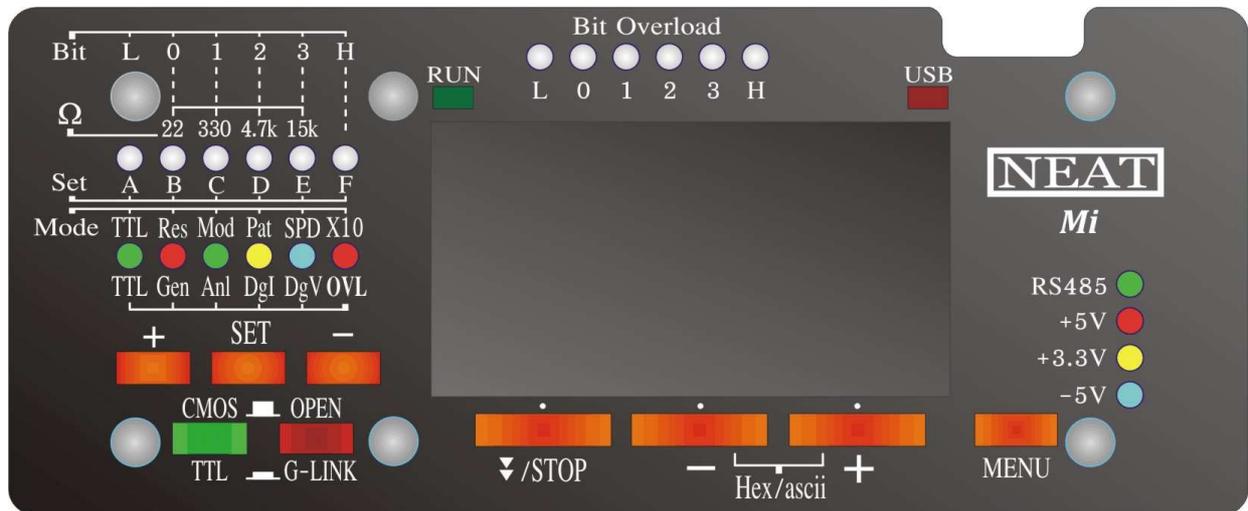


# NEAT

*Mi*

## User's Manual



### Main features:

- Dual channel oscilloscope, with external trigger.
- VI component tester. Fully parametric, with switching and auto range mode.
- 8-channel logic analyzer. Wide voltage range 3-18V, and TTL/CMOS threshold option.
- 4+2 channel logic generator, 3-18V output, multi pattern, multi speed, with overload protection.
- In circuit logic IC tester (by the combination of logic analyzer/generator).
- Triple frequency meter, with analog and digital input, plus counter function.
- Dual voltmeter, with P-P and VDC option, plus waveform view.
- Optocoupler testing ability.
- In circuit Opamp tester.
- Arbitrary audio and over audio high current variable impedance waveform Generator with advanced wave parameters and sweep options.
- Protocol Sniffer: SPI, I2C, UART and RS485/RS422.
- Advanced Triggering System: Normal / Single / Auto / Free, with many trigger modes, adjustable trigger level, and ability to view signals prior to the trigger.
- XY Mode: For plotting Lissajous figures, or checking the phase difference between two waveforms.
- Spectrum Analyzer with different windowing options and selectable vertical log and IQ visualization.
- Channel Math: add, multiply, invert, and average.
- Horizontal and Vertical Cursors, with automatic waveform measurements, and waveform references.
- All the above in a absolutely portable size.

**Description:**

The NEAT *Mi* is a combination of many electronic instruments together. *Mi* name came from “Multi Instrument”.

Is especially designed for electronic circuits diagnosis, allowing in-circuit test for a wide range of components, including passive, linear ICs, and digital ICs.

Comparing to other instruments, this one can do the job faster and more effective.

In circuit method of testing, minimize unnecessary desoldering.

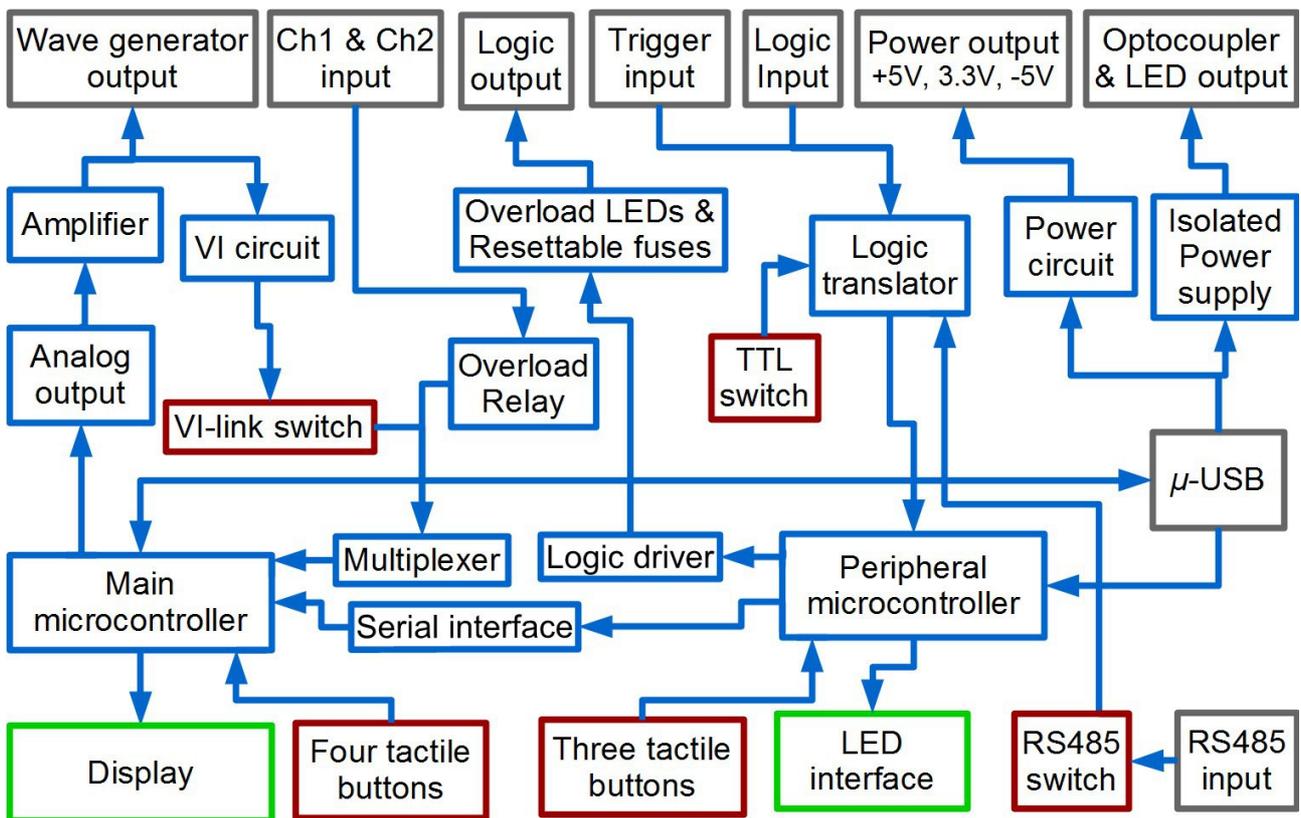


Figure 1: *Mi* Block Diagram

**About user manual**

To extract the most from this manual, you should be an expert in the field of electronics.

This user manual is made as brief as possible, to eliminate the user frustration.

'Contents' pages has been skipped. Using 'Find' function (ctrl-F), you can go directly to the point of interest.

Those pages contain over 70 pictures, to get more comprehensive.

In any case, is strongly recommended to read the whole manual at least once.

Credits should be given to Gabriel Anzziani for his great job on a significant part of this project.

**Precautions**

Do not expose *Mi* device to direct sunlight heat sources moisture or rain.

This device is not by any meaning shock-proof. Do not drop it or hit it.

This device is equipped safety features, to forgive a potential mistake. Do not expect to forgive everything.

Check twice for the correct choice of terminals and proper setup.

Do not overpass absolute limits referred in this manual.

## Hardware

Package include the following:

- *Mi*
- IC clamps
- 2 pairs of ThimbleProbes
- USB wall outlet power supply + EU/US adapter
- USB cable
- Protective bag
- CD with manual and software
- Assortment of dupont cables
- Power bank

## *Mi*

This is the main unit. Details and instructions about the operation of this unit, will follow later in this manual.

## IC clamps

Used to connect *Mi* unit, with the under trial IC. The versatile tips can be attached on THD (through hole devices), and SMD (surface mounted devices).

To apply a clamp to a pin place the first and the middle finger front, thumb rear, and squeeze to open the clamp tip. While hold tip open place it to the pin which going to be tested, an release.

Clips are detachable from the cable. Use the included Dupont male/female 40cm cables to connect them on the *Mi* device.



Figure 2: IC clamps

## ThimbleProbes

Is an innovative type of Probes. Designed to fit on finger, and so to handle simultaneously up to 4 probes, by one person only. Comparing to IC clamps, provide instant more penetrative and fast contact.



Figure 3: A ThimbleProbe

Are very convenient for testing of 2 terminal forms, simple forms of ICs, and optocouplers.

They have a special designed sharp forked tip, to attach securely and slipless on a component's pin. Tip is sharp enough to penetrate better than any other probe a dirty or coated component.

Be careful not puncture your shelf during use.

Package include 1 pair of ThimbleProbes (Red and black) for general use, and 1 low resistance pair (Blue and white) for more accurate signatures on VI function.

### **USB wall outlet power supply**

As expected, package include a power unit to supply *Mi* device.

This power supply unit work in a wide voltage range 100 – 220V. Inside package included an adapter EU to US, to use power supply unit in US type wall outlets.

*Mi* have a  $\mu$ -USB port, for power and data connection. This provide to the device exceptionally flexible ways of supply.

Except from his own power unit, can be supplied from:

- A power bank.
- A computer with USB port.
- A Laptop.
- A third party mobile USB charger capable for 1.5A or more.
- A car USB adapter.

### **In circuit diagnosis**

By *Mi* device, you can perform in circuit diagnosis, in component level. So desoldering of components eliminated, and testing get faster, and avoid risk of thermal and mechanical PCB damage.

Optocouplers, operational amplifiers, gates, transistors, diodes, resistors, potentiometers, capacitors and many other electronic components, can be tested, fast and effectively.

Many instruments are integrated in *Mi* device, and many combination of them can implemented. So initially you should spend some time to get familiar with *Mi* device.

### **Structure**

Before start operation, is important to understand the structure of the unit.

*Mi* device divided into 2 parts: Main module and peripheral module.

Main module consist:

- Display
- Oscilloscope
- Logic analyzer
- Frequency meter
- Voltmeter
- Spectrum analyzer
- Wave generator
- $\mu$ -USB socket, USB led and RUN led

Main module controlled by the buttons under the display (K1-K3), the menu button, and the commands from the peripheral module.

Peripheral module consist:

- All remaining LED indicators
- Input/Output connectors
- Logic generator
- Optocoupler/LED driver

# NEAT *Mi*

- VI circuit
- Oscilloscope scaler
- Logic analyzer voltage translator
- TTL/CMOS input threshold selector
- Safeties
- Wave generator amplifier/doubler

Peripheral module controlled by the rest off buttons and switches.

Both modules are interconnected by a serial bus. Through this bus, peripheral module sub-control main module, and set all parameters at once to suit the selected function. Consider it as a shortcut to every main function.

While changing function from peripheral module, parameters change both for main and peripheral module. However you can change main module parameters without influence peripheral module parameters.

This is useful when composite adjustments needed. In this case, set peripheral module before main module. Instruction's manual, will start with the peripheral module operation, and then the main module operation.

## General overview

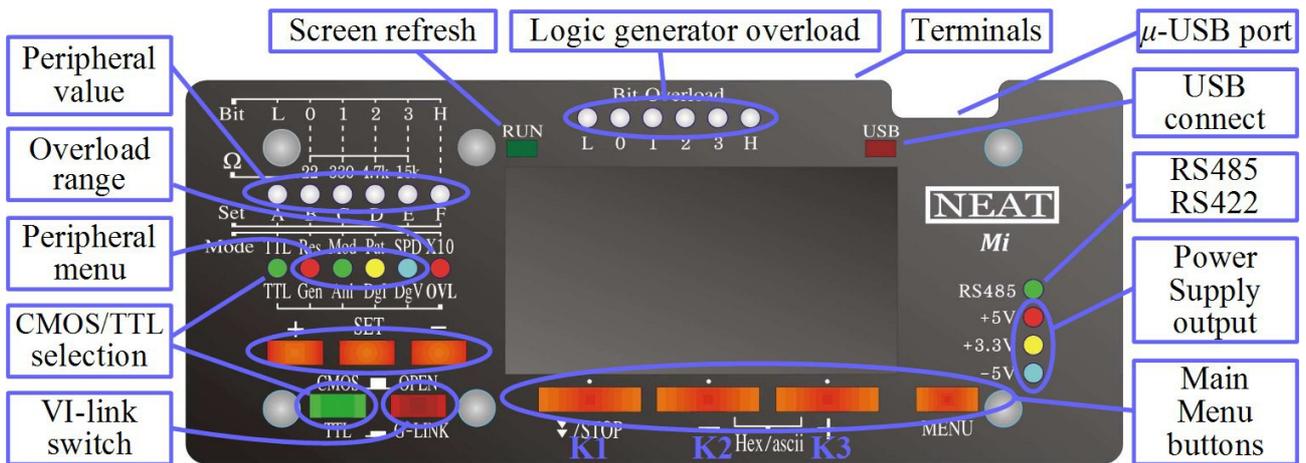


Figure 4: Front view description

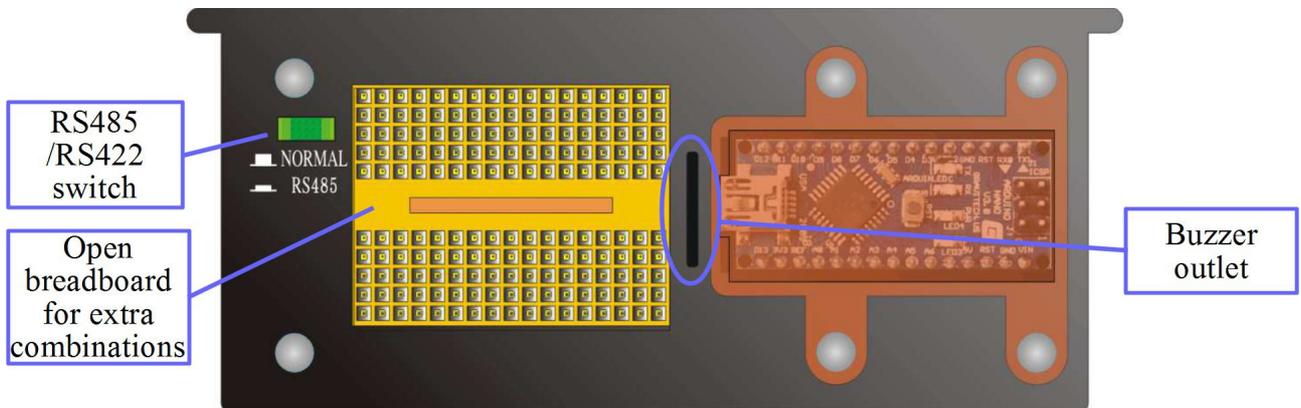


Figure 5: Rear view description

# NEAT Mi

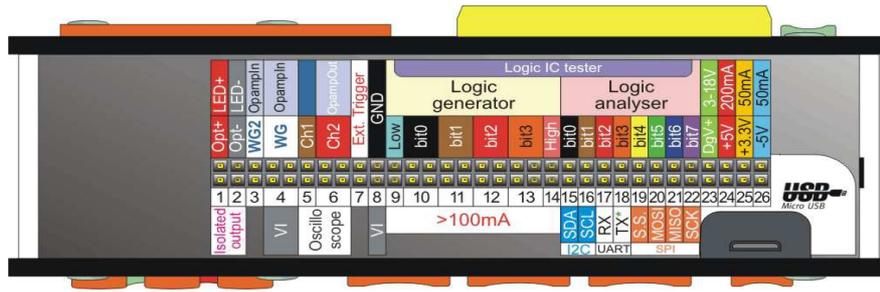


Figure 6: Upper & side view

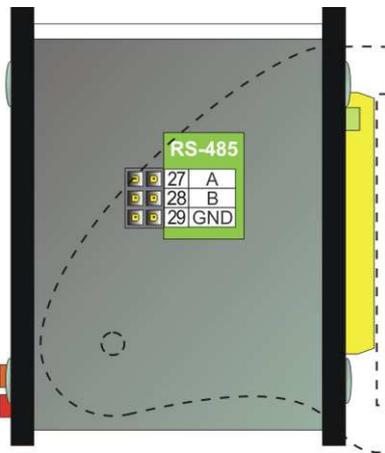


Figure 7: Upper & side view

Pin #	Name 1	Name 2	Description	Notes
1	Opt+	LED+	Positive drive to optocoupler input or LED	Max. voltage 5VDC Max. current 30mA Isolated
2	Opt-	LED-	Negative drive to optocoupler input or LED	
3	WG2	OpampIn	Operational amplifier input drive	Combined with WG
4	WG	Opamp	Wave generator output / Operational amplifier input drive / VI	Max. voltage 9V P-P
5	Ch1		Oscilloscope's 1 <sup>st</sup> channel / Alternative opamp output	
6	Ch2	OpampOut	Oscilloscope's 2 <sup>nd</sup> channel / Opamp output	Max.V -14-20 / -140-200
7	Ext.trigger		External trigger for Oscilloscop	Voltage range 0 - Dgv
8	GND	VI	VI and ground/common for all signals	
9	Low	Logic generator	Permanently low when enable	Tri-state output "F" LED off = disable Voltage = Dgv Current > 100mA
10	bit0		1 <sup>st</sup> bit of logic generator	
11	bit1		2 <sup>nd</sup> bit of logic generator	
12	bit2		3 <sup>rd</sup> bit of logic generator	
13	bit3		4 <sup>th</sup> bit of logic generator	
14	High		Permanently high when enable	
15	bit0		1 <sup>st</sup> bit off logic analyzer + I2C (SDA)	

## NEAT *Mi*

16	bit1	Logic analyzer	2 <sup>nd</sup> bit off logic analyzer + I2C (SCL)	Voltage = Dgv TTL/CMOS input Max frequency 950kHz
17	bit2		3 <sup>rd</sup> bit off logic analyzer + UART (RX)	
18	bit3		4 <sup>th</sup> bit off logic analyzer + UART (TX)	
19	bit4		5 <sup>th</sup> bit off logic analyzer + SPI (slave select)	
20	bit5		6 <sup>th</sup> bit off logic analyzer + SPI (MOSI)	
21	bit6		7 <sup>th</sup> bit off logic analyzer + SPI (MISO)	
22	bit7		8 <sup>th</sup> bit off logic analyzer + SPI (SCK)	
23	Dgv			
24	+5V		5V positive power supply output	Max 200mA
25	+3.3V		3.3V positive power supply output	
26	-5V		-5V negative power supply output	
27	A		RS485/422 bus. Input terminal A	Max voltage -7 – 11V During use, GND Should be always connected
28	B		RS485/422 bus. Input terminal B	
29	GND		RS485/422 GND (common to general GND)	

Table 1: Pin description

Pin of every terminal is double or quadruple. This provide the capability to connect more than one cable to each terminal, or to provide better contact when needed (e.g. VI function).

## Peripheral module

### Get started

Connecting *Mi* via the  $\mu$ -USB cable to power supply. *Mi* automatically power on.

Device load VI function at start up.

Pressing + button (of peripheral module), function change in a cyclic way, by the following order:

- Logic IC tester
- Frequency meter
- Voltage meter
- Opamp tester
- VI (starting point)

Pressing – button, function change in reverse order.

A small delay appear toggling between functions. This is normal. During this time, a great number of parameters change to meet the new selected function.

During toggling, some artifacts appear on screen. This is normal too.

If an unexpected pattern appear on screen, repeat toggling.

There is a submenu in every function. Submenu include several useful adjustable paramenterers.

To have access in every submenu, press SET.

When a submenu has been selected, one of the peripheral menu LEDs (fig.4) turn on, to indicate which parameter is ready to adjust. Below follow the explanation of peripheral menu LEDs.

### Peripheral menu LEDs

At the left of the unit (fig. 4) located the peripheral menu LEDs. Their general meaning explained below:

**Res:** Is the output resistance of wave generator. Useful mostly for VI function, which will be discussed later in this user manual.

**Mod:** Have two meanings, depend from the functions previously selected.

For VI function means the way of resistance change. There are 3 modes: Permanent, Switching, and Auto.  
 For Voltmeter function means mode of measuring. There are 2 modes: Peek to peek and VDC.

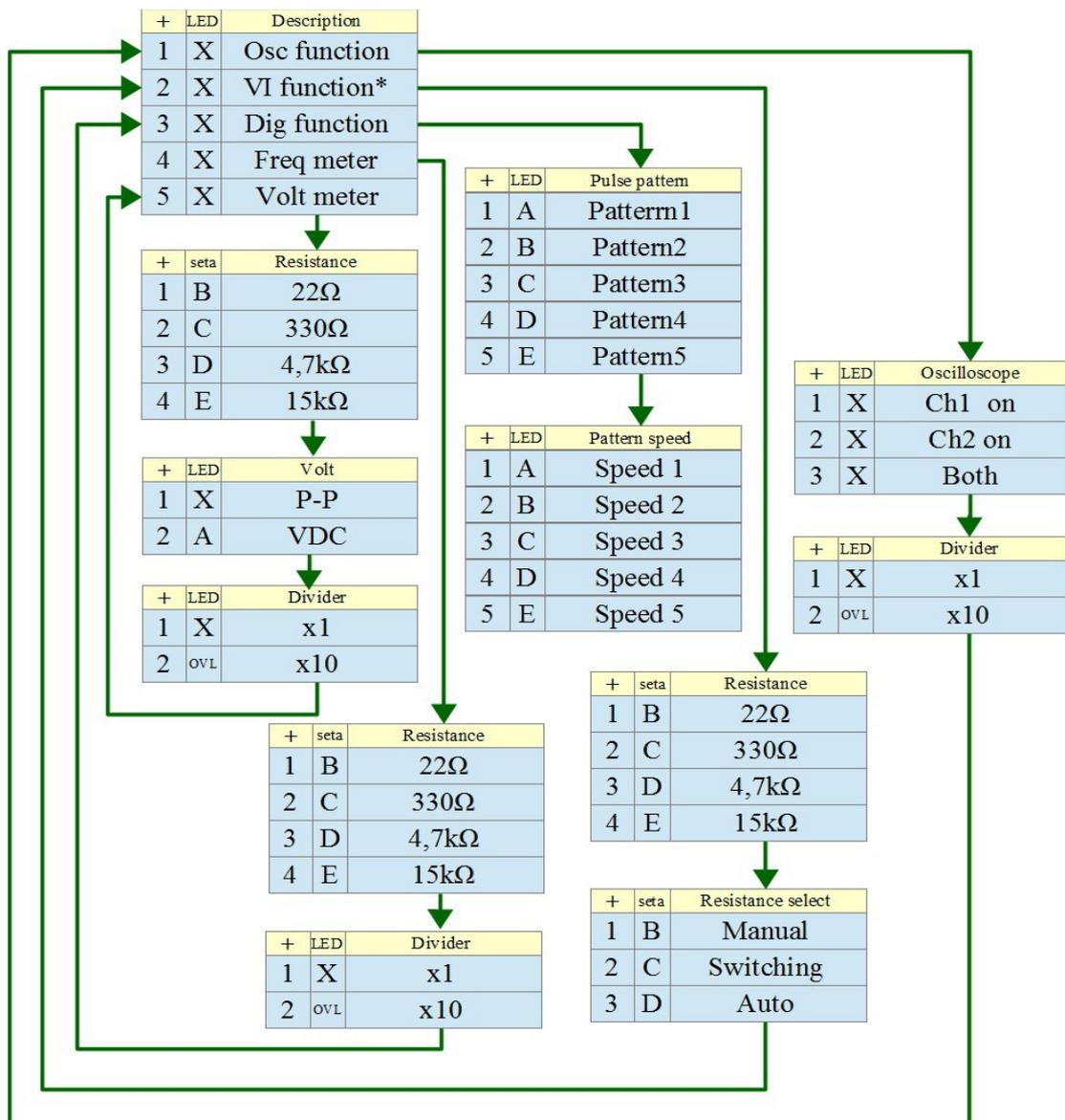
**Pat:** Means pattern. You can choose the required output pattern from logic generator, to perform a test to analog IC. There are 5 patterns. May 2 or more pattern be suitable for the same IC.

**SPD:** Means speed. Speed of pattern. There are 5 different speed levels.

**X10:** Means analog scaler set. When LED turn on scale is set to X10. This change the voltage for both analog channels, Ch1 and Ch2. X10 can be also energized from internal safety circuits.

Below, there is a flow chart about navigation in the peripheral module menu.

Green arrows indicate the SET button effect.



\*Default

Figure 8: Flow chart of peripheral menu navigation

*Mi* can perform Logic and Opamp IC testing, in circuit. So unnecessary desoldering can be avoided. This method of testing is especially useful when a circuit have a great number of ICs. However is more composite than this of a regular, out of the circuit IC tester. The reason is the variety of circuit designs for logic gates and opamps. After an initial adaption time, testing get way more faster and easier.

By this method, every gate or opamp located inside a single IC, tested separately. So less terminals needed to attach on circuit, during every test. Consequently, for up to 4 probes, the very quick and convenient Thimbleprobes can be used. Depending from the experience and the type of the component, test can last few seconds.

### CMOS / TTL Switch

The CMOS/TTL switch change the voltage input level of logic.

For 5V supply	TTL	CMOS
High threshold	2V	3.5V
Low threshold	0.8V	2.5V

Table 2: Comparison table (example)



TTL/CMOS level should not be confused by DgV voltage, which must always supplied primary to signal input.

### G-link Switch

This switch connects the wave generator to analog channels. This is used in particular for creating VI curve traces. An example of setting the device for curve tracing is showed in figure 9 & 10.

G-link switch bypass scaler, so when scaler is energized indicated voltage is 10 times higher the that actual one.



Do not connect CH1 CH2 to a voltage source while the CURVE switch is on. Damage to the device will occur.

### RS485/422 switch

The RS485 switch, is located at the back of the device, and enable hardware of RS485 sniffer. Terminals located at the right side of the device (27, 28, & 29 pins).

When this switch is enabled pin18 is disabled. RS485 LED show the position of the switch.

### USB Port / Device power supply

The USB port is used to power the device, as well to communicate with a computer. Alternately, a power bank can be used for portable operation.

## VI

By this function, can be tested mainly non IC components. Suggested to use the low resistance Thimbleprobes, for fast use and more accurate signatures during testing.

### Principals

A sine wave generator send a signal through the resistor "Res". A dual channel oscilloscope measure signal before and after this resistor.

The relation between the voltage the current and the phase, showed by a simple signature on display.

The AC signal allow test of components which does not respond to DC, like capacitors and coils.

The AC signal also allow test of a component in various voltage levels and both polarities. This is especially beneficial providing test at a glance for semiconductors.

## NEAT *Mi*

An experienced technician, can specify the type and the condition of a component in few tenths of second. *Mi* have practically instant response, especially compared to a multimeter.

Actually the wick link during test, is your eyes response!

If you are new to VI curve testing, experiment with healthy components to get familiar with the displayed signatures.

### Connections

Place the 2 terminals to each VI socket (pin 4 & 8). In this function, Thimbleprobes is the ideal choice for VI function. See below:

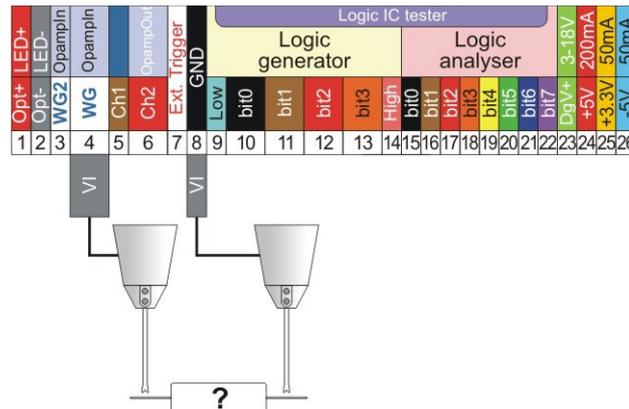


Figure 9: VI connection

### VI menu

Press SET during VI function, to access VI parameters.

By pressing button once, resistance level can be selected.

By pressing button twice, resistance changeover can be selected.

By pressing a third time SET button Res, Mod, Pat, and SPD LEDs flash briefly to indicate menu exit.

### Resistance level

By pressing SET once, Res LED lights on. In this position, by - & + button, select resistance level.

“B”-“E” LEDs show the level of resistance. There are 4 consequent levels to choose: 22Ω, 330Ω, 4,7kΩ, and 15kΩ.

22Ω is the default value. Low resistance is useful to diagnose continuity problems, or test large capacitors. Selection of a high resistance is useful for leak detection.

### Resistance changeover

By pressing SET twice, Mod LED lights on. In this position, press - & + button select resistance changeover mode.

There are 3 consequent modes to choose. Permanent resistor, Switching, and Autorange.

Permanent resistor: Is the simplest VI mode, and the resistance level is fixed to the resistance level set by the user from the previous option.

Switching resistor: Is an innovative mode, where resistance change continuously every 200ms, in 3 consecutive levels, 22Ω, 330Ω, and 4,7kΩ. The corresponding LEDs start to flashing. In this mode 3 signatures displayed at the same time.

Is useful when conductivity and leak should checked at the same time, without touching *Mi* controls. Is very useful to test semiconductors and potensionmeters.

Displayed clutter off course is increased, and show initially may frustrate beginners.

Autorange mode: Is an innovative mode too, where resistance level adapt in such a way, making signature on display readable in a wider variety of components.

Is useful when the tested circuit have components with very different values between them. Capacitor and

resistors is a fine example. Keep in mind this mode may not work properly at all VI adjustments like amplitude and frequency, and their combinations.

Some of the signatures a user may expect are displayed in fig. 10

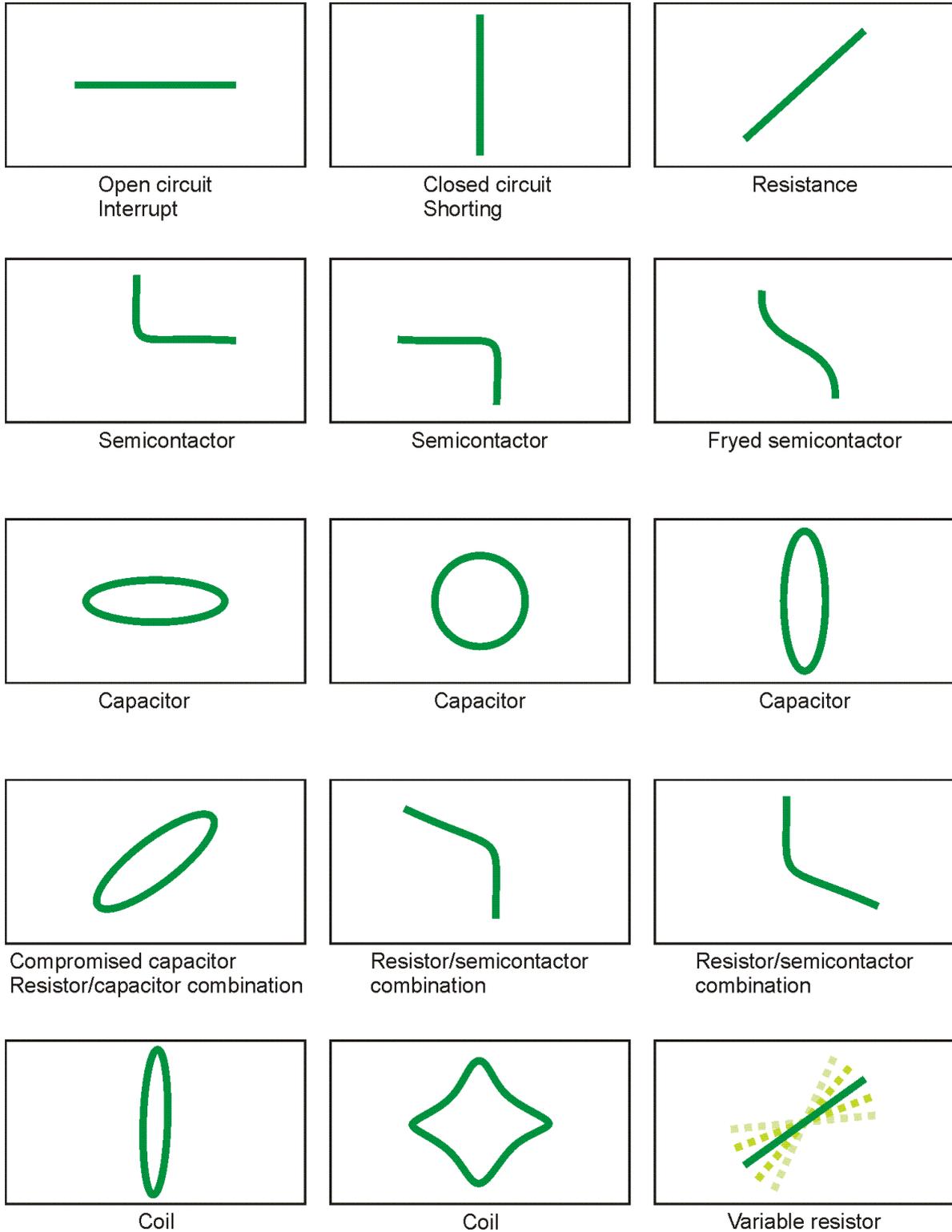


Figure 10: Basic Signatures and their meaning.  
Hundreds of variations are expected.

### VI & wave generator parameters

Changing wave generator parameters affect VI function.

Useful parameter to change are the following:

- Frequency
- Amplitude
- Frequency sweep

Those parameter change through main module controls Referred to Wave Generator chapter.

### Frequency

High frequency help testing low capacitance and inductance, and conversely.

### Amplitude

Voltage level can be changed for some rare occasions.

Low voltage can be used to ignore semiconductor during measurement.

High voltage can reveal easier a leak/breakdown of a component.

### Frequency sweep

A great feature is the Sweep function. When used for frequency, components can be examined by a wide range of frequencies.

This is very useful when a circuit contain both very low and very high values of capacitors or coils.

### Exit

When exit menu of each function, device return to root state, where + & - buttons choose the general function of the device.

## Logic IC tester

This function is the most composite, and user should have at least basic knowledge of binary logic and true tables. User should be able to recognize a timing diagram.

During this function, on screen appear up to 8 digital numbered lines. The number of lines depending from the adjustments of logic analyzer, representing the timing diagram.

To perform IC test, the corresponding datasheet is necessary, to provide information about gate type, pinout, and working voltage. Datasheets can be downloaded from internet. An alternative is ECA books. Are very well written, without unnecessary information, and so low clutter.

Below there is an example of a xx4002 gate physical test:

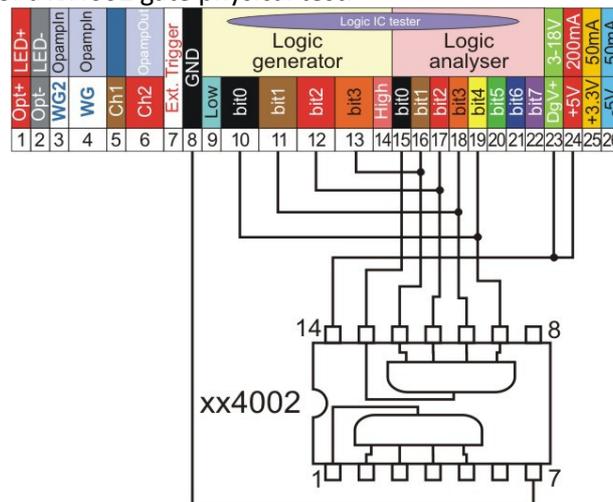


Figure 11: physical connection

## **Principals**

Every gate have 1 or more inputs, and 1 or more outputs.

Implementing the adequate logic signals to input channels, a healthy gate, export the correct results.

*Mi* is equipped with a 4 bit logic generator, configurable to test a wide range of gates.

Also provide an 8bit logic analyzer, to examine the outputs of a multichannel gate.

Logic generator produce enough current to ignore in circuit other gates output, however current is limited to avoid damage to *Mi* device or the circuit.

## **Logic menu**

To enter Logic parameters, press SET during IC test function.

## **Pattern**

By pressing button once, Pat LED lights up, and logic generator pattern can be selected.

Device provide 5 different patterns, to cover a wide range of logic ICs.

## **Speed**

By pressing button twice, SPD LED lights up, and speed can be selected.

By pressing a third time SET button, Res, Mod, Pat, and SPD LEDs flash briefly to indicate menu exit.

## **CMOS/TTL switch**

This switch set logic analyzer to accept the appropriate output signal type of the IC/circuit.

Below described a 5V example, and their official margins.

CMOS: Low = 0V – 0.05V      High = 4.95V – 5V

TTL:   Low = 0V – 0.5V      High = 2.7V – 5V

## **Safety**

*Mi* is equipped with several safety features. Separated into categories those safeties are about to described below:

Analog circuit safeties:

- Ch1 overvoltage
- Ch2 overvoltage
- Wave generator overload

Logic circuit related safeties:

- Overvoltage of logic power supply Dgv.
- Resettable fuses, plus bit overload LED indicators for every channel of logic generator.
- All channels sum, overcurrent trip for logic high failure.
- All channels sum, overcurrent trip for logic lowfailure.

Elementary power supply safeties:

- +5V 200mA resettable fuse
- +3.3V 50mA resettable fuse
- -5V 50mA resettable fuse

When one of the above dangerous situation occur, buzzer sounds, and overload LED blinking simultaneously with one of the peripheral menu LEDs.

Under those LEDs, there is a abbreviation to describe the nature of each alarm. The meaning of each abbreviation described below:

**Gen.** Wave generator overload. Pin 4 is abnormally connected. If G-link switch is on, may pin 5 or/and 6 are abnormally connected. In any case discontinue those connections immediately.

**Anl.** Analog channels Ch1 and Ch2 receive excessive voltage. When this occur, simultaneously with alarm, device turn to X10 scale, to confront the excessive voltage.

If a any of the peripheral buttons (+, SET, -) pressed once, audible alarm stops. If pressed once again, the corresponding LEDs turn off, and if in the meantime the voltage has drop, scale return to X1. In any case you should check wiring at pins 5 & 6.

**Dgl.** Digital overload. Two or more channels of logic generator consume high current. Applied the same handling as in Anl. Overload bit LEDs may strobe briefly and show the shorted channels, and then check wiring of the corresponding bits. The related pins are 9,10,11,12,13 and 14.

**DgV.** Digital overvoltage. Logic power supply DgV+ (pin 23), receive excessive voltage. Buzzer sounds and the corresponding LEDs lights up to warn the voltage exceed 18V. If the voltage drop, device turn back to normal.

**Bit Overload.** Every LED of this group, represent each channel of the logic generator. Those LEDs in normal conditions are remain off. If a shorting appear in a circuit, the corresponding LED glow blue or red. Blue color, means logic 1 failure. Red color, means logic 0 failure.

**+5V.** Under normal conditions, this LED is on. A shorting or a heavy load on pin 24 with respect to GND, LED turn off. In this case, power off immediately *Mi* device, and trace the problem.

**+3.3V.** Under normal conditions, this LED is on. A shorting or a heavy load on pin 25 with respect to GND, LED turn off. In this case, power off immediately *Mi* device, and trace the problem.

**-5V.** Under normal conditions, this LED is on. A shorting or a heavy load on pin 24 with respect to GND, LED turn off. In this case, power off immediately *Mi* device, and trace the problem.

**Keep in mind, never wire power supply channels between them. Damage may occur.**

### Precautions

Before initiate logic test connections, is advised to check if some inputs are unused. Designers, to avoid noise issues, connect unused inputs to Vcc (positive of power supply), or Vss (negative of power supply).

An easy way to trace such a case is to check by VI function, if any input is shorted to Vcc or Vss, before power supply the circuit.

Then, to verify it, check printed circuit if input is really connected there.

If this has been verified, there is no reason to be occupied with this input any more, and treated like is a healthy one.

### Connections

First should connect power supply. *Mi*'s GND connect to circuit GND, and *Mi*'s Dgv to VCC of one of the logic ICs. Dgv use the power of the under test circuit, and consequently adapt logic generator and analyzer voltage level accordingly.

Dgv work effectively and safely at a wide voltage range, 3.3V – 18V, covering all known gates.

There are 2 ways to establish power supply.

Internal power supply:

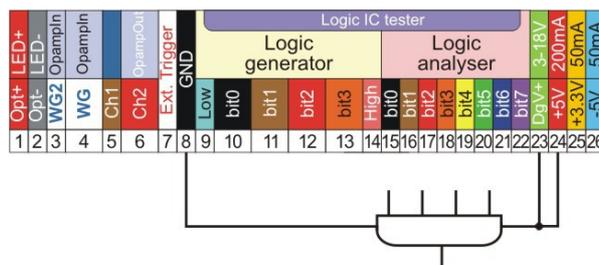


Figure 12: Internal power supply

Above we have an example of a 5V gate. For a 3.3V IC, just select pin 25 instead of pin 24. Internal power supply is convenient for portable use, minimizing apparatus needed for testing. External power supply:

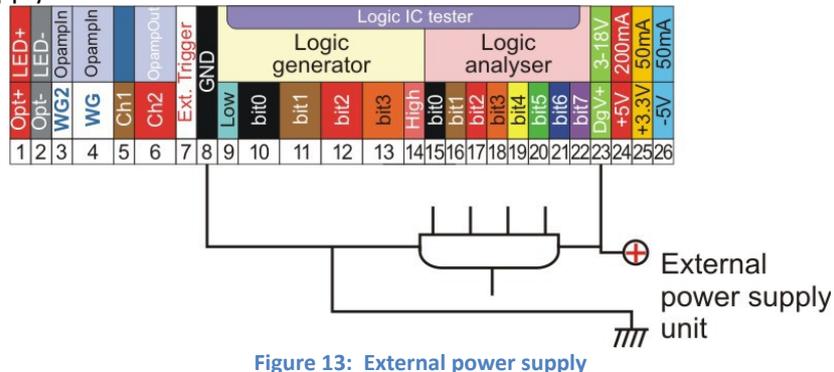


Figure 13: External power supply

An external lab power supply unit, can provide some significant advantages in this connection scheme than the previous one, like:

- A more controllable voltage, starting from 0V. This help to avoid a damage from a possible power supply connection mistake.
- Voltage range is wider, allowing test more ICs.
- Current is higher, allowing to test power hungry circuits.

For extra safety, of both internal and external power supply, is better to connect DgV and +5V to different pins in the circuit, than bridge pin 24 to 23 on *Mi* device. Why? Logic generator is designed to build signal equal to DgV. So in case of power bad contact (0V), *Mi* stop generate signal. So suggested the following:

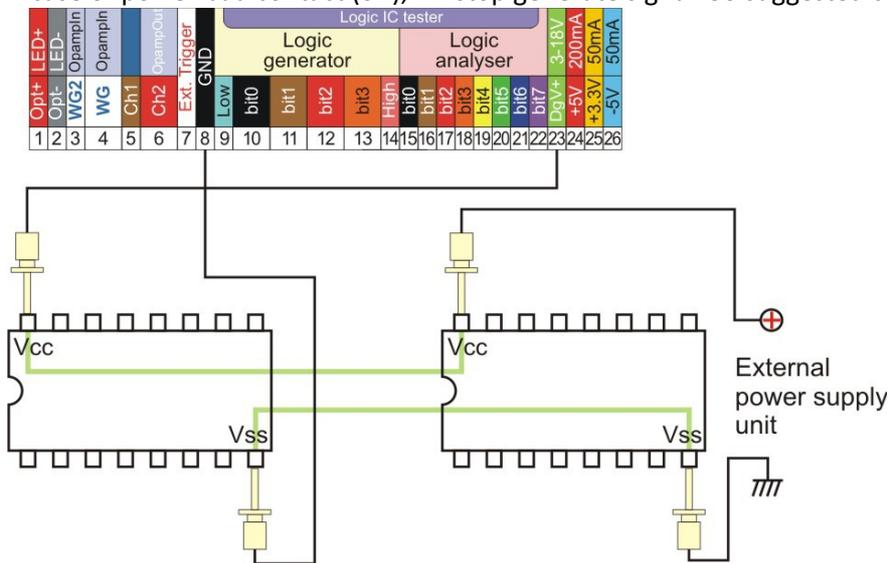


Figure 14: Suggested power connection

Instead of:

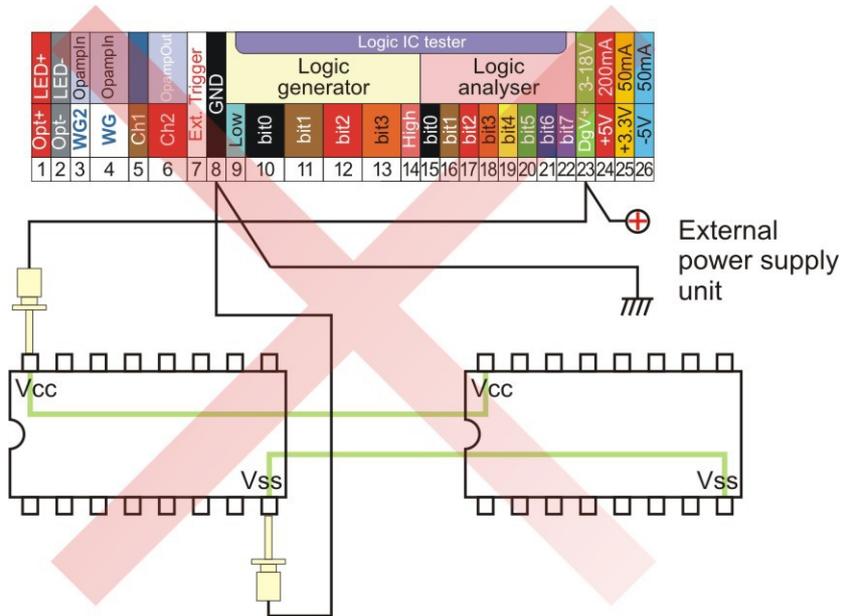


Figure 15: Not desirable power connection

Ideally, power voltage level should be near to the lowest functional limit, according to the related IC datasheet. If your circuit include stabilizer (for example 78xx), distribute the input of stabilizer instead of the IC directly, like below:

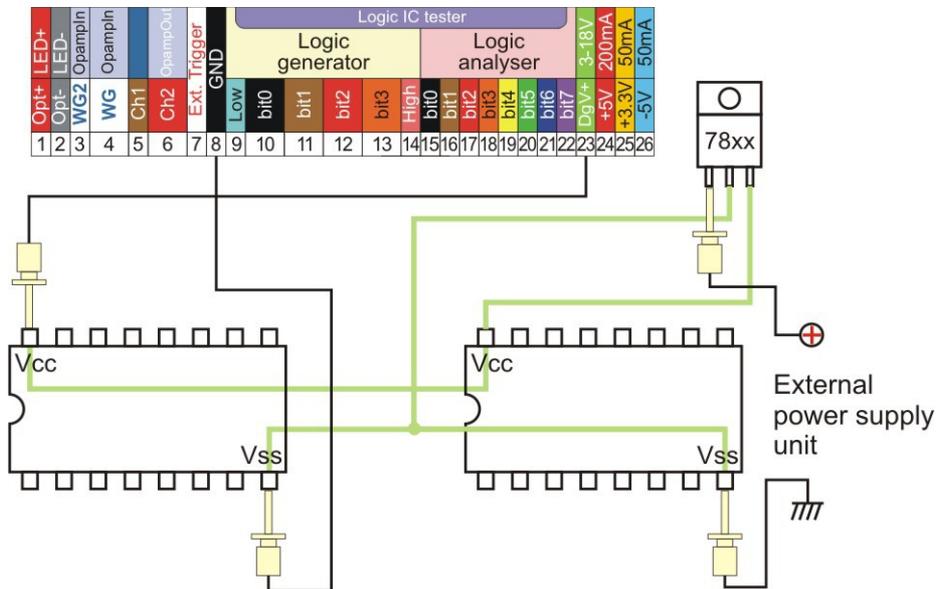


Figure 16: Power supply connection with stabilizer

In this scheme, stabilizer's input voltage should set low enough to achieve the lowest voltage limit on IC power pins.

Next step is to connect gate's input/output with logic generator and logic analyzer. Configuration depend from the type of the gate. There are enough ways to do that for the same gate, however usually the less

cables the faster the test. When the gate connections are up to 4, you can use ThimbleProbes, which are way faster than the traditional clamps and hooks.

A gate can be connected like the example below:

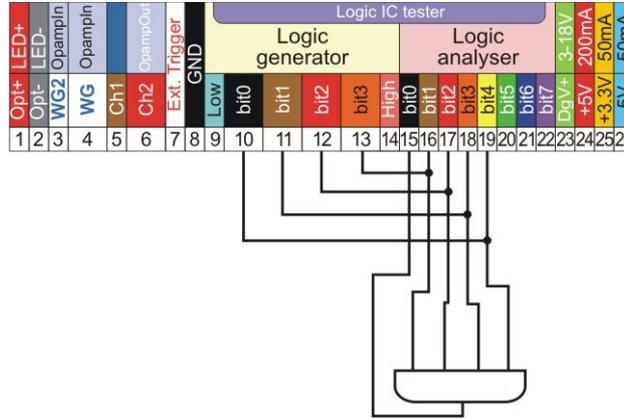


Figure 17: Gate connection diagram

The above is a typical connection scheme for a 4input/1output gate. Logic generator is connected to logic analyser, to monitor input and output simultaneously.

If a gate have less input channels, pins 10 & 19 and/or pins 11 & 18 can be removed.

If a gate have more than 4 inputs, the extra ones can be connected temporary on Low (pin 9) or High (pin 14) depending from the gate type. Test, then exchange inputs, and test again. Those 2 phases described on both schematics below:

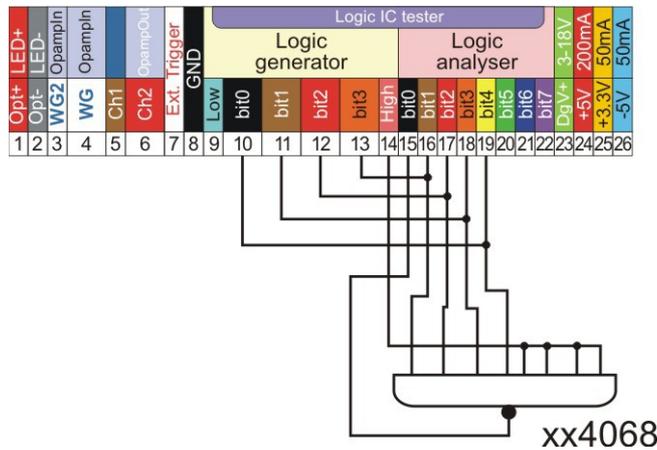


Figure 18: Test, phase 1

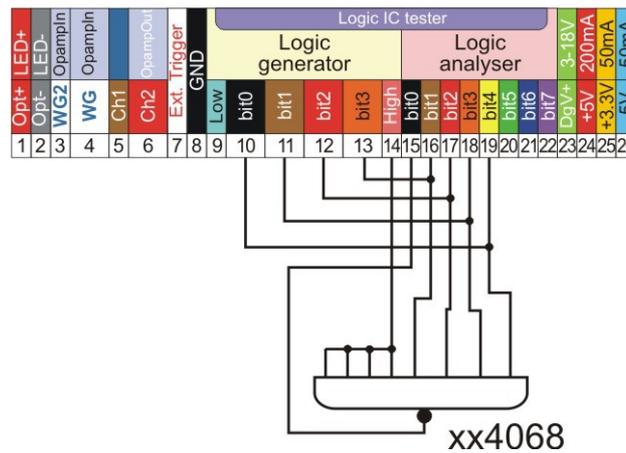


Figure 19: Test, phase 2

Next example show the connection with a counter. Counter is a type of gate with one input and multiply outputs. Below follow an example:

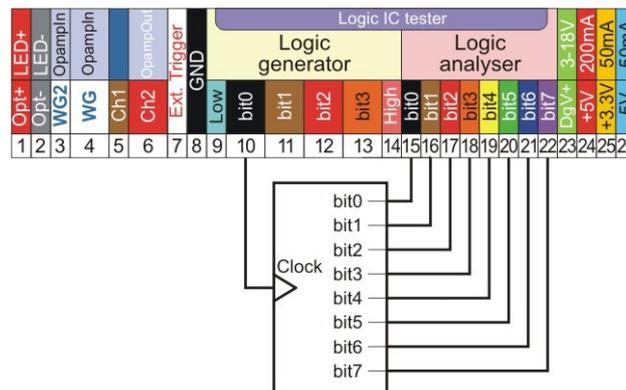


Figure 20: Counter connection diagram

As we mentioned before, less cables make the test faster, so using only 3 cables, we can execute effectively the same test.

During test, bit0 connect to clock like before, however output executed consecutively in pairs, with the following order: bit0 & bt1, bit1 & bt2, bit2 & bt3, and so on. Comparing the couple of channels each time, for a healthy counter, higher bit should have always half speed.

Low (pin 9) and High (pin 14), as their name say, they provide constantly logic low, and logic high. Those pins are very useful for several occasions, like hold a reset of an IC to a certain position, or hold the leftover gates, to allow a test divided into phases.

All six channels have overload protection, and bi-color led to inform for both logic 1 or logic 0 overload. When "F" LED goes off logic generator disabled, and all channels go to high impedance state.

Warning: Debris or a possible coating on circuit can provoke an undesirable interrupt. This could lead to a failed test, leading to the conclusion of a defected IC. In case of such a failure, ensure all related pins contact properly, and repeat test.

If connection has been completed successfully but you get confused about the correct result of timing diagram, always remember (under correct wiring), a constant low or a constant high output, means gate defected.

**Procedure**

Next step is to adjust *Mi*, and read display.

Firstly set *Mi* to logic IC tester function. Then set the corresponding pattern.

Some patterns can be used for more than one gate type.

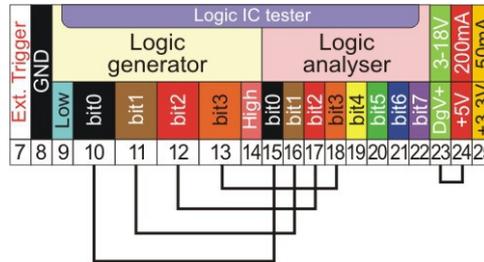


Figure 20a: Counter connection diagram

**“A” pattern (Counter)**

Here logic generator export incrementally a parallel 4 digit binary number. Bit0 is the least significant bit (LSB), and bit3 most significant bit (MSB). When number reach the end (1111) start from the beginning (0000). At this pattern, every complete cycle cover all combinations of 1 and 0. This make it ideal to check all common gates like: AND, NAND, OR, NOR, EX-OR, EX-NOR, Inverter, Buffer.

Pattern 1 signal can also be used by other type of gates like: Counters, timers, Schmitt-triggers, etc.

Below is a timing diagram screenshot of a xx4002. Connection could be like figure 17. bit0 – bit3 are gate input.

For a simple type of gate like this, sequence is not important.

In figure 21, bit4 is output. Red cycle show the conditions under a 4-input healthy NOR gate behave. So here output is High, only when all input channels are Low.

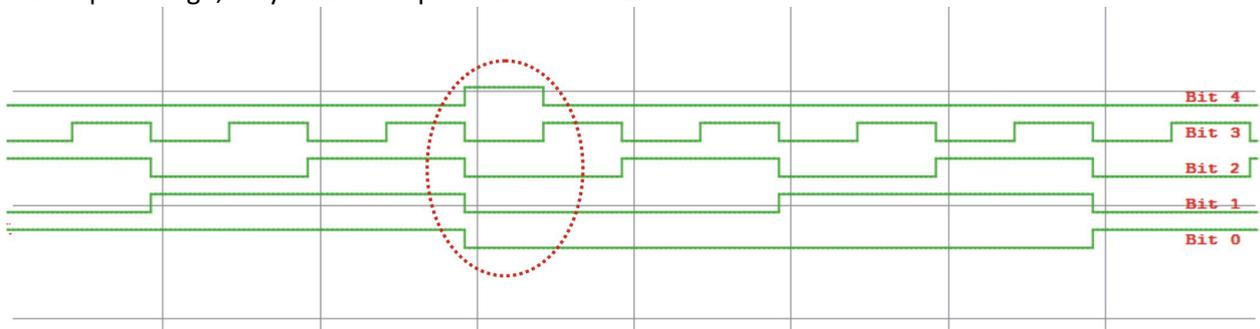


Figure 21: Timing diagram for 4002 NOR gate

**“AB” pattern (FF0)**

This pattern intended for gates with timing input, like Flip-flops. This one is for falling triggered gates.

Bit0 send a short logic 0 pulse.

Bit1, Bit2 & Bit3 produce a parallel 3 digit binary number.

**“B” pattern (FF1)**

This pattern also intended for gates with timing input, like Flip-flops. This one is for rising triggered gates.

Bit0 send a short logic 1 pulse.

Bit1, Bit2 & Bit3 produce a parallel 3 digit binary number.

### **“BC” pattern (FF01)**

This pattern intended for gates with timing input too, like Flip-flops. This one is for gates which include rising and falling triggered inputs, sacrificing one digit from binary number generator

Bit0 send a short logic 0 pulse.

Bit1 send a short logic 1 pulse.

Bit2 & Bit3 produce a 2 digit binary number.

### **“C” pattern (Pulses)**

This pattern intended for cases were a gate need only pulses to function.

Bit0 & Bit1 send a short logic 0 pulse in a different timing.

Bit2 & Bit3 send a short logic 1 pulse in a different timing.

A potential use of this pattern, is for flip flops like JK

### **“CD” pattern (Multiplexer)**

This pattern generate a 3-digit binary number, and and a high frequency output. This is useful for multiplexer and demultiplexer testing.

Bit0 send fast pulses.

Bit1, Bit2, & Bit3 produce a 3 digit binary number.

### **“D” pattern (A. Multiplexer)**

This pattern generate a 3-digit binary number, and and a high power analog output, throught WG (pin 4). This is useful for analog multiplexer and demultiplexer testing.

Bit0 is constantly logic 1, and during this function not have any useful function.

WG generate a high power analog signal. Parameters can be altered from Menu of main module.

Bit1, Bit2, & Bit3 produce a 3 digit binary number.

### **“DE” pattern (Random)**

This pattern produce random pulses to all channels.

When any of the included pattern does not effect a gate, this might provide a solution.

### **“E” patterns (Various)**

E is a group of rarely in use patterns, and are described below:

#### **1<sup>st</sup> “E” pattern**

In this pattern, pulse length of every bit overlap the previous bit.

#### **2<sup>nd</sup> “E” pattern**

In this pattern, phase of every bit delayed by 90° from previous bit.

#### **3<sup>rd</sup> “E” pattern**

In this pattern, phase of every bit delayed by 120° from previous bit.

Bit3, toggle state in every circle.

#### **4<sup>th</sup> “E” pattern**

A serial of pulses generated from bit0. Don't confuse it with UART, this one have lower speed than any UART baud rate, and is adjusted by SPD parameter.

bit1 generate clock pulses

bit2 generate a sync pulse at the start of each serial byte

bit3 generate a sync pulse just before bit2.

### Stop button

During Logic IC tester function, Stop button do the following:

- Freeze screen
- Disable logic generator (high impedance)

So, during this period, the observation of the timing diagram, can be done without any stress of the circuit.

Below is a list of officially supported logic ICs. The number of supported ICs does not restricted to this list.

AM26LS31	AM26LS33	AM26S10	AM26S10	AM26S11	MC3446	MC3450						
MC3452	MC3453	MC3486	MC3487	N8T26	SN75107	SN75108						
SN75109	SN75110	SN75111	SN75113	SN75114	SN75115	SN75121						
SN75122	SN75123	SN75124	SN75125	SN75127	SN75128	SN75129						
SN75136	SN75138	SN75140	SN75141	SN75151	SN75153	SN75154						
SN75157	SN75158	SN75159	SN75160	SN75163	SN75172	SN75174						
SN75175	SN75177	SN75179	SN75183	SN75LS192	SN75ALS194							
SN75C188	$\mu$ A9638											
4000	4001	4002	4009	4010	4011	4012	4013	4014	4015	4016*	4017	4018
4019	4020	4022	4023	4024	4025	4026	4027	4028	4029	4030	4033	4040
4041	4042	4043	4045	4047	4048	4049	4050	4051	4052	4053	4055	4056
4060	4063	4067	4068	4069	4070	4071	4072	4073	4075	4077	4078	4081
4082	4085	4093	4095	4096	4097	4098	4099	4501	4502	4503	4507	4510
4512	4516	4518	4520	4521	4522	4526	4528	4529	4536	4538	4541	4551
4555	4556	4572	4584	4585	40106							
7400	7402	7404	7408	7410	7411	7412	7413	7414	7418	7419	7420	7421
7423	7424	7425	7427	7428	7430	7431	7432	7434	7436	7437	7440	7442
7443	7444	7450	7451	7452	7454	7455	7456	7457	7458	7463	7464	7468
7469	7470	7471	7472	7473	7474	7475	7476	7477	7478	7485	7486	7490
7493	74100	74101	74102	74103	74105	74106	74107	74108	74110	74111	74112	74113
74114	74115	74116	74118	74119	74121	74122	74123	74125	74126	74128	74132	74133
74134	74135	74137	74138	74139	74140	74152	74153	74154	74155	74157	74158	74171
74174	74175	74221	74230	74231	74240	74241	74243	74244	74245	74248	74251	74253
74257	74258	74260	74265	74273	74276	74279	74290	74293	74340	74341	74344	74352
74353	74363	74364	74365	74366	74367	74368	74373	74374	74375	74376	74377	74378
74379	74386	74390	74393	74422	74423	74425	74426	74436	74437	74445	74446	74449
74465	74466	74467	74468	74490	74520	74521	74533	74534	74540	74541	74563	74564
74573	74574	74575	74576	74577	74580	74590	74620	74623	74640	74643	74645	74688
74795	74796	74797	74798	74800	74802	74804	74805	74808	74810	74821	74822	74823
74824	74825	74826	74832	74841	74842	74843	74844	74845	74846	74873	74874	74876
74878	74879	74880	741000	741002	741004	741008	741010	741011	741020	741032	741034	
741036	741240	741241	741242	741243	741244	741245	741620	741623	741640	741643	74644	
741645	742620	742623	742645	748003								

### Frequency meter

This function used to measure frequency.

2 analog frequency meters appear on the upper side of screen, and one digital meter underneath them.

### Connection

Analog frequency meter terminals, connect to Ch1 (pin 5) and Ch2 (pin 6).

Digital frequency meter connect to the pin chosen as digital trigger. So measurement pin could be one of

the follow: External trigger (pin 7), or bit0 bit7 (pin 15 – pin 22).

DgV should have the same voltage as the input signal, and off course input signal should be between 3 – 18V.

Common of all pins is GND.

### Frequency meter menu

To enter frequency meter parameters, press SET during frequency meter function.

### Resistance level

By pressing SET once, Res LED lights on. Work the same as in VI mode.

### X10

By pressing SET twice, X10 LED blinks. In this position, by - & + buttons, toggle resistor dividers in and out to both analog channels Ch1 and Ch2.

When X10 LED is off, analog channels Ch1 and Ch2 receive voltage directly (1:1).

When X10 LED is on, analog channels receive 1/10 of the actual voltage. In this selection, analog frequency meters can receive up to 140V (peak), however this device is designed for low voltage testing, and should be avoided.

## Volt meter

This function used to measure voltage.

2 voltmeters appear on screen. Underneath them, appear the waveform of each.

### Connection

Left voltmeter correspond to Ch1 (pin 5). Right voltmeter correspond to Ch2 (pin 6). Common of both pins is GND.

### Voltmeter menu

To enter voltmeter parameters, press SET during voltmeter function.

### Resistance level

By pressing SET once, “Res” LED lights on. Work the same as in VI mode.

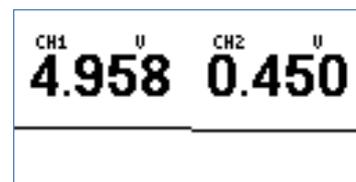


Figure 22: Meter mode

### DC - AC

By pressing SET twice, Mod LED lights on. In this position, - & + buttons, toggle between DC and AC reading.

When A LED is off, voltage reading is set to AC (Peak to peak).

When A LED is on, voltage reading is set to DC.

### X10

By pressing SET a third time, X10 LED blinks. Work the same as in Frequency meter mode.

When X10 is active, voltage is 10 times higher than the displayed one.

## Opamp tester

This function used for operational amplifier test, like 741, 1458, 324 and many others.

There are ICs with single, double, and quadruple opamps. Test procedure should repeated to all opamps an IC contain.

An opamp could be one of the following:

- a) Amplifier.
- b) Comparator.
- c) Buffer.

d) Unused.

e) Dead, and so IC should be replaced.

Most likely to be (a) or (b), so first follow the directions below:

### Connections

Power supply can be internal or external.

When power supply is internal, then the build-in elementary power supply provide the necessary power.

Ideal power supply unit, is an external lab type, with dual output variable voltage and current.

There are also 2 main opamp power supply schemes: Single power supply, and symmetrical power supply.

All the combinations of the above are 4. Below there are all the related connection schematics.

Below appears power supply schemes, with the old popular single opamp xx741:

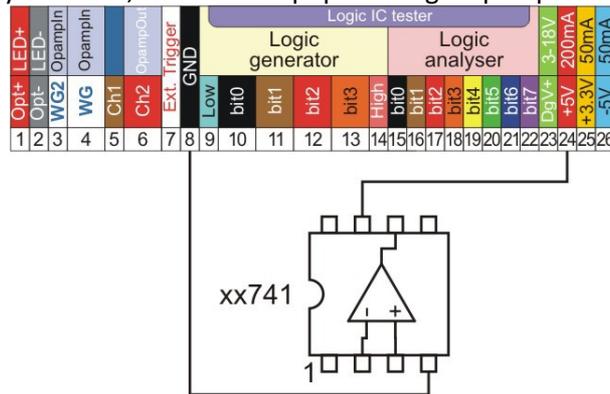


Figure 23: Internal single power supply

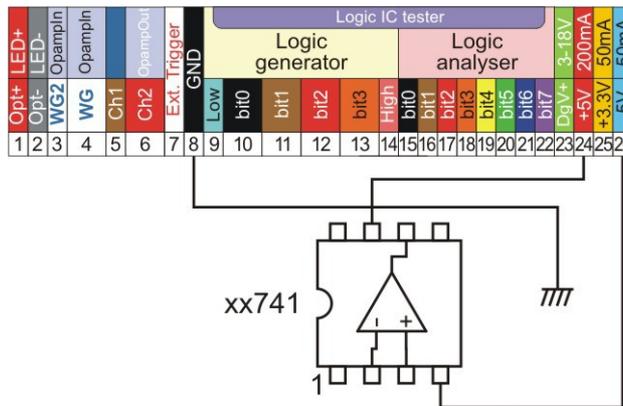


Figure 24: Internal symmetrical power supply

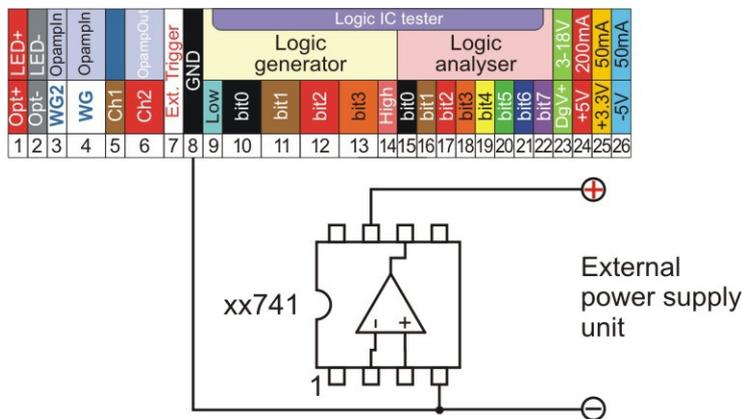


Figure 25: External single power supply

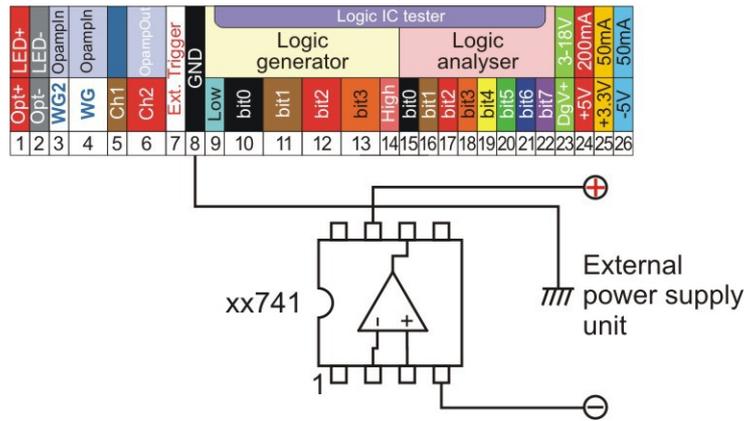


Figure 26: External symmetrical power supply

After power supply completion, next step is the connection of signals for input and output. The signal pins for an opamp are only three, so the use of ThimbleProbes is ideal. A brief touch with those terminals is enough to show the condition of an opamp.

Most common use of an opamp is as amplifier or comparator, so initially suggested to test it for this configuration. Connect input of opamp to each Opampin (pin 3 & 4) of *Mi*, and output of opamp to OpampOut of *Mi*, like below:

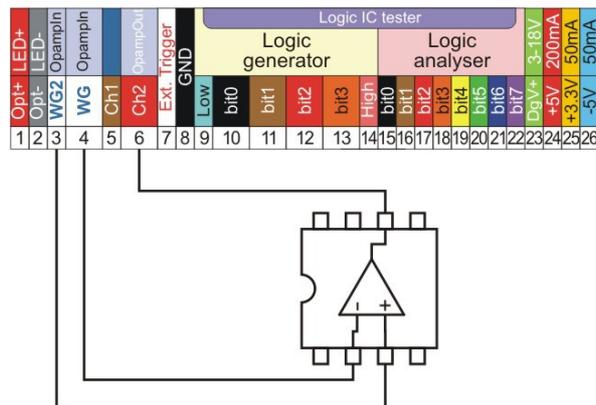


Figure 27: Test as an amplifier or comparator

### Procedure

During the connection above, screen should show a square or trapezoidal waveform, for a healthy opamp. If this happened, opamp have pass the test, and no additional test needed.

If not, then few more tests should run to ensure opamp is defected. The first is to reverse input like below:

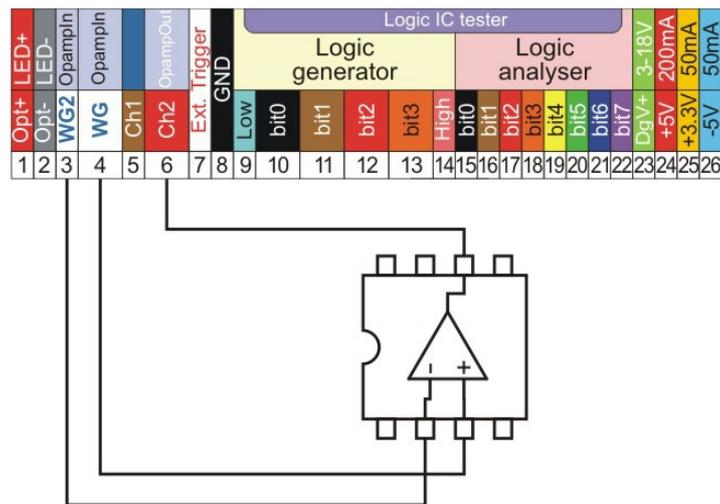


Figure 28: Test in reverse

If not, then may opamp is configured as a driver. In driver configuration negative feedback is 100%. So, input is directly connected to output of opamp. Check circuit visually or/and by VI function to confirm it. If it is driver WG2 (pin 3) should be removed, and WG (pin 4) remain to the same pin, like below:

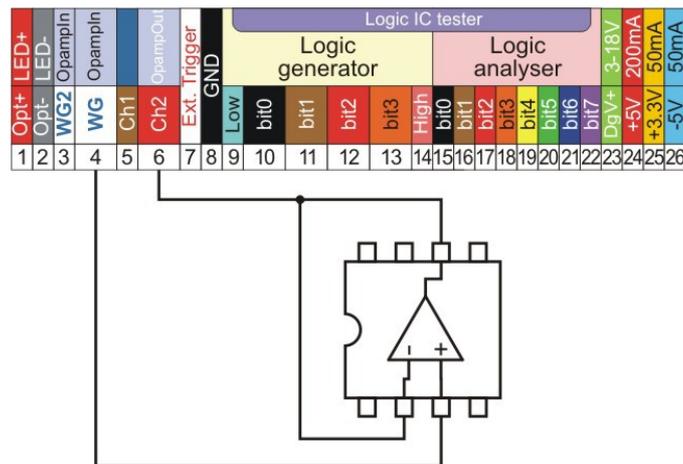


Figure 29: Driver configuration

Amplitude should be set at 2V. A sine waveform should be appear on screen, for a healthy opamp. Actually Input is equal to output. If no signal found, then may is an unused opamp.

Check if opamp output is connected to the rest of the circuit. Possible connection with it's own -input does not count.

If isn't connected, then is unused, and treat opamp as a functional one. Continue test to other components.

If it is connected to other component, then opamp is defected and you should replace IC.

In figure 29a, appears waveforms of a tested opamp configured as amplifier or comparator.

Dead opamp waveform may appear to a healthy opamp, if is not configured as amplifier or comparator.

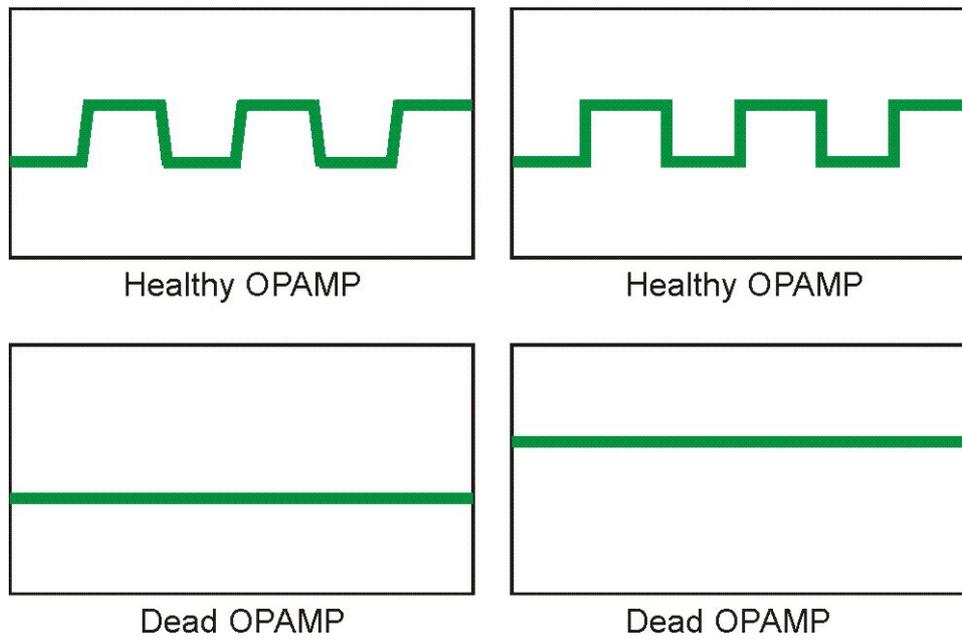


Figure 29a: Examples to distinguish the condition of an opamp

Below is a list of officially supported analogue ICs. The number of supported ICs does not restricted to this list, and *Mi* device virtually can test any conventional non open collector opamp.

A3000	A3001	A3002	A3003	AD042	AD108	AD208
AD381	AD502	AD503	AD506	AD512	AD514	AD515
AD523	AD540	AD542	AD544	AD545	AD547	AD642
AD644	AD647	AD647	AD741	AD3542	AD8007	ADOP07
AM308	AM324	AM406	AM1660	AN1081	AN1082	AN1084
AN1324	AN1358	AN1741	AN4250	AN4558	AN6553	AN6554
AN6556	AN6558	B109	B110	C438	CA080	CA081
CA082	CA083	CA084	CA107	CA108	CA124	CA258
CA307	CA308	CA324	CA358	CA741	CA747	CA748
CA1458	CA1558	CA3008	CA3015	CA3016	CA3029	CA3030
CA3031	CA3032	CA3037	CA3100	CA3240	CA3260	CA3290
CA3493	CA6741	F418	HA17458	HA17741	HA17747	HA17902
HA1-2540	HA1-4156	HA1-4600	HA1-4602	HA1-4605	HA1-4620	HA1-4622
HA1-4625	HA1-1741	HA1-5064	HA1-5084	HA1-5144	HA1-5190	HA1-6195
HA1-909	HA1-2050	HA1-2055	HA1-2702	HA1-4156	HA1-4600	HA1-4602
HA1-4605	HA1-4605	HA1-4620	HA1-4622	HA1-4625	HA1-4741	HA1-5064
HA1-5084	HA1-5144	HA1-5190	HA2-909	HA2-911	HA2-2050	HA2-2055
HA2-2060	HA2-2065	HA2-2500	HA2-2502	HA2-2505	HA2-2510	HA2-2512
HA2-2515	HA2-2520	HA2-2522	HA2-2525	HA2-2600	HA2-2602	HA2-2605
HA2-2620	HA2-2622	HA2-2625	HA2-2640	HA2-2645	HA2-2650	HA2-2655
HA2-2700	HA2-2704	HA2-2705	HA2-5062	HA2-5082	HA2-5100	HA2-5105
HA2-5110	HA2-5115	HA2-5141	HA2-5142	HA2-5170	HA2-5180	HA2-2500
LF155	LF156	LF157	LF255	LF256	LF257	LF347
LF351	LF353	LF354	LF355	LF356	LF357	LF400
LF411	LF412	LF441	LF442	LF444	LF2155	LF2156
LF2157	LF2255	LF2256	LF2257	LF2355	LF2356	LF2357

## NEAT *Mi*

LF13741	LFT155	LF355	LF356	LH0022	LH0024	LH0042
LM101	LM107	LM108	LM112	LM118	LM124	LM143
LM144	LM148	LM149	LM158	LM160	LM192	LM193
LM201	LM201	LM207	LM208	LM212	LM216	LM218
LM224	LM248	LM249	LM258	LM292	LM293	LM301
LM307	LM308	LM312	LM318	LM324	LM343	LM348
LM349	LM358	LM392	LM393	LM709	LM725	LM741
LM747	LM748	LM1458	LM1558	LM2902	LM2903	LM2904
LM2908	LS141	LS147	LS201	LS307	LS709	LX727
MC1420	MC1430	MC1431	MC1435	MC1436	MC1437	MC1439
MC1455	MC1456	MC1458	MC1520	MC1530	MC1531	MC1536
MC1537	MC1539	MC1555	MC1558	MC1709	MC1712	MC1741
MC1747	MC1748	MC3303	MC3358	MC3401	MC3458	MC3471
MC3558	MC3571	MC4202	MC4558	MC4741	ML741	ML747
NE530	NE531	NE532	NE535	NE538	NE5512	NE5514
NE5530	NE5532	NE5533	NE5534	NE5535	NJM2041	NJM2058
OP01	OP02	OP04	OP05	OP06	OP07	OP08
OP09	OP10	OP11	OP12	OP14	OP15	OP16
OP17	OP20	OP21	OP37	OP41	OP215	OP220
OP221	OP227	OP420	OP421	PM155	PM208	PM355
TAA761	TAA762	TAA765	TAA861	TAA862	TAA865	TAE2453
TL022	TL044	TL081	TL084	TL1709	TL1741	TL2741
ULN2171	XR3403	XR3503	XR4136	XR4202	XR4212	ZLD709
$\mu$ A101	$\mu$ A108	$\mu$ A155	$\mu$ A156	$\mu$ A157	$\mu$ A201	$\mu$ A207
$\mu$ A208	$\mu$ A301	$\mu$ A307	$\mu$ A308	$\mu$ A709	$\mu$ A715	$\mu$ A725
$\mu$ A734	$\mu$ A739	$\mu$ A740	$\mu$ A741	$\mu$ A747	$\mu$ A748	$\mu$ A749
$\mu$ A776	$\mu$ A777	$\mu$ A798	$\mu$ A799	$\mu$ A1458	$\mu$ A1558	$\mu$ A3403
$\mu$ A3503	$\mu$ A4136	$\mu$ A355	$\mu$ A356	$\mu$ A357	$\mu$ PC55	$\mu$ PC151
$\mu$ PC153	$\mu$ PC154	$\mu$ PC156	$\mu$ PC157	$\mu$ PC159	$\mu$ PC251	$\mu$ PC254
$\mu$ PC258	$\mu$ PC301	$\mu$ PC318	$\mu$ PC324	$\mu$ PC354	$\mu$ PC358	$\mu$ PC451
$\mu$ PC452	$\mu$ PC458	$\mu$ PC741	$\mu$ PC801	$\mu$ PC802	$\mu$ PC803	$\mu$ PC804
$\mu$ PC804	$\mu$ PC1251	$\mu$ PC1458	$\mu$ PC3403	$\mu$ PC4081	$\mu$ PC4082	$\mu$ PC4084
$\mu$ PC4556	$\mu$ PC4557	$\mu$ PC4558	$\mu$ PC4559	$\mu$ PC4741		

### Optocoupler tester

Optocoupler test is easy and fast.

Can be tested many types of optocouplers, conventional and mosfet, passive and active.

### Connections

Conventional optocouplers require 4 probes for test. Thimbleprobes are ideal for this test.

Connections showed below:

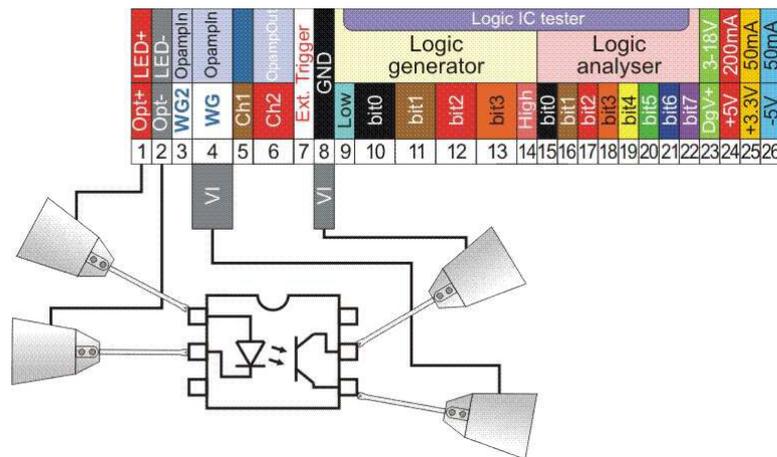


Figure 30: Conventional optocoupler test

Pin 1 and 2 are polarity sensitive, however cause no damage by reverse polarity.

For pins 4 and 8, polarity is not important.

Most optocouplers have the above pinout. Confirm it by downloading the corresponding datasheet.

The above optocoupler is the most common in use and contain a phototransistor for output. *Mi* device can test virtually all types of optocoupler, including those with photomofset, phototriac, and active output.

### Procedure

For optocouplers, procedure is easy.

Set *Mi* device to VI function, set Res to 330Ω, and attach pins 4 and 8.

Then attach one of the “Opt” pin on, and see display. The signature of VI may show an open circuit or a diode, depending from the surrounding circuit. By attaching the second Opt pin the signature should change.

If nothing happened, and you are sure everything contact properly, then optocoupler is defected. While both Opt probes are on, signature is different, depending from the output type of optocoupler.

Transistor = Add a diode to the signature.

MOSFET = Look like shortcircuit

Triac = 2 opposite diodes

Active = No VI use. Logic or Oscilloscope function should be used.

In figure 30a appear some examples of signatures found on optocoupler.

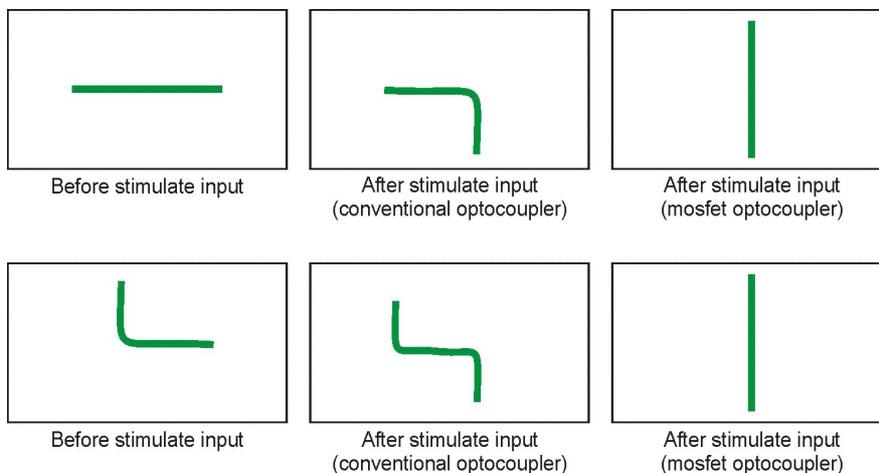


Figure 30a: Signatures commonly found during optocoupler test

## NEAT *Mi*

Below is a list of officially supported optocouplers. The number of supported optocouplers does not restricted to this list:

4N22	4N23	4N24	4N25	4N26	4N27	4N28
4N35	4N36	4N37	4N47	4N48	4N49	6N135
6N136	6N137	6N138	6N139	HCPL2502	HCPL2530	HCPL2531
HCPL2601	HCPL2630	HCPL2631	HCPL2730	HCPL2731	HCPL4502	MCT2
MOC3009	MOC3010	MOC3011	MOC3012	MOC3020	MOC3021	MOC3022
MOC3023	OPI8012	OPI8013	OPI8014	OPI8015	TIL102	TIL103
TIL111	TIL113	TIL114	TIL116	TIL117	TIL118	TIL119
TIL120	TIL121	TIL124	TIL125	TIL126	TIL127	TIL128
TIL153	TIL154	TIL155	TIL156	TIL157	TIL181	TIL186
TIL187	TIL188	TIL189	TIL190	TIL191	TIL192	TIL193
TIL194	TIL195	TIL196	TIL3009	TIL3010	TIL3011	TIL3012
TIL3020	TIL3021	TIL3022	TIL3023	TLP421	TLP521	TLP627
PC817	G3VM					

### Transistor array / Driver test

Those are special types of ICs, which allow other gates to drive higher loads like relays. *Mi* device can test those ICs too.

### Connections

Usually those ICs include 7 or 8 drivers. Like gates, you can break test into parts. For every driver only 2 ThimbleProbes needed. See schematic below:

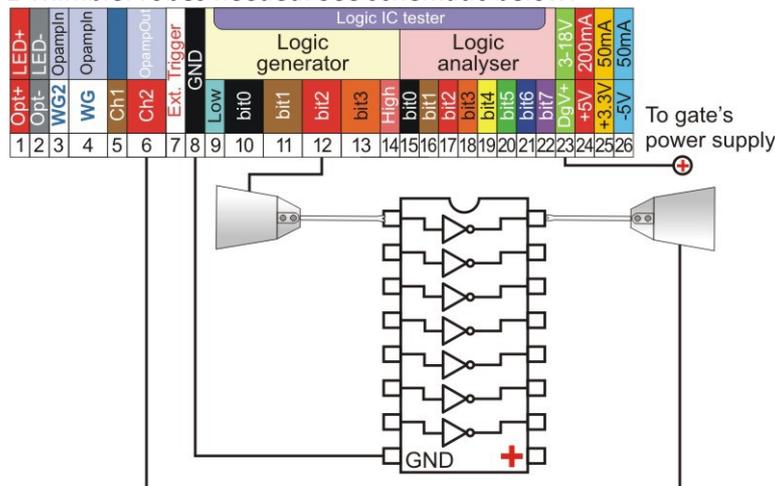


Figure 31: Test of a driver/ transistor array

### Procedure

- Set *Mi* to logic IC tester.
- Select pattern 1 (default).
- From main module controls, close logic analyzer, and activate oscilloscope.
- Enable a channel (for the above schematic Channel 2).
- Place channel position low.
- Adjust channel gain to meet driver output voltage.
- Adjust time base at 1s/div.
- For a healthy driver, a square wave should appear on screen.
- Unconnected drivers (output), should ignored.



If output load is relay you may hear a click sound came out of it.

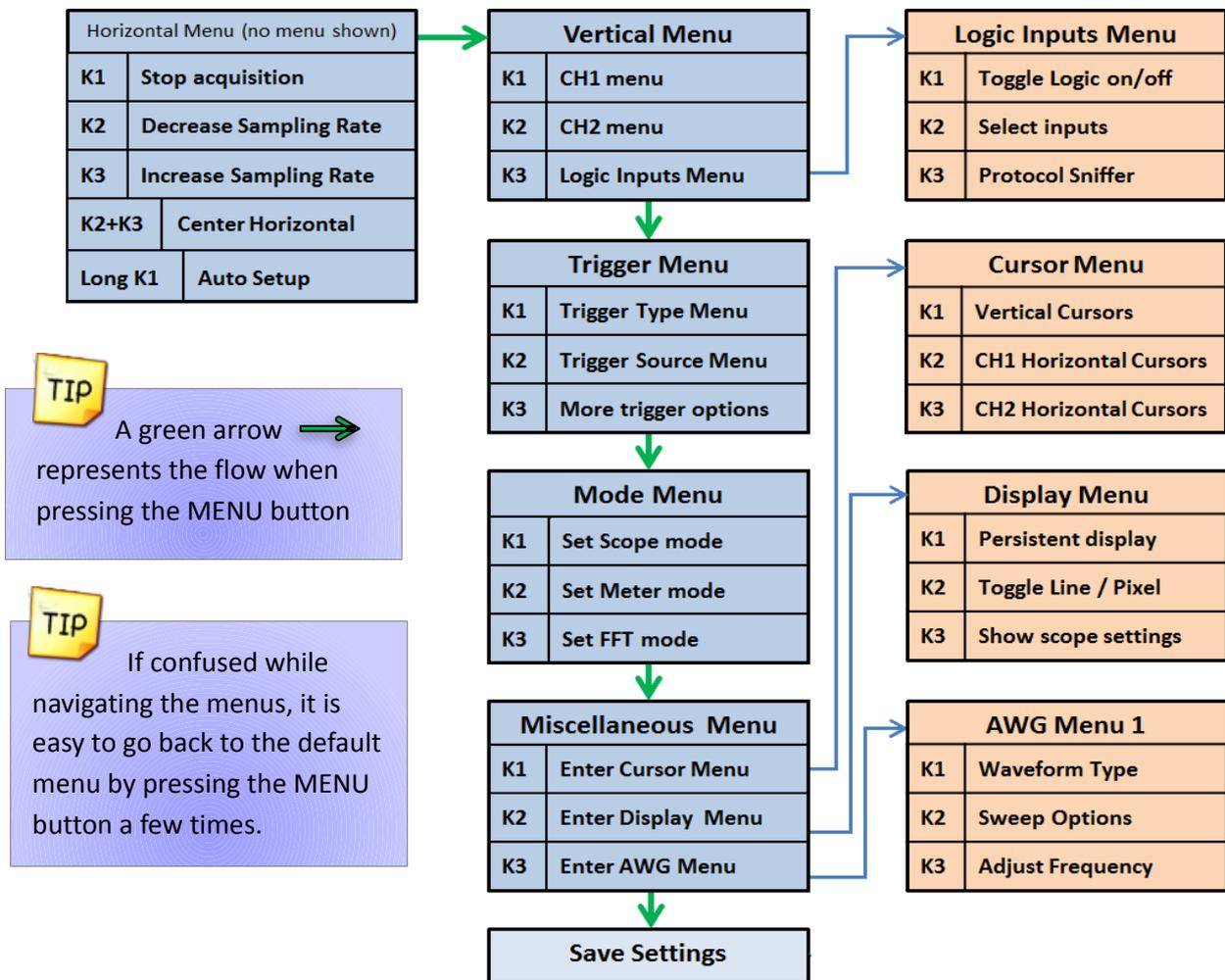
Below is a list of officially supported Drivers/arrays. The number of supported components does not restricted to this list:

KA2656	KA2657	KA2658	KA2659	L293	MC1412	MC1413
MC1416	SN75477	SN75478	ULN2002	ULN2003	ULN2004	ULN2013
ULN2014	ULN2064	ULN2065	ULN2066	ULN2067	ULN2068	ULN2069
ULN2070	ULN2071	ULN2074	ULN2075	ULN2076	ULN2077	ULN2802
ULN2803	ULN2804	ULN2805	$\mu$ A9666	$\mu$ A9667	$\mu$ A9668	

## Main module

### Description

Most common tests, executed directly from peripheral module, however for some cases, special configurations may needed. So in such cases, some adjustments should be done through main module. Instructions about those adjustments follow below:



**TIP** A green arrow represents the flow when pressing the MENU button

**TIP** If confused while navigating the menus, it is easy to go back to the default menu by pressing the MENU button a few times.

Figure 32: Primary Menu

### Factory Setup

The main module can enter factory options if the MENU key is pressed during power up. The following options are available:

**1) Offset calibration:** The unit is calibrated before being shipped, but calibration is required again if the main module firmware is updated. During calibration, two graphs are shown that represent the calibration on each channel. Calibration should be done by G-LINK switch and X10 scaler in off position. Ch1 and Ch2 should be disconnected.

**2) Shut off timeout:** Sets the time to shut down main unit after the last key has been pressed.

It will only shut off the display and put the main microcontroller to sleep.

In some functions delay may is not applicable.

Shut off apply only on main module.

**3) Restore defaults:** Select this function to restore to the default the main module settings. There are many settings on the device, if you are not familiar with them, this function is useful to set the device to a known state.

### User Interface

MENU button used to navigate through main module menu. The K1 - K3 buttons action depend on the current menu.

The green arrows represent the flow when pressing the MENU button. When the MENU button is pressed on the last menu, the device settings are saved and the menu goes back to the default. Figure 32 shows the primary menus in blue, and some secondary menus in yellow. Further ramifications are shown on the respective chapters.

### Mixed Signal Oscilloscope

*Mi*, among others, is a mixed signal oscilloscope; it has 2 analog channels and 8 digital channels. This chapter will focus on the analog signals. More information about the digital channels is presented in chapter 3.

#### Horizontal Settings

The horizontal settings are controlled on the default menu. The menu is shown on figure 33.

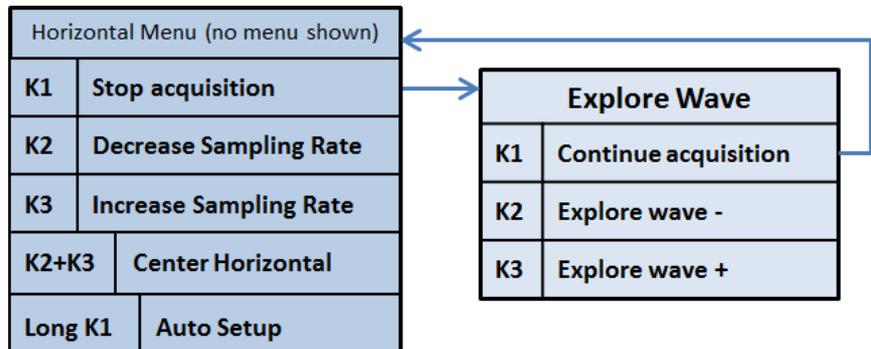


Figure 33: Horizontal Menus

#### Time Base

The time base can be varied from 8µs/div to 50s/div. Table 4 shows all the possible time bases. One time division consists of 16 pixels. Example: 8µs / division = 8µs / 16 pixels → 500ns / pixel.

Time Base ( s / div )	<b>Fast</b>	*8µ	16µ	32µ	64µ	128µ	256µ	500µ	1m	2m	5m	10m
	<b>Slow</b>	20m	50m	0.1	0.2	0.5	1	2	5	10	20	50

Table 3: Time divisions \*At 8µs/div, CH2 is not displayed.

## Technical Details

There are two distinct sampling methods: Fast Sampling and Slow Sampling.

- **Fast Sampling** (10ms/div or faster): All samples are acquired to fill the buffer, and then they are displayed on the screen.
  - Pre-trigger sampling (ability to show samples before the trigger) is available only with fast sampling.
  - Only 128 samples are visible at a time, varying the horizontal position allows exploring the full buffer.
- **Slow Sampling** (20ms/div or slower): Single samples are acquired and simultaneously displayed on the display.
  - The ROLL mode (waveform scrolls to the left during acquisition) is only available with the slow sampling.
  - All 256 samples are visible on the display (each vertical line will have at least two samples)

## Explore Wave

The horizontal position can be varied on the Fast Sampling time bases. There are 256 samples for each channel, but only 128 are displayed on the screen. When the acquisition is stopped, the full sample buffer can be explored with the K2 and K3 buttons. Pressing K2 and K3 simultaneously on the default menu will center the horizontal position.

## Auto Setup

This is a very useful feature

The Auto Setup (long press of K1 button), will try to find the optimum gain and time base for the signals being applied on CH1 and CH2.

## Vertical Settings

The analog channel controls are discussed in this section. Figure 34 shows the Vertical menu flow.

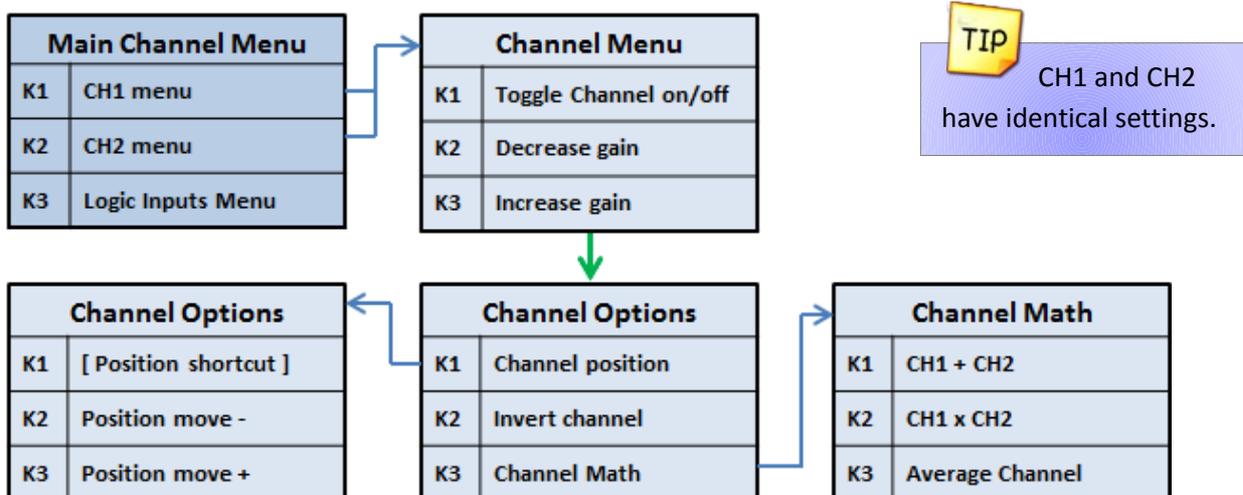


Figure 34: Vertical menus

### Disable Channel

Any channel can be disabled; this is useful to reduce clutter on the display.

### Channel Gain

Table 4 shows the possible gain settings for the analog channels. One gain division consists of 16 pixels. The current gain settings for the analog channels are shown in the top right part of the display (If the SHOW setting of the display is enabled).

Gain Settings (Volts / Division)
5.12
2.56
1.28
0.64
0.32
0.16
80m

Table 4: Gain Settings

### Channel Position

The position of the waveform can be moved up or down in the Channel Position menu.

### Channel Invert

The channel can be inverted. The displayed waveform and channel calculations will be affected.

### Channel Math

Subtract: The channel trace will be replaced with the difference.  
 Multiply: The channel trace will be replaced with the product.  
 Average: The channel samples will be averaged to reduce aliasing. (See Figure 35).

8 $\mu$ s/div:	1 sample	(no average)
16 $\mu$ s/div:	1 sample	(no average)
32 $\mu$ s/div to		
10 ms/div:	2 samples	are averaged
20 ms/div:	1 sample	(no average)
50 ms/div:	2 samples	are averaged
100 ms/div:	4 samples	are averaged
200 ms/div:	8 samples	are averaged
500 ms/div:	20 samples	are averaged
1 s/div:	40 samples	are averaged
2 s/div:	80 samples	are averaged
5 s/div:	200 samples	are averaged
10 s/div:	400 samples	are averaged
20 s/div:	800 samples	are averaged
50 s/div:	2000 samples	are averaged

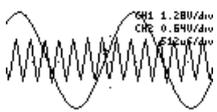


Figure 36: Two signals



Figure 37: CH1+CH2

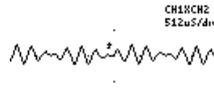


Figure 38: CH1xCH2

Figure 35: Number of samples averaged when enabling the channel AVERAGE option. The device's sampling rate is normally faster than needed to be able to average samples



To display CH1+CH2, first invert CH2 and then select the SUBTRACT function.

### Trigger Settings

*Mi* has an advance triggering system, it has most of the trigger controls of a professional oscilloscope. Figure 39 shows the trigger menus.

### Trigger Types

There are four different trigger types, which determine when to display the trace on the screen:

- **Normal:** Trace only when the trigger event occurs.
- **Single:** Only one trace is displayed when the trigger event occurs.
- **Auto:** Trace when the trigger event occurs, or after a timeout.
- **Free:** Trace continuously ignoring the trigger.

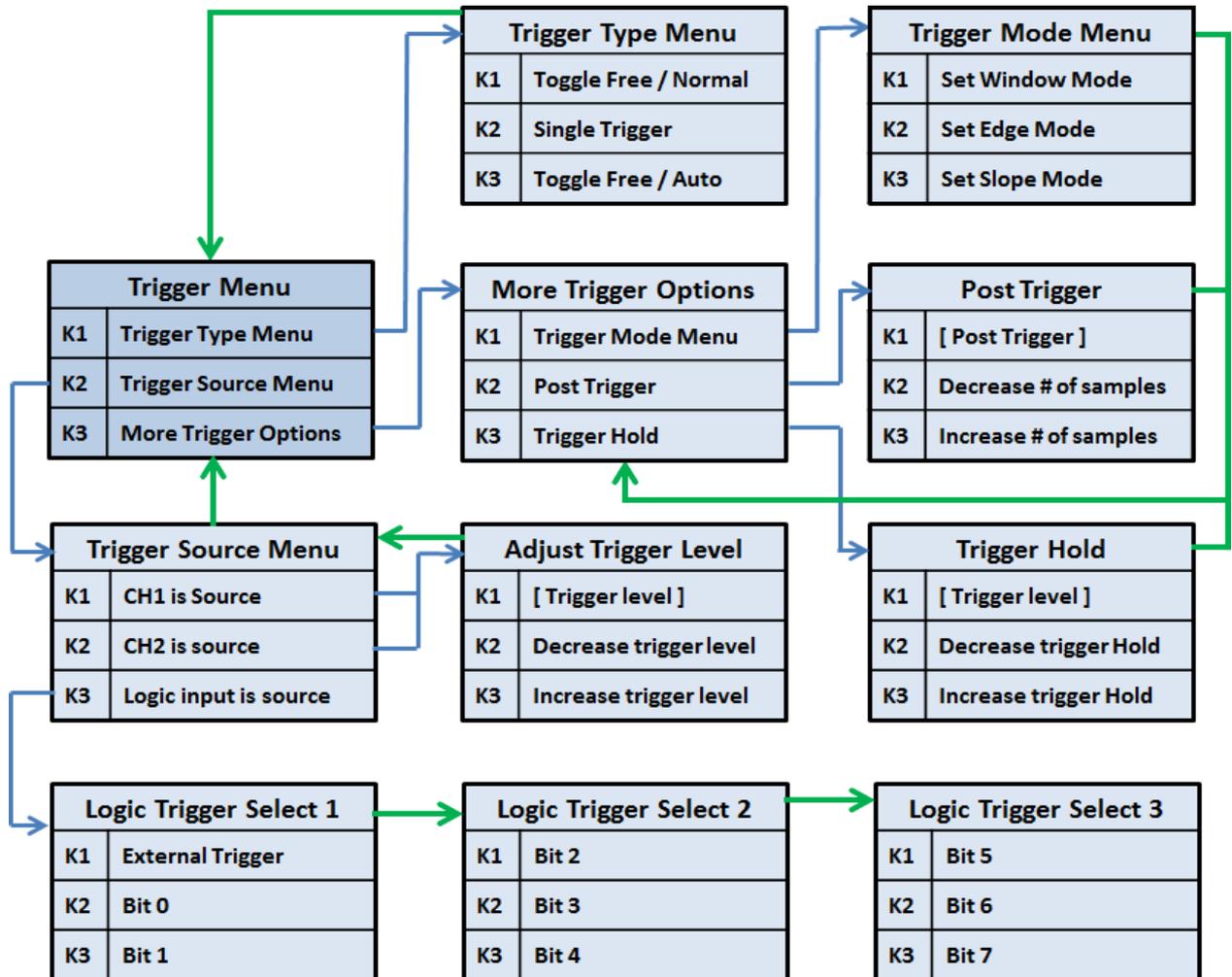


Figure 39: Trigger menus

## Trigger Modes

Three triggering modes are available: Edge, Window, and Slope. The Edge and Slope have selectable direction. When selecting an analog trigger source, the trigger direction is changed in the “Adjust Trigger Level” menu, by moving up or down the trigger level. When selecting a digital trigger source, the trigger direction is toggled on every button press.

- **Edge Trigger:** The trigger occurs when the signal crosses the trigger level in a certain direction. The trigger level is represented on the display as a rising (↑), falling (↓) or dual arrow (↕).
- **Rising edge:** The trigger occurs when the signal crosses the level from below to above.
- **Falling Edge:** The trigger occurs when the signal crosses the level from above to below.
- **Dual Edge:** The trigger occurs when the signal crosses the trigger level in any direction. To select the Dual Edge mode, deselect Window, Edge, and Slope in the “Trigger Mode Menu”, the trigger mark will change to a dual arrow: ↕

TIP

### Edge Trigger:

The signal crosses a level.

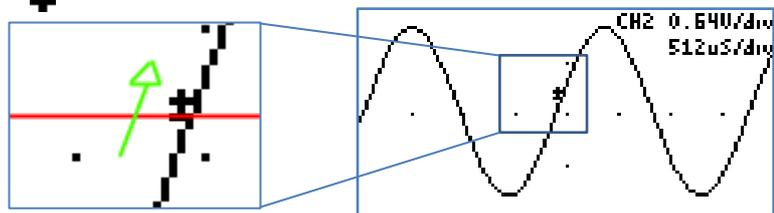


Figure 40: Edge Trigger

**Window Trigger:** The trigger occurs when the signal leaves a voltage range. This mode is useful for detecting overvoltages or undervoltages. Two arrow trigger marks represent the window levels.

TIP

### Window Trigger:

The signal is outside a range.

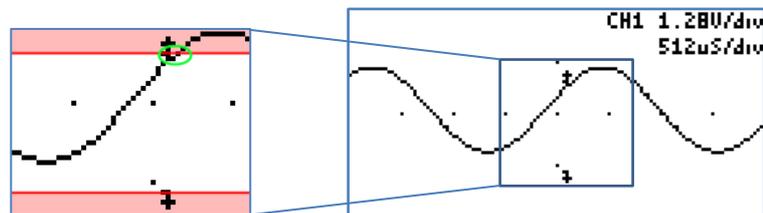


Figure 41: Window Trigger

**Slope Trigger:** The trigger occurs when the difference between two consecutive samples is greater or lower than a predefined value. This is useful for detecting spikes or for detecting high frequency signals. The trigger mark is represented on the screen as two small lines, with a separation proportional to the trigger value.

TIP

### Slope Trigger:

The difference of two points in the signal is above a value.

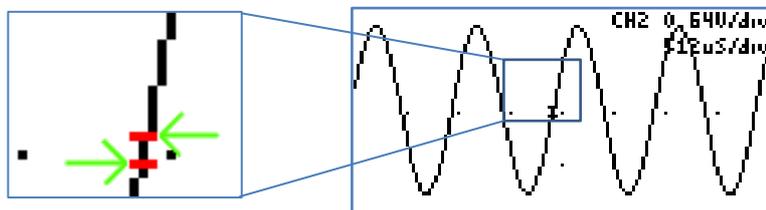


Figure 42: Slope trigger

## Trigger Hold

The trigger hold specifies a time to wait before detecting the next trigger. It is useful when the signal can have multiple trigger events occurring close to each other, but you only want to trigger on the first one.

## Post Trigger

Oscilloscope continuously acquiring samples in a circular buffer. Once the trigger event occurs, the oscilloscope will acquire more samples, specified by the Post Trigger value. The ability to show samples before or after the trigger is one of the most powerful features of a digital sampling oscilloscope. The post trigger is only available on the fast sampling rates.

Depending on the post trigger settings, different parts of a signal can be displayed. Consider the signal on figure 43:



Figure 43: Sample signal

Even though the buffer sample is relatively small, any section of the shown figure can be analyzed by varying the post trigger value. Examples:

- Post trigger = 0 (don't acquire more signals after the trigger). Only the signals that occurred before the trigger event are shown.

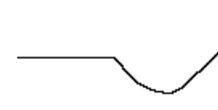


Figure 44: Post trigger value equal zero

- Post trigger = 50% of the sample buffer (default setting). Half of the buffer contains samples before the trigger, and half contains the samples after the trigger.

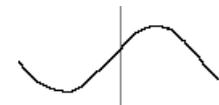


Figure 45: Post trigger = 50% of sample buffer

- Post trigger = 100% of the sample buffer. Only signals immediately after the trigger event are shown.



Figure 46: Post trigger = 100% of buffer

The actual post trigger value can vary between 0 and 32768 samples, so you can explore the signal after a very long time after the trigger event has occurred, but with a high post trigger value, the refresh rate of the scope will be reduced.

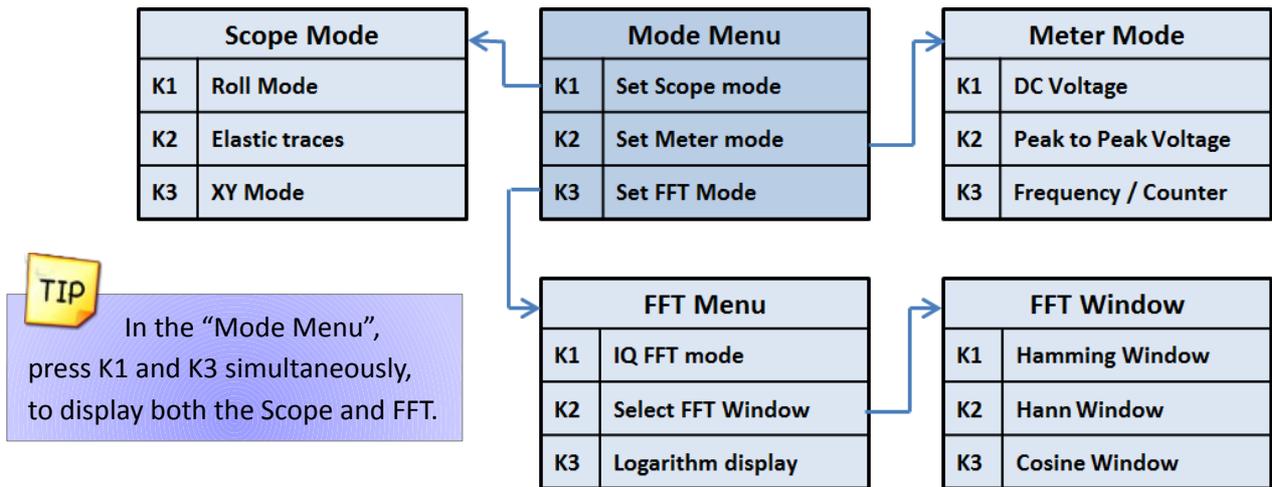
## Trigger Source

Any analog or digital channel can be the trigger source. If selecting a digital channel as trigger source, the slope and window modes are not applicable; the device will use edge triggering. The external trigger input is an additional digital trigger source which tolerates voltages up to Dgv.

## Device Modes

There are multiple device modes that can be selected; the menus shown on figure 47 allow selecting the Scope Mode, the Meter Mode or the Spectrum Analyzer Mode (FFT). Another device mode is the Protocol Sniffer, which is discussed in section 3.8.

## NEAT Mi



In the "Mode Menu", press K1 and K3 simultaneously, to display both the Scope and FFT.

Figure 47: Device mode menus

### Oscilloscope Mode

The 2 analog and 8 digital channels are sampled simultaneously. Any of these 10 channels can be shown on the display. Figure 48 shows the oscilloscope mode and the various sections of the display are detailed.

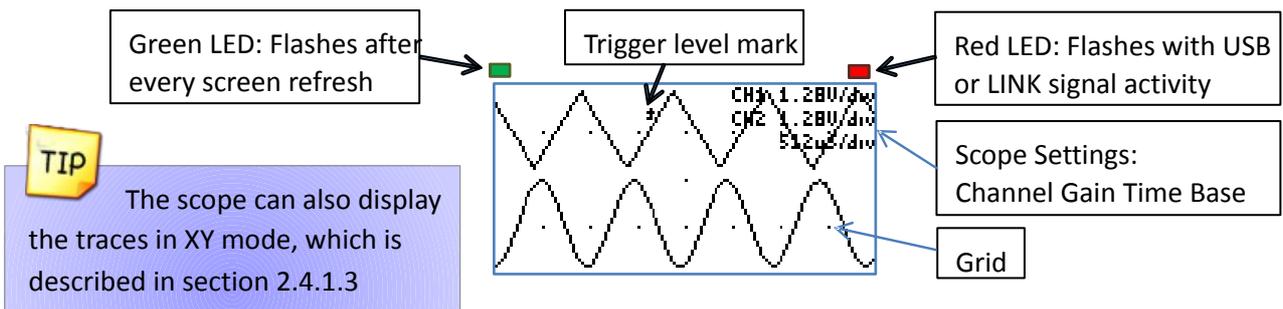


Figure 48: Oscilloscope Mode

### Roll Mode

The data on the display is scrolled to the left as new data comes in. This is only available on the Slow Sampling rates.

The Roll mode and Elastic mode cannot be selected simultaneously. The Roll mode disables the triggering.

### Elastic Traces

This is also called "Display average" on other digital oscilloscopes. It works by averaging the trace data with the new data. The result is a more stable waveform displayed on the screen. However, using this setting only makes sense when the scope is properly triggered on a periodic signal. The Elastic trace computes this equation for every point in the trace:

$$\frac{Y_{n+1} + Y_n}{2}$$

### XY Mode

The XY mode changes the display from volts vs. time, to volts vs. volts. You can use XY mode to compare frequency and phase relationships between two signals. The XY mode can also be used with transducers to display strain versus displacement, flow versus pressure, volts versus current, or voltage versus frequency. Lissajous figures can be plotted using the XY Mode. Component VI curves can also be plotted, see section 8.5.

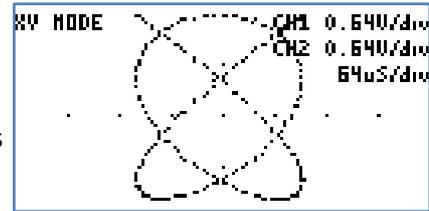


Figure 49: XY Mode



When using the XY modes with a Slow Sampling rate, activating the ROLL mode will display a continuous “beam”.



You can use the “Explore Wave” menu to move the graph vertically.

### Meter Mode

Dual digital voltmeter can be selected from main module also. The font used is bigger in meter mode to facilitate reading. The available measurements in meter mode are: Average Voltage (DC), Peak to Peak Voltage, Frequency, and Pulse counting. A small trace of the analog signals is displayed below the voltage measurements.

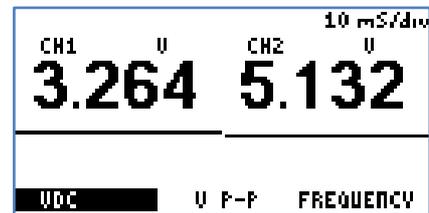


Figure 50: Meter Mode

### Frequency Measurements

The device can measure frequencies on any channel (analog or digital). The measurements on the analog channels are always shown, and the trigger source (see section 2.3) selects which digital channel to measure.

Frequency measurements on the analog channels are done using the FFT of the acquired data, so measured

frequencies have discrete steps. The frequency range is determined by the highest frequency of the analog channels. If there is a high frequency on one channel and a low frequency on the other, the channel with the lowest frequency will have low resolution. Frequency measurements with the FFT are best suited for analog signals. Frequency measurements on the digital inputs are done counting the pulses on the pin over one second. The resolution of the measurement is 1Hz.

Frequency measurements with the Frequency counter are best suited for digital signals.

	FFT (Analog channels)	Frequency Counter (Digital channels)
Maximum voltage range	-14V to 20V (OVL -140 to 200V)	Logic level range (or Ext. Trig -0.3V to 18V)
Maximum Frequency	500kHz	16MHz (or 12MHz on the Ext. Trig)
Resolution	Variable, depending on frequency range. From 6.25Hz to 7.812kHz	1Hz
Signal is noisy, or is mixed with other signals	Finds the fundamental frequency	Not suitable
Signal has a high offset	Still works	Stops working when the offset is above the logic threshold.

Table 5: FFT vs. Frequency Counter

### Pulse Counter

The device can count the number of pulses on a digital input. The counter will roll over after reaching 99,942,399.

The counting can be stopped by stopping the acquisition (K1 button on the main menu). Pressing any button will reset the counter. A stopwatch displays the time since the Pulse Counter started, and can reach 255 hours, 59 minutes, 59 seconds.

### Spectrum Analyzer

The spectrum analyzer is done by calculating the Fast Fourier Transform (FFT) of the selected analog channels (or the channel math functions if enabled). When the FFT is enabled, the spectrum is plotted as frequency vs. magnitude. The horizontal axis represents the frequency (Hertz), and the vertical axis represents the magnitude. Figure 51 shows the *Mi* in Spectrum Analyzer Mode. The Nyquist frequency is shown on the top right corner of the display.

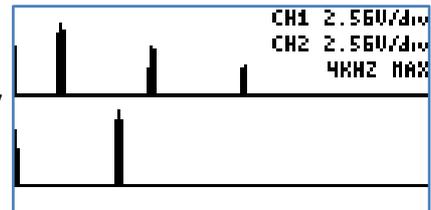


Figure 51: Spectrum Analyzer



If only interested in one channel, turn off the other channel to maximize the vertical display.

### IQ FFT Mode

When the IQ FFT is disabled, *Mi* calculates two independent 256 point FFTs of the analog channels, the Real and Imaginary components of the FFT have the same data. The output of the FFT is symmetrical, but only half of the result is shown on the display. When the IQ FFT is enabled, only one FFT is calculated, the Real component is filled with the CH1 data, and the Imaginary component is filled with the CH2 data.

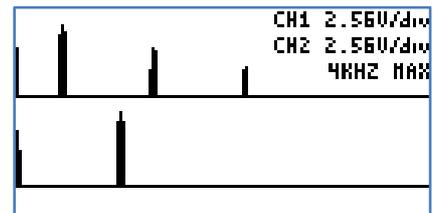


Figure 52: Spectrum Analyzer Mode

The result is a 256 point FFT, you can use the horizontal controls described in section 2.1.3 to explore all the data (since only 128 points can be shown on the display). The IQ FFT is useful to monitor RF Spectrums with the proper hardware mixer.

### Logarithm display

The log is useful when analyzing low level components on the signal. When analyzing audio, it is also very useful as it maps more directly to how humans perceive sound.

The actual function performed is:  $y = 16 * \log(x)$ .

Example:



Figure 53: Triangle Wave



Figure 54: FFT without Log



Figure 55: FFT with Log

### FFT Windows

To reduce the spectral leakage, an FFT window function can be applied. Four FFT window types are available:

**Rectangular:** No window applied

**Hamming:**  $0.53836 - 0.46164 * \cos\left(\frac{2 * \pi * n}{N - 1}\right)$

**Hann:**  $0.5 * \left(1 - \cos\left(\frac{2 * \pi * n}{N - 1}\right)\right)$

**Blackman:**  $0.42 - 0.5 * \cos\left(\frac{2 * \pi * n}{N - 1}\right) + 0.08 * \cos\left(\frac{4 * \pi * n}{N - 1}\right)$

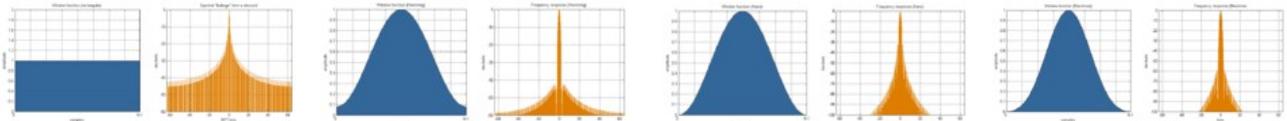


Figure 56: Window and sine frequency response, from left to right: Rectangular, Hamming, Hann and Blackman

### Cursors

You can measure waveform data using cursors. Cursors are horizontal and vertical markers that indicate X-axis values (usually time) and Y-axis values (usually voltage) on a selected waveform source. The position of the cursors can be moved on the respective menu. Figure 41 shows the cursor menus.

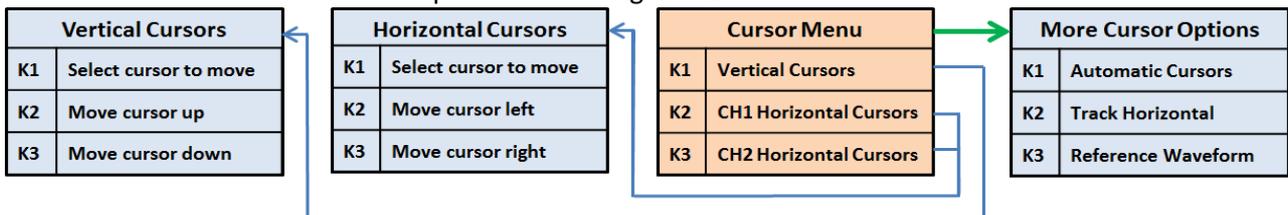


Figure 41: Cursor menus

### Vertical Cursors

Time interval measurements are made with a pair of time markers. The oscilloscope automatically calculates the time difference between the two markers and displays the difference as a delta time. Additionally, the oscilloscope calculates the inverse of the delta time, which is the frequency of the selected period.

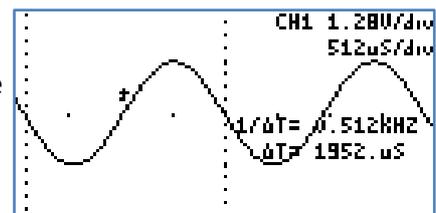


Figure 58: Vertical Cursors

### Horizontal Cursors

Voltage measurements are made with a pair of voltage markers to determine 1 or 2 specific voltage points on a waveform. The oscilloscope automatically calculates the voltage difference between the two markers and displays the difference as a delta voltage value.

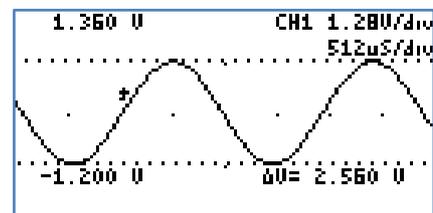


Figure 59: Horizontal Cursors

### Automatic Cursors

When the automatic cursors are enabled, the device will try to automatically make measurements on the waveform.

- **Vertical Cursors:** The device will try find a full or half cycle of the selected waveform. If both CH1 and CH2 are enabled, the channel with the most amplitude will be used.
- **Horizontal Cursor:** The selected horizontal cursor will be set with the maximum and minimum points of the waveform.

### Track Horizontal Cursors

When Track is enabled, the location of the horizontal cursor will track the signal located on the vertical cursor.

### Reference Waveform

A snapshot is taken of the analog waveforms to be used as reference waveforms (the captured waveforms stay on the screen). The reference waveforms are stored in non-volatile memory.

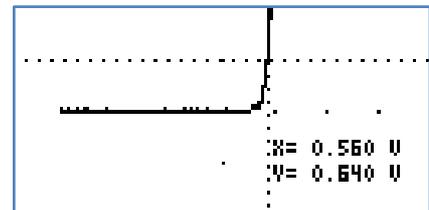


Figure 60: Cursors in XY Mode

### Cursors in XY Mode

When the XY mode is active, the vertical cursors are disabled, and the pair of horizontal cursors represent the X and Y position.

### Display Settings

These menu control various characteristics of the display. Figure 61 shows the display menus.

Display Menu		More Display Options	
K1	Persistent display	K1	Select Grid Type
K2	Toggle Line / Pixel	K2	Flip Display
K3	Show scope settings	K3	Invert Display

Figure 61: Display menus

### Persistent Display

When the persistent display is enabled, the waveform traces are not erased. The persistent display is useful as a simple data logger or to catch glitches in the waveform. The persistent mode can also be used to make frequency plots in combination with the wave generator frequency sweep.

### Line / Pixel Display

This menu item selects the drawing method.

- **Line:** A line is drawn from one sample to the next.
- **Pixel:** A single pixel represents a sample. The pixel display is useful at slow sampling rates or when used in combination with the persistent mode. Figure 62 shows the pixel display.

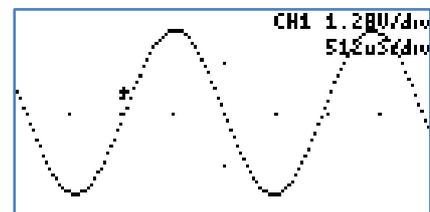


Figure 62: Pixel Display

### Show scope settings

Toggles the display of the scope settings (Channel gain and time base).

### Grid Type

There are 4 different grid types:

- **No grid.**
- **Dots for each division:** Vertical dots represent the scale divisions. Horizontal dots represent the time base setting and the ground level of each channel.
- **Vertical grid line follow trigger:** Vertical dots represent the position of the trigger, the location of the vertical dots follow the trigger position. Horizontal dots represent the time base setting and the ground level of each channel.
- **Dot graticule:** The screen is filled with dots that represent the vertical and horizontal divisions.

### Flip Display

The display orientation is flipped backwards.

### Invert Display

When enabled, the display's pixels are inverted (the display will have a green background).

## Logic Analyzer and Protocol Sniffer

The *Mi* has an 8 bit logic analyzer and can do sniffing on standard protocols: I2C, UART, SPI and RS485/422. The logic inputs provide wide voltage range, 3 -18V.

DgV and GND should be always connected securely to the examined circuit, in order to work in proper voltage. Figure 63 shows the logic menus.



Logic generator consume power from DgV terminal, so make sure DgV source can support this extra power.

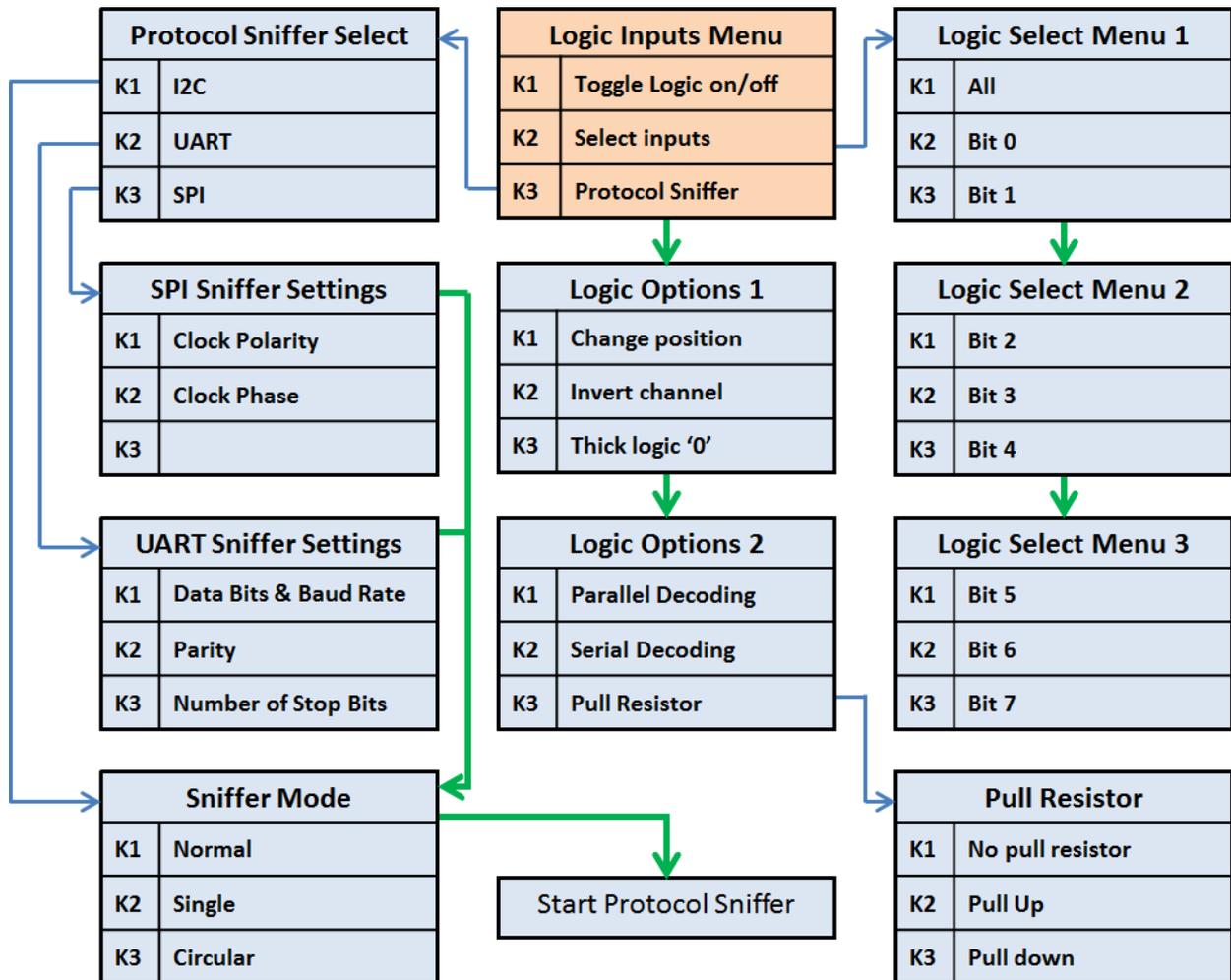


Figure 63: Logic Analyzer Menus

### Input Selection

A subset of the 8 digital signals can be selected. Any digital signal can be enabled or disabled.

### Channel Position

The selected digital channels can be moved up or down. Only applicable if less than 8 digital signals are selected.

### Invert Channel

All digital channels are inverted. This setting also affects the protocol sniffer!

### Thick Logic '0'

A thick line is drawn when the signal is at logic '0'. This is useful to quickly differentiate a '0' from a '1'.

### Parallel Decoding

Shows the hexadecimal value of the 8 bit digital input lines. The hexadecimal number is shown below the last digital trace. If all the 8 digital traces are enabled, then there is no space to show the parallel decoding. Figure 64 shows an example of the parallel decoding with 4 logic lines enabled.

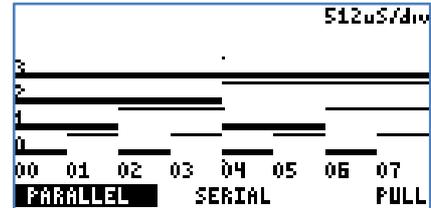


Figure 64: Parallel Decoding

Rear RS485 switch, should be disabled during Parallel and serial decoding.

### Serial Decoding

Shows the hexadecimal value of the stream of bits on each channel. The decoding starts at the first vertical cursor and ends at the second vertical cursor, 8 bits are decoded. If the cursors are disabled, then the decoding is done from the start of the screen, to the end. The data can be decoded MSB first or LSB first, depending on the position of the first vertical cursor.



Figure 65: Serial Decoding

### Protocol Sniffer

When the XScope is in Sniffer mode and before any data is received, a brief text appears on the screen to indicate where to hook up the signals. As soon as data is received, the data is displayed in "pages". There are 16 pages of data. To browse thru the pages, use the buttons K2 and K3. To stop and start the sniffer, press the K1 button. Figure 66 shows the device in sniffer mode.

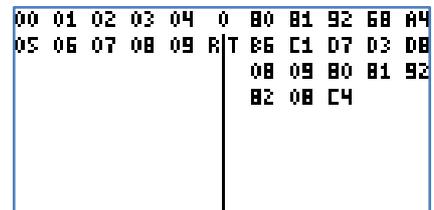


Figure 66: Sniffer

In the UART and SPI sniffers, the data can be displayed in HEX or ASCII, press K2 and K3 simultaneously to toggle between them.

When the ASCII mode is enabled:

- Only codes 0x0A, 0x0D and 0x20 thru 0x7A will show valid characters.
- More information fits the screen but the size of the buffer is the same:  
The data on each page will double and the number of pages is halved.

Figure 67 shows the 3x6 font.

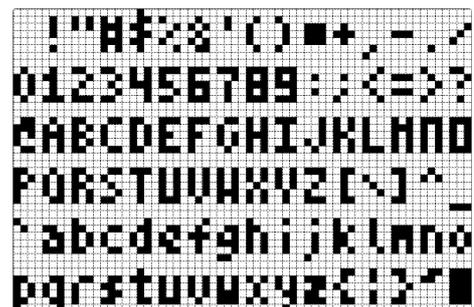


Figure 67: Small 3x6 font (characters 0x20 thru 0x7A)

## Sniffers Modes

- **Normal** mode: Continuous operation, when the buffer is filled, all pages are erased, the index goes back to page 1
- **Single** mode: The sniffer will stop when the buffer is filled.
- **Circular** mode: New data will be placed at the end of the last page, older data will be shifted towards the first page. At the beginning, the device will show 0x00 on all pages, and the last page will be set. The circular mode is useful if you are only interested in the most recent data received.

## I2C Sniffer

### Connect SDA to Bit 0, SCL to Bit 1

*Mi* implements the I2C sniffing in a bit-bang fashion. The maximum tested clock frequency is 400kHz (Standard I2C Fast Speed). As the data is decoded, the data in HEX will appear on the screen, accompanied by a symbol:

When the Master initiates a read, < is an ACK and ( is a NACK

When the Master initiates a write, > is an ACK and ) is a NACK

Subsequent data in the frame will be accompanied by + for ACK or a -for NACK.

There are 16 pages of data, each page shows 64 bytes => the total memory for the I2C sniffer is 1024 bytes.

Example communicating to a Si570 Programmable oscillator:

```
55> 07+           (Master initiates Write to slave 55, byte address 7)
55< 05+ 42+ B6+ 04+ 79+ 9A- (Master initiates Read to slave 55, then reads 6
bytes)
```

## UART Sniffer

### Connect RX to Bit 2, TX to Bit 3

The *Mi* can decode both the TX and RX lines of the UART at the standard baud rates, and with selectable data bits:

5,6,7,8 Data bits      /      1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200 bps

When the sniffer begins, the screen is split in two, the left side is used for the RX line, and the right side is used for the TX line. Each side can show 40 bytes per page. With 16 pages, a total of 640 bytes can be stored for each decoded line.

00	01	02	03	04	0	00	01	02	03	04
05	06	07	08	09	R/T	05	06	07	08	09
						0A	0B	0C	0D	0E
						0F	10	11	12	13

Figure 68: UART Sniffer screen

## RS485/422 Sniffer

### Connect side connector A, B, GND

To set device as RS485/422 sniffer do the follow:

- Set device as UART sniffer.
- Press the rear switch to RS485 position.
- Use the side RS485 connector.

At the right side of the screen (TX), appear sniffed data. RX used and connected as UART sniffer.

During RS485 sniffing mode, Bit3 (pin 18) of logic analyzer is disabled.

During sniffing, GND of *Mi* should be always connected to sniffed source GND.

*Mi* accessories include an 120Ω terminal resistor, to place it if needed. Like all terminals, those of RS485 port are double, so terminal resistor can also be placed on the port between A and B.

### SPI Sniffer

#### Connect the Slave Select to Bit 4, MOSI to Bit 5, MISO to Bit 6, SCK to Bit 7

The *Mi* can decode both the MOSI and MISO lines of an SPI bus.

The SPI's MOSI pin decoding is done in hardware, so it can decode data at high speed (up to 950kHz), but the SPI's MISO pin decoding is implemented in software using bit-banging.

The maximum clock is 439kHz. Decoding starts when a falling edge on the SS pin is detected.

Configuration	Leading edge	Trailing edge
CPOL CPHA	Rising, sample	Falling, setup
CPOL CPHA	Rising, setup	Falling, sample
CPOL CPHA	Falling, sample	Rising, setup
CPOL CPHA	Falling, setup	Rising, sample

Table 6: SPI Configuration

The screen is split in two, the left side is used for the MOSI line, and the right side is used for the MISO line. Each side can show 40 bytes per page. With 16 pages, a total of 640 bytes can be stored for each decoded line. Table 6 shows the SPI configuration.

### Arbitrary Waveform Generator

*Mi* have an embedded high current arbitrary waveform generator. The waveform generator output is independent from the data acquisition, and is always running in the background. You can adjust all the parameters of the waveform: type, frequency, amplitude, offset, duty cycle, and impedance. You can sweep the frequency, amplitude and duty cycle.

Figure 69 shows the AWG Menus.

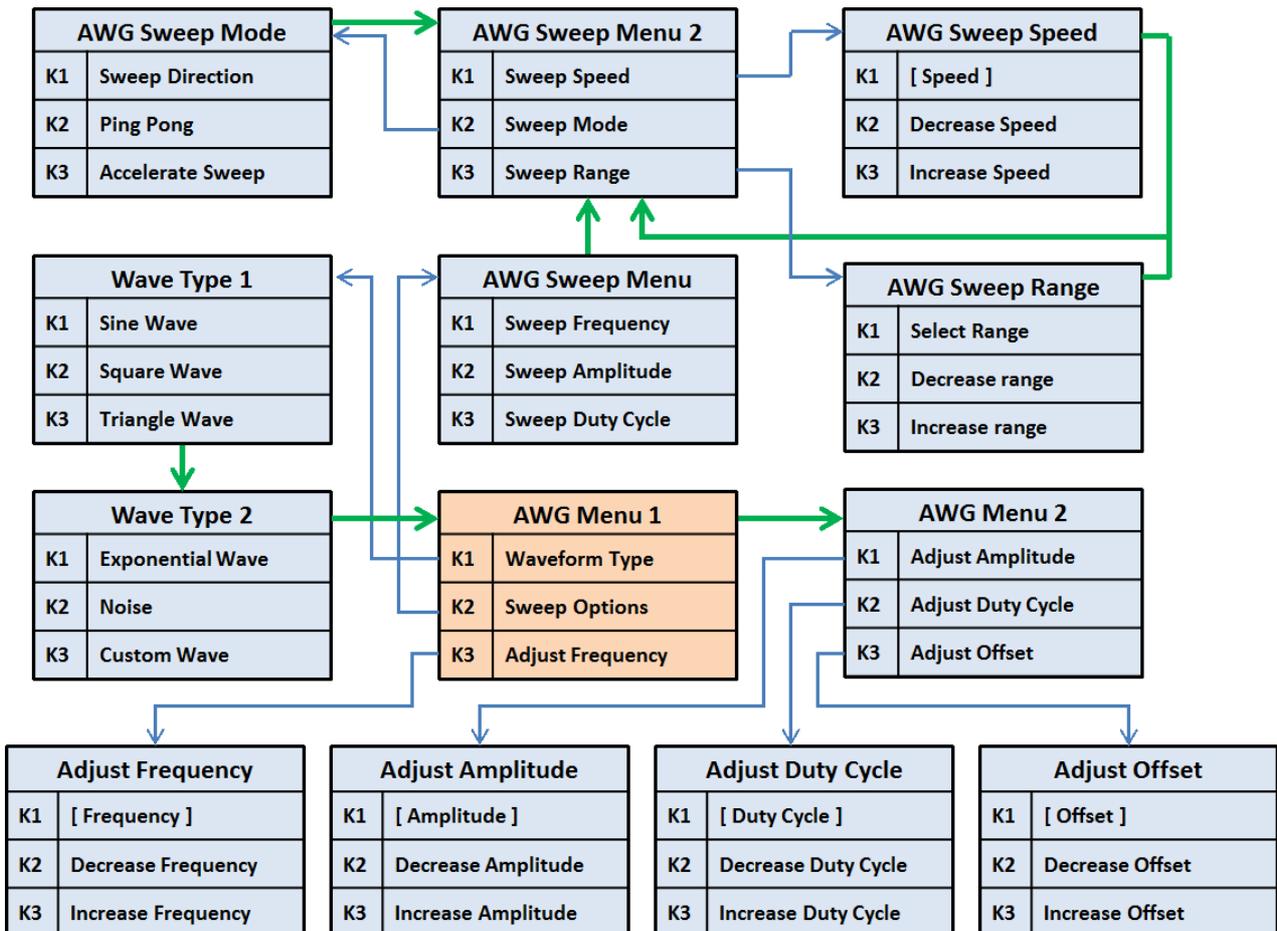


Figure 69: AWG Menus

**TIP**

When adjusting the parameters, the K1 button serves as a shortcut key, which sets predefined values.

**TIP**

When enabling the Sweep, the waveform will be updated only on a screen refresh. For a smooth sweep, set the scope with a high speed sampling, or stop the oscilloscope.

**Predefined Waveforms**

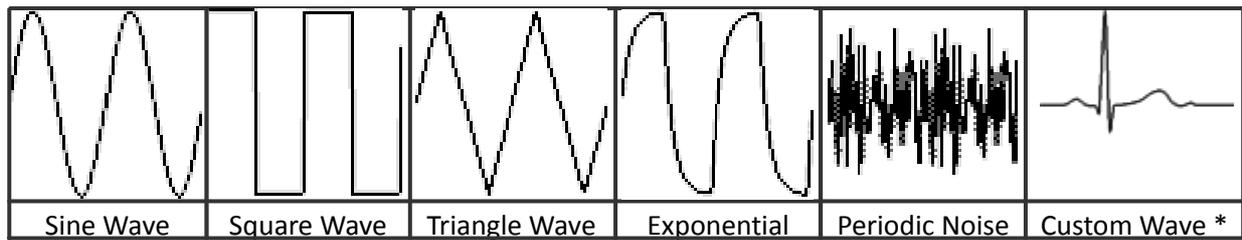


Table 7: AWG Preprogrammed Waveforms

The *Mi* can output the following waveforms: Sine, Square, Triangle, and Exponential. There is a “Periodic Noise” option that fills the AWG buffer with random data, it is periodic because the same data is output over and over, but each time the Noise wave is selected, new random data will be generated. There is also a custom waveform which is initially set with an ECG wave, but can be changed with the PC interface (see section 5.2).

**Parameter Sweep**

The *Mi* has a SWEEP feature, which increases one or more parameter values automatically **on each screen refresh of the oscilloscope**. When the sweep is enabled, three dots will appear at the bottom of the screen, representing the start, end, and current sweep value. When doing a Frequency sweep, the frequency range is determined by the current time base. Since the frequency sweep is synchronized with the oscilloscope, displaying perfect frequency plots is easy.

To make a frequency plot, set the mode to FFT, and set the display to persistent. See section 8.6 for an example.

**Sweep Modes**

In the Sweep Mode menu, the sweep direction can be changed. Automatic change of the direction is done by enabling the Ping Pong mode. The sweep acceleration increases or decreases the sweep speed, the sweep speed is reset when reaching the start or end of the sweep.

**Technical Details**

The waveform is stored in a 256 byte long buffer, this buffer is fed to the *Mi*'s DAC thru the DMA. Once the waveform is set, the waveform will be generated without any CPU intervention. The maximum conversion rate of the DAC is 1Msps, this limits the maximum output frequency of the AWG as a system. For example, if the AWG is generating a sinewave with 256 points, the maximum frequency is 3906.25Hz. If generating a sinewave with only 32 points, the maximum frequency is 31.25KHz. The AWG amplifier has a low pass filter of 44.1KHz. The predefined AWG Frequency range is: 1Hz thru 125 kHz

The resolution of the waveform generator varies depending on the frequency range: the lower the frequency, the higher the resolution. Note that the possible frequencies are discrete:

$$\text{Frequency} = \text{Cycles} * \frac{125000}{\text{? ? ? ? ? ?}}$$

**Cycles:** Integer number, with these possible values: 1, 2, 4, 8, 16, 32  
**Period:** Integer number, with values between 32 and 65535

An amplifier circuit follow after wave generator. This amplifier double the output voltage. Also significantly increase current. Current depend from the output load, and the selected Res resistance. Res selected from peripheral module.

## PC Interface

The device can interface with a PC (Linux, Mac, or Windows).

### Connecting the device

The *Mi* can communicate to a PC through the USB port. When the application starts, it will try to connect automatically. When *Mi* connect to computer a short blink of red “USB” LED appear.

### Controlling the device

All of the main module functions described previously in this manual, can be controlled with the PC interface. The main operating modes of the device can be selected by switching to the corresponding tab of the interface. Figure 70 shows a snapshot of the device in the Oscilloscope mode.

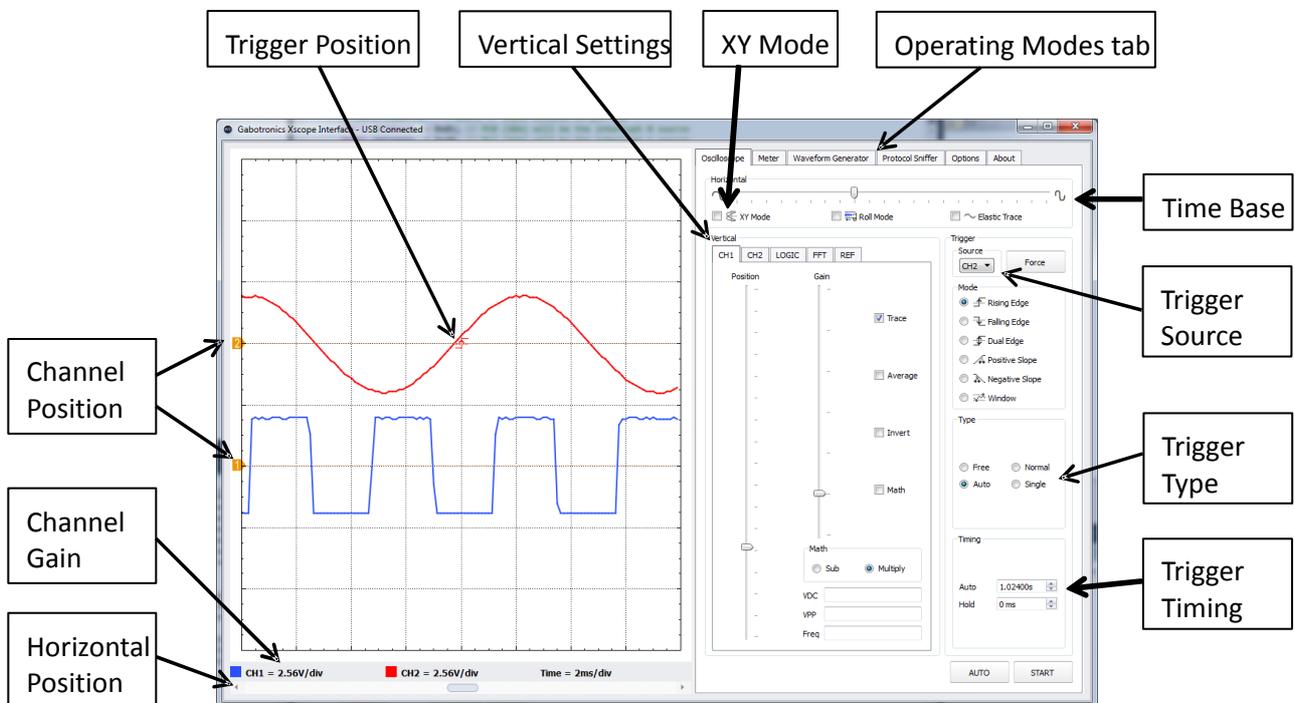


Figure 70: PC Interface

### Custom WG Waveform

You can define your own waveforms for the AWG. On the Waveform Generator tab, click “Open CSV” and select your CSV file. Then click “Save as Custom”. The waveform will be permanently saved in the device’s EEPROM memory. When creating a CSV file, the range of the data must be [-127, 127], and there should be only 256 numbers.

### Saving Waveforms and Screenshots

On the Options tab there are buttons to save and load waveforms, as well as saving screenshots of the graph area in PNG format. When saving a waveform or screenshot, the program will ask for a destination folder only once, and then use this folder for subsequent files. When opening a waveform, the “Clear” button must be pressed to continue normal operation.

The Record button allows saving waveforms continuously. The Play button is used to playback a recording.



Figure 71: File operations

### Android interface

*Mi* can be connected to a tablet or a smart phone. Requirements described below:

- Tablet or smart phone, equipped with OTG capable USB port
- OTG-USB adapter & USB cable
- Android 3.1 or higher operating system
- NFX Oscilloscope application
- 3MB of free space Compatibility to all tablets and smart phones is not warrantied.

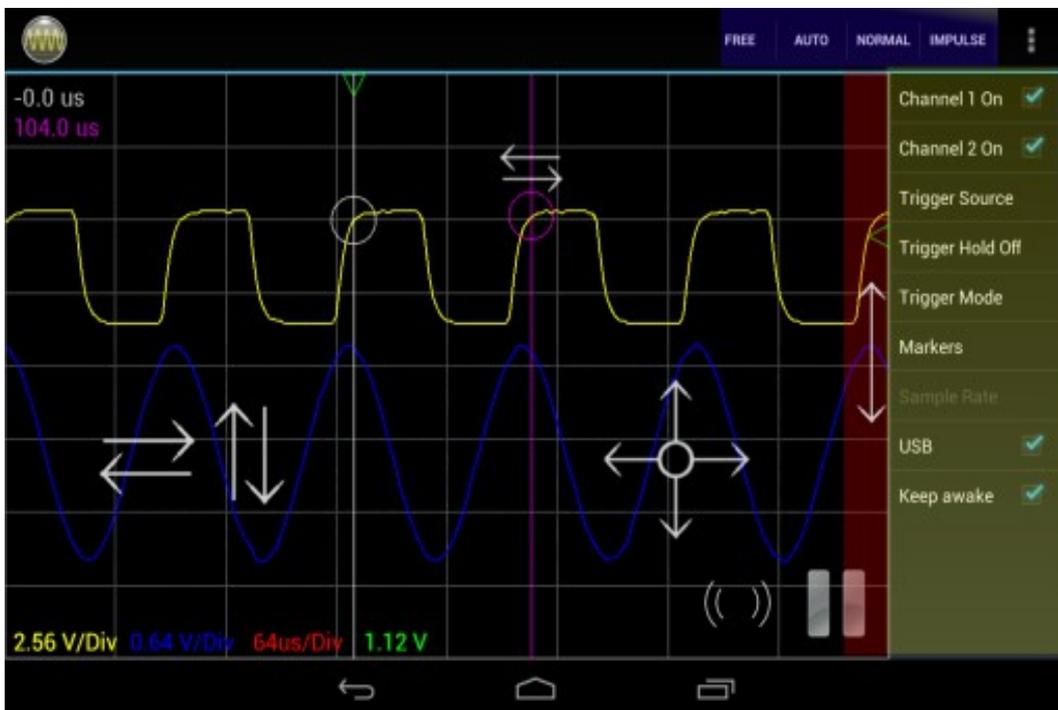


Figure 72: Screenshot from NFX Oscilloscope application

**Troubleshooting**

<b>The unit does not power up!</b>	Bad connection. Check cable and charger for proper connection
	USB cable defected. Try an other cable
	Wall outlet dead. Try an other device
	USB charger defected. Try with an other charger
<b>Display is off, however few LED glow up</b>	Display fell to sleep. Press MENU to wake up
<b>Device have erratic behaviour</b>	Press menu during power up to restore factory settings
<b>5V, 3.3V, or -5V LED is off</b>	External shortcircuit. Remove cables from 24,25,26 pins
	Excessive load. Use external power supply
<b>VI signature show open circuit</b>	Check for correct probes connection, pins 4 & 8
	Very high component impedance. Increase Res
	Defected probe cable. Change cable
<b>Oscilloscope not show waveforms</b>	Channels disabled. Enter main module menu, and set them on
	Waveforms out off screen. Set POSITION properly
<b>Oscilloscope show flat waveforms</b>	Wrong connection. Related pins are 5, 6, & 8
	Gain too low. Increase GAIN
	Overload/x10 enabled. Disable from peripheral menu
<b>Logic IC tester not work properly</b>	Bad connection. Check all cables for proper connection
	Wrong cabling/setup. Reevaluate connection & setup
	Defected probe cable. Change cable
	Switches wrong position. Check TTL & RS485 switch position
	Tested IC truly is defected
<b>Analog IC tester not work properly</b>	Bad connection. Check all cables for proper connection
	Not all combination explored. Read instructions again
	Defected probe cable. Change cable
	Wrong oscilloscope setup. Check Channel/GAIN/POSITION
	Wrong wave generator setup. Reenter to analog IC tester function
<b>Unable to connect with computer</b>	Driver not installed. Install driver
	"File missing" message. Install C++ application
	USB cable defected. Change cable
	Connection disabled. Press Connect button in Options tab
	Non of the above working. Change USB port or restart computer

Figure 73: Troubleshooting table

## Specifications

General	Microcontroller	Dual ATXMEGA32A4U & ATmega328
	Display Type	Graphic OLED Green, 128x64 pixels, max. refresh rate 122Hz & 24 LED
	Display Size	2.42 inches
	Display Life Time	40,000 hours min.
	Device size	W:135mm x H:61mm x D:52mm
	Weight	300 grams
	Interfaces	10 Tactile Switches, USB ( $\mu$ -USB connector)
	Power supply	External battery, 100-240V power supply (through $\mu$ -USB connector)
	Active current	45mA to 700mA
	Sleep current	40 mA
Logic Analyzer	Logic Inputs	8 Digital Inputs
	Logic Input levels	3V – 18V, TTL and CMOS
	Input Pull	None
	Max. Sampling rate	2Msps
	Buffer Size	256
	Frequency Counter	16MHz, 1Hz resolution, +/- 100ppm accuracy
	Sniffer Protocols	UART, I2C, SPI, RS485
Oscilloscope	Analog Inputs	2 Analog Inputs
	Max. Sampling rate	2Msps
	Analog Bandwidth	200kHz
	Resolution	8 bits
	Input Impedance	1M $\Omega$
	Buffer size	256 on each channel
	Input Voltage Range	-14V to +20V
	Vertical Sensitivity	80mV/div to 5.12V/div
AWG	Analog Outputs	2 Analog Outputs
	Max. Conversion rate	1Msps
	Resolution	8bits
	Buffer Size	256
	Output current	> +/- 200mA
	Output Voltage	+/- 9V P-P
	Low Pass Filter	44.1kHz

Notes:1. The Active current varies depending on the number of pixels lit on the display, and load of output.

Table 8: *Mi* Specifications

## Absolute Maximum Ratings

Parameter	<i>Mi</i>		
	Minimum	Maximum	Unit
Supply Voltage (+5V)	-0.5	5.5	V
Analog Inputs <sup>1</sup>	-30	30	V
Digital Inputs	-0.5	20	V
External Trigger	-3.5	20	V
Operating Temperature	-40	55	°C
Storage Temperature	-40	65	°C

- The analog inputs are equipped by a safety circuit. When energized increase measured range by ten times, however time response and other factors, does not allow to rely always on it. So, to avoid any damage in the device please check carefully voltage connection and setup before use.

Table 9: Absolute Maximum Ratings

NEAT Mi

Dimensions

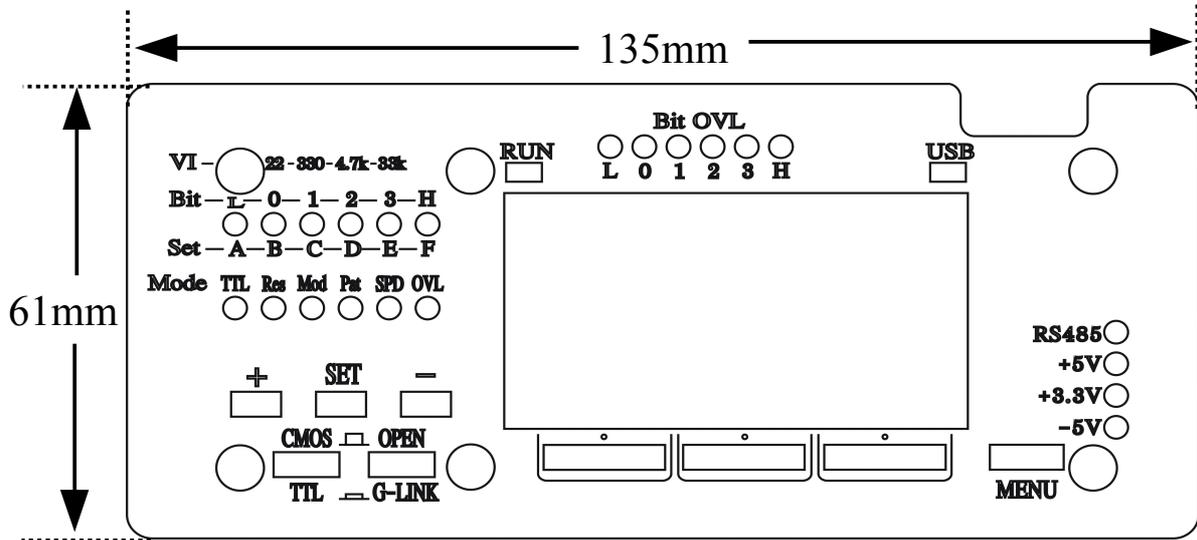


Figure 74: Front view dimensions

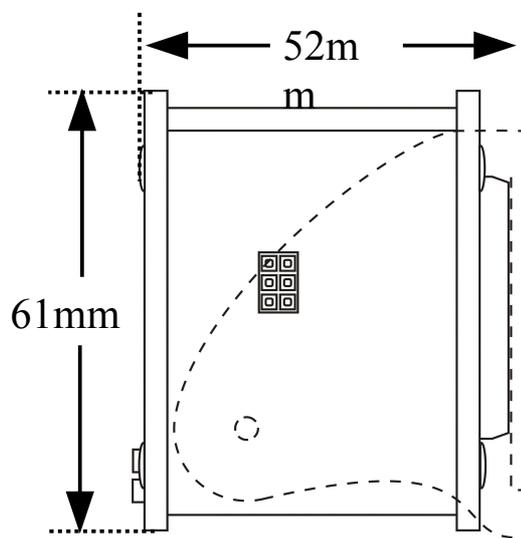


Figure 75: Side view dimensions