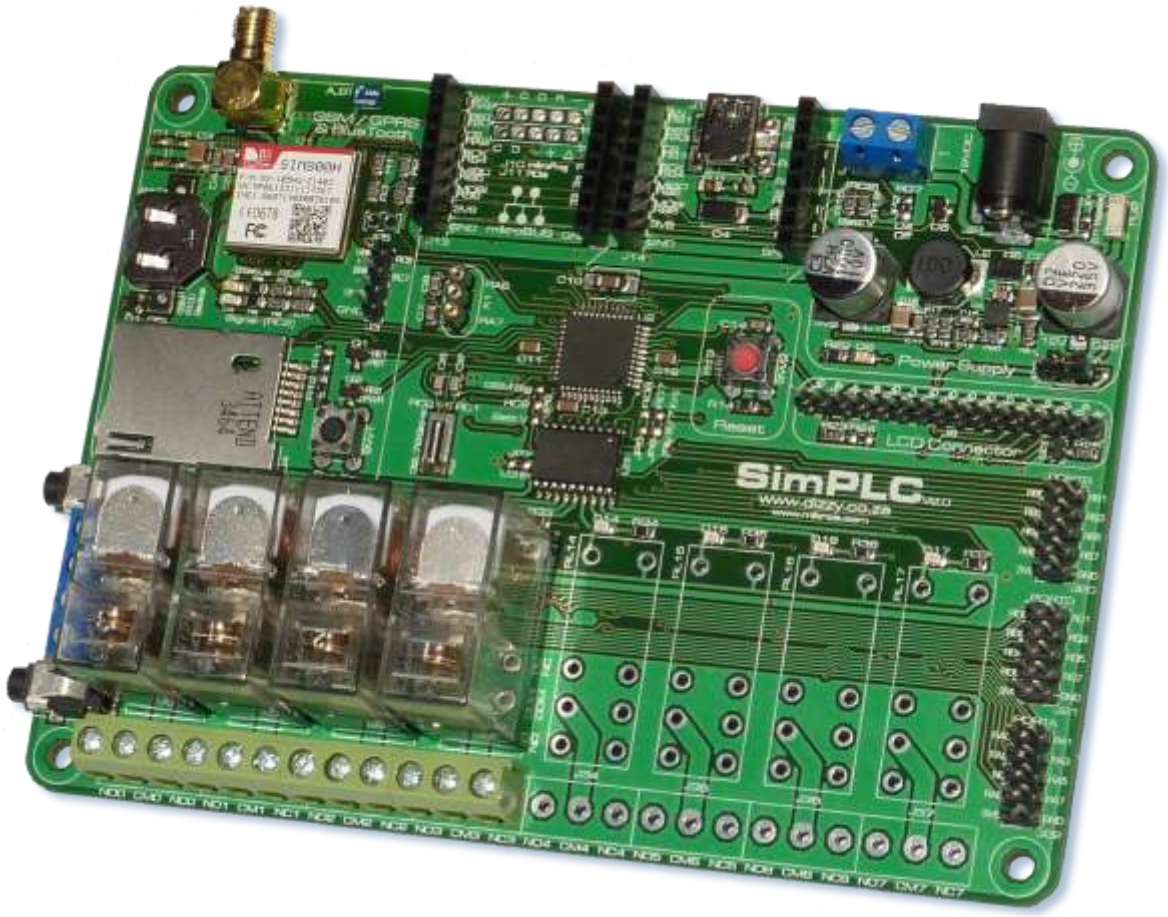
SimPLC

v2.0



User Manual

DIZZY enterprises

www.dizzy.co.za

Contents

Introduction

The SimPLC is a compact and cost-effective platform which is targeted at remote control / monitoring applications. It includes the following features:

Relays

- Up to 8 relays (rated at 16A/250VAC) allow external devices (such as lights, pumps, security devices, etc) to be switched on and off.

GSM/GPRS/BlueTooth Communication

- The SIM800 GSM/GPRS/BlueTooth module provides a convenient means of wireless communication to/from the board.

RTCC (Real-Time Calendar and Clock)

- The PIC18F46J50 microcontroller features a built-in RTCC (real-time calendar and clock), allowing you to perform tasks at set dates / times.

Inputs and Outputs

- Two mikroElektronika (www.mikroe.com) mikroBus sockets allow the functionality of the system to be easily extended by plugging in any of a huge range of "click" accessory boards. One application of this is to add up to 8 opto-coupled inputs to the board (using OPTO click boards).
- Ports A, B and D are also exposed via IDC10 headers on the right-hand side of the board, providing convenient access to any free inputs/outputs. (mikroElektronika IDC10 type accessory boards can also be plugged into these headers).

USB

The microcontroller on the SimPLCv2 (PIC18F46J50, or PIC18F47J53 on newer boards) also features built-in USB, and the board includes a miniUSB connector in order to take advantage of this. This feature could be used to configure the board, and/or for in-field firmware updates (via the pre-programmed USB bootloader).

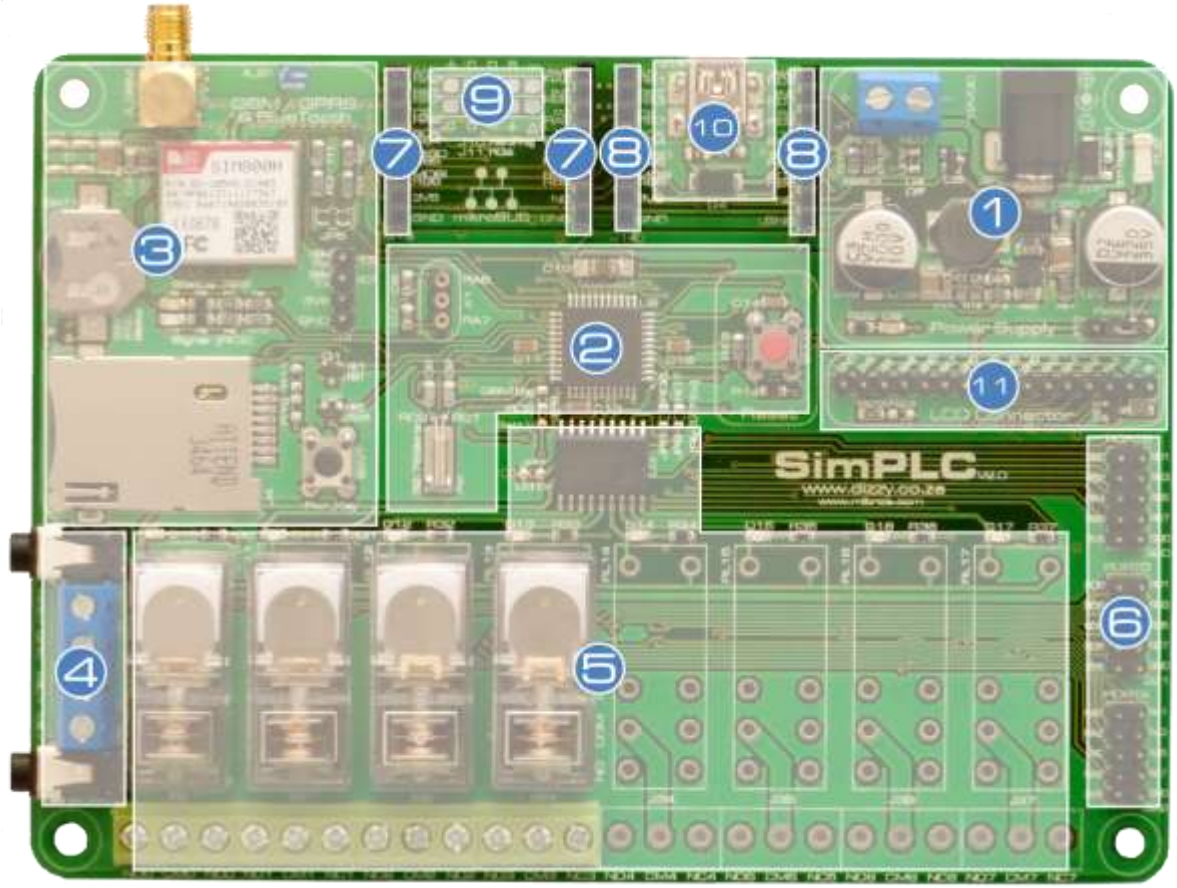
LCD Display Connector

- A convenient Alphanumeric LCD Display connector is included on the board.

FM Radio

- The SIM800 also features an FM radio (speaker line is used as the antenna).

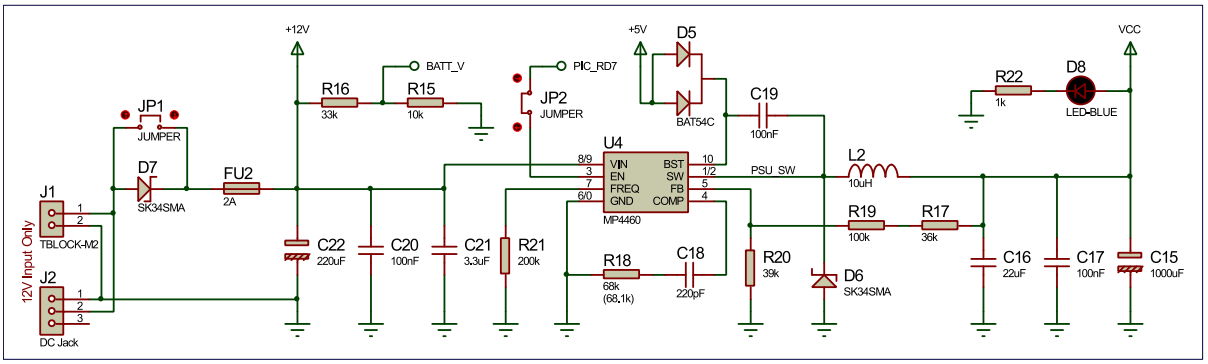
Overview – Top



1. Power-supply circuitry.
2. PIC18F46J50 or PIC18F47J53 microcontroller, and supporting circuitry.
3. SIM800 GSM/GPRS module with BlueTooth and FM Radio, and supporting circuitry.
4. Speaker and microphone connectors for SIM800 GSM/GPRS module.
5. Up to 8 relays.
6. IDC10 connectors, exposing Port A, B and D of the microcontroller.
7. mikroBus socket 1.
8. mikroBus socket 2.
9. mikroProg and PICkit programming connectors.
10. miniUSB connector, and supporting circuitry.
11. Alphanumeric LCD connector.

Power Circuitry

The schematic for the SimPLC's power circuitry is detailed below:



The power circuitry is centred around a MP4460 buck converter, which is configured to provide a 3.6V supply to the board. By powering the board on 3.6V, the need for a separate power supply for the SIM800 GSM/GPRS module is eliminated, and the voltage is still within the operating range of the PIC18F46J50 / PIC18F47J53 microcontroller.

Both DC jack and screw terminal connectors are available for supplying power to the board. From the connectors, power passes through a 2A fuse and (optional) polarity-protecting diode, before arriving at the MP4460. (The polarity protection diode can be bypassed, using jumper JP1, for situations where minimum power consumption is required.)

The input voltage is used directly to activate the relays on the board, and is this required to be 12V DC. If the relays are not however being used, then the input voltage can be in the range of 5V – 36V DC.

The input voltage is made available for measurement by the microcontroller by passing it through a voltage divider, which reduces it by approximately 77% (e.g. 12V would be reduced to approximately 2.8V). The voltage is made available on PortC.2 of the microcontroller, provided that jumper JP6 is in the default position (please also see the "Microcontroller" section of this manual for more information).

For applications where minimum power consumption during standby is of importance, it is possible to control the MP4460 (switch it on and off) using PortD.7 of the microcontroller, by changing jumper JP2 to the RD7 position (note that PortD.7 may also be used for Relay RL17, or the INT pin on mikroBus socket 2).

Jumper JP3, although found in the power supply section of the board, is covered in the "Relays" section of this manual.

For powering the board via USB, please see the "USB" section of this manual.

Microcontroller

The microcontroller used on the SimPLC is the PIC18F46J50, or PIC18F47J53 on newer boards.
The PIC18F46J50 features:

- 64KB of program memory and 3776B of SRAM.
  (Approximately 6800B of program memory are used by the USB-HID bootloader).
- Operating frequency up to 48MHz (12MIPS).

For more information on the PIC18F46J50 please download its datasheet from
http://ww1.microchip.com/downloads/en/DeviceDoc/39931d.pdf

The PIC18F47J53 features:

- 128KB of program memory and 3776B of SRAM.
  (Approximately 6800B of program memory are used by the USB-HID bootloader).
- Operating frequency up to 48MHz (12MIPS).

For more information on the PIC18F47J53 please download its datasheet from
http://ww1.microchip.com/downloads/en/DeviceDoc/30009964C.pdf

Real-Time Calendar and Clock (RTCC)

The PIC18F46J50 features a built-in RTCC, and a 32.768kHz crystal (X2) as well as two 12pF capacitors are connected to the PIC's PortC.0 (T1OSCO) and PortC.1 (T1OSCI) pins, in order to facilitate the accurate operation of this peripheral.

Reset Button

A tactile switch (SW2) is connected to the MCLR pin of the microcontroller. Depressing this button will place the microcontroller in a state of reset. (Note: The reset button will not work if the MCLR function has been disabled on the PIC by programming it with the relevant configuration setting).

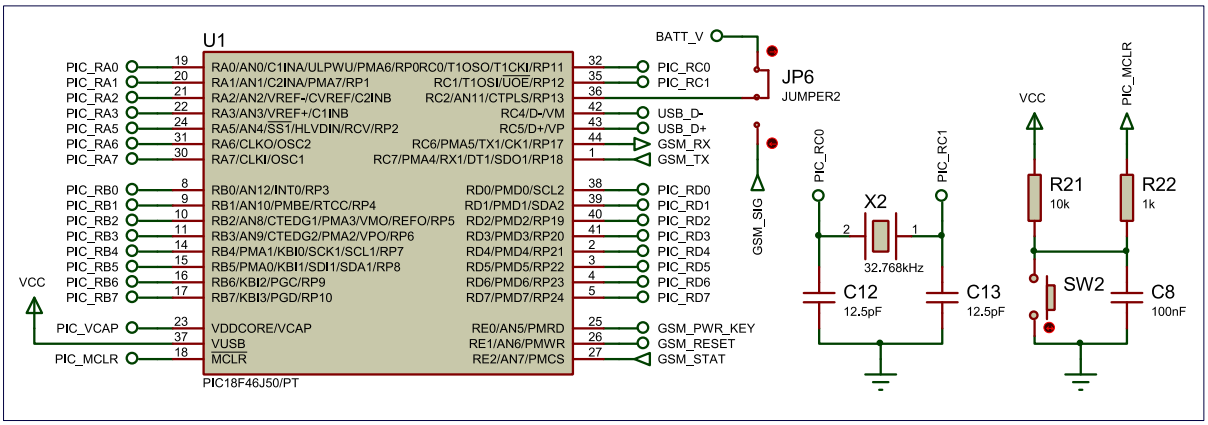
Oscillator Socket

The SimPLC comes programmed to run from the PIC's internal oscillator. An external oscillator socket (X1), with 22pF capacitors, is however provided should you wish to connect an external oscillator. The oscillator socket is connected the PIC's PortA.6 (CLKO) and PortA.7 (CLKI) pins.

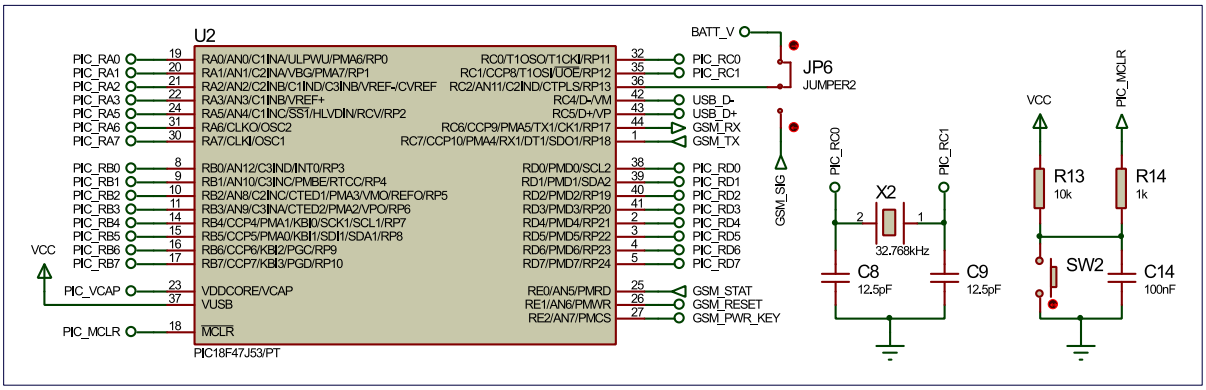
Schematic

The schematic for the microcontroller, 32.768kHz RTCC oscillator and reset button is detailed below:

PIC18F46J50

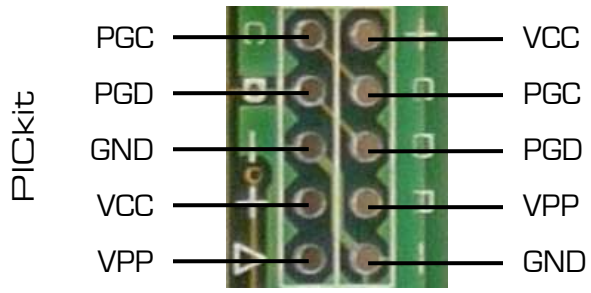


PIC18F47J53



Programming

The SimPLC comes pre-programmed with a bootloader, meaning that no external programmer is needed in order to use the board. It is however possible to use an external programmer if desired, with connectors provided for both the mikroProg and PICkit programmers.



VCC: Power (VSYS)
GND: Ground (0V)
PGC: Program Clock (RB6)
PGD: Program Data (RB7)
VPP: Programming Voltage
(The VPP pin on the PIC is also its MCLR (reset) pin).

Bootloader

To use the bootloader on the SimPLC:

1. Download the mikroElektronika USB-HID bootloader software from the SimPLC page on our website. Run the software.
2. Connect your SimPLC to the computer via a USB cable.
3. When the USB symbol next to the "1. Wait for USB link" text in the bootloader application turns red, click the "Connect" button. If you don't manage to click the button within the 5 second window period, then press the Reset button on the SimPLC and try again.
4. Click the "Browse for Hex" button, and locate the .hex file which you wish to load onto the microcontroller.
5. Click the "Begin uploading" button. Your code will be loaded onto the SimPLC.

SIM800 GSM/GPRS Module

Overview

1. SIM800 GSM/GPRS module.
2. SIM Card socket.
3. Pwr_Key button (used to manually power the module on and off).
4. SMA antenna connector.
5. Status (power) and signal LEDs.
6. Debugging header.
7. GSM TX protection bypass jumper.
8. BlueTooth Antenna.
9. SIM800 RTCC (Real-Time Calendar and Clock) backup battery.

SIM800 Module

For more information on the SIM800, including datasheets and AT commands, please see the SIMCom website.

Powering On/Off

The Pwr_Key button can be used to manually switch the SIM800 module on or off, by pressing and holding it for 1 second. From the microcontroller, the same effect can be achieved by switching PortE.2 high for 1 second (and then switching it low again).

Note that the module may take a few seconds to power down. It can also be powered down, either normally or urgently, using the "AT+CPOWD" command (please see the AT Command Manual, available from the SIMCom Website). In the case that the module is not responding to either the Pwr_Key input or "AT+CPOWD" commands, the Reset input can be used to reset it, by switching PortE.1 high for at least 50uS (and then switching it low again).

If the SIM800 detects an under-voltage condition (such as if the board is not being supplied with enough power) then it will automatically power off.

Power and Signal Indication

The Status LED indicates whether the module is powered up or not. This is also provided as an input to the microcontroller on PortE.0.

The Signal LED indicates (by blinking at differently timed intervals) whether the module has signal or not. The different intervals are indicated below:

Constant Off	SIM800 is not running
64ms On / 800ms Off	SIM800 is not registered on the GSM network
64ms On / 3000ms Off	SIM800 is successfully registered on the GSM network
64ms On / 300ms Off	SIM800 has established GPRS communication

This is also provided as an input to the microcontroller on PortC.2, if jumper JP6 is in the "GSM Sig" position (please also see the "Power Supply" section of this manual for more information).

Network status can also be interrogated using the "AT+CREG" command (please see the AT Command Manual, available from the SIMCom Website).

Communication

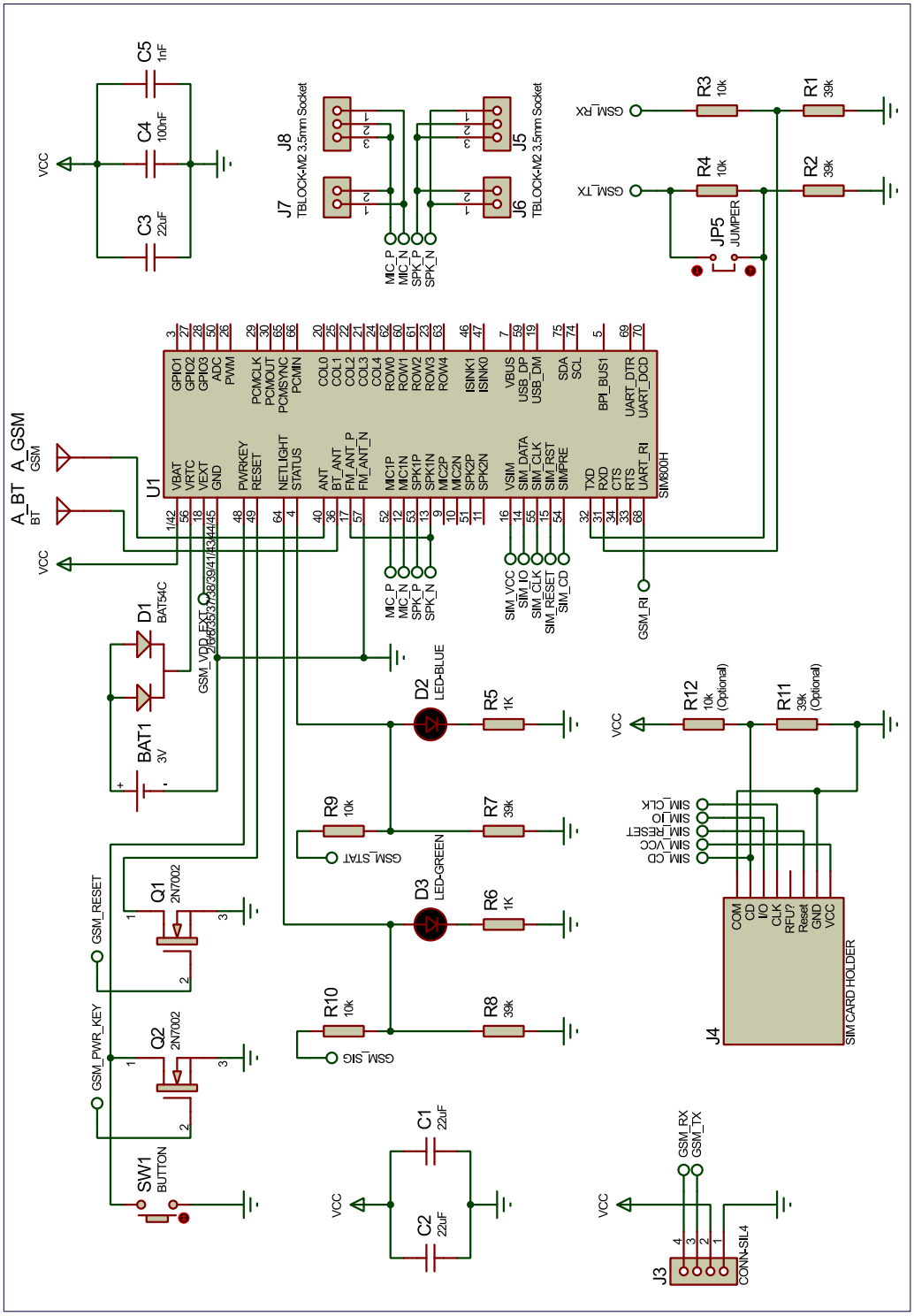
The SIM800 communicates via a UART RX/TX connection (9600bps by default), connected to the microcontroller's UART #1 RX/TX pins, using AT commands. The AT Command Manual is available from the SIMCom Website.

The debugging header can be used to "spy" on UART (serial) communication taking place between the microcontroller and the SIM800. It can also be used to communicate directly with the SIM800. Due to the protection measures in place, reception of the GSM TX communications may not be possible by certain equipment (e.g. MAX3232) connected to the debugging header – the JP5 jumper can be used to bypass the protection, thus allowing the aforementioned equipment to function properly.

Speaker and Microphone Connectors

Both screw-terminal and 3.5mm jack connectors are provided for speaker audio output and microphone audio input.

Schematic


U1
SIM800H
J4
SIM CARD HOLDER
J3
CONN-SIL4
J5
TBLOCK-M2 3.5mm Socket
J6
TBLOCK-M2 3.5mm Socket
J7
TBLOCK-M2 3.5mm Socket
J8
TBLOCK-M2 3.5mm Socket
JP5
JUMPER
SW1
BUTTON
BAT1
3V
D1
BAT54C
D2
LED-BLUE
D3
LED-GREEN
Q1
2N7002
Q2
2N7002
C1
22uF
C2
22uF
C3
22uF
C4
100nF
C5
1nF
R1
39k
R2
39k
R3
10k
R4
10k
R5
1K
R6
1K
R7
39k
R8
39k
R9
10k
R10
10k
R11
39k
(Optional)
R12
10k
(Optional)
A_BT
A_GSM
BT
GSM
VCC
GSM_RX
GSM_TX
GSM_RI
GSM_RESET
GSM_PWR_KEY
GSM_STAT
GSM_SIG
MIC_P
MIC_N
SPK_P
SPK_N
SIM_VCC
SIM_IO
SIM_CLK
SIM_RESET
SIM_CD
GSM_VDD_EXT
GPIO1
GPIO2
GPIO3
ADC
PWM
PCMCLK
PCMOUT
PCMSYNC
PCMIN
COL0
COL1
COL2
COL3
COL4
ROW0
ROW1
ROW2
ROW3
ROW4
ISINK1
ISINK0
VBUS
USB_DP
USB_DM
SDA
SCL
BPI_BUS1
UART_DTR
UART_DCD
VBAT
VRTC
VEXT
GND
PWRKEY
RESET
NETLIGHT
STATUS
ANT
BT_ANT
FM_ANT_P
FM_ANT_N
MIC1P
MIC1N
SPK1P
SPK1N
MIC2P
MIC2N
SPK2P
SPK2N
VSIM
SIM_DATA
SIM_CLK
SIM_RST
SIMPRE
TXD
RXD
CTS
RTS
UART_RI
COM
CD
I/O
CLK
RFU?
Reset
GND
VCC

Relays

The SimPLC features up to 8 relays (rated at 16A/250VAC), connected to PortD of the microcontroller. The relays are driven through a ULN2803 Darlington transistor array. Each relay has a normally open (NO), normally closed (NC) and common (CM) connection available. An LED is connected to each relay, in order to indicate whether or not it is activated.

Relays RL16 and RL17 are disabled by default. This is because PortD.6 are PortD.7 may also be used elsewhere on the board:

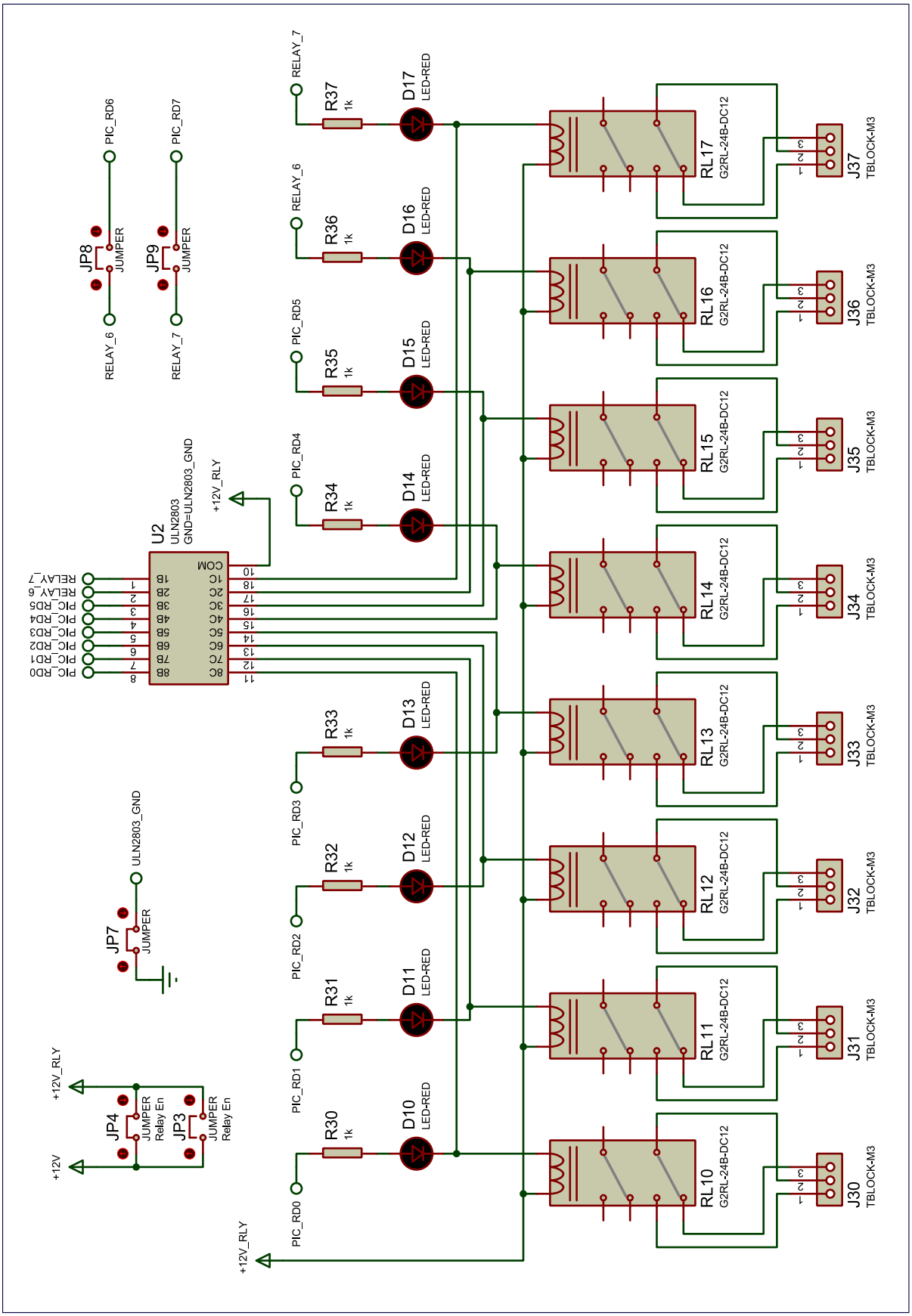
- PortD.6 may be used as the PWM connection in mikroBus socket 2.
- PortD.7 may be used as the INT connection in mikroBus socket 2. It may also optionally be used to shut-down the MP4460 switching regulator (please see the "Power Supply" section of this manual for more information).

By connecting jumpers JP8 and JP9, relays RL16 and RL17 (respectively) will be enabled.

It is possible to temporarily disable the relays, by disconnecting jumper JP3 (found in the Power Supply section of the board). The LEDs will however continue to operate normally. This can be a useful feature during the development phase of your project. It also means that the input voltage to the board does not need to be 12V DC, but can be in the range of 5V – 36V DC. It is also possible to power the board directly from the USB connection in this state.

If required, it is also possible to completely disable both the relays and LEDs, by disconnecting jumper JP7. This jumper is found next to the ULN2803, and completely disables it.

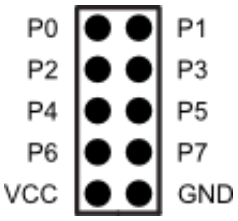
Schematic


PIC_RD6
PIC_RD7
JP8
JP9
JUMPER
RELAY_6
RELAY_7
U2
ULN2803
GND=ULN2803_GND
+12V_RLY
COM
RELAY_7
RELAY_6
PIC_RD5
PIC_RD4
PIC_RD3
PIC_RD2
PIC_RD1
PIC_RD0
R37
R36
R35
R34
R33
R32
R31
R30
1k
D17
D16
D15
D14
D13
D12
D11
D10
LED-RED
RL17
RL16
RL15
RL14
RL13
RL12
RL11
RL10
G2RL-24B-DC12
J37
J36
J35
J34
J33
J32
J31
J30
TBLOCK-M3
JP7
ULN2803_GND
JP4
JP3
Relay En
+12V

Inputs and Outputs

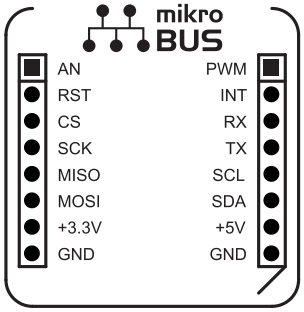
IDC10 Headers

Ports A, B and D are exposed via IDC10 headers, on the right-hand side of the SimPLC. These headers expose the 8 pins of the port, as well as power and ground (note that PortA is missing pin 4). They are also compatible with mikroElektronika (www.mikroe.com) IDC10 accessory boards.



mikroBus Sockets

The mikroBus sockets allow a huge variety of mikroElektkronika (www.mikroe.com) "click" add-on accessory boards to be connected to the system. There are currently over 100 "click" boards and counting, performing a vast variety of functions such as communication, storage, audio, etc.



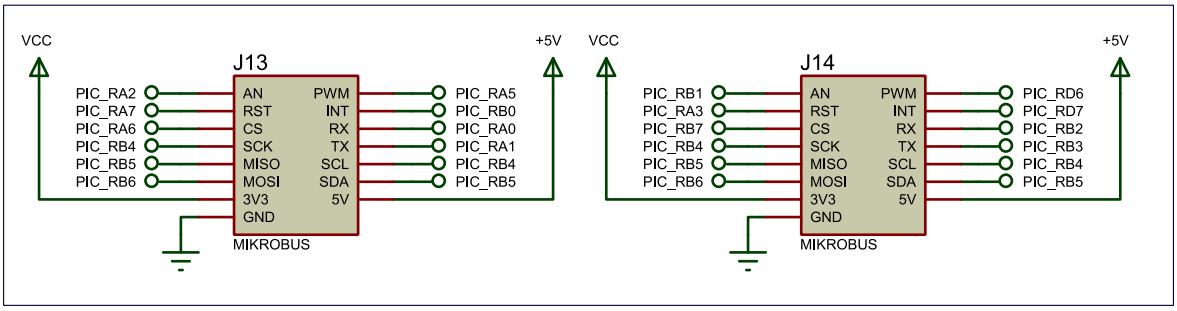
Most notably, OPTO click boards can be used to add up to 8 opto-coupled inputs to the SimPLC.

The mikroBus connections are explained in greater detail below:

AN	Analogue	Pulse Width Modulation	PWM
RST	Reset (different from the PIC's reset)	Interrupt	INT
CS	SPI Chip Select	UART (Serial) Receive	RX
SCK	SPI* Serial Clock	UART (Serial) Transmit	TX
MISO	SPI* Master-Out Slave-In (SDI on the PIC)	I²C** Serial Clock	SCL
MOSI	SPI* Master-In Slave-Out (SDO on the PIC)	I²C** Serial Data	SDA
+3.3V	3.3V Power Supply	5V Power Supply	+5V
GND	Ground (0V Power Supply)	Ground (0V Power Supply)	GND

*Serial Peripheral Interface (communication interface)

**Inter-Integrated Circuit (communication interface)



USB

The PIC18F46J50 / PIC18F47J53 microcontroller includes built-in USB, and a miniUSB connector is included on the SimPLC in order to take advantage of this. The board also comes pre-loaded with a fast USB-HID bootloader (please see the "Programming" section of this manual).

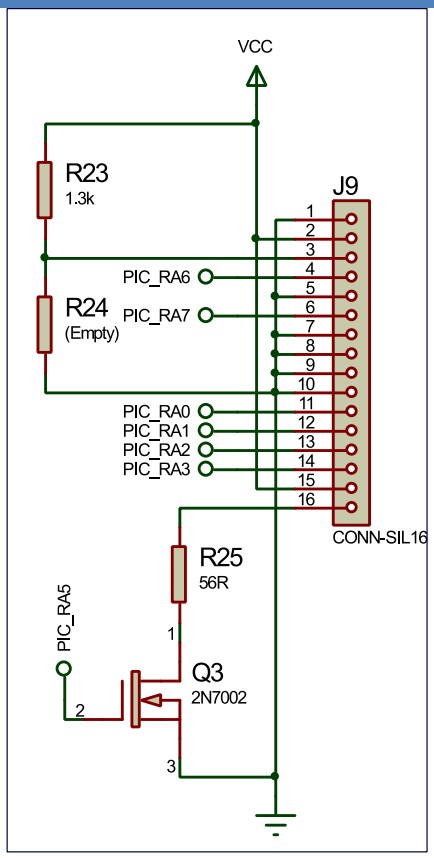
If no power supply is available at the power inputs of the board then the board will draw power from the USB connection, and it is thus possible to also power the board via the 5V USB supply (jumper JP3 should be disconnected in this case in order to disable the 12V relays). Drawing power from the USB connection is protected by a 1A resettable fuse on the board.

LCD Connector

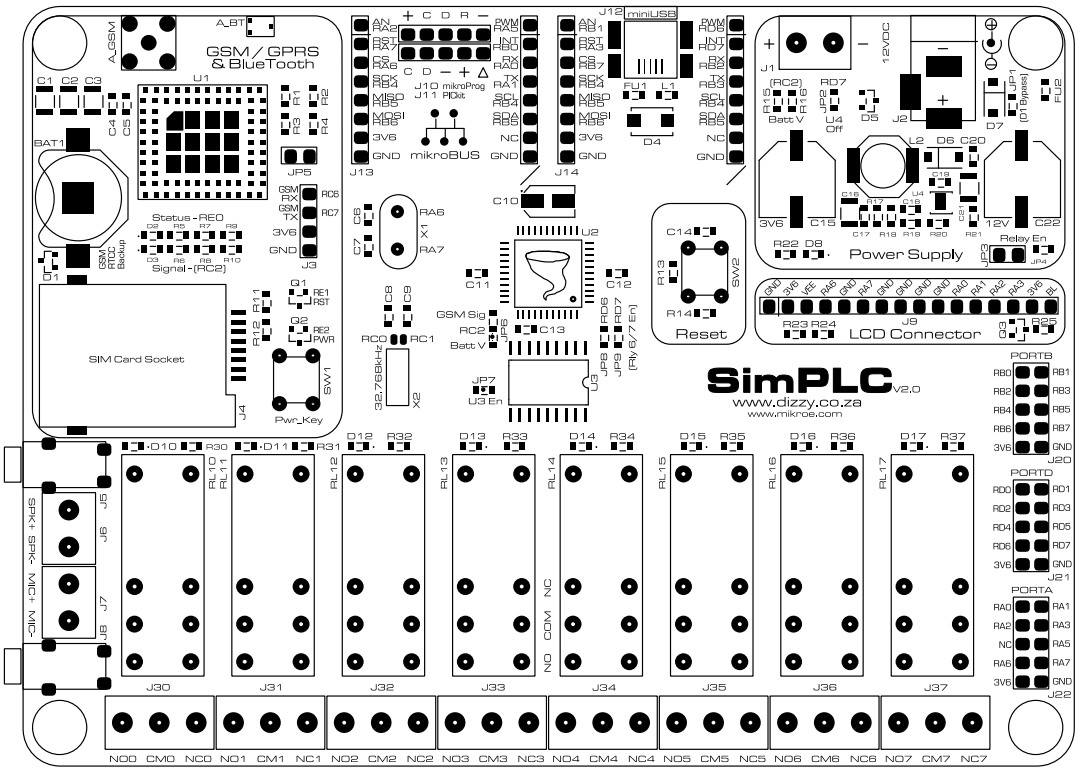
A standard alphanumeric LCD may be connected to J9, with LCD connections as follows:

LCD D4	RA0
LCD D5	RA1
LCD D6	RA2
LCD D7	RA3
LCD RS	RA6
LCD E	RA7
LCD Backlight	RA5

LCD contrast can be controlled using R23/R24.



Drawing



Links

The SimPLC:

- Is designed by Dizzy Enterprises (www.dizzy.co.za).
- Is designed in the Proteus Design Suite (www.labcenter.com).
- Features two mikroBus sockets (www.mikroe.com).
- Features the SIM800 module (SIMCom website).

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Microcontroller I/O Map

MCU Pin	Default Connection	Alternative Connection	Notes
RA0	mikroBUS1 RX	LCD D4	
RA1	mikroBUS1 TX	LCD D5	
RA2	mikroBUS1 AN	LCD D6	
RA3	mikroBUS2 RST	LCD D7	
RA5	mikroBUS1 PWM	LCD Backlight	
RA6	mikroBUS1 CS	LCD RS	X1 (MCU Ext. Osc.)
RA7	mikroBUS1 RST	LCD E	X1 (MCU Ext. Osc.)
RB0	mikroBUS1 INT		
RB1	mikroBUS2 AN		
RB2	mikroBUS2 RX		
RB3	mikroBUS2 TX		
RB4	mikroBUS SCK/SCL		
RB5	mikroBUS SDI/SDA		
RB6	mikroBUS SDO	PGC	
RB7	mikroBUS2 CS	PGD	
RC0	X2 (MCU RTCC Osc.)		
RC1	X2 (MCU RTCC Osc.)		
RC2	BattV	GSM Sig	JP6
RC4	USB D-		
RC5	USB D+		
RC6	GSM RX		
RC7	GSM TX		
RD0	Relay0		
RD1	Relay1		
RD2	Relay2		
RD3	Relay3		
RD4	Relay4		
RD5	Relay5		
RD6	mikroBUS2 PWM	Relay6	JP8
RD7	mikroBUS2 INT	Relay7	JP9 (Also, JP2 – U3 shutdown)
RE0	GSM Status		
RE1	GSM Reset		
RE2	GSM Pwr_Key		

Note:

JP3/JP4 can be used to cut power to the relays (whilst leaving their LEDs working).

JP7 can be used to disable both the relays and their LEDs.

Ports A, B and D are also exposed via IDC10 headers J20, J21 and J22.

Disclaimer

This part says that you cannot sue us because we accept no responsibility for any damages whatsoever that may be caused in connection with our products. We've designed them the best we can, but please, use your common sense.