

MEMS(Micro Electro Mechanical Systems) technology has enabled us to realize advanced micro devices by using processes similar to VLSI technology. MEMS are the integration of mechanical elements, sensors, actuators, and electronics on a common silicon substrate through micro fabrication technology. It is an emerging technology which uses the tools and techniques to build microscopic machines, which are built on standard silicon wafers. When MEMS devices are combined with other technologies, new generations of innovative technology get created offering outstanding functionality, including efficiency regarding space, accuracy, precision, etc.. The main challenge is to integrate all these potentially non-compatible (which cannot be interfaced directly) technologies, with both electrical and mechanical components using processes from semiconductor technology, into a single working micro system. A typical MEMS device size ranges from 1 to 1000 microns. Micromechanical systems can be used to fabricate both application specific devices and the associated micro packaging systems that will allow for the integration of devices or circuits, made with non-compatible technologies, with a system-on-chip(SoC) environment.



The MEMS technology can be used for permanent, semi permanent or temporary interconnection of sub modules in an SoC implementation. Electronic devices such as CMOS, Bipolar, or BICMOS are fabricated using integrated circuit (IC) process sequences. Micromechanical components are fabricated using 'micromachining' processes to form the mechanical and electromechanical devices. MEMS is an enabling technology allowing the development of smart products. It helps to augment the computational ability of microelectronics with the perception and control capabilities of micro sensors and micro actuators. Also it helps to expand the space of possible designs and applications. No wonder these tiny machines are becoming popular and are quickly finding their way into a variety of commercial and defense applications. You may find them in the war front. Alas, even in the pockets of the terrorists.

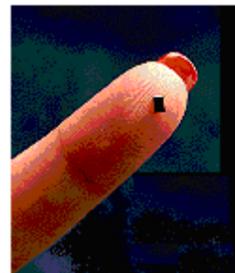
Anuj Abraham

*Students' Page* ✓

**Biosensors**

Biosensors are transducers which make use of biological material (e.g. tissue, microorganisms, cell receptors, enzymes, antibodies, nucleic acid, bacteria) to convert a biological response into an electrical signal.

Biosensors come in a large variety of sizes and shapes. These are mostly used to monitor changes in environmental conditions. They can detect and measure concentrations of specific bacteria or hazardous chemicals. They can measure pH levels.



This is a medical telesensor chip. It can measure and transmit the body temperature.

Which is bigger, the nail or the biosensor ?

Different types of biosensors are there. One example is electrochemical biosensors. These are normally based on enzymatic catalysis of a reaction that produces or consumes electrons ( such enzymes are called redox enzymes).

One type of biosensor has five components: a biological sensing element, a transducing element, a signal conditioner, a data processor, and a signal generator.

The field of biosensors is a fast expanding one. Get in touch with this new technology and the wide horizon of applications it presents.

Aneesh R Nair, S8AEI

**Curiosity**

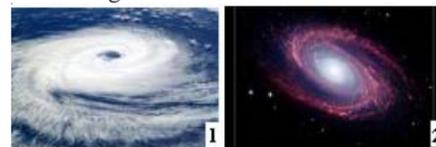
Corner



Can you find him in Bible.

Answer to the question in the previous issue

See the centre of each figure.



Cyclon

Spiral Galaxy

Winner: George Thomas Valluran, S8 AEI



**From the HoD's desk**

Dear Reader,

A few days back, a student complained about not having time for completing assignments. The student was always very attentive in class, had a polite behaviour, but would not complete any of his home assignments or projects. After talking to the student and enquiring about his routine activities, we could conclude that the student was a bad manager of time. This is not only the case with this particular student, but with most of us. In spite of being very good in the business we do, unless we are good time managers, we may not end up being successful.

Do successful people have different number of hours per day? Definitely not. More time results from good time management. Time is money. You become richer by managing your time better.

What is time management? Good time management starts with prioritizing and organizing one's activities. Time can be saved by effective planning. Here are a few tips for managing time better.

-List out goals and divide goals into sub goals

We have to first have a long term goal and a plan to achieve it. The goal should be split into short term goals. We have to plan our working hours and schedules. Specific time limit is to be set for each activity while planning.

-Prioritize goals

When we prioritize, most likely urgent tasks take up the first position in the list. What about posterior items? If we neglect those, they could build up and create problems. It is important to allot some time for those items as well.

-Prepare action plan and stop making excuses

Set dead lines for all the work. Prepare your 'to do' list. One effective way to multiply time is through delegation. Every one need not be good at every thing. So rather than doing the entire task oneself, it is better to find out right person for the right job, and hand over that part of the job.

-Learn to organize, delegate and supervise

Learn also to be flexible. There may be unforeseen activities that may have to be carried out. But don't let all activities fall into that category.

**Introducing science journals**

Review of Scientific Instruments: published by the American Institute of Physics.

It is devoted to scientific instruments, apparatus, and techniques. Contents include original and review articles on instruments in physics, chemistry, and the life sciences; and sections on new instruments and new materials. By 'scientific instruments', the journal means all the tools which scientists/engineers use. The journal publishes information on instruments, apparatus, techniques of experimental measurement, and related mathematical analysis, not strictly confined to the physical sciences, but from biological sciences and related cross-disciplinary areas of science and technology.

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Only those who will risk going too far can possibly find out how far one can go. - T.S.Eliot

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Observations/Comments

[A column by PRM]

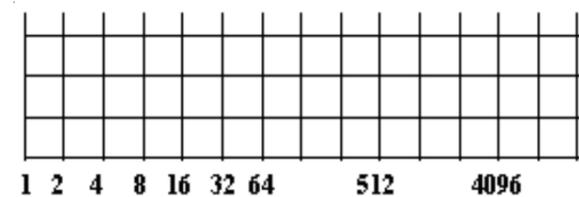
This month too, I would like to use this column to invite you to review our laboratory sessions. Determination of frequency response of a transistor amplifier is one of the experiments done by the second year students. I find a few lapses there. As soon as a student completes the wiring part, he/she gives a signal from the signal generator, monitors the output on the scope, and, if the output is found measurable with some gain (irrespective of whether the gain is as expected or not), he/she proceeds to start taking readings. This does not seem to be a good practice. Will it not be far better to follow the following steps?

Before you give input signal, confirm that the dc voltages and currents (quiescent condition) are as desired. Otherwise, see what is wrong, and correct.

Then you apply a suitable signal at the input. Monitor the output on CRO. Change the frequency in steps looking at the output level. Check if the gain is ok when the output remains more or less steady. If the gain is much different from what is expected, check what is wrong, and correct if required. Having done this step, see at least approximately the upper frequency at which gains falls by 3 dB (output falling to 0.707 of the steady value already observed). Now you have the necessary inputs to decide on the frequencies at which input is to be given.

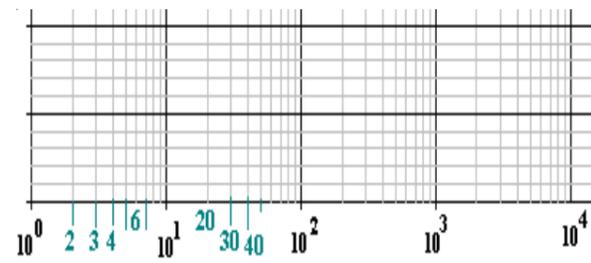
Let us see how it is to be done.

Be sure that you are about to draw frequency response plot. This necessarily demands frequency to taken on log scale. This does not mean that you should start taking logarithm of frequencies. I have seen students taking logarithm, and plotting the points. There are two issues. Taking frequency on log scale is not taking 'log frequency' on linear scale. Taking 'log frequency' itself is a blunder. You can attach meaning to logarithm of a dimensionless quantity only. Frequency is not dimensionless; it has the dimension of reciprocal of time. Instead of taking frequencies at equal intervals, suppose you take frequencies in geometric progression, like 2Hz, 4Hz, 8Hz, 16Hz, 32Hz, 64Hz, etc.



You know that logarithms of the numbers 2,4,8,16,32,64, etc. are in arithmetic progression with a common difference of log2. So, if you mark 2,4,8,16,32,64, etc. on a linear graph at regular intervals, as shown in the following figure, that is

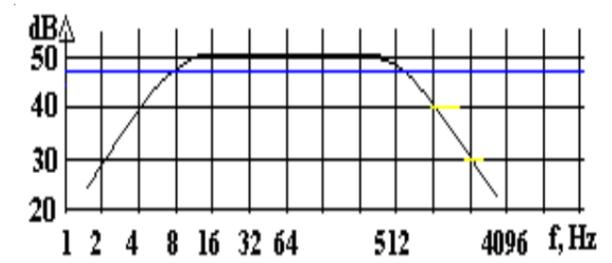
on log scale; in fact, that is the meaning of log scale. You can do it on semilog graph also as shown below.



In the semilog sheet divisions are given based on logarithm. Note that in the interval from 1 to 10, markings are for 2, 3, 4, etc.; in the interval from 10 to 100, markings are for 20, 30, 40, etc., and so on. Semilog sheet is suitable for decade scale, where base is 10; linear graph can be used directly, using log scale, for both octave scale (having base 2) and decade scale. Please make sure that you select frequencies such that both in the rising region and in the falling region you get three or four points.

You may also note that not only the above mentioned scales are used for log scale. A very frequently used scale is the one-third octave scale. This finds application in vibration tests and analysis. Here you multiply the lowest frequency selected by cube root of 2 to get the next frequency, then multiply this by cube root of 2 again to get the next frequency, and so on. Starting with 1Hz, other frequencies are 2<sup>1/3</sup>, 2<sup>2/3</sup>, 2, 2<sup>4/3</sup>, 2<sup>5/3</sup>, 4, ... You have 2 more frequencies between every two on the full octave scale.

There is a major advantage in selecting the input frequencies themselves on log scale. Take the case of doubling the frequency in every step. See the gain reduction or gain increase from one point to next point; it directly gives you the rate of fall or rate of rise in dB/octave. For example, in the response shown below, there is a fall of 10 dB when frequency increases from 1024 Hz to 2048 Hz, which means that the fall rate is 10dB/octave.



[ Next issue:  
On using measuring instruments]

AUTOMATED CALIBRATION SYSTEM

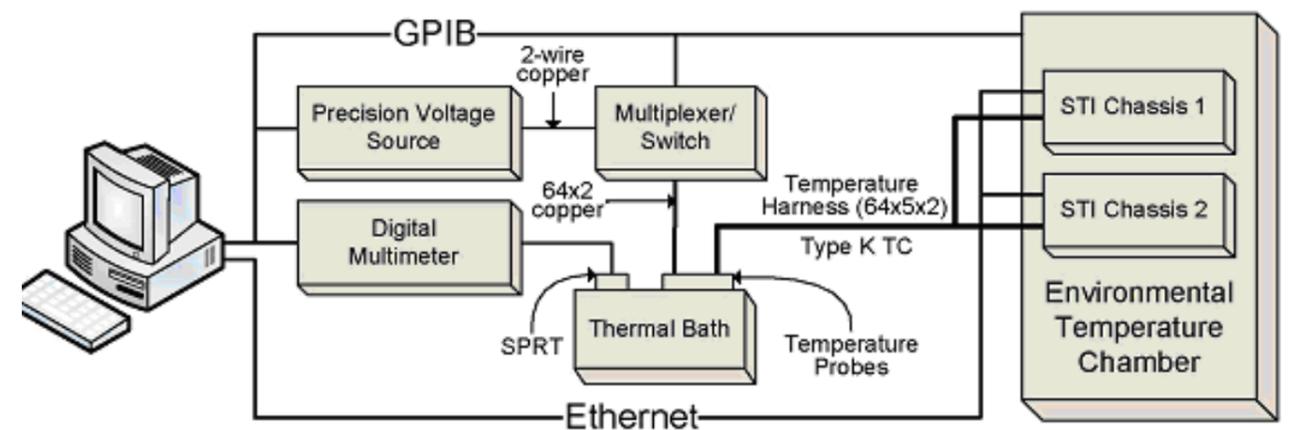
In every industry calibration is an important task. It is mostly done manually involving lot of effort and time. Efforts are on to make calibration automated. Many successes in this direction have been reported. Let me introduce a brief paper on such a successful effort. Its title is 'automated calibration and validation of automotive test instrumentation'.

This paper appears in:  
'Automation Congress, 2008. WAC 2008. World Publication Date: Sept. 28 2008-Oct. 2 2008'

Authors:  
Scott M. Creasman, Western Microsystems, USA &  
David C. Pheanis, Arizona State University, USA.

This paper introduces an automated calibration system, with details on many checks that are added as additional ones to what a manual system does. Technician's time is cut to about 4%. The automated system is more reliable than the manual system.

The paper also deals with the system hardening aspects to operate in a broad range of environments including harsh ones. Transitions between moderate and severe operating environments, collection and analysis of numerous measurements, and the accurate presentation of the many different inputs that are necessary for both calibration and validation of the test instrument, are all mentioned in this article. General scheme is shown in the figure.



The devices that the system uses and controls include a precision voltage source, digital multimeter, a temperature bath with 0.005°C uniformity, a secondary platinum resistance thermometer (SPRT), a 96-channel multiplexer, a temperature chamber, and two Standard Thermal Instrument (STI) chassis. In addition, the system uses a 320-channel voltage harness and a calibrated 320-channel temperature harness with sixty-four calibrated temperature probes. The software of the calibration system controls the two STI chassis via Ethernet, and it controls the remaining instrumentation via GPIB.

The STI Calibration Application, and System Control include the STI chassis, the calibration-system software, and the system controller (i.e., the personal computer) that controls the STI chassis and the various devices that reside on the GPIB. STI and its modules are controlled via an Ethernet interface. The communication is directly with the STI's communication card, which serves as a gateway to the system-controller application inside the STI chassis. The software sends commands from the controller to the chassis and receives responses from the chassis. The controller commands the chassis to send collected samples as part of the as-found (i.e., pre-calibration) or as-left (i.e., post-calibration) data collection, and the controller commands the collection of calibration measurements for each channel for calibration. Environmental Control includes only the system's environmental temperature chamber. The two STI chassis reside inside the temperature chamber, and over the course of the eight-hour calibration, the chamber exposes the chassis to temperatures ranging from -40°C through +71°C. Note that the eight hour requirement is not because of calibration, it is for the temperature to reach the specified levels.

Bath Monitoring group includes the 8.5-digit digital multimeter, a secondary platinum resistive thermometer (SPRT), and the thermal bath, which contains the hot junctions of the thermocouples that connect to the chassis.

The resistance of an SPRT varies with temperature, so we can measure the resistance of the SPRT with the digital multimeter to determine the precise temperature of the bath. The thermal bath is guaranteed to have 0.005°C thermal uniformity throughout, so the SPRT gives us the temperature of the entire bath with tremendous precision.

Signal Supply and Temperature Simulation provides all of the reference signals for the overall calibration.

Mary Hexy