UIB-PC104

User Interface Board

Product manual

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Version 2.0

UIB-PC104 Product manual

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Scope

This document applies to UIB-PC104 hardware revision V1.0.

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Contents

Icons

Following is shown the meaning of the icons that reader can find on this manual.

Information
Provides the user with tips and tricks and other useful data.

Warning
Provides the user with important information. Omitting this warning may cause the device not to work properly.

Critical Warning
Provides the user with critical information. Omitting this critical warning may destroy the device.

1 Overview

This chapter presents an overview about UIB-PC104, its range of applicability and its connectivity options together with iCM4011.

What is UIB-PC104?

UIB-PC104 (see Figure 1) is a User Interface Board that enables the interaction between humans and control modules connected to its main socket, through input and output sources (widely known as human interfaces).

The design of a user interface affects the amount of effort the user must expend to provide input for the system and to interpret the output of the system, and how much effort it takes to learn how to do this. The design of UIB-PC104 has been performed taken special care of its usability to provide users with an **efficient** and **effective** training tool.

The board has the following interfaces:

- Six LEDs
- 16x2 alphanumeric LCD with backlight
- 122x32 graphic LCD with backlight
- Two potentiometers
- Twelve pushbuttons
- One buzzer

In addition, the board has a set of connectors dedicated to multiple purposes: A DB9 connector used for communications, a screw connector to power the board and an expansion bus. The board also comes with switches to select the working mode of the board.

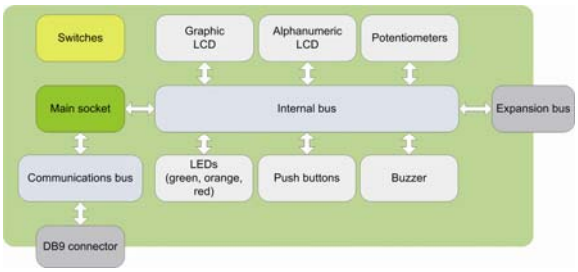

Figure 1: Block diagram

Image 1: UIB-PC104

UIB-PC104 is a perfect complement for control modules (such as iCM4011) when facing to initial training and new designs based on them.

iCM4011 communication module is an embeddable module that incorporates a powerful hybrid DSP/MCU (up to 30MIPS) in conjunction with a full set of transceivers (USB, RS232, RS485 and CAN). In addition, the processor is equipped with intra-board communications like SPI or I^2C. Refer to iCM4011 Product Manual for further information.

In order to use the UIB-PC104 together with the iCM4011, just plug the module in the UIB-PC104 socket (see Figure 2) and run any of the examples delivered with this product.

Figure 2: UIB-PC104 with iCM4011

UIB-PC104 has been designed following a stackable architecture (see Figure 3) and complying with the dimensions (90x96mm) and drills of the PC/104[1] standard. It is possible to stack multiple boards to fulfill specific user needs. For example, to drive and control an electric motor, you could stack an expansion board with motor drivers and a signal conditioning stage for multiple sensors.

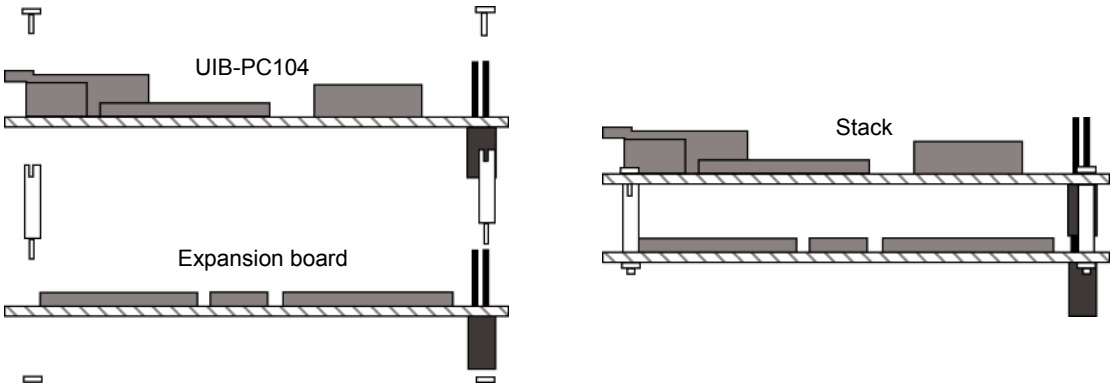

Figure 3: Stack PC/104

In the following chapter, the reader will find a detailed functional description of each component of the UIB-PC104, as well as their relationship with the pins of the main socket.

[1] *www.pc104.org PC/104 Consortium website*

2 Functional description

In this chapter the reader will find a detailed description about all functional blocks of the UIB-PC104.

Introduction

Image 2 shows the physical distribution of UIB-PC104 functional blocks, and following subchapters go deeply into them.

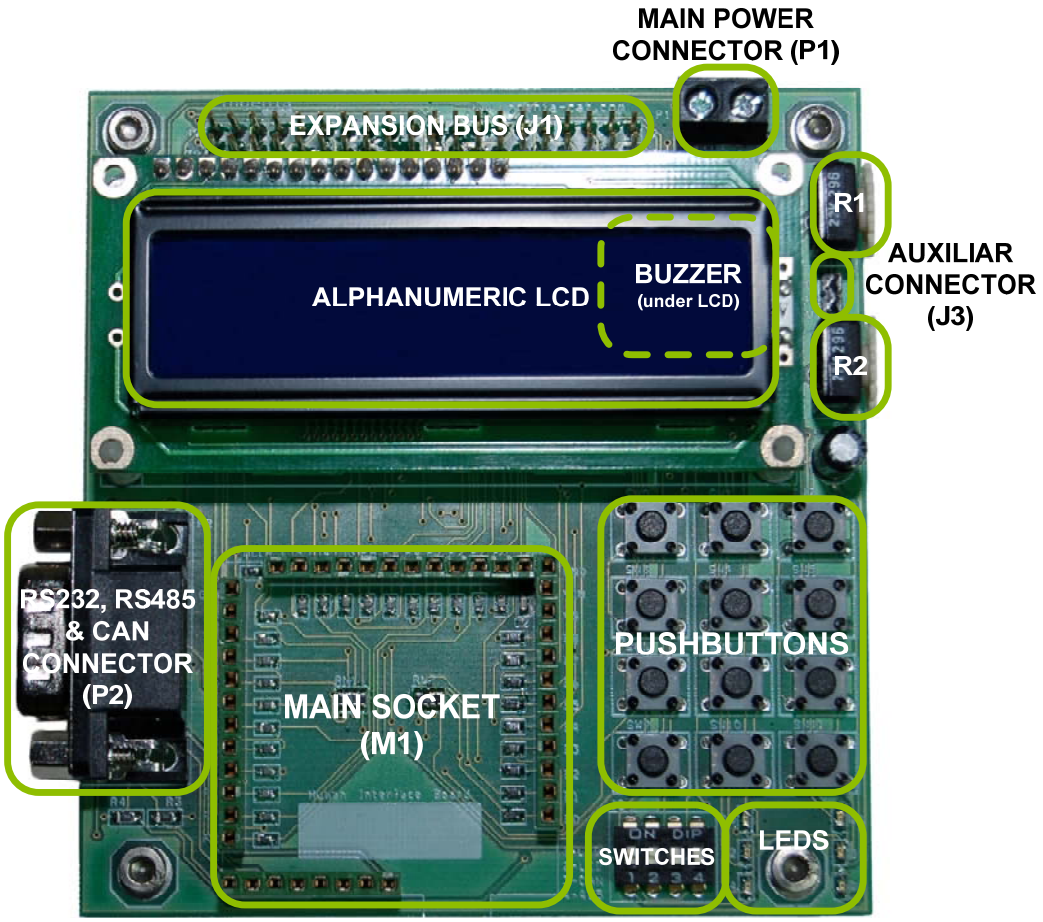

Image 2: UIB-PC104 functional diagram

Main socket

The main socket (M1) of UIB-PC104 is the place to plug the control module (iCM4011 or similar). The module connected to this socket may access to all peripherals of the board.

In this socket there are the power pins (VIN, GND and V5), as well as the connections to the signals of the P2 connector.

Note that the main socket has the same pinout as the iCM4011.

Power

UIB-PC104 has been made up with passive and electromechanical components, with the exception of the liquid crystal display (LCD). In order to power it, a terminal connector (P1) has been added to the board. The voltage on its pins is rectified and applied to pins VIN (Pin 2) and GND (Pin 1) of the main socket M1 (see Figure 5). The user must regulate the voltage at VIN to 5 volts and further redirect it to pin V5 (Pin 3 of M1) in order to power the LCD with the correct supply voltage (see Figure 4).

Never apply a voltage greater than +5V between V5 and GND. In addition, never inverse the polarity between GND and V5. Both cases may damage the UIB-PC104 as well as the modules connected to its main socket.

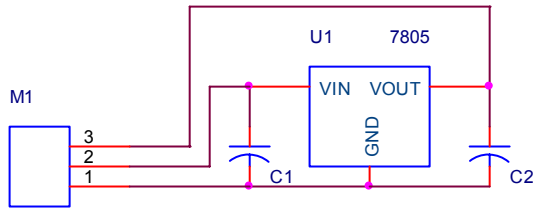

Figure 4: Adding a voltage regulator to M1

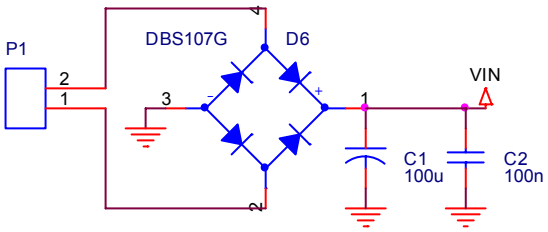

Figure 5: Main power connector

Note that the iCM4011 has this voltage regulator included. It is capable to deliver 5V/100mA to V5, which is enough to power the UIB-PC104.

The following table shows the pins of the main socket dedicated to power supply (see the UIB-PC104 schematics):

Main socket (M1)	Pin
VIN	2
V5	3
GND	1,15,18,32

Table 1: Main socket

Powering the UIB-PC104 together with the iCM4011 is quite straight forward. Just power the ensemble through P1 (see Image 3) or connect the USB cable to iCM4011 (see Image 4).

Remember that iCM4011 is capable to automatically switch between the different power sources.

Image 3: Powering through P1

Image 4: Powering through USB

Image 5: Powering through P1 and USB

Note that the UIB-PC104 together with the iCM4011 may be powered simultaneously through USB and main power connectors (see Image 5).

The signals V5 and GND are present in the expansion bus (J1) as well as in an additional connector (J3) in order to give to the user the maximum flexibility and connectivity. The signal VIN is also present in the expansion bus. The following tables resume the pins used in both connectors.

Expansion bus (J1)	Pin
VIN	2
V5	1
GND	16

Table 2: Expansion bus

Additional connector (J3)	Pin
V5	2
GND	1

Table 3: Additional connector

Expansion bus

UIB-PC104 has been designed following a stackable architecture. It uses a 40-pin expansion bus and complies with PC/104 standard for dimensions and drills.

Note that the connector has been reversed upside down with respect to standard PC/104 boards in order to protect the pins when developing in the lab and to provide an easiest access to probes.

Figure 6 shows the schematic of the expansion bus. Below the reader can find a detailed list with the connector pin assignment.

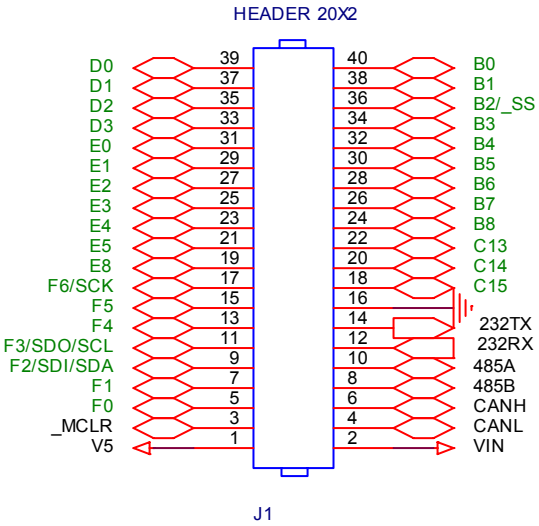

Figure 6: Expansion bus

Interface	Pin
CANL	4
CANH	6
485B	8
485A	10
232RX	12
232TX	14

Table 4: Interface pin assignment

Pin iCM4011	Pin
B0	40
B1	38
B2/_SS	36
B3	34
B4	32
B5	30
B6	28
B7	26
B8	24
C13	22
C14	20
C15	18
D0	39
D1	37
D2	35
D3	33
E0	31
E1	29
E2	27

E3	25
E4	23
E5	21
E8	19
F0	5
F1	7
F2/SDI/SDA	9
F3/SDO/SCL	11
F4	13
F5	15
F6/SCK	17

Table 5: iCM4011 pin assignment

Power and reset	Pin
VIN	35
V5	33
GND	16
_MCLR	3

Table 6: Power and reset pin assignment

Be extremely careful when connecting your design to the expansion bus. Keep in mind that other devices are connected, and they may not work properly or could be damaged.

Communications

The following subchapter is devoted to the UIB-PC104 with the iCM4011.
UIB-PC104 together with iCM4011 allows the user to interface with multiple communications, such as:

- USB
- RS232
- RS485
- CAN
- SPI
- I^2C

The USB interface is directly accessible in the iCM4011 module. The interfaces requiring transceivers (i.e., RS232, RS485 and CAN) are accessible through the standard male DB9 connector as well as through the expansion bus. Intra-board interfaces (SPI and I^2C) are only accessible through the expansion bus.

CAN, RS232 y RS485

The board includes a DB9 male connector in right angle, which allows for accessing to the RS232, RS45 and CAN signals of the iCM4011 module. Figure 7 shows the pinout of this connector.

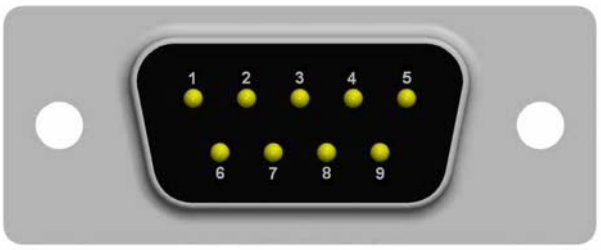

Figure 7: DB9 male connector (Front view)

DB9 male	Connector	Pin
Not connected	P2	1
232RX (Receive, RX, RxD,…)	P2	2
232TX (Transmit, TX, TxD,…)	P2	3
CANH (CAN High)	P2	4
GND (Ground)	P2	5
CANL (CAN Low)	P2	6
485B (Inverting)	P2	7
485A (Non inverting)	P2	8
Not connected	P2	9

Table 7: DB9 pinout

The board has 120Ω terminator resistors for RS485 and CAN buses. To activate the termination the proper switch in the component J2 needs to be enabled.

Bus termination	Component	Position
120Ω resistor between 485A and 485B	J2	4
120Ω resistor between CANH and CANL	J2	3

Table 8: Bus termination

RS232, RS485 and CAN communication interfaces are also accessible through the expansion bus.

Do not forget to correctly set the jumper J8 in the iCM4011 module according to the interface you want to use. Refer to iCM4011 Product Manual for further information.

SPI, I²C

UIB-PC104 also allows for accessing to intra-board communications of the iCM4011 module (SPI and I²C). These are accessible exclusively through the expansion bus.

Table 9 and Table 10 show the pins of J1 used for each interface.

SPI	Connector	Pin
SDI	J1	9
SDO	J1	11
SCK	J1	17

_SS	J1	36

Table 9: SPI interface

I²C	Connector	Pin
SDA	J1	9
SCL	J1	11

Table 10: I²C interface

Please refer to Microchip's dsPIC30F4011 datasheet for a detailed description of each communication interface.

LCDs

UIB-PC104 comes with two liquid crystal displays: a 16x2 alphanumeric display and a 122x32 graphic display.

Each display type has its own dedicated connector and its use is mutually exclusive. Here below the user may find the characteristics and interfaces of both displays.

Alphanumeric LCD

The alphanumeric CFAH1602BTMIJP LCD is a super twist nematic (STN) LCD with 2 rows of 16 chars each with white backlight. The characters are shown with negative yellow impression over a blue background.

Figure 8: Alphanumeric LCD *front view*

Figure 9: Alphanumeric LCD *back view*

The LCD is based on a HD44780 controller, which enables both 4 and 8 bit interface with the main module.

Refer to CFAH1602BTMIJP Product manual and to HD44780 Product manual for further information on alphanumeric LCD.

The pins of the main socket used to interface with the display are listed in Table 11:

LCD 16x2	Main socket (M1) pin
DB7	D3
DB6	D2
DB5	D1
DB4	D0
DB3 (*)	F5

DB2 (*)	F4
DB1 (*)	F1
DB0 (*)	F0
R/_W	E8
READ STROBE	C15
ENABLE	B6

Table 11: LCD interface

(*) Not used in 4-bit interface mode

If you plan to use multiple input/outputs in your designs, it is strongly recommended to interface the LCD using the 4-bit mode. This will free the usage of pins F5, F4, F1 and F0 in the main socket.

The contrast of the LCD may be adjusted by varying the variable resistor R2.

Remember that the potentiometer R2 is also connected to pin B8 of the iCM4011. If the LCD is used in your application, it is strongly recommended not using this potentiometer for other purposes.

The LCD may be activated/deactivated through the appropriate switch in component J2. If the application does not require the LCD, it is recommended to disable it.

LCDs	Component	Position
LCD enabling/disabling	J2	2

Table 12: Alphanumeric LCD activation/deactivation

Graphic LCD

The graphic LCD is a super twist nematic (STN) LCD of 122x32 pixels with green backlight. The characters are shown with positive grey impression over a yellow background.

Figure 10: Graphic LCD *front view*

Figure 11: Graphic LCD *back view*

The graphic LCD, based on two SED1520 controllers, allows only for 8-bit interface mode.

Refer to CFAG12232DYYHN Product manual and to SED1520 Product manual for further information.

The pins of the main socket used to interface with the display are listed in the next table:

LCD 122x32	Main socket (M1) pin

DB7	D3
DB6	D2
DB5	D1
DB4	D0
DB3	F5
DB2	F4
DB1	F1
DB0	F0
R/_W	E8
READ STROBE	C15
ENABLE1	B6
ENABLE2	B5

Table 13: Graphic LCD interface

The contrast of the LCD may be adjusted varying the potentiometer R2.

Remember that the potentiometer R2 is also connected to pin B8 of the main socket. If the LCD is used in your application, it is strongly recommended not using this potentiometer for other purposes.

The LCD may be activated/deactivated through the appropriate switch in component J2. If the application does not require the LCD, it is recommended to disable it.

LCDs	Component	Position
LCD enabling/disabling	J2	2

Table 14: Graphic LCD activation/deactivation

LEDs

The board contains two groups of three LEDs (red, yellow and green) each connected in common cathode. The anode of each LED is connected to a main socket pin through a total resistance of 1120Ω. Setting up the pin to logic high value will light the LED connected to that pin. Table 15 shows the pin-LEDs connections:

LED	Main socket (M1) pin
D0 (Red)	E0
D1 (Red)	E1
D2 (Yellow)	E2
D3 (Yellow)	E3
D4 (Green)	E4
D5 (Green)	E5

Table 15: LEDs connections

The entire group of six LEDs may be activated/deactivated by using the appropriate switch in component J2. If the application does not require the LEDs usage, it is recommended to disable them.

LEDs	Component	Position
LEDs and buzzer enabling/disabling	J2	1

Table 16: LEDs and buzzer activation/deactivation

Potentiometers

UIB-PC104 has two variable resistors (potentiometers) directly connected to the pins B7 and B8 of the main socket. This allows to the control module plugged into the main socket to perform measures of analog voltages between 0 and 5V. Table 17 shows the pins of M1 used for this purpose.

Potentiometer	Main socket (M1) pin
R1	B7
R2	B8

Table 17: Potentiometer pins

The potentiometer R1 is always enabled and its wiper applies a variable voltage between 0 and 5V to the pin B7.

The potentiometer R2 may be enabled/disabled through the switch 2 of the component J2. When activated, its wiper applies a variable voltage between 0 and 5V to the pin B8 of the main socket. This potentiometer is also used to adjust the contrast of the LCD modules.

R2 potentiometer	Component	Position
LCD and R2 enabling/disabling	J2	2

Table 18: R2 potentiometer and LCD activation/deactivation

Remember that the potentiometer R2 is also connected to pin B8 of the main socket. If the LCD is used in your application, it is strongly recommended not using this potentiometer for other purposes.

Pushbuttons

UIB-PC104 contains a pushbutton matrix of four rows and three columns. In order to read the status of each button, the user has to read the entire matrix in a column by column basis (see Figure 12).

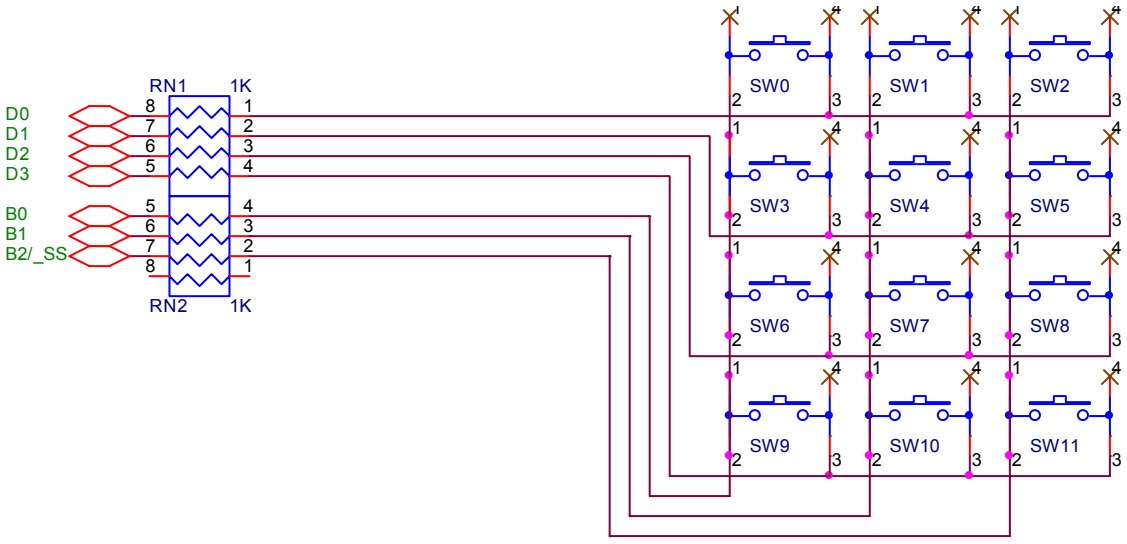

Figure 12: Pushbutton matrix

Pushbutton	Row	Column
SW0	0	0
SW1	0	1
SW2	0	2
SW3	1	0
SW4	1	1
SW5	1	2
SW6	2	0
SW7	2	1
SW8	2	2
SW9	3	0
SW10	3	1
SW11	3	2

Table 19: Pushbuttons

Row	Main socket (M1) pin
0	D0
1	D1
2	D2
3	D3

Table 20: Matrix rows

Column	Main socket (M1) pin
0	B0
1	B1
2	B2/_SS

Table 21: Matrix columns

First of all, to read the status of all pushbuttons of the matrix, the user needs to configure the pins corresponding to rows 0 to 3 as digital inputs. Then, configure the pins corresponding to columns 0 to 2 as digital outputs.
Once this is done, the user may scan the keyboard matrix in a column basis. Figure 13 shows the read process for the first column of the matrix. The user has to force a logic-low in the first column (green) and after doing that, he can read the values in all the columns. The logic-low will be propagated through the activated pushbuttons (blue).

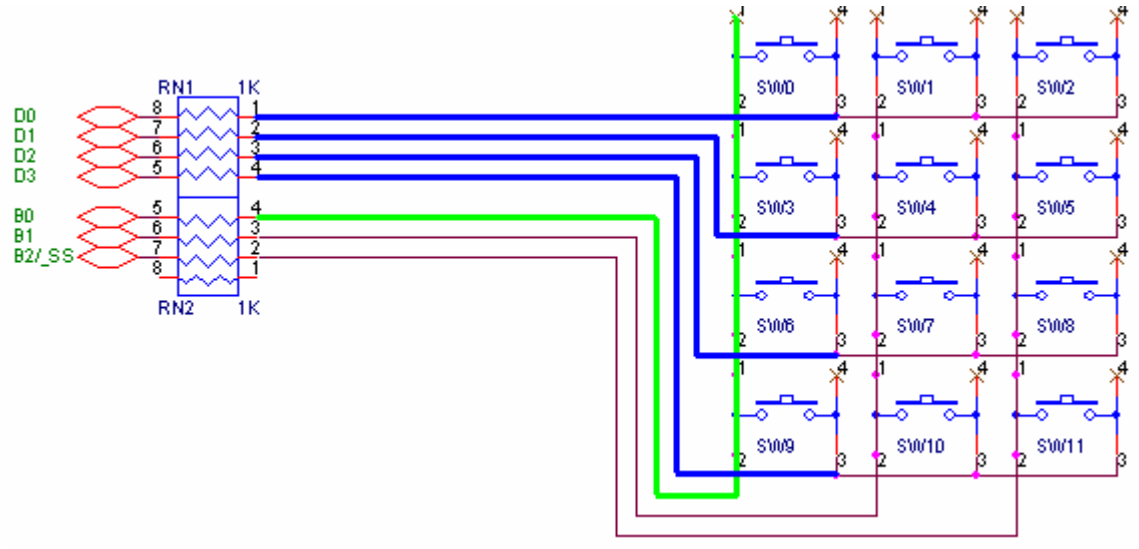

Figure 13: Reading the first column of the matrix

This process needs to be repeated for the two remaining columns in order to read the entire matrix.

The complete algorithm is as follows:

- `Configure D0, D1, D2 and D3 as digital inpust`
- `Configure B0, B1 and B2/_SS as digital outputs`
- `For the columns c = 0..2`
  - `Force output to logic-low for this column and logic-high for the remaining.`
  - `Read the value for the rows r=0..3`

Buzzer

The UIB-PC104 contains a buzzer, located just below the alphanumeric LCD. This buzzer is capable to deliver a sound pressure of 80dBs at 10cm.

In spite of the fact that its resonant frequency is 4000±500Hz, the buzzer may generate tones in the range of 1KHz to 10KHz. To generate them, the buzzer must be excited at the desired frequency through the B7 pin of the main socket M1.

Buzzer	Main socket (M1) pin
PZ1	B7

Table 22: Buzzer pin

Remember that B7 is also used for the UIB-PC104 as a connection point for R1 potentiometer's whiper.

If the user wants to use this pin for other purposes rather than exciting the buzzer, it is recommended to disable the buzzer by switching off the first position of the configuration switches.

Buzzer	Component	Position
Buzzer and LEDs enabling/disabling	J2	1

Table 23: Buzzer and LEDs activation/deactivation

Be aware that the same switch in J2 also enables and disables the LEDs.

Configuration switches

The board contains four configuration switches, grouped into J2 component. Switches in positions 1 and 2 are used to enable/disable the LEDs, the buzzer, the R2 and the LCDs respectively. Switches in the third and fourth positions are used to terminate CAN and RS485 buses with 120Ω resistors.

Table 24 shows the purpose of each switch:

Switches	Component	Position
LEDs and Buzzer enabling/disabling	J2	1
LCDs and R2 enabling/disabling	J2	2
120Ω resistor between CANH and CANL	J2	3
120Ω resistor between 485A and 485B	J2	4

Table 24: Switches

3 Usability matrix

Use and access to UIB-PC104 interfaces.

How to use UIB-PC104 interfaces?

Table 25 shows a list with all hard-wired connections of the main socket of the UIB-PC104 to each of its peripherals.

In the table we can see, for example, that pin B7 is used for both the buzzer and the Digital to Analog converter. Because of this, it is not possible to use this pin to drive the buzzer and perform A/D readings simultaneously. However, it is possible to time multiplex these operations.

The iCM4011 has also a usability matrix, which completes the matrix presented in this manual when using the UIB-PC104 together with the iCM4011.
Refer to iCM4011 Product Manual for further information.

	AD	Buzzer	Pushbutt.	LEDs	Alphanum LCD 4-Bit	Alphanum LCD 8-Bit	Graphic LCD
B0			X				
B1			X				
B2			X				
B3							
B4							
B5							X
B6					X	X	X
B7	X	X					
B8	X				X	X	X
C13							
C14							
C15					X	X	X
D0			X		X	X	X
D1			X		X	X	X
D2			X		X	X	X
D3			X		X	X	X
E0				X			
E1				X			
E2				X			
E3				X			
E4				X			
E5				X			
E8					X	X	X
F0						X	X
F1						X	X
F2							
F3							
F4						X	X
F5						X	X
F6							

Table 25: Usability matrix

Appendix A. Mechanical specifications

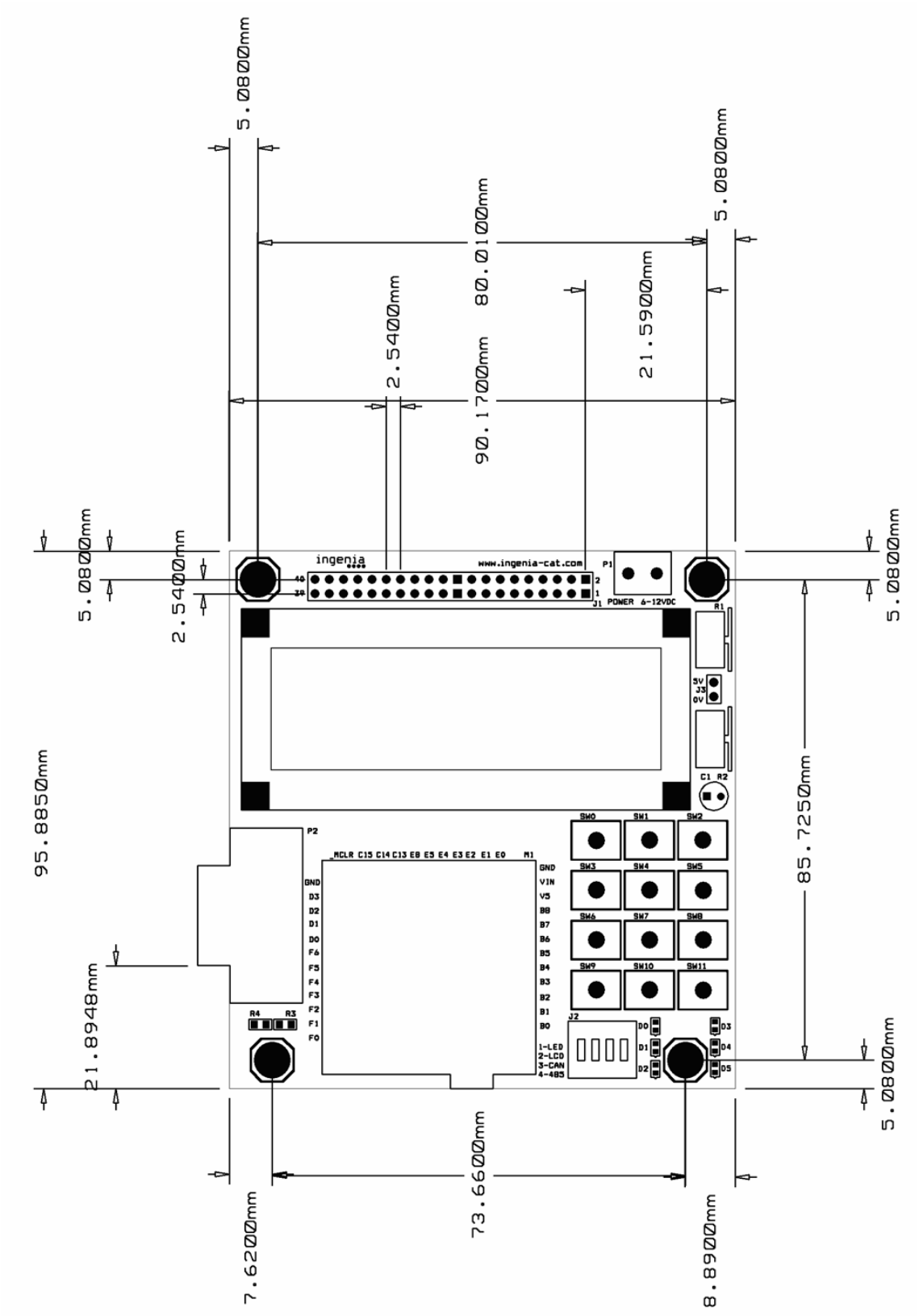

Figure 14: UIB-PC104 mechanical specifications

Appendix B. Schematics

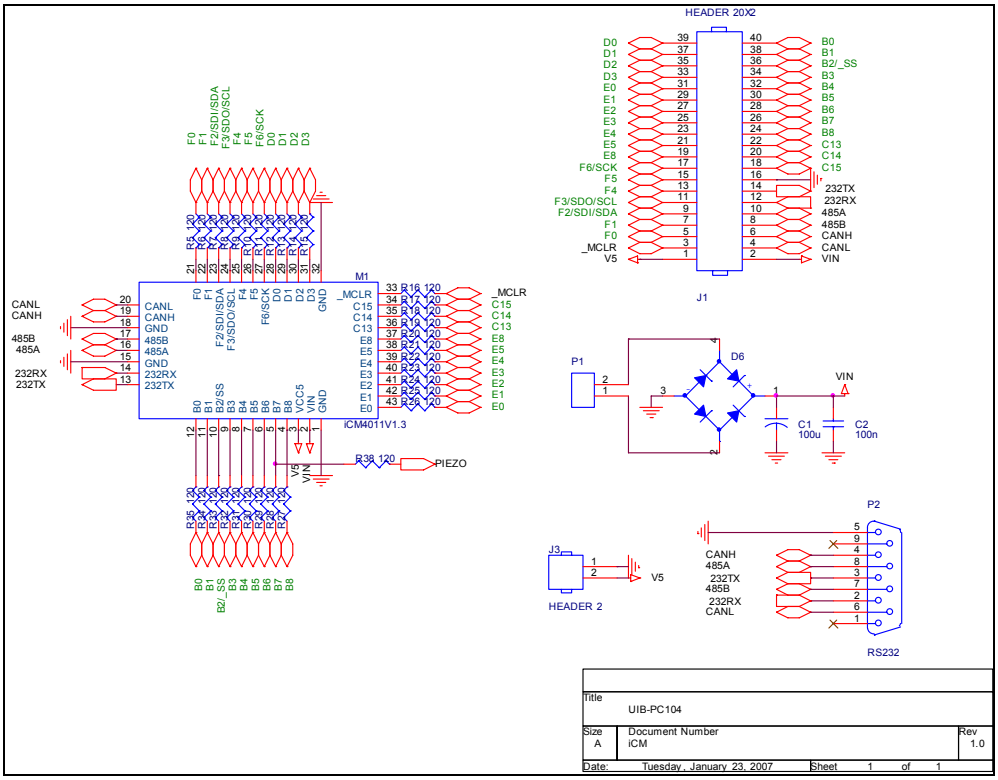

Figure 15: UIB-PC104 schematic (1/3)

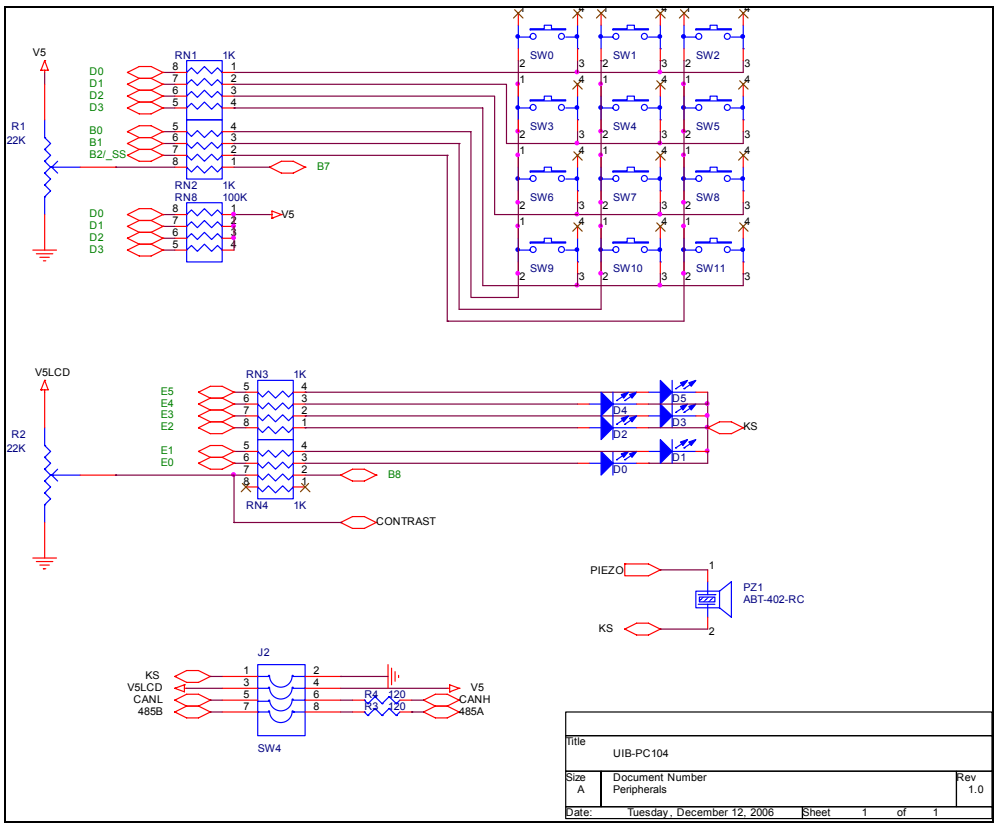

Figure 16: UIB-PC104 schematic (2/3)

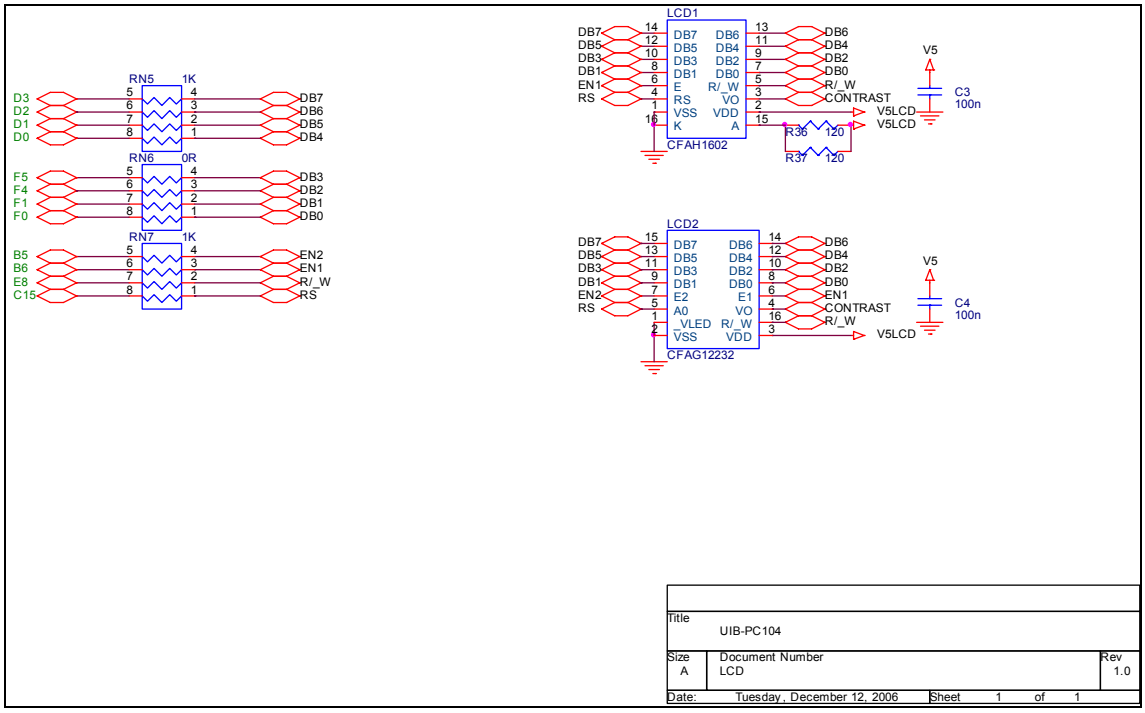

Figure 17: UIB-PC104 schematic (3/3)

References

ingenia *“iCM4011 Product manual”*
ingenia *“UIB PC104 Examples guide for iCM4011”*
Microchip *“dsPIC30F4011/4012 Data Sheet”*. DS70135
Microchip *“dsPIC30F Family Reference Manual”*. DS70046
Crystalfontz *“CFAH1602BTMIJP text LCD Data Sheet”*
Crystalfontz *“CFAG12232DYYHN graphic LCD Data Sheet”*
Hitachi *“HD44780 Dot Matrix Liquid Crystal Display Controller/Driver”*
Epson *“SED1520 Dot Matrix LCD Driver Data Sheet and Design Guide”*