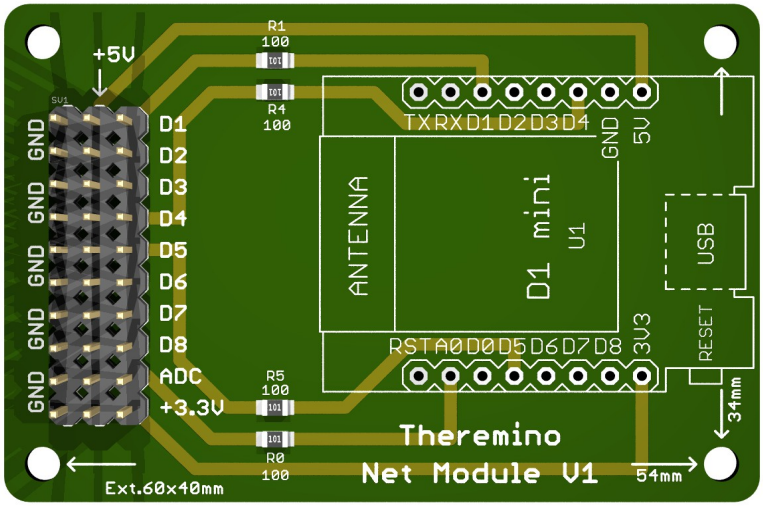
Theremino **System**

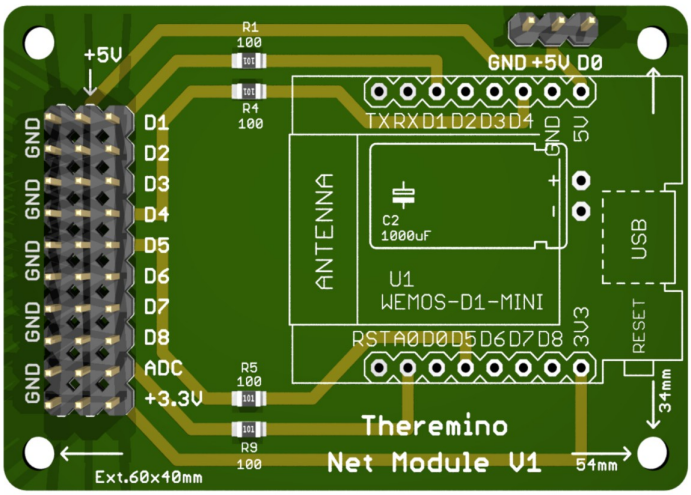


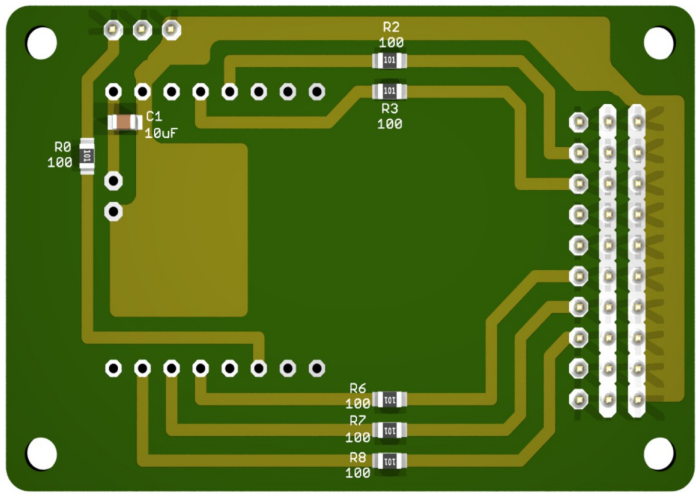
NetModule

Connect sensors and actuators through WiFi, LAN and Internet

The "NetModule"

The NetModule is an input-output module of Theremino system, similar to the Master module, but connected to the WiFi system via the network, rather than via USB.





On the left are the input and output connectors. For convenience all connectors bear the mass, the 5 volts and the signal. The last connector in the bottom instead of the signal provides the 3.3 volts stabilized voltage, useful for some sensors.

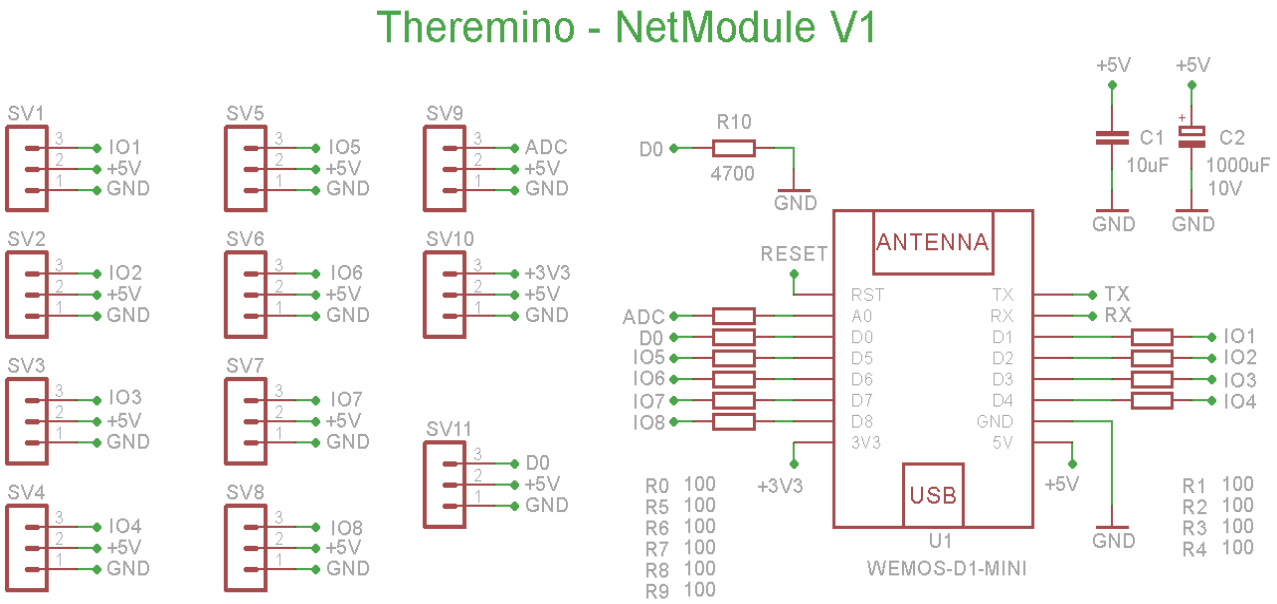
The electrolytic capacitor C2 (1000 uF) helps to stabilize the supply voltage, improves the stability of the measures which are carried out with the ADC and decreases the interference caused by users (eg servomotors) with strong inrush currents.

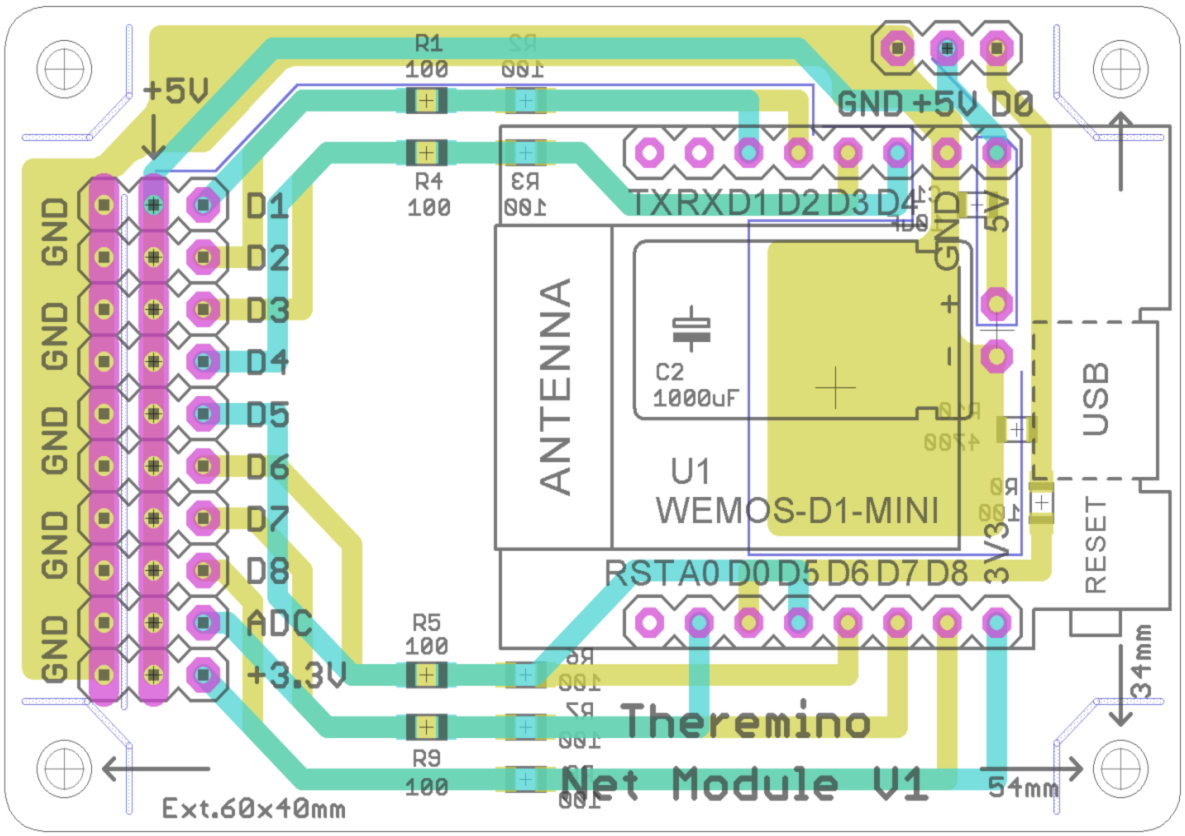
The 100 ohm resistors improve the protection of the inputs, in case of errors, and allow direct connection of the LEDs, without the risk of damaging them with too high current.

The USB connector should only be used for a possible reprogramming. Instead during normal operation it is always better power the modules from the lateral connector (GND, + 5V and D0).

By connecting a PowerBank to the lateral connector, you can feed even heavy loads, for example 10 Kg/cm and beyond servomotors.

Electrical schematics





Safety Note

In recent years, there is much talk of safety and dangers of IOT (Internet of Things) devices, which also NetModule "should" do part. We write "should" because our implementation removes the root any possibility of fraudulent use.

To avoid any possible hacking, we have not provided any kind of expansion and we have not implemented any “service” digital communication functions (this is a constant throughout the Theremino System, and also applies to the Master and to the Arduino, connected to our system via USB).

The only data we transfer are floating point numbers and we write and read them exclusively in the Theremino System Slots. It is impossible to send commands or viruses via floating point numbers.

In addition, our modules are designed to work only on the local network, though some (at your own risk) may also use the Internet (Note 1).

(Note 1) As we use the WPA2 encrypted protocol, which is considered totally safe when you go on the Internet you can never be 100% sure. An attacker might be able to guess the password, or read through fraudulent applications. Also someone could connect our modules even at AccessPoints unprotected or poorly protected and if so security would drop further.

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However, all of Theremino system modules are designed to perform simple functions only as:

- Measuring soil moisture
- Open or close the irrigation
- Turn off the lights when you leave the room
- Laboratory measuring equipment
- Thermostats
- Etc..

So in the local network there is no possibility of using our modules to spy data, send mails or vehiculate virus.

And even in the event of Internet connections, the maximum damage that an attacker could get, could be to turn on the lights or irrigation. A result for which no one could lose time.

Supply Current

Exchanges per second	HAL communication speed	Pins Configuration	mA
Disconnected	- - -	- - -	75.5
10	1	3 + 1 PWM Servo	75.8
20	2	3 + 1 PWM Servo	76.0
30	3	3 + 1 PWM Servo	76.2
50	4	3 + 1 PWM Servo	76.5
60	5	3 + 1 PWM Servo	76.8
100	6	3 + 1 PWM Servo	77.6
150	7	3 + 1 PWM Servo	78.4
200	8	3 + 1 PWM Servo	79.3
380	9	3 + 1 PWM Servo	80.6
480	10	3 + 1 PWM Servo	82.3
590	11	3 + 1 PWM Servo	82.5
800	12	3 + 1 PWM Servo	85.3
150	7	8 Unused	77.5
150	7	8 Dig_in	77.5
150	7	8 pWM	78.5

These measurements were carried out on an original “Wemos D1 Mini” module.

The measures on some non-original modules have given about 10 mA more.

The current is pretty independent (within +/- 5mA) from the transmission rate and the pin configuration.

The current remains constant with voltage from 3.8 volts to 5.5 volts (and beyond).

So in the calculations of the consumption and battery life, you could considered a constant supply current of approximately 80..90 mA.

Leakage currents of the input Pins

Pin	0 volts	3.3 volts	5 volts	Note
D1	0	0	2 uA	
D2	0	0	2 uA	
D3	5 mA	0	150 uA	Strong pullup current to the 3.3 volt
D4	1.25 mA	0	150 uA	10k resistor and LED to the 3.3 volts
D5	0	0	2 uA	
D6	0	0	2 uA	
D7	0	0	2 uA	
D8	0	330 uA	500 uA	Resistor 10 k to ground
A0	0	10 uA	16 uA	Resistive divider 320 k total to gnd

All Pin accept voltages up to 5 volts (in English "5-volt tolerant").
The leakage currents indicated with "0" are less than 50 nA.

Features of the input Pins

- Minimum voltage: - 0.3 volts
- Maximum voltage: + 5.5 volts
- Maximum voltage for the logic zero: 0.8 volts
- Minimum voltage for a logical: 2.5 volts
- Capacity of an input Pin: Less than 5 pF (typical 2 pF)
- Pullup current: 72 uA
- The digital inputs are not schmitt trigger so they need rapid and clean switching fronts.

Maximum currents for input Pins

- Maximum input power on protection diodes: +/- 10 mA
- Protection against ESD (HBM) up to 2 KV

Maximum currents for the output Pins

- Positive peak output current: 12 mA (Source to 2.64 volts)
- maximum negative output current: 20 mA (sink to 0:33 volts)
- The 100 ohm resistors on the NetModule PCB, further limit the output current

Net Module Pin Types

The special D0 Pin

- **D0** (as output) - This pin is brought to a high level when the communication is active. You can then use it to safety shutdowns.
- **D0** (as input) - If you hold high the D0 during power on, then the module starts in SoftAP mode.

The Pin configurable and valid types

- **D1** - Unused / DigOut / PWM / Servo / DigIn / DigIn_Pu / Counter / Counter_Pu / Period / Period_Pu / EncoderA / EncoderA_Pu
- **D2** : Unused / DigOut / PWM / Servo / DigIn / DigIn_Pu / Counter / Counter_Pu / Period / Period_Pu / EncoderA / EncoderA_Pu
- **D3** : Unused / DigOut / PWM / Servo
- **D4** : Unused / DigOut / PWM / Servo / DigIn / DigIn_Pu / Counter / Counter_Pu / Period / Period_Pu
- **D5** : Unused / DigOut / PWM / Servo / DigIn / DigIn_Pu / Counter / Counter_Pu / Period / Period_Pu / EncoderA / EncoderA_Pu
- **D6** : Unused / DigOut / PWM / Servo / DigIn / DigIn_Pu / Counter / Counter_Pu / Period / Period_Pu / EncoderA / EncoderA_Pu
- **D7** : Unused / DigOut / PWM / Servo / DigIn / DigIn_Pu / Counter / Counter_Pu / Period / Period_Pu / EncoderA / EncoderA_Pu
- **D8** : Unused / DigOut / PWM / Servo / DigIn / DigIn_Pu / Counter / Counter_Pu / Period / Period_Pu / EncoderA / EncoderA_Pu
- **A0** : Unused / DigIn / ADC

In practice, the Pin are all the same except:

- **D3** : That can only be used as output.
- **D4** : That can not be used for the encoders.
- **A0** : That can only be DigIn or ADC.

The operation of all Pin types is explained in "Theremino_NetHAL_Help" file.

ADC Features

The ESP8266 has a single ADC that (when mounted on Wemos D1 Mini module) has the following characteristics:

- Number of Bits: 10
- Minimum voltage: 0 volts
- Maximum Voltage: 3.3 volts (influenced by the supply voltage)
- Conversion time: about 95 uS
- Noise: about 1 LSB (if the supply voltage is stable)
- Impedance: 320 k resistive to ground
- Tolerance to the continuous surge: from - 50 volts to +50 volts
- Tolerance for short overvoltage: from - 200 volts to 200 volts
- Maximum input power on protection diodes: +/- 10 mA

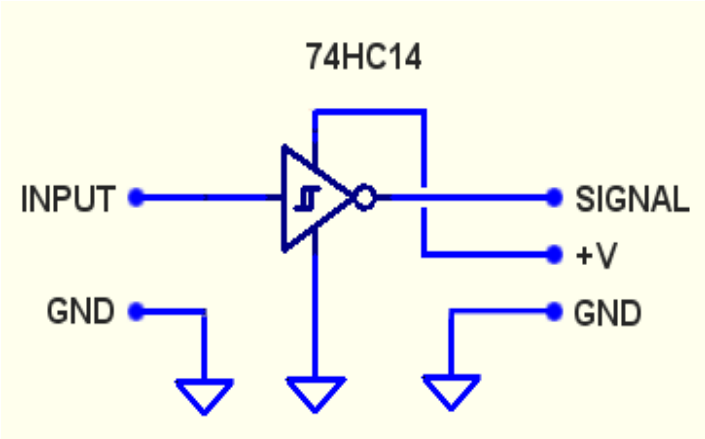
We did not have tested the surge and overvoltage tolerance, but we deduced them from the characteristics of the resistors, and from the +/- 10 mA current, bearable by the protection diodes inside the chip.

Electrostatic discharge and overvoltage bearable for short times, are definitely higher than the +/- 200 volts shown here.

Features of the digital inputs

The digital inputs of NetModule based on ESP8266 are not Schmitt-Trigger type so, in order to avoid false counts, a Schmitt-Trigger should be externally added.

You could use, for example, the 74C14, 74HC14, CD40106 or HEF40106 that contain six triggers, or the 74v1g14 that is small and contains only one.

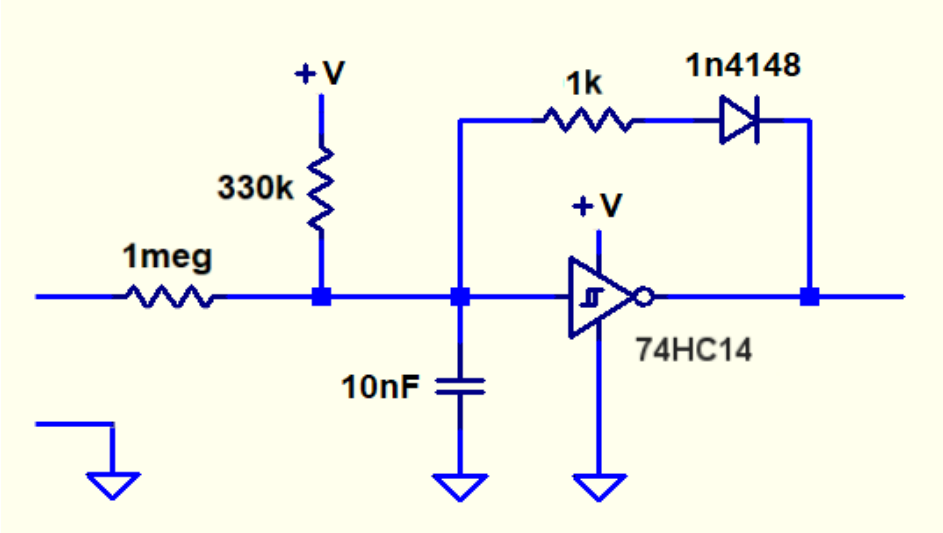


In some cases this measure may not be necessary, but it is for sure if you have input signals with slow edges (longer than 1 uS) and if the pin is configured as Period or Counter input.

The voltage +V is connected to the NetModule 3.3 volt or 5 volt, depending on whether you have input signals with a range of 3.3 volts or 5 volts.

For more information see ***this page***.

Increase the number of ADC inputs



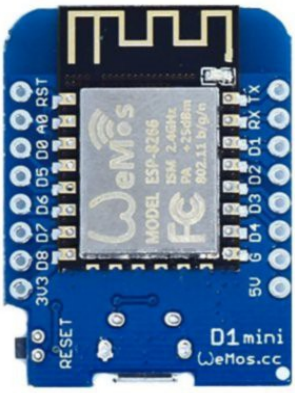
With this circuit every digital input can become an ADC. You will then have up to eight ADCs on a NetModule, or transform to ADC the Pins 7 to 12 of a Master.

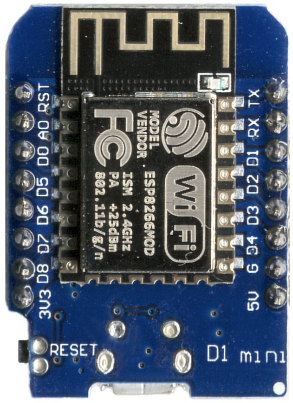
The conversion quality is comparable to a nine bits (0.5% accuracy) ADC, with a speed of about 500 samples per second. Features are modest but sufficient for many control applications.

The voltage +V is connected to the NetModule 3.3 volt or 5 volt, depending on whether you have input signals with a range of 3.3 volts or 5 volts.

For more information see ***this page***.

Notes for modules not-Wemos





A Wemos form A NON-Wemos form The power connector

Non-Wemos modules can lose communication if powered from the USB connector and using loads that absorb a lot of current (eg servomotors).

To use them without problems just do not feed them from the mini-USB connector, but by the Pins GND and + 5V who are close to D0.

The designers of the printed circuit of the non-Wemos modules have done a wrong arrangement of the traces. To which the incoming current from the mini-USB makes the goose around and causes differential voltages on the processor, that is resetted, or that strive its protection diodes until it goes in error.

You could probably correct the PCB, cutting a track and doing a jumper wire somewhere. But it's worth it anyway because powering from “power side” is cleaner, and it is good to use it always.

Notes for Power Banks

The Power Banks are great for powering portable devices. But by measuring their output voltage with the tester, you might read only 3 or 4 volts instead of 5 volts. And this might suggest that do not work well.

This behavior is generated by the circuit thet reduces the consumption to zero when there is no load.

As soon as you load them a bit (probably at least a few dozen or hundred uA) they emit 5 volts. But a tester loads them with only 0.5 uA, which are not enough to turn them on.