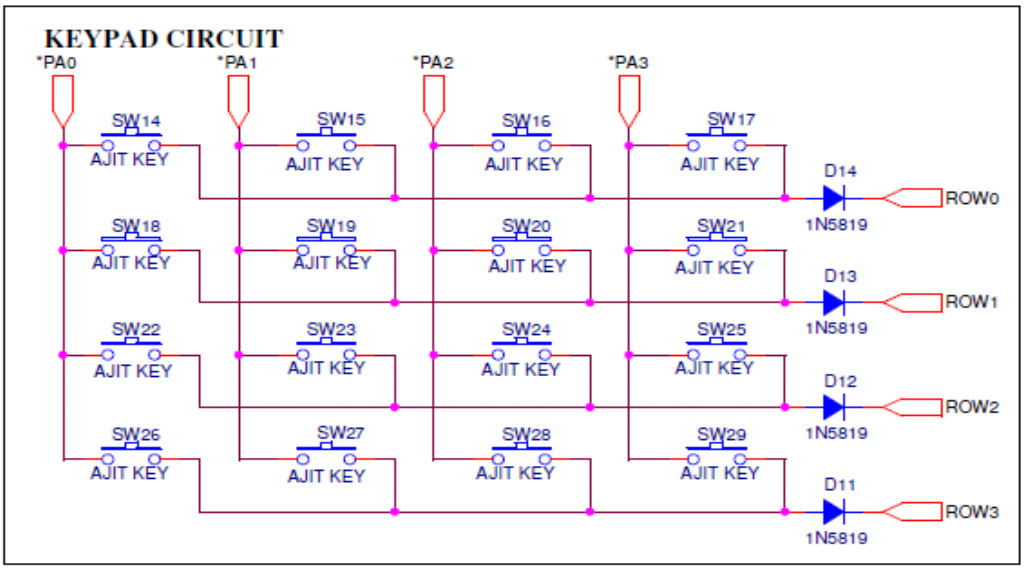
6.11 PWM

Using P0.8 (PWM4) port line we are testing PWM. Here match register (PWMMR4) is used to adjust the duty cycle (T-on to T-off ratio). Initially the duty cycle goes on increasing up to some specified value, when it reaches maximum value the duty cycle goes on decreasing and this process continues. Observe the output on CRO at TP8 and also LED (L11) will change status slowly.



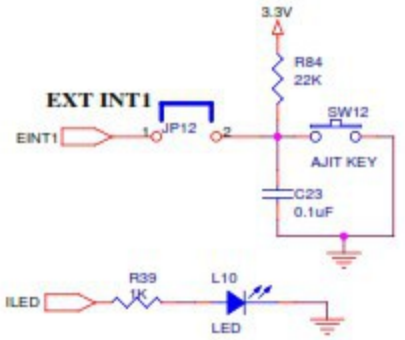
6.12 Keypad (4 Rows X 4 Columns):

The switches **SW14** to **SW29** are organized as 4 rows X 4 columns matrix. One end of all the switches are connected to port lines P1.20 – P1.23, which is configured as rows. The other end of the matrix is connected to the port lines P1.16 – P1.19 which is configured as columns. The interface diagram for keypad is shown below.



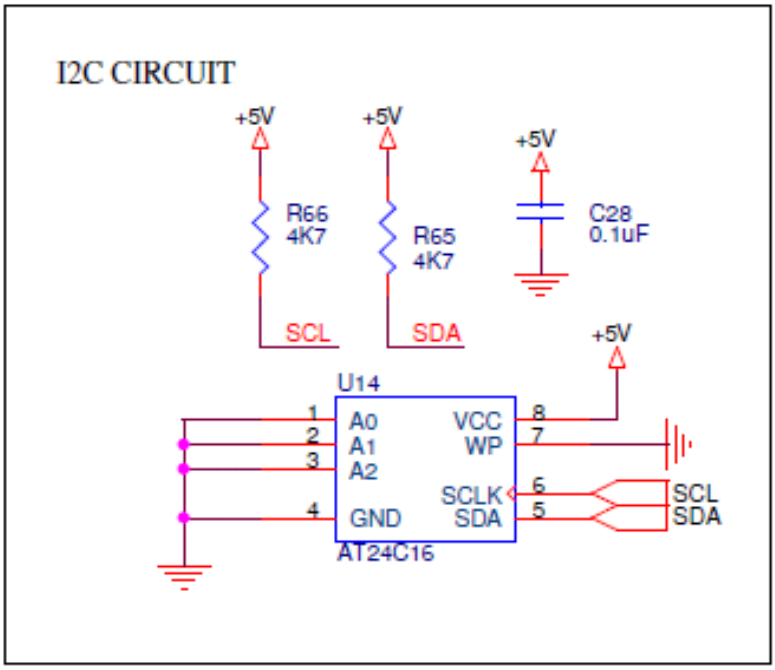
6.13 External Interrupt 1

By using P0.3 port line we are generating external interrupt (EINT1).Short JP12, when we press the switch SW12 the port line goes low & the external interrupt occurs at port line P0.16.



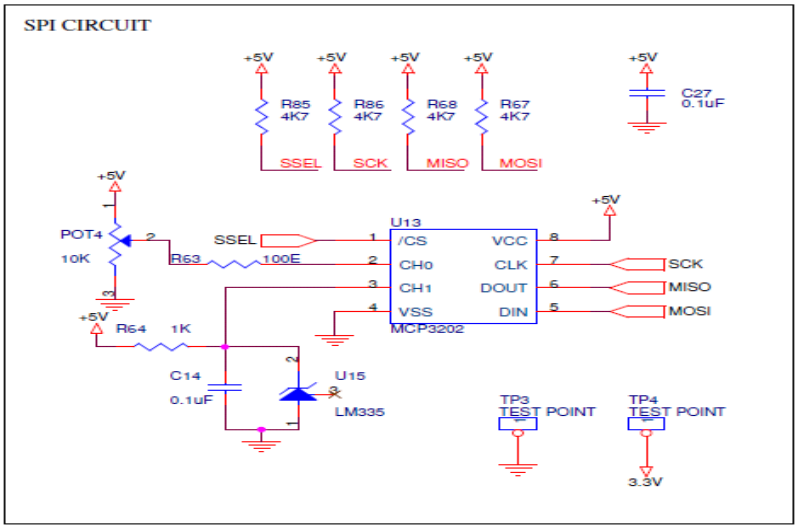
6.14 Inter IC Communication interface

The board has a peripheral for I2C, to illustrate the example. I2C1 is used for this example. Port line used are SDA1 – P0.14 and SCL1 – P0.11. Short the pins 1 & 2 of JP18 and JP19 to use this peripheral and remove inter connected cable between CN7 to CN8.



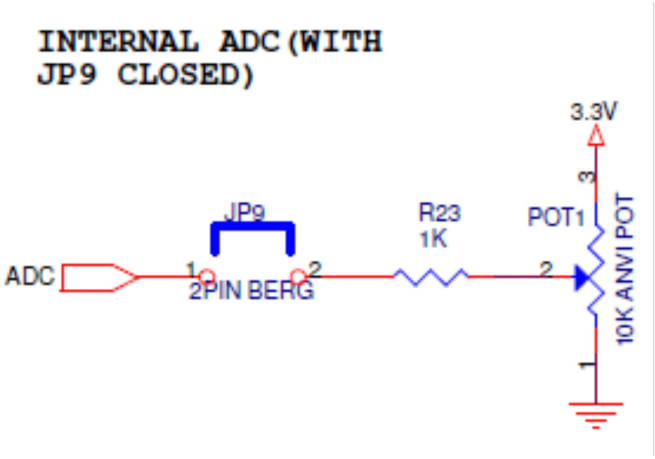
6.15 Serial peripheral Interface:

Serial interface portion has a dual channel ADC. Temperature sensor and Resistor POT (POT4) provides the inputs to the two channels. SPI1 is used for the communication. Port line used are SCK1 – P0.17, MISO1 – P0.18, MOSI1 – P0.19, SSEL – P0.20. Short pins 1 & 2 of JP14, JP15, JP16, JP17 to use this peripheral and remove inter connected cable between CN7 to CN8.



6.16 Internal ADC interface:

On board there is one interface for internal ADC. AD0.4 (pin P0.25) of controller is used to convert the analog input voltage varied using POT1 to digital value. A 0.00 to 3.3V is the input voltage range. 000 to 3FF is the converted digital voltage range here. Jumper JP9 (1, 2) has to be shorted to use this interface.



6.17 ISP Circuit:

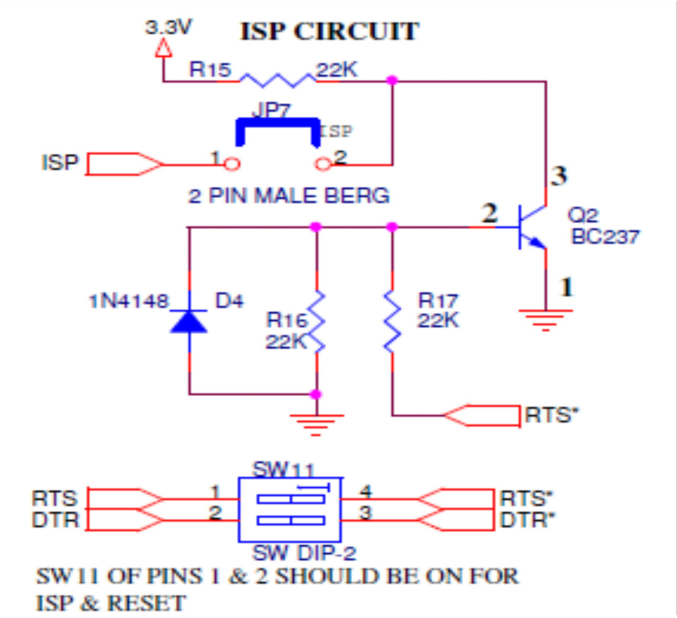
A LOW level after reset at pin P0.14 is considered an external hardware request to start the ISP command handler. Assuming that power supply pins are on their nominal levels when the rising edge on RESET pin is generated, it may take up to 3 ms before P0.14 is sampled and the decision on whether to continue with user code or ISP handler is made.

During programming the controller using Flash magic software, jumper – JP7 needs to be shorted. This jumper connects the ISP line P0.14 to ground level during the Flash magic attempt to program the flash.

SW11 – is to isolate the hand shaking signals from board signals (RTS, DTR) and connector. Keep this switch ON before programming the controller flash memory with the application code. Keep it open to Run the loaded program and reset. Especially if UART0 is using for any communication purpose, user must keep these switch open to execute UART0 related code.

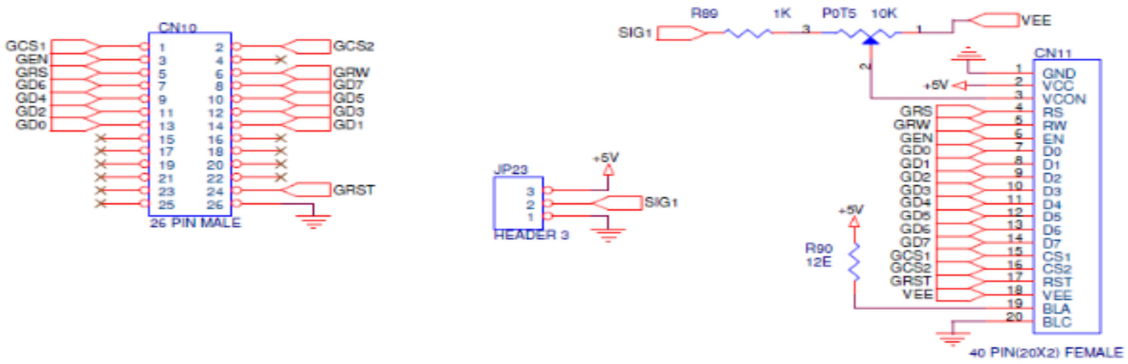
RTS – Controls the ISP line of the controller P0.14

DTR – Used to interface controller reset.



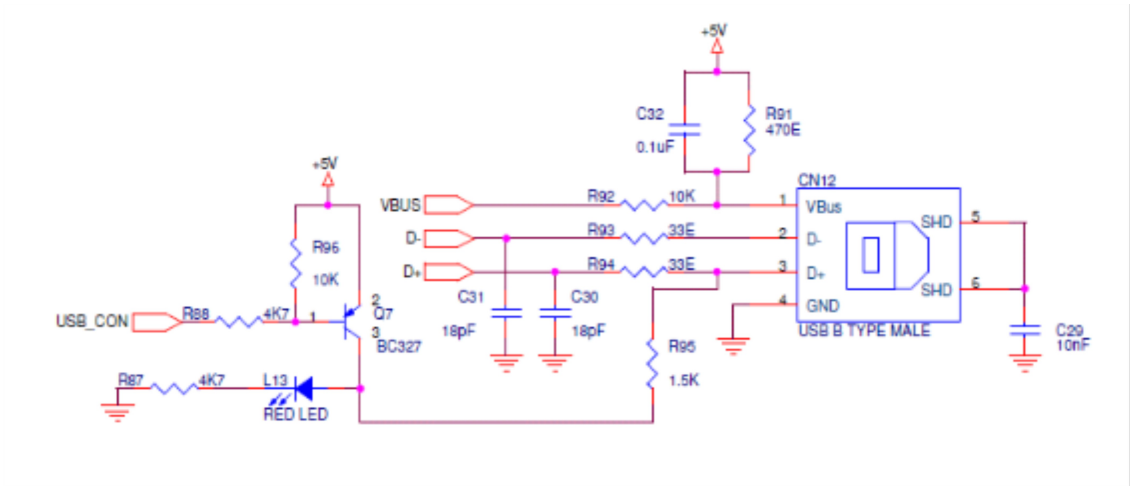
6.18 GRAFHIC LCD:

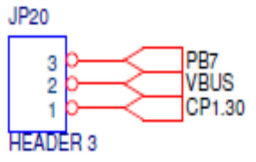
This portion consists of two connectors C10 and C11.Graphic LCD is connected to CN11 and CN10 is connected CN7.Normally JP23(1,2) is connected and vary pot 5 for contrast adjustment.



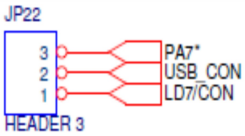
6.19 USB DEVICE:

This consists of CN12 connector to connect B-type USB cable from PC. Short JP20(2,3) and JP22(2,3).

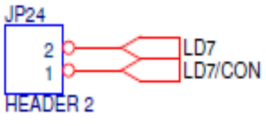




JP20(1, 2) - VBUS OF LPC1768
JP20(2, 3) - VBUS OF LPC2148
WHEN NOT USING USB DO NOT SHORT ANY OF THESE PINS



JP22(1, 2) - USB CONNECT OF LPC1768
JP22(2, 3) - USB CONNECT OF LPC2148
WHILE USING JP22, DO NOT SHORT JP24 & JP2(1, 2)



SHORT JP24 TO USE AN LCD
WHILE USING JP24, KEEP JP22 OPEN

NOTE:
NOT POSSIBLE TO USE LED L8
WHILE USING USB
SINCE PB7 IS VBUS

CHAPTER7

DEMO PROGRAMS IN KEIL uVISION4 IDE:

For all the demo programs make sure that the corresponding settings have to be made:

1. Both the pins of SW11 should be in ON position for ISP programming.
2. Short JP7 for ISP programming.
3. Short JP4 to connect +5v to Interface Board.
4. Short JP13 while testing the on-board stepper motor interface.
5. Inter connect **CN7** to **CN8** by means of 26 core FRC cable to use **On board interfaces**.
6. Use only **CN7** connector for **External NIFC's**. Use 26 core 2 feet flat cable

Note: 1) Do not short any pins of JP14, JP15, JP16, JP17, JP18 and JP19 when you make connection from CN7 to CN8.

2) While using SPI and I2C do not make connection from CN7 to CN8.

7.1 TO TEST Stepper Motor

File Name: cd_drive:\ALS-SDA-ARM7-07\SOFTWARES\EXP01_Stepper motor\STPM.hex
Download the "STPM.hex" file.

Connect the Female Powermate of the stepper motor to the male Powermate PM1 present on the board. Short JP13.

Result: The stepper motor rotates one rotation **Clockwise** & other rotation **Anti Clockwise** direction. This process is continuously in loop.

7.2 TO TEST DC Motor:

File Name: cd_drive:\ALS-SDA-ARM7-07\SOFTWARES\Exp02_DC_clkwise_aclkwaise\dcmotor.hex
Download the "dcmotor .hex" file.

Connect the Female relimate of the DC motor to the male Relimate RM4 present on the board.

Result: The DC motor rotates **Clockwise** when the relay is in off status & **Anti Clockwise** when the relay is in on status. This process is continuously in loop.

7.3 TO TEST LED's:

File Name: cd_drive:\ALS-SDA-ARM7-07\SOFTWARES\Exp03_Led_Blink\Blink.hex
Download the "Blink. hex" file.

Result: Observe LED's L1 to L8 toggling with some delay when JP21 is shorted. This process is continuously in loop.

7.4 TO TEST 7 Segment Display:

File Name: cd_drive:\ALS-SDA-ARM7-07\SOFTWARES\Exp04_7Segment\SevenSeg.hex
Download the "SevenSeg.hex" file.

Short jumper JP2/ 1-2.

Result: Keep all pins of SW13 in ON position and unshort JP21. Press SW1 and observe display changing from **0000 to FFFF.** For every press of SW1 the display will change ***ex:*** **0000, 1111, 2222, 3333** etc upto **FFFF** and then back to **0000.** This process is continuously in loop.

7.5 TO TEST LCD:

File Name: cd_drive:\ALS-SDA-ARM7-07\SOFTWARES\Exp05_LCD\LCD.hex
Download the "LCD.hex" file.

Short JP24 and vary the pot2 for contrast adjustment.

Result: The message as shown below will be displayed on LCD

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BENGALURU-58

7.6 TO TEST Binary Display:

File Name: cd_drive:\ALS-SDA-ARM7-07\SOFTWARES\Exp06_Binary_Disp\BinDisp.hex
Download the "BinDisp.hex" file.

Result: Short JP21. Observe counting from 0x00-0x0F on L1-L8 continuosly.

7.7 TO TEST Buzzer (+5V):

File Name: cd_drive:\ALS-SDA-ARM7-07\SOFTWARES\Exp07_Buzzer\Buzzer.hex
Download the "Buzzer.hex" file.

Result: You can hear the buzzer sound for one second and L10 will toggle correspondingly. This process is continuously in loop.

7.8 TO TEST 7 Segment Display counter:

File Name: cd_drive:\ALS-SDA-ARM7-07\SOFTWARES\Exp08_Counter\Counter.hex
Download the "Counter.hex" file.

Short jumper JP2/ 1-2.

Result: Make sure that Four Pins of SW13 should be kept "ON" for enabling digits On seven segment display and unshort JP21, the display starts counting from 0000, 1111, 2222 and so on till FFFF and then back to 0000. This process is continuously in loop.

7.9 TO TEST DAC0800:

A) Sine Wave:

File Name: cd_drive:\ALS-SDA-ARM7-07\SOFTWARES\Exp09_DAC\sinewave\sinewave.hex
Download the "sinewave.hex" file.

Connect 26 pin FRC from CN7 to CN8. Press the reset switch to run the program. Observe the Analog output waveform at the Pin-1 of RM3 using Oscilloscope (CRO) with respect to GND pin-2 of RM3. For **Bipolar** mode open jumper JP11. For **Unipolar** mode short jumper JP11.

B) Square Wave:

File Name: cd_drive:\ALS-SDA-ARM7-07\SOFTWARES\Exp09_DAC\square\square.hex
Download the "square.hex" file.

Connect 26 pin FRC from CN7 to CN8. Press the reset switch to run the program. Observe the Analog output waveform at the Pin-1 of RM3 using Oscilloscope (CRO) with respect to GND pin-2 of RM3. For **Bipolar** mode open jumper JP11. For **Unipolar** mode short jumper JP11.

C) Triangle Wave:

File Name: cd_drive:\ALS-SDA-ARM7-07\SOFTWARES\Exp09_DAC\triangular\triangular.hex
Download the "triangular.hex" file.

Connect 26 pin FRC from CN7 to CN8. Press the reset switch to run the program. Observe the Analog output waveform at the Pin-1 of RM3 using Oscilloscope (CRO) with respect to GND pin-2 of RM3. For **Bipolar** mode open jumper JP11. For **Unipolar** mode short jumper JP11.

7.10 TO TEST RELAY (+5V):

File Name: cd_drive:\ALS-SDA-ARM7-07\SOFTWARES\Exp10_Relay\Relay.hex
Download the "Relay.hex" file.

Result: The Relay **RLY2** will be toggling and the LED L12 toggles.

7.11 TO TEST EXTERNAL INTERRUPT0:

File Name: cd_drive:\ALS-SDA-ARM7-07\SOFTWARES\Exp11_EXT_INT0\EXT_INT0.hex
Download the "EXT_INT0.hex" file.

To test this short JP6.

Result: When switch SW10 is pressed, the port line goes low & the external interrupt occurs at port line P0.16. To show the external interrupt has occurred LED L10 has been used. (LED L10 toggles at each Press of the SW10).

7.12 TO TEST INTERNAL ADC:

A) Polled Mode

File Name: cd_drive:\ALS-SDA-ARM7-07\SOFTWARES\Exp12_INT_ADC\INT_ADC.hex
Download the "INT_ADC.hex" file.

Short jumper JP9 and J P 2 4 .

Result: Vary the POT1 (10K) and observe the corresponding analog input value & digital output value on LCD. (The input can be varied from 0.00V to 3.30V, the output displays from 000 to 3ff.)

B) Interrupt Mode

File Name: cd_drive:\ALS-SDA-ARM7-07\SOFTWARES\Exp12_INT_ADC\adc_in_intr_mode \adc_in_intr_mode.hex
Download the "adc_in_intr_mode.hex"

Short jumper JP9 and J P 2 4 .

Result: Vary the POT1 (10K) and observe the corresponding analog input value & digital output value on LCD. (The input can be varied from 0.00V to 3.30V, the output displays from 000 to 3ff.)

7.13 TO TEST KEYS:

File Name: cd_drive:\ALS-SDA-ARM7-07\SOFTWARES\Exp13_KEY_TEST\KEY_TEST.hex
Download the "KEY_TEST.hex" file.

S h o r t t h e j u m p e r J P 2 4 .

Result: Press the keys SW1 to SW8 and the Corresponding outputs will be displayed on LCD **'01 to 08'.**

7.14 TO TEST Pulse Width Modulation (PWM):

File Name: cd_drive:\ALS-SDA-ARM7-07\SOFTWARES\Exp14_PWM\pwm.hex
Download the "pwm.hex" file.

Short jumper JP10.

Result: Check the output waveform on CRO at TP8 with respect to GND, LED (L11) will change the intensity.

7.15 TO TEST Keypad (4X4 Matrix):

File Name: cd_drive:\ALS-SDA-ARM7-07\SOFTWARES\Exp15_4x4keypad\4x4keypad.hex
Download the "4x4keypad.hex" file.

S h o r t t h e j u m p e r J P 2 4 .

Result: Press the keys SW14 to SW29 and the Corresponding outputs '0 to F' will be displayed on the LCD.

7.16 TO TEST EXTERNAL INTERRUPT1:

File Name: cd_drive:\ALS-SDA-ARM7-07\SOFTWARES\Exp16_EXT_INT1\EXT_INT1.hex
Download the "EXT_INT1.hex" file.

S h o r t t h e j u m p e r J P 1 2 .

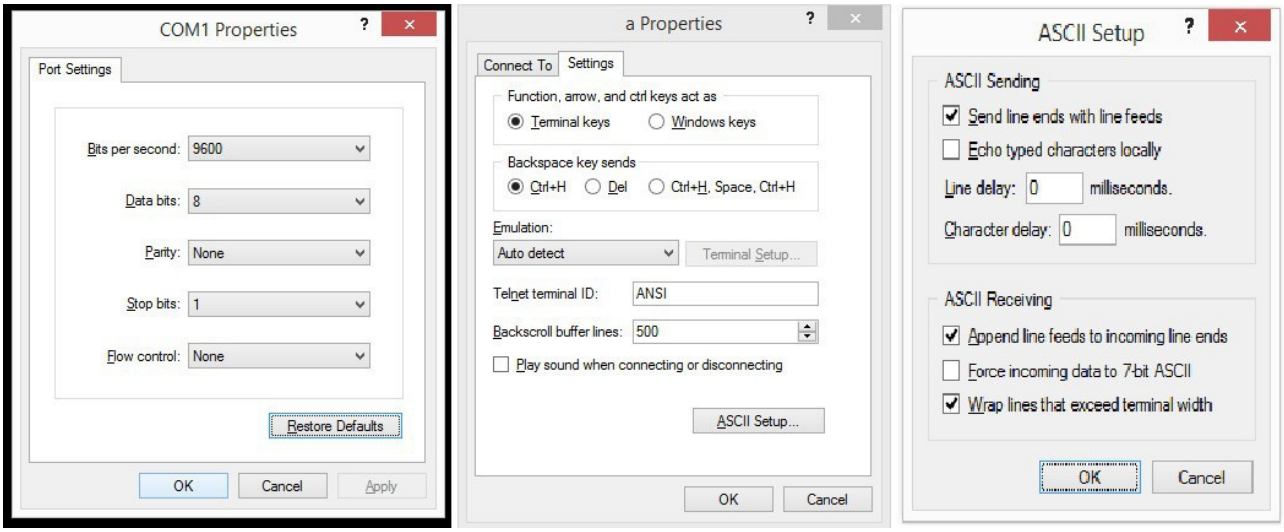
Result: When switch SW12 is pressed, the port line goes low & the external interrupt occurs at port line P0.16. To show the external interrupt has occurred LED L10 has been

used. (LED L10 toggles at each Press of the SW12).

7.17 UART0:

File Name: cd_drive:\ALS-SDA-ARM7-07\SOFTWARES\Exp17_uart0\uart0.hex
Download the "uart0.hex" file.

Result: After downloading is completed, Push both pins of dip-switch SW11 to OFF position. open the jumper JP7. Press RESET switch (SW9). Open the hyper terminal, set the Com port, baud rate and other settings as shown below. Pres any key on the PC keyboard the same will be displayed on the monitor.

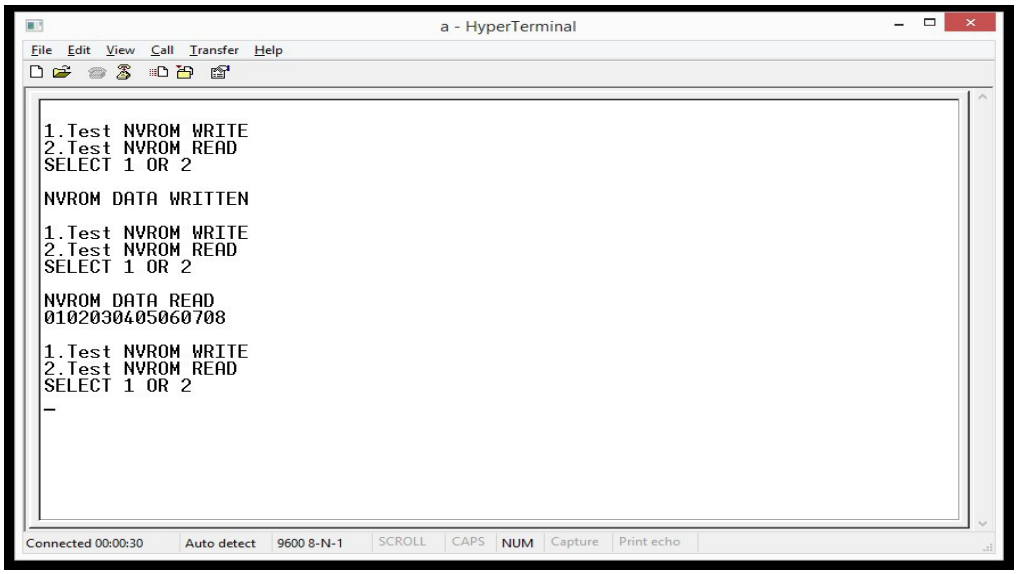


7.18 I2C Test

File name: cd_drive:\ALS-SDA-ARM7-07\SOFTWARES\Exp18_I2C_24C16\I2C_24C16.hex
Download the "I2C_24C16.hex" file.

Connections: Remove the interconnected cable between CN7 to CN8. Short pin 1 & 2 of JP18 & JP19. Set up the hyper terminal as shown above. After downloading the hex file, push both pins of dip-switch SW11 to OFF position. open the jumper JP7. Go to the hyper terminal window with the above settings. Press RESET (SW9).

RESULT: A menu will be displayed on hyper terminal. Press 1 at PC keyboard to write data to NVROM. Press 2 to read back the NVROM data and the data 0102030405060708 will display on hyper terminal as shown below.

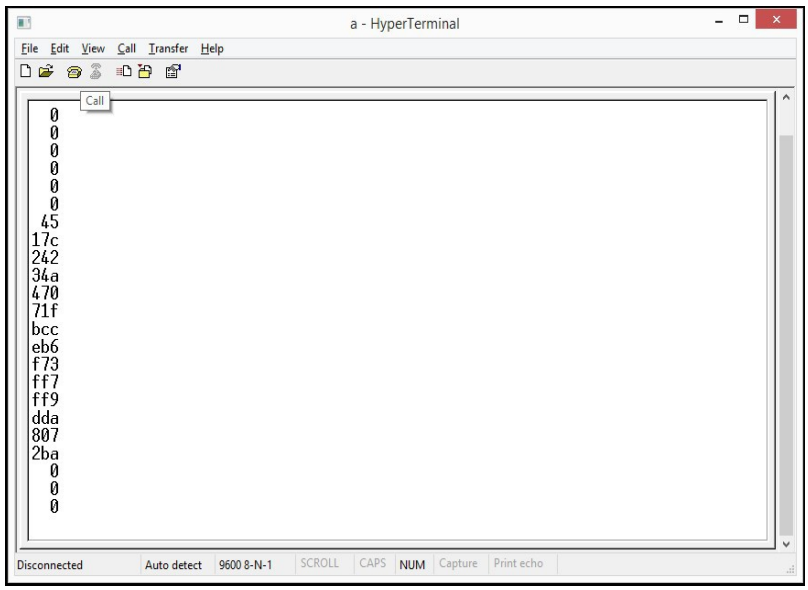


7.19 SPI ADC Test

File name: cd_drive:\ALS-SDA-ARM7-07\SOFTWARES\Exp19_SPI_ADC\SPI_ADC.hex
Download the "SPI_ADC.hex" file.

Connections: Remove the interconnected cable between CN7 to CN8. Short pin 1 and 2 at JP14, JP15, JP16 and JP17. Setup the hyper terminal as shown above. After downloading the hex file, push both pins of dip-switch SW11 to OFF position. open the jumper JP7. Go to the hyper terminal window with the above settings. Press RESET switch (SW9).

RESULT: A digital output value corresponding to the Analog input value at POT4 will be displayed on hyper terminal. Vary POT4 and observe the different values.

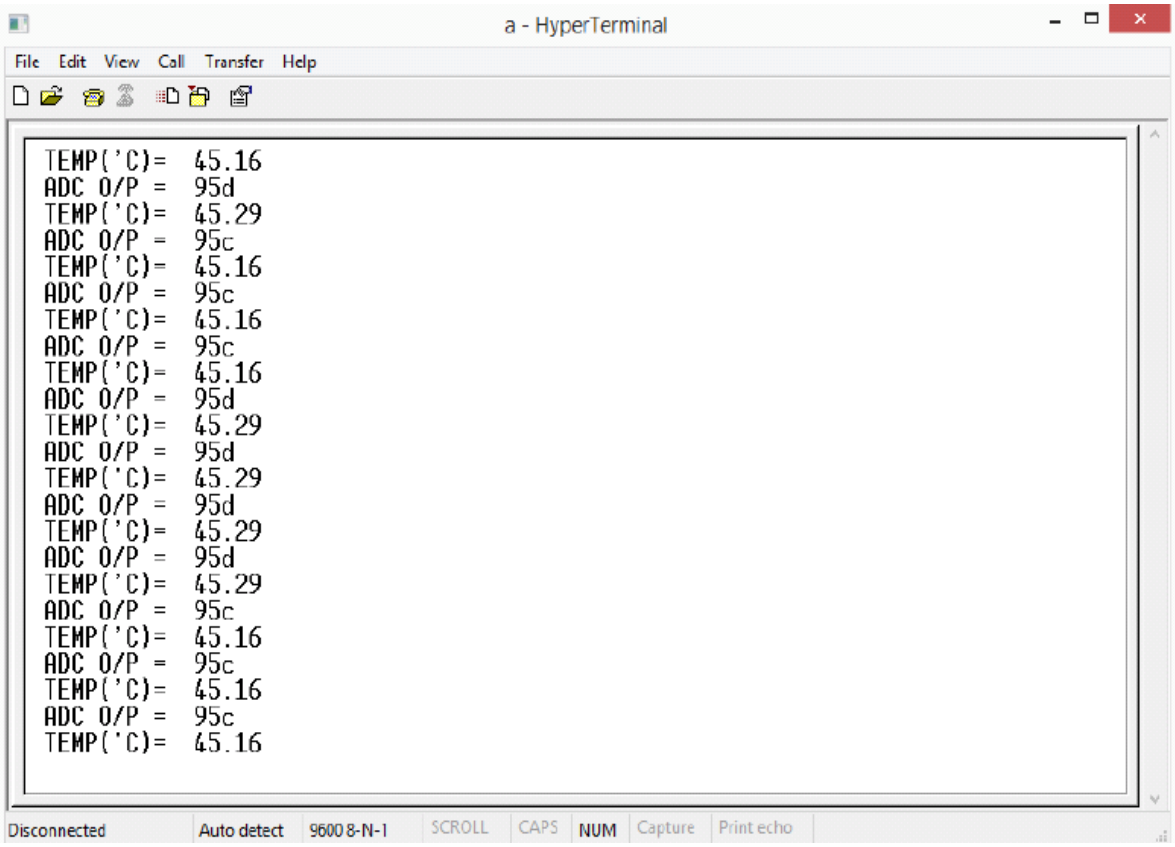


7.20 SPI Temperature Sensor

File name: cd_drive:\ALS-SDA-ARM7-07\SOFTWARES\Exp20_SPI_SENSOR\SPI_SENSOR.hex
Download the "SPI_SENSOR.hex" file.

Connections: Remove the interconnected cable between CN7 to CN8. Short pin 1 and 2 at JP14, JP15, JP16 and JP17. Setup the hyper terminal as shown above. After downloading the hex file, push both pins of dip-switch SW11 to OFF position. open the jumper JP7. Go to the hyper terminal window with the above settings. Press RESET switch (SW9).

RESULT: Temperature value will be displayed on hyper terminal as shown below.



7.21 Graphic LCD

File name: cd_drive:\ALS-SDA-ARM7-07\SOFTWARES\Exp21_Graphic_LCD_ALS\GLCD.hex
Download the "GLCD.hex" file.

Graphic LCD is connected to CN11 and CN10 is connected CN7.Normally JP23(1,2) is connected and vary pot5 for contrast adjustment.

Result: A fixed message will be displayed on GLCD.

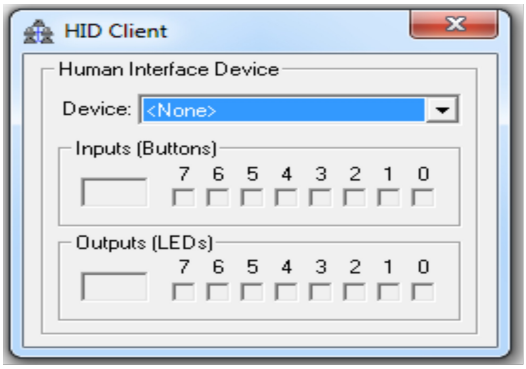
7.22 USB DEVICE

File name: cd_drive:\ALS-SDA-ARM7-07\SOFTWARES\Exp22_USB_HID\Obj\HID.hex
Download the "HID.hex" file.

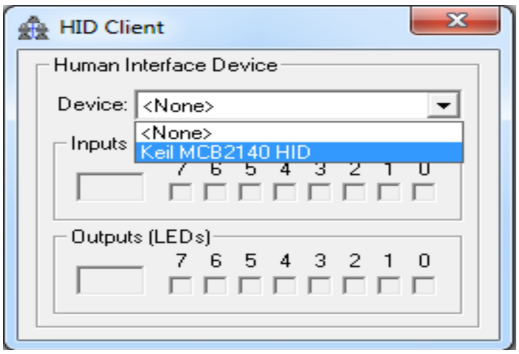
Connect 26 pin FRC from CN7 to CN8. Short JP20(2,3) and JP22(2,3), Connect USB to B type cable from CN12 to PC USB port. Check L13 is On.

After the above steps, a device will get detected from the PC and device driver software get automatically installed in the PC. And the device (controller) get identification as a **HID – compliant device** under **Human Interface Devices.** Check at Computer → Manage.

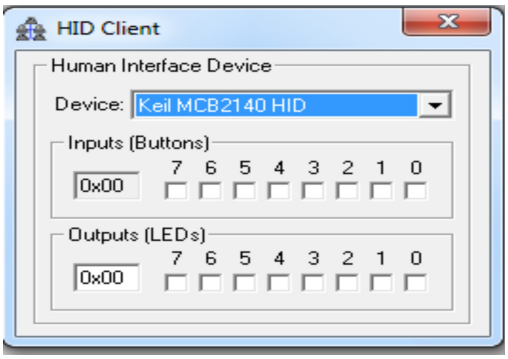
Then open **HIDClient.exe** software in the USB_HID project folder.



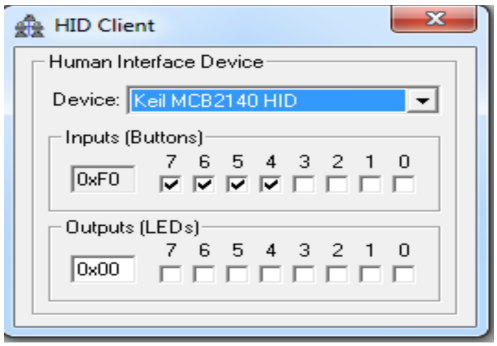
In this utility select the device Keil MCB2140 **HID**.



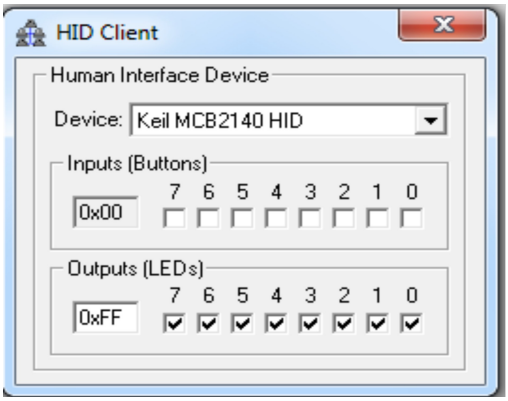
After selection of the device, the window looks like this.



Now press a key from sw1 to sw8. A check appears at the corresponding I/p of Input buttons while the key is pressed as shown below



Close JP21(1,2) and Now check a box from 0 to 7 in the above window corresponding to Output(LED's). A corresponding LED from L1 to L7 will glow on the board but not L8.



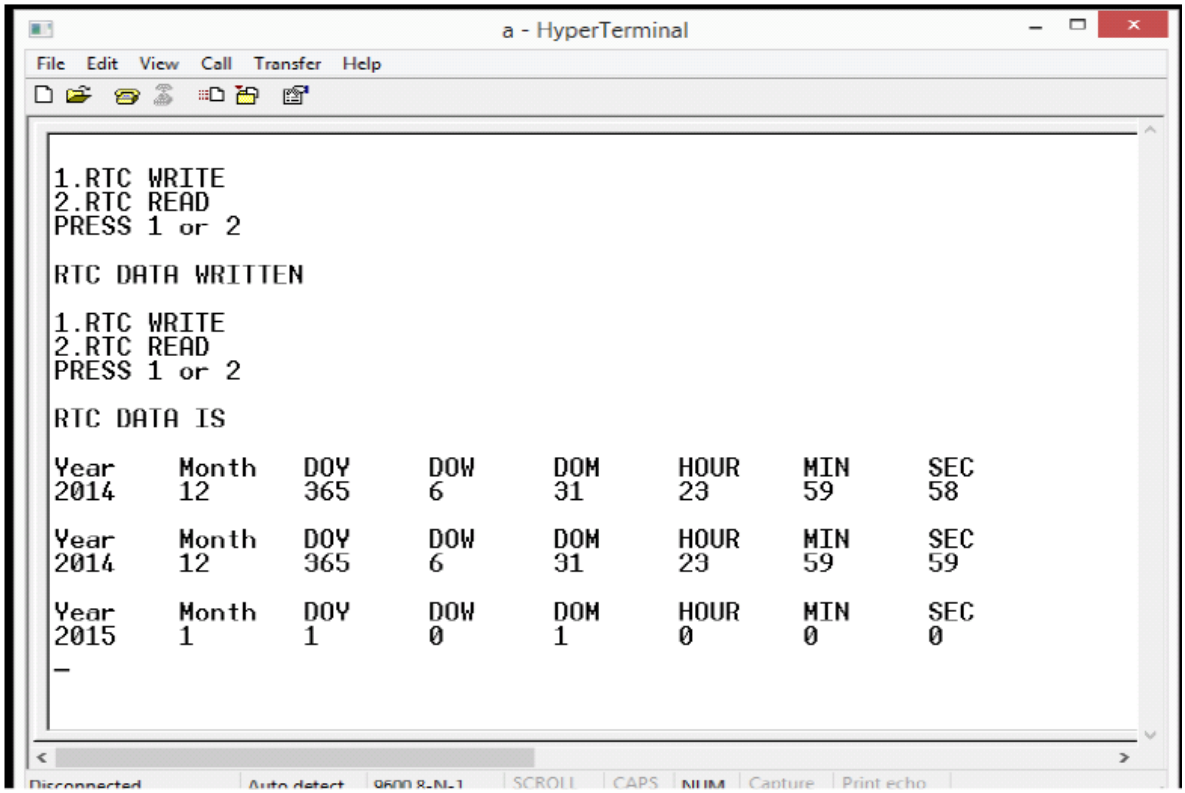
The above two steps indicates simple communication of the controller operation as a Human interface input/output device.

7.23.Internal RTC Test:

File name: cd_drive:\ALS-SDA-ARM7-07\SOFTWARES\Exp23_INTERNAL_RTC\INT_RTC.hex
Download the "INT_RTC.hex" file.

Hardware setup: Make UART0 communication setup.

Working: According to this software, Internal RTC is operated based on the commands sent from PC terminal through UART0. A read and write operation is done and read values are sent to serial port UART0. Until **Esc** key pressed at PC key board a read operation will continue.



7.24 TO TEST INTERNAL_DAC-10Bit:

A) Sine Wave:

File Name: cd_drive:\ALS-SDA-ARM7-07\SOFTWARES\Exp24_INT_DAC \sineware\sinewave.hex
Download the "sinewave.hex" file.

Press the reset switch to run the program. Open JP9 and Observe the Analog output waveform at the Pin-1 of JP9 using Oscilloscope (CRO) with respect to GND.

B) Square Wave:

File Name: cd_drive:\ALS-SDA-ARM7-07\SOFTWARES\Exp24_INT_DAC\square\square.hex
Download the "square.hex" file.

Press the reset switch to run the program. Open JP9 and Observe the Analog output waveform at the Pin-1 of JP9 using Oscilloscope (CRO) with respect to GND.

C) Triangle Wave:

File Name: cd_drive:\ALS-SDA-ARM7-07\SOFTWARES\Exp24_INT_DAC\triangular\ triangular.hex
Download the "triangular.hex" file.

Press the reset switch to run the program. Open JP9 and Observe the Analog output waveform at the Pin-1 of JP9 using Oscilloscope (CRO) with respect to GND.

7.25 Transfer-tx-rx Test:

File Name:
1)cd_drive:\ALS-SDA-ARM7-07\SOFTWARES\Exp25_Transfer-tx-rx\uart0-tx\uart0-tx.hex
2)cd_drive:\ALS-SDA-ARM7-07\SOFTWARES\Exp25_Transfer-tx-rx\uart0-rx\uart0-rx.hex

Download the "uart0-tx.hex" file to Board-1 and "uart0-rx.hex" file to Board-2.

Download the uart0-tx.hex to Board-1 and uart0-rx.hex to Board-2 separately. Make serial communication setup between two board using 9pin D-sub connector (ie- from DB2 of Board-1 to DB2 of Board-2) and Press RESET switch SW9. A fixed Text will be transferred from Board-1 to Board-2 and it will be displayed on LCD of Board-2 adjust contrast using POT2.

Serial Test Cable:

9pin D-sub Male	**9pin D-sub Male**
3-Rx	2-Tx
2-Tx	3-Rx
5-GND	5-GND

Note: If User want to use the UART1 then we Provided Reliamate RM2 to interface serial TX and RX lines to the LPC2148 as well as LPC1768. To use Uart1 user must Short jumper JP25(1,2),JP8(1,2) for LPC2148.And for LPC1768 user must Short jumper JP25(2,3),JP8(2,3).

CHAPTER 8

TROUBLE SHOOTING

1. Power Supply:

- Short jumper **JP5 to** connect **+3.3V.**

2. In System Programming / Download (ISP):

- **In System Programming** or download could not be established properly then check out whether the following conditions are met
- The cable used for communication should be **cross cable**.
- Switch ON 1 & 2 switches of the SW11 **DTR** and **RTS** for serial communication.
- IC MAX3232 is in good condition.
- JP8 1 to2 to connect +5V for IC MAX3232

3. JTAG Programming / Download:

- Short jumper **JP1 (RTCK)** for communication.
- Switch ON 1 &2 pins of the SW11 **DTR** and **RTS** for serial communication.

4. General Problems:

- Make Proper Jumper Connections as mentioned in Hardware Details**.**
- Make Proper Connections as mentioned in Demo Programs Set up.

CHAPTER 9

QUICK REFERENCE

PORT LINE DETAILS – Used for on board interfaces:

SL No.	PROGRAM NAME	PORT LINE
1	LCD	P0.2 - P0.7
2	7SEG DISPLAY	P0.16 - P0.23 & P0.28 - P0.31
3	GP LED'S	P0.16 – P0.23
4	SWITCHES	P1.16 – P1.23
5	STEPPER MOTOR	P0.12 – P0.15
6	DC MOTOR	P0.8 & P0.11
7	RELAY	P0.10
8	BUZZER	P0.9
9	EXT-INTERRUPT0	P0.16
10	DAC0800	P0.16 – P0.23
11	PWM	P0.8
12	Internal ADC	P0.25
13	4X4 KEY MATRIX	P1.16 – P1.23
14	EXT-INTERRUPT1	P0.3
15	I2C	P0.11(SCL) and P0.14(SDA)
16	SPI	P0.17,P0.18,P0.19,P0.20
17	GLCD	P0.8(RS),P0.9(RW),P0.10(EN), P0.16 to P0.23(D0 to D7), P0.12(CS1),P0.13(CS2),P0.15(RST)