



Virtual Instrument

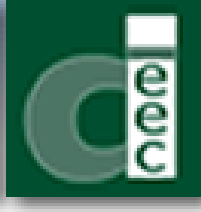
LABORATORIO REMOTO VISIR

Systems In Reality

1. INTRODUCCION
2. CICLO DE OPERACION
3. INTERFAZ DE USUARIO
4. CLIENTE
5. MATRIZ
6. MEASUREMENT SERVER
7. EQUIPMENT SERVER



# INTRODUCCION



- VISIR is the acronym of Virtual Instrument Systems In Reality.
- VISIR is a remote laboratory for wiring and measuring electronics circuits remotely on a virtual/simulated workbench that resembles the real lab instruments and components.
- The wiring mechanism is developed by means of a relay switching matrix connected to a PCI eXtensions for Instrumentation (PXI).
- The entire equipment is controlled by LabVIEW server software, in addition to a measurement server software that protects the equipment from hazard connections by verifying input circuit designs, sent by students, before being executed.
- VISIR allows multiple users concurrently.



INTRODUCCION



	NI PXI-Chassis	NI PXI-Modules	NI PXI-Controller
Description	It is the backbone of the PXI platform into which all the instrument cards (NI PXI-modules) and the NI PXI-controller are plugged.	The instrument cards that substitute the real instruments. They are plugged into the NI PXI-Chassis. All these cards can be added and removed depending on the demands.	It is an embedded PC plugged into the NI PXI-Chassis. It includes an integrated CPU, a hard drive, RAM, Ethernet, video card, keyboard/mouse connectors, serial, USB, Microsoft windows software etc. All these features are integrated. Hence, it eliminates the need for an external PC but, it could be replaced by a PC.
<p>The instrumentation platform of VISIR is based on NI PXI platform, which consists of instrument module cards, a controller card and a chassis into which all the cards are plugged. For every component, there are various models depending on its technical characteristics and there is a flexibility to choose among them.</p>			

Model installed at UNED	NI PXI-Chassis (NI PXI-1031)	NI PXI-DC Power Supply (NI PXI-4110) NI PXI-Digital Multi-Meter (NI PXI-4072) NI PXI-Function Generator (NI PXI-5412) NI PXI-Oscilloscope (NI PXI-5114)	NI-PXI Controller (NI PXI-8105)
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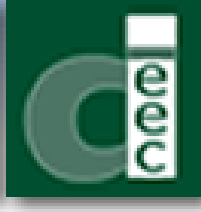


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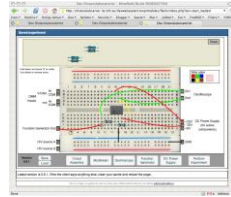




# CICLO DE OPERACION



Virtual Breadboard



Client computer  
side

XML, TCP/IP, port 2324

Switching Matrix

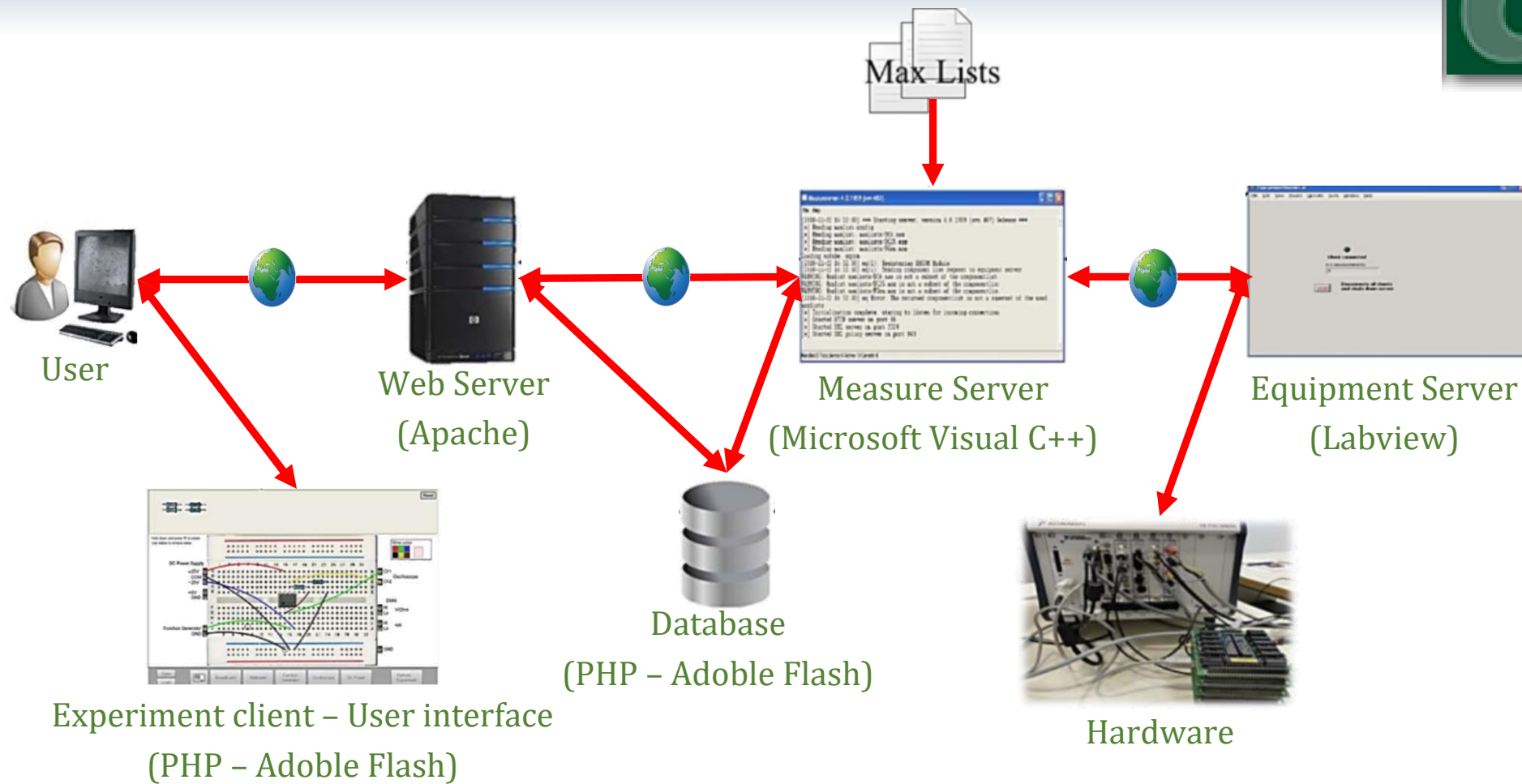
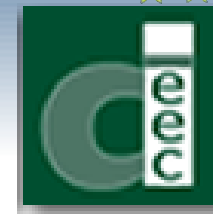


Equipment  
Server side

The procedure creating the circuit in the matrix mimics how the student wires the circuit on the breadboard



# CICLO DE OPERACION





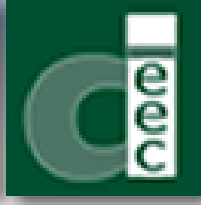
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# INTERFAZ USUARIO



The UI is the frontal web page of VISIR that handles all the administration, access, and authentication process.

It is written in the scripting language PHP in connection with a Relational Database Management System (RDMS) MySQL, and it is hosted in an Apache Hypertext Transfer Protocol (HTTP) Web server.

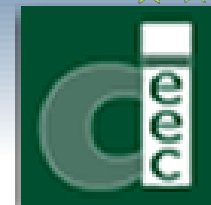
It uses the secure protocol HTTP Secure (HTTPS) and provides many features similar to those provided by a Learning Management System (LMS) in order to facilitate the implementation of VISIR in the learning process.

The capabilities and limitation of these features are associated with the account types. The properties and the privileges of each account type are explained as follows.







# INTERFAZ USUARIO



## OpenLabs Electronics Laboratory

Logout  

**MAIN MENU**

- Start
- About
- Demo
- FAQ


**STUDENT**

- Guest course integrator
- Guest course op. amp.

**TEACHER**

- Guest course integrator
- Guest course op. amp.

**OPENLABS**



**Guest course op. amp.**

Start Experimenting

Starting an experiment without a reservation gives you one hour of experimentation time. Experimenting without a reservation has lower priority and you will be kicked out if a reservation needs your seat.

**My ongoing reservations**

No ongoing reservations

**My reservations**

Start	End	
2008-09-08 08:00:00	2008-09-08 11:00:00	<u>Cancel</u>

Make new reservation

**Teacher scheduled reservations**

Start	End	Booked	Max	
2008-09-09 08:00:00	2008-09-09 12:00:00	0	16	<u>Reserve Seat</u>





# INTERFAZ USUARIO



## Administrator account

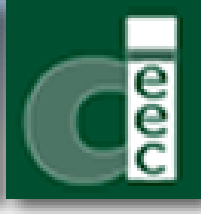
It is the account of the lab provider. VISIR can have one or more administrator account. The administrator account has the following privileges:

- Create contents in the UI through the WIKI markup syntax.
- Upload files, videos, manuals, etc.; this can be done by uploading them to the web server (Apache) and linking them to the PHP code of the Page.
- Create, update, and delete courses associated with a start and an end date, a maximum number of users, and assigned teachers and/or instructor accounts.
- Modify or remove any user account.
- In any course, the administrator account can switch to “teacher view” to have all the teacher privileges in that course.





# INTERFAZ USUARIO



## Teacher account

It is created by the administrator and associated with a certain course. It has the following privileges:

- Add and remove experiments; this is done by allowing certain components to appear to the student in each experiment.
- Add, remove, and modify student accounts.
- Make a teacher scheduled reservation; the teacher reserves a number of seats within an interval of time so that, she can put his/her students in groups and assign an instructor to each group. These seats are visible to the student with the teacher's name. Accordingly, the student chooses his/her group and reserves his/her seat.
- The teacher can switch to "student view" in order to view the contents as seen by his/her students.





# INTERFAZ USUARIO



## Student and instructor accounts

They are created by the teacher and are associated with a certain course. They only allows access to the experiments that are created by the teacher within such course.

The student and the instructor, likewise, can make a scheduled reservation separately or reserve a seat belonging to the scheduled reservation of the teacher.





# INTERFAZ USUARIO



## Guest account

It is a public limited trial account created by the administrator and it does not require registration. It can be utilized by anyone wanting to try an available experiment prepared by the teacher assigned to that account.





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# CLIENTE

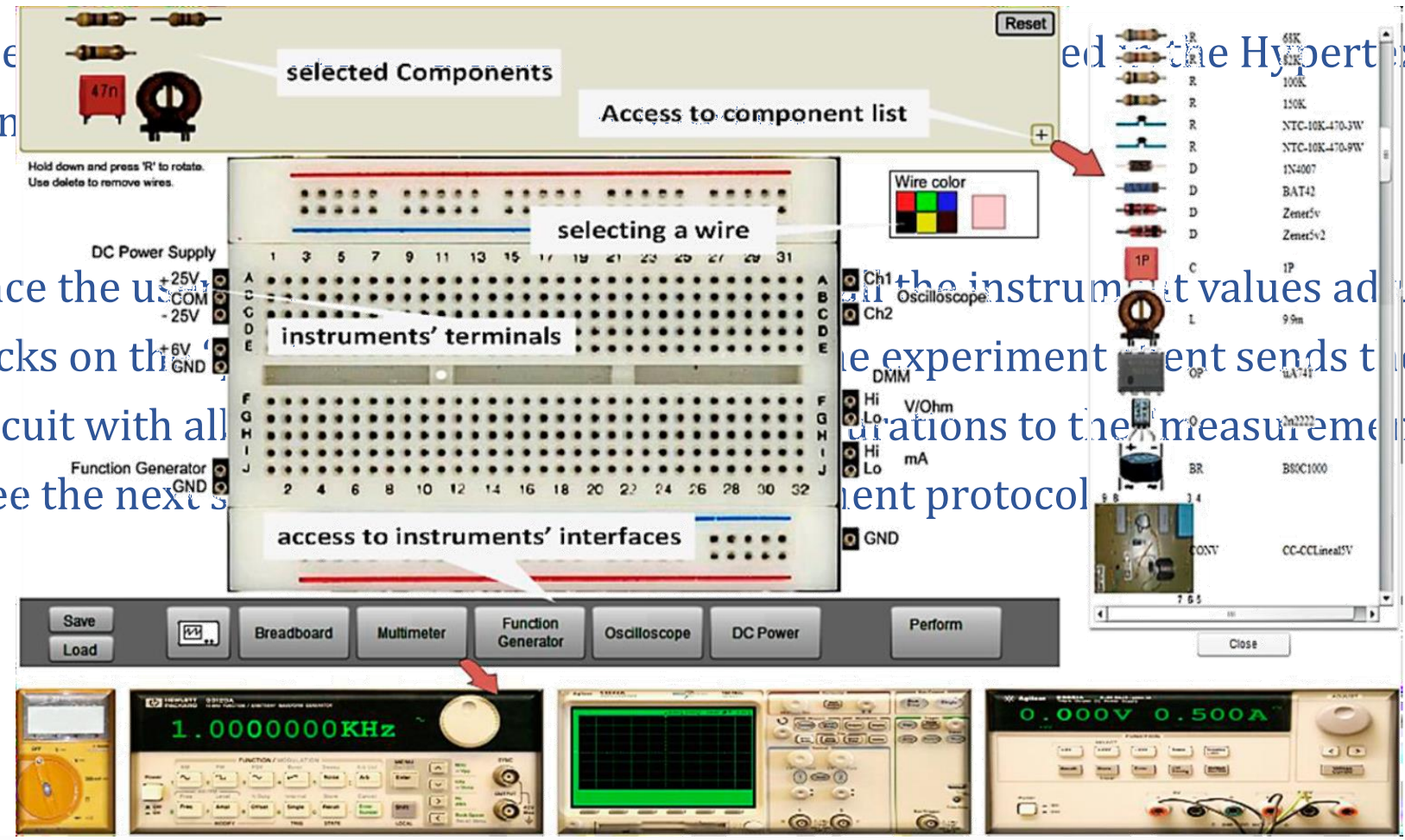


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Once the user  
clicks on the  
circuit with all  
(see the next s

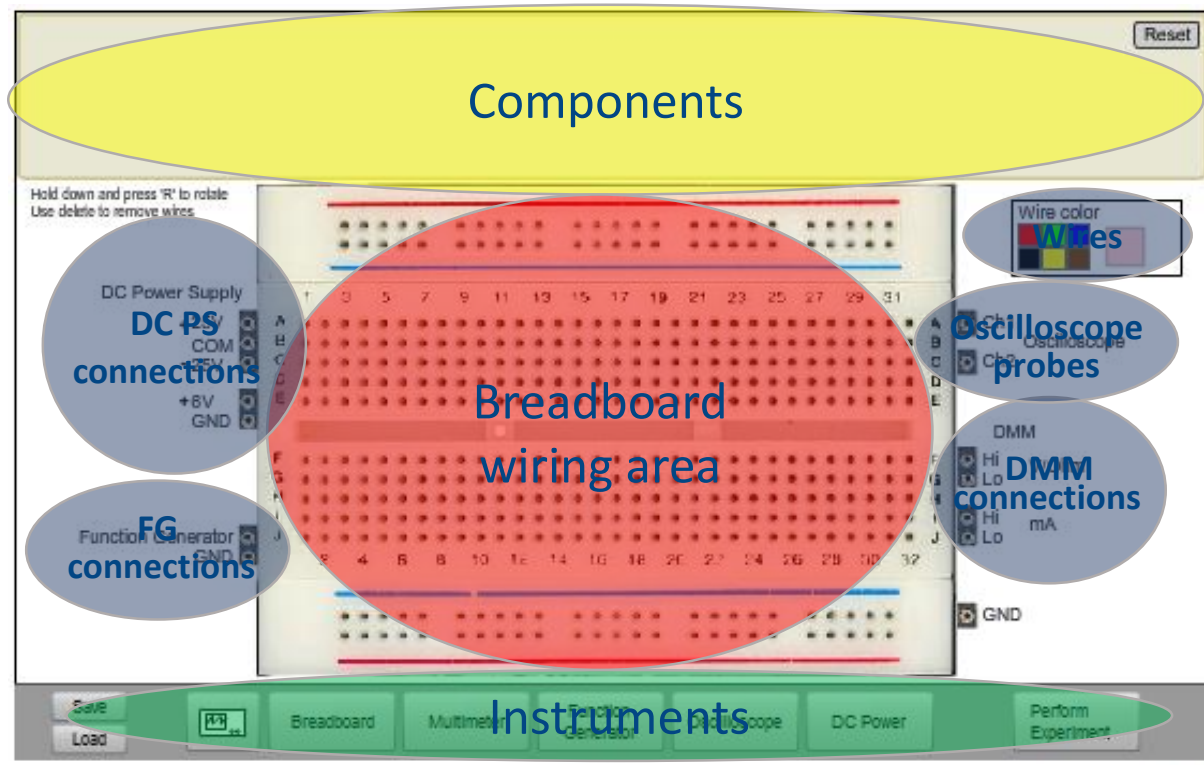
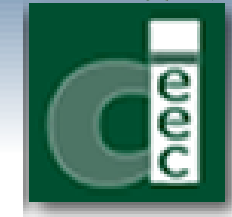
all the instrument values adjusted, and  
the experiment sends the designed  
urations to the measurement server"  
ent protocol





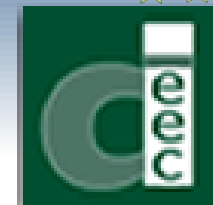


# CLIENTE

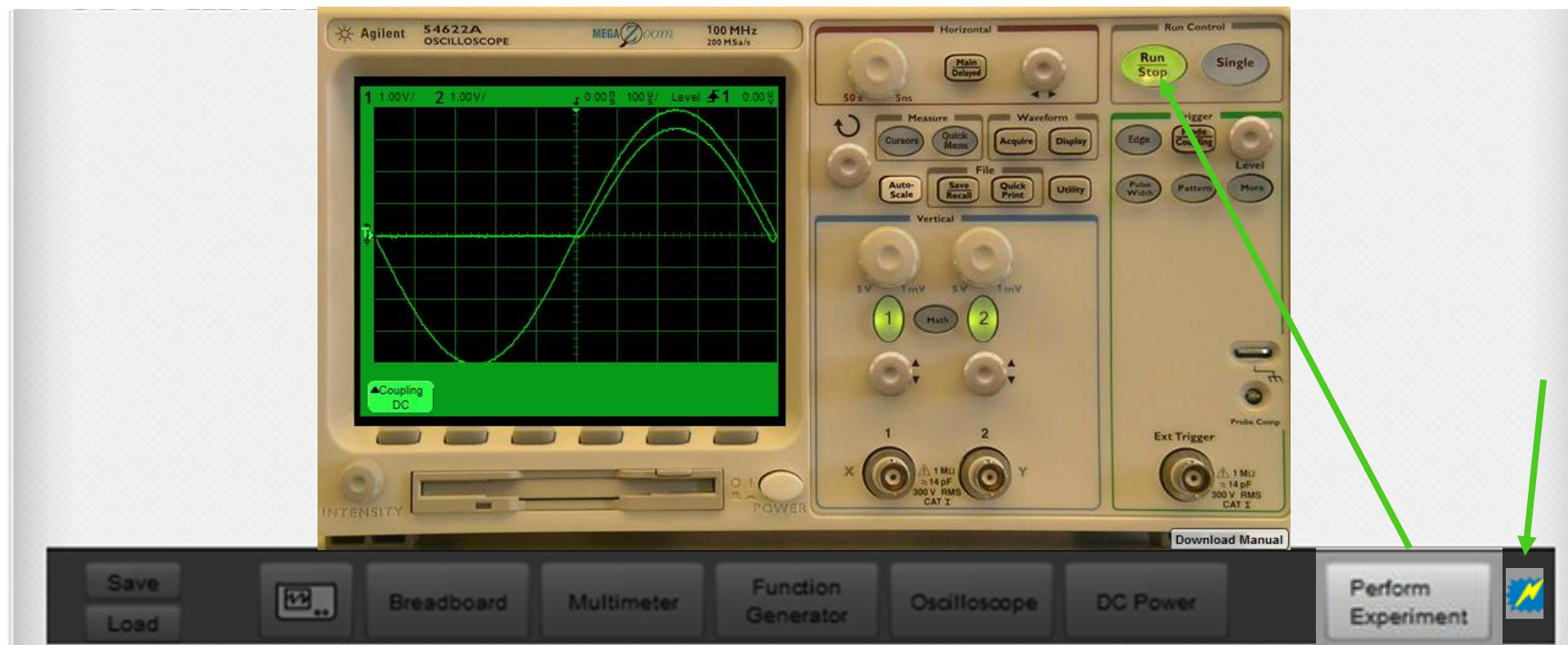




# CLIENTE



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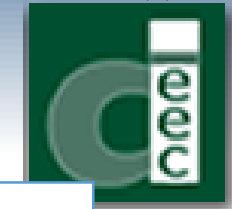


# CLIENTE

## Componentes

```
<component type="R" value="150K" pins="2">  
  <rotations>  
    <rotation ox="-27" oy="-7" image="150K.png" rot="0">  
      <pins>  
        <pin x="-26" y="0" /><pin x="26" y="0" />  
      </pins>  
    </rotation>  
    <rotation ox="-8" oy="-27" image="150K.png" rot="90">  
      <pins>  
        <pin x="0" y="-26" /><pin x="0" y="26" />  
      </pins>  
    </rotation>  
  </rotations>  
</component>
```





# CLIENTE

## Componentes

```
<component type="OP" value="uA741" pins="8">
  <rotations>
    <rotation ox="-18" oy="-14" image="uA741.png" rot="0">
      <pins>
        <pin x="-13" y="26" />
        <pin x="0" y="26" />
        <pin x="13" y="26" />
        <pin x="26" y="26" />
        <pin x="26" y="-13" />
        <pin x="13" y="-13" />
        <pin x="0" y="-13" />
        <pin x="-13" y="-13" />
      </pins>
    </rotation>
  </rotations>
</component>
```



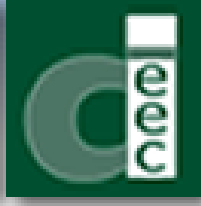


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# MATRIZ



The relay switching matrix is a stack of “PCI/104” ([www.pc104.org](http://www.pc104.org)) sized boards, manufactured at BTH, which controls the terminals connection of the components and the NI PXI-modules.

It acts as a circuit-wiring robot and it is designed for low frequency analog electronic circuits’ experiments. It consists of two types of boards:

- instrument boards, which handle the connection of their corresponding NI PXI-module.
- component boards, which handle the connection of the components installed in them.





# MATRIZ



The relay switching matrix is connected to the NI PXI-chassis by a USB cable and the terminals of the NI PXI-modules are connected to it by either coaxial cables or cords.

Each component board comprises 10 sockets and each socket is connected to a DPST relay— four of these sockets can be connected instead to 2 Single-Pole Single-Throw (SPST) relays each. Thus, a matrix can contain up to  $16 \times 10$  DPST relays.







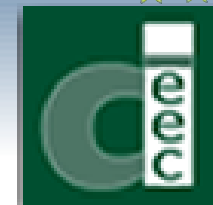
# MATRIZ

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# MATRIZ



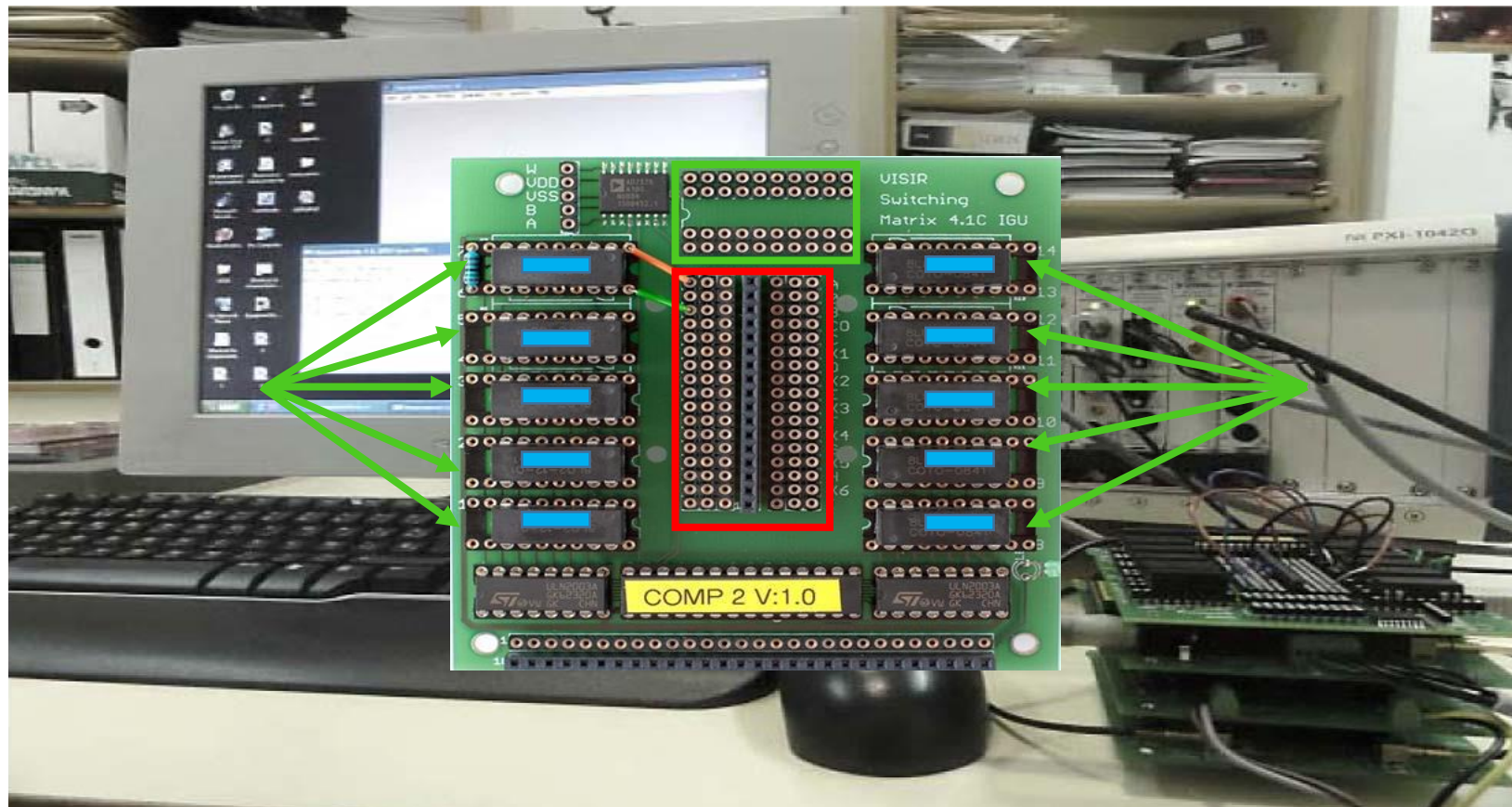
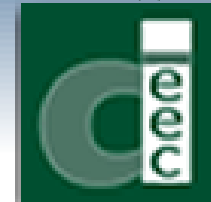
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# MATRIZ

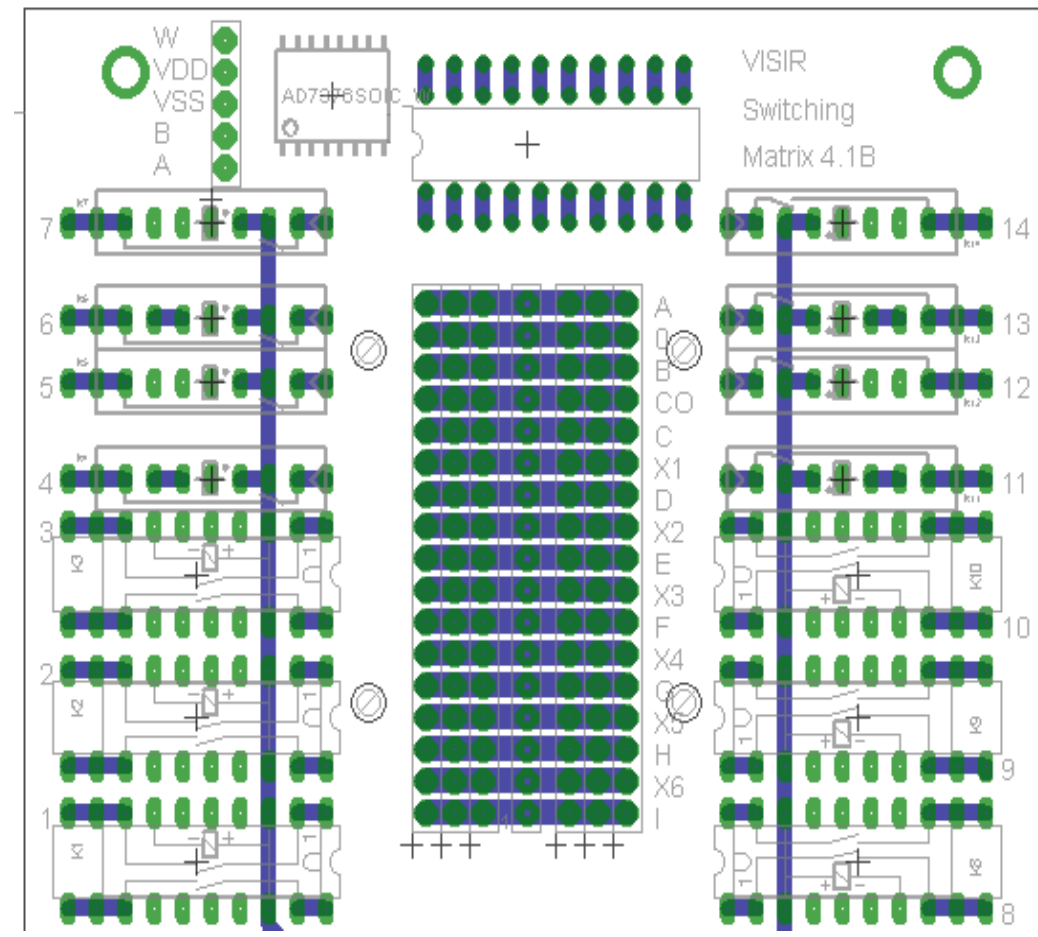




# MATRIZ



- The relay numbers are used to identify the components the relays connect.
- The two upper sockets for relays on both sides of the node bus can be populated with either dual pole DIL relays or with single pole SIL ones. If DIL relays are used then the relay numbers are 5,7 and 11,13.
- The nodes are denoted A – I and 0.
- The other conductors in the node bus are denoted X1 – X6 and COM (power supply connections).







# MATRIZ



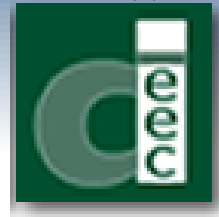
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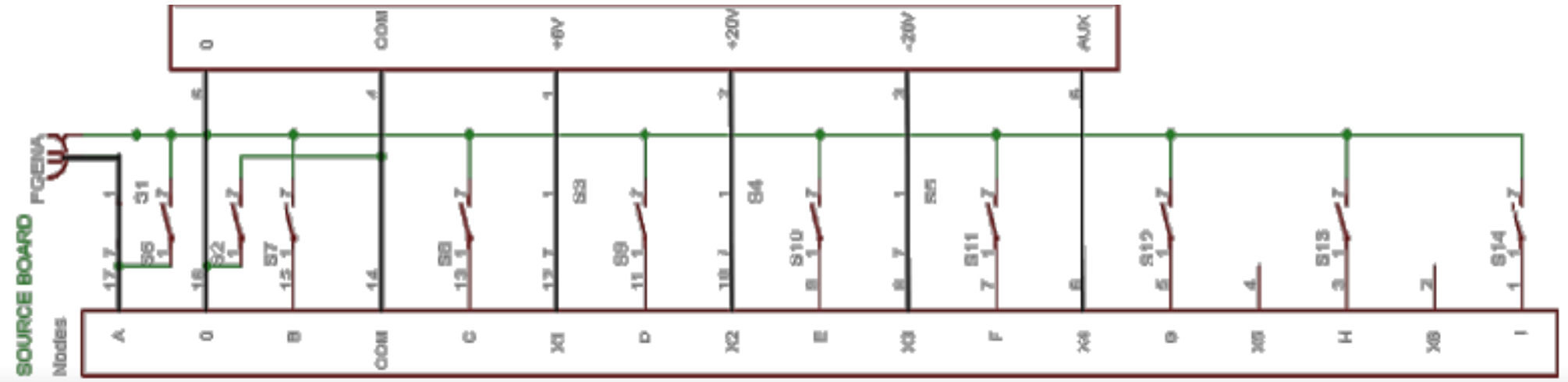


# MATRIZ



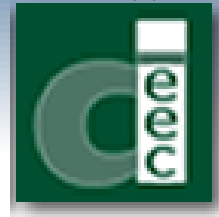
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- The function generator output can be connected to node A only. While the oscilloscope channels as well as the DMM channels are dynamically connected to any node depending on the user circuit design and they are not listed in the component list design. The Power source connectors (0, COM, +6V, +20V, -20V, AUX) are connected internally to the node 0 (GND) and the nodes of the second group (COM, X1, X2, X3, X4) respectively.

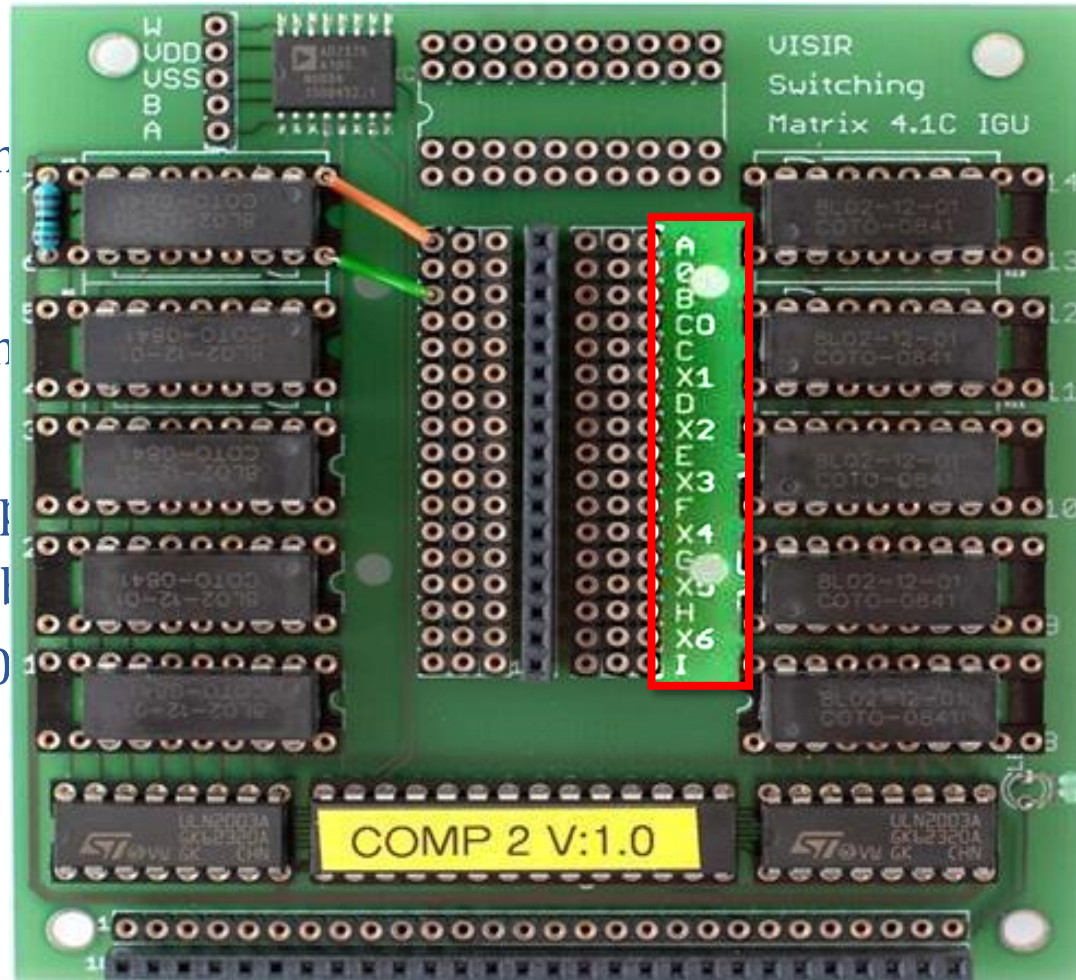




# MATRIZ



- The described m
- In relay switching  
interconnection  
common nodes p  
creating a node l  
named A-I and 0  
COM.



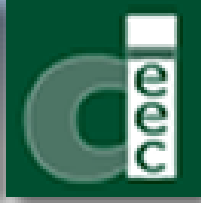
lays controlling the  
However, there are  
m together,  
e first contains the  
med X1-X6 and



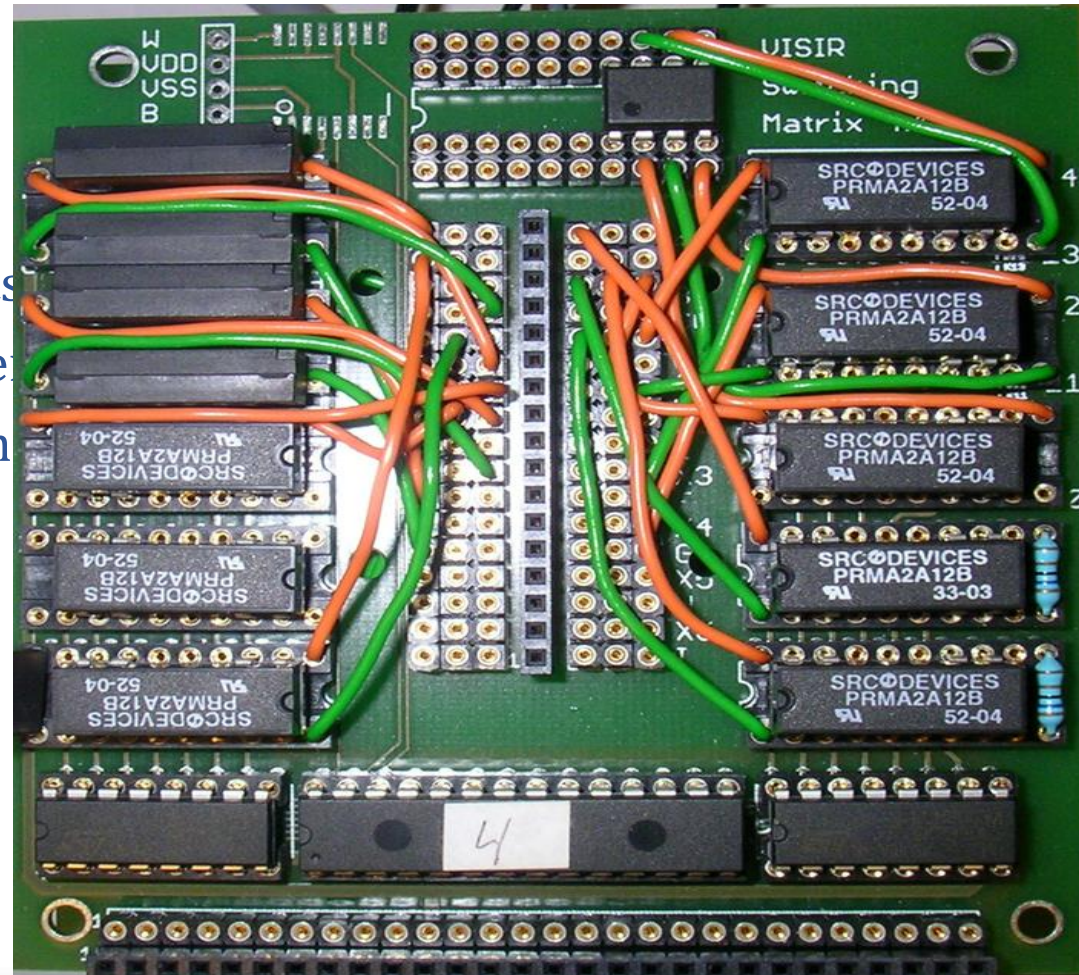




# MATRIZ

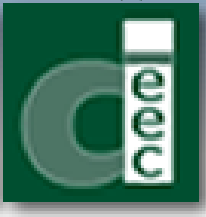


- The components are connected to the ground terminals of the function generator depending on the component's function.





# MATRIZ

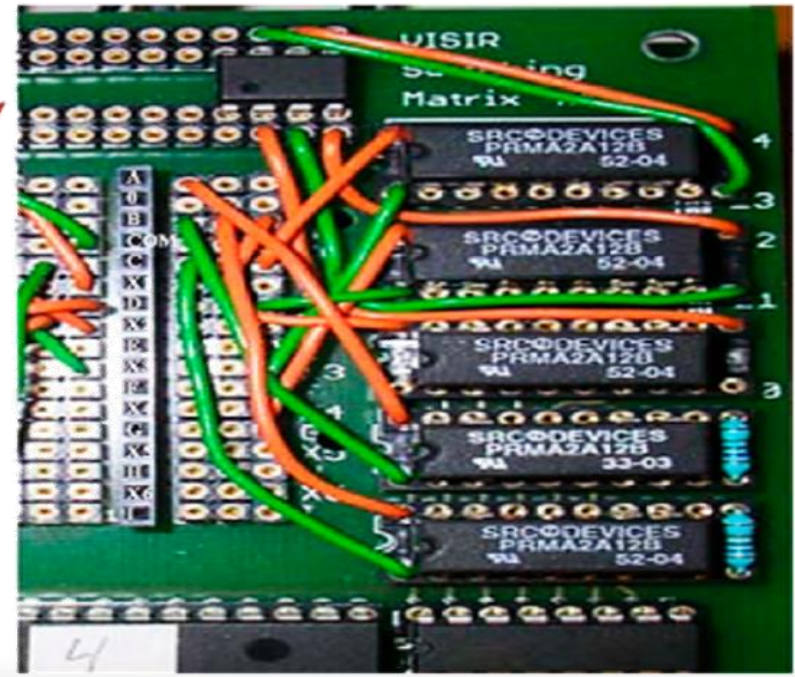


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- For components with more than two leads, more relays are used and they are mounted on the 20 pin IC sockets. The operational amplifier shown in figure has 8 pins. Pin 1 and 5 are not connected, this operational amplifier is described in the component list as “OP\_4\_10:4\_11:4\_13 NC B D G NC C F NC uA741”

*OP\_4\_10:4\_11:4\_13 NC B D G NC C F NC uA741*

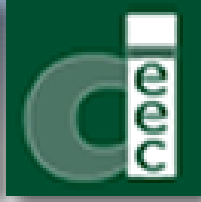
Op amp pin	Card	Relay	Nodes
1	4	Not connected	NC
2	4	10	B
3,4	4	11	D, G
5	4	Not connected	NC
6,7	4	13	C, F







# MATRIZ



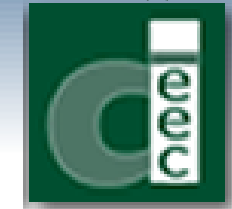
- The nodes of the second group (X1-X6) and the node COM are not supported in the current version of the software and must not be used in the component list. The power supply terminals (6V, +25V, -25V and COM) are connected internally to the nodes (X1, X2, X3 and 0) respectively through the relays (3, 4, 5 ad 2) on the source board (board label= 24).

Thus, the power supply could be connected to the nodes of the first group (A-I) by either one of the following two way

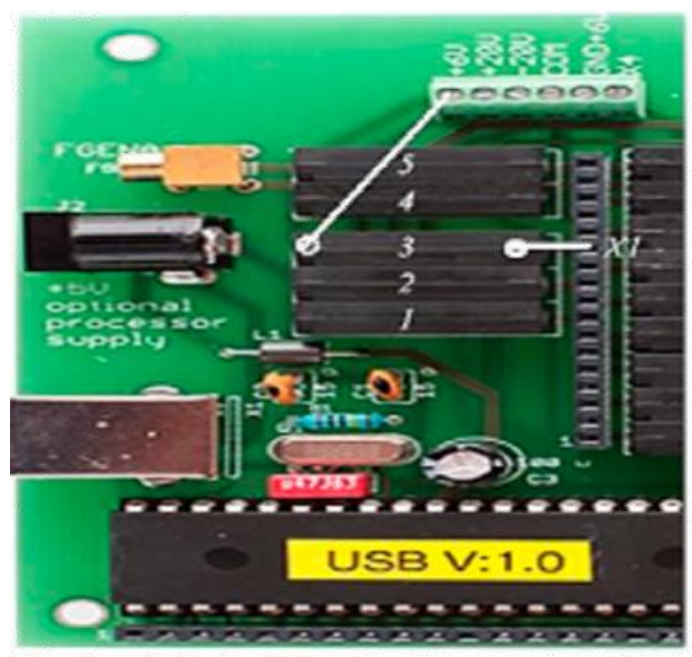




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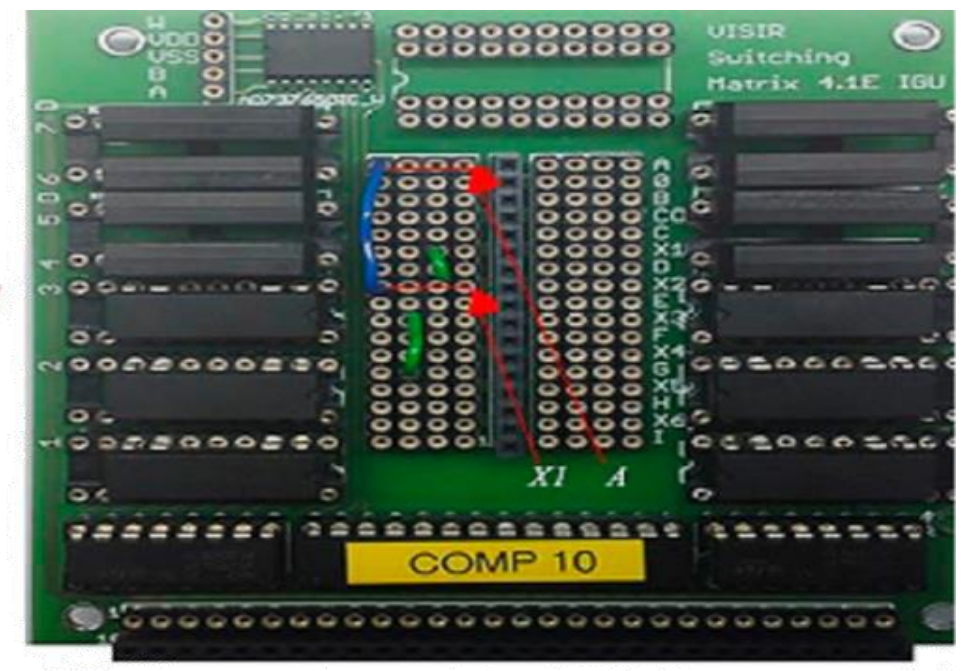


- Shortcut wires connecting the (X1-X3) nodes to the nodes of the first group (the node COM is hardwired to the node 0). For example, the internal connection of the 6V DC power source which will be described in the component list as “VDC+6V\_24\_3 A”.



Source Board

VDC+6V\_24\_3 A

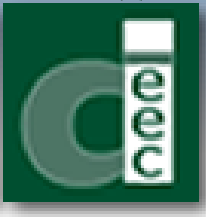


Component board

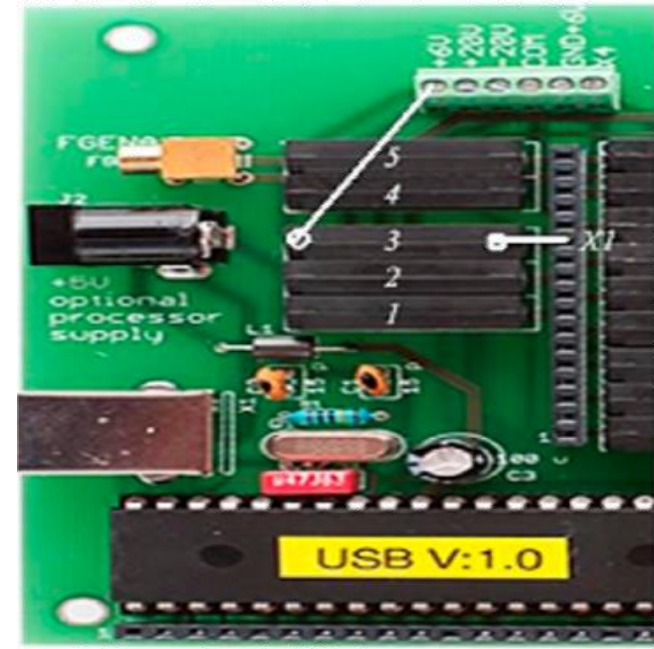




# MATRIZ

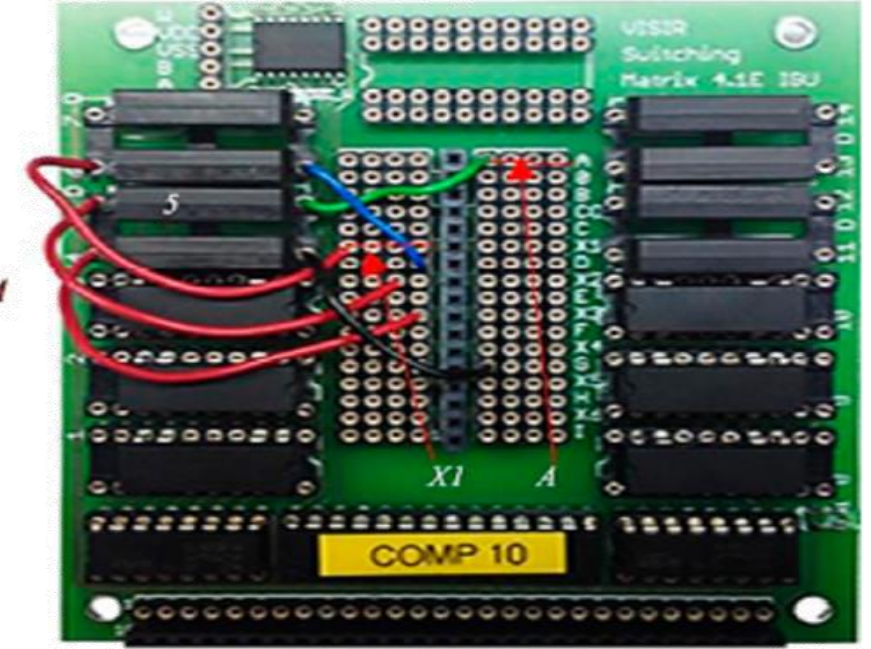


Single pole relays on a component board. For example, figure shows the internal connection of the 6V DC power source, which will be described in the component board as “VDC+6V\_24\_3:10\_5 A”.



Source Board

Relay 5 on component board 10  
VDC+6V\_24\_3:10\_5 A  
Relay 3 on source board 24



Component board







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# MEASUREMENT SERVER



Measureserver 4.0.2051 (svn 494)

File Help

Circuit checksum: b752232a71e503329536a27171a8a139

Matching maxlist: /maxlists/General.max

Solved list is:

VFGENA\_FGENA1 A 0 max: 5

SHORTCUT\_2\_2 A E max: 6 imax: 0.5

D\_5\_3 E F VDCCOM\_24\_2 0

SHORTCUT\_1\_9 G 0

R\_4\_5 F G 3K

PROBE1\_1 A

PROBE2\_2 F

Circuit checksum: b752232a71e503329536a27171a8a139

Matching maxlist: /maxlists/General.max

Solved list is:

VFGENA\_FGENA1 A 0

SHORTCUT\_2\_2 A E

D\_5\_3 E F 1N4007

SHORTCUT\_1\_9 G 0

R\_4\_5 F G 3K

PROBE1\_1 A

PROBE2\_2 F

Handled:30616 Total clients: 49 Active: 0 Current: 0

1. Receives a request from the user.

2. Checks if the user is authenticated correctly (by means of a cookie).

3. If the user is correctly authenticated, generates a file with the circuit connections (\*.cir).

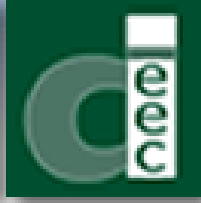
4. Compares the file .cir to the available maxlists.

5. If it finds a maxlist in which the design is possible, translate the request to the equipment server.





# MEASUREMENT SERVER



The measurement server is a software application written for Microsoft Windows in Microsoft Visual C++.

It receives the measurement requests from the experiment client in separate TCP sessions and through the port 2324.

connection and disconnection are required for every request made to the server.







# MEASUREMENT SERVER



The role of the measurement server can be defined in the following steps:

**Authentication:** at each request, it verifies that the client is a valid user by validating the client cookie generated by the Web server with the database.

**Verification:** it acts as a virtual instructor and compares the received circuit data with the “max lists” before sending it to be executed on the real instruments, to avoid hazardous circuits or any damage that may be caused to the real instruments.

**Queuing:** it can handle requests from simultaneous clients by queuing all the simultaneous requests and performing them sequentially with regard to the priority, reservation, etc.

**Proxy server:** after validating and queuing the requests, it starts to send the requests sequentially in separate TCP sessions over TCP/IP through the port 5001 to the “equipment server”.





# MEASUREMENT SERVER

## maxlists



- The maxlists are lists that describe all safe circuits that could be created and prevent hazardous circuits from being activated  $\Rightarrow$  It is only possible to activate circuits that are safe according to a defined maxlist.
- The “maxlists” are created by the teacher to define the permitted values of the components and the instruments in a certain experiment. This enables the teacher to be the sole person responsible for any damage.
- The “max lists” of all the available experiments are inserted inside the folder of the measurement server software.
- The max list of an experiment determines which connections are allowed in an experiment and it describes also how they can be connected to other listed sources or components if appropriate relay switches are closed





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# MEASUREMENT SERVER

## maxlists

VDC+25V_4	B	max:20	imax:0.5	VFGENA_FGENA1	A 0	max:5
VDCCOM_24_2		0		VDC+6V_3	D	max:6 imax:0.5
				VDCCOM_24_2	0	
R_5_3	B C	1K		SHORTCUT_8_12	F 0	
R_4_3	B C	470-9W		R_2_8	E F 3K01	
SHORTCUT_1_12	C D			SHORTCUT_5_14	A D	
SHORTCUT_3_11	D E			SHORTCUT_1_12	C D	
R_1_10	E F	1K		D_3_1	C E	1N4007A
R_2_9	E F	10K		SHORTCUT_2_5	B C	
R_2_8	E F	3K01		D_3_8	C E	BAT42
SHORTCUT_8_12	F 0			SHORTCUT_6_12	A F	
SHORTCUT_8_9	E H					
R_3_6	H I	100K				
SHORTCUT_2_4	I 0					





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# EQUIPMENT SERVER

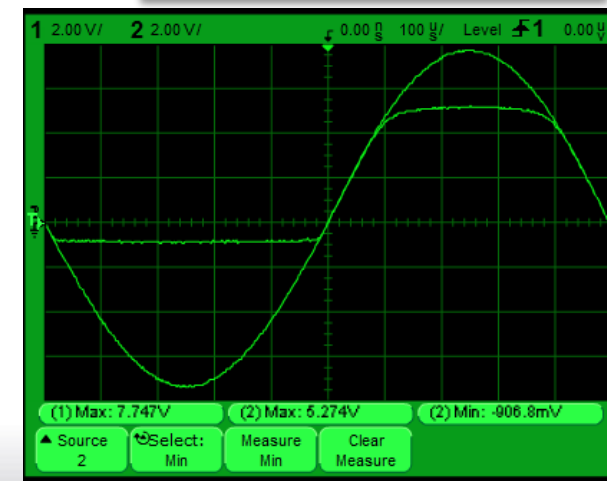


- The equipment server software is installed in the NI PXI-controller. It is a software application for instrumentation control developed by LabVIEW.



- The equipment server software receives validated sequential experiment protocol requests from the measurement server in separate TCP sessions over TCP/IP and it executes it through the connected instruments.

```
<functiongenerator>
<fg_waveform value="sine" />
<fg_amplitude value="1000.0" />
<fg_frequency value="1000.0" />
<fg_offset value="0.0" />
<fg_startphase value="0.0" />
<fg_triggermode value="continuous" />
<fg_triggersource value="immediate" />
<fg_burstcount value="0" />
<fg_dutycycle value="0.5" />
<fg_userdefinedwave length="20" encoding="BASE64">ABCD1234ABCD1234ABCD
</fg_userdefinedwave>
</functiongenerator>
```



- The results return back to the client PC-screen with the same sequence. The results are represented in the form of measurements on the virtual instrument interfaces.



# EQUIPMENT SERVER Experiment Protocol



The experiment protocol is an Extensible Markup Language (XML)-based protocol, which uses either XML Socket or HTTP (the current configuration) over the TCP/IP model to transport the requested data to the “measurement server”.

The experiment protocol describes which settings and functions each instrument type can perform, independent of hardware manufacturer, thus it is possible to select an instrument simulated interface independently of the manufacturer, and also to create new interfaces of instruments that do not exist in the current set.





# EQUIPMENT SERVER Experiment Protocol

## REQUEST

### Digital multimeter settings

<multimeter id="1">

<dmm\_function value="ac volts"></dmm\_function>

<dmm\_resolution value="3.5"></dmm\_resolution>

<dmm\_range value="-1"></dmm\_range>

<dmm\_autozero value="1"></dmm\_autozero>

</multimeter>



# EQUIPMENT SERVER Experiment Protocol

## REQUEST

### Function generator settings

```
<functiongenerator id="1">
```

```
<fg_waveform value="sine"> </fg_waveform>
```

```
<fg_frequency value="1000"> </fg_frequency>
```

```
<fg_amplitude value="0.5"> </fg_amplitude>
```

```
<fg_offset value="0"> </fg_offset>
```

```
</functiongenerator>
```





# EQUIPMENT SERVER Experiment Protocol

## REQUEST

### DC Power settings

```
<dcpower id="1">  
  <dc_outputs>  
    <dc_output channel="6V+">  
      <dc_voltage value="0"></dc_voltage>  
      <dc_current value="0.5"></dc_current>  
    </dc_output>  
    <dc_output channel="25V+"> ... </dc_output>  
    <dc_output channel="25V-"> ... </dc_output>  
  </dc_outputs>  
</dcpower>
```





# EQUIPMENT SERVER Experiment Protocol

## REQUEST

### Oscilloscope settings

```
<oscilloscope id="1">  
  <horizontal> ... </horizontal>  
  <channels> ... </channels>  
  <trigger> ... </trigger>  
  <measurements> ... </measurements>  
</oscilloscope>
```





# EQUIPMENT SERVER Experiment Protocol

## RESPONSE

### Digital multimeter settings

```
<multimeter id="1">  
  <dmm_function value="dc volts"/>  
  <dmm_resolution value="3.5"/>  
  <dmm_range value="-1.000000e+000"/>  
  <dmm_result value="7.956630e+000"/>  
</multimeter>
```



# EQUIPMENT SERVER componentlist



- The ***componentlist*** describes all the installed components and instruments in the matrix to make them known to the software. There is only one componentlist per switching matrix.
- The ***componentlist*** of all the available experiments are inserted inside the folder of the equipment server software.
- The max list format is:

<Component type>\_<board label>\_<relay number> <Node1>< Node2> <etc.> <Name>







# EQUIPMENT SERVER componentlist



- <Component type>\_<board label>\_<relay number> <Node1>< Node2> <etc.> <Name>
- **R\_2\_1 IH 10K** : represents a resistor of 10K ohms is installed on the relay 1 and connected to the nodes (I, H) in the board 2.
  - **SHORTCUT\_2\_3 HG**: represents a shortcut is installed on the relay 3 and connected to the nodes (H, G) in the board 2.
  - **C\_2\_4 AB 10n**: represents a capacitor of 10n farad is installed on the relay 4 and connected to the nodes (A, B) in the board 2.
  - **R\_1\_1:8\_10 E F 10k**: means that, by activating rely 1 on board 1 and rely 10 on board 8 a resistor with the value of 10k ohms are going to be connected between node E and F.



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# Preguntas?

