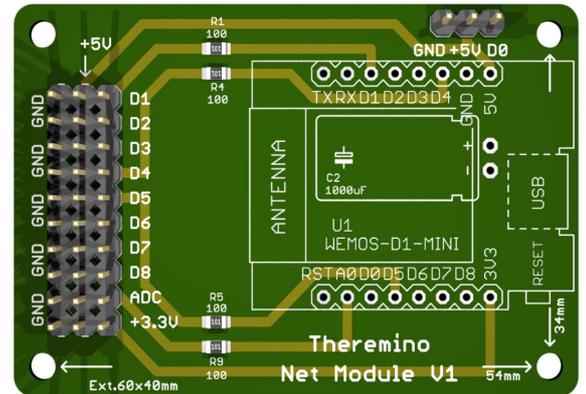Theremino **System**

Theremino NetHAL
V2.x
Instructions

Principle of operation

The NetModule is powered with 5 volts and communicate via a WiFi access point.

You can connect up to 9 sensors and/or actuators to the connectors labeled D1 to D8 and ADC.

Conveniently voltages of 5 volts and 3.3 volts are available on the connectors.

The access point can act as a bridge so any Notebook, Tablet, or PC with Windows can connect to the Net Module.

You can read data on the PC and even transfer them from one to another NetModule.

You could, for example, connect a potentiometer to a NetModule and rotate a servo which is located on another NetModule.

You can also transfer data to and from the Master or the Arduino modules in any number and combination.
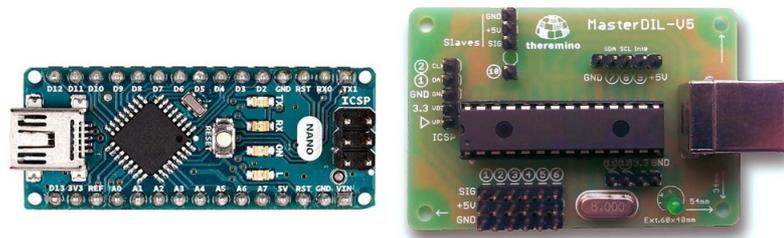
With the application _NetHAL_ you configure the output Pin input to read sensors, move motors, etc...

You can use more than one hundred Theremino system applications that are covering almost all fields, from scientific experiments to music, to radioactivity, teaching methods... see _This Page_.

And everything works immediately without writing a single line of firmware or software.
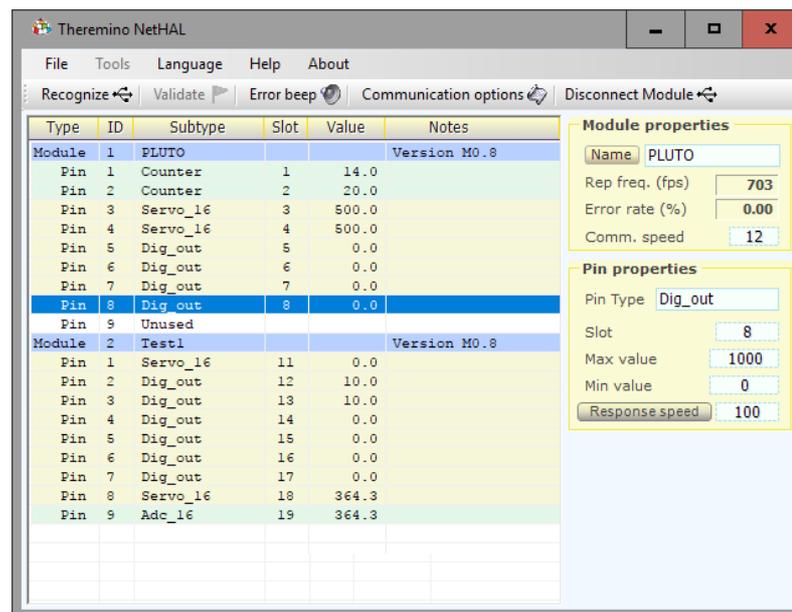
First use of the modules

The new modules, which are programmed via USB, or that start with D0 held high (3.3V or 5V) are started in the state SoftAP.

Every time you restart it will be SoftAP, until you configure them differently with the "NetModule Programmer" application.

The modules in the SoftAP (Access Point Software) state, allow you to connect to them with any computer (or Laptop or Tablet), that has a WiFi module.
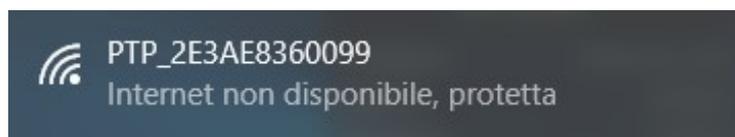
The modules in SoftAP state, appear in the list of networks as "PTP_xxxxxxxxxxxx".

The connection requires a password and you will have to write "password".

Then you will be asked "Do you want to allow a PC to be identified ..." and you will have to press the "Yes" button.

The connection will be of type "Protected - Without Internet"

At this point you can open the NetHAL, to use the module directly, or the NetModuleProgrammer, to set it up.

Important to note that the two applications can not operate simultaneously. If a module is connected to NetHAL, it will not appear in the list of NetModule Programmer, and vice versa.

Connect to the module with the NetHAL

When the module is in "SoftAP" you can connect directly to him, without the need for an additional AccessPoint, that provides the bridge between the modules and PC.

You can then open the NetHAL and use it directly.
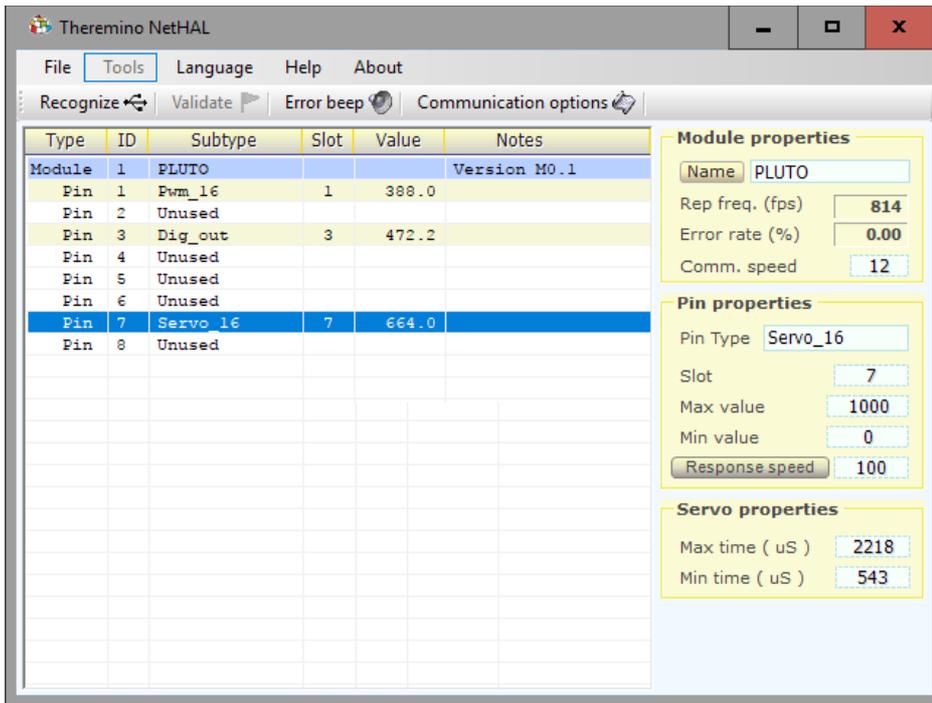
In SoftAP mode you can use the module in all its functions, but only one module at a time.

Wanting to connect multiple modules simultaneously, you have to program them in "Station DHCP" or "Station Static" with the "NetModuleProgrammer" application.

If the module does not appear on the NetHAL list, you should read the page: "If the module does not appear in the lists" in the "NetModule UsbProgramming" document.

Connect the module with the NetModuleProgrammer

When the module is in "SoftAP" you can connect directly to him, without the need for an additional AccessPoint, that provides the bridge between the modules and PC.

You can then open the NetModuleProgrammer to configure the module.
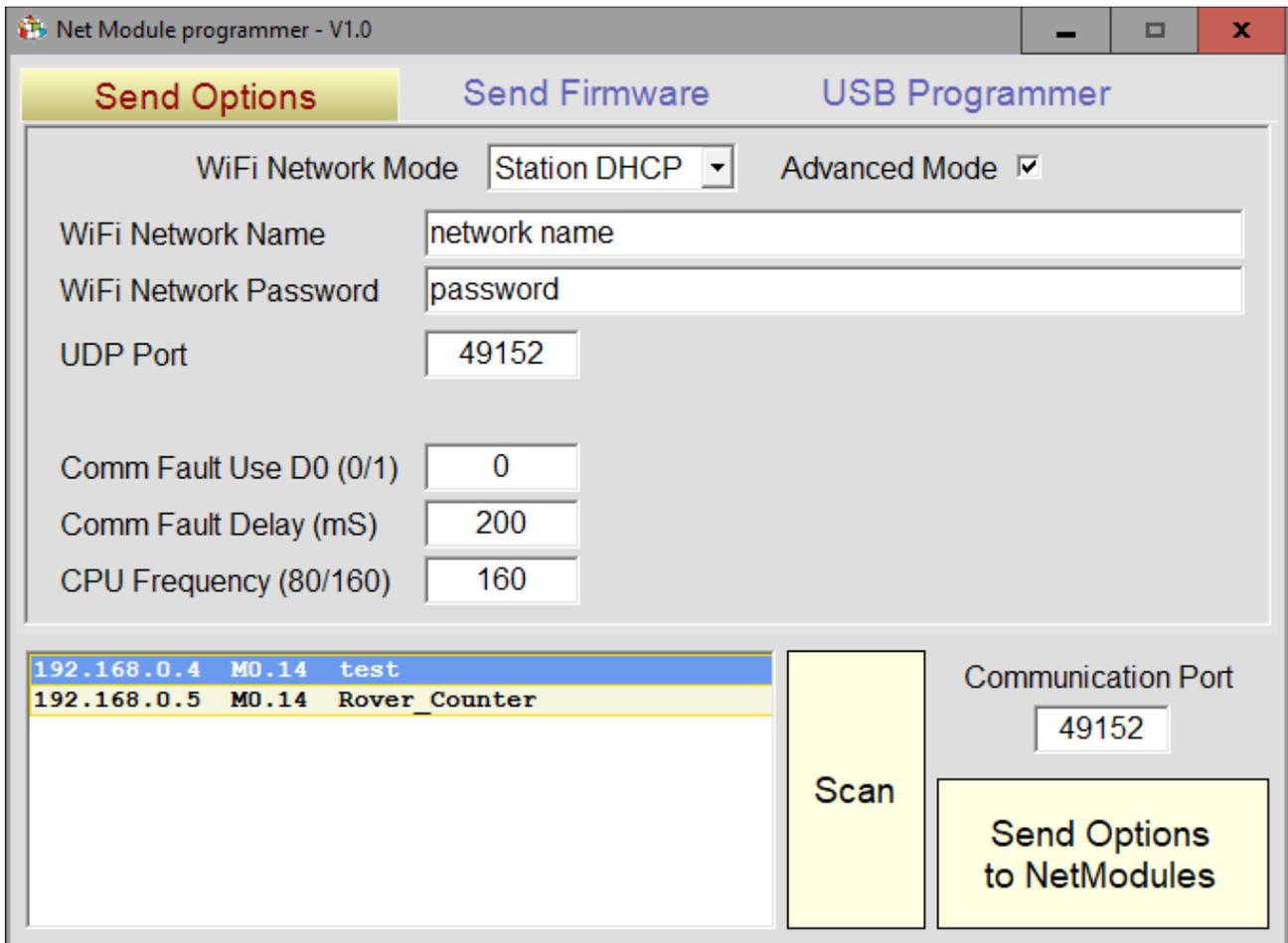
The different operating modes (SoftAP, Station DHCP and Station Static) are explained in the "NetModuleProgrammer_Help" document, that you download from *This Page*.

If the module does not appear on the NetModuleProgrammer list, you should read the page: "If the module does not appear in the lists" in the "NetModule UsbProgramming" document.

Theremino NetHAL
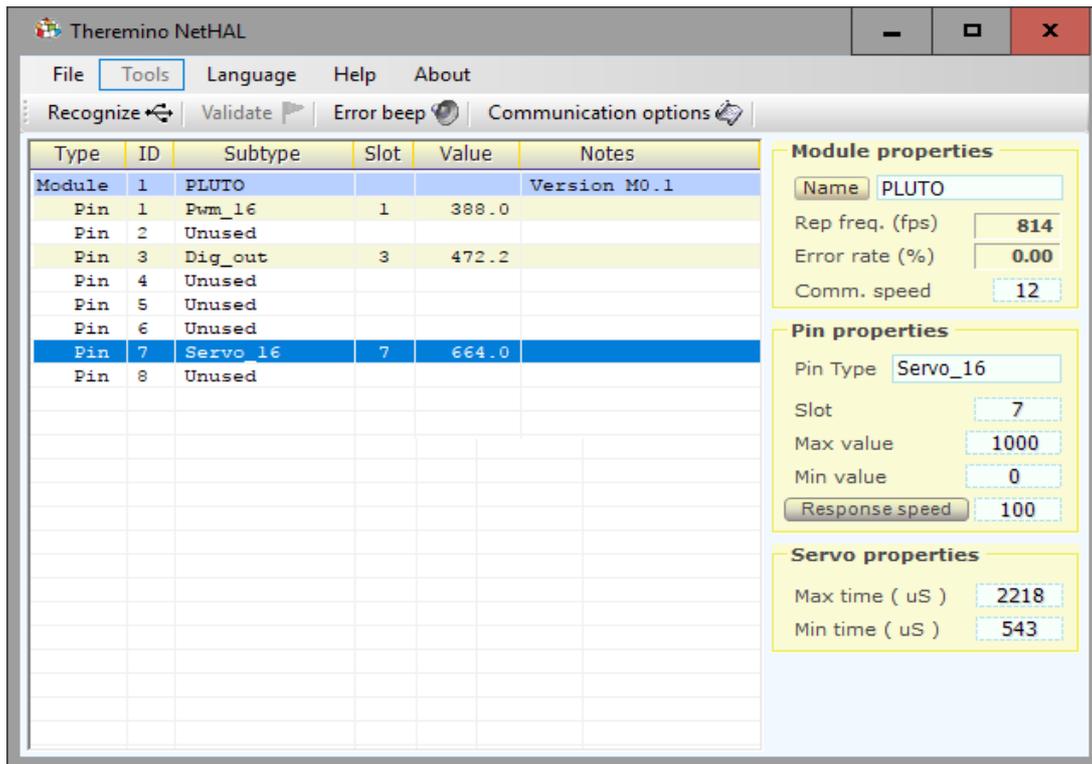
Theremino NetHAL connected to a NetModule via WiFi

The Theremino NetHAL (Hardware Abstraction Layer), which is discharged from **This Page**, It appears with a fairly simple interface, but carries out complex operations, with algorithms that benefit from many years of research and development with the Master modules.

NetHAL is the heart of communication with the hardware, can communicate with many NetModules simultaneously, he knows the USB protocol and knows all the most common types of input-output.

Without NetHAL communicate with the hardware would be difficult (as with the Arduino), would require much time and effort (as with the Arduino) and finally, for all types of InOut, such as moving a motor or even light a LED, you should write the appropriate firmware (like with Arduino).

In Theremino system there are also two other HAL, the first is simply called HAL and communicates via USB with the Master modules, the second is called NetHAL and communicates via WiFi, network and Internet with the NetModules. In this document sometimes we will be referred to generically as HAL, to indicate all the three applications.

If you use hardware modules then the HAL is indispensable and must remain on, you can minimize it, but must remain in operation.

If you do not use hardware then the HAL is not necessary, the theremino system applications of can communicate with each other, through the slot, even without HAL.

When you add or subtract modules, Some red lines warn that the configuration has changed. With the "Valid" button you choose to lose your old configuration and adapt existing hardware.

Connecting multiple NetHAL modules

The application Theremino NetHAL can communicate with any number of NetModules.

In the module list they will be presented in alphabetical order so the list looks the same even if you swap IP addresses.

The Pin of all modules will be read and written all at once and the maximum speed permitted by each module. In other words, a slow module does not cause a slowing of communication with others.
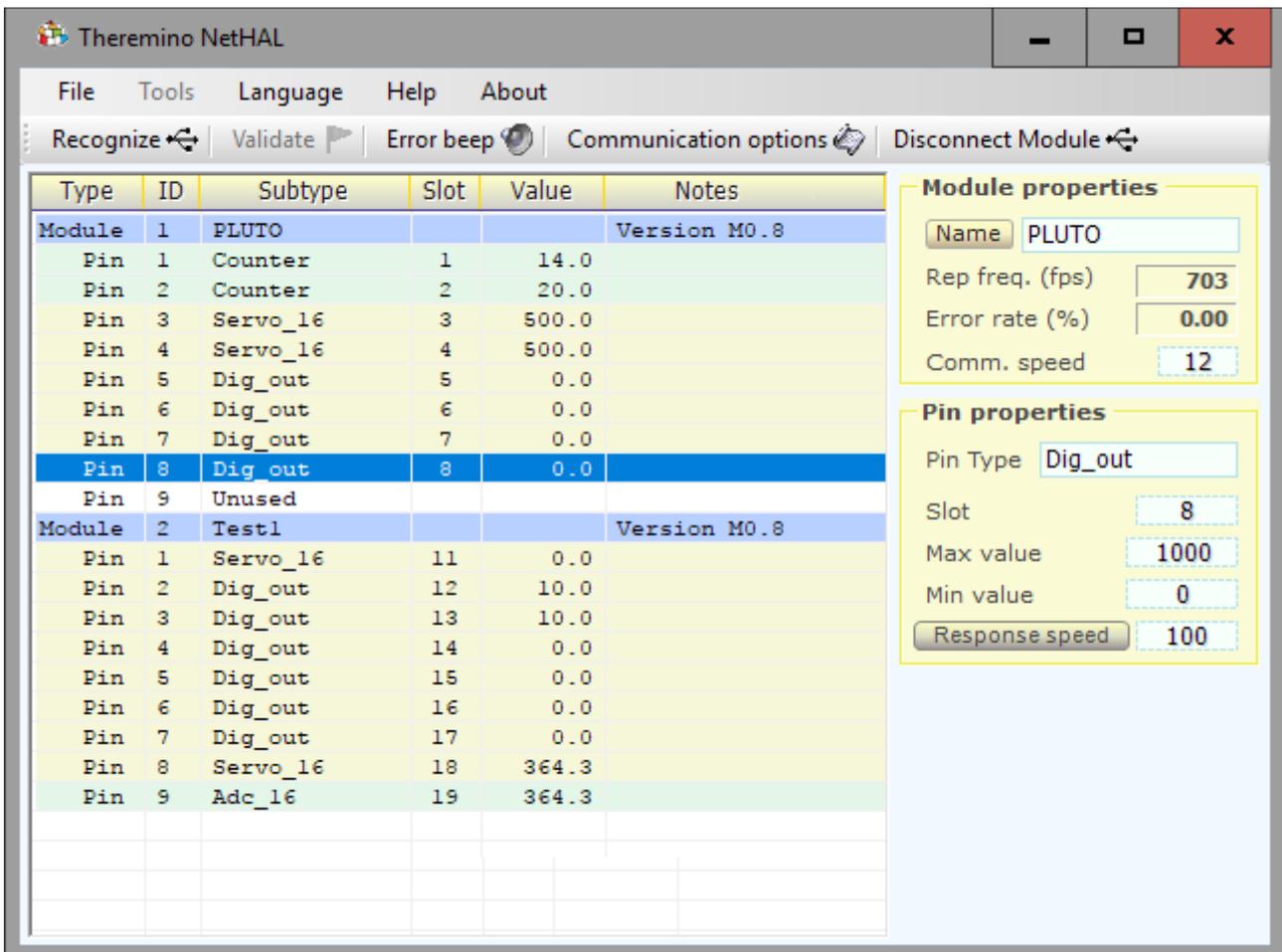
Theremino NetHAL connected to two NetModules via WiFi

The two modules have the names "Test Generic" and "ZetaTest". If you connect other modules these are recognized when starting the application, or by pressing "Recognize" if the application is already started.

The names are stored in the modules themselves, so even if you change networks, access points and IP addresses of the modules, they are recognized and each is assigned its configuration.

The "Slot"

The Theremino System Slots are identified by a number from 0 to 999 and are all part of a MemoryMappedFile called "Theremino1". Each Slot contains a "Float" number, which can be read or written by any module of the Theremino System.
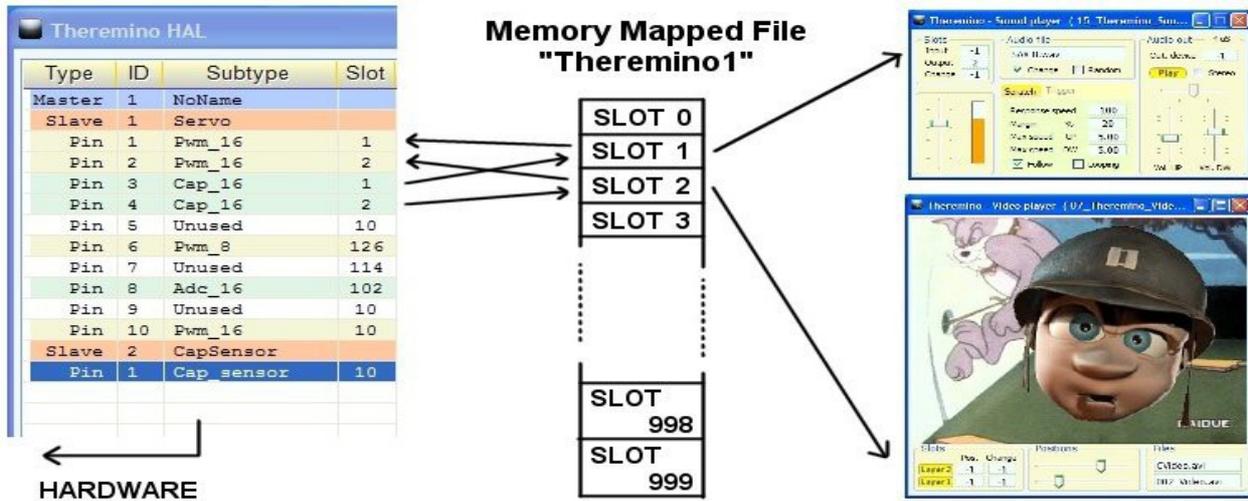
In this picture, only HAL writes in the Slots, but in reality all the components of the system can both read and write in any of the Slots, even if already used by others.

Choosing the right Slot, you should be aware of two things:
- Ensure you do not use the same Slot by mistake, for two different functions.
- Avoid writing on the same Slot, with two or more components.

Input Pins, that are writing in the Slots, are highlighted in light green. If two of more input pins have the same Slot, then the HAL application warn with red lines and the text **SLOT CONFLICT**.

Many applications and Pins can read from the same Slot. But avoid configuring more than one Pin writing on the same Slot; doing so nothing is broken, but the results are unpredictable.

Sending multiple streams of data to the same Slot, all data are mixed and the last who writes wins. if you want to merge data in order, some rules are required.

Type	ID	Subtype	Slot	Value	Notes
Master	1	TestSlotCo...			
Slave	1	MasterPins			Firmware V5.0
Pin	1	Adc_16	1	105.3	
Pin	2	Adc_16	2	99.5	
Pin	3	Dig_in	4	0.0	SLOT CONFLICT
Pin	4	Dig_in	4	0.0	SLOT CONFLICT
Pin	5	Dig_in	5	0.0	
Pin	6	Dig_in	6	0.0	
Pin	7	Dig_in_pu	7	1000.0	
Pin	8	Unused			

To establish mathematics and logic rules between the Slots and to write complex behavioral algorithms, as well, we use Theremino Automation or Theremino_Script, or else any other programming language, such as C + +, CSharp, VBnet or VB6. Visual languages like MaxMSP, Processing, PureData, LabView and EyesWeb, can also be used. Plugins and examples for MaxMSP, are ready made here:
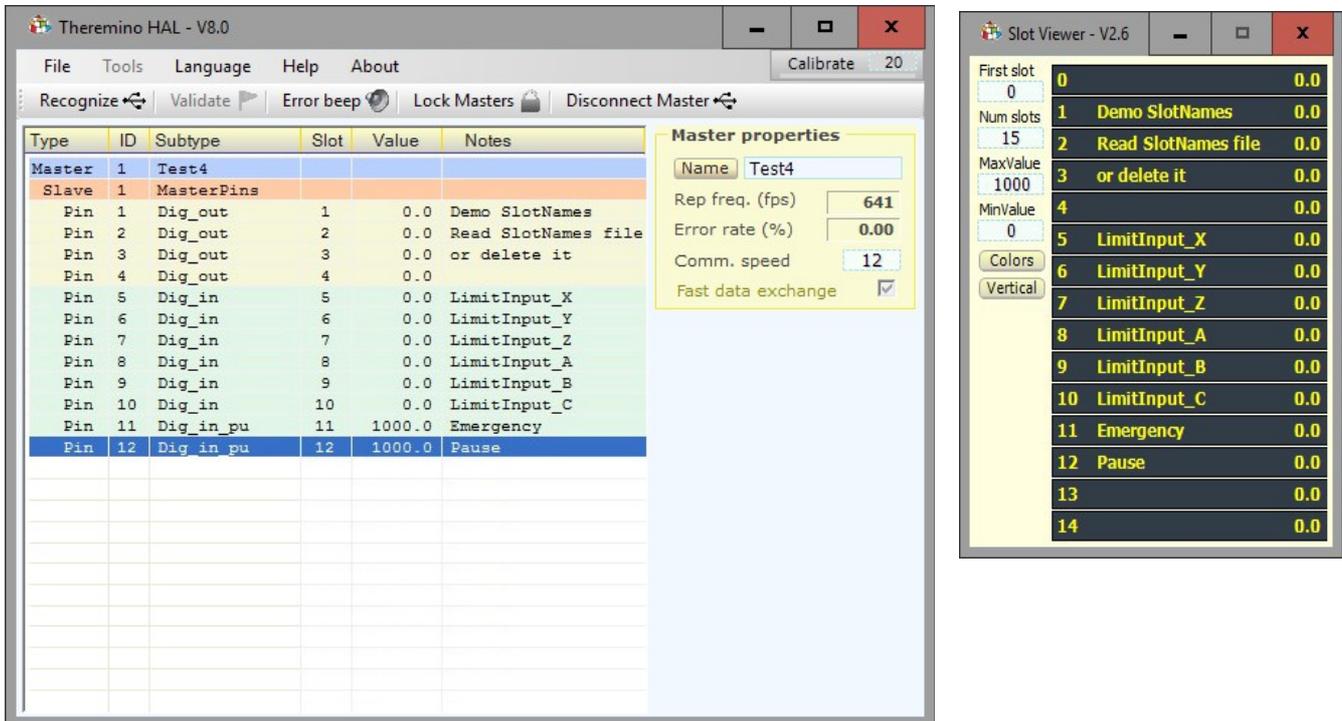*www.theremino.com/downloads/foundations*

More information about the communication in these pages:
www.theremino.com/technical/communications
www.theremino.com/technical/pin-types

The names of the Slots

All the HAL applications and even SlotViewer can view the names of the slot (or annotations or comments).

Important to note that the names are not related to physical Pins, but to the Slots.

The names are written in a file, that should be called "SlotNames.txt" and that must be in the same folder as "Theremino_ArduHAL.exe folder" and "Theremino_SlotViewer.exe". If the file "SlotNames.txt"

If the file "SlotNames.txt" is not present then the comment field will remain empty.

To modify the Slot names you open the "File" menu, choose "Edit slot names file", and edit it with the default system editor (normally NotePad). Finally you save the file and it will be reloaded automatically.

The rules are simple and are shown in the sample file, located in the latest versions of HAL and SlotViewer.

Each line of the file begins with the Slot number, followed by a space and the text to be displayed. The line can also continue with a comment, that does not appear, preceded by a single quote.

If you want to use the same file of comments, for both HAL and SlotViewer, you have to keep the files "SlotNames.txt", "SlotViewer.exe" and "ArduHAL.exe", all in the same folder.

The "Command Slot"

The Theremino System applications, or other applications created by users, can communicate with the NetHAL, sending commands or receiving data, using a special Slot to communicate.

For example an applications may change the parameters of all the Pins, rewriting the configuration file, and then sending the command "Recognize". Or an application could verify how many NetModules are really connected, sending the "Recognize" command, and then reading their number from the Command Slot. Or a musical application could calibrate the CapSensor modules or the CapKeys, sending the "Calibrate" command (actually unimplemented in the net-modules).

Using other Slots in place of the Slot zero.

Normally the Command Slot is zero, but may happen that you want to use multiple independent applications on the same PC. In these cases, each application would reside in separate folders together with its NetHAL, and accesses its modules. In these cases, a different Command Slot can be assigned to each NetHAL. For the commands you can use any Slot (from 0 to 999) but be careful not to assign it to any Pin.

To assign a non-zero number to the Command Slot, manually edit the last line of the file "Theremino_NetHAL_INI.txt". So to assign, for example, the Slot 300, you would write: `CommandSlot= 300`. Be careful not to delete the "=" sign. If something is wrong, the Slot zero is used and the HAL rewrites the corrected line in the INI file.

How to send commands

Currently two commands are defined:

- Recognize   You send the "NAN_Recognize", or the number "1"
- Calibrate (*)   You send the "NAN_Calibrate", or the number "2"

(*) Currently (September 2018), there are not NetModule Pin types needing a calibration.

The applications that are NOT able to send the NANs (Not A Number) special numbers, can use the the numbers "1" and "2" instead of the "NAN_Recognize" and "NAN_Calibrate".

If you use numbers "1" and "2", they must be preceded by a sequence. This sequence has two numbers (333 and 666) that correspond to actually floating point numbers, with seven figures of precision, 333.0000 and 666.0000. So it is virtually impossible for an ADC or other devices to send this sequence by mistake.

Response messages

Responses, and error messages, are communicated with numbers in the command slot.

- -1   The "Recognize" command is still executing.
- 0   No NetModule have been found. The list is completely white.
- 1 and up   The number of NetModule that has been recognized.
- NAN_MasterError   One of the connected Masters has stopped communicating.

The "Command Slot" - Examples

To send the "Recognize" command you write:

```
------------------------------------ VbNet
Slots.WriteSlot (0, NAN_Recognize)

------------------------------------ CSharp
Slots.WriteSlot(0, NAN_Recognize);

------------------------------------ Theremino Script
WriteSlot (0, NAN_Recognize)
```

As explained on the previous page, some applications (Theremino Automation for example) are not capable to use the NAN special numbers. Not using NANs the previous examples would become:

```
------------------------------------ VbNet
Slots.WriteSlot (0, 333)
System.Threading.Thread.Sleep(50)
Slots.WriteSlot (0, 666)
System.Threading.Thread.Sleep(50)
Slots.WriteSlot (0, 1)


------------------------------------ CSharp
Slots.WriteSlot(0, 333);
System.Threading.Thread.Sleep(50);
Slots.WriteSlot(0, 666);
System.Threading.Thread.Sleep(50);
Slots.WriteSlot(0, 1);

------------------------------------ Theremino Automation
Slot 0 = 333
Wait Seconds 0.05
Slot 0 = 666
Wait Seconds 0.05
Slot 0 = 1

------------------------------------ Theremino Script
WriteSlot (0, 333)
Threading.Thread.Sleep(50)
WriteSlot (0, 666)
Threading.Thread.Sleep(50)
WriteSlot (0, 1)
```
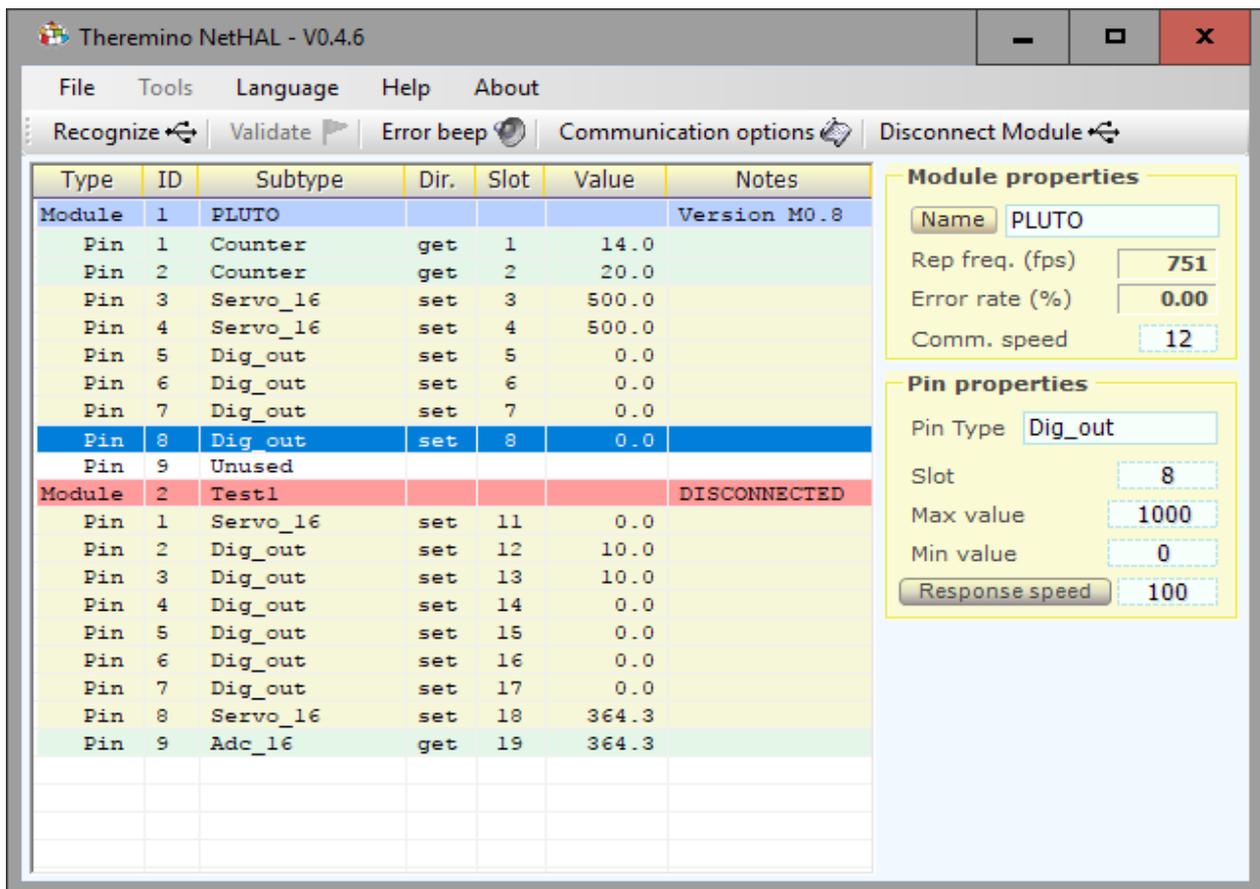
The 50 milliseconds waiting instructions are used to give time to the HAL to read the Slot.

The HAL colors

The color scheme helps to recognize the components and their configuration

The first module (named PLUTO) It provides:

> *Two "Pins" configured as "Counter" (the light green color indicates an Input)*

> *Two "Pins" configured as "Servo_16" (the light yellow color indicates an Output)*

> *Four "Pins" configured as "Dig_out" (of which the pin 8 is selected)*

> *A "Pin" configured as "Unused" (the white color indicates "not used")*

The second form (with the name TEST1) provides:

> *A "Pin" configured as "Servo_16" (the light yellow color indicates an Output)*

> *Six "Pins" configured as "Dig_out" (the light yellow color indicates an Output)*
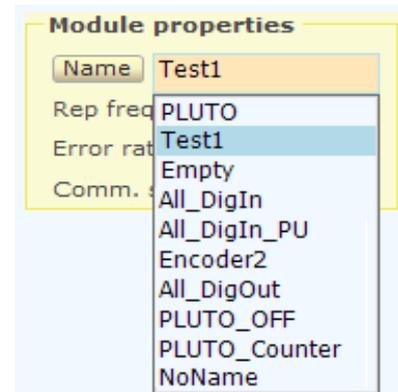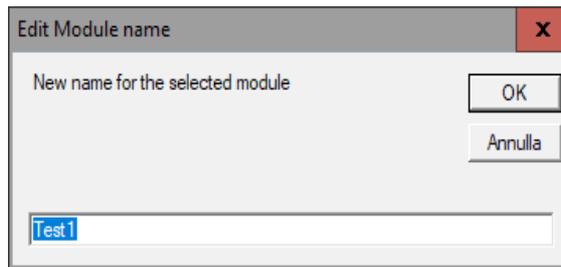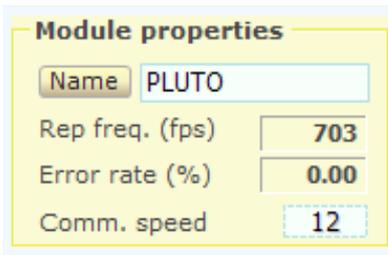
> *A "Pin" configured as "Servo_16" (the light yellow color indicates an Output)*

> *A "Pin" configured as "Adc_16" (the light green color indicates that it is an Input)*

The blue line "Pin 8 - DigOut" is the selected row and its properties are shown on the right

The line "Module 2 - Test1" has a red background because the "Test1" module is disconnected (off)

The properties of the module - The name

The selected module name can be changed in two ways:
- ♦ Pressing the "Name" button and changing its name.
- ♦ Clicking on the name box and choosing a different configuration from the drop down menu.

The module name It is written to the hardware module and is used to recognize when you reconnect it.

A newly attached module is called "NoName". We suggest you to rename the module, to distinguish it from all the others.

While dialing the name, the letter case (uppercase or lowercase) does not count.

If in the data base there are two modules with the same name, then the first configuration is used for both the modules. It is therefore important to give different names to each module (unless you want to have a replacement module with the same name as the main one)

The modules are always listed in alphabetical order, so if the IP address changes, then the module order does not change.

- - - - -

The HAL program almost always manages to use the right configuration when disconnecting, replacing and restoring components, but if you change the module names using a different computer or with another application (HAL located a separate folder - with separate parameters) or in other difficult and complicated cases, then the alignment between hardware and configurations could be lost.

If you lose the alignment you should restore the configuration manually, a Pin at a time, but experts can edit the configuration file and possibly copy this file entirely, or only a part of configurations, from a HAL application to another, on another computer or to another folder.

When the configuration is invalid to change the name of the module does not change the configuration file, but only the name written in hardware. You can then change the names of the modules to match them to the right ones in the configuration.

The module properties - Communication
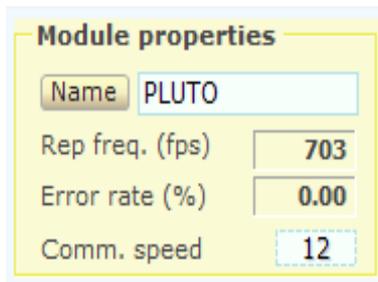
Module properties

Name PLUTO

Rep freq. (fps)   703

Error rate (%)   0.00

Comm. speed   12

- Number of communications per second
- Percentage of transmission errors (normally zero)
- Communication Speed Adjustment

The number of messages per second "Fps" should normally be above 500 and often above 800, increasing the Pin number used this frequency may drop slightly.

For many applications, a 100 fps is more than enough, for some applications it is good to keep fps high as possible, at least 400 or 500.

The percentage of errors normally is zero. You should have errors only in case of disturbances caused by another network on the same channel, or if the distance from the access point exceeds 20..50 meters.

Tips to increase attendance "fps"

- Move closer to the access point
- Change the WiFi channel on the access point in order to avoid disturbances from neighbors.
- Use the app *WifiInfoView* to see which channels are less used.
- Use a better Access Point.
- Increase the "Comm Speed".
- Decrease the number of bytes used by configuring as "Unused" all the unnecessary Pins.

Adjust the frequency "fps"

With the "Comm speed" value you can adjust the refresh rate "fps".

To increase the response speed would be good to maximize the exchange rate, and set "Comm Speed" to "12". But for many applications exchanges percent per second it is more than enough, so normally you can adjust "Comm Speed" from 8 to 10 and charge less the CPU.

The modules NetModule

The NetModule provides eight Pin in the classic format (GND / + 5V / SIGNAL). So you can connect servos and sensors with their original connectors, not bare the wires and screw or weld them.
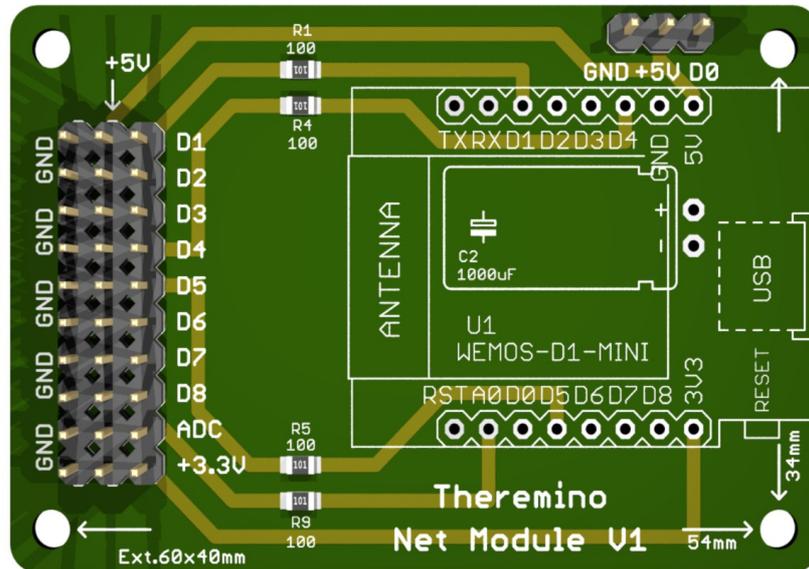
All input and output pin work between zero and 3.3 volts, but also accept input signals up to five volts. In addition, the NetModule has limiting resistors on all inputs and outputs that greatly reduce the risk of damage to the processor and allow to connect any LED directly, without risking to send them too much current.

On connectors is available the 5 volts and also the 3.3 volts which is necessary for some sensors. The 5 volts is stabilized by a large electrolytic, which allows to overcome the motors starting pulses, without risking a loss of communication.

The eight connectors from D1 to D8 are digital inputs-outputs and can be configured as DigIn, DigOut, Pwm, Servo, Counter, Period, Frequency and Encoder. The ADC connector is an analog input and can only be configured as ADC or DigIn.

The digital inputs are not of Schmitt-Trigger type, so in order to avoid false counts should be externally add a Schmitt-Trigger. For example, 74C14, 74HC14, CD40106 or HEF40106 that contain six, or the 74v1g14 that is small and contains only one. In some cases this arrangement may not be necessary, but it is for sure if you have input signals with slow edges (longer than 1 uS) and are configured as Period or Counter inputs.

The Pin D0 has two functions:
1) Is held at 3.3 volts if the communication is active and goes to zero if the communication is missing. It can then be used for safety shutdowns.
2) If during the startup is held at 3.3 volts, the module enters the special configuration mode (explained in Theremino_NetModule file). So during the startup this pin it is normally held to zero with a 4.7 k resistor to ground.

The Wemos D1 Mini Modules

Currently the NetModule connects to WiFi using a "Wemos D1 Mini", that can be purchased on eBay for a few Euros.

There are two types, those produced by Wemos (who wrote Wemos front and back) and the aftermarket.

Original Wemos Modules

The modules produced by Wemos cost twice (though less than ten Euros) and the PCB have done better, so you can even power them via the USB port.
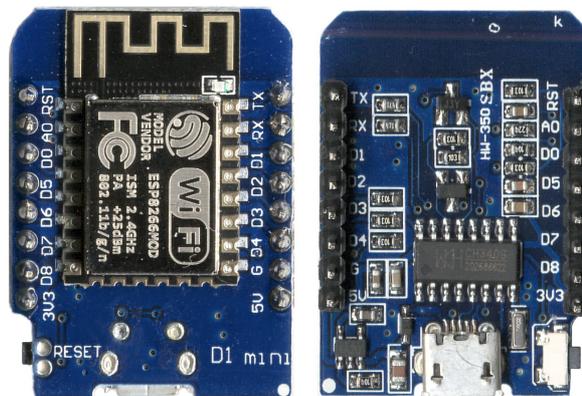
not Wemos Modules

Those NOT produced by Wemos should be powered from the GND, 5V, D0 connectors of the NetModule, otherwise the communication is interrupted as soon as you move the Servo or other users who consume a lot of power.

However, the USB connector should only be used for a module programming. Instead during operation is always better power with the NetModule 5 volt connector. Powering via the NetModule, even the non-original modules work perfectly.

The types of Pin

The pins can be configured as:

Pin properties
Pin Type: **Unused**
Unused
Dig_out
Pwm_16
Servo_16
Dig_in
Dig_in_pu
Counter
Counter_pu
Period
Period_pu
Encoder_a
Encoder_a_pu

- Not used

- Digital Output
- PWM output (250 Hz)
- Output for servo-motors

- Digital input
- ADC Input for potentiometers and transducers
- Counter, frequency and period input
- Input for two phases encoders

Special NetModule Pins:

- The Pin 1 to 8 can be configured with all types, except the ADC.
- The Pin D3 can be configured as Dig_out, PWM and Servo.
- The Pin D4 can not be configured as Encoder.
- Pin 9 can only work as ADC and Dig_in.

All Pin configured as "Unused"This allows to decrease the number of bytes passing on serial and USB line and maximize the number of exchanges per second.

The types with pullup, Whose name ends in "_pu", allow to easily connect switches, buttons and open-collector devices, without having to add external resistors (pullup current typical = 70 uA).

The parameters common to all Pins
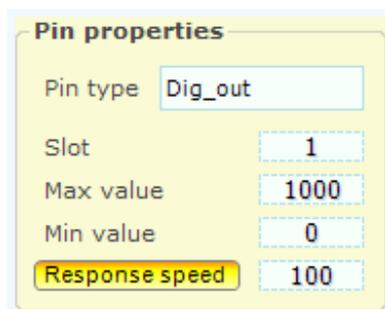
Pin properties

Pin type	Dig_out
Slot	1
Max value	1000
Min value	0
Response speed	100

"Slot" indicates where to write or read data. The slots are a thousand, numbered from 0 to 999, and can be read or written by all Pins and all the Theremino System applications.

Please note: Many applications and Pins can read from the same Slot,
but avoid to configure more than one Pin, writing to the same Slot.
Doing so doesn't damage anything, but the results are undefined.

"Max value" normally set to 1000, indicates the value that the Pin must have, when at its maximum.

"Min value" usually set to zero, indicates the value that the Pin must have, when at its minimum.

By adjusting Max and Min, with values other than 0 and 1000, you can achieve any scale ratio and calibration. If you exchange the two values (min value larger than max), then the scale is reversed, this is useful to reverse the movement of the actuators or to turn the readings of sensors, that act reversed.

"Response speed" adjusts the filter IIR (Infinite Impulse Response) for the best compromise between noise and response speed. With a value 100, the filter is disabled and the maximum speed of response is obtained. The value 1 produces the maximum filtering, (elimination of any jitter) but a very slow response (approximately one second). Normally we use the value of 30, which provides a good filtering and a fast enough speed.

If the **"Response speed"** button is pressed, the IIR filter adapts to variations in order to obtain a higher reactivity, when there are wide variations and a greater damping, when the changes are minor. As a result you get a good stability of the digits, without too much sacrificing the settling time.

Some sensor signals may malfunction with **"Response speed"** pressed. This is specially true for sensors producing a signal with little variations around a high base value. In this case the signal never arrives to the final value or is very slow to arrive. If you experience this, disable **"Response speed"**.

The "Output" Pin types -> Dig / PWM / Servo

◆ Dig_out

Pin properties

Pin type	Dig_out
Slot	1
Max value	1000
Min value	0
Response speed	100

This type of pin provides a digital output.

The incoming value from one slot, limited between "Min Value" and "Maximum value" and filtered by "Response speed" is compared with the intermediate value between "Min value" and "Max value", if it exceeds the Pin turns on, otherwise off.

The Pin can only assume voltages 0 volts (off) and 3.3 Volt (on) and the output current is limited to approximately +/- 10 mA

◆ Pwm_16

Pin properties

Pin type	Pwm_16
Slot	1
Max value	1000
Min value	0
Response speed	100

PWM properties

Max time (uS)	4000
Min time (uS)	0
Logarithmic response	☐

This type of Pin provides a PWM output (pulse width modulation)

The incoming value from one slot, limited between "Min Value" and "Max value" and filtered by "Response speed" is transformed into a pulse width between "Min time (uS)" and "Max time (uS)"

The repetition time of the pulses is 4000 uS (250 Hz) fast enough to turn on a LED with variable intensity. For users who require a real variable voltage is added to a low pass filter, usually composed of a resistor and a capacitor.

The Pin provides pulses between the voltages 0 V (off) and 3.3 Volt (on) and the output current is limited to approx. +/- 10 mA

◆ Servo_16

Pin properties

Pin type	Servo_16
Slot	1
Max value	1000
Min value	0
Response speed	100

Servo properties

Max time (uS)	2500
Min time (uS)	500

This type of Pin controls servo motors directly.

The value coming from a Slot, limited between "Min value" and "Max value" and filtered by "Response speed" is converted to pulses of width between "Min time (uS)" and "Max time (uS)"

The pulses repetition time is adjusted to normal aero-model servo, spinning around 180 degrees, between the min and max time.

The Pin provides voltages of 0 and 3.3 volts, adequate in all normal servos fed from 3 to 6 volts and a current sufficient to drive dozens of parallel servo.

The "Input" Pin types <- Dig / ADC

◆ Dig_in and Dig_in_pu

Pin properties	
Pin type	Dig_in
Slot	1
Max value	1000
Min value	0
Response speed	100

This type of pin provides a digital input.

The voltage value is read with a digital input (low if less than 0.8 volts and higher if greater than 2.5 volts) and transformed into an ON-OFF information that ultimately become "Max value" and "Min value." The value is finally filtered with "Response speed" and then written into the slot. The filtering produces intermediate values and approximately proportional to the time relationship between On and Off

◆ Adc_16

Pin properties	
Pin type	Adc_16
Slot	1
Max value	1000
Min value	0
Response speed	30

This type of Pin provides an analog input.

The voltage value from 0 Volt to 3.3 Volt is converted into a number between "Min value" and "Max value." The value is finally filtered with "Response speed" and then written into the slot. The filtering reduces the noise present in the input signal, but slows down response. The value 30 represents a good compromise between speed and noise.
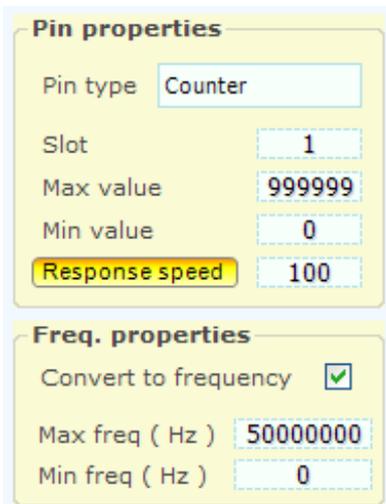
The "Input" Pin types <- Counter

◆ Counter and Counter_pu
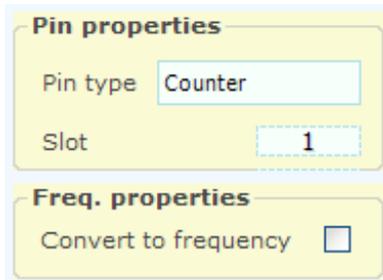
Pin properties

Pin type | Counter
Slot | 1

Freq. properties

Convert to frequency ☐

All Pin can be programmed as Counter or Counter_pu but the maximum counting speed is quite limited, at around tens of KHz, load-dependent on the micro-controller and the duty-cycle of the signal.

◆ Counter and Counter_pu with the "Freq" option

Pin properties

Pin type | Counter
Slot | 1
Max value | 999999
Min value | 0
Response speed | 100

Freq. properties

Convert to frequency ☑

Max freq (Hz) | 50000000
Min freq (Hz) | 0

The Pin programmed as Counter or Counter_pu can be transformed from counters to frequency meter.

The frequency value to be compared "freq Min" and "Max freq", is then compared between "Min worth" and "Max value," filtered with "Response speed" and finally sent to the slot.

The "Input" Pin types <- period

◆ Period and Period_pu

Pin properties

Pin type | Period

Slot | 1

Freq. properties

Convert to frequency ☐

This type of Pin measure the period of a repetitive wave form, up to a maximum period of about 260 seconds.

The resolution is three microsecond and the precision is +/- 1% in a range of ambient temperatures from 0 C to 50 C

◆ Period and Period_pu with the "Freq" option

Pin properties

Pin type | Period

Slot | 1

Max value | 1000

Min value | 0

Response speed | 30

Freq. properties

Convert to frequency ☑

Max freq (Hz) | 1000000

Min freq (Hz) | 0

The Pin programmed as Period or Period_pu can be transformed from period to frequency meter.

This technique allows to measure very low frequencies (up to about a tenth of Hertz) with very high resolution.

The frequency value limited between "freq Min" and "Max freq", is then compared between "Min value" and "Max value," filtered "Response speed" and finally sent to the slot.

The "Input" Pin types <- Encoder

Pin properties

Pin Type	Encoder_a
Slot	3
Max value	1000
Min value	0
Response speed	100

Pin properties

Pin Type	Encoder_b

All Pins, except Pin A0, can be programmed as Encoder.

For each encoder requires two input Pin: Encoder_A and Encoder_B or Encoder_A_Pu, and Encoder_B_Pu.

This pair of inputs of the encoder reads the two "phases in quadrature". The encoder count is written in the slot associated with the Pin "Encoder_A".

Each Pin "Encoder_A" type uses 16 bits for data transmission, while the "Encoder_B" are just a placeholder and will not send data.

- - - - - -

The encoder reads the angular position of a pin, such as potentiometers, but the number of rounds is unlimited.

There are similar encoder to small pots (the best known are the KY-040 of the following images). These models are mechanical and provide 18, 20 or 24 pulses per revolution, depending on the manufacturer. The firmware obtained from these pulses 72, 80 or 96 angular positions per revolution.

The maximum counting speed is limited to about 10 KHz, and is load-dependent on the micro-controller. So it should be used only Encoders with a few steps per revolution or limit the speed of rotation or demoltiplicarli.

The encoder generates a count ranging from 0 to 65535 (16 bits). When the count exceeds 65535 the number starts from zero. This system allows many applications, asynchronous to each other, to read the sequence number without losing counts.

For further information about encoders, read this page:
http://www.theremino.com/hardware/inputs/sensors#encoders

CAUTION: In the site page that speaks of KY-040 encoder, we recommend using 100 nF capacitors with Master Pins set as Pullup. The same solution is also possible with the NetModule, but the two capacitors must be from 10 nF and not 100 nF. Because of the NetModule Pullup current is about ten times lower than that of the Master.

The viewer of the details Pin
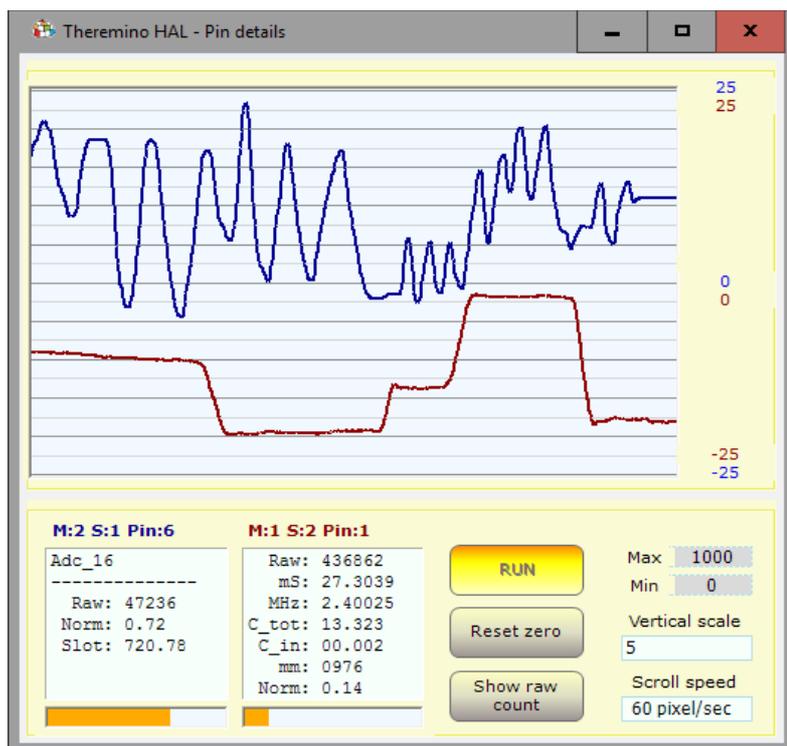
Double-clicking on the line of an active Pin, opens this tool. For two signals, first click on a pin and then on the second, with a single click.

The vertical scale can be set to "Scale Min-Max", which corresponds to the Min and Max textbox values.

Or it can be set in 24 levels from 0.01 to 50000 points per vertical division (ten dark lines). When the vertical scale is set to those vaues, to center the traces you press "Reset zero."

In some cases it may be useful to display the "Raw" values with the "Show raw count" button.

The "Scroll" control adjusts the graph scrolling speed from 0.1 Pixel Pixels per second up to 60 per second.

The two text boxes show the internal details of Pin, Pin the title indicates what is in this text "M: S 1: 1 Pin: 2" means "Module 1, slave 1, Pin 2".

The Pin details can help in the control and regulation of Output Input devices (sensors and actuators).

Some Pin types are more complex and have more intermediate values. Typically there is a "Raw" value with values very variable depending on the type of Pin, a "Normalized" value that always goes from 0 to 1, and a "Slot" value which normally ranges from 0 to 1000 and which is the simplified value available on Slots and easily usable by all the high-level software.

- ❖ **Raw** "Raw" value that can be a count, a time, a voltage or otherwise.
- ❖ **mS** Time in milliseconds
- ❖ **usec** Time in microseconds
- ❖ **Smoot** Value that was passed in a FIR filter smoothing (only used in Cap8 and CAP16)
- ❖ **Mean** Average value (used in type Cap8 and CAP16 as zero calibration)
- ❖ **Norm** Normalized value between zero and one
- ❖ **Slots** Value written to or read from the slot associated with the Pin (normally 1 to 1000)
- ❖ **Out** digitized value that can be processed only in "0" or "1" (only used by DigOut)

Menu commands
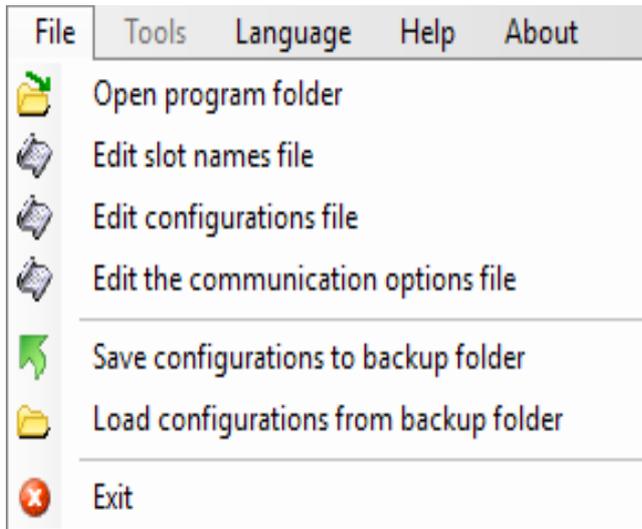
Open the program folder it may be useful to modify the documentation files and languages.

Edit the file: "SlotNames" Comments and slot names are explained in the first pages.

Edit configurations it may be convenient in some cases. For more info, please read "Questions and Answers" on the last page of this document.

Change communication options the communication options file is opened to change the valid IP addresses, the NetModule valid communication ports and names.

The instructions and examples of options, are in the same communication options file, which is called "CommOptions.txt".

Save the configuration as a backup It allows to make the configurations of the security copies. If the configuration files are modified by mistake you can then load them from a previous version. Previous versions show the date and time they were saved.

The language files are located in the "Docs" folder next to ThereminoHAL.exe application.

To make new language files just copy the file Language_ENG.txt, change "ENG" with "FRA", "ESP", "DEU" or "JPN" and edit text with Notepad.
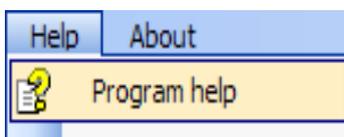
This command opens the documentation files.

The Toolbar Commands

Recognize
It recognize the active modules.

Validate
When modules are modified, it is advised that the configuration has changed with red lines in the list. If you choose to lose your old configuration and adapt existing hardware, with this button it will make the new configuration effective.

Errors
When pressed communication errors are highlighted with a sound.

Communication Options
The communication options file is opened to change the valid IP addresses, the NetModule valid communication ports and names. The instructions and examples of use are the same communication options file, which is called "CommOptions.txt".

Disconnect Module
Deletes the selected module from the list. This way you can delete unwanted modules without having to physically switch off.

Isolated Applications

Some Theremino system applications automatically launch its own HAL. This happens if there is a Theremino_HAL.exe in the folder ThereminoHAL located near to your application EXE file. You could also place Theremino_HAL.exe next to the exe file of the application, but it is better that the HAL has its own folder, with the "Docs" sub-folder containing documentation and language files.

These HAL use their own private configuration and if they have the "Master Lock" button, you can only connect to its Master, identifying them by name among those connected to the USB ports. An application composite in this way, will continue to operate even when copied to a different computer, and even if other Theremino System applications are connected with their Master, on other USB ports.

The applications that benefit most from these possibilities, are applications with a specific task, such as: Theremino Geiger, Theremino OilMeter, Theremino Weather, Theremino Theremin, Theremino Arm, Theremino Geo and Theremino EmotionMeter.

This does not mean that isolated applications can not communicate with each other. The modular communication is always possible and is done through the Slot, which are common to all applications.

To avoid using the same Slot for different tasks we have defined a broad pattern:

```
Experimental 100 slots 000-099
- - -
Theremino_Theremin 100-199
Theremino_SlotsToMidi 200-299
Theremino_MusicKeys 300-329
- - -
469 free slots 330-799
- - -
Theremino_OilMeter 800-809
Theremino_EEG 810-819
Theremino_Meteo 820-839
Theremino_Arm 840-849
10 free slots 850-859
10 free slots 860-869
10 free slots 870-879
Theremino_EmotionMeter 880-889
Theremino_Geiger 900-909
Theremino_Bridge 900-909
Theremino_GEO 910-919
Theremino_GeoPreampTester 920-929
Theremino_Radar 930-939
10 free slots 940-949
10 free slots 950-959
10 free slots 960-969
10 free slots 970-979
10 free slots 980-989
10 free slots 990-999
```

This scheme is only indicative. You can use the Slots as you like, providing that, the same Slots are not used for different tasks in the same PC. If you make a mistake does not break anything, but the data overlap with undefined results.

Adjusting the numerical boxes

Draw speed (fps)   5

The HAL numerical boxes (and all other Theremino system applications) have been developed by us (note 1), to be more comfortable and flexible, than the original Microsoft TextBox.

The numerical values are adjustable in many ways
 - By clicking and holding down the left mouse button and moving the mouse up or down
 - With the mouse wheel
 - By pressing the arrow-up and arrow-down keys
 - With conventional methods used to write numbers with the keyboard
 - With the usual selection and copy-paste methods

 - By pressing SHIFT the variation speed is multiplied by one hundred
 - By pressing CTRL the variation speed is multiplied by ten
 - By pressing ALT the rate of variation is divided by ten

Moving the mouse up and down allows wide and fast adjustments
The mouse wheel allows a comfortable and immediate setting
The arrow keys allows fine adjustments without having to look away from what you are adjusting

(1) Like all our software, their source files are available (Freeware and Open Source licensed under Creative Commons) and can be downloaded from here: **www.theremino.com/en/downloads/uncategorized** *(See "Custom controls"). These controls can be used freely in any project without name a source. The "Open" sources also serve as a guarantee that we have not included malware.*

Adjusting the sliders
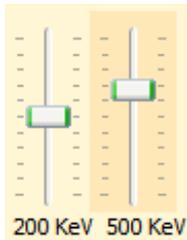
These are the original Microsoft cursors, they are pretty comfortable, so we just added the orange color and the possibility to reset them.

<<< Non-zero sliders are marked with an orange color, to reset them just click with the right mouse button (not all sliders have a zero, in this case they do not change color and cannot be reset with the mouse)

Sliders can be adjusted in the following ways
- Clicking the cursor with the right mouse button, to reset them
- Clicking the cursor with the left mouse button and moving the mouse up or down
- With the mouse wheel
- Using the left-arrow and right-arrow on your keyboard
- By pressing the up-arrow and down-arrow keys

The method of moving the mouse up and down, allows wide and fast adjustments.
The mouse wheel allows comfortable and immediate adjustments
The arrow keys allow fine adjustments without taking your eyes from what you are adjusting.
The arrow keys left/right or up/down have the same effect, it might be be more intuitive to use the first for horizontal cursors and the seconds for vertical sliders.

Questions and answers

The module connects to network but does not appear in the NetHal and NetModuleProgrammer

Sometimes the network may be in an abnormal state, some say it is due to the Proxy, others to be due to configuration errors. We recommend that you perform the following sequence:

- Click on the search box (bottom left)
- Write CMD and wait for it to appear "Command Prompt"
- Click it with the right mouse button and choose "Run as administrator"
- Copy the following two commands one by one and give ENTER to everyone.
  ```
  netsh int ip reset reset.txt
  netsh winsock reset
  ```
- Try again if the modules appear on NetHAL (or starting it or by pressing "Recognize")
- If they do not yet appear try to make a restart.
- If they do not yet appear also try the following command (that completely resets the firewall and therefore may block some programs).
  ```
  netsh advfirewall reset
  ```

Check the starting procedure of the NetModule

- Connect the NetModule to a USB port
- Start the *Theremino Terminal* application
- Connect COM port which is connected to the NetModule, with Speed = 74880
- Press the reset pushbutton on NetModule or send a letter R.
- Read the incoming lines in the "Receive" monitor.
- If necessary, copy everything that comes in and it analyzed by an expert.

What to do if the USB connection does not work and does not appear a COM port

Some computers may be missing the driver for the CH340 chip. Read the instructions to install it in "NetModule_UsbProgramming" file.

Change the text of the program panels in various languages

Certainly, just edit the files: ".. \ Docs \ Language_Eng.txt" and ".. \ Docs \ Language_Ita.txt"
For languages German, French and Spanish just copy the English file three times with the following names:
".. \ Docs \ Language_Deu.txt", ".. \ Docs \ Language_Fra.txt", ".. \ Docs \ Language_Esp.txt"

Edit the configuration file

Normally the association between configurations and modules is kept aligned by ThereminoHAL, which uses the names of the modules to determine the proper configurations to be taken. Normally the HAL can use the right configuration even if you disconnect and replace modules. But in some cases, if you change your name to the modules with a HAL that is on a different computer, or to a different folder, then the alignment between hardware configuration and you lose. In these cases, you can click on the drop down drop down the name of the form and restore the alignment by choosing the right configuration for each module.

To make more complex changes, you can open the "Theremino_HAL_ConfigDatabase.txt" file with a text editor such as "Notepad" and manually edit the configurations that are quite simple.

How to reduce CPU work?

- Close or minimize the "Component window details".
- Minimize the main window.
- Reduce the "Comm speed", as explained in the opening pages of this document.