

TEACHER'S GUIDE TO THE VISIR ONLINE LABORATORY FOR ELECTRICAL EXPERIMENTS

If you teach a course with experiment sessions and want to introduce them in a VISIR online laboratory for electrical experiments, you have to do some administrative work. To do this you need the instruction manuals of the experiment sessions of the course. Each one of them should include at least the schematics of all the experiment circuits of the session and a list of the components of the set of components to be used. If you are not familiar with a VISIR laboratory, refer to the student's guide for an introduction. The VISIR online laboratory for electrical experiments is intended to be a replica of a hands-on laboratory at BTH and is adapted to its procedures. Appendix A presents traditional hands-on laboratory instruction from a Swedish perspective.

The laboratory staff and the teachers create the rules of the Virtual Instructor together. These rules are associated with the online component store, which comprises at least the components of all the component sets of the experiment sessions of the courses so far introduced in the laboratory. **You must check that all your experiment circuits comply with the Virtual Instructor rules.** The rules are explained in the next session. Laboratory session administration is described in section 2. Restrictions and known errors are listed in section 3.

1. A short introduction to the Virtual Instructor rules

The purpose of the Virtual Instructor rules is preventing hazardous circuits from being activated. The rules are a number of net lists so called Max Lists describing all safe circuits. Circuits described by subsets of a Max List are also safe. It is only possible to activate circuits that are safe according to a Max List installed in the laboratory. Of course, the Max Lists must only contain components that are present in the online component store i.e. are installed in the switching matrix that is described in Appendix B. The Max Lists may not list all safe circuit possible to create using the components of the store. Especially if the number of components is great, it is not likely that all circuits possible to create can be found in the Max Lists. The laboratory staff and the teachers create new Max Lists when needed. For each experiment you want to introduce, you must check that you can find your circuit in any of the Max Lists. If not you must discuss your circuit with the laboratory staff. A new Max List and/or new components may be required.

Max Lists

A Virtual Instructor rule is a net list called Max List defining a safe circuit. Each list lists a number of sources and components and it describes also how they can be connected to other listed sources or components if appropriate relay switches are closed. The maximum output allowed of each source is specified as well. Appendix C contains all Max Lists defined for the current matrix configuration at BTH. Appendix B intro-

duces matrix nodes and how they are related to circuit nodes. The format of an entry in a Max List is:

<Type>_<serial number> <array of nodes> <value>

For example, the entry FGENA_FGEN1 A 0 max: 5 means that the Virtual Instructor allows function generator FGEN1 to be connected to the matrix nodes A and 0 and that the maximum output allowed is 5 V. For an IC circuit the <array of nodes> is an array of pins in pin number order starting with pin 1. NC means pin not connected. A SHORTCUT¹ found in most of the lists is effectively a jumper lead i.e. a zero ohm resistor. Physically it is a single relay switch. Jumper leads are used to connect two matrix nodes.

You and your students are only permitted to activate circuits where all components and sources of each circuit are listed in one of the Max Lists. Please note that it is not enough that the <value> is correct the <array of nodes> must be correct too. Examples of allowed circuits are given in the next subsection. There is no need to include the DMM set as voltage meter and the oscilloscope in the max lists because they are high impedance and do not affect the circuit so much. You are free to connect these instruments to any node A – I and 0. However, the DMM set as current meter is low impedance and is only allowed to replace a jumper lead. The DMM set as R, L or C meter is a special case where the instrument acts as a source.

Examples of circuits permitted to be created in the BTH online laboratory

Suppose you want to see if you are allowed to create the circuit in Fig. 1 in the VISIR laboratory for electrical experiments at BTH. Its Virtual Instructor rules are listed in Appendix C. The function generator can only be connected between the matrix nodes A and 0. The letters A – I and 0 denotes matrix nodes. The generator is listed in, for example, the Max List Op.max in Appendix C. So are the 1 k Ω resistor possible to be connected between the matrix nodes A and B and the 10 k Ω resistor possible to be connected between the nodes 0 and B. The DMM set as voltage meter can be connected to any two nodes. Thus, the Max List Op.max allows the circuit in Fig. 1 to be activated. Thus it should be safe.

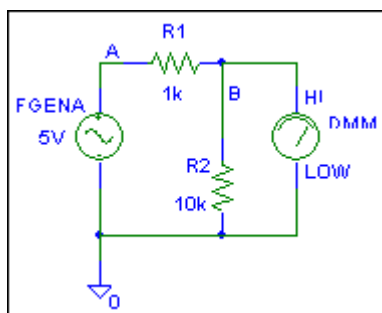


Figure 1. A simple circuit

A second example, a non-inverting operational amplifier circuit, is shown in Fig. 2. It illustrates how to use a jumper lead. For example, a jumper lead is required to connect

¹ SHORTCUT is a bad translation from Swedish and should be replaced by JUMPER_LEAD.

the matrix nodes A and D i.e. the function generator output and pin three of the operational amplifier. This jumper-lead allows the wire from the function generator to pin three of the operational amplifier in Fig. 3 etc. All the elements of the circuit shown in Fig. 2 and wired on the virtual breadboard in Fig. 3 are listed in the Max List Op.max. Thus, the circuit in Fig. 3 can be activated. The oscilloscope connection in Fig. 3 is omitted in Fig. 2.

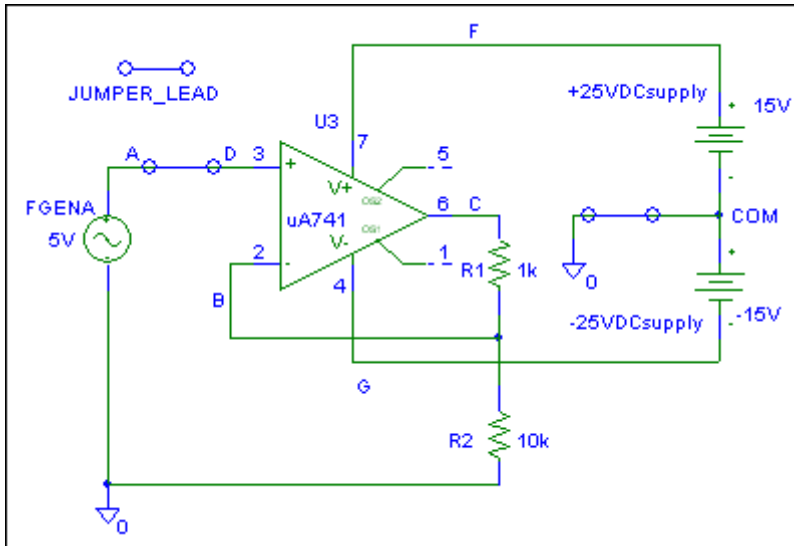


Figure 2. Non-inverting operational amplifier circuit

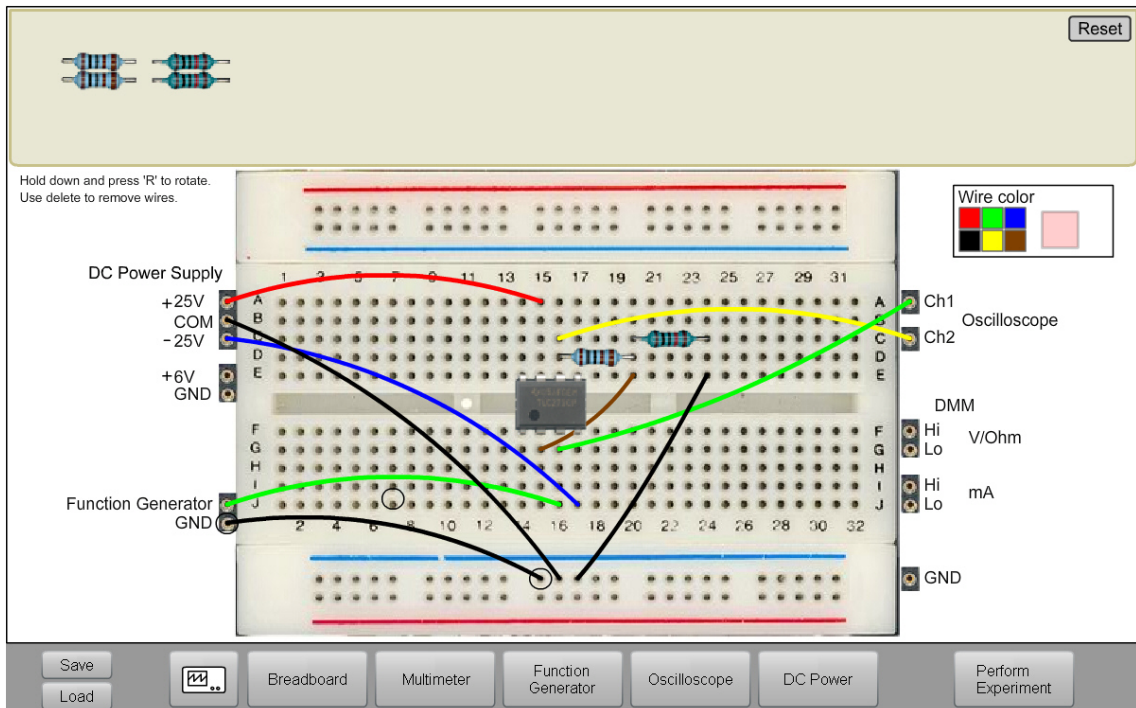


Figure 3. Operational amplifier circuit wired on the virtual breadboard

A third example in Fig. 10 shows a circuit where it is possible to measure current with the DMM. Jumper leads must be introduced to enable current measurement because an amp.-meter must only replace a jumper lead. The source, the components and the jum-

per leads with the specified connection in Fig. 4 are listed in the Max List Figure20.max.

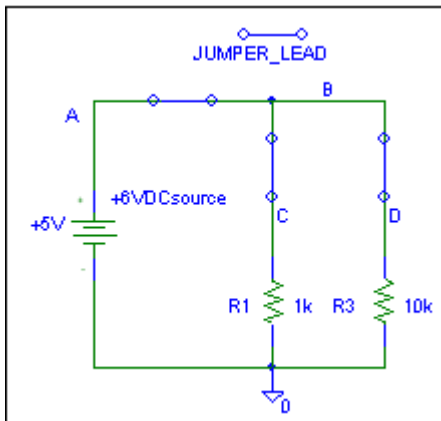


Figure 4. Preparations for current measurement with the DMM

2. Laboratory session administration

You need a teachers account to use the laboratory. To create an account the VISIR laboratory administrator needs to know the email address you want to use as login id. If you only want to be registered as a teacher of a course already existing in the laboratory the administrator needs to know the notation of the course in the laboratory. If your course is new to the laboratory the administrator needs the following information about it:

1. The name of the course i.e. the notation you want the students to see.
2. Start and end date of the course.
3. Maximum number of students to be registered in the course.

The URL of the online workbench at BTH is <http://openlabs.bth.se/electronics/>. The first time you visit, you must activate your account. In Fig. 5, a user is logged in as a teacher. You can see the courses for which the user is registered as a teacher.

Select the course you want to administer in your course list under the heading TEACHER. Now you will see your course page, which should look like the page in Fig. 6. Here you can add Experiment sessions (prepared experiments), make time reservations for the sessions, and add accounts for students who are enrolled in the course.

Adding a experiment session (prepared experiment)

To add a prepared experiment i.e. a set of components, click "Add prepared experiment" in the course view. Fig. 7 shows the dialog to add prepared experiments. You must first start the client in teacher mode by clicking the link at the top. In this mode, it is possible to select components from the Component Library, which contains a photo and a description of every component defined for the VISIR platform. Thus, the component Library defines more components than are available in the online component store. The Component Library is a part of the VISIR open source distribution. You can display the component library by pressing the plus (+) sign in the lower right corner of the box for

components in Fig. 8. By clicking on a component in the component library, it will appear in the component box. Add all the components listed in the bill of materials of your laboratory instruction manual. Close the component library by pressing the close button. Now you can add a wiring on the breadboard if you want. If you want to change the default instruments displayed, press the button with the instrument symbol and pick the instruments you would like to be presented as default. After the setup is complete, press the save button to save your setup. Enter the filename and location of where you want to save your file. The details of this procedure are described in the Student's Guide. Then, return to the webpage displayed in fig. 7. Choose a name of your prepared experiment and pick the file you have just saved. Finally, press the "Add" button to upload and add the prepared experiment to the system.

Time reservations for supervised laboratory sessions

Click "Make a teacher scheduled reservation" in Fig. 6 to make a time reservation for a supervised laboratory session. Each session accommodates up to sixteen students.

Accounts for students

Add students by listing their email addresses in the "Users" section at the bottom section of the course page in Fig. 6. All students listed in that section are permitted to perform the experiments listed in the "Prepared experiments" section.

OpenLabs Electronics Laboratory

[Logout](#)

MAIN MENU

- Start
- About
- Demo
- FAQ

TEACHER

- Circuit Analysis (ET1107)
- Guest Course

STUDENT

- Circuit Analysis (ET1107)
- Guest Course

Courses		
Name	Start	End
Circuit Analysis (ET1107)	2009-08-18	2009-12-31
Guest Course	2001-01-01	2020-01-01

If you have any questions about this page or the laboratory, contact the [administrator](#).

Figure 5. Teacher's course list

OpenLabs Electronics Laboratory

Logout

MAIN MENU


- Start
- About
- Demo
- FAQ

TEACHER

- Circuit Analysis (ET1107)
- Guest Course

STUDENT

- Circuit Analysis (ET1107)
- Guest Course



Circuit Analysis (ET1107)

Start 2009-08-18

End 2009-12-31

Max Users 10

Max Seats 16

LMS link [Copy this](#)

Prepared experiments

Name	
DC experiments	✘
Transients	✘
AC Experiments	✘
Black Box	✘

[Add prepared experiment](#)

Reservations

[Make teacher scheduled reservation](#)

Users

E-Mail	User Type	Activated	Enabled	
ingvar.gustavsson@ser.se	Student	•	•	✘
ingvar.gustavsson@bth.se	Teacher	•	•	✘

E-Mail

Separate multiple users by newline

User Type

If you have any questions about this page or the laboratory, contact the [administrator](#).

Figure 6. Teacher's course page

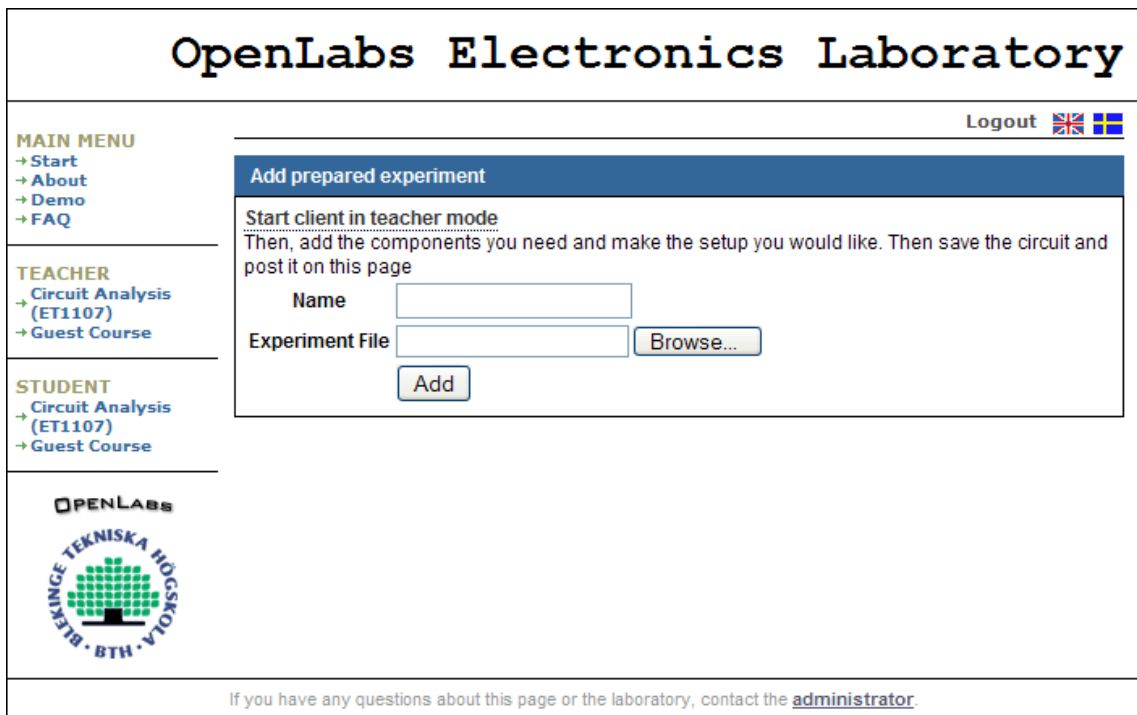


Figure 7. Add a prepared experiment

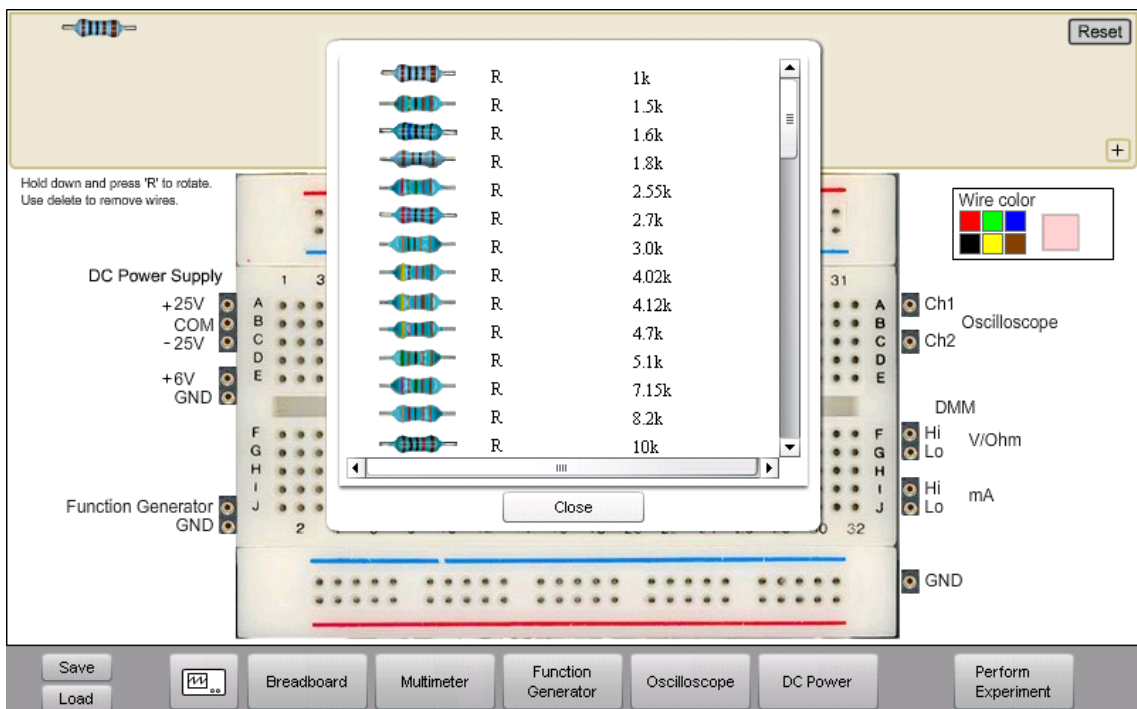


Figure 8. Add components

3. Restrictions and known errors

1. SHORTCUT should be replaced by JUMPER_LEAD.
2. A source or a measuring instrument has two terminals. However, in the current Max List format each DC Power Supply has only one, for example:

```
VDC+25V_1    F      vmax:15 imax:0.5
VDC-25V_2    G      vmax:-15 imax:0.5
```

The COM terminal is listed as a separate entry:

```
VDCCOM_1     0
```

In a future release the format will be:

```
VDC+25V_1    F COM  vmax:15 imax:0.5
VDC-25V_2    G COM  vmax:-15 imax:0.5
JUMPER_LEAD  1 COM  0
```

As already shown in Fig. 2 and

```
VDC+6V_1     A 0      vmax:5
```

3. New notations of the DC Power Supplies not including a range should be introduced.

Appendix A. Laboratory education organization

This Appendix explains terms and procedures used in a hands-on laboratory in electrical engineering education at BTH. Significant terms are italicized. Engineering is a practical discipline, and many courses in engineering education include practical *experiment sessions* in hands-on instructional laboratories supervised by *laboratory instructors*. Most such laboratories for electrical experiments contain a number of identical *workbenches* and a *component store*. Before a student is permitted to enter a laboratory for the first time, the student has to learn the safety rules of the laboratory and pass a test in order to be aware of the risk of being hurt or of damaging the expensive instruments. Usually, two students share one workbench and perform experiments together. Hands-on laboratories are generally open only during supervised sessions when an instructor is present, and such sessions are only three or four hours. No other opportunities for hands-on experimenting are provided, at least not for novices.

In each experiment session in electronics, the students perform a number of experiments that usually cover a particular part of the course, for example, all will be experiments on DC circuits. The experiments of a session are described in an *instruction manual*. A *set of components* to be used by the students to create the circuits described is also listed in the manual. The instructor collects as many component sets from the component store as there are workbenches in the laboratory and puts one set on each workbench before she starts an experiment session. The administration of experiment sessions, e.g., time reservation and links to the instruction manuals, is included in a Learning Management System (LMS).

During an experiment session, the students wire each circuit described in the manual on a solderless breadboard and connect the instruments. However, before they are allowed to switch on the power source, the instructor checks that the circuit wired is harmless. Instruments or components must not be damaged, but if the instructor makes a mistake and a component is destroyed, she can easily provide a new one. After the instructor has approved a circuit and the students have activated the sources, the circuit will reach steady state before the students read the instruments because the students are acting in human time. The students perform the experiments prescribed and make notes of their observations in a laboratory report.

The fact that the component store of a VISIR laboratory is online offers new possibilities not available in the hands-on one. It is possible to skip the sets of components displayed in the component box and allow the students to pick components directly from the component library. Then the administration of experiment sessions (prepared experiments) and of sets of components will not be necessary. However, it would be necessary for the student either to have the Max Lists or a schematic of the experiment circuit to avoid frequent error messages from the Virtual Instructor.

Appendix B. A short introduction to the relay switching matrix

The switching matrix is a stack of printed circuit boards. Three types of boards are defined so far; one for connecting sources, one for connecting measuring instruments and one for carrying components or for connecting external test circuits. A matrix with four boards is shown in Fig. B1. The bottom board is a source board. It has inputs for a triple power supply and a function generator. The two instrument boards in the middle are configured for connecting a low frequency instrument such as a multi-meter and for connecting a high frequency one such as a dual channel oscilloscope. The component board on the top carries sockets where components can be installed. One component board can carry 10 components with two leads or as many components with more than two leads as can be installed in the onboard 20 pin IC socket. By adding more component boards, more components can be online.

Two stacking connectors connect the boards. One of them propagates so-called matrix nodes to every board. The notation “node” refers to the fact that each conductor created by these stacked node connectors can be a node in a desired circuit. This three dimensional arrangement where the relay switches are embedded in the desired circuit limits the length of the “wires” of the circuit compared to an arrangement with separate switch modules. A compact circuit means higher bandwidth.

The matrix nodes are denoted $A - I$ and 0 . Each lead or pin of each component installed in the matrix can only be connected to a certain matrix node via a relay switch. A software module, *Circuit Solver*, maps each node of a circuit wired on the virtual breadboard to a matrix node.

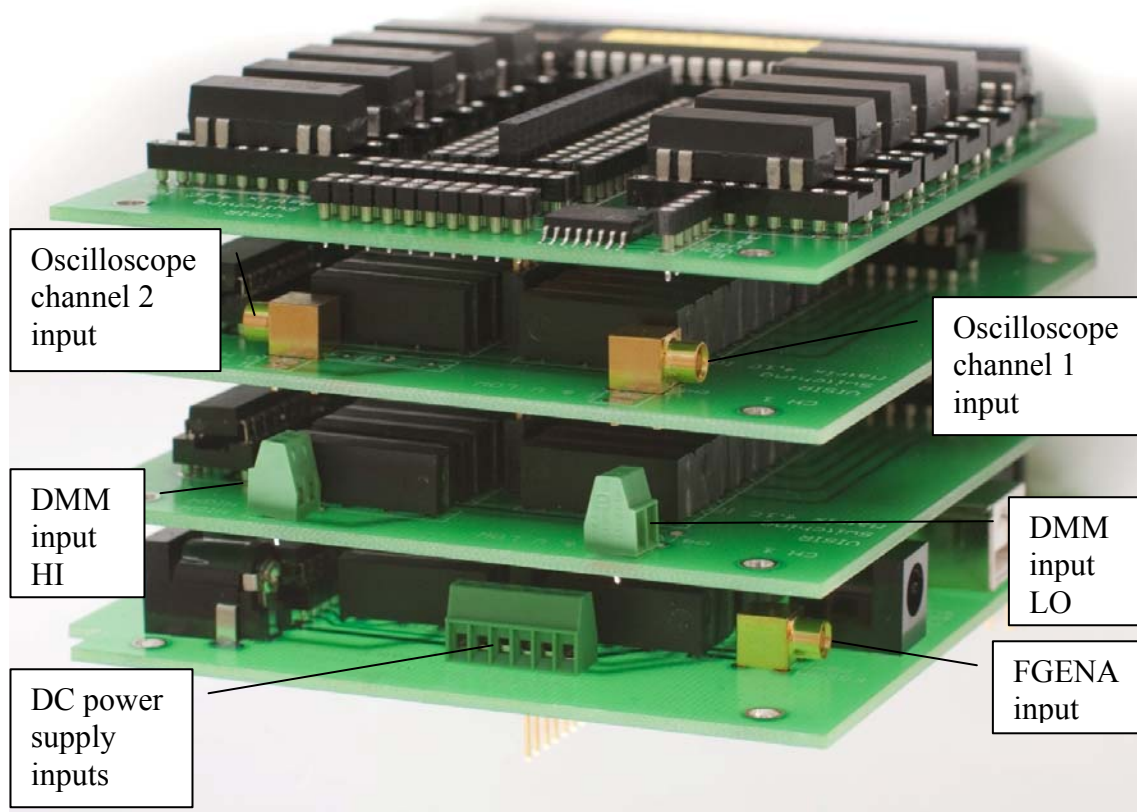


Figure B.1. Matrix with four boards

Appendix C. Max Lists

These are the Max Lists of the online workbench that is used in regular education at BTH.

Blackbox.max

```
VFGENA_FGENA1      A 0
BLACKBOX_BLACKBOX1 0 A C
```

Figure18.max

```
VDC+6V_1           A          VMAX: 5
VDC+25V_2          D          VMAX: 5
VDCCOM_1           0
```

```
*0-A
SHORTCUT_1         0 A
*5VA_7_1           A 0
```

```
*A-B
R_2                A B  1.6k
R_3                A B  1k
R_1                A B  10k
C_3                A B  56n
```

```
*0-B
```

```

R_5          0 B  2.7k
R_4          0 B   1k
R_6          0 B  10k
C_1          0 B  56n

*B-C
R_9          B C  10k
R_8          B C  2.7k
R_7          B C   1k

*0-C
R_10         0 C   1k
R_11         0 C  10k
C_2          0 C  56n
L_3          0 C  82m

*C-D
R_12         C D   1k

*0-D
R_13         C D  2.7k
R_14         C D  10k
SHORTCUT_2_1 0 D
*5VB_7_4     D  0

```

Figure20.max

```

VDC+6V_1     A          VMAX:5

*0-A
VFGENA_FGENA1 A 0 max:5
SHORTCUT_1   0 A
*5VA_1       A  0

*A-B
SHORTCUT_2   A B
R_1          A B  10k
R_2          A B  1.6k
R_3          A B   1k
C_3          A B  56n

*0-B
R_4          0 B   1k
R_5          0 B  2.7k
R_6          0 B  10k
C_1          0 B  56n

*B-C
SHORTCUT_3   B C
R_9          B C  10k
R_8          B C  2.7k
R_7          B C   1k

*B-D
SHORTCUT_4   B D

*0-C
R_10         0 C   1k
R_11         0 C  10k
C_2          0 C  56n

*C-D
R_12         C D   1k

*0-D
R_13         0 D  2.7k
R_14         0 D  10k

```

Figure21.max

```

VDC+6V_1     A          VMAX:5

*0-A
SHORTCUT_1   0 A

```

```

*5VA_1          A 0

*A-B
R_1            A B 10k
R_2            A B 1.6k
R_3            A B 1k
C_3            A B 56n

*0-B
R_4            0 B 1k
R_5            0 B 2.7k
R_6            0 B 10k
C_1            0 B 56n

*B-C
SHORTCUT_3     B C
R_9            B C 10k
R_8            B C 2.7k
R_7            B C 1k

*B-D
SHORTCUT_4     B D

*0-C
R_10           0 C 1k
R_11           0 C 10k
C_2            0 C 56n
L_3            0 C 82m

*C-D
R_12           C D 1k

*0-D
R_13           C D 2.7k
R_14           C D 10k

```

Figure22.max

```

VDC+6V_1      A          VMAX:5

*0-A
VFGENA_FGENA_1 A 0 max:5
SHORTCUT_1     0 A
*5VA_1        A 0

*A-B
R_1            A B 10k
R_2            A B 1.6k
R_3            A B 1k
C_3            A B 56n

*0-B
SHORTCUT_2     0 B
R_4            0 B 1k
R_5            0 B 2.7k
R_6            0 B 10k
C_1            0 B 56n

*B-C
SHORTCUT_3     B C
R_9            B C 10k
R_8            B C 2.7k
R_7            B C 1k

*B-D
SHORTCUT_4     B D

*0-C
R_10           0 C 1k
R_11           0 C 10k
C_2            0 C 56n

*C-D
R_12           C D 1k

*0-D

```

R_13	C D	2.7k
R_14	C D	10k
SHORTCUT_5	0 D	

Lab1_4.max

SHORTCUT_S2	B D	
R_R13	0 D	2.7K
R_R14	0 D	10K
SHORTCUT_S1	A B	
R_R4	0 B	1K
*5VA_5VA	A 0	
VDC+6V_1	A	VMAX:5

Laboration2.max

VFGENA_1	A 0	
*5VA_DCA1	A 0	
VDC+6V_1	A	VMAX:5
R_R3	A B	10k
R_R6	0 B	10k
C_C1	A B	56n
L_L1	0 C	82m
XSWITCHOPEN_1	A B	
XSWITCHOPEN_2	B C	

Op.max

VFGENA_FGENA1	A 0	max:5
VDC+25V_1	F	vmax:15 imax:0.5
VDC-25V_2	G	vmax:-15 imax:0.5
VDCCOM_1	0	
OP_1	NC1 B D G NC2 C F NC3	ua741
R_R1	A B	1k
R_R2	A B	1.6k
R_R3	A B	10k
R_R4	B C	1k
R_R5	B C	1.6k
R_R6	B C	10k
R_R7	0 B	1k
R_R8	0 B	10k
SHORTCUT_S1	A B	
SHORTCUT_S2	A D	
SHORTCUT_S3	B C	
SHORTCUT_S4	0 D	
SHORTCUT_S5	0 C	
SHORTCUT_S6	0 B	

Zetatest.max

*5VA_DCA1	A 0	
VDC+6V_1	A	VMAX:5
R_R10	0 C	1k
R_R13	0 D	2.7k
R_R14	0 D	10k
SHORTCUT_S1	A B	
SHORTCUT_S3	B C	
SHORTCUT_S5	B D	