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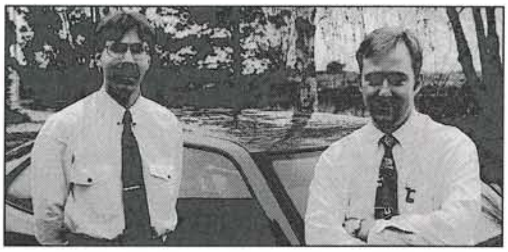
PEOPLE, PRODUCTS & NEWS

Measuring vibrations in exterior rear-view mirrors on cars

Anders Dahlén, Liceata Engineering AB



Liceata Engineering AB was formed in the autumn of 1994 by Hans Jartoft and Anders Dahlén, and its objectives included designing, with the permission of SAAB, this vibration-measuring equipment and offering it to customers in the car industry, subcontractors and consultancies.

Background

SAAB Automobile had no easy-to-use, repeatable method of measuring vibrations in the exterior rear-view mirrors on cars. The objective was to design a piece of equipment which could easily be fitted to a car and which displayed the vibrations in the rear-view mirrors in a manner which facilitated assessment of the performance of such mirrors. This equipment had to be flexible enough to be used on cars on a vibration rig, in a wind tunnel or on a test track.

Several different principles which were deemed applicable were investigated. We looked at methods such as inferometry and carried out tests using accelerometers. However, it became apparent that one method using a PSD to register the deflection of a laser beam reflected in the rear-view mirror would most accurately meet our requirements.

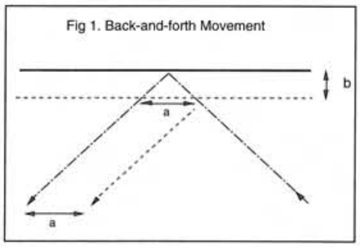


Figure 1: Back-and-forth movement.

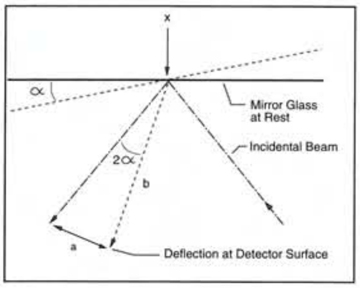


Figure 2: Angular deviation. The deflection depends on the distance between the glass of the rear-view mirror and the detector.

Measurement method

When a rear-view mirror vibrates, the drivers view of the object behind the car is distorted. There are primarily two types of movement which affect the quality of the image: a back-and-forth movement and angular deviation. When measuring the vibrations, it is important to know how these different types of movement are dealt with by the measuring equipment used. The principles of these two types of movement are described in Figures 1 and 2. The arrows represent the incidental laser beam and the reflected laser beam.

The reflected beams are parallel in the first illustration but not in the second. This is an example of properties pertaining to the measurement object which can be used when designing measuring equipment. Placing the detector close to the measurement object permits the user to emphasise the back-and-forth movement, while the contribution made by the angular deflection increases as the detector moves further away. Other factors which may be of significance in this particular case were the manner in which the equipment was attached to the car and the angle of the incidental laser beam.

Equipment

The equipment comprises a frame on which a laser diode and a two-dimensional SiTek PSD is mounted: see Figure 3.

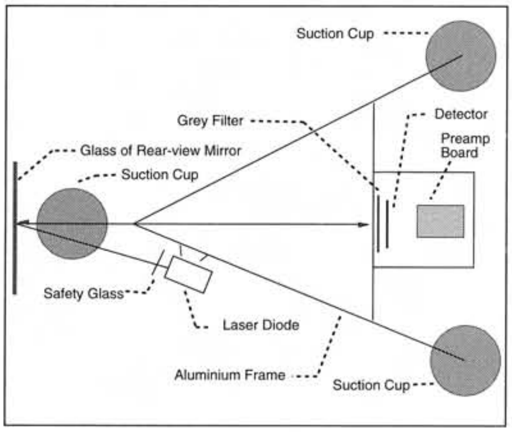


Figure 3: Frame with laser and position-sensing detector fitted.

A preamplifier board is directly connected to the detector. The signals are then transmitted via a flat cable in the car and to a measurement rack where two PM cards from SiTek are used to calculate the position of the reflected laser beam. The position signals are then processed in a data collection system and displayed in an appropriate manner, as a function of time, as an X-Y plot or as a spectrum, for example. The figure below is an example of a signal as a function of time.

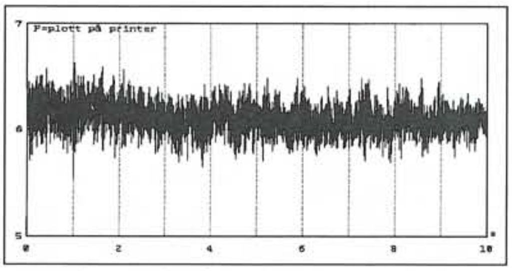
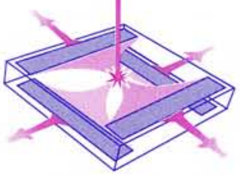


Figure 4: X-Y plot of the vibration in the rear-view mirror.

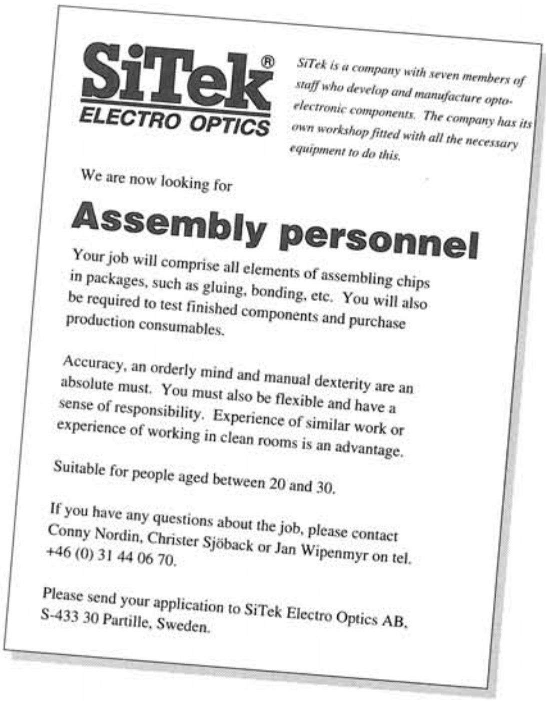
Since the distance between the glass of the rear-view mirror and the detector is known, the corresponding angular deviation can be calculated.



Full speed ahead towards new goals!

This year has seen a massive upswing in the number of orders received. One measure of this is that we produced as many components during the first half of this year as we did during the whole of 1994. We were nevertheless forced to delay a few deliveries (with the consent of our customers). We have therefore not really been able to supply products to our customers at the rate they require, even though we have had one extra person working in production since the end of January. Thus we are now looking for more staff for production. Since it takes time to find and then train the right person, we will unfortunately have to put up with minor delivery delays for the rest of the year. However, we are aiming to be back to normal by the beginning of 1996; that is to say, delivering products to meet the requirements of our customers.

In 1996, we will also be continuing our efforts to eliminate bottlenecks in production and to adjust our production methods and our equipment for larger series. This is so that we can meet the ever-increasing demand for our products. However, we have no intention of doing away with our capacity to manufacture specially-adapted PSDs in small series. This has been SiTeks´strength and will remain so. Consequently, SiTek has an exciting year ahead, with great challenges and significant investment, but also hard work.



SiTek® ELECTRO OPTICS

SiTek is a company with seven members of staff who develop and manufacture opto-electronic components. The company has its own workshop fitted with all the necessary equipment to do this.

We are now looking for

Assembly personnel

Your job will comprise all elements of assembling chips in packages, such as gluing, bonding, etc. You will also be required to test finished components and purchase production consumables.

Accuracy, an orderly mind and manual dexterity are an absolute must. You must also be flexible and have a sense of responsibility. Experience of similar work or experience of working in clean rooms is an advantage.

Suitable for people aged between 20 and 30.

If you have any questions about the job, please contact Conny Nordin, Christer Sjöback or Jan Wipenmyr on tel. +46 (0) 31 44 06 70.

Please send your application to SiTek Electro Optics AB, S-433 30 Partille, Sweden.

New measuring system

During the autumn, we made a large investment in a new measuring system for checking our PSDs. This has been in service since September.

Background

We check all components for leakage current, noise and resistance before they are delivered. Therefore, it is absolutely vital that we have a measuring system which measures accurately and is always operational. Since we also store all our measurement data, it is important that such data is easy to save and re-access.

Our old measuring system has now been in service since 1985 and started to have problems handling the bigger and bigger quantities of goods which we now supply. Moreover, this old system was not designed to cope with the ever-increasing sources of noise which surround us today. Its storage options were also limited to paper printouts which were filed in binders. This was a simple, uncomplicated system which, however, required floor space and offered limited search options.

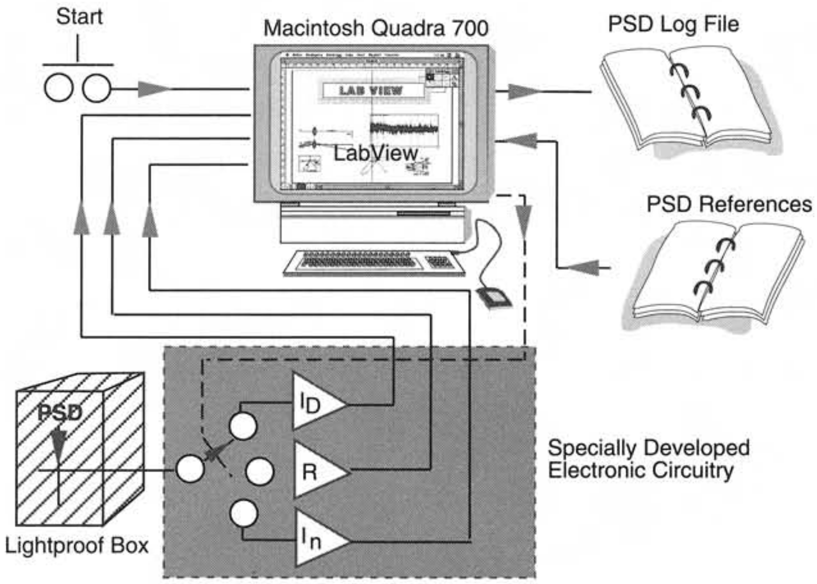
Advantages

The new measuring system will afford both us and our customers several benefits and enhanced options compared to the old system.

- The measurement values will be more correct and more accurate due to less inherent noise, modern components and a design which is less sensitive to interference.
- The system will be able to handle large amounts of data simultaneously.
- Improved management of measurement results due to better storage options, the option of allowing the computer to search for a certain component, etc.
- The option of generating statistics and thereby monitoring yield.
- More flexible system due to the ease with which new components can be added, and the option of amending specifications easily if a customer has special requirements.
- Powerful tool for our development work.
- More well-defined test parameters: resistance is measured at 0.1 V, noise at a bandwidth of 60 kHz and the option of measuring with a bias of between 0 and 25 V in 1 V stages.

Configuration

The measuring system comprises the following parts: a Macintosh Quadra 700 fitted with a National Instruments I/O card. The measurement procedure, including control and presentation of the results, is programmed using LabView measurement software. However, the most important component is the specially-developed electronic circuitry which provides the object to be measured with the correct test parameters and amplifies the extremely weak signals to values suitable for the I/O card. This amplification is of the order of $4x10^9$, which places great demands on the design, selection of components and protection from noise. Last, but not least, the system has a lightproof box in which the object to be measured is placed.



SiTek´s PSD-school

Part 4 by Lars Stenberg, ESDE AB

In Part 2 of SiTeks´PSD School we dealt with design parameters for a triangulation probe and derived the eleven formulae which are best used when designing a triangulation probe. In Part 3 we studied how these are applied in practice. In this and future parts we will be looking at how to select and find suitable optical components for a triangulation probe. To make this part easier to read, we have incorporated Figure 1 from Part 2 into Part 4, also as Figure 1.

Light source

We need some kind of light source which sends a beam of light in the direction AD towards the object to which we wish to measure the distance. It is important to ensure that the light beam undergoes what is known as diffuse reflection when it hits the object to be measured since only then will light travel via the main objective E. One example of a diffuse reflector is ordinary white typing paper. The opposite of diffuse reflection is specular reflection, which means that the light beam is reflected as per the law of reflection; that is to say, the angle of incidence is equal to the angle of reflection. In practical terms, this means that if a light beam hits a mirrored surface, for instance, at right angles, the light is reflected back in the same direction from which it came. No light hits the main objective E, which means that no signal is emitted by the detector F. In practice, therefore, it is necessary to take care when using shiny metal surfaces, glass surfaces or shiny plastic surfaces. If in doubt, you should carry out a test to find out whether a sufficient amount of light is being diffused in the direction of the main objective E in order to receive a sufficiently strong measurement signal or to find out if it is necessary even to reduce the angle (and thereby impair the accuracy of the measurement).

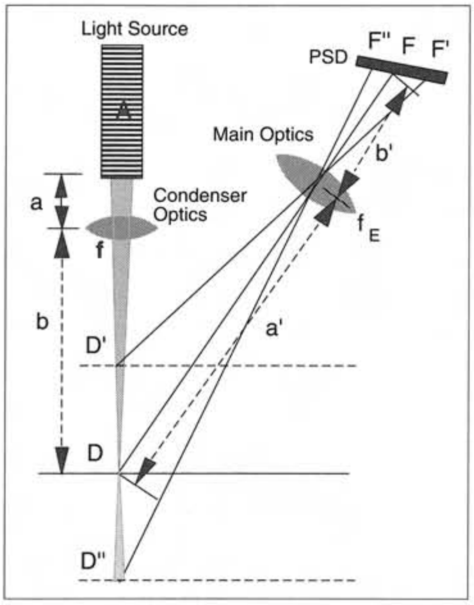


Figure 1.
The triangulation probe.

What demands should be made of the light beam?

First and foremost, it is necessary to decide which light wavelength to use. If, for example, one wishes to see exactly where on the measurement object distance is being measured, one should select a light source in the visible wavelength range, that is to say between 400 and 700 nm. If the measurement object absorbs a lot of light, such as black rubber, one should select a wavelength range closer to 700 nm if one still wishes to see the measuring light, as the maximum sensitivity of most PSDs is in the region of 930 nm. In other cases, it may be distracting for the operator (for example) to look at a small red spot on the measurement object, and in this instance a wavelength in excess of 700 nm should be selected.

Often it is desirable for the spot of light which occurs when the light beam AD hits the measurement object to be as small as possible. There are several reasons for this. Firstly, the actual measurement object may require a small spot of light, such as when measuring threads on a screw. Secondly, it is easier to achieve good triangulation probe linearity if the spot of light is not too big. This is due to the fact that if the main objective is not sufficiently well corrected in respect of optical reproduction errors, a large spot of light will be reproduced as an even bigger spot of light on the detector at the edge of the main objectives´field of vision, i.e. at the points D' and D". Since a PSD measures what is known as the central point of gravity of the light spot, an error will occur in measurement if, for instance, the image of the spot of light is impaired by strong spherical aberration and coma. Furthermore, it is desirable for the light beam to be of approximately the same diameter over the entire measurement range for the reasons outlined above. A bunch of rays which comprises parallel light beams is known as a collimated light beam. If the light beams are not strictly parallel, but are instead slightly convergent or divergent (approx. 0.05 radians or less), this is sometimes known as a quasi-collimated light beam. The light beams used with triangulation probes are a good example of quasi-collimated light beams.

Lars Stenberg

How are quasi-collimated light beams generated?

There are primarily two things which should be taken into consideration when such a light beam is to be generated: what is known as Gaussian amplification, and also the diffraction of the light; that is to say, the diffraction phenomena caused by the fact that the wavelength of the light is not zero.The first problem with Gaussian amplification affects what is known as the geometric optics, which deals with that part of the optics which can be explained in relation to the laws of reflection and refraction. The various sub-figures in Figure 2 show how to determine where the image lands and how big it is using three auxiliary beams if the focal length f of the lens, the distance of the object from the lens and the size of the object are known. The following applies for these three auxiliary beams:

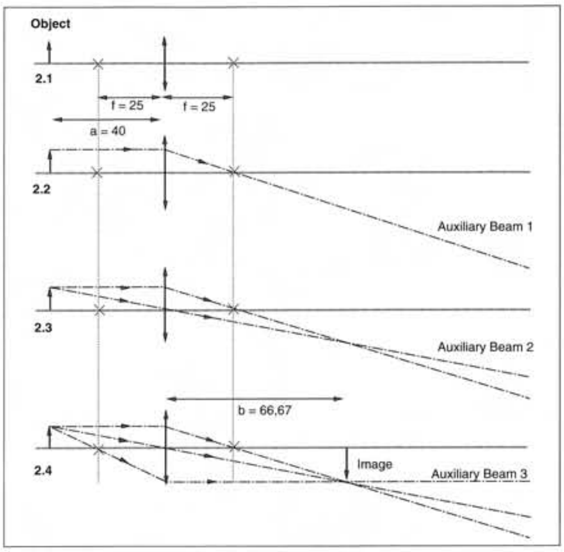


Figure 1.

Auxiliary beam 1: A light beam which approaches a lens from the left in parallel with the optical axis leaves the lens via the focal point of the lens (for a positive lens the right focal point, and for a negative lens the extension of the light beam goes backwards via the left focal point).

Auxiliary beam 2: A light beam which passes through the central point of a thin lens is not broken.

Auxiliary beam 3: A light beam which approaches a positive lens via one focal point leaves the lens in parallel with the optical axis.

Of course, it is also possible to calculate the distance from the lens at which the image is formed by means of what is known as the lens formula:

Equation $1/a + 1/b = 1/f$

where a is the distance from the object to the lens, b is the distance from the lens to the image, and f is the focal length of the lens. If we enter the values in Figure 2 and calculate b, we find that b = 66,67 mm.

If we study Figures 2.3 or 2.4, we can see that it is possible to draw a diagram and thereby easily determine the focal length of the lens which we need in order to generate an appropriate light beam. Since we have decided in accordance with the above to use a free air separation of 100 mm, we draw a new diagram (see Figure 3.1) in which we can draw the line b as 120 mm, since the lens in reality is of a specific thickness, and to this must be added the lens mounting. It may also be necessary to include a safety window in order to protect the optical components from oil, particles of metal, etc. Then we can draw in the light source. I have drawn the image as being 20 mm in size in Figure 3. In reality, we want as small an image as possible, but we shall be using Figure 3 only to determine the focal length of the condenser lens. We shall return to the question of the size of the spot of light soon. Therefore, the condenser lens is placed 120 mm from the object, but where should the actual light source be placed? If we make the distance a large, image enlargement of the light source will certainly be reduced, but on the other hand the condenser lens will not be able to catch as many light beams from the light source, which means that less light will be reflected via D. Moreover, a large distance a may perhaps necessitate a larger housing for the triangulation probe. The distance a should therefore be 30 mm or less.

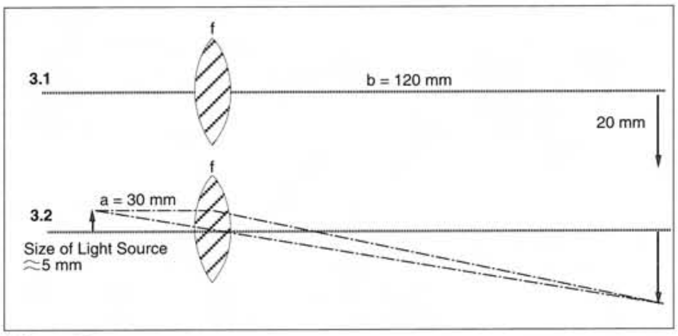


Figure 2.

Once this has been done, it is sufficient to use auxiliary beam 2 as shown in Figure 2.3 to work out the size of the light source. Figure 3.2 shows that the light source is approximately 5 mm. The light source is therefore enlarged approximately four times. Since uniform triangles are always applicable, we are now able to establish that it really does not matter how large an image is drawn from the start, since it is always possible to read off the enlargement using Figure 3.2. Figure 3.2 also shows that the focal length of the condenser lens is approximately 24 mm. Inserting 30 mm as the value a and 120 mm as the value b in the lens formula given above, we find that the focal length f of the condenser lens is 24 mm in this case as well.

In Part 3 we calculated the focal length of the main objective, and in Part 4 we have calculated the focal length of the condenser lens. In the next part we will be discussing the choice of light source and determining the suitable condenser lens aperture. We will then be discussing how to obtain the various optical components required.

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