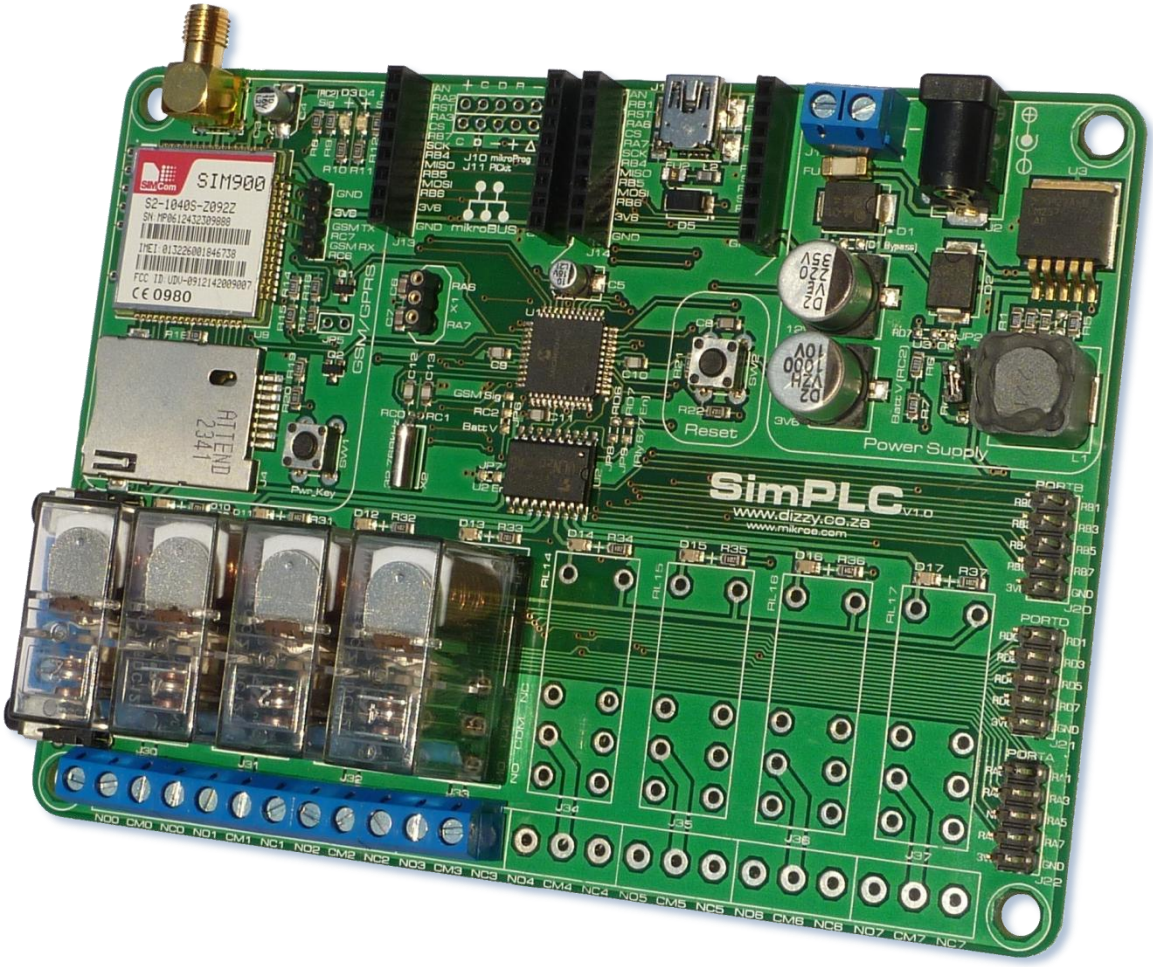
SimPLC



User Manual

DIZZY enterprises

www.dizzy.co.za

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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 Communication

- The SIM900 GSM/GPRS 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.

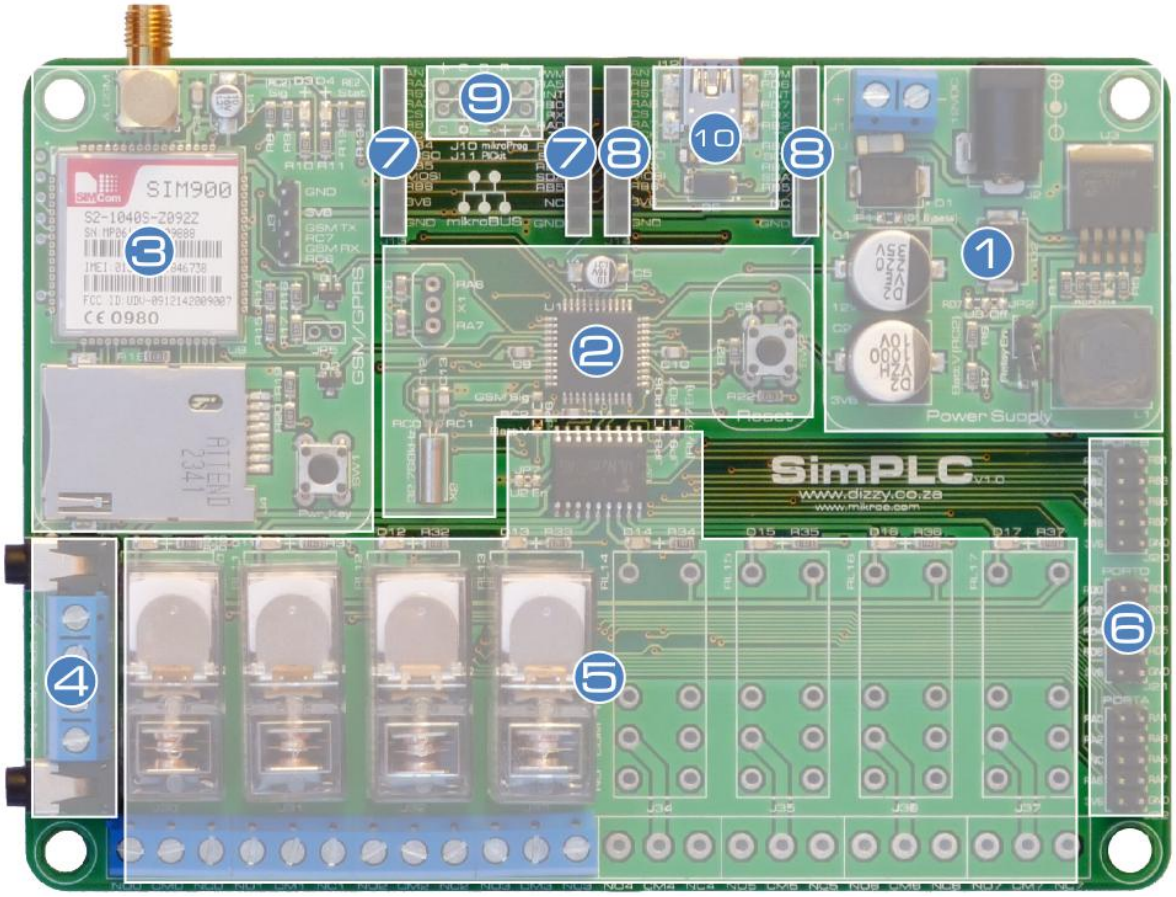
Inputs and Outputs

- 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 PIC18F46J50 microcontroller also features built-in USB (including USB On-The-Go), 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).

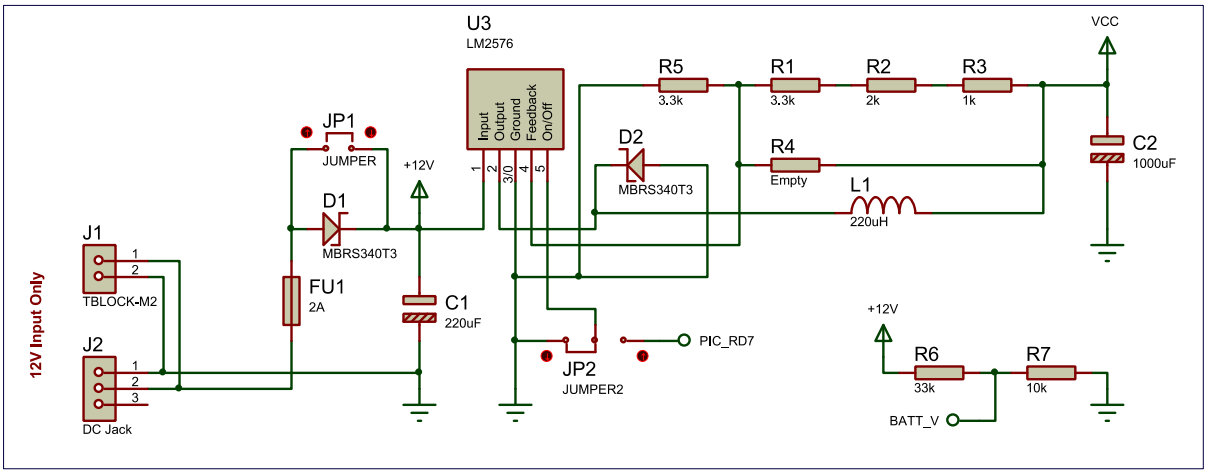
Overview – Top



1. Power-supply circuitry.
2. PIC18F46J50 microcontroller, and supporting circuitry.
3. SIM900 GSM/GPRS module, and supporting circuitry.
4. Speaker and microphone connectors for SIM900 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.

Power Circuitry

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



The power circuitry is centred around a LM2576-ADJ 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 SIM900 GSM/GPRS module is eliminated, and the voltage is still within the operating range of the PIC18F46J50 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 LM2576-ADJ. (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 – 40V 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 LM2576-ADJ (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.
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

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

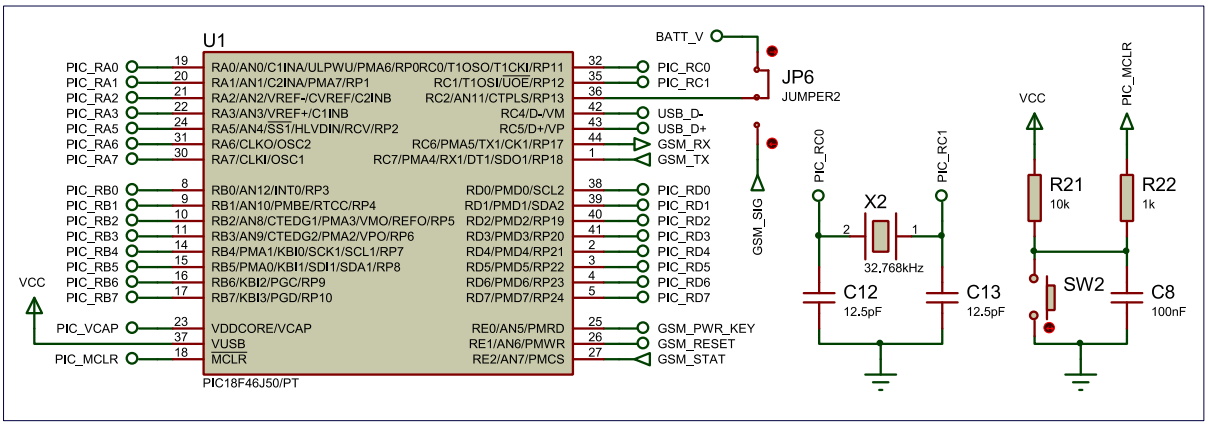
A tactile switch (SW2) is connected to the MCLR pin of the microcontroller. Depressing this button will place the microcontroller in a state of reset. (Note: The reset button will not work if the MCLR function has been disabled on the PIC by programming it with the relevant configuration setting).

Oscillator Socket

The Breeze 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.

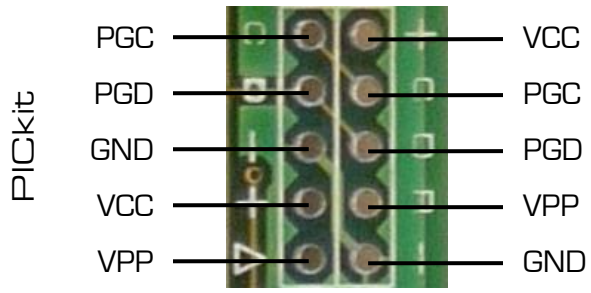
Schematic

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



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.

SIM900 GSM/GPRS Module

Overview

1. SIM900 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.

SIM900 Module

For more information on the SIM900, including datasheets and AT commands, please see http://wm.sim.com/producten.aspx?id=1019

Powering On/Off

The Pwr_Key button can be used to manually switch the SIM900 module on or off, by pressing and holding it for 1 second. From the microcontroller, the same effect can be achieved by switching PortE.0 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 SimPLC page on our 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 SIM900 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.2.

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	SIM900 is not running
64ms On / 800ms Off	SIM900 is not registered on the GSM network
64ms On / 3000ms Off	SIM900 is successfully registered on the GSM network
64ms On / 300ms Off	SIM900 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 SimPLC page on our website).

Communication

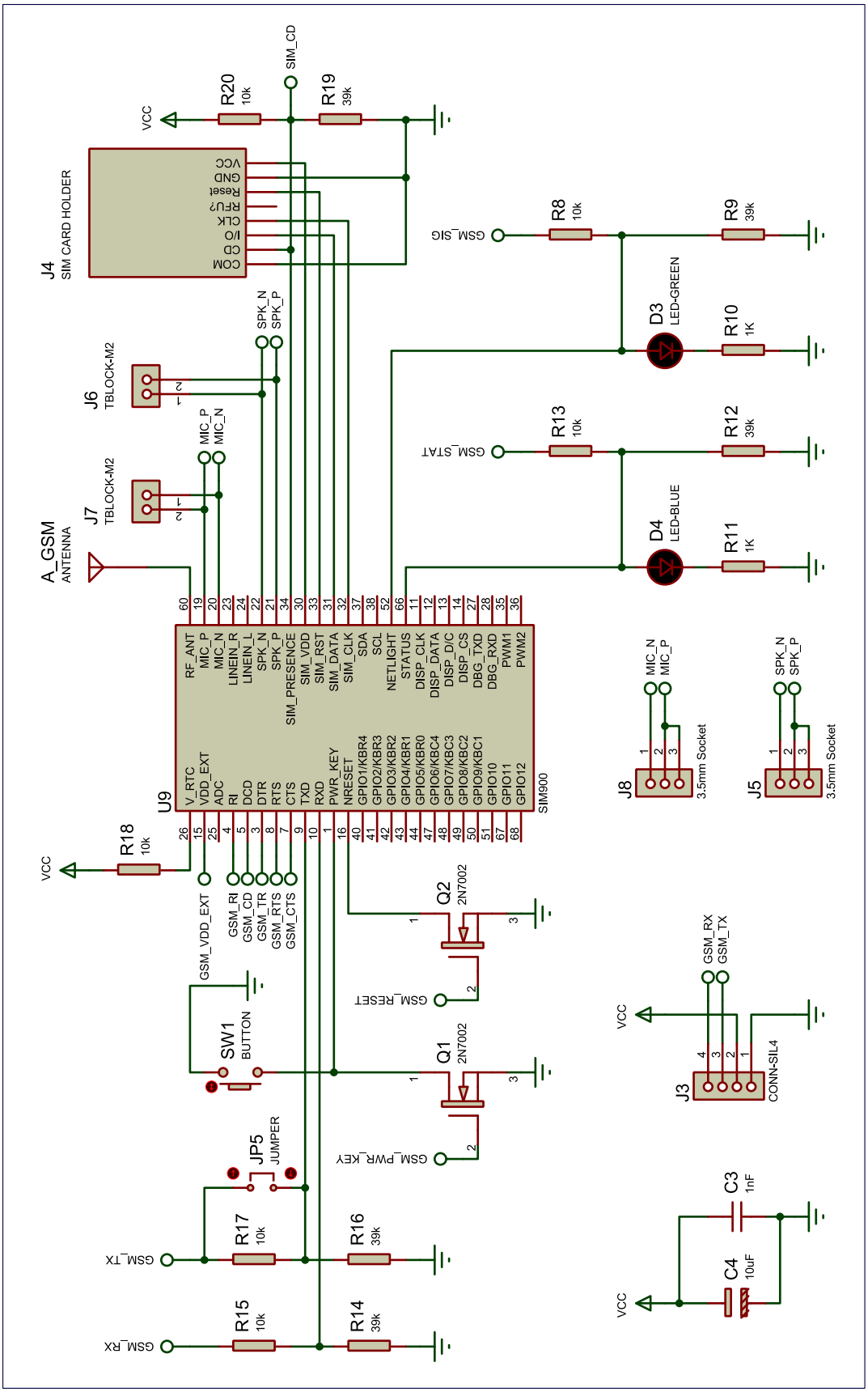
The SIM900 communicates via a UART RX/TX connection (9600bps by default), connected to the microcontroller's UART #1 RX/TX pins, using AT commands. The AT Command Manual is available from the SimPLC page on our website.

The debugging header can be used to "spy" on UART (serial) communication taking place between the microcontroller and the SIM900. It can also be used to communicate directly with the SIM900. 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


J4
SIM CARD HOLDER
COM
CD
I/O
CLK
RFU2
Reset
GND
VCC
R20
10k
R19
39k
SIM_CD
VCC
GSM_SIG
R8
10k
R9
39k
D3
LED-GREEN
R10
1K
J6
TBLOCK-M2
SPK_N
SPK_P
GSM_STAT
R13
10k
R12
39k
D4
LED-BLUE
R11
1K
J7
TBLOCK-M2
MIC_P
MIC_N
A_GSM
ANTENNA
U9
SIM900
RF_ANT
MIC_P
MIC_N
LINEIN_R
LINEIN_L
SPK_N
SPK_P
SIM_PRESENCE
SIM_VDD
SIM_RST
SIM_DATA
SIM_CLK
SDA
SCL
NETLIGHT
STATUS
DISP_CLK
DISP_DATA
DISP_D/C
DISP_CS
DBG_TXD
DBG_RXD
PWM1
PWM2
V_RTC
VDD_EXT
ADC
RI
DCD
DTR
RTS
CTS
TXD
RXD
PWR_KEY
NRESET
GPIO1/KBR4
GPIO2/KBR3
GPIO3/KBR2
GPIO4/KBR1
GPIO5/KBR0
GPIO6/KBC4
GPIO7/KBC3
GPIO8/KBC2
GPIO9/KBC1
GPIO10
GPIO11
GPIO12
J8
3.5mm Socket
MIC_N
MIC_P
J5
3.5mm Socket
SPK_N
SPK_P
R18
10k
VCC
GSM_VDD_EXT
GSM_RI
GSM_CD
GSM_TR
GSM_RTS
GSM_CTS
Q2
2N7002
GSM_RESET
SW1
BUTTON
Q1
2N7002
GSM_PWR_KEY
VCC
GSM_RX
GSM_TX
J3
CONN-SIL4
JP5
JUMPER
R17
10k
R16
39k
GSM_TX
R15
10k
R14
39k
GSM_RX
C3
1nF
C4
10uF
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:

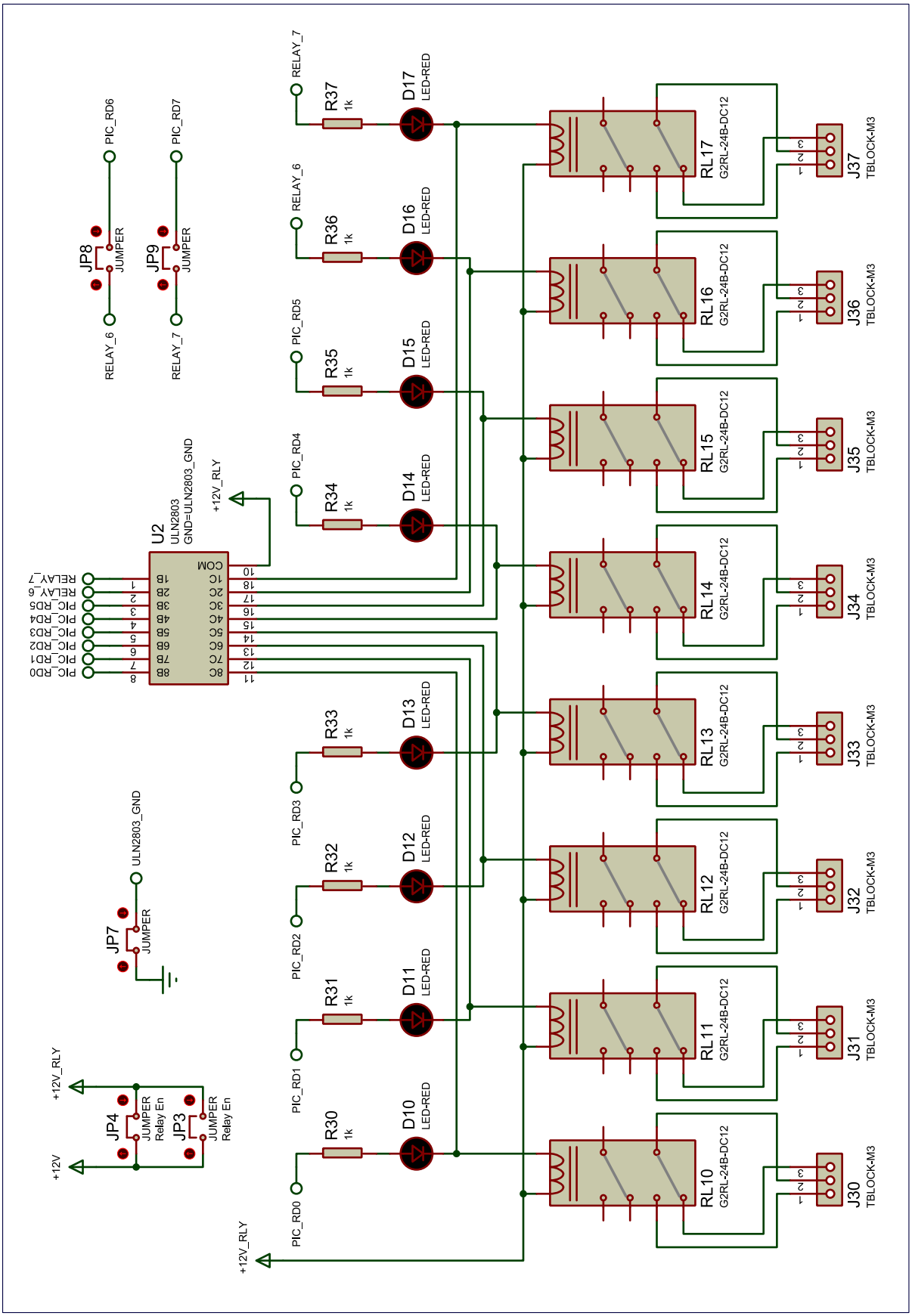
- PortD.6 may be used as the PWM connection in mikroBus socket 2.
- PortD.7 may be used as the INT connection in mikroBus socket 2. It may also optionally be used to shut-down the LM2576-ADJ switching regulator (please see the "Power Supply" section of this manual for more information).

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 – 40V DC. It is also possible to power the board directly from the USB connection in this state (please note however that the SIM900 module may require more current at times than what can be provided by the USB connection, which will cause it to automatically power down).

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.

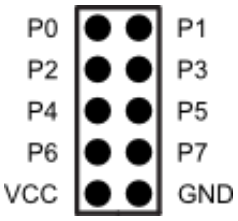
Schematic


U2
ULN2803
GND=ULN2803_GND
+12V_RLY
COM
RELAY_7
RELAY_6
PIC_RD5
PIC_RD4
PIC_RD3
PIC_RD2
PIC_RD1
PIC_RD0
JP8
JP9
JP7
JP4
JP3
JUMPER
Relay En
ULN2803_GND
+12V
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

Inputs and Outputs

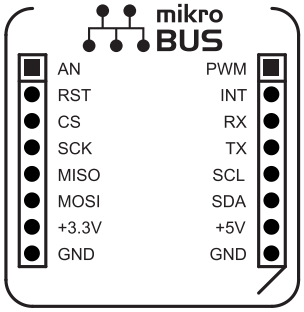
IDC10 Headers

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 50 "click" boards and counting, performing a vast variety of functions such as communication, storage, audio, etc.



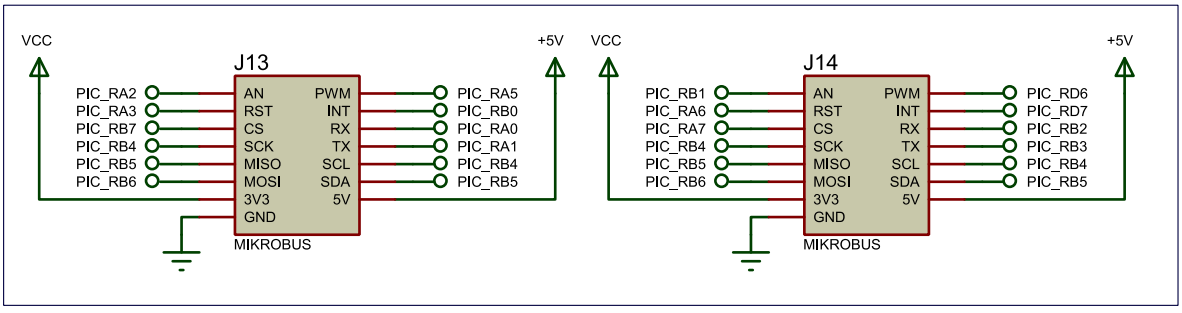
Most notably, OPTO click boards can be used to add up to 8 opto-coupled inputs to the SimPLC.

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)

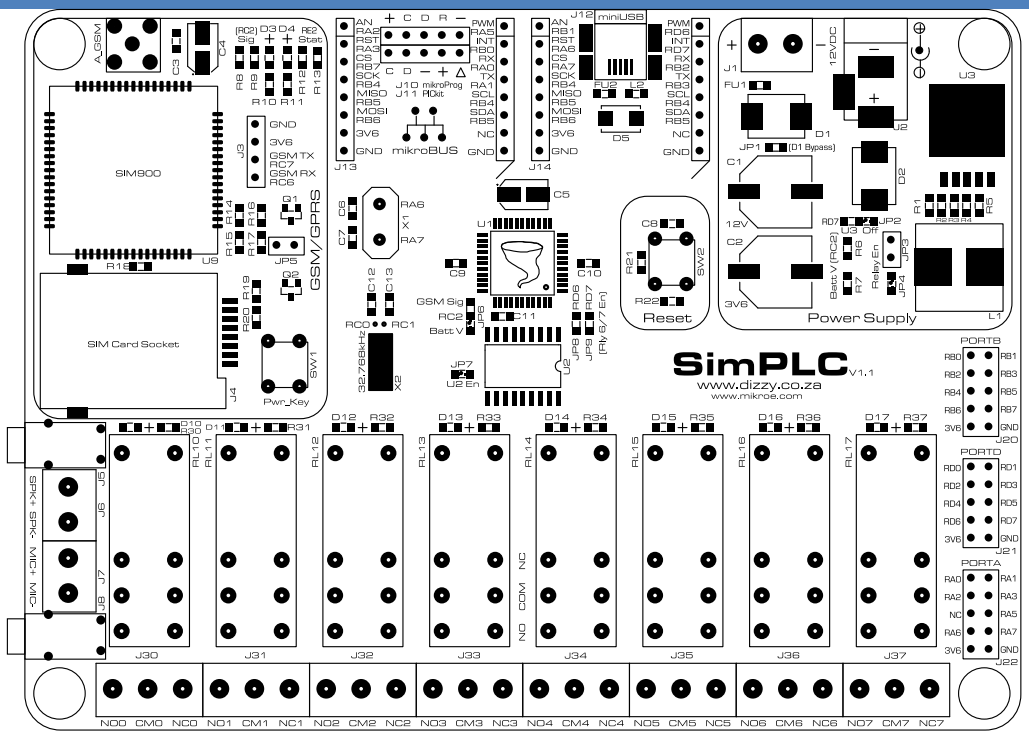


USB

The PIC18F46J50 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). Note however that the SIM900 GSM/GPRS module may require more power than the USB connection is able to supply (please see the "Power Supply" section of this manual). Drawing power from the USB connection is protected by a 1A resettable fuse on the board.

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 SIM900 module (http://wm.sim.com/producten.aspx?id=1019).

Microcontroller I/O Map

MCU Pin	Default Connection	Alternative Connection	Notes
RA0	mikroBUS1 RX		
RA1	mikroBUS1 TX		
RA2	mikroBUS1 AN		
RA3	mikroBUS1 RST		
RA5	mikroBUS1 PWM		
RA6	mikroBUS2 RST	X1 (MCU Ext. Osc.)	
RA7	mikroBUS2 CS	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	mikroBUS1 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 Pwr_Key		
RE1	GSM Reset		
RE2	GSM Status		

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.