

Next Generation Lab

A solution for remote characterization of
analog integrated circuits

Outline

- Background
- Goals
- Technologies
- Physical architecture
- Software architecture
- Conclusion

Background

- Based on work done in the field of remote laboratories at Norwegian University of Science and Technology and Rensselaer Polytechnic Institute (NY)
- Previous laboratories are dedicated to device characterization
- Bringing the remote laboratory to the circuit level

NGL Goals

- To provide a remote laboratory course for education in design of analog integrated circuits at our department.
- To create a platform for circuit experiments where it is easy to add new experiments.
- To create a prototype experiment that measures frequency response of operational amplifiers that have been designed by students.

Available Technologies

- Server-side:
 - PHP: Hypertext Preprocessor (PHP), Active Server Pages (ASP), Practical Extraction and Report language (PERL) , .NET Platform
- Instrument interface:
 - LabView, GPIB C libraries
- Graphical representation:
 - Bitmap, Java Applet, Scalable Vector Graphics (SVG) from Adobe

Choosing Technologies

- Main consideration: short development time
- Server-side (.NET Platform):
 - Explore a new technology
 - Promising features
 - Low learning threshold
- Instrument interface (C libraries):
 - Simple interfacing with .NET platform
- Graphical representation (SVG):
 - LAB-on-WEB

.NET Platform (1)

- New development technology from Microsoft
- Seamless integration between standard windows components and web applications
- Large class library
- Theoretically platform and language independent
- Supported by several languages. Visual Basic 7.0, Managed C++, C#, PERL and many more

.NET Platform (2)

- ASP.NET, successor to ASP
- ASP.NET features:
 - Separation of presentation and code
 - Pagelets: reusable ASP.NET code
 - WebControls: Custom tags, written in pure C# as a object
 - WebServices: application logic that is programmatically available, and can be exposed over the Internet.

C# - The Preferred Language

- New object-oriented language developed by Microsoft.
- Combines the power of C++ with low learning threshold.
- Garbage collection relieves the programmer from the burden of manual memory management.

Scalable Vector Graphics

- New graphics file format and web development language
- SVG features:
 - Not a proprietary standard
 - Zooming capabilities
 - Supports scripting
 - Based on XML, possible to manipulate SVG-files using standard API.
 - Small size

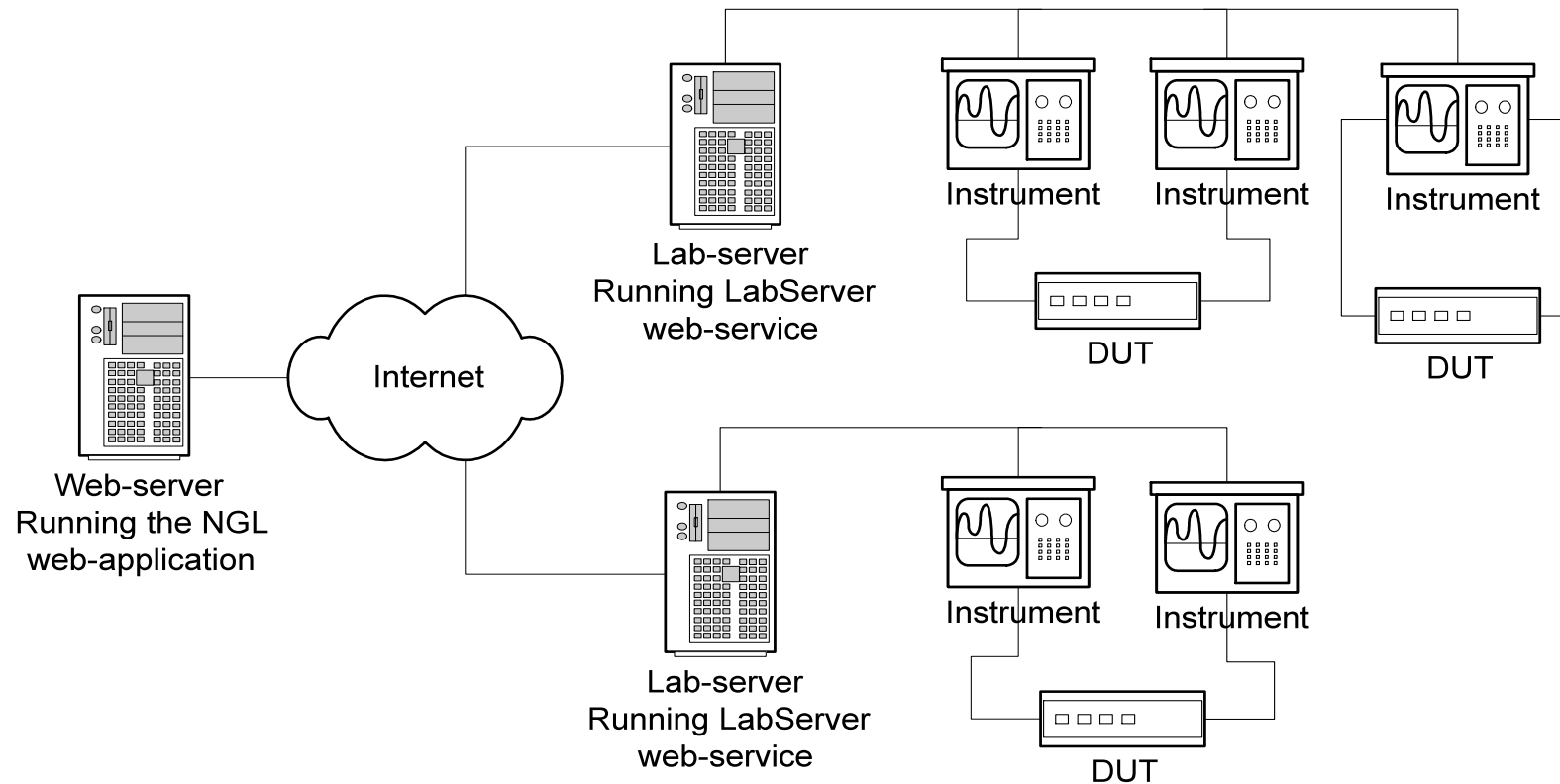
Other Technologies used

- Hypertext Markup Language (HTML)
 - Web pages
- Cascading Style Sheets (CSS)
 - Formatting of web pages
- JavaScript
 - Creating and controlling SVG output
 - Realtime feedback to user
- Extensible Markup Language (XML)
 - Internal application communication

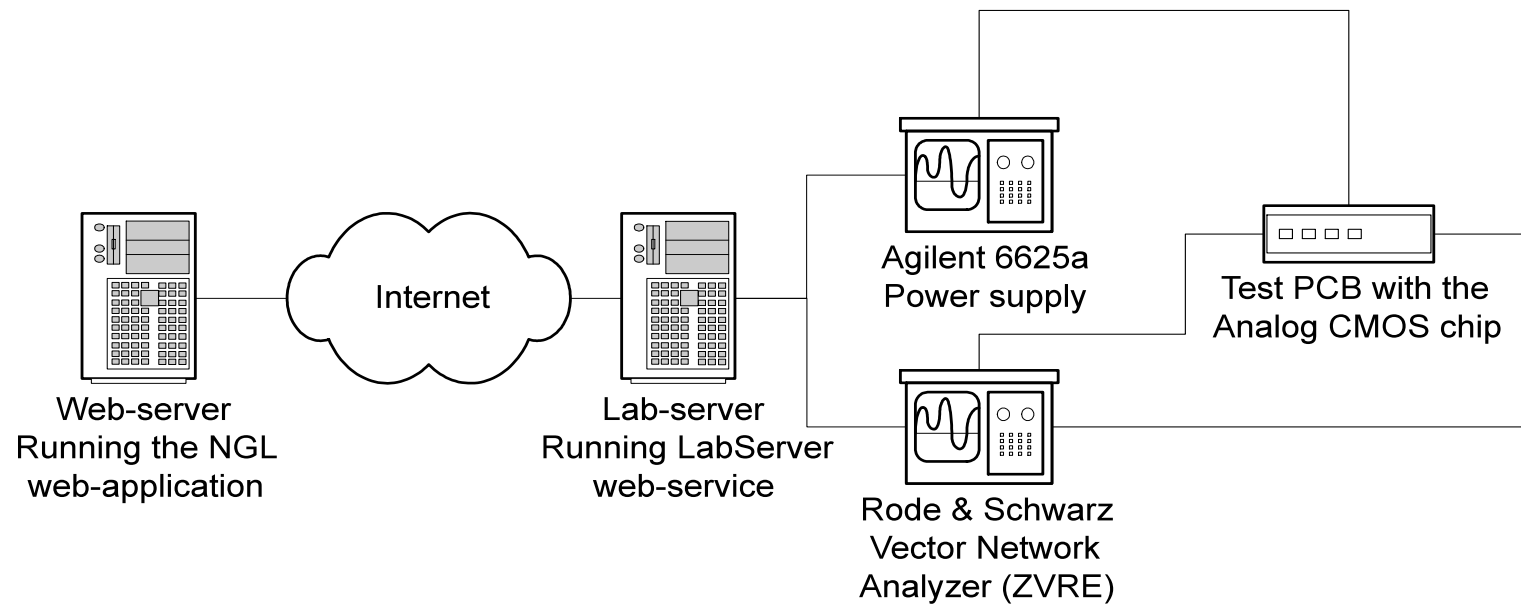
Physical Architecture (1)

- Main objectives:
 - Scalability
 - Ease of adding new experiment setups
- Keyword:
 - LabServer webservice: Interface to GPIB and DAQ (Data Acquisition) boards on the lab server

Physical Architecture (2)



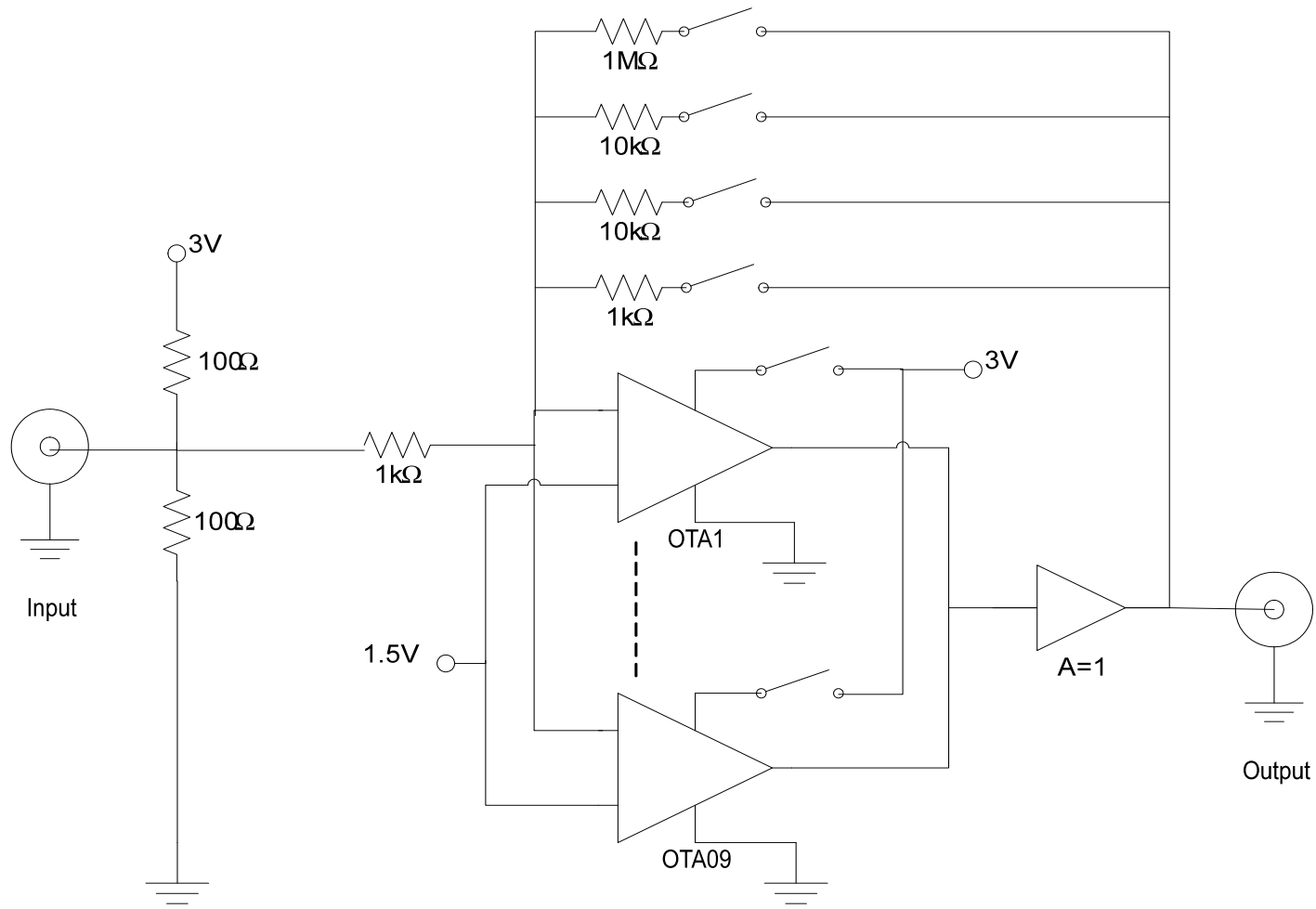
Physical Architecture (3)



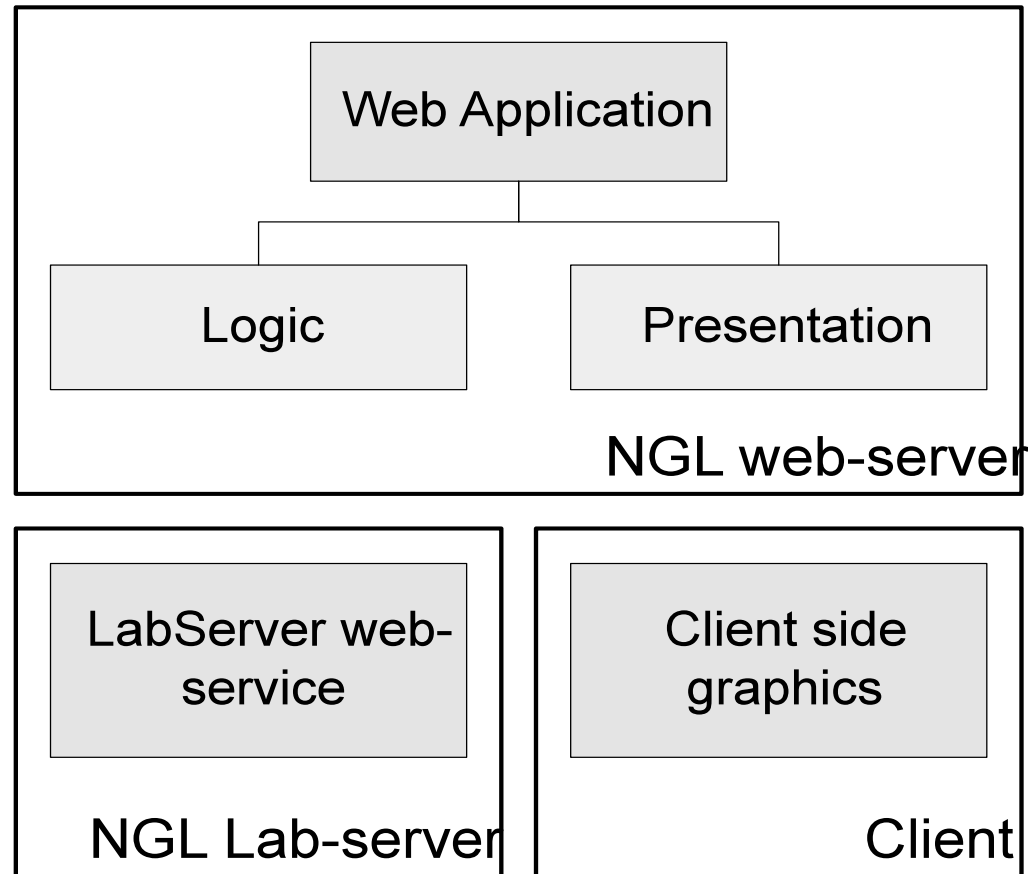
Test PCB (1)

- Analog CMOS ic containing 9 opamps created by students as project work
- Ability to select any of the 9 opamps for testing
- Ability to select 4 different resistors for controlling gain in a closed loop configuration
- Adjusting bias current to opamp
- Adjusting offset from common mode level at positive input

Test PCB (2)



Software Architecture (1)



Software Architecture (2)

- Server-Side:
 - Written in C#
 - Provides real-time feedback to the user
 - Provides a framework for new experiments
 - Controls running of experiments
 - All experiments are automatically available on the menu through the use of reflection

Software Architecture (3)

- LabServer webservice:
 - Written in a combination of Managed C++ and Unmanaged C++
 - Provides easy to use functions for accessing GPIB and DAQ boards
 - 250 lines of code

Software Architecture(4)

- Client-side graphics:
 - Server-side logic feeds data to a JavaScript which draws the plots
 - Handles logarithmic and linear values on x and y axis
 - Handles values between $1E-25$ and $1E27$
 - Auto scaling of values

Conclusion

- The NGL gives the users a reliable and efficient tool for analog CMOS integrated circuit experiments
- The NGL provides a framework for distributed experiments spanning wide geographical areas
- Choosing the .NET platform for development provides distributed architecture with no additional cost

NGL Front Page

.NGL

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Experiments

[AnCMOS_FreqRes](#)
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What is it?

Next Generation Lab is a prototype on using .NET technology from Microsoft to create an online laboratory. The intention is to provide students with access to commercial grade instruments through a web interface, and to give access to real time measurements of analog integrated circuits

News from NGL

NGL updated to .NET final (3/15/2002)
NGL has been upgraded to .NET final after running the .NET Beta 2 for 6 months.

Plots now work in Opera and Netscape (3/15/2002)
Any browser that supports JPG images can now (in theory) be used to run the experiments that produce a graphical plot.

New design (1/26/2002)
.NGL has had a makover to simplify navigation and improve visual satisfaction.

Experiments up again! (1/15/2002)
The network analyzer has new options and the experiments are back.

NGL still down (1/7/2002)
The Vector Network Analyzer we use to measure the frequency response is being refitted with some extra modules. Hopefully the lab will be online before february.

Analog CMOS lab is down for maintenace (11/29/2001)
The experiments AnCMOS Freq Res and AnCMOS All gain are down because of maintenance work on the test board. It is uncertain how long this will take. Sorry for any trouble that this may cause.

Pictures of NGL set-up (11/27/2001)
Pictures of the NGL lab set-up has been added, they can be displayed by selecting "Pictures" under "About".

NewsTicker added (11/27/2001)
A control for displaying news was added. It uses C# and ODBC to extract information from an MySQL database

webmaster: carsten@wulff.no Status: Department of Physical Electronics

NGL Frequency Response Measurement (1)

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Frequency Response of AnCMOS chip

Description:
Measures the magnitude and phase response of OpAMP's designed by Analog CMOS 1 class of 2000.

Input: 1k

OpAMP1

Output

1k

Offset: 0mV

Common mode:

Bias Current: 5uA

Get response

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NGL Frequency Response Measurement (2)

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Frequency Response of AnCMOS chip

Description:
Measures the magnitude and phase response of OpAMP's designed by Analog CMOS 1 class of 2000.

Input: 1k
Feedback: 10k
OpAMP: OpAMP1
Bias Current: 5uA
Offset: 0mV
Common mode: 5uA
Get response

Download Result

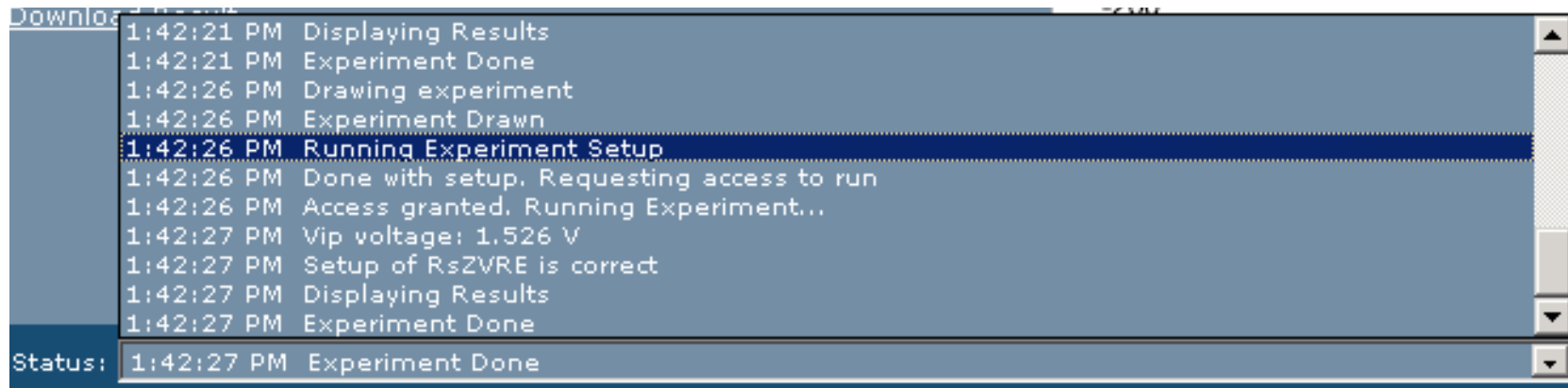
Frequency (Hz)	Magnitude (dB)
10k	15
100k	15
1M	15
10M	0
100MHz	-35

Frequency (Hz)	Phase (DEG)
10k	180
100k	180
1M	180
10M	90
100MHz	0

Stroke width Grid

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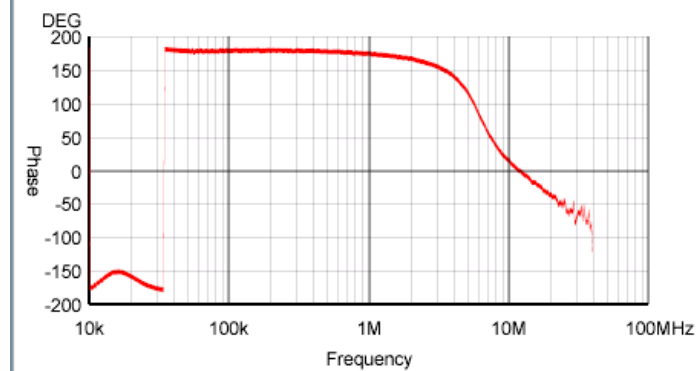
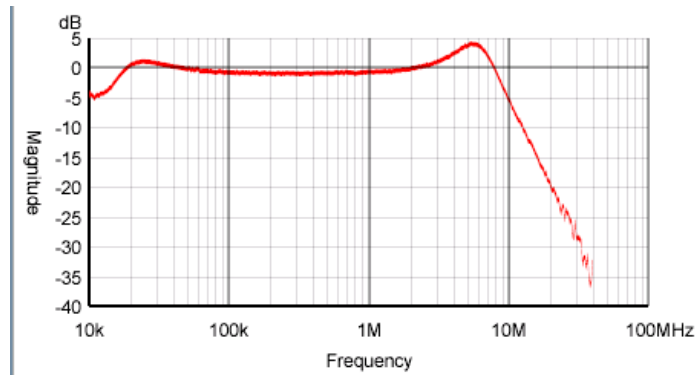
Realtime Feedback



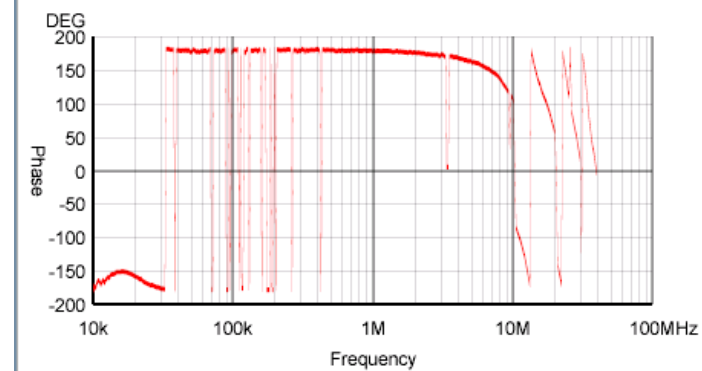
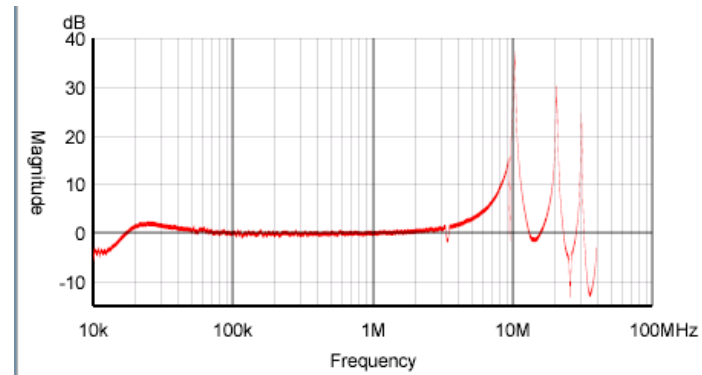
The screenshot shows a terminal window with a log of events. The log entries are as follows:

```
Download: 1:42:21 PM Displaying Results  
1:42:21 PM Experiment Done  
1:42:26 PM Drawing experiment  
1:42:26 PM Experiment Drawn  
1:42:26 PM Running Experiment Setup  
1:42:26 PM Done with setup. Requesting access to run  
1:42:26 PM Access granted. Running Experiment...  
1:42:27 PM Vip voltage: 1.526 V  
1:42:27 PM Setup of RsZVRE is correct  
1:42:27 PM Displaying Results  
1:42:27 PM Experiment Done  
Status: 1:42:27 PM Experiment Done
```

Example Results (1)

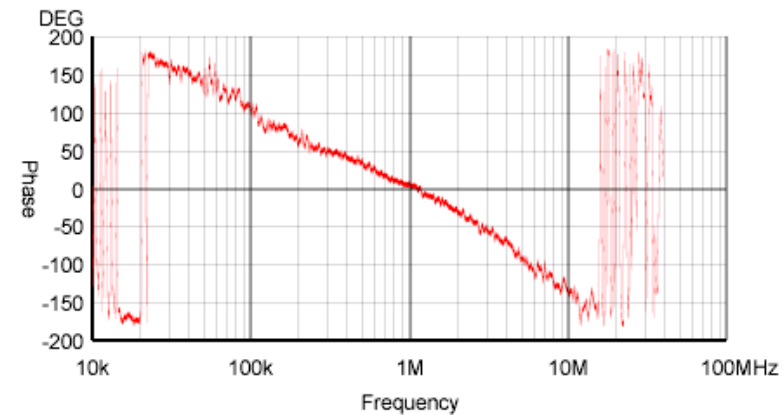
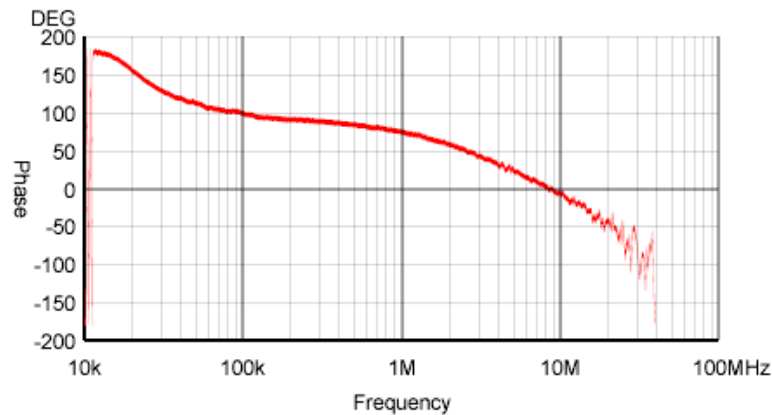
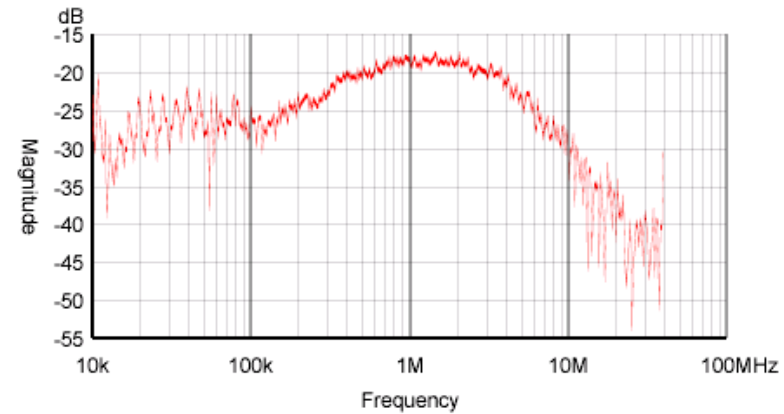
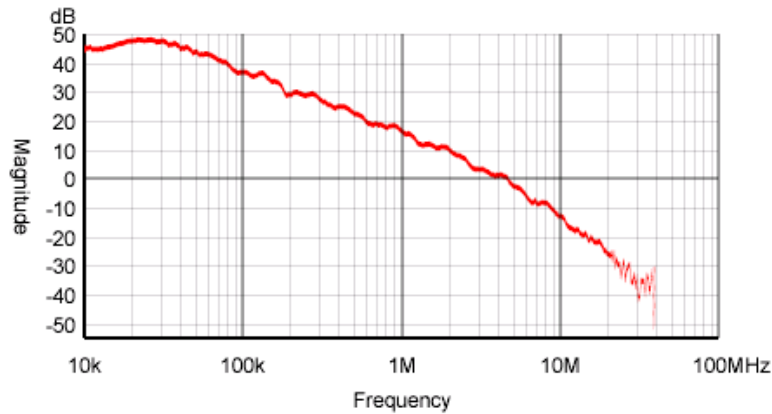


Opamp=1, Bias=**5uA**, Gain=0dB



Opamp=1, Bias=**25uA**, Gain=0dB

Example Results (2)



Opamp=1, Bias=5uA, Gain=0dB,
Offset=**0mV**

Opamp=1, Bias=5uA, Gain=0dB,
Offset=**+10mV**