# MAXWELL

Magazine of the Electrotechnische Vereeniging

## Graduation report
Estimating stator insulation condition

## Exploring the EE departments
Electronics

## Circuit bodging
Make music with your own theremin

Edition 14.3

April 2011

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# From the Board

Dear Members,

The last time I wrote the "From the board" it started with: "At this time it is already getting cold". Fortunately, the weather is far more pleasant now and it is only getting warmer. We are currently very busy with the 105th anniversary activities so as the Board we cannot enjoy the sunny weather very much. Usually I would tell you about the activities that took place the last few months but this time I will tell you something about the history of our study association and the study that we all enjoy so much. Time to go back in time.

As of 1888, there were a few Electrical Engineering courses in the Physics programme. As of 1906 Electrical Engineering was a last year specialization (like a Master´s course) of Mechanical Engineering. On March 26th 1906, as you might know, the Electrotechnische Vereeniging was officially founded as a part of Gezelschap Leeghwater.

In the early years, there already were a lot of excursions. At this moment I am reading a letter of the Gemeentetram, the municipality tram in Amsterdam, where we went on an excursion on April the 3rd 1909. The letter says that the cost for hiring a whole tram back then were only *f*5,- (€2,26) while today it would cost you about €350,-! They also went to Amsterdam´s electricity networks in 1909 where they watched a just installed steam engine. In our archive you can find loads of these letters, and letters of famous people too. There are letters in the archive written by H.A. Lorentz. As you might know, he won the Nobel Prize for Physics in 1902. In one of those letters he promised to give a lecture with the title: "New studies about Electromagnetism". You can find so many useful and useless things in our archive, it´s just incredible! There are, for example, postcards with stamps of 2,5 guldencent – which is now about 1 eurocent.

Nowadays, we have a yearly tour through Europe. It is very interesting to see that we already went to Geneva, Switzerland with a group of students in 1907. There are also letters from hotels in Germany that wrote us in 1909. The last thing that caught my eye was the way the letters were written. Most letters are handwritten and some of them are typed with a typewriter. The way of expressing yourself is also very different: in those days it was far more formal.

Now you know something more about the past of our association. If you are interested, there is a summary of our whole history on our website: http://www.etv.tudelft.nl.

It is good to look back and learn from those experiences because after all that is where we are headed. There will be the Electrip to Stuttgart, Zurich and Geneva, where we will visit CERN and in the weekend of June 3rd there will be a sailing trip. But of course, there are also a lot of 105th anniversary activities like a barbecue, a volleyball tournament for staff and students, a '21 verdiepingendiner' - a 21-floor-dinnerparty- , a symposium about safety in transport, a big stunt (we are making a world record attempt for the biggest game controller) and as a grand finale: our dance.

There are a lot of activities, and we think there should be an activity for everyone.

I look forward to see you at our activities,
On behalf of the entrepreneurial Board,

Tobias Dekker, President

# Editorial

The editorial. A subject of much contention amongst the editors. Somehow it's always the last thing that gets done, even though usually the author of the editorial is picked months in advance.

Well, I say picked. Usually it's either the one person who wasn't at the meeting, or an editor who wasn't paying attention and is thereby stuck with the task.

However, I volunteered for this job. The editorial is the one space within Maxwell were you don't have to take yourself quite so seriously, and I quite like not taking myself seriously. This helps to keep meetings fresh, as apparently the best ideas (and the worst ones) are generated when you're not really paying attention. I'm not sure if that's true, but it has generated a few good ideas in the past, so I'm not going to challenge the concept. Sometimes, you just have to let things happen at their natural pace, and it all works out fine.

Secretly there's a writer inside me. I'm not quite sure how he got there, but there he is. Long story short is he comes in handy when faced with a task such as this one. Quite frankly, I don't see why my fellow editors don't like writing the editorial. It's a mysterious beast, yes, but with a little creative thinking it is a beast that can be easily overcome.

The editorial. Some say that it's a good space-filler, but that it doesn't actually add anything of value. Others say that it's an integral part of the Maxwell, and that it once broke a sheep in half with its teeth.

All we know is, it's fun to write.

Ben Allen
*Editor*

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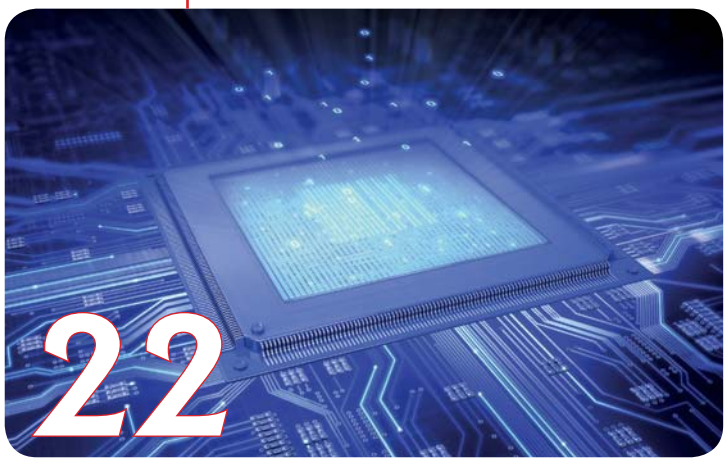


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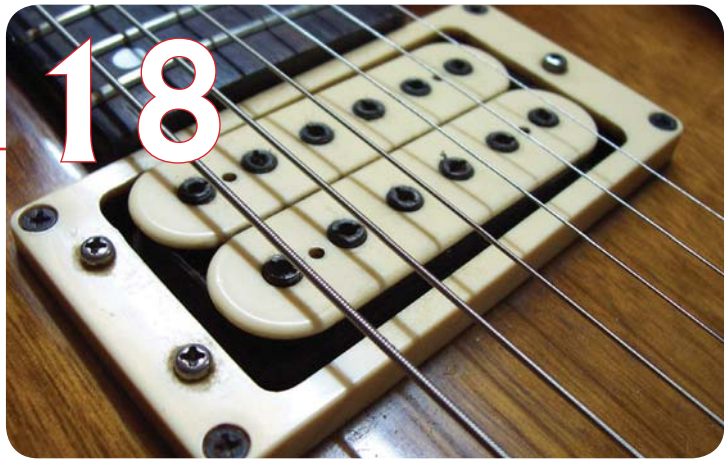


First lustrum week


Cooking with: Guit-Jan Ridderbos

# Newsflash

Author: Jeroen Ouweneel

## Smart robot for covert surveillance

Engineers of Lockeed Martin's Advanced Technology Laboratories have recently developed a prototype robot, whose purpose is to survey areas without being detected by humans or security measures, such as cameras.

The current prototype had to stick to four basic rules: avoiding detection by known sentries on a predefined location, avoiding detection by known sentries with an unknown location, avoiding areas from which the robot would not be able to escape again and avoiding lit areas – as the robot will mainly operate at night.

Figure 1: The first spying robot prototype.

The robot does this by first creating a 3D map of its environment, using a laser scanner. Next, it makes itself aware of the dynamics within the environment, by using a set of acoustic sensors which can detect sound made by moving objects or people and then determine their direction. When the robot detects someone or something moving too close, it tries to move to a position where it can't be detected. While this sounds very logical to humans, it is very hard to program a robot to 'understand' these concepts. Moreover, simply programming something like "when you hear a noise, move to the nearest dark spot" will not be enough for the robot to remain undetected in actual surveyed areas.

The next step, according to Lockeed Martin, is to develop far more sophisticated behaviour – that is, creating artificial intelligence. But despite the relatively simple prototype, the US army has already shown interest in these spying robots, as the Department of Defense has announced cash awards for better working designs.

Source: *New Scientist*, http://www.newscientist.com

## Phone app enhancing sound quality at festivals

It is generally known that the sound quality at large, open-air festivals isn't very balanced – bass and other low frequencies travel well over long distances, but the higher frequencies, produced by for example voice and guitar, do not. Because of this, it is often very hard to distinguish the singers' voice.

A team of researchers at the Technical University of Denmark has developed a system that takes care of the problem, using an FM radio antenna and a simple phone app that picks up this frequency. Through this channel, the higher frequencies of the audio spectrum are sent and then played on the Phone; the user plugs in his or hear earphones and hears the higher frequencies as an extra 'layer' on the sound of the stage speakers.

The reason for the researchers to use a phone instead of a regular FM-radio is that sound from the stage travels a lot slower than the radio-waves with the higher frequencies; the phone app delays the signal according to the distance between the user and the stage with the use of GPS.

The sound-enhancing system has already been tested last June during two performances at a festival in Denmark, and the reactions were positive. The team is currently working on commercialising the system to make it globally available.

Source: *New Scientist*, http://www.newscientist.com

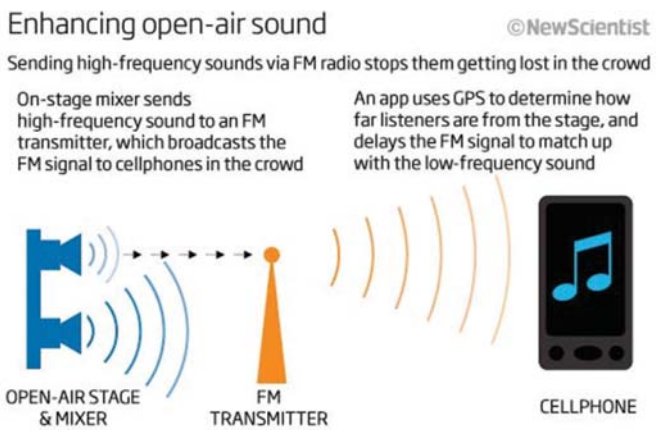


Figure 2: Graphical depiction of the sound-enhancing system.

## First commercially viable nanogenerator

A team of scientists under the lead of Zhong Lin Wang, PhD, recently developed the first commercially viable nanogenerator – in the form of a flexible chip that uses movement to generate Electricity – after six years of intensive research.

The current result of this, depicted in figure 1, is a small generator able to power commercially available LED's and even a small LCD-display, simply by moving it back and forth between two fingers.

The nanogenerator promises to be a very important milestone in the field of powering portable electronics such as MP3-players, since a big enough version of the nanogenerator placed in – for example – a shoe sole could make batteries and charging obsolete.

The most important technological breakthrough is the Zinc Oxide (ZnO) nanowires, which are piezoelectric – and can thus create a current when they are strained or flexed. Since any movement of the nanowires will do, the nanogenerators are very easy to apply to any (body) movement.

The next step in de development is to increase the nanogenerators' output, enabling it to power more than just a LED. Developers estimate that a practical nanogenerator will be on the market in three to five years.

Source: *American Chemical Society,* http://portal.acs.org

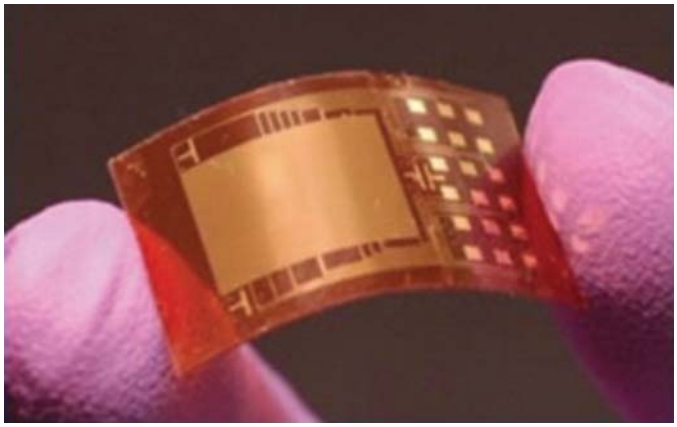

Figure 3: The nanogenerator in action.

## Infrared light may let the deaf hear again

Researchers from the University of Utah succesfully made ear cells send brain signals by stimulating them with infrared light. Ultimately, this technique may be used to create a workaround, letting the ear cells of deaf people work again.

The specific cells used during this test were of a 'Opsanus Tau'-fish's inner ear; these cells are typically used when conducting ear cell research. Once infrared pulses were applied, the cells responded by making a neurotransmitter, theoratically enabling them to communicate with the brain again. The reason for this process to work, is that the researchers used infrared light of a specific frequency that can activate a cells 'mitochondria' – which is the energy source of a cell.

Because the light can theoretically activate the mitochondria of any type of cell, the applications of this process may even be far greater than just letting deaf people hear again; it was also tested on a rats heart cell, which immediately contracted as a result of the infrared light. Because of this, the used technique may also be used as a replacement for pacemakers.

Despite the obviously great possibilities, the researchers emphasize that their new technique is in a very young stage; short-term practical applications are not to be expected. Most importantly, the researchers need to check wether the used technique will work on human cells as well.

Source: *Physorg,* http://www.physorg.com

Figure 4: Bioengineer Richard Rabbitt behind the test setup.

# Activiteiten van de Electrotechnische Vereeniging

## Lunchlezing Deerns

**Auteur: Colin Simons**

Bij de laatste lunchlezing van het derde kwartaal was het deze keer aan Deerns de eer om een praatje te houden. Onder het genot van een gratis lunch kregen we een interessante lezing voorgeschoteld over wat voor soort bedrijf Deerns is en wat de mogelijkheden zijn als toekomstig ingenieur voor het bedrijf.

Deerns is het grootste onafhankelijke ingenieursbureau in Nederland op het gebied van installatietechniek, energie en bouwfysica. Deerns is ook internationaal actief in landen als Duitsland, Dubai, Spanje, Frankrijk en de Verenigde Staten.

Het bedrijf houdt zich bezig met het technische aspect van het ontwerpen van verschillende soorten gebouwen: van het ROC in Twente tot het UPC kantoorgebouw in Leeuwarden en van datacenters in Rusland tot luchthaventerminals in de Verenigde Arabische Emiraten.

Bij het ontwerpen besteedt Deerns veel aandacht aan de duurzaamheid van de gebouwen. Zo wordt er gebruik gemaakt van elektrotechniek om onder andere duurzame klimaatregeling in gebouwen te realiseren. De presentator liet daar een aardig voorbeeld van zien met de zonnecellen op het dak van het nieuwe UPC kantoorgebouw. Ook wordt er in de zomer warm water in de grond gepompt dat vervolgens in de winter wordt gebruikt voor verwarming. Deze duurzame instelling bij Deerns heeft het bedrijf al een aantal grote duurzaamheidsprijzen opgeleverd.

Na afloop van de lunchlezing krijgt de spreker een fles wijn en een jaarboek cadeau.

## Excursie CeBIT

**Auteur: Bas van Wee**

In maart was er in Hannover het jaarlijks terugkomende CeBIT. Ook dit jaar ging de ETV weer met een bus vol leden en niet leden naar Hannover toe. We verzamelde al om half 4 's-ochtends bij EWI. Iedereen had weinig geslapen, sommigen zelfs helemaal niet. Dit mocht echter dit de pret niet drukken. Vol enthousiasme gingen we op weg naar Hannover. Na een zes uur durende rit met veel slapende mensen kwamen we aan in Hannover. In een klein groepje begonnen wij in de business hallen van CeBIT. Dit viel echter een beetje tegen. Deze hallen waren voornamelijk bedoeld voor bedrijven. Hier zijn we daarom ook maar snel door heen gelopen. Nog wel een aantal leuke dingen gezien zoals een systeem om automatisch de snelheid van een auto aan te passen met behulp van camera's en sensoren die naar verkeersborden kijken.

Na deze hallen eerst maar even wat gegeten en door naar de ICT hallen. Hier was van alles te vinden, van 3D-tv's tot telefoons. Hier hebben we ons rijkelijk vermaakt met het testen en bekijken van alles en nog wat. Hierna nog even langs de Intel-hal geweest om te zien hoe de beste gamers van de wereld het tegen elkaar opnamen tijdens de wereldkampioenschappen.

Om drie uur werd het echter tijd voor een rondleiding bij Alcatel-Lucent. Gedurende deze rondleiding vertelde ze met welke ontwikkelingen Alcatel-Lucent bezig zijn. Bijvoorbeeld een systeem om al je elektronische apparaten met elkaar (via het internet) te verbinden. Iemand liet zien hoe je hierdoor bijvoorbeeld eenvoudig met je iPad je media vanaf je netwerkschrijf op je tv of geluidsinstallatie kan afspelen. Bovendien als je onderweg een film aan het kijken en je wil thuis op je tv verder kijken kan dat ook met dit systeem (zonder eerst te zoeken waar je was gebleven). Daarnaast lieten ze ons hun nieuwe type antenne zien die veel kleiner is en meerdere frequenties kan uitsturen dan de huidige gsm antennes. Daarnaast zijn ze ook druk bezig met betere en snellere manieren voor het verspreiden van media en data. Eigenlijk te veel om op te noemen en erg interessant.

Als afsluiting zijn we nog naar de zogenoemde resellers area geweest waar normaal alleen maar bedrijven op komen die gadgets door-verkopen. Het is ons echter ook gelukt om ook daar te komen. Hier hebben we nog gezellig geborreld en de dag goed afgesloten met een glas prosecco.

Veiliger rijden met een stysteem dat aangeeft wanneer het veilig is om van baan te wisselen.

We mochten ook de nieuweste handheld uitproberen. De nintendo 3DS!

# Estimating stator insulation condition using damped AC

Electric motors and generators exist in an exceptional large range. Inside a quartz watch a tiny 1 $\mu$W motor can be found. Much larger examples include the 1 to 5 MW generator found in a new wind turbine and the two 2.3 MW motors mounted in a typical NS locomotive. The largest electric machine is a 1750 MW generator currently being installed in a French nuclear power plant. Of course, with higher power output higher voltages are needed and this is where my graduation project comes into play. In this article I will give an overview of this project, performed at TU Delft's high voltage laboratory.

**Author: Corné van Eeden, MSc**

## Voltages and currents

Higher power output can only be achieved with higher I×U in the stator of the electric machine. It is not surprising that larger currents result in more heat and require a larger cross size of the copper conductors. On the other hand, increasing the voltage results in higher electric field strength. This requires better stator insulation materials, which have to be applied in a thicker layer, which on their turn reduce the efficiency of the machine. Next to that, electrical insulation has thermal insulating properties too, which causes an increase in cooling effort.

## Stator insulation

Above a few hundred kVA output, the usage of high voltage is inevitable. In this respect, we usually talk about more than 3 kV: beyond this level greater care has to be taken to design a reliable stator insulation system. Figure 1 shows the stator of a high voltage machine. Ideally such an insulation system would have the following properties: very high electrical field strength to get breakdown, high thermal conductivity, resistant to chemical exposure, to mechanical stress, to dust and moisture, to high temperatures and to changes in temperature. All these stresses appear during operation of a machine. Next to that, the insulation should last decades without maintenance, and shouldn't be expensive.

These requirements have resulted in mica based insulations. Mica is a white to transparent mineral with excellent thermal and electrical properties; it is also used in capacitors. Early systems used a mica-asphalt combination; starting in the sixties usage of epoxy instead of asphalt is common.

Applying epoxy-mica insulation involves multiple steps. First, the bare copper is shaped into a stator bar, to fit in the stator core. Second step is to wind a tape containing mica flocks around the bar. Then the taped bars are mounted in the stator core, bar ends are welded together and taped too. Finally the whole stator is impregnated with epoxy to fix everything together. Impregnation involves vacuum, which removes most air pockets in the insulation. Impregnating is finished with a curing treatment, like applying heat and/or high pressure. Figure 2 shows a cross section of a conductor and its insulation layers inside in a stator core slot.

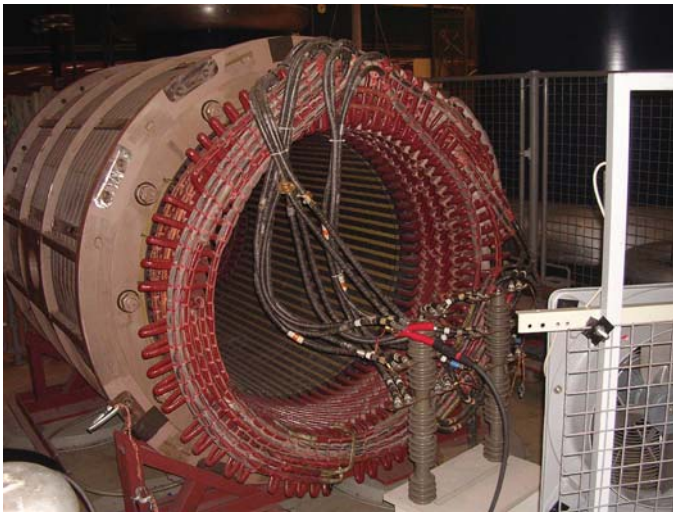

Figure 1: Stator of an 11 kV 23 MW generator at the high voltage laboratory. Rotor and stator housing have been removed.

The main part of stator insulation is the groundwall insulation, because it has to withstand the full operating voltage of the machine, and is therefore the most interesting to a high voltage engineer. This is the thickest layer and is built of mica tape and epoxy.

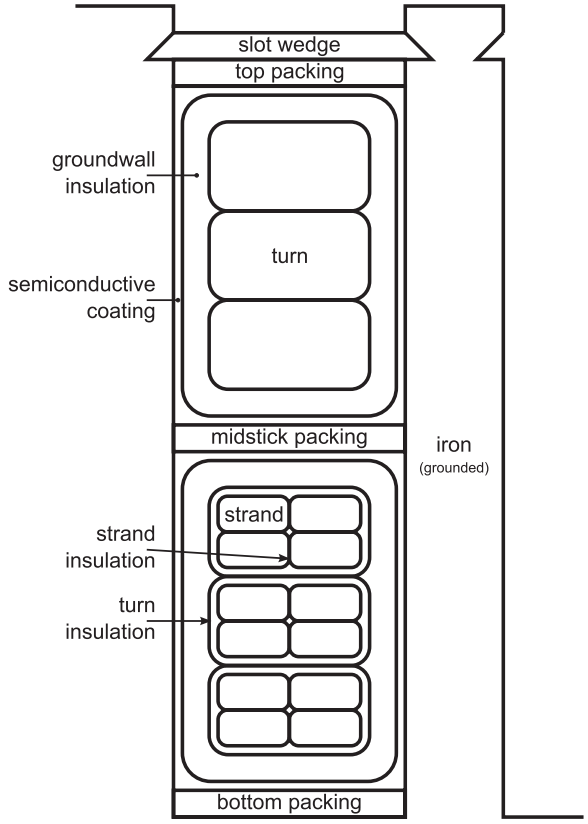


Figure 2: Slot cross section of a form wound multi-turn coil. Current flows through the copper strands.

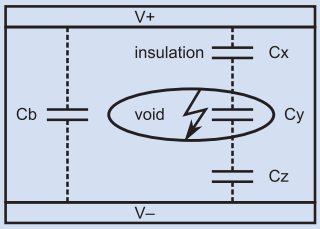


Figure 3: Schematic of a partial discharge inside a void in solid insulation.

## Partial discharges

The void in figure 3 is gas filled, usually air. During normal operation the changing voltage between V+ and V– causes insulation capacitance Cb to charge and discharge. The void can be represented by capacitance Cy, the insulation surrounding Cy by Cx and Cz. Cx, Cy and Cz will charge and discharge too. When the voltage on Cy causes a field strength beyond 3 kV/mm, the air will break down and we have a partial discharge (PD). This happens multiple times as long as Cy is recharged.

## Classic PD measurement

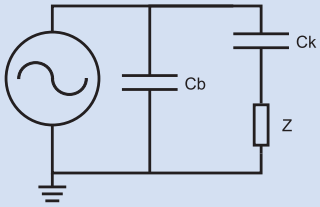


Figure 4: Schematic of a partial discharge measurement circuit.

The winding insulation, represented by Cb, is energized using a high voltage supply. When a PD occurs in the insulation, it will cause a current pulse through Cb, coupling capacitor Ck and inductance Z. The voltage on Z is recorded using a computer or peak detector, and is called apparent charge.

Given the epoxy-mica insulation, the practical upper voltage for generators is 20 to 30 kV line-to-line. The 1750 MW generator mentioned in the introduction runs on 'just' 23 kV (and a massive current of 28 kA, handling this is a challenge too). A transformer is used to get the voltage to 220–400 kV transmission levels. In epoxy-mica insulations for 6 kV machines and higher, field strength is beyond 3 kV/mm, the breakdown value of air. Such field strength can cause partial discharges (PD), which can cause lots of trouble. Luckily PD also allows some advanced diagnostics to be performed.

## Insulation degradation

Larger electric machines are designed to operate for decades. For example, the new French plant Flamanville 3, including that 1750 MW generator, is designed to last 60 years. To reach such an age in an economically sound way, some form of condition based maintenance (CBM) is needed. Outages can easily lead to high loss in revenue, in some cases more than the value of a new machine itself because of long repair and delivery times. To prevent such loss, one needs to assess the condition of his assets to take CBM decisions. In case of a high voltage machine it turns out stator insulation failure is one of the more common outage sources, so preventing this has priority.

As noted before, requirements on stator insulation are fairly high. Next to electric stresses, significant mechanical stresses are present, caused by for example vibration, Lorentz forces and thermal expansion, not surprising when a machine heats up more than 70°C. Another cause of weak spots are the air pockets which have survived the vacuum impregnation, or which have been newly created by these degradation processes.

All these processes cause deterioration of insulation, which is accelerated by the presence of moisture, pollution and chemicals. Usually the time between initiation of a weak spot and a resulting short circuit is on a multi-year scale – if the short circuit ever occurs – however a short circuit is that costly that preventing it is key.

## Partial discharges

When the electric field on the site of a weak spot is large enough, partial discharges (PD) will occur. Basics of partial discharges are shown in a separate box. PD cause very local pressure increase, heating and generation of some reactive by-products like ozone. As PD on a local site easily occurs millions of times, it can start to affect the surrounding insulation, and cause local degradation. Luckily measurement of PD is possible since a PD event is a tiny charge movement, resulting in high frequency current pulse. The measurement circuit returns an 'apparent charge', which is some indication of the charge which moved during the partial discharge. Apparent charge is measured in pico Coulomb (pC) or nC. Techniques and procedures for measuring apparent charge have been standardized by IEC and IEEE.

The PD level (level of apparent charge) of a stator insulation depends on many factors, including voltage, temperature, humidity, and deterioration of the insulation. PD in stator insulation is always present, and the level generally rises with test voltage and greater deterioration. Therefore, a periodical measurement of PD level at different voltages provides an indication of the condition of the weakest spot in the insulation.

Another useful property of PD is that their occurrence is related to the phase angle of the sine voltage and to the type of defect they come from. In this way, patterns like given in figure 5 can be generated when PD occurrences during multiple periods are accumulated. Interpreting such patterns is an expert task, requiring both knowledge and experience.

## Periodical measurements using damped AC

Usually a high voltage machine is taken out of service once a year or few years to take diagnostic measurements. Next to PD levels and patterns at different voltages, the dielectric loss factor is measured. Dielectric loss is usually small but the value is important to indicate overall insulation condition. Trending PD and dielectric loss data over years gives a good estimation of insulation condition and is used to determine need for maintenance like coating or rewinding.

One of the difficulties of high voltage AC measurements is the power required to energize the winding. Since tests are to be performed at different voltages, also higher than normal operating voltage, a mobile controllable power supply is needed. Even with small motors at least a few kVA is required to compensate the winding capacitance. Test sets are therefore relatively hefty.

In testing of high voltage cables in the field similar problems exist. To solve this, TU Delft and the Swiss company Seitz Instruments developed the Oscillating Wave Test System (OWTS) which became a world wide success. The same technology can be applied to stator insulation. An OWTS is shown in figure 6.

The main difference between a conventional AC test set and an OWTS is the power supply. In OWTS a small high voltage DC supply charges the winding to the required voltage and then a large coil switches in parallel to the winding. A lightly damped oscillation (DAC) at 50–500 Hz starts which gives electric stresses comparable to AC testing. During the damped oscillation, PD is measured, and the amount of damping relates to the dielectric loss factor. The usage of a small HVDC supply results in low power requirements (wall outlet), and in a test set which can easily be taken along in a van.

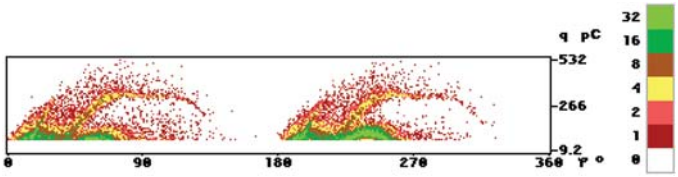


Figure 5: PD pattern of a stator insulation. Phase angle is on the horizontal axis, apparent charge on the vertical axis. Each dot represents at least one PD, multiple PDs at the same place are indicated by change in colour. The bows starting at 40° and 220° indicate larger voids are present.

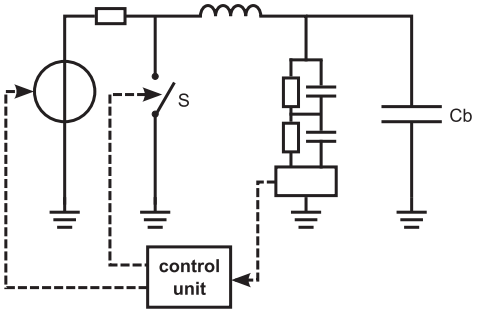


Figure 6a: Schematic of an OWTS. When switch S operates, test object Cb and the inductor start to oscillate.

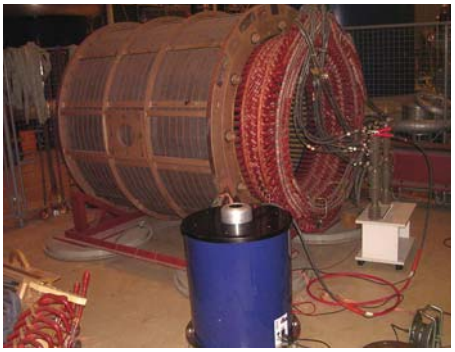

Figure 6b: 30 kV DAC test set (blue) connected to a 23 MW stator. The system is remote controlled using a laptop.

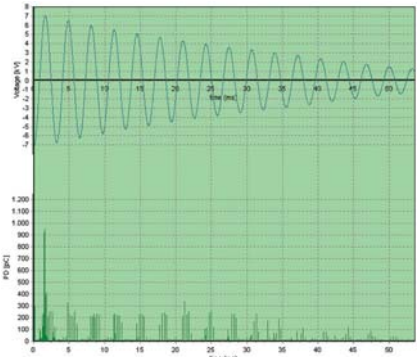

Figure 6c: Example voltage and PD record of a single oscillation.

## Goals and results

Goal of this project was to determine how suitable DAC test technology is to test stator insulation, and to determine how it has to be applied. My first task was to figure out how AC standards have to be applied in DAC machine testing. Conforming to a standard is important because it allows for better comparisons. Comparing AC IEEE and IEC standards on PD and dielectric loss factor measurement may not be the most inspiring duty, it was very important to get a good test procedure. These comparisons, along with first hand practical experience, resulted in a test procedure description with flow chart.

It is nice if we can measure according to standards – seems possible – and it is even better if the parameter values at AC and DAC are comparable. If that is the case, the experience gathered in decades of interpreting data can be used. To check this, I conducted several measurements on real motors and generators, using AC and DAC, and compared the results. Measurements have been performed both in the laboratory and on service aged machines in the field. It turns out no significant differences exist between the AC and DAC PD and dielectric loss factor magnitudes. Figure 7 shows some data obtained for the comparison.

A third achievement of this project is a software to generate PD patterns like figure 5 using DAC. In the AC case, such a picture is generated using data of a fixed amount of time, for example 2 minutes. In the DAC case data of a number of consecutive oscillations, for example 100, is gathered and processed. The patterns obtained show many features known from AC. An expert can get an idea of the defect type(s) using the patterns, and since not every defect type is severe, this is useful. More real

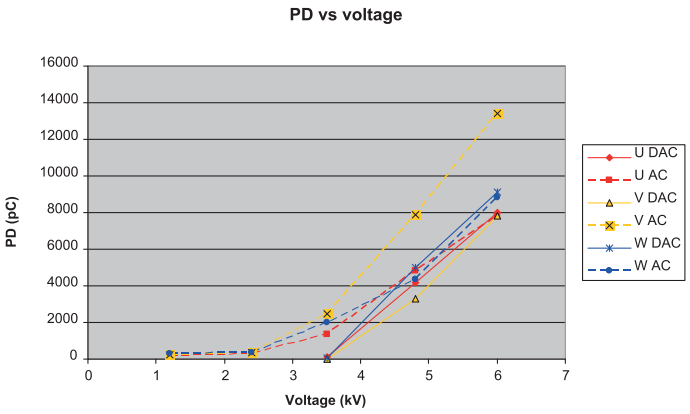


Figure 7: Example of PD values measured at a 36 year old 6 kV 3 MW motor, using both AC and DAC. Each winding U, V, W was measured separately. Winding V shows difference, but given the facts PD occurrence is a statistical process, different measurement equipment was used, and ten days passed between AC and DAC measurement, this is not significant.

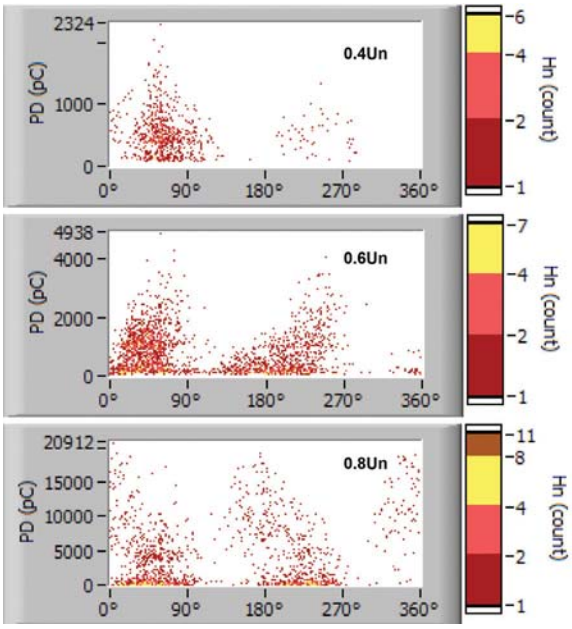


Figure 8: Example of DAC PD patterns obtained at an electrically aged stator. Un is the rated line to line voltage, in this case 15.7 kV. DAC frequency is 426 Hz.

world experience will be needed to interpret these patterns and to see if it is that promising. Figure 8 shows an example.

Doing many measurements and a lot of programming, a bunch of data analysis, many answers and questions arise, and not all questions can be answered. For example, when doing a PD measurement on a machine which has been off-line some time, standards recommend pre-stressing by applying the highest test voltage for a few minutes immediately before measuring. Some voids will then stop giving PD, because PD by-products turn the void inner surface more conductive (when voltage is removed and many hours pass, that conductive layer disappears again). At 50 Hz AC, in 5 minutes 15000 cycles occur while DAC does not get beyond some tens. However during charging of DAC the electric field is not constant either, which can add up to the cycle count. To get an answer to a question like this, how to do pre-stressing, more systematic comparisons on different stator insulation types are to be performed than one's graduation project allows for.

Overall, the DAC technique for PD measurement on machines looks very promising. Both PD level and dielectric loss levels do not show significant differences between AC and DAC measurement. PD patterns also show many similarities. Therefore same rules of thumb can be applied which have been created during more than 40 years experience of AC measurements. Also the DAC method has showed up to be user-friendly, and an easy to use test procedure was derived from standards and first hand experience.

# De eerste lustrumweek

Menig lezer weet het wellicht al; de Electrotechnische Vereeniging bestaat dit jaar 105 jaar. Dit is een happening die wij niet onopgemerkt voorbij kunnen laten gaan. Door het jaar heen zorgt de vereniging dat voor de leden altijd iets leuks valt te beleven. Daar komen dit jaar dan ook nog eens twee lustrumweken bij die helemaal afgetopt zijn met activiteiten voor zowel leden als niet-leden.

**Auteur: Jasper Boot**

Om dit lustrumjaar in goede banen te laten verlopen heeft het Bestuur verschillende commissies geïnstalleerd, waaronder de Lustrumcommissie. Dit jaar bestaat deze commissie uit vier geklofte commissieleden die dag in, dag uit in de weer zijn om geweldige activiteiten neer te zetten en de leden te voorzien van de correcte dasjes, strikjes en truien. Zo'n Lustrumcommissie is niet zomaar een commissie en daarom wordt hun maXXImale inzet ook maXXImaal gewaardeerd. Daarop inhakend heeft de commissie voor het thema "MaXXImal" gekozen en dit thema valt dan ook vaak terug te vinden op kledingstukken en promotiemateriaal.

Door het jaar heen zorgen de commissieleden van de Lustrumcommissie voor leuke evenementen waar iedereen naar uitkijkt. Al aan het begin van het jaar voorzagen zij de leden van de Vereeniging van pre-lustrumactiviteiten waar menig persoon bekend werd gemaakt met het thema. Ook kregen zij voorproefjes van de activiteiten die hen nog te wachten staan.

De eerste activiteit waar de leden van hebben mogen genieten was letterlijk het Lustrumvoorproefje. Bij dit samenzijn werd het thema gepresenteerd en kwamen verscheidene personen erachter of zij wel of geen rum lustten. Ondanks dat niet iedereen over de rum was te spreken was dit een geslaagde borrel.

Niet lang daarna werd de borrel opgevolgd door een 21-spellenavond. De hele avond lang werden er spellen gespeeld die zo veel mogelijk met het getal 21 te maken hadden. Er werd onder andere blackjack gespeeld en het door de commissie in elkaar gezette spel Blokus zorgde ervoor dat de deelnemers elkaar goed dwars konden liggen.

De ´Ken je deze nog?´-borrel stond in het thema van nostalgie. Iedereen kent de cartoons en gespeelde series van vroeger nog wel. Een combinatie van een leuke quiz en oude intromuziekjes van vroeger op de achtergrond leverde deze avond aan de aanwezigen veel "Ohja!"-momenten op.

Zoals eerder in de tekst vermeld heeft de ETV dit academisch jaar twee lustrumweken. De eerste lustrumweek is inmiddels al voorbij en de activiteiten binnen deze week hebben enorm bijgedragen aan de leuke herinneringen die ons geheugen staan gegrift. Van maandag 21 tot en met zaterdag 26 maart was er van alles te beleven.

Een sfeervolle impressie van de 21-spellenavond.

Iedereen was erg geconcentreerd tijdens het Groot Dictee der ETV.

Op maandag ging de lustrumweek van start met de Cabaretavond. In de /Pub samengekomen zorgde Camerettenfestivalfinalist Theo van Duuren voor een mooi optreden, waarop menig deelnemer zijn of haar lachspieren weer eens kon trainen. Niemand zal meer op dezelfde manier tegen goede doelen aankijken en niet-rokers denken nu wel een tweede keer na voordat ze een sigaretje afslaan.

De dinsdag daarna vond het Groot Dictee der ETV, samengesteld door twee van onze meest taalkundige leden, plaats in DOK Delft. De fraaie ruimte droeg enorm bij aan de sfeer en deze werd nog eens mooi afgekleed door de echo's van de krakende hersenpannen van de aanwezige elektrostudenten. Woorden als "vousvoyeren" en "ge-e-maild" zorgden voor vele vraagtekens bij de deelnemers. De deelnemer met de minste fouten mocht zich de gelukkige winnaar noemen en nam na het dictee een mooie, gegraveerde pen in ontvangst. De avond werd afgesloten met een heerlijk "convalescentiepintje".

De dag erna zaten de eerste mensen om half acht 's avonds al afwachtend met een pintje in hun hand aan de bar van de Kobus Kuch. Aldra zou de kroeg snel vollopen met studenten van alle jaren. Vooral de eerstejaarsstudenten van Electrical Engineering waren goed vertegenwoordigd. Eenmaal verenigd werden de drankjes afgerekend en ging de Kroegentocht van start. Bij de bezoekjes aan onder andere de Doerak en De Klomp werden de nodige, goudgele rakkers genuttigd. De kroegentocht werd met een bezoek aan Café De Oude Jan afgesloten.

Op donderdag begon het Bestuur al vroeg met de voorbereidingen om een overheerlijke taart in de hal te serveren. Om half elf mochten de President en de Commissaris Onderwijs in de faculteit EWI omroepen dat er gratis taart werd uitgedeeld in de hal op de begane grond. Het duurde dan ook niet lang voordat er zich een menigte had gevormd van mensen die graag een graantje mee wilden pikken. Niet geheel onverwachts ging de taart helemaal op.

Kort daarna kon iedereen zijn beste beentje voor zetten bij de activiteit die volgde; het ETVoetbaltoernooi. Met prachtig weer en enthousiaste voetbalteams was dit een erg leuk toernooi. Het Bestuur was gekleed in jacquet en hoewel dat prachtige teamkledij was, zorgde de gladde brogues en de dikke kledinglaag i.c.m. een felle zon toch voor een kleine handicap.

Onder het genot van een biertje werden meerdere kroegen bezocht.

Op donderdag werd gratis taart uitgedeeld aan iedereen die er belangstelling voor had, om de verjaardag van de ETV te vieren.

Na de sportsensatie werd er de mogelijkheid geboden om bij te komen in de /Pub bij de Zusjesborrel. Iedereen mocht zijn of haar zusjes meenemen en ook andere studieverenigingen waren van de partij.

De volgende dag was het tijd voor een uitgebreid evenement. 's Ochtends vroeg stonden er zeven teams klaar om te vertrekken vanaf EWI. Door middel van opdrachten manoeuvreerden de teams in hun voertuig over smalle en soms wat hobbelige wegen. Zo nu en dan week een team wat af van de route, maar gelukkig was iedereen aan het eind van de dag weer terecht. Het team dat de het minst aantal kilometers had gereden was de winnaar van de competitie.

De laatste dag van de lustrumweek, zaterdag 26 maart, was een bijzondere dag voor de vereniging. Behalve dat de ETV deze dag 105 jaar oud werd, mochten er ook nog eens twee professoren van faculteit EWI toetreden tot het selecte gezelschap Ereleden van Vereeniging. Middels een buitengewone vergadering werden de heren prof. ir. L. van der Sluis en em. prof. dr. ir. L.P. Ligthart geïnstalleerd. Na een toespraak van de President en vervolgens van de Erevoorzitter em. prof. ir. J.L. de Kroes werd de daad bij het woord gevoegd en ontvingen beide professoren hun ereledendas en hun speldje. Beide heren hielden nog een toespraak waarin zij onder andere de bestuursleden voor het eerbetoon bedankten en de anderen voor hun aanwezigheid. De vergadering werd gesloten en in de /Pub stonden iedereen lekkere hapjes en drankjes te wachten, alwaar de aanwezigen de kans kregen om de zojuist geïnstalleerde ereleden te feliciteren.

De eerste week is weliswaar afgelopen, maar de tweede week belooft ook erg mooi te worden. De verkoop van de soms wat antieke objecten moeten een bron van inkomsten gaan vormen tijdens de lustrumveiling. De veiling komt niet ten einde voordat de strijd om het laatste object is gestreden.

Het Bestuur van de intussen wat rijkere Vereeniging neemt niet veel later bij de lustrumreceptie de felicitaties van de aanwezigen in ontvangst, waarna zij zich samen met enthousiaste leden buiten de deur vol zal stouwen met een lekker diner.

Een echte ETV'er weet zijn voorkeur voor sterk te beperken tot de jonge jenever genaamd Vlek. Inmiddels wordt deze Delftsche drank niet meer in Delft gebrouwen, maar dat staat ons niet in de weg om de distilleerderij in Leeuwarden te bezoeken.

Solide consumpties kunnen weder worden genuttigd tijdens het 21-verdiepingendiner. Elke etage van faculteit EWI zal deze avond iets lekkers bereiden, opdat er voor iedereen genoeg heerlijkheden aanwezig zullen zijn.

Laat de volgende dag de handjes maar wapperen tijdens de tweede sportdag, waar ETVolleybal zal worden gespeeld. De gebruikelijke barbecue, gevolgd door een avondje met karaoke in de /Pub zorgen voor een mooie afsluiting van de dag.

De laatste activiteit van de lustrumweek is het OGD-ETV Gala op 21 mei. Het vindt plaats in Partycentrum De Schaapskooi en het belooft nu al een prachtig gala te worden. Tot slot organiseert de ETV op de dinsdag na de lustrumweek nog het Symposium met als thema "Veiligheid in de transport" Lang verhaal kort: er staat ons nog heel veel leuks en interessants te wachten!

**Tijdens het ETVoetbaltoernooi deed men erg enthousiast mee, zoals ook te zien is.**

**De lustrumcommissie met haar QQ´ers.**

Electrotechnische Vereeniging

# ETV-OGD Lustrumgala

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Losse verkoop: 4 april | Tickets @ ETV-balie | Diner: 18:30 | Gala: 22:00 - 4:00

# The Mysteries of the Electric Guitar

During the 1930's, big bands became even bigger than before. As a result, guitarists struggled to compete with large brass sections, and the need for an electrically amplified guitar became apparent. People had been experimenting with electronically amplifying musical instruments since the early 1900's, with the first patents dating back to the 1910's, but the first commercially available electric guitar didn't become available until 1931.

**Author: Ben Allen**

Nowadays, the electric guitar is an instrument played by many around the globe. While its prevalence in pop music has faded because of the use of computers to make music quickly and easily, the electric guitar is still used in many forms of music and most live bands will have a guitar and bass player who use electronic instruments. But when it comes down to it, most musicians have no idea how their instrument really works. It seems like black magic, you plug the guitar into an amplifier and sound comes out when you play the strings. So how do these pickups really work?

## Two Kinds of Pickups

In general, there are two forms of electronic pickups: piezoelectric and magnetic pickups.

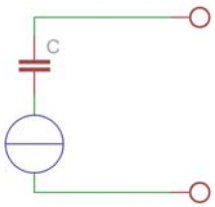



Figure 1: The electrical model for a piezo pickup.

Piezoelectric pickups work on every kind of string because they transform vibrations into electrical signals. The term piezo comes from the greek word that means "to squeeze". The pickup generates a voltage proportional to the amount of pressure applied - which means that a sound wave compresses the material in the pickup. Piezoelectric pickups must be used in combination with a special preamplifier, because piezo pickups appear as a voltage source in series with a capacitance, as shown in figure 1.

Magnetic pickups only work with steel strings, as they consist of coils and magnets. The arrangement of these magnets varies per pickup. Some pickups have the magnets sitting within the coils, while others have the magnets sitting below the coils with soft iron cores inside the coil. The basic operation of the pickup, however, is unchanged.

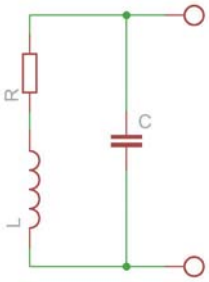



Figure 2: The electrical model for a magnetic pickup at rest.


Figure 3: A single-coil pickup.

## The Magnetic Pickup

The most commonly used pickup in electric guitars is the magnetic pickup. These pickups have the advantage of a low output impedance and the fact that they do not require a preamp, which also means they do not require power to operate. However, some guitar models include a preamp after a magnetic pickup to shape the sound of the guitar.

In general there are two forms of magnetic pickup used in guitars. The first is the single-coil pickup, as shown in figure 3. The second, predictably, is a dual-coil pickup more commonly known to guitarists as a humbucker, shown in figure 4. Humbuckers are known for their more powerful output and are popular among rock guitarists for this reason, but this is but a by-product of the technique used to accomplish the feat they were

Figure 4: A humbucker pickup. Note the enclosure contains two single-coil pickups.

named after, and what they were intended for. Humbuckers consist of two coils wound in opposite directions, in series with each other. Because these coils are electrically out of phase, to describe it roughly, common-mode signals - such as hum generated by nearby transformers - cancel each other.

## Black Magic

We have taken a cursory glance at what a pickup looks like electrically and what kinds of pickups are in common use, but now we come to the core issue: how do they actually work?

The answer is deceptively simple. The permanent magnets in the coil cause a magnetic field, of which the field lines run through both the coil(s) and a section of the strings. When the strings are at rest, the flux through the coils is constant. When the strings are in motion, the flux changes, which induces a current in the coil. The magnitude of the current produced is dependent on the velocity of the moving string, and not its amplitude as one might expect - but this follows from the reasoning that it is the change in flux that induces the current in the coil.

As we saw in figure 2, a guitar pickup which is at rest can be modeled with a similar model to the one we use for coils in basic network theory. When the vibrating strings start to add energy to the mix, the analogy ceases to be accurate and we must add an AC voltage source in series with the inductor to account for the induced voltage across it. However, at this point all we have is a guitar pickup, but no additional circuitry for amplification.

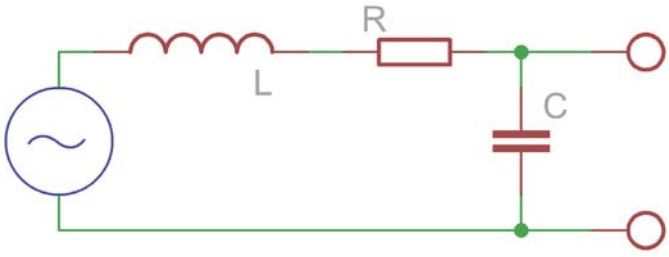



Figure 5: A model for a pickup that is being excited by vibrating strings.

## Let's Get Loud!

Now we have a basic model of our pickup in its excited state, we need to feed the signal to the amplifier. We modeled the combined system of cable + amplifier input as a parallel capacitance and resistance. As you can see in figure 6, the addition of $C_{ext}$ and $R_{ext}$ changes the equation somewhat, and the network becomes a second-order low-pass filter.

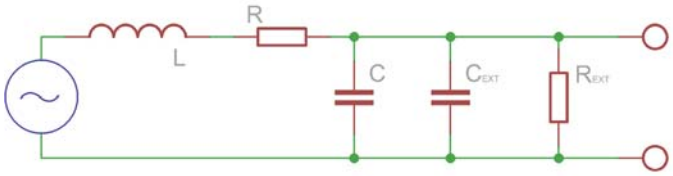



Figure 6: The same as figure 5, but with Cext and Rext added to represent the effects of the guitar cable and amplifier input.

What this means is that the difference between an inexpensive cable and a professional-grade well-shielded cable, or a well-designed amplifier and a cheap one, can become very pronounced. This is why most bass guitars and some 6-string electric guitars include a built-in preamp. While this might have the disadvantage of requiring a battery, the advantage is that the output is buffered and not so dependent on external components. Guitarists can spend decades looking for the right sound, or a cable that sounded *"just like the old one used to"*. With some elementary circuit analysis techniques, we can come one step closer to that perfect tone.

However, in the end a good guitar sound depends on the skill of the musician playing. You can have € 5000,- worth of guitar gear, but if the music isn't in your soul, you'll never sound good.

On the other hand, if you are Eddie van Halen, it doesn't matter what guitar you use - as long as it still has six strings.

# Joost may know it

Why are LEDs always dome-shaped, and never, for instance, elongated, so that you could make a LED tube light out of them?

**Author: Dr. Ir. Michiel Pertijs, Electronic Instrumentation Laboratory**

A flexible OLED tile by Holst Centre and AGFA

The short answer is: they're not always dome-shaped, and LED tube lights actually exist! But indeed: most of us will associate the term 'LED' with the little red or green indicator lights that faithfully tell us whether our stereo is turned on, or whether the battery of our smart phone needs to be charged.

The majority of these devices tend to come in small, cylindrical, dome-shaped packages. Inside the package is a small semiconductor chip, the actual light-emitting diode, which is essentially a point source of light. The dome-shaped epoxy encapsulation plays the role of optical lens, and turns the light emitted by the diode into a beam. Moreover, the high refractive index of the encapsulant prevents light from being reflected internally at the semiconductor-epoxy interface, thus typically increasing the LED's efficiency by a factor of 2-3.

LED technology has gone through considerable changes since such indicator LEDs became commercially available in the 1960's. Modern high-power LEDs can emit white light at efficiencies of over 140 lumens per watt. This makes them an ideal replacement for the good-old incandescent light bulb, whose efficiency is typically more than a factor of 7 lower. Combined with the much longer lifetime of LEDs, this has given rise to a fast growing solid-state lighting market.

As a first step towards replacing incandescent lamps, various companies are selling retrofit LED lamps to replace traditional bulb or tube lamps. These LED lamps come in packages that fit in conventional lamp fixtures, and also look like conventional bulbs or tubes. Inside, however, they contain arrays of highly-efficient solid-state LEDs. Putting many of these point sources together creates the impression of a light-emitting surface.

The shapes and forms in which such LED lamps can be made are limited by thermal considerations. LEDs lose the energy that they dissipate in the form of heat in a very different way than incandescent lamps. The latter emit the majority of the energy that they don't turn into visible light in the form of infrared radiation. Therefore, no special measures are needed to prevent them from overheating, in spite of their low efficiency. LEDs, in contrast, rely on thermal conduction through their package to keep cool. As a result, even though LEDs waste much less energy in the form of heat than incandescent lamps, they can get very hot. And when they do, their efficiency and lifespan drops, and their colour changes. Therefore, LED packages and fixtures need to provide sufficient ability to sink heat, and cannot have arbitrary shapes and forms.

An emerging class of LEDs that allow much more flexibility and can be used to make truly light-emitting surfaces are organic LEDs, or OLEDs for short. OLEDs consist of one or more layers of organic semiconducting materials, sandwiched between electrodes. They can in principle be produced at very low cost using roll-to-roll production techniques. Thus, flexible, large-area lamps and displays can be made. While still lagging behind in efficiency, these devices have the potential to radically change the way we illuminate our homes and offices in the future. You may someday find yourself decorating your living room with LED wallpaper.


The Master LED light bulb from Philips

# Hier invoegen: p21Topdesk.pdf

# Exploring the EE groups

## Electronics

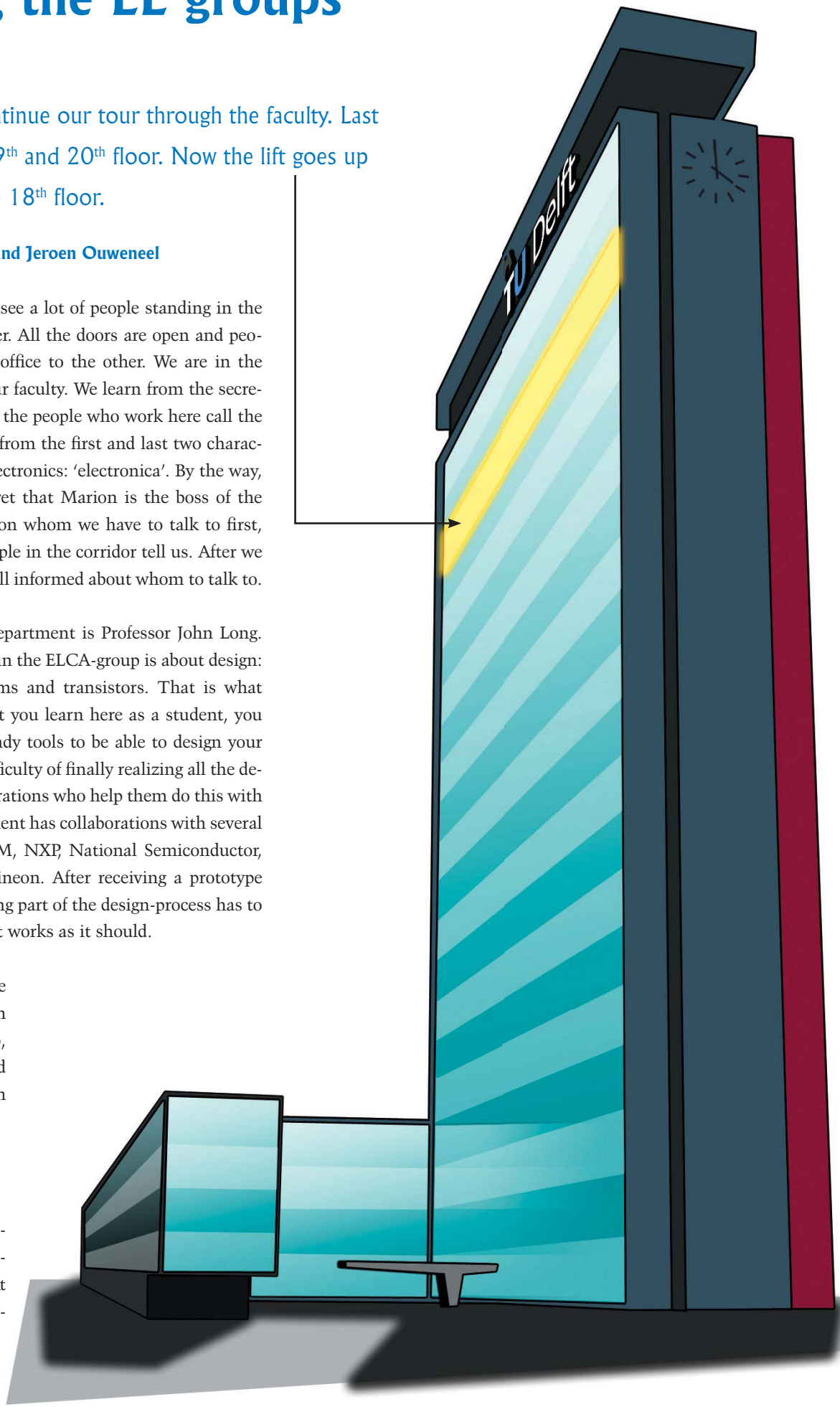
In this Maxwell we continue our tour through the faculty. Last time we went to the 19th and 20th floor. Now the lift goes up and finally stops at the 18th floor.

**Authors: Imke Zimmerling and Jeroen Ouweneel**

We jump out of the lift and see a lot of people standing in the corridor talking to each other. All the doors are open and people keep walking from one office to the other. We are in the electronics department of our faculty. We learn from the secretary, Marion de Vlieger, that the people who work here call the group 'ELCA', which comes from the first and last two characters of the dutch term for electronics: 'electronica'. By the way, it seems to be an open secret that Marion is the boss of the department. She is the person whom we have to talk to first, that is what the friendly people in the corridor tell us. After we have left her office we are well informed about whom to talk to.

The real chairman of the department is Professor John Long. He explains that everything in the ELCA-group is about design: making new circuits, systems and transistors. That is what people do here. This is what you learn here as a student, you learn how to use lots of handy tools to be able to design your own systems. Due to the difficulty of finally realizing all the designs there are several cooperations who help them do this with in the industry. The department has collaborations with several companies. For example IBM, NXP, National Semiconductor, STMicroelectronics and Infineon. After receiving a prototype of a design another interesting part of the design-process has to take place: testing whether it works as it should.

We also learn that there are three subdepartments within the group: the space group, the biomedical group and the wireless communication group.




### History

In the late sixties, the Microelectronics department started off as a TV-laboratory. At the time, a couple of revolu-

tionary techniques were being developed in this field: color-TV and a new information service called 'Teletekst'.

Under the lead of Professor Jan Davids, a new department was started at the TU Delft, whose aim was to improve these techniques and - in general - to study and design analog circuits. These last two are still the main focus of the Electronics group.

## Research topics

### Wireless Transmissions

The wireless transmission researchers are currently busy with developing microscale wireless transmission devices. There are a number of challenges here. To begin with, the signals are to be sent on frequencies in excess of 10 GHz - instead of the commonly used GHz range used for modern wireless communication. The higher frequencies allow a much higher data rate.

Furthermore, research is being done to reduce the power consumption of the wireless systems, which is not just useful for consumer electronics (i.e. less frequent battery charges needed), but also very important when these systems are integrated in the implantable devices made by the biomedical team, which will be discussed in more detail later on. These two points (transmission speed and power effeciency) form a difficult, but always present trade-off.

Another interesting topic of reasearch is radio imaging. Normal optical sensors respond to electromagnetic frequencies that range within the spectrum of visible light. Sensorsystems are being designed that can detect EM-waves ranging outside of the visible spectrum and the resulting pictures contain very different information. This enables us, for example, to look through the human skin, which makes it possible to see tumors without the need for any incisions or being exposed to radiation.

### Biomedical Engineering

The field of biomedical engineering researches and develops different kinds of microelectronic devices that can be used in the medical sector. Currently, cochlear implants are designed that offer a more permanent solution to the hearing impaired, as the devices are implanted into the ear. Using these systems, hearing can be greatly improved, compared to 'regular' hearing aids.

Another interesting research topic is that of neurostimulators. These are devices that can be implanted directly into the human brain, stimulating certain areas that do not work as they should. The idea is that these devices first read signals from the human body, and then respond (i.e. send a certain signal directly into the brain) accordingly.

Figure 1: The lab-room where a modulator is being tested.

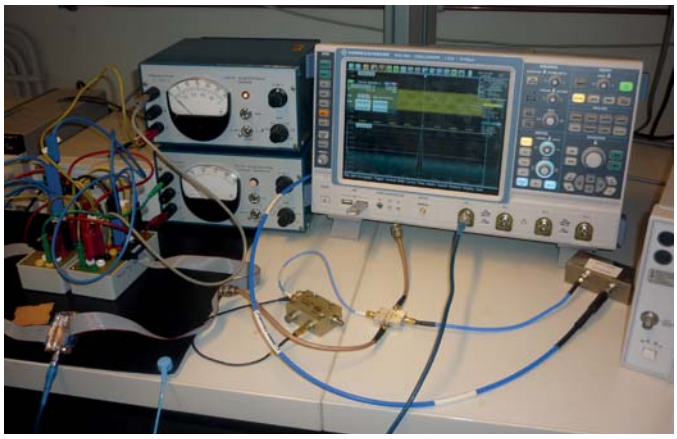


Figure 2: The test-setup for the modulator.

Figure 3: The inner workings of a neural stimulator.

At the moment, these devices are actually being built and tested. Some of the main design issues are the power supply - as the implants need power to send signals, they also need their own power supply built-in, but they have to be small enough to actually be implanted. Also, to change settings, or read the sensor data, these implants have to be able to send and receive wireless signals. As mentioned, this is where the research of wireless transmissions can be applied directly.

## Satellites

In the space group everybody is enthusiastic about satellites. Two years ago the very first satellite from Delft ever was launched: the Delfi C3. It is still operating in orbit. But the designers of the satellite are not yet satisfied: The next missions are already scheduled. The next satellite to be launched is the Delfi N3xt. Its task is to bring new experiments into space. It will be able to test a special new type of solar cells which is fabricated in Dimes. It will also test a new type of satellite drive, which can operate without explosives.

Another new mission is the QB50 experiment. The aim is to let 50 nanosatellites fly in a formation. As we are told you can compare them to little bees or ants. The satellites are ought to operate as one big swarm. It is common knowledge among biologists that bees are able to overlook a huge area as they fly in a swarm. This is exactly what this new mission aims at: To be able to control a big area with the help of satellites. At the moment this is already done by big satellites. They are able to see a lot more details than a nanosatellite. But they have a big disadvantage: because they go in an orbit around the earth, they sometimes loose an object and cannot find it again. With a swarm of satellites this would not be a problem any longer. More 'eyes' are able to fully monitor a big area.

But there is one big aim left: reaching the moon with a satellite. The mission is called 'Olfar' and its aim is to support the 'Lofar' telescope in detecting more radiation from space. It is the intention to have a satellite in the orbit of the moon, but it would already be a great succes to reach the moon with one of the nanosatellites at all.

The group cooperates with the faculty of aerospace engineering and also with astronomists. A lot of different people work on the projects: students, PhD's and other scientific staff. »

Figure 4: an impression of the satellite lab.

## Social activities

The ELCA-group is, in general, a very social group of people. They have weekly group meetings, in which everyones problems are discussed, offering a wide view from both people who are directly involved in the research and people that are not, but may have an interesting perspective on the matter.

But there has to be fun besides studying and working as well, so every now and then there is an ELCA movie night on the 18th floor. To keep in shape, other activities are planned, such as soccer tournaments or - a typically Dutch activity - walking across the mud flats in the North Sea.

Since last year, the ELCA-group even managed to initiate a musical evening activity: the ELCA-festival. With its second edition, held only a few weeks ago on the 20th of March, it promises to be an annual musical festival. The ELCA-festival was held in the /Pub - the faculty bar in the basement of EWI - and featured many bands and other performances. Here of course also the ELCA-band has to be mentioned. This band performs exclusively at the festival. It consists of people of the department, but also some guests play with the band. The rehearsals of the band at the cultural centre in the weeks and months before the festival were a good experience. Many members of the group joined in to listen or perform their own little piece. So every rehearsal was a social event, aswell. The ELCA-festival is not just exclusively for the Electronics staff and students, so if you missed it, keep an eye open for the posters of the next edition!

If you want to come in contact with one of the members of the ELCA-department we recommend you to do the same as we did: drop in at Marion's office!


Figures 5,6,7: Impressions of the ELCA-festival.

# Experiences of MSc students

## Menno Vastenholt: A Sub-GHz UWB receiver for Wireless Biomedical Communication

### Supervisor: Dr. ir. Wouter A. Serdijn

The Biomedical Electronics Group is known for its contributions of microelectronics in neuroscience and medicine. An example of this are implantable medical devices which are used for monitoring, adjusting and improving the treatment of medical disorders. A part of the technology in these implantable devices is wireless communication. Mark Stoopman, a previous MSc student, completed his thesis in the field of Ultra-Wideband Communication [1], and designed a transmitter architecture. However, a receiver architecture still has to be designed. Therefore, my thesis focuses on designing a corresponding UWB receiver. Important factors that I need to tackle are in-band and multipath interference as well as antenna readout to minimize signal distortion.

[1] Mark Stoopman and Wouter A. Serdijn, "Sub-GHz UWB Biomedical Communication", Proc. IEEE BioCas, Paphos, Cyprus, Nov. 3 – 5, 2010

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# Cooking with...

## Guit-Jan Ridderbos

# Venere

At the start of this year, during January, I spent three weeks on Sicily, Italy. As you may know, Italians, and when it comes to that especially Sicilians, are very fond of cooking and eating good food. As I was there, I tried to go along with the flow, so I did my very best to spend some time in the kitchen now and then to make some unusual dishes. As I was going through my local supermarket, I found a pack of black rice, which is called Riso Venere. This rice is originally from China, but it has been imported into Italy some time ago and now it is readily available across the country. If you ever visit Italy, be sure to bring some home with you. For this recipe you can also use other kinds of rice. Venere Nero is very aromatic wholegrain rice. As a substitute, look for some solid rice like "Notenrijst" or "Meergranenrijst".

### Ingredients for 2 persons

- Venere Nero, Black rice or some other wholegrain rice.
- Smoked salmon (>100gr.)
- Cherry tomatoes (1 packet, about 12)
- Some white wine (a glass to go into the dish)
- Parsley (a handful)
- Some garlic
- Olive oil
- Salt and pepper

OK, so now that we have this rice thing sorted out, let's start the cooking. Start off by chopping your garlic and fry it in some olive oil. Wait until the garlic is golden brown and remove it from the oil, we don't need it anymore. Put your chopped tomatoes and the glass of white wine in the oil and simmer for about 8 minutes. Next, add the chopped smoked salmon and continue to simmer for another 5 minutes. Before serving, add some salt and pepper and the chopped parsley. Don't forget to prepare the rice; the black rice needs a boiling time of at least 20 minutes.

Mix everything together; add some parsley on top to decorate and make some green salad on the side for some extra vegetables… after all, you should look after your health being a student!

*Eet smakelijk!*

Enjoy your meal!

### About Guit-Jan Ridderbos

I studied mathematics at the Vrije Universiteit in Amsterdam and I also obtained a PhD. from that university. My specialty is in topology. This branch of mathematics provides the foundations for analysis. Terms like continuity and limits are really topological concepts. A topologist is not so much interested in the shape of an object but rather in things like the number of holes it has. If a plane region does not have any holes, then it is called simply connected. If you studied Green's Theorem then you should have heard about this, since for some applications you need regions to be simply connected.

I started lecturing mathematics at Delft in January 2009 and I still enjoy doing this very much!

# Circuit Bodging

## Light-sensitive Theremin

The theremin is a musical instrument designed by a young Russian physicist by the name of Lev Segeivich Termen, known in the West as Léon Theremin, in 1920 and was actually an accidental discovery. Theremin was involved in Russian government research into proximity sensors, but ended up making the first truly electronic musical instrument.

**Author: Ben Allen**

After positive reviews at Moscow electronics conferences he showed the device to Vladimir Lenin, who was so impressed that he took lessons in playing it, and commissioned 600 to be made and distributed throughout the Soviet Union. Eventually, Theremin ended up in the United States, where he patented the invention in 1928.

While schematics for the RF-based theremin are available on the Internet, they're too complex to properly discuss here. Instead, to keep things simple and to allow you to build the circuit with parts you might have lying around, we present a light-sensitive theremin based on the NE555 timer IC. While possibly not as accurate or as nice sounding as the original theremin, it is a lot simpler and easier to build properly.

### So what does the circuit do?

The original theremin used the capacitance of a nearby body to change the speed of an RF oscillator, which was then modulated by another oscillator to produce a beat pattern - which is then amplified and is the sound you hear. Since we are using light instead of disturbed electric fields to create our sound, we have to approach things differently. Simply put, we need to change the output frequency of a NE555-based on how much light is available.

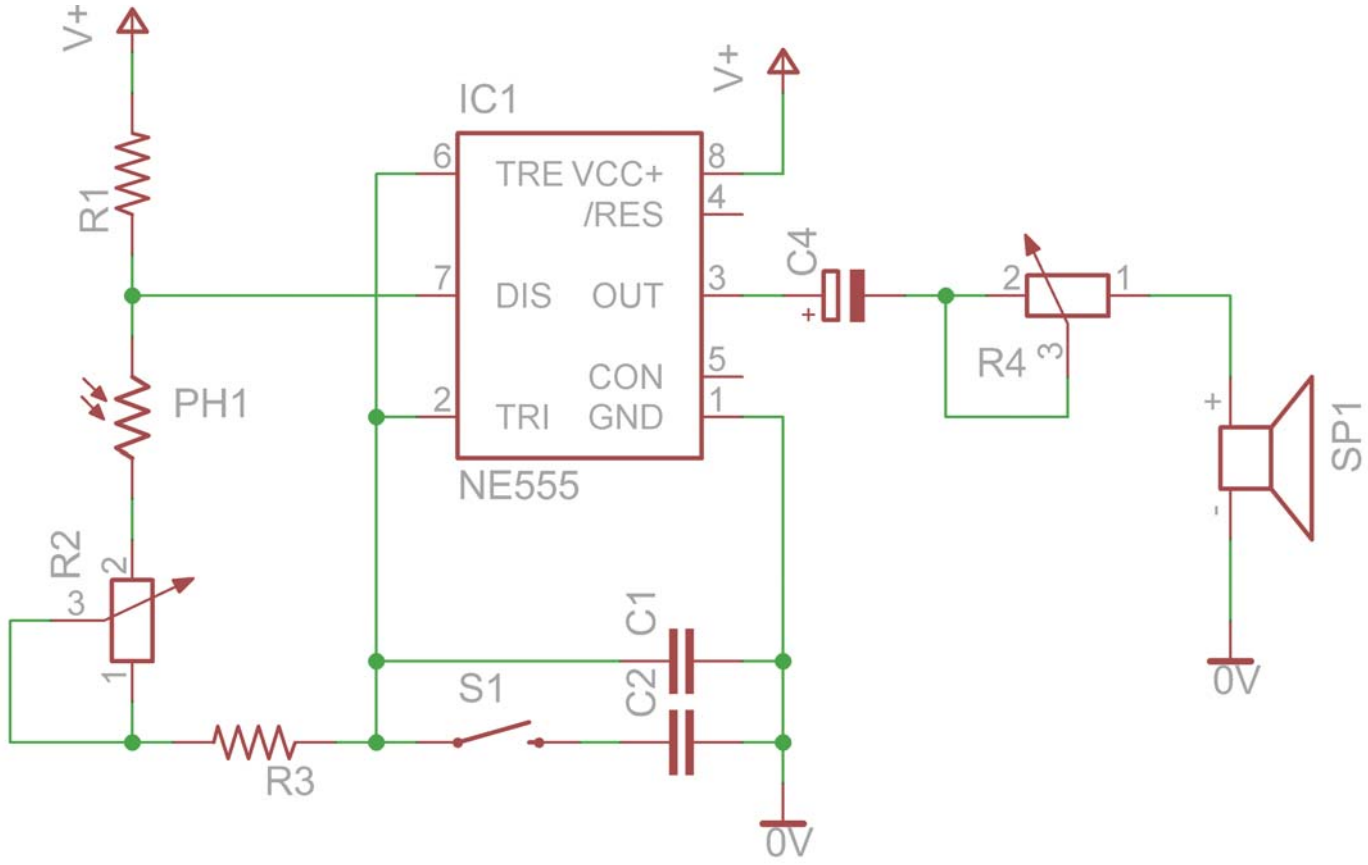


Figure 1: The circuit for the light-based Theremin.

In Figure 2 you can see the circuit to use an NE555 as a standard timer. C1 charges through R1 and R2, and by changing the value of R2 we can change the period of the oscillator. The output of this circuit is an approximate square wave, but by playing with the values of R1 and R2 the duty cycle of the output can be changed.

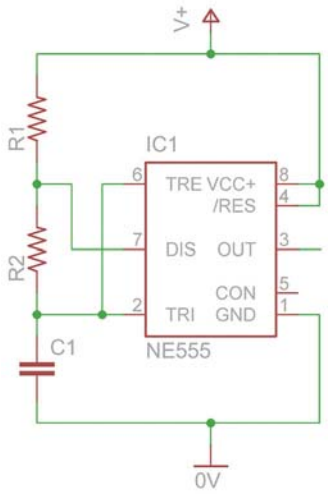


Figure 2: A basic 555 astable multivibrator circuit.

If you now look back at Figure 1, we have replaced R2 with a network consisting of PH1, R2, and R3. PH1's resistance changes with incoming light, R2 is a potentiometer to set the base frequency and R3 is a 100 ohm resistor to stop the total resistance approaching 0. As for S1, all this does is add another capacitor in parallel with C1, doubling the effective capacitance. What this does is double the RC time of the R2-C1 replacement network, which causes the output frequency to drop by 50% - to the user, the sound produced is now an octave lower.

C4 filters any DC offset in the signal and R4 and SP1 are a resistor-divider, making R4 the volume control. If the output isn't strong enough, or you need to condition it before sending it to a seperate audio amplifier, you can remove R4 and SP1 and use a seperate amplifier to condition the signal to your requirements.

The astute reader might remark that NE555s have quite a prominent presence in the Circuit Bodging section - and they would be right. The truth of the matter is that the NE555 is one of the most flexible and useful ICs money can buy.

## Part List

| | |
|---|---|
| **R1:** | **10kΩ** |
| **R2:** | **50kΩ** |
| **R3:** | **100Ω** |
| **R4:** | **1kΩ** |
| **C1, C2:** | **1μF** |
| **C3:** | **10μF** |
| **SP1:** | **8 Ω** |

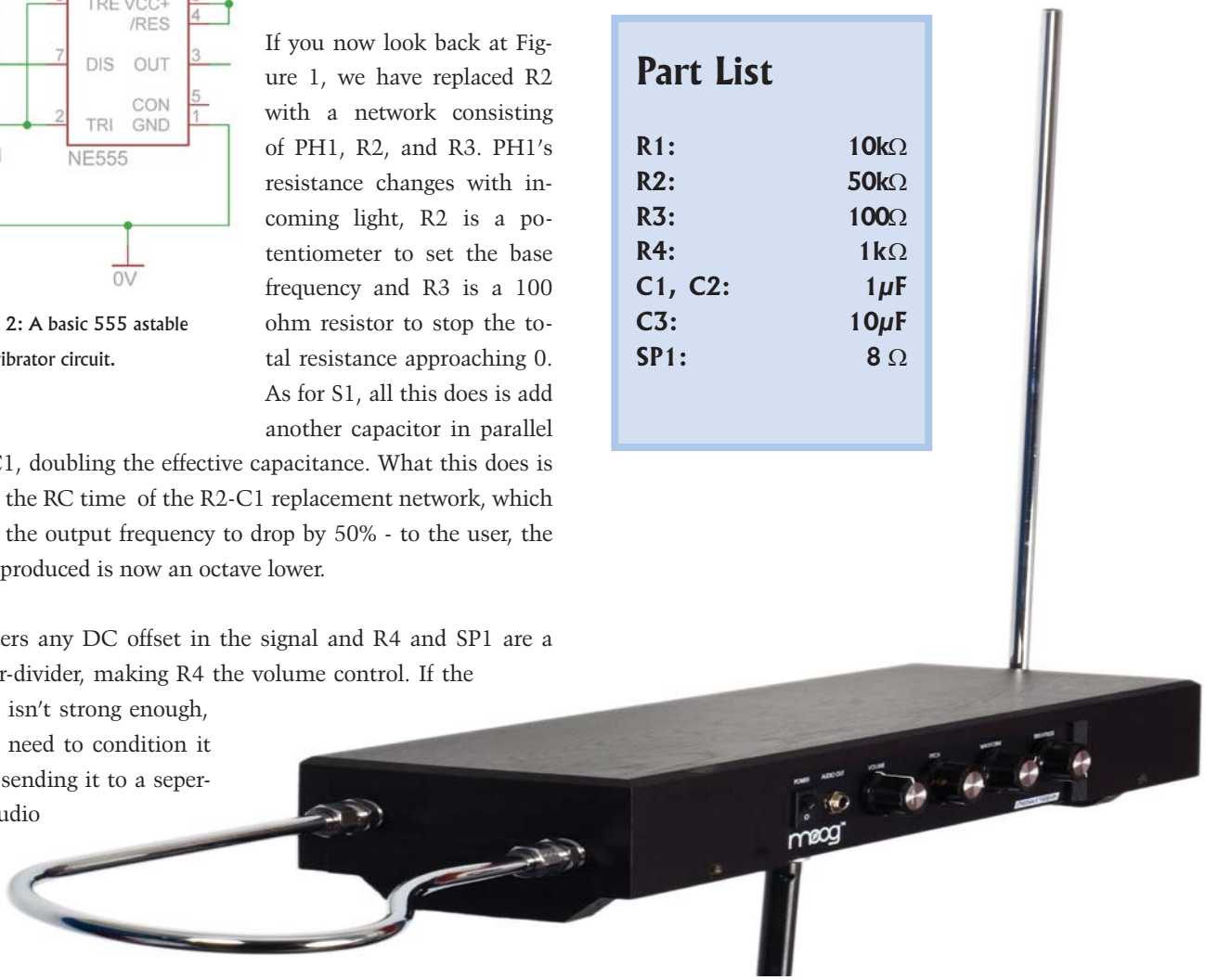


Figure 3: A Moog theremin.

# Column

**Rob Fastenau**
**Decaan van de faculteit Elektrotechniek, Wiskunde & Informatica**

## Zeekomkommer

Professor Kees Beenakker heeft heel veel over voor het versterken van onze relaties met de universitaire wereld in China, maar hij blijft weigeren om zeekomkommers te eten. 't Ding ziet er, drijvend in een geel soepje, inderdaad niet erg appetijtelijk uit, maar de smaak valt me mee. Tijdens het taxiritje erna vindt begeleider Jaap, van het consulaat in Shanghai, on-line uit op zijn iPad dat het een dier is en geen plant; een stuk darm eigenlijk. Op YouTube kun je smakelijk zien, wat het beestje doet in een benauwde situatie.

We bezoeken Philips Research en Licht en NXP. Overal hetzelfde liedje: hoe komen we aan getalenteerde medewerkers voor onze groei in China? Daar heeft Kees meer dan tien jaar geleden al iets op gevonden. We leiden ze op in Delft. En dus gaan we met een pakketje ASML-beurzen naar de Tsonghi, Fudan en Tsinghua universiteiten. De TU Delft, het MIT van Europa, we hebben inderdaad een hele goede naam. Men heeft respect voor ons onderwijs en onderzoek; 10 IEEE fellows en een heuse IC-lijn voor nog meer "More than Moore" werk.

't Wordt allemaal nog spannender als Professor Kouchi Zhang, (her-) benoemd bij EWI per 1 april, gloedvolle presentaties geeft over zijn ideeen over "Solid State Lighting", LED's, en hoe we hier een hele forse reductie van het energiegebruik mee kunnen realiseren. De "More than Illumination" sectie trekt ook volop de aandacht. We voeren een succesvolle discussie met de top van het Institute of Semiconductors over een serieuze partnership in SSL-onderzoek en bezoeken hun cleanroom. Hun onderzoek loopt van A tot Z. Van productie apparatuur, front-end tot packaging en applicatie onderzoek. Aan de overkant is een mooi gebouw bijna klaar. De helft van de acht verdiepingen gaat ingericht worden voor SSL onderzoek. We zullen een hele slimme muis moeten zijn naast die olifant. Professor Wu, managing director, van de Chinese en de internationale SSL association, legt ons uit dat China heel stevig inzet op LEDs. Allereerst om hun Kyoto en volgende afspraken over het energieverbruik na te komen. Maar ook omdat China nu 80% van alle klassieke lampen ter wereld maakt en er dus serieuze vervangingswerkgelegenheid moet komen. Ze is apetrots op de complimenten die ze kreeg van president Hu Jintao voor het vervangen van alle lampen in het "National Peoples Congres" door LEDs. SSL zit prominent in het nieuwe vijfjarenplan.

Wat voor lampen hebben wij eigenlijk in de Tweede Kamer?

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