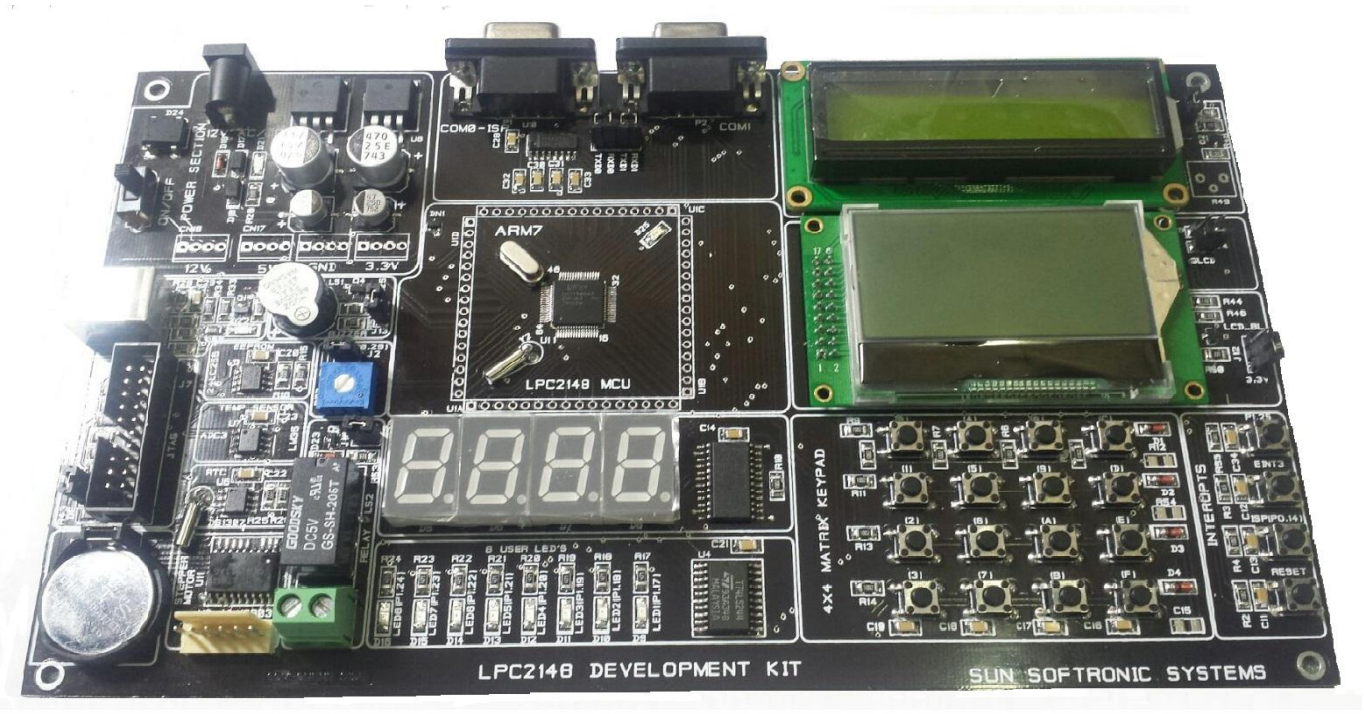
Sun Softronic Systems

LPC2148 DEVELOPMENT KIT

User Manual



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1 Introduction

ARM7 LPC2148 Development Kit, is proposed to smooth the progress of developing and debugging of various designs encompassing of High speed 32-bit MCU from NXP. The board supports NXP's LPC214x family devices with various memory and peripheral options. It integrates on board two UARTs, LEDs, Relays, Motor Interface, keypads, 7 Segment, an ADC input and GLCD/LCD Display to create a stand-alone versatile test platform.

1.2 Features

ARM7 L*PC2148 Development Kit* with NXP's ARM7TDMI LPC2148 microcontroller lets you get up-and-running quickly. The small form factor board offers many unique features that ease your learning curve and program development.

- NXP ARM7TDMI LPC2148 microcontroller with 512 Kbyte program Flash and 32+8 Kbyte SRAM
- 12.0000 MHz crystal for maximum execution speed and standard serial bit rates
  - Phase-locked loop (PLL) multiplies frequency with five; 5 x 12 MHz = 60 MHz
- 32.768 kHz RTC crystal
- Onboard Peripherals
  - 8 Nos. LED's
  - 4x4 matrix Keypad
  - 16x2 Character LCD with back light
  - 128x64 GLCD with back light
  - 4 Nos. 7-Segment Display (SPI)
  - Potentiometer
  - Temperature Sensor
  - EEPROM
  - Stepper Motor Interface
  - SPDT Relay
  - RTC with Battery Backup
  - 2 Nos. UART (RS232)
  - USB 2.0 device interface
  - Piezoelectric buzzer
  - Reset, ISP, EINT Push Buttons
- Connectors
  - Type - B USB connector
  - JTAG
  - 2.1 mm power supply connector

- Power supply
  - 9-15 VDC, ≥200 mA from 2.1 mm power connector
  - Can also be powered directly from any of type- B USB connectors

1.3 ESD Precaution

Please note that the *LPC2148 Development Kit components* are exposed for finger touches and therefore extra attention must be paid to ESD (Electro-Static Discharge) precaution.

Make it a habit to always first touch the metal surface of one of the USB connectors for a few seconds with both hands before touching any other parts of the boards. That way, you will have the same potential as the board and therefore minimize the risk for ESD.

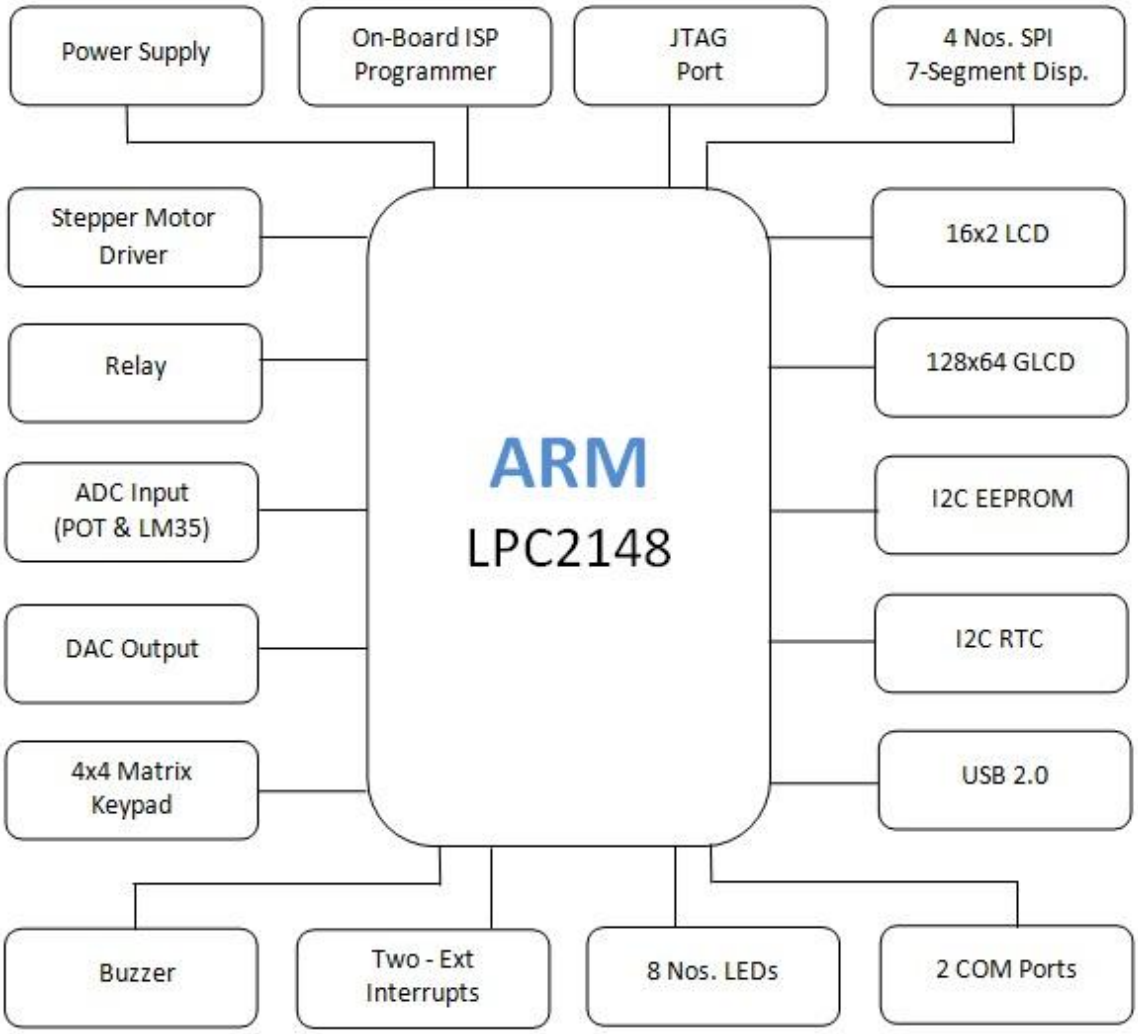
1.4 Other Products from Sun Softronic Systems

Sun Softronic Systems has established in the embedded world with its high efficient Evaluation and Development Boards based on various platforms ranging from TI, NXP, Freescale, Nuvoton, etc. S3 offers a full range of design services for embedded system development that include system architecture and design, electronic circuit design & analysis, real-time software design, GUI and tool development, printed circuit board design, mechanical packaging design, and documentation.

1.4.1 Design and Production Services

Sun Softronic Systems provides services for custom designs, either completely new or modification to existing boards. Specific peripherals and I/O can be added easily to different designs, for example, communication interfaces, specific analog or digital I/O, and power supplies. Sun Softronic Systems has a broad and long experience in designing industrial electronics, in general, and with NXP's LPC2xxx microcontroller family, in specific. Our competence also includes wireless and wired communication for embedded systems. For example IEEE802.11b/g (WLAN), Bluetooth™, ZigBee™, ISM RF, Ethernet, CAN, RS485.

2. General Block Diagram



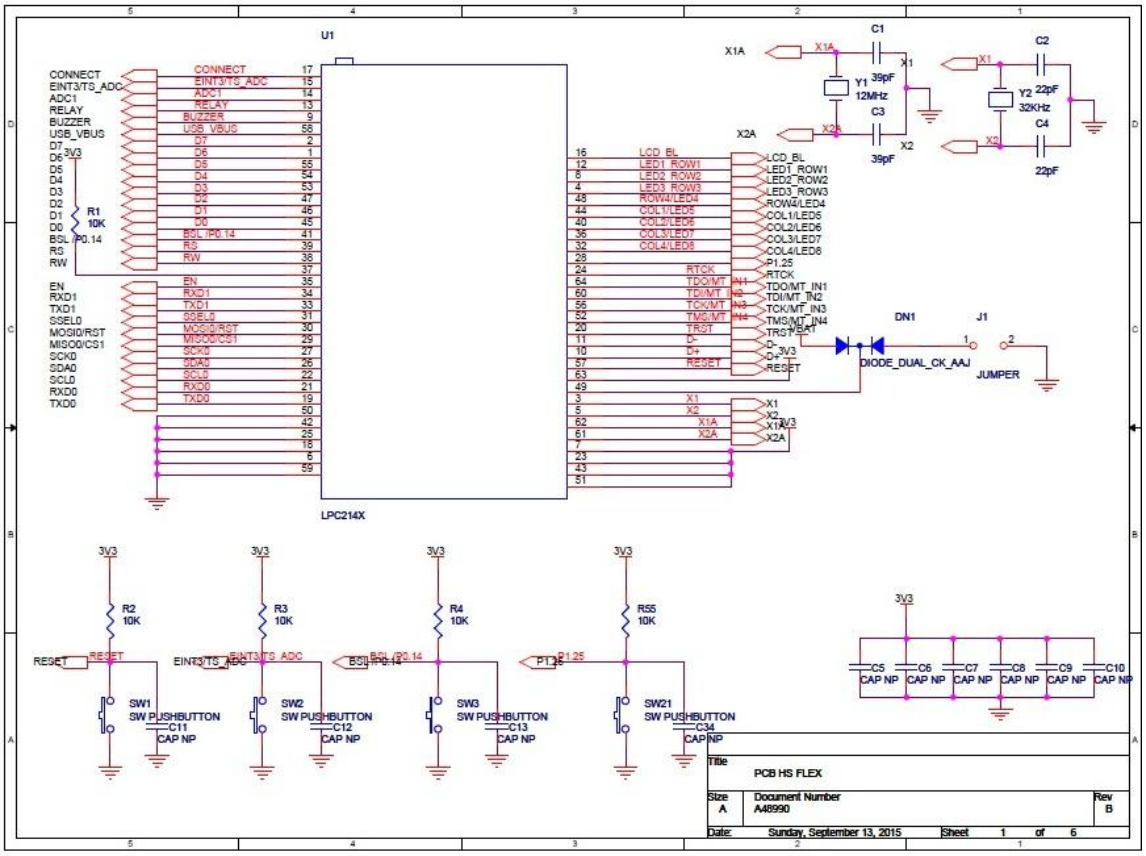
2.1 LPC2148 Processor Features

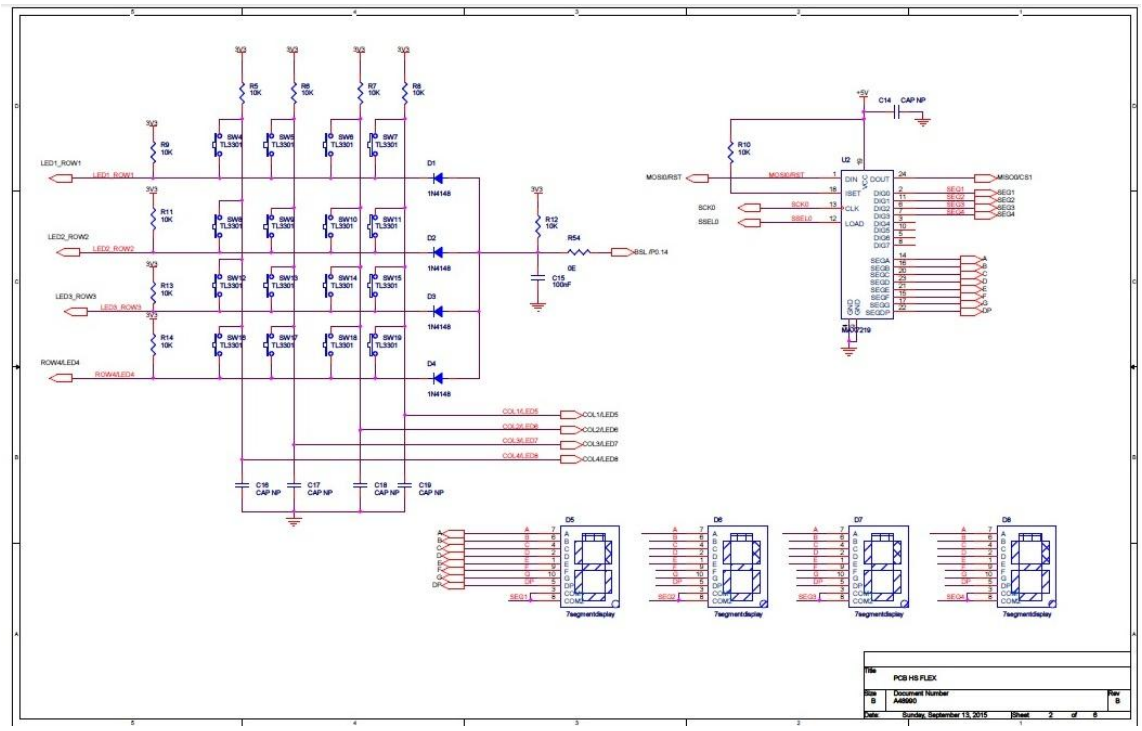
- 16-bit/32-bit ARM7TDMI-S microcontroller in a tiny LQFP64 package.
- 8KB to 40KB of on-chip static RAM and 32KB to 512KB of on-chip flash memory. 128-bit wide interface/accelerator enables high-speed 60 MHz operation.
- In-System Programming/In-Application Programming (ISP/IAP) via on-chip boot loader software. Single flash sector/full chip erase in 400 ms and programming of 256 bytes in 1 ms.

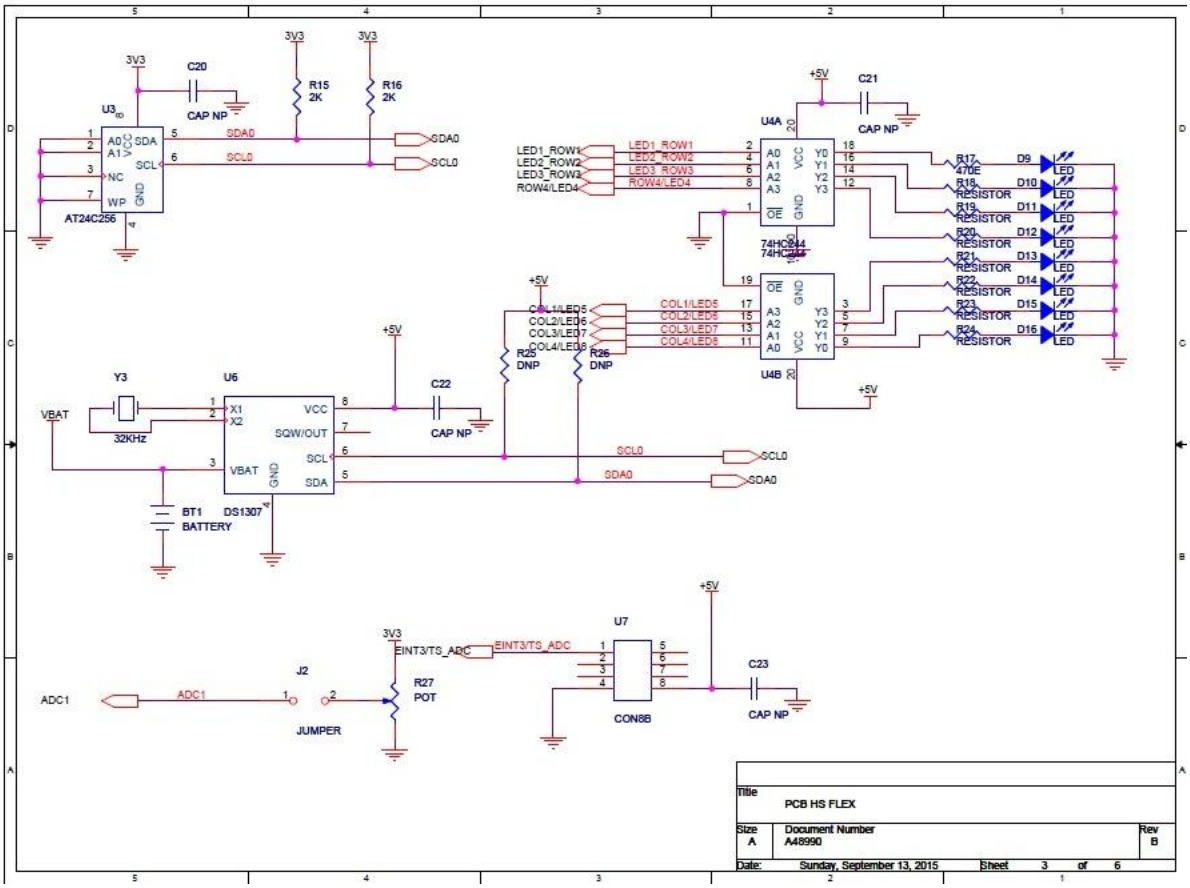
- USB 2.0 Full-speed compliant device controller with 2KB of endpoint RAM. In addition, the LPC2146/48 provides 8KB of on-chip RAM accessible to USB by DMA.
- One or two (LPC2141/42 vs. LPC2144/46/48) 10-bit ADCs provide a total of 6/14 analog inputs, with conversion times as low as 2.44 µs per channel.
- Single 10-bit DAC provides variable analog output (LPC2142/44/46/48 only).
- 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 UART's, 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 of 5 V tolerant fast general purpose I/O pins in a tiny LQFP64 package.
- Up to 21 external interrupt pins available.
- 60MHz maximum CPU clock available from programmable on-chip PLL with settling time of 100µs.
- On-chip integrated oscillator operates with an external crystal from 1 MHz to 25MHz.
- Power saving modes include idle and Power-down.
- Individual 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.
- CPU operating voltage range of 3.0 V to 3.6 V (3.3 V ± 10 %) with 5 V tolerant I/O pads.

3. Board Schematics

The detailed information about the electrical design of the ***LPC2148 Development Kit*.**



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C20
CAP NP
R15
2K
R16
2K
U3
AT24C256
SDA0
SCL0
C21
U4A
74HC244
LED1_ROW1
LED2_ROW2
LED3_ROW3
ROW4/LED4
R17
470E
D9
R18
D10
R19
D11
R20
D12
R21
D13
R22
D14
R23
D15
R24
D16
RESISTOR
LED
COL1/LED5
COL2/LED6
COL3/LED7
COL4/LED8
U4B
R25
DNP
R26
DNP
Y3
32KHz
U6
DS1307
VBAT
BT1
BATTERY
C22
U7
CON8B
C23
J2
JUMPER
R27
POT
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EINT3/TS_ADC
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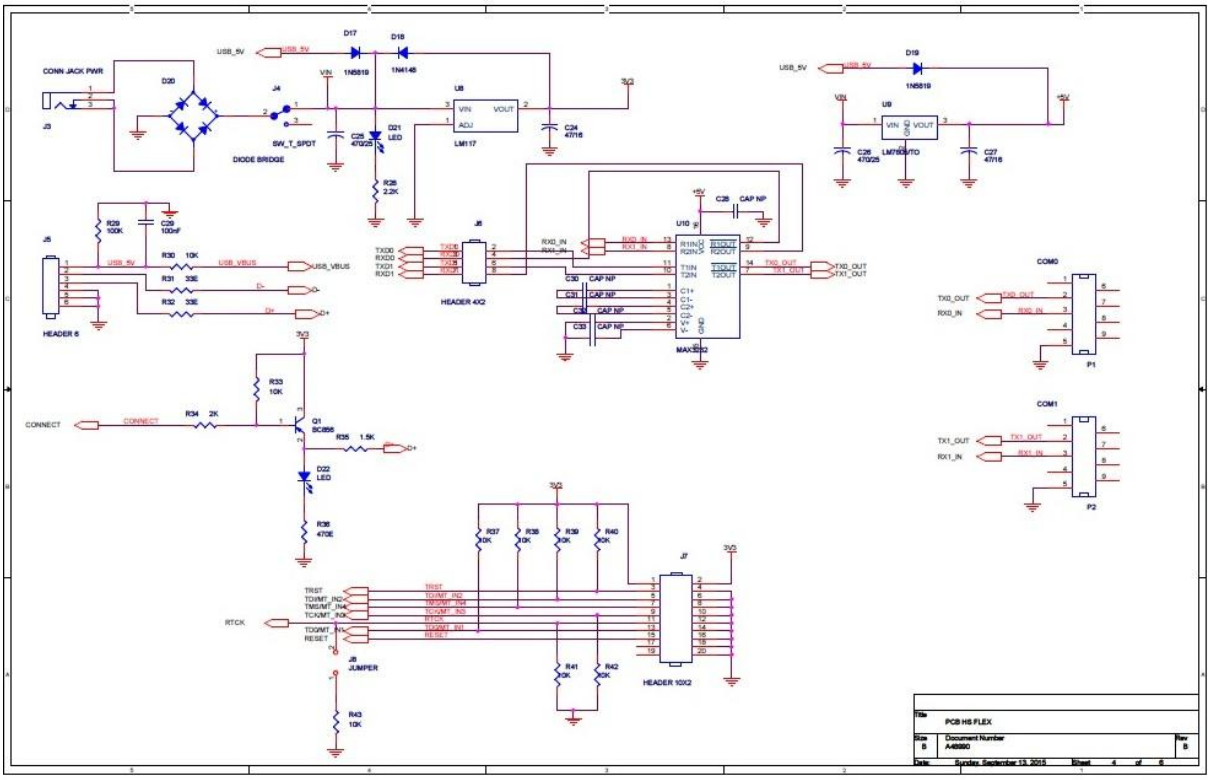
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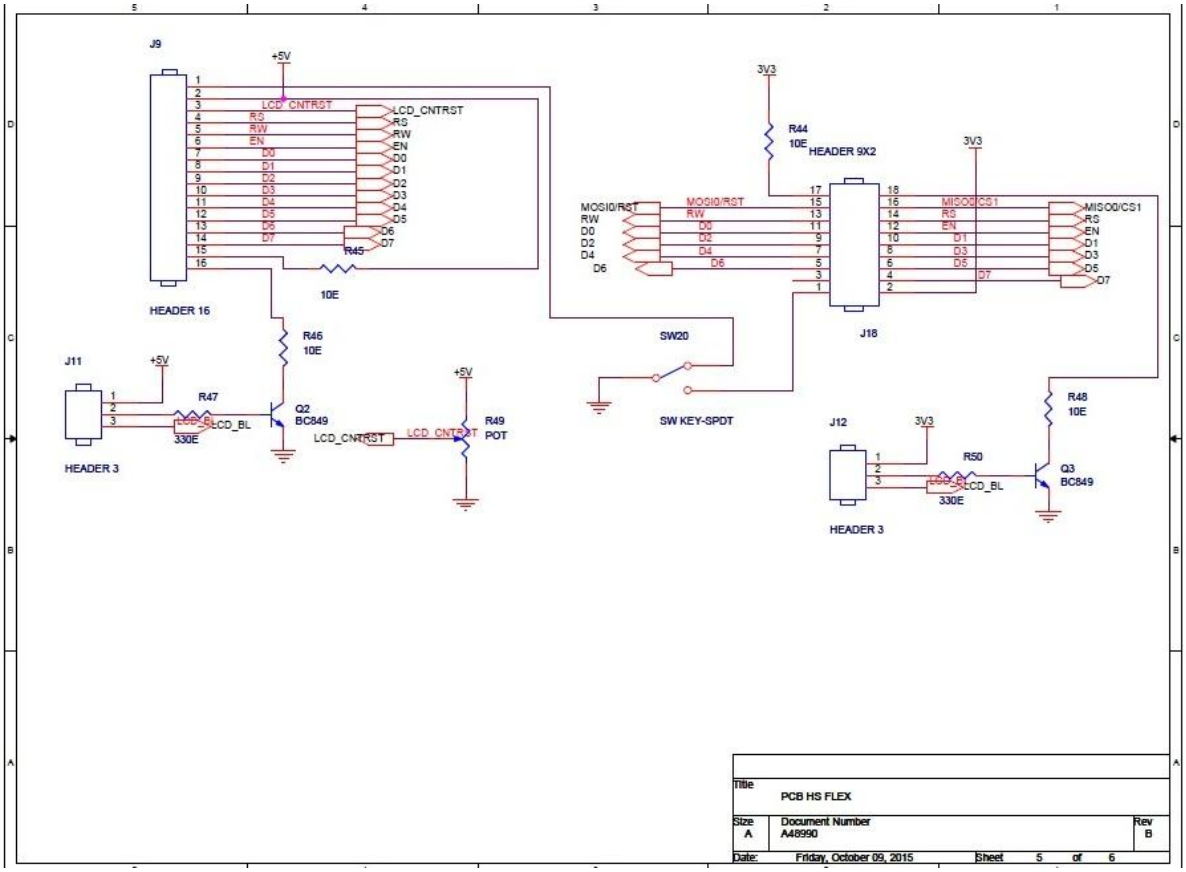
DIODE BRIDGE
SW_T_SPDT
LM117
LM7805/TO
HEADER 6
HEADER 4X2
MAX232
COM0
COM1
HEADER 10X2
JUMPER
CONNECT
PCB HS FLEX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HEADER 16
R45
10E
R46
10E
J11
HEADER 3
R47
330E
Q2
BC849
R49
POT
SW20
SW KEY-SPDT
R44
10E
HEADER 9X2
J18
R48
10E
J12
HEADER 3
R50
330E
Q3
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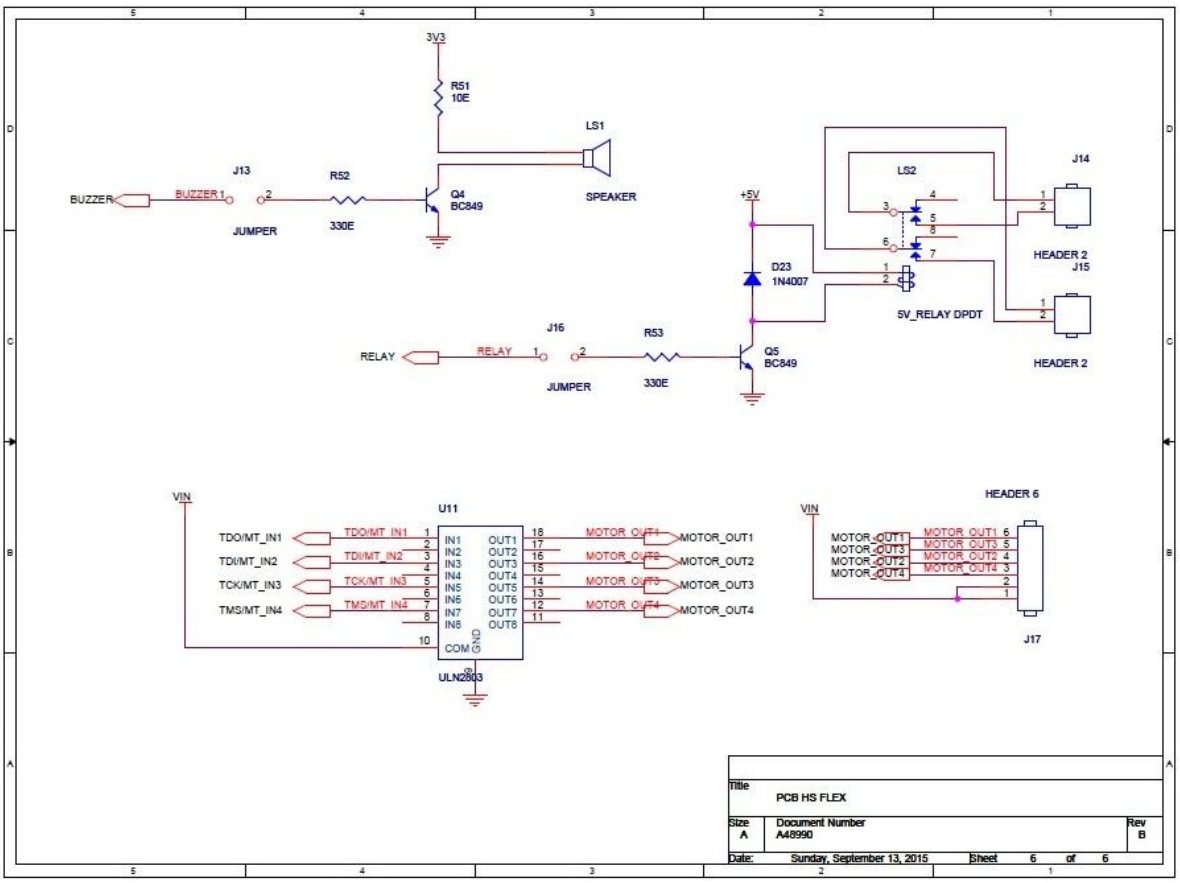
R51
10E
LS1
SPEAKER
J13
JUMPER
R52
330E
Q4
BC849
LS2
J14
HEADER 2
J15
HEADER 2
D23
1N4007
5V_RELAY DPDT
J16
JUMPER
R53
330E
Q5
BC849
U11
ULN2803
HEADER 6
J17
Title
PCB HS FLEX
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4. Power Supply

The external power can be AC or DC, with a voltage between (9V/12V, 1A output) at 230V AC input. The ARM board produces +5V using an LM7805 voltage regulator, which provides supply to the peripherals. LM1117 Fixed +3.3V positive regulator used for processor & processor related peripherals. USB socket meant for power supply and USB communication, user can select either USB or Ext power supply. An On/Off Switch for controlling power to the board.

5. On-Board Peripherals :

The **LPC2148 Development kit** comes with many interfacing options

- 8 Nos. LED's
- 4x4 matrix Keypad
- 16x2 Character LCD with back light
- 128x64 GLCD with back light
- 4 Nos. 7-Segment Display (SPI)
- Potentiometer
- Temperature Sensor
- EEPROM
- Stepper Motor Interface
- SPDT Relay
- RTC with Battery Backup
- 2 Nos. UART (RS232)
- USB 2.0 device interface
- Piezoelectric buzzer
- Reset, ISP, EINT Push Buttons

5.1 Light Emitting Diodes

- Light Emitting Diodes (LEDs) are the most commonly used components, usually for displaying pin's digital states.
- The **LPC2148 Development Kit** has 8 nos., of Point LEDs, connected with port pins (P1.17 to P1.24), to make port pins high LED will glow.

LED's	LPC2148 Lines
LED1	P1.17
LED2	P1.18
LED3	P1.19
LED4	P1.20
LED5	P1.21
LED6	P1.22
LED7	P1.23
LED8	P1.24

5.2 LCD 16x2 IN 8-BIT MODE

The **LPC2148 Development Kit,** have 2x16 character LCD. 11 pins are needed to create 8-bit interface; 8 data bits (P0.15 – P0.22, D0-D7), address bit (RS-P0.13), read/write bit (RW-P0.12) and control signal (EN-P0.10). The LCD is powered from the 5V power supply and back light is controlled by enabling jumper **J11** with 5v supply voltage.

LCD Module	LPC2148 Lines
EN	P0.10
RW	P0.12
RS	P0.13
D0	P0.15
D1	P0.16
D2	P0.17
D3	P0.18
D4	P0.19
D5	P0.20
D6	P0.21
D7	P0.22

5.3 128x64 GLCD Graphical LCD

The **LPC2148 Development Kit,** have 128x64 pixels GLCD. 13 pins are needed to create 8-bit interface; 8 data bits (P0.15 – P0.22, DB0-DB7), chip select line P0.5 (CS1), address bit (RS-P0.13), read/write bit (RW-P0.12) and control signal (EN-P0.10) and Reset (RST-P0.6). The GLCD is powered from the 5V power supply and back light is controlled by enabling jumper **J12** with 3.3v supply voltage.

GLCD Module	LPC2148 Lines
CS1	P0.5
RST	P0.6
EN	P0.10
RW	P0.12
RS	P0.13
D0	P0.15
D1	P0.16
D2	P0.17
D3	P0.18
D4	P0.19
D5	P0.20
D6	P0.21
D7	P0.22

5.4 SPI Seven Segment Display

In **LPC2148 Development Kit**, have 4 nos. of common cathode seven segment displays are controlled by SPI Enabled drivers. SPI Lines serial clock **SCK0 (P0.4)**, Slave Select **SSEL0 (P0.7),** data out **MOSI0 (P0.6)** connected to the SPI based 7- segment display driver. The 7-segment display is powered from the 5V power supply.

7-SEG Driver	LPC2148 Lines
SCK0	P0.4
MOSI0	P0.6
SSEL0	P0.7

5.5 4x4 Matrix Keypad

Keypads arranged by matrix format, each row and column section pulled by high, all row lines (P1.17 – P1.20) and column lines (P1.21 to P1.24) connected directly by the port pins.

4x4 Matrix Lines	LPC2148 Lines
ROW-1	P1.17
ROW-2	P1.18
ROW-3	P1.19

ROW-4	P1.20
COLUMN-1	P1.21
COLUMN-2	P1.22
COLUMN-3	P1.23
COLUMN-4	P1.24

5.6 Stepper Motor

The ULN2803A is a high-voltage, high-current Darlington transistor array. The device consists of eight NPN Darlington pairs that feature high-voltage outputs with common cathode clamp diodes for switching inductive loads. The collector - current rating of each Darlington pair, 500 mA. ULN2803 is used as a driver for port I/O lines, drivers output connected to stepper motor.

Stepper Motor (12v)	LPC2148 Lines
COIL - A	P1.27
COIL - B	P1.28
COIL - C	P1.29
COIL - D	P1.30

Note: After downloading the program into the board, do power ON reset, to run the motor.

5.7 Relay Interface

Relay module is interfaced to port P0 (P0.28 for relay module), make port pins to high, relay will activate, use Jumper J16.

Relay Module	LPC2148 Lines
Relay SPDT	P0.28

5.8 Buzzer Interface

A small piezoelectric buzzer on the **LPC2148 Development Kit**, *b*y pulling pin P0.25 high, current will flow through the buzzer and a relatively sharp, single-tone frequency will be heard. The alternative PWM feature can be used to modulate the buzzer to oscillate around different frequencies. It's not the pulse width feature that is used to change the frequency. Only the volume of the sound will be changed by alternating the pulse width. Instead, it's possible to change the frequency of the PWM signal, and this will also change the frequency of with the buzzer oscillate. The buzzer can be disconnected by removing jumper J13, and

this is also the default position for this jumper since the buzzer sound can be quite annoying if always left on.

Buzzer Module	LPC2148 Lines
Buzzer	P0.25

5.9 Push-Button

The signal (ISP) P0.14 can be configured as an interrupt input pin on the processor. A push-button is connected to this signal so it's possible to pull the signal low. There is a pull-up resistor (10 Kohm) on the signal, which is also needed for the ISP feature. The signal P0.14 must be sampled high after reset in order to start normal program execution; else the internal boot loader will be activated.

The Vectored Interrupt Controller (VIC) takes 32 interrupt request inputs and by programming we can assign them into 3 categories, FIQ, vectored IRQ, and non-vectored IRQ. The programmable assignment scheme means that priorities of interrupts from the various peripherals can be dynamically assigned and adjusted.

Features

ARM Vectored Interrupt Controller

- 32 interrupt request inputs
- 16 vectored IRQ interrupts
- 16 priority levels dynamically assigned to interrupt requests
- Software interrupt generation

LPC2148 Development Kit, have three external interrupts lines are terminated at (ISP-P0.14, EINT0-P1.25, and EINT3 – P0.30) and one reset push button (RESET).

Push Buttons	LPC2148 Lines
RESET	Reset
ISP	P0.14
EINT3	P0.30
EINT0 (Normal SW)	P1.25

5.10 Serial Communication (UART)

- RS-232 communication enables point-to-point data transfer. It is commonly used in data acquisition applications, for the transfer of data between the microcontroller and a PC.

- The voltage levels of a microcontroller and PC are not directly compatible with those of RS-232, a level transition buffer such as MAX3232 be used.

	UART DB-9 Connector	LPC2148 Lines
UART0 (ISP)	TXD - 0	P0.0
	RXD - 0	P0.1
UART1	TXD - 1	P0.8
	RXD - 1	P0.9

5.11 Serial EEPROM

The AT24LC256 provides 256 words of 8 bits each. The device is optimized for use in many industrial and commercial applications where low-power and low-voltage operation are essential.

	I2C EEPROM	LPC2148 Lines
AT24LC256	SCL	SCL0 – P0.2
	SDA	SDA0 – P0.3

5.12 Real Time Clock (DS1307)

The Real Time Clock (RTC) is a set of counters for measuring time when system power is on, and optionally when it is off. It uses little power in Power-down mode. On the LPC2148, the RTC can be clocked by a separate 32.768 KHz oscillator, or by a programmable prescale divider based on the VPB clock. Also, the RTC is powered by its own power supply pin, VBAT, which can be connected to a battery or to the same 5 V supply used by the rest of the device.

Features:

- Measures the passage of time to maintain a calendar and clock.
- Ultra Low Power design to support battery powered systems.
- Provides Seconds, Minutes, Hours, Day of Month, Month, Year, Day of Week, Day of Year.
- Dedicated 32 kHz oscillator or programmable pre-scalar from VPB clock.
- Dedicated power supply pin can be connected to a battery or to the main 5 V.

	I2C RTC	LPC2148 Lines
DS1307	SCL	SCL0 – P0.2
	SDA	SDA0 – P0.3

5.13 On-Chip Analog to Digital Convertor (ADC)

Basic clocking for the A/D converters is provided by the VPB clock. A programmable divider is included in each converter, to scale this clock to the 4.5 MHz (max) clock needed by the successive approximation process. A fully accurate conversion requires 11 of these clocks

In **LPC2148 Development Kit**, for testing on-board analog input, port lines P0.29 connected through 10K potentiometer selected by jumper J2 and P0.30 connected through Temperature Sensor (LM35D). The signals P0.29 and P0.30 can be used as general purpose pins if the analog inputs are not used and in this case the analog voltages can easily be removed by removing the jumper on J2.

Features

- 10 bit successive approximation analog to digital converter (two in LPC2148).
- Input multiplexing among 8 pins.
- Power-down mode | Measurement range 0 to 3.3 V.
- 10 bit conversion time ≥ 2.44 µs.
- Burst conversion mode for single or multiple inputs.
- Optional conversion on transition on input pin or Timer Match signal.
- Global Start command for both converters (LPC2148 only).

On-Chip ADC	ADC Inputs	LPC2148 Lines
POT	ADC0.2	P0.29
LM35	ADC0.3	P0.30

5.14 Temperature Sensor-LM35

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in ° Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling.

The LM35 does not require any external calibration or trimming to provide typical accuracies of ±¼°C at room temperature and ±¾°C over a full -55 to +150°C temperature range. Low cost is assured by trimming and calibration at the wafer level. It can be used with single power supplies, or with plus and minus supplies. The LM35 is rated to operate over a -55° to +150°C temperature range, while the LM35C is rated for a -40° to +110°C range (-10° with improved accuracy).

Features

- Calibrated directly in ° Celsius (Centigrade)
- Linear + 10.0 mV/°C scale factor
- 0.5°C accuracy guarantee-able (at +25°C)
- Rated for full -55° to +150°C range
- Operates from 4 to 30 volts.

In **LPC2148 Development Kit**, LM35 Temp sensor connected at P0.30 (AD0.3)

On-Chip ADC	ADC Inputs	LPC2148 Lines
POT	ADC0.2	P0.29
LM35	ADC0.3	P0.30

5.15 On-Chip Digital to Analog Converter (DAC)

DAC Features

- 10 bit digital to analog converter
- Resistor string architecture
- Buffered output
- Power-down mode
- Selectable speed vs. power

In **LPC2148 Development Kit**, DAC (P0.25) output terminated at connector J13.

On-Chip DAC	DAC Output	LPC2148 Lines
J13	Aout	P0.25

5.16 Universal Serial Bus (USB)

The LPC2148 also contains a USB 2.0 device interface as one of its peripheral units. The USB interface supports the Soft Connect functionality and voltage sense. The Soft Connect feature is controlled by IO-pin P0.31 and is activated by placing a 1.5 Kohm resistor between the D+ signal and +3.3V. The voltage sense feature is handled by IO-pin P0.23, which is connected to VCC of the USB interface, and after the successful communication with USB is indicated by RED LED (D22).

USB Connector	LPC2148 Lines
Pin No-1 (VBus)	USB_VBus - P0.23
Pin No-2 (D -)	D -
Pin No-3 (D +)	D +
Pin No-4 (GND)	GND
	Connect – P0.31

5.17 JTAG

The JTAG interface is a standard 20-pin (2x10) connector with shoulders – 'standard', at least in the ARM world. The JTAG interface shares 6 general IO-pins (GPIOs) and is enabled by shorting jumper J8, i.e., pulling P1.26 low during reset. When the JTAG interface is enabled, the 6 IO-pins cannot be used for other purposes than the JTAG interface.

USB Connector	LPC2148 Lines
Pin No-3 (TRST)	TRST – P1.31
Pin No-5 (TDI)	TDI – P1.28
Pin No-3 (TMS)	TMS – P1.30
Pin No-4 (TCK)	TCK – P1.29
Pin No-11 (RTCK)	RTCK – P1.26
Pin No-13 (TD0)	TD0 – P1.27
Pin No-15 (RESET)	RESET