



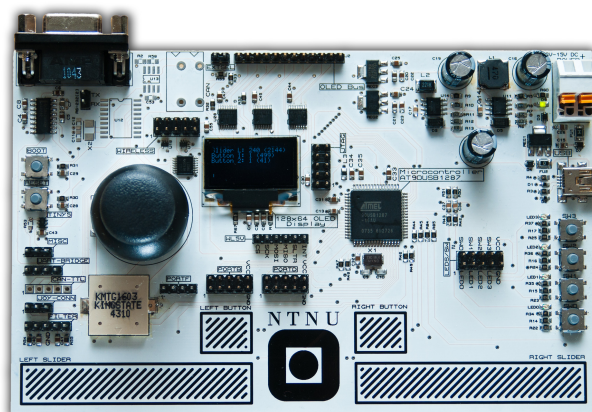
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# USB Multifunction Board Users Guide

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# Chapter 1

## Introduction

The USB multifunction board is a board developed for NTNU. It has a lot of features allowing students to be creative in their design.

### 1.1 Features

- Atmel AT90USB187 microcontroller
- Atmel ATtiny5 microcontroller
- 128x64 OLED Display (Selectable MCU or external interface)
- USB Bootloader
- Two touch sliders
- Two touch buttons
- UART to RS-232 Level converter
- 4 Buttons
- 4 LEDs
- Two axis analog joystick
- Buzzer
- Flexible IO headers

# Chapter 2

## Hardware

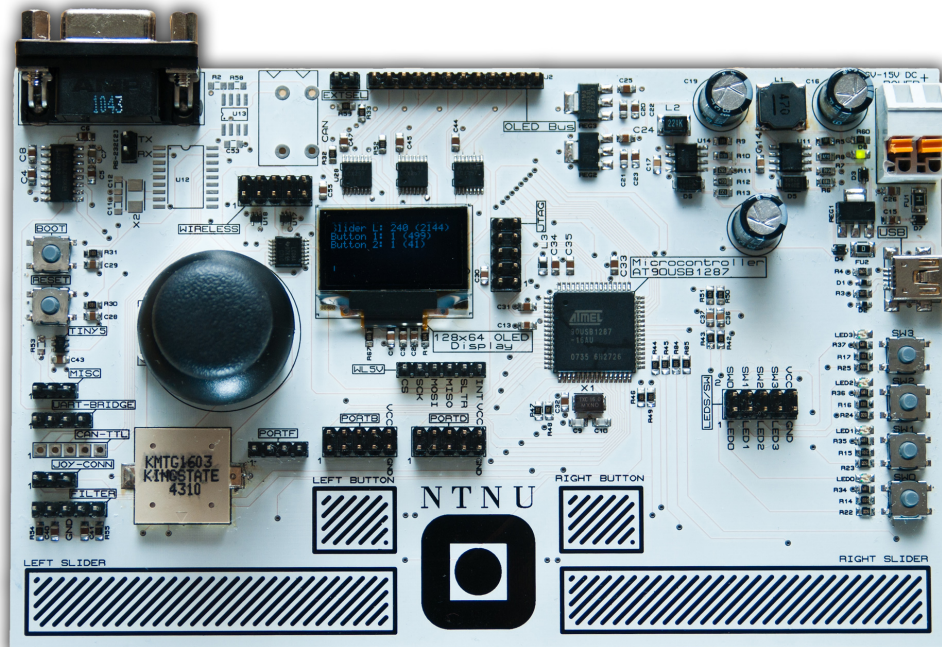


Figure 2.1: USB multifunction board

### 2.1 Microcontrollers

#### 2.1.1 Atmel AT90USB1287

The main microcontroller on this board is an Atmel AT90USB1287. It is running on 5V and uses a 16MHz crystal as clock source. Please refer to the datasheet of this device for more information.

#### 2.1.2 Atmel ATTINY5

There is a small 6 pins microcontroller on this board as well. The main purpose of this controller is to make sure that both the 5V and 3.3V circuits get a reset signal when the RESET button is pressed.

## 2.2 Power

The board can be powered both through the USB connector and through the power connector. If using the dedicated power connector, the voltage provided needs to be between 6V - 15V.

## 2.3 OLED

The OLED is connected to the microcontroller by default, but by shorting EXTSEL it can be accessed from the external headers called OLED Bus.

Both externally and internally it is connected as a memory mapped device. Please refer to the OLED datasheet for details. It can be downloaded here <http://www.nimron.no/P1000>.

## 2.4 UART to RS-232

There is a two channel level converter for UART communication. A standard MAX232 IC is used. Please refer to pinout and the schematics for details.

## 2.5 LEDs and Switches

There are 4 general purpose LEDs and switches as well as two fixed function switches on board. These are connected to pinheaders so that the user can select what it should be used for.

### 2.5.1 LEDs

Pins for the LEDs needs to be pulled low for the LED to light up. They are also connected with a current limiting resistor for safe usage. The reason for using active low is because CMOS devices usually can sink more current than it can source. The second reason is that it will not contribute to extra current consumption (and not give an extra load on the power pins) on the device used.

### 2.5.2 User selectable switches

Pins for the switches have pull-ups when switch is not active and it will be pulled low when the button is pushed. There are also current limiting resistors on the pins. Please refer to the schematics for more information (Appendix A, sheet 2).

### 2.5.3 RESET button

Sends a reset signal to all circuits on the board including, AT90USB1287, ATtiny5, OLED and Wireless.

### 2.5.4 BOOT button

If the main microcontroller has a bootloader programmed, holding this button during power up or reset will make the device go into bootloader mode. It can then be programmed through USB.

## 2.6 CAN

The board has footprints for a CAN controller and a CAN transceiver.

## 2.7 Buzzer

There is a piezo buzzer on board. It is not connected to the microcontroller by default, but is available on the MISC header.

## 2.8 Touch interface

The board has two touch buttons and two sliders connected to the AT90USB1287. These are operational with the default firmware. Please refer to documentation on Atmel's Touch Library for information on how to use the touch sensors.

## Chapter 3

# Pinout

### 3.1 OLED Interface

Note that EXTSEL jumper must be mounted for external control of the display, otherwise the AT90USB1287 will be connected to the OLED.

Pin number	Description
1	$\overline{CS}$
2	$\overline{D}/C$
3	$R/\overline{W}$
4	$D1$
5	$D2$
6	$D3$
7	$D4$
8	$D5$
9	$D6$
10	$D7$
11	$D8$
12	$GND$

Table 3.1: OLED Pinout

### 3.2 WIRELESS

The wireless connector is compatible with the RZ600 kit from Atmel. Note that these signals are 3V3.



Pin number	Description
1	<i>RESET(3V3)</i>
2	<i>NC</i>
3	<i>INT</i>
4	<i>SLTR</i>
5	<i><math>\overline{CS}</math></i>
6	<i>MOSI</i>
7	<i>MISO</i>
8	<i>SCK</i>
9	<i>GND</i>
10	<i>VCC(3V3)</i>

Table 3.2: Wireless Pinout

### 3.3 WL5V

This connector is the 5V side of the levelshifted signals to the wireless connector for RZ600.

Pin number	Description
1	<i><math>\overline{CS}</math></i>
2	<i>SCK</i>
3	<i>MOSI</i>
4	<i>MISO</i>
5	<i>SLTR</i>
6	<i>INT</i>

Table 3.3: Wireless Pinout - 5V

### 3.4 MISC

Pin number	Description
1	<i>TINY – PB0</i>
2	<i>TINY – PB1</i>
3	<i>BUZZER</i>

Table 3.4: MISC pinheader

### 3.5 UART-BRIDGE

This is the TTL side of the RS-232 levelshifter. TX1 and RX1 is belongs to the DSUB9 connector while TX2 and RX2 belongs to the pinheader next to the DSUB9 connector.

Pin number	Description
1	<i>TX1</i>
2	<i>RX1</i>
3	<i>TX2</i>
4	<i>RX2</i>

Table 3.5: UART-BRIDGE pinheader

### 3.6 CAN-TTL

This is the TTL (5V) side of the CAN controller. Not mounted by default.

Pin number	Description
1	<i>CS</i>
2	<i>SO</i>
3	<i>SI</i>
4	<i>SCK</i>
5	<i>INT</i>

Table 3.6: CAN-TTL pinheader

### 3.7 JOY-CONN - Joystick connector

This connector has two analog voltage outputs depending on the position of the thumbstick and one digital output connected to the button of the thumbstick.

Pin number	Description
1	<i>AXIS1</i> (0V - 5V)
2	<i>AXIS2</i> (0V - 5V)
3	<i>BUTTON</i> (NC - GND)

Table 3.7: JOY-CONN pinheader

### 3.8 FILTER - Low pass filter

Used for making PWM to analog voltage.

Pin number	Description
1	Filter 1 IN
2	Filter 1 OUT
3	GND
4	Filter 1 OUT
5	Filter 1 IN

Table 3.8: FILTER pinheader

## 3.9 PORTF

Connection directly to PORTF on the AT90USB1287.

Pin number	Description
1	PF0
2	PF1
3	PF2
4	GND

Table 3.9: PORTF pinheader

## 3.10 PORTB

Connection directly to PORTB on the AT90USB1287. Compatible with most Atmel tools like STK500 and STK600.

Pin number	Description
1	PB0
2	PB1
3	PB2
4	PB3
5	PB4
6	PB5
7	PB6
8	PB7
9	GND
10	VCC (5V)

Table 3.10: PORTB pinheader

## 3.11 PORTD

Connection directly to PORTD on the AT90USB1287. Compatible with most Atmel tools like STK500 and STK600.

Pin number	Description
1	PD0
2	PD1
3	PD2
4	PD3
5	PD4
6	PD5
7	PD6
8	PD7
9	GND
10	VCC (5V)

Table 3.11: PORTD pinheader

## 3.12 LEDS/SW

Used for interfacing the four LEDs and the four switches on the board. Please refer to the schematics (Appendix A, sheet 2) for usage.

Pin number	Description
1	LED0
2	SW0
3	LED1
4	SW1
5	LED2
6	SW2
7	LED3
8	SW3
9	GND
10	VCC (5V)

Table 3.12: LEDS/SW pinheader

## 3.13 JTAG

Used for programming and debugging the AT90USB1287. Compatible with Atmel debuggers.

Pin number	Description
1	TCK (PF4)
2	GND
3	TDO (PF6)
4	VCC (5V)
5	TMS (PF5)
6	RST (5V)
7	NC
8	NC
9	TDI (PF7)
10	GND

Table 3.13: JTAG pinheader

# Chapter 4

## Firmware

### 4.1 Default firmware

#### 4.1.1 AT90USB1287

This microcontroller is the main control unit for this board. As default it reads the touch pads and give corresponding signals on output pins as well as showing the status of the touch on the display. The display is not needed for it to read touch signal, so it can be safely be used externally by setting a jumper on EXTSEL.

Touch pad	Output
Left slider	PWM PB4
Right slider	PWM PD1
Left button	PB5
Right button	PD0

Table 4.1: Touch signal output

#### 4.1.2 ATtiny5

This microcontroller is making sure that all circuits on the board are properly reset. It is not intended to be reprogrammed by the user.

It does however have an extra function that the user can make use of. It has a voltage controlled frequency generator. It outputs a square wave on PB1 (MISC header pin 2) and the frequency of this is controlled by the input voltage applied on PB0 (MISC header pin 1). Input voltage is **0V - 5V**.

### 4.2 Programming

#### 4.2.1 AT90USB1287

This microcontroller can be programmed over USB through a bootloader or through the JTAG header.

**JTAG** Please use a programming or debugging tool from Atmel for programming through this header.

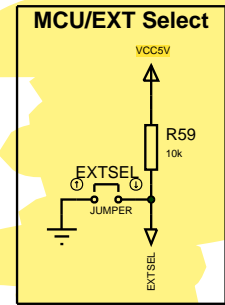
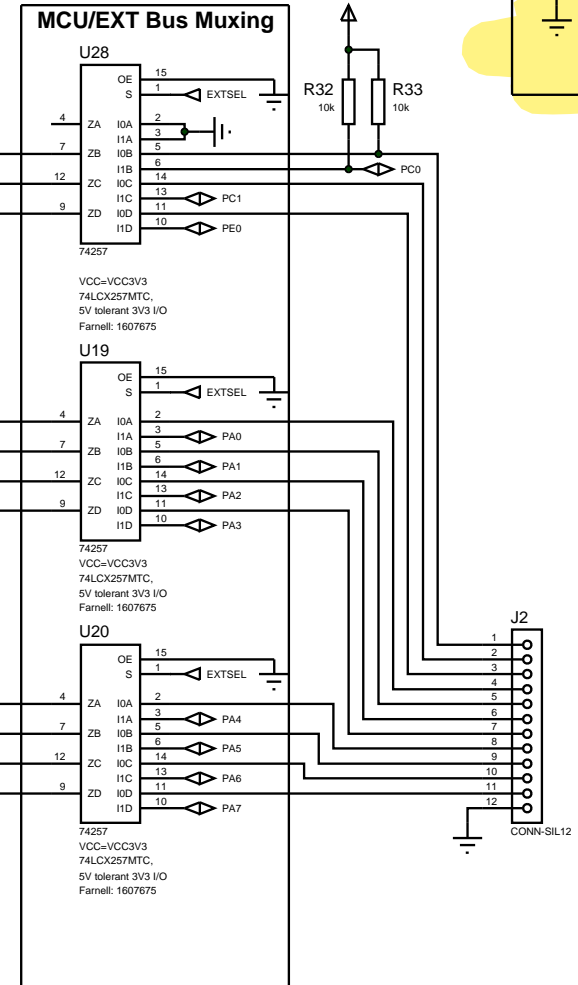
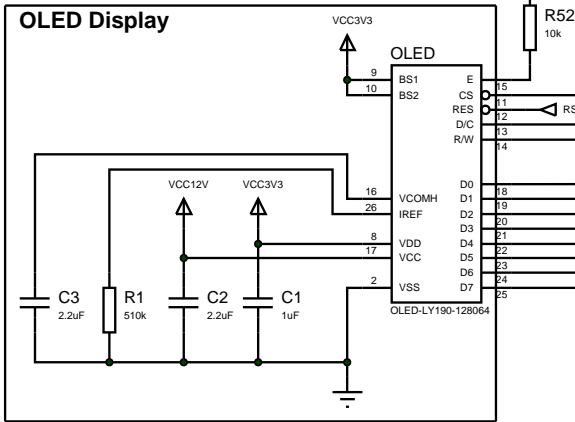
**Bootloader** To program the device through the bootloader the user need to use a program called FLIP. This can be found on Atmels website for free <http://www.atmel.com>. To enter programming mode hold the BOOT button while pushing RESET or during power on. Drivers for Windows are required and is provided with the FLIP software. Note that the bootloader can be erased through the JTAG interface. If this has been done, programming over USB will not work.

#### 4.2.2 Restoring the bootloader

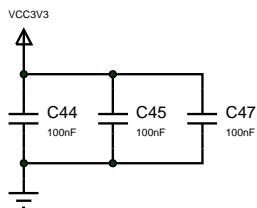
If the bootloader has been erased, it can be restored by programming it onto the device with a hardware programmer. The hex file needed can be found on <http://www.nimron.no/P1000>. Please refer to Atmel's tools for details on how to program a hex file. The easiest way is to use AVR Studio 4 or AVR Studio 5.


# **Appendix A**

## **Schematics**



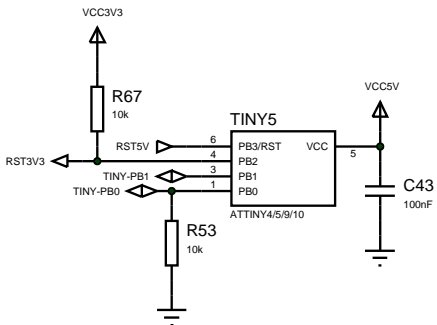
**Decoupling capacitors**



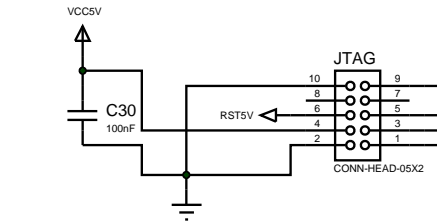
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FILE NAME: P1000-NTNU.DSN		Last modified: 20.08.2011 13:46:35		
BY: Nimron		DOC NO: <NONE>	PAGE: 1 of 5	REV: E



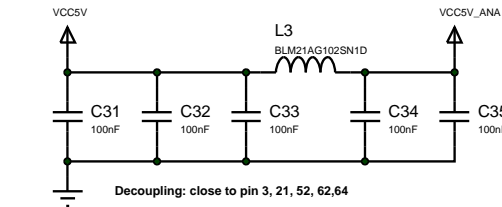
## ATTiny Reset Handler



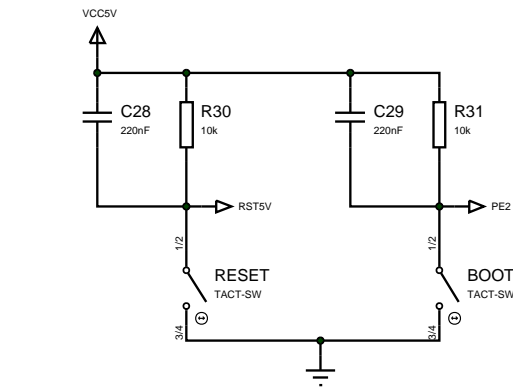
## JTAG MCU Connector



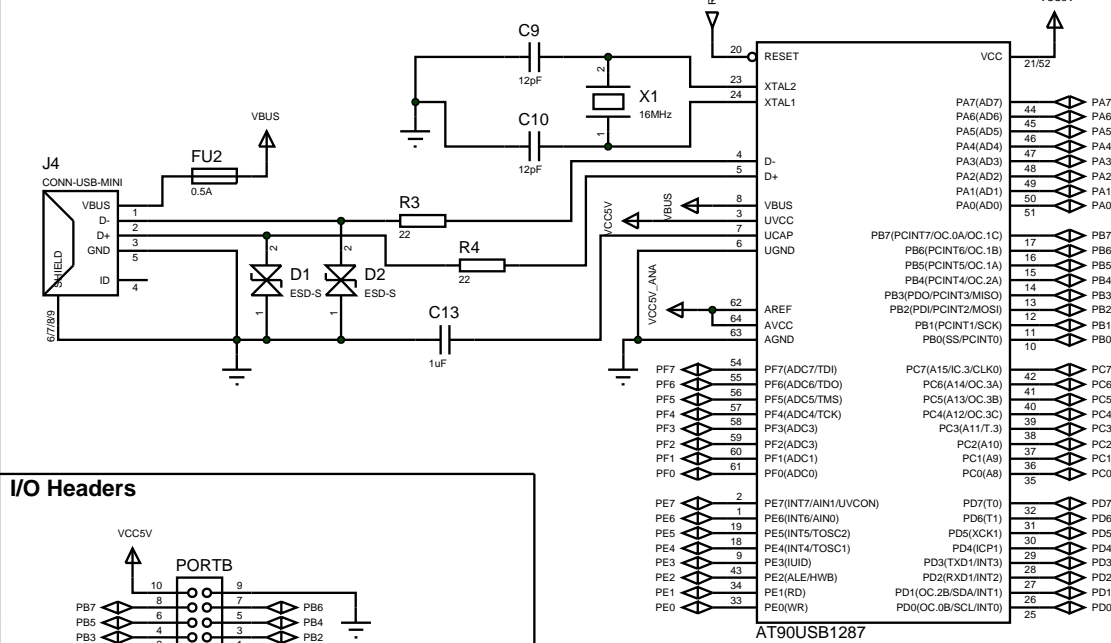
## MCU Decoupling



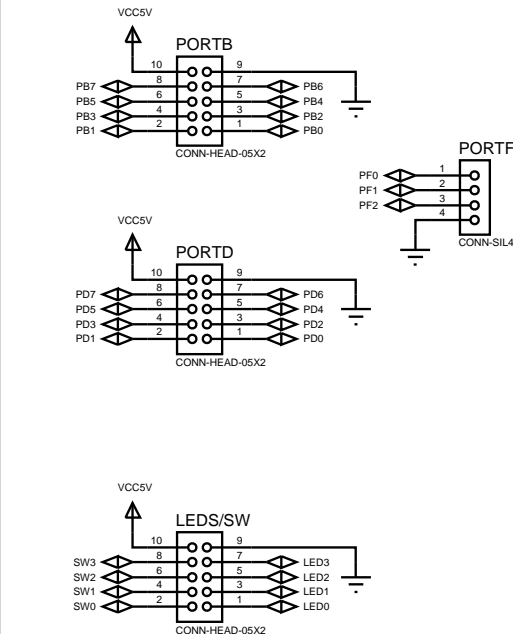
## Reset and Boot Switch



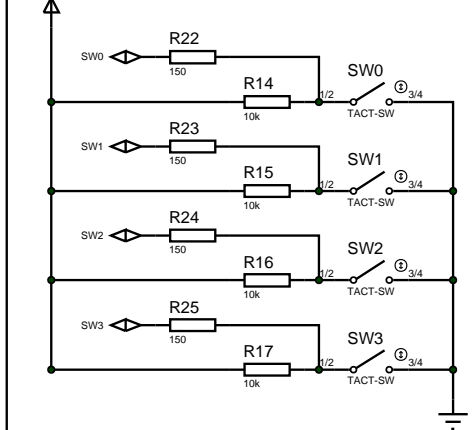
## Microcontroller Unit



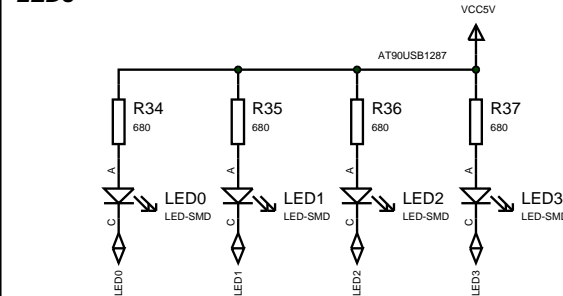
## I/O Headers



## Switches



## LEDs



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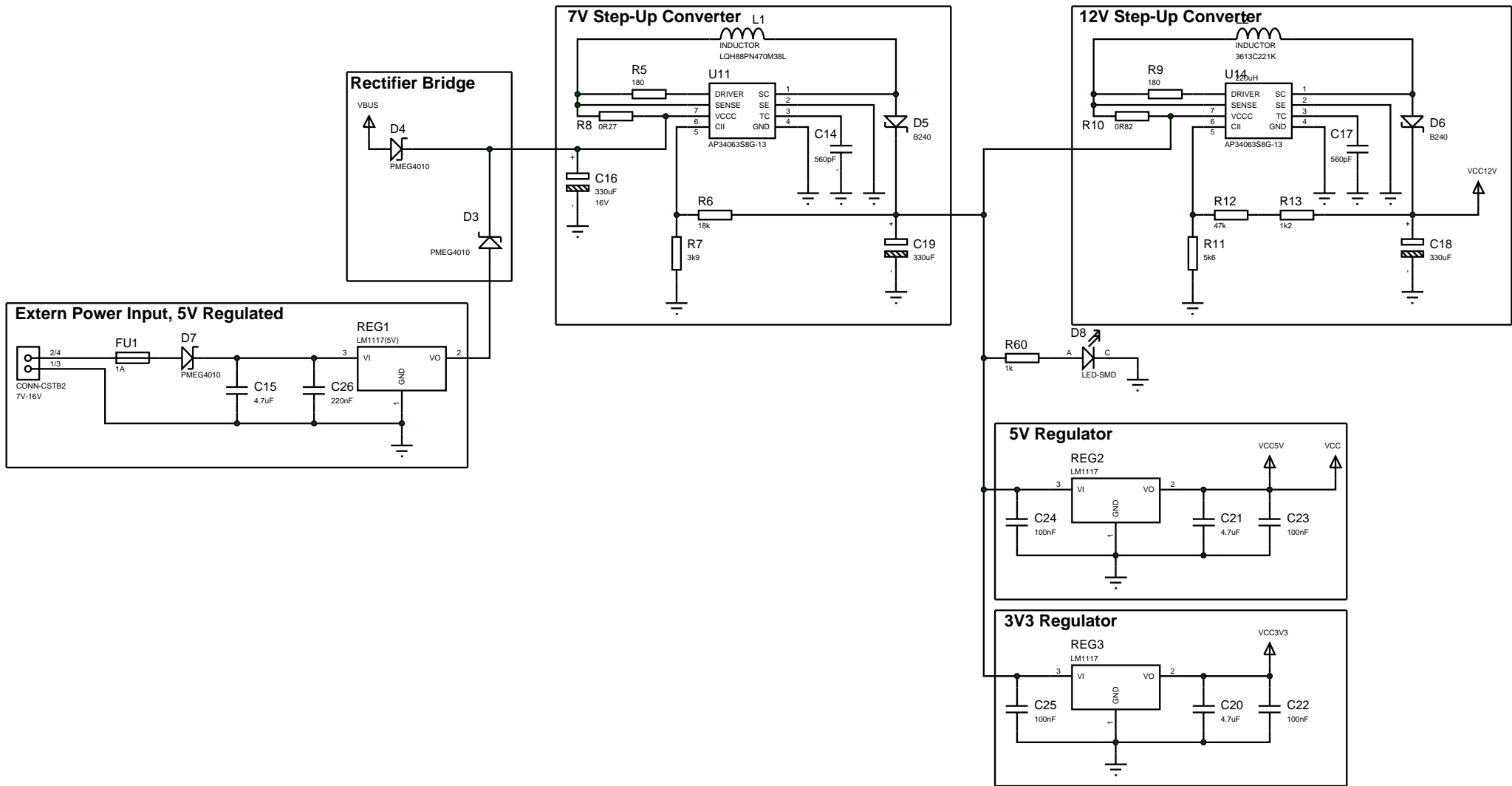
BY: Nimron


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Last modified: 20.08.2011 13:46:35

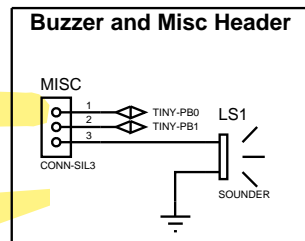
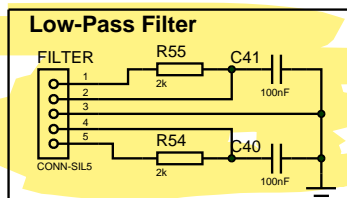
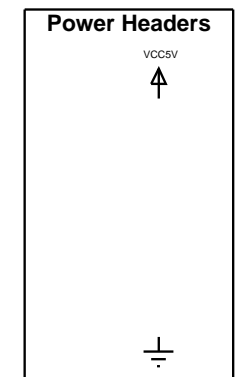
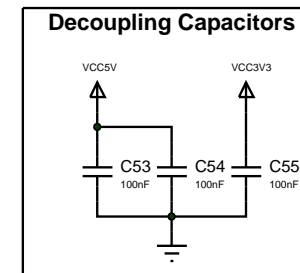
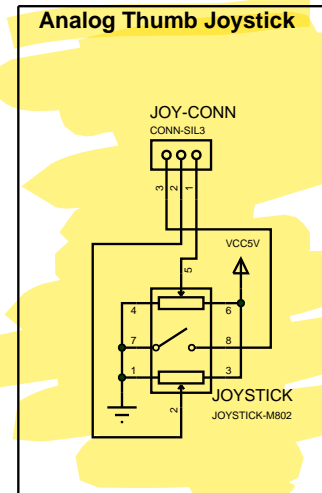
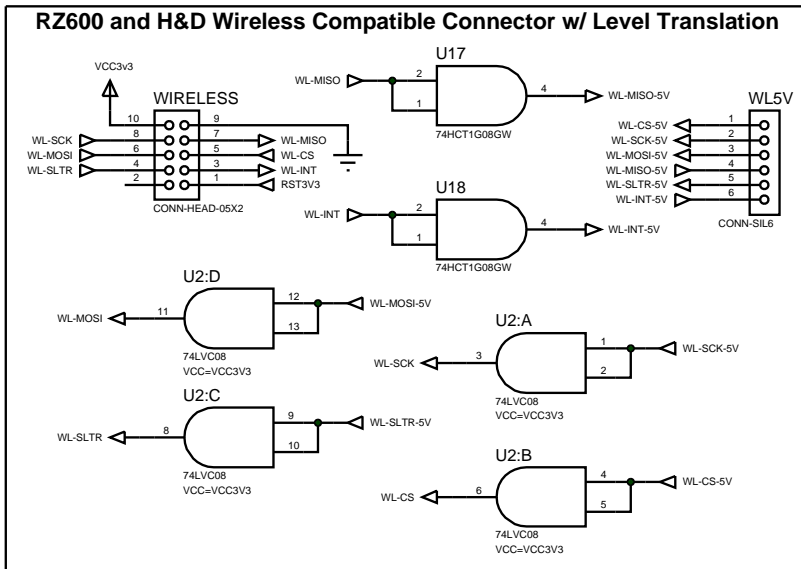
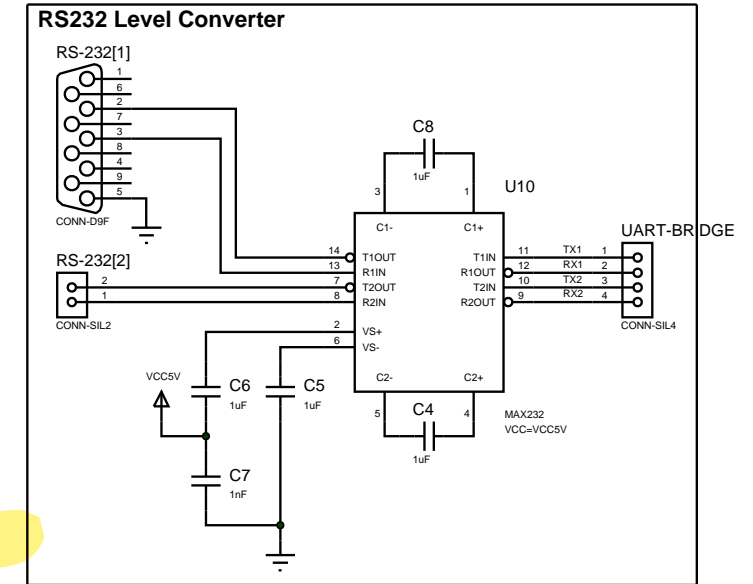
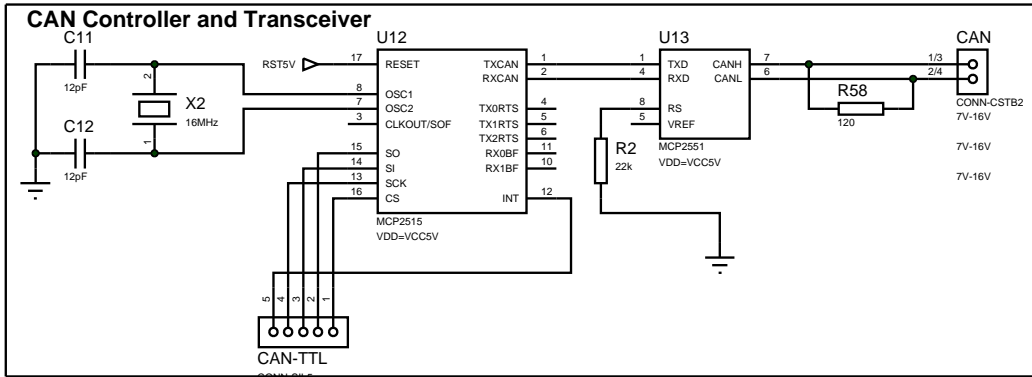
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PAGE: 2 of 5 REV: E



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BY: <b>Nimron</b>	DOC NO:	<NONE>		
PAGE: 3 of 5			REV: E	

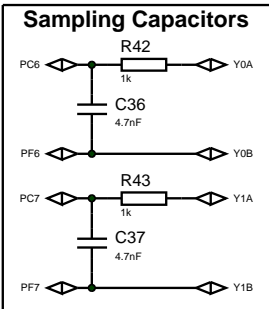


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BY: Nimron	DOC NO: <NONE>		PAGE: 4 of 5	REV: E	

# EMI Suppressors

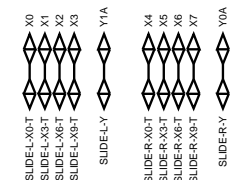
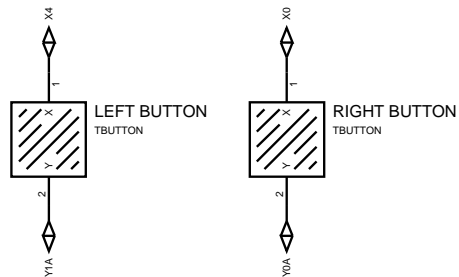
The diagram illustrates the connection of eight EMI suppressor components to various pins and ground. Each component is represented by a rectangle with a diagonal line, indicating a resistor. The components are labeled R49, R46, R48, R47, R44, R45, R84, and R85. The pins are labeled PE7, PE3, PE5, PE4, PC2, PC3, PC4, and PC5. The ground connections are labeled X0, X1, X2, X3, X4, X5, X6, and X7. Each resistor is labeled with its value, 1k.


Component	Pin	Value	Ground
R49	PE7	1k	X0
R46	PE3	1k	X1
R48	PE5	1k	X2
R47	PE4	1k	X3
R44	PC2	1k	X4
R45	PC3	1k	X5
R84	PC4	1k	X6
R85	PC5	1k	X7



## Discharge Resistors

The diagram illustrates the connection of discharge resistors R50 and R51. R50 (470k) is connected between Y0B and a common ground point. R51 (470k) is connected between Y1B and the same common ground point. The common ground point is also connected to SNP. Pins PF5, PE6, and AINO are shown with ground symbols, indicating they are also connected to ground.

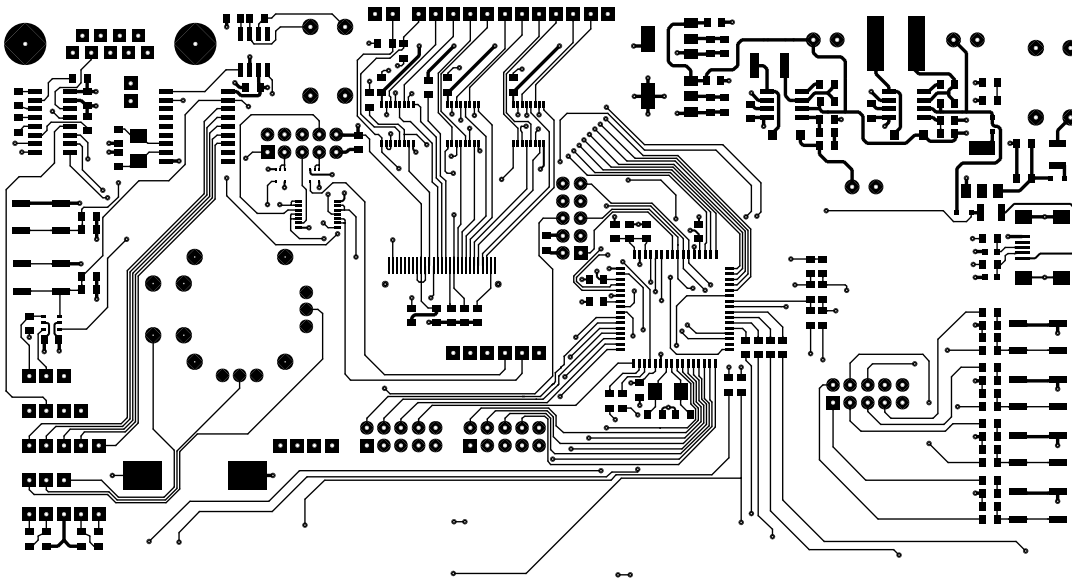


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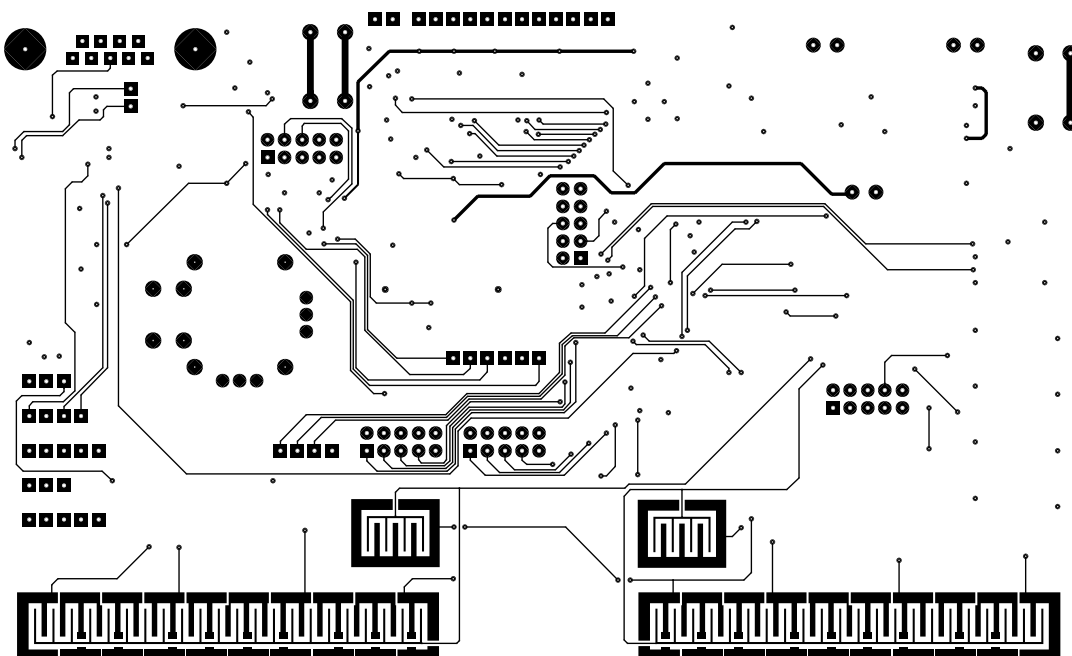
## **Appendix B**

# **Layout**

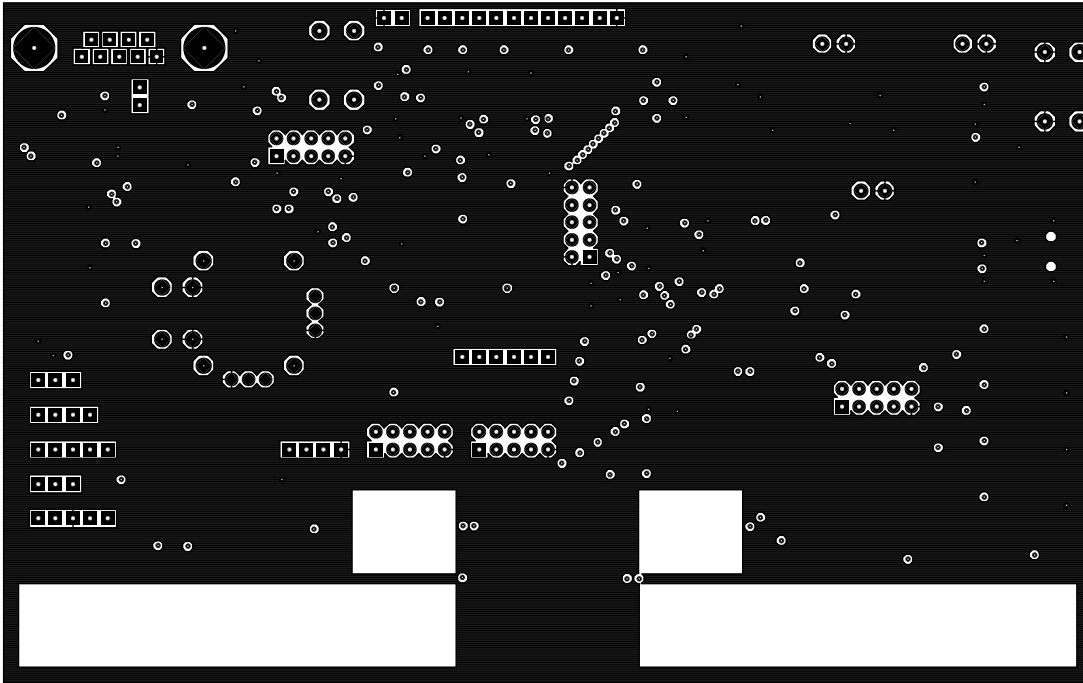
## B.1 Top copper



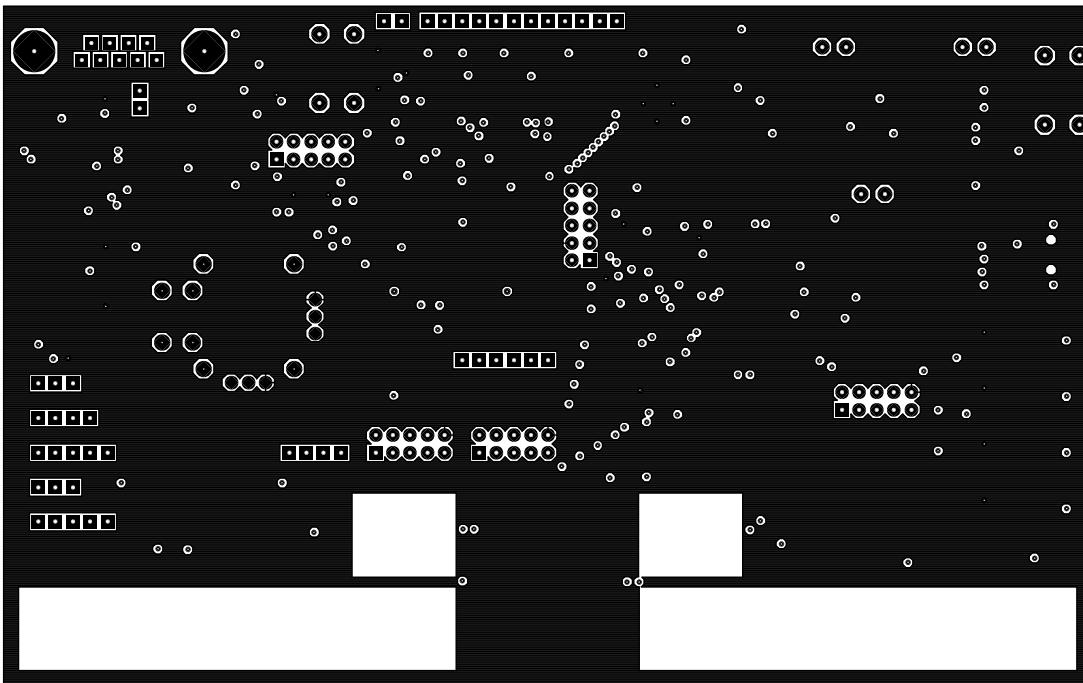
## B.2 Bottom copper

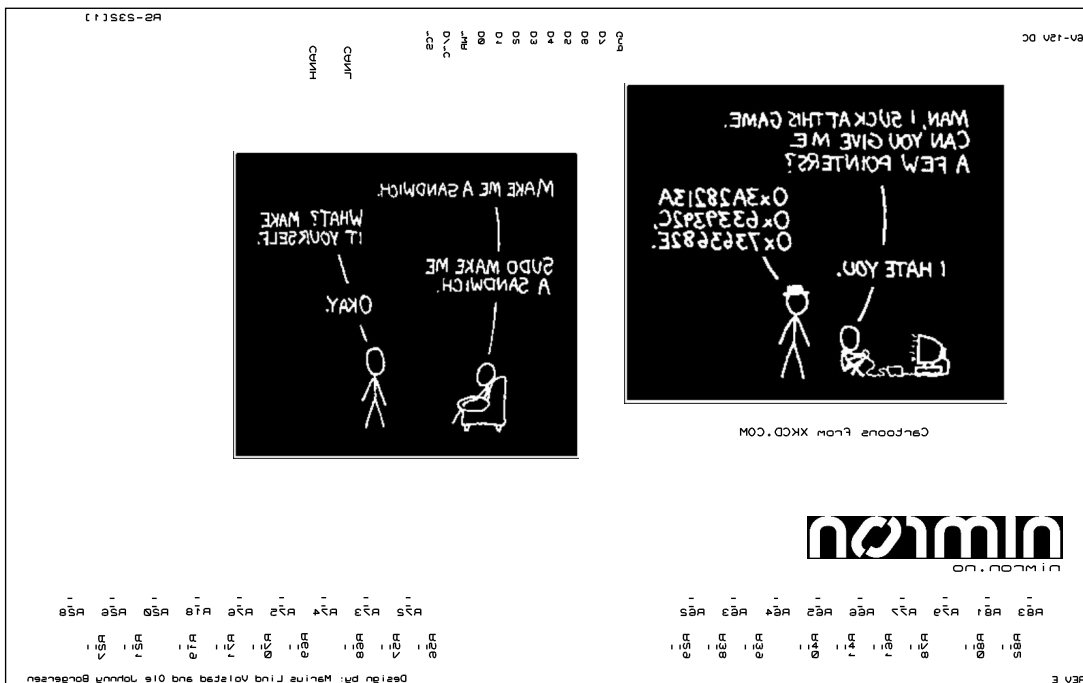
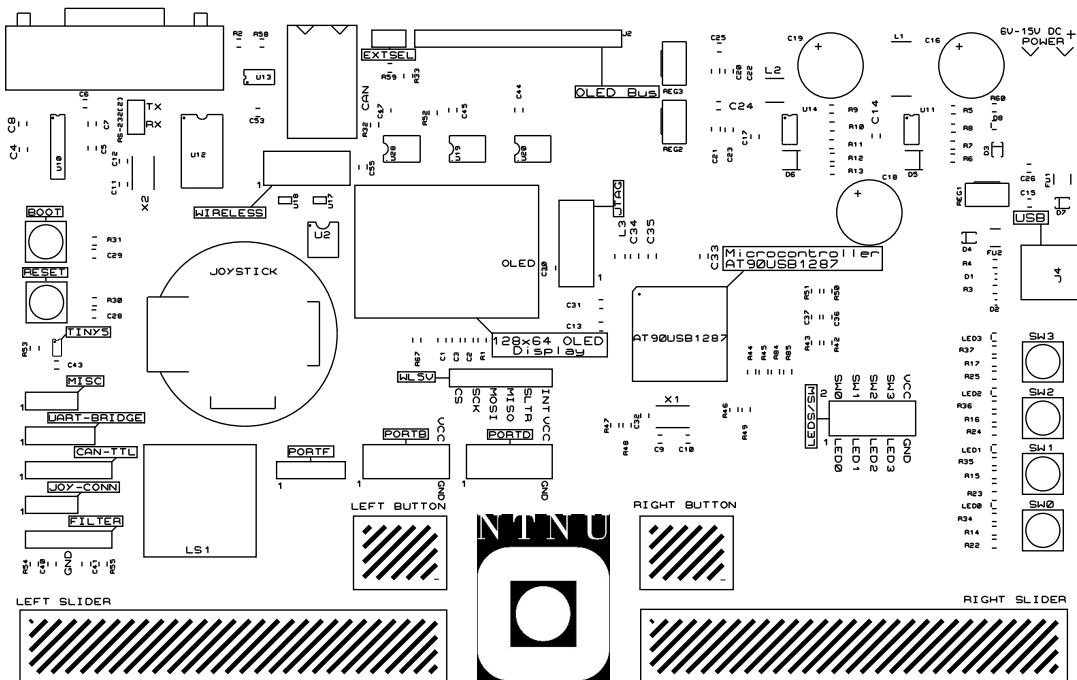


### B.3 Inner layer - GND



### B.4 Inner layer - VCC







## **Appendix C**

### **BOM**

## 85 Resistors

Qty	Ref	Value
1	R1	510k
1	R2	22k
2	R3, R4	22
2	R5, R9	180
1	R6	18k
1	R7	3k9
1	R8	0R27
1	R10	0R82
1	R11	5k6
1	R12	47k
1	R13	1k2
12	R14-R17, R30-R33, R52, R53, R59, R67	10k
18	R18, R20, R26, R28, R62-R66, R72-R77, R79, R81, R83	3k3
18	R19, R21, R27, R29, R38-R41, R56, R57, R61, R68-R71, R78, R80, R82	0R
4	R22-R25	150
4	R34-R37	680
11	R42-R49, R60, R84, R85	1k
2	R50, R51	470k
2	R54, R55	2k
1	R58	120

## 45 Capacitors

Qty	Ref	Value
6	C1, C4-C6, C8, C13	1uF
2	C2, C3	2.2uF
1	C7	1nF
4	C9-C12	12pF
2	C14, C17	560pF
3	C15, C20, C21	4.7uF
3	C16, C18, C19	330uF
19	C22-C25, C30-C35, C40, C41, C43-C45, C47, C53-C55	100nF
3	C26, C28, C29	220nF
2	C36, C37	4.7nF

## 11 Integrated Circuits

Qty	Ref	Value
1	U2	74LVC08
1	U10	MAX232
2	U11, U14	AP34063S8G-13
1	U12	MCP2515
1	U13	MCP2551
2	U17, U18	74HCT1G08GW
3	U19, U20, U28	74257

8 Diodes		
Qty	Ref	Value
2	D1, D2	ESD-S
3	D3, D4, D7	PMEG4010
2	D5, D6	B240
1	D8	LED-SMD
48 Miscellaneous		
Qty	Ref	Value
1	AT90USB1287	AT90USB1287
6	BOOT, RESET, SW0-SW3	TACT-SW
2	CAN, POWER	CONN-CSTB2
2	CAN-TTL, FILTER	CONN-SIL5
1	EXTSEL	JUMPER
1	FU1	1A
1	FU2	0.5A
1	J2	CONN-SIL12
1	J4	CONN-USB-MINI
2	JOY-CONN, MISC	CONN-SIL3
1	JOYSTICK	JOYSTICK-M802
5	JTAG, LEDS/SW, PORTB, PORTD, WIRELESS	CONN-HEAD-05X2
2	L1, L2	INDUCTOR
1	L3	BLM21AG102SN1D
4	LED0-LED3	LED-SMD
2	LEFT BUTTON, RIGHT BUTTON	TBUTTON
2	LEFT SLIDER, RIGHT SLIDER	FINGER-SLIDER
1	LS1	SOUNDER
1	OLED	OLED-LY190-128064
2	PORTF, UART-BRIDGE	CONN-SIL4
1	REG1	LM1117(5V)
2	REG2, REG3	LM1117
1	RS-232[1]	CONN-D9F
1	RS-232[2]	CONN-SIL2
1	TINY5	ATTINY4/5/9/10
1	WL5V	CONN-SIL6
2	X1, X2	16MHz