future concepts for the

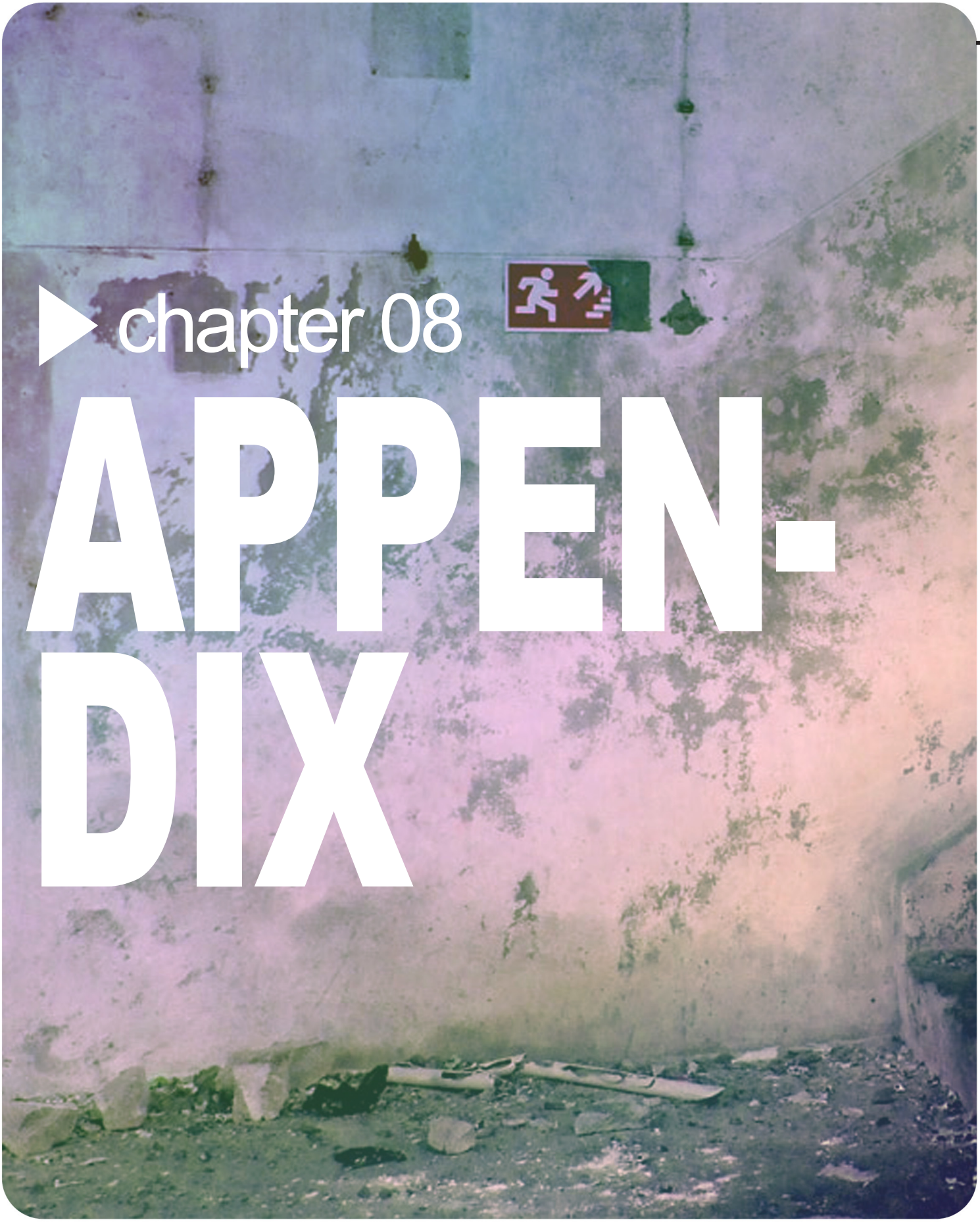
FLUKE ScopeMeter

by M.B.C. Grob

APPENDIX

20th of April 2011

UNIVERSITY OF TWENTE.
INDUSTRIAL DESIGN ENGINEERING



chapter 08

APPEN-DIX

Table of contents

An overview of the content of the appendix

Interoffice memos

A brief introduction to the purpose of the interoffice memos

The interoffice memos serve as communiques within the company. The standardised format allows for easy and convenient sharing and storing. One can share minutes of meetings, but also outcomes of research. The author and the recipients are listed at the top of the document.

The interoffice memos here in the appendix offer insight into the process behind conducted research, decisions and goals. The memos are arranged by date and act as a log-book, from original idea to final presentation.

Benchmark electronics

Interoffice Memo

Date: 18th of January 2011

To: Christian Suurmeijer, Maarten van Alphen

From: Mark Grob

Re: Meeting; possibility of an integrated dedicated scope module

CC:

Ref. nr.:

On Tuesday the 18th of January 2011, a meeting was held to discuss the possibility of creating an integrated dedicated scope module. This memo is a summary of the items discussed during the meeting. The meeting took place from 10:00-13:00 and from 14.00-15.30.

Attendees:

Maarten van Alphen
Christian Suurmeijer
Mark Grob

The basis for the meeting is a discussion about the possibility of creating an integrated dedicated processor for a single channel scope module, of which the opportunities have been laid out in models of the architecture (see MS Visio models).

Opportunities

The advantages of a single channel scope module is that it is possible to increase safety and freedom of movement for the user.

Fluke is currently looking for a replacement for the scopemeter 120 series; the question is whether or not they want to include galvanic isolation.

Fluke or Tektronix could benefit through shared development and production costs. The educational segment must not be forgotten; it establishes consumer loyalty. Tektronix is quite interested in this area (e.g., to create a low cost scope), while Fluke already tends to give away DMMs that have cosmetic production flaws to educational institutes.

Wireless connection & data rate

One needs to be aware of the difference between electronic (hobby) and electrical (high-end, high danger). The difference between parametric measurement and scope signal is discussed as well; a logger function is mostly parametric and only takes a snapshot of the signal when information deviates from user settings. Memory is an issue if one wants to log a complete signal.

To transfer real-time scope information via a wireless connection, one needs a high speed connection. The problem however with a high speed connection is power consumption.

The general consensus is that standard wireless protocols to link up to a computer would not convey the brand image of Fluke, nor would it create sufficient revenue compared to a 'base station' with their own protocols. Also, if one wants to use standard protocols (Bluetooth, OS), one needs to take into account that the software needs to be compatible with those protocols.

Benchmark electronics

Power consumption

Instead of the current NiMH and NiCd battery, one could use a smaller lithium-ion battery (phone battery) for the scope module. The scope module could be placed on top of the battery and have the same size. Ideally the scope module would include a dial that allows a trade-off between high performance & high power consumption and low performance & low power consumption.

Other

When conducting user research for the scopemeter, one needs to be aware of the difference between the boss and actual user; due to the high price the boss tends to make decisions as to the product that gets bought, the user actually has to use the product.

The possibility of creating a database has been discussed, such as with Fluke's engine vibration product. It would suit Fluke's target group very well; incorporating signal analysis instead of merely presenting raw data. The question however is how extensive such a database would have to be and what the error rate would be (if 1 out of 10 diagnostics is wrong, the user will not be pleased).

The trend is to move to higher data rates and higher performance; Fluke is distribution driven and do not have direct contact with the consumer. The consumer will need to be convinced just by looking at the catalogue; as a result of this the consumer will usually just crunch numbers.

Benchmark electronics

Interoffice Memo

Date: Januari 25 2011

To: Bert Wichers, Chistian Suurmeijer, Harald Kanning, Mark Grob

From: Maarten van Alphen

Re: Visit to Henk Koppelmans on future low cost scope products

CC:

Ref. nr.:

This memo is stricktly confidential!

On Thursday Januari 20, 2011 we had a discussion with Henk Koppelmans on possible future low cost scope products. This memo is a summary of the items discussed.
Attendees: Fluke: Henk Koppelmans
Benchmark: Maarten van Alphen, Christian Suurmeijer, Harald Kanning, Mark Grob

For Fluke there are 3 main fields of interest for low cost scope products:

- Fluke 120 series successor
- iFluke waveform applications
- Wireless Scope Probes

Fluke 120 series successor

The main design goal for a 120 series successor will be factory price reduction.
Fluke expects that a high integration grade should lead to a factory price reduction of about 50%.
Performance improvement is not a primairy goal, but Fluke expects that by using modern integration technology bandwidth will go up to about 100MHz without significant extra effort.
The formfactor of the 120 series is considered beyond discussion. Fluke expects it to be a more or less "empty box".

iFluke waveform applications

iFluke is a concept where remote measurement units at difficult to reach places are wireless readout at a short distance (20-100m?) The concept will start with Voltage, Temperature, CO2, and other parametric modules readout by a dual display DVM-like instrument with a proprietary wireless link. This link will be optimized for low power and probably low datarates. In the next stage a graphical tablet-like application (hence the name: iFluke) will show the data and the workflow and possibly other information. Transfer of this information to a computer or network is also part of the concept. The sensors units are intended to be left in place and will be sold as more or less "disposables" in "sixpacks". They should be accordingly low priced and have a long battery life. The concepts core target user is Service and (Preventive)Maintenance.
Question is how this concept can be extended with waveform applications.
Although the proprietary wireless link will almost certainly not be usable for "live" scope information, other waveform applications could still be possible within the concept. One example is a form of waveform capture device that captures "waveform snapshots" at certain predefined conditions.
Fluke expects Benchmark to come up with ideas to extend the iFluke range.

Benchmark electronics

Wireless Scope Probes
Fluke has a keen interest in wireless scope probes.
In the ideal world this would be an option that could be used on the whole scope range.
On the question what minimum bandwidth would still be acceptable for a wireless probe, the conclusion was that although a low frequent wireless probe would still have valid applications, the perception of the word "scope" is something that has 2 channels and measures at least 20MHz signals.
Getting rid of (long) wires and being able to measure in difficult to reach places could be a hot topic for scopes used in Repair and (Preventive)Maintenance.

Notes from the author (not part of the discussion with Fluke)

On the 120 series successor:
The target of 50% factory price reduction will require a technology effort that is fully aimed at the 120 series application and not necessarily result in a flexible solution.
However, if we succeed in building a low cost, highly integrated scope circuit with 120 series performance, it could also be used for other applications like an USB-scope. The expected 100MHz bandwidth however may make it unsuitable for real low power applications like iFluke or wireless probes.

On iFluke:
We need more information about the proprietary wireless link. Why did they not use a commercial solution like Zigbee or Bluetooth?
Carefull application research could reveal interesting waveform applications for the iFluke concept.
Here low power is of the utmost importance if you want to leave the sensor behind.
Sensors for mains monitoring applications (motors, converters etc.) could power themselves from the application with a small backup battery.

On wireless scope probes:
A fundamental issue with wireless probes is how to time-synchronize 2 or more channels (wireless or a combination of wired – wireless) with an accuracy sufficient for multi-channel scope use. A single channel scope application has limited use and again the perception of the word "scope" implies 2 or more channels.
Also wireless data transfer rate and battery consumption are issues, but more of a technical nature.

Benchmark electronics

Interoffice Memo

Date: 26th of January 2011

To: Christian Suurmeijer, Maarten van Alphen

From: Mark Grob

Re: Visit to Imtech at Coevorden; meeting with Fluke user Menno Koopman

CC:

Ref. nr.:

On Wednesday the 26th of January 2011, user research was carried out at *Imtech Vonk*[1] at Coevorden, with cooperation of Fluke (scope) user Menno Koopman (Fluke 190 series ScopeMeter). This memo is a summary of the items discussed during the visit, accompanied with photos for clarification and context.

Attendees:

Imtech:	Menno Koopman
Benchmark:	Christian Suurmeijer
	Mark Grob

The meeting was structured using the following main steps:

01. Explain the purpose of the visit.
02. Map the current procedures with the aid of CUTA cards.
03. Discuss opportunities, ideas and problems.
04. Use endowed props to explore concept directions and acquire feedback.

General introduction

Imtech deals with a wide variety of problems in the gas, offshore and electrical businesses. They encounter a wide array of problems and causes that do not let itself be easily compiled in a general database. Though it has to be noted that Imtech is a specialised company and takes on tasks that are beyond standard.

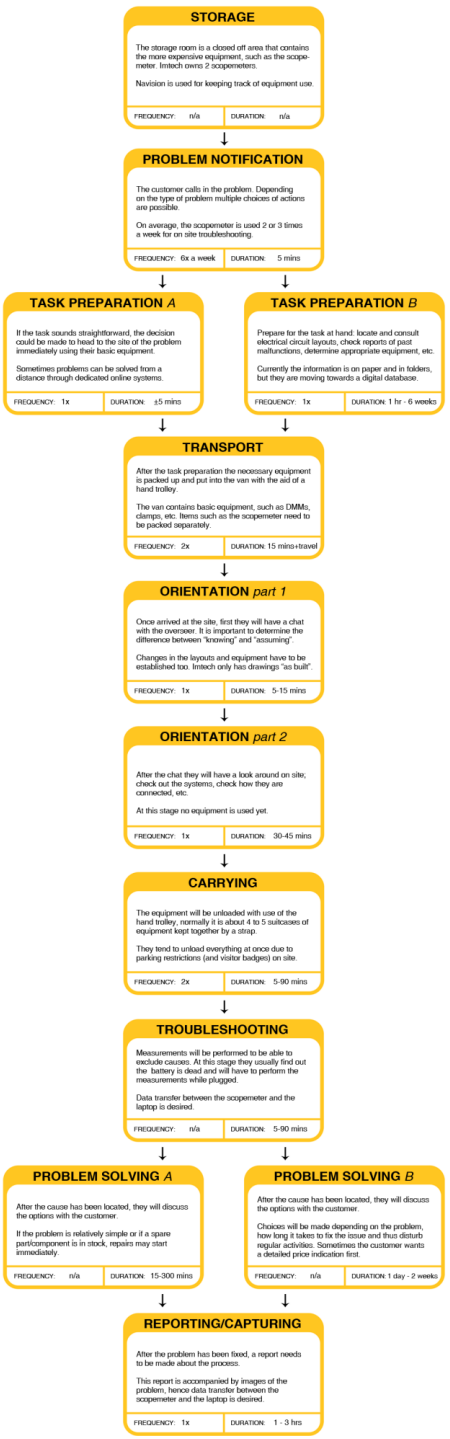
Scopemeters are mostly applied to problems related to electrical power systems, such as electric motors and generators. Power quality analysers are employed for the majority of industrial issues. Most customers of Imtech experience problems on PLC level, some of which can be solved by offering advice over the phone or by logging on to the system through dedicated modems.

To measure high frequent data they do not use a Fluke product, but four units worth €25,000.- each. Three of them are in use, the fourth is a back up in case the others need to be calibrated. The brand selected for purchase was €1,500.- cheaper than the one desired and recommended by Menno and hence selected, but unfortunately it was the brand's first product of that type and thus at Imtech they experienced all kinds of teething issues.

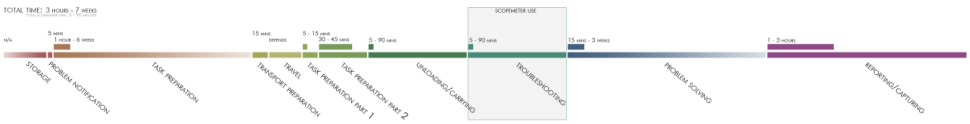
Mapping the process

The CUTA session (*fig. 1*) was aimed at uncovering the complete process surrounding the scopemeter and to stimulate conversation, rather than merely focus on how the scopemeter is used.

fig. 1 - CUTA session



01. Storage
    - Storage area is closed off
    - Imtech owns two scopemeters
    - Expensive equipment is shared
    - Navision[2] is used to track equipment
02. Problem notification
    - Customer calls in
    - Scopemeter is used 2 or 3x per week
03. Task preparation
    - Depending on the task, preparation is short or long
    - Datasheets are consulted (as built)
    - Past malfunction reports are checked
    - Trending and logging aid in the process as well
    - Currently the database is hardcopy, but they move towards digital
04. Transport
    - They bring 4 or 5 suitcases secured with straps
    - A hand trolley is used to load and transport items
    - Every employee has basic equipment, such as DMMs, clamps, etc
05. Orientation
    - On site the overseer will be consulted
    - Have to separate fiction from fact
    - Knowledge of staff on site tends to be very limited
    - Changes in the electrical systems are established; safety comes first
    - They check out the site, no equipment is used at this stage
06. Carrying
    - The hand trolley is used again
    - All equipment is unloaded at once due to parking restrictions on site
    - Sometimes visitor badges are required, which take time to arrange
07. Troubleshooting
    - Measurements are performed to exclude causes
    - The DMM is the first piece of equipment used
    - More often than not the battery of the scopemeter is dead and measurements have to performed while the scopemeter is plugged in, negating its safety characteristic
    - Data transfer between the scopemeter and the laptop is desired, but is troublesome with Fluke products
08. Problem solving
    - After the cause has been determined, solutions will be discussed
    - A price indication is requested by the customer
09. Reporting/capturing
    - A report is written about the problem and solving it
    - Again data transfer is desired, but is troublesome with Fluke products



A timeline of the total process is displayed above: the total time for a task ranges anywhere between 3 hours and 7 weeks, of which the scopemeter is employed between 5 and 90 minutes (for easy reference: it is the area that is highlighted in grey).

Prior to leaving for a job, Menno will check the equipment he needs to bring for the task at hand. The equipment is contained in several suitcases (*fig. 2*) and will be loaded into his Ford Focus Station with aid of a hand trolley (*fig. 3*). Once arrived at the location, all the equipment will be unloaded. This is due to parking restrictions most customer companies have imposed. If the location is hard to reach, some equipment will be transferred to a backpack and carried to the location (e.g. in a tower). Menno uses a plain Imtech backpack for this purpose.


fig. 3 - trolley


fig. 2 - suitcases/boxes

Every employee at Imtech has their own basic toolkit, which includes relatively cheap tools such as clamp meters and multimeters (prices < €600.-). Tools such as the scopemeter are commonly shared amongst employees; they are kept in a storage room and can be taken if needed.

Problem and opportunities


fig. 4 - custom wires

Menno says the causes of issues he encounters are very varied, though a lot of the issues they encounter are related to the life span and durability of electrical components and thus can be predicted.

Companies tend to economise on maintenance because the benefit is not overly clear to them. However, they do expect a problem to be fixed immediately.

Oftentimes Menno and his colleagues will create their own probe wires (*fig. 4*) for the multimeter so they can perform their measurements from a safe distance in the operator room. They will create 10 metre long probes for example, allowing them to monitor changes in the system as they turn systems on and off. Menno definitely has the DMM 233 with the wireless display on his wish list.

Most of the electrical systems they work with have failsafes; the electronics are embedded in metal housings, which cannot be turned on as long as the doors or hatches are open. In these cases Menno will have to get creative, in these cases they either:

- guide the wires through vents (*fig. 5*) by poking it through the filter or cloth. These vents are usually both at the top and bottom of the housing: the top one is where the ventilator is located, hence cannot be used, but the bottom one is where air is sucked in and thus can be used to guide wires through;
- tape off the failsafe to fool it, so they can keep the door open while performing their

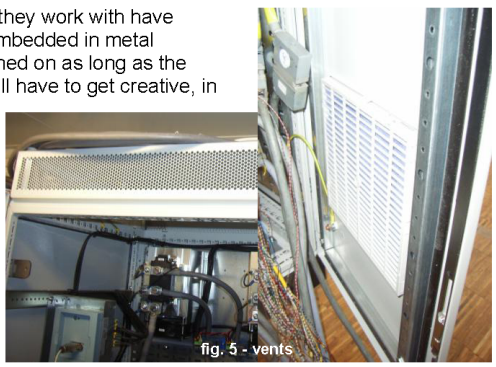


fig. 5 - vents

Benchmark electronics

measurements;
- force open the door slightly to allow the wires to run through the crack thusly created.

These vents could be used for the scope module as well; the wireless antenna could be placed behind them or poked through them.

Charging the scopemeter is an issue. The person who used it last is supposed to charge it, but usually this does not happen and Menno will be forced to plug in the scopemeter while using it. This is an unwanted situation and creates added risk. However, seeing as the scopemeter is kept in its suitcase in the storage room, the charger is also in the suitcase and thus the scopemeter cannot be charged while in the storage room.

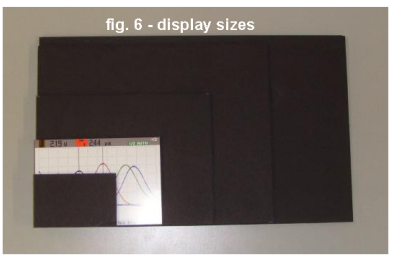


fig. 6 - display sizes

During the endowed props session Menno was presented with a series of five different display sizes to establish his needs regarding the display. The sizes used were: smart phone display, scopemeter 190 series display, Samsung Galaxy tab display, iPad display, and a widescreen laptop display (*fig. 6*). Menno says he is wholly satisfied with the current size of the display and does not see the need for a bigger display, though he admits he zooms in and out very frequently which costs a fair amount of his time. An easier method to zoom in and out would be welcome.

While carrying out measurements, Menno often has to change settings on the multimeter or the scopemeter. In such cases it would be ideal to have the display and the interface close to each other.


fig. 7

The equipment they use to measure the phase angle is 30 years old (*fig. 7*). Modern equipment is incapable of displaying the signal fast enough to be able to synchronise the phase angle.

The clamp meters in Fluke's assortment do not have the same range and accuracy of the old LEM clamps (*fig. 8*). LEM has since been taken over by Fluke and the clamps are no longer in production.


fig. 8 - LEM clamp

Menno's latest acquisition is a USB scope; he is curious how useful it is for tasks that require travel abroad.

Suggestions

A live view / lifetrace is preferred, a delay would render the scopemeter useless for many purposes.

Space is really an issue while performing the measurements; the product cannot be bigger than the probes' current size, as became apparent during the endowed props session (*fig. 9*). Space is not an issue at all during transport.

Clamping methods were explored as well, to see what method would be most versatile at the work place – a magnetic connection is the easiest and most versatile by far.


fig. 9 - a selection of the props

Menno always carries a laptop with him as well, so already possesses the necessary processing power. However, he acknowledges this is not commonplace for other scopemeter users.

Three or more channels is desired, two channels would be too few.

A flexible probe head would be very convenient.

When probing for a signal it is usually sufficient to see digits rather than the complete signal.

Communication between Fluke products and other devices such as laptops is still an issue. The drivers cause problems in particular. Often Menno will resort to taking a picture of the scope display with his digital camera or will use a LeCroy instead.

Menno can see a need for a small cheap scopemeter (*fig. 10*), or a basic integrated scope function in their current digital multimeters. They could use this to check for basic harmonic disturbances to pinpoint issues quicker. Their multimeters are around €500.-, while the scopemeters are around €3,200.- to €4,000.-. Something below €700.- would be ideal.


fig. 10 - small scopemeter

Menno reckons that it should not be too difficult or expensive to incorporate a scope feature in advanced DMMs (such as the DMM 287) that are already capable of logging and graphing data onscreen. *(note: Fluke has once pursued a similar project called "RITA", which was a combination of DMM and oscilloscope functionality. However, it was an expensive and very chunky device)*

Sources:

1. *"Imtech | Vonk | Imtech Vonk"*, http://www.imtech.eu/nl/vonk
2. *"Dynamics NAV (previously Navision)"*, http://www.microsoft.com/netherlands/dynamics/product/nav_overzicht.aspx

Benchmark electronics

Interoffice Memo

Date: 09th of February 2011

To: Christian Suurmeijer, Maarten van Alphen

From: Mark Grob

Re: Interim meeting; single chip scope concepts

CC:

Ref. nr.:

On Wednesday the 9th of February 2011, an interim meeting was held to discuss *single chip scope concepts*. This memo is a summary of the items discussed during the interim meeting.

Attendees:

Bert Wiggers
Rinus Verdult
Maarten van Alphen
Harald Kanning
Mark Grob

The presentation was led by Maarten van Alphen; he presented the two relevant categories (SM123 and iFluke) and laid out the possibilities and opportunities from there. The main directions thereof are, respectively: the scope module and the waveform device. The derivative architectures were presented and discussed.

The presentation is currently very much focused on Fluke, mainly due to the origin of the concept. However, Fluke already have their resources committed and will not be able to make major investments, while Tektronix is able to invest. Hence the concepts need to be adapted to entice Tektronix to invest, and to interest Fluke. The visualisations for example need to be more neutral.

In order to entice Tektronix, the opportunities and advantages for USB related products need to be augmented, considering Tektronix has expressed a clear interest in this direction. This needs to be further explored; a visit to a Tek user would be very beneficial, to explore the need/desire for wireless probing and to gauge the importance of safety. Also, the USB scope market needs to be charted to be able to position the concept propositions well.

In addition to the above: Tektronix has expressed an interest in a low end educational application, to establish brand loyalty amongst young consumers – perhaps herein lies an opportunity for the USB scope.

The general impression of USB scopes is that its main distinguishable feature lies in the software package. However, this is not an interesting notion for Benchmark.

Key words describing the concepts are: safe, robust & reliable.

The proposition was made to structure the presentation as follows:

- Three categories:
  - USB
  - SM123
  - iFluke
- User cases

- Architecture plus derivatives
- Concept opportunity examples
- Summary of key points
    - For example: focus on the importance of exploring the possibilities of a wireless scope module, it could lead to an IP.

Other remarks

The front end of the 120 is obsolete, replacement is inevitable. Fluke would be interested in a more versatile version to be able to create a larger product family.

Next steps

On the 1st of March 2011, another meeting will be held to ensure that the framework for the presentation is solid. After confirmation, graphical representations need to be adapted and/or created to best convey the concept.

The engineering conference in the US will be on Wednesday the 30th and Thursday the 31st of March 2011. A meeting will be planned for the 1st of April to present the concepts to Tektronix, with presence of Fluke representatives.

Page 2 of 2

Benchmark electronics

Interoffice Memo

Date: 08th of March 2011

To: Christian Suurmeijer

From: Mark Grob

Re: Fluke/Tek USB/wireless scope presentation review

CC:

Ref. nr.:

On Tuesday the 8th of March 2011, there was a review of the Fluke/Tek USB/wireless scope presentation. This memo is a summary of the items discussed during the meeting. The meeting took place from 11:00-12:00.

Attendees:

Bert Wiggers
Rinus Verdult
Christian Suurmeijer
Mark Grob

Christian showed the presentation in its current form; feedback was generated by Bert and Rinus.

General remarks:

- The mix between Tektronix and Fluke needs to be more apparent in the background images, opportunies and product impressions.
- The product impressions should include a point of reference to indicate size.
- For every product direction a clear indication needs to be made of the advantages of the product and the benefit for the user, for Tektronix, and for Fluke.
- The slides explaining the waveform module device should be removed.
- There should be a slide explaining the clear benefits of a wireless scope. In addition to this, an indication needs to be made of the possibilities with regards to transmitting (trace) data (include a simple data rate calculation).
- The final slide of the presentation needs to revert to the opportunity roadmap and perhaps include impressions of fake future product ads for both Fluke and Tektronix.

Slide specific remarks:

Slide 1: the term "industrial handheld" needs to be reconsidered.
Slide 2: images of clean industries need to be added.
Slide 4: "what's next" -> a comment was made about clearly displaying two different product 'clouds', namely bench/medical vs. dirty/industrial, however the images are currently a compilation of several different brands.

Opportunity roadmap remarks:

- Do the sizes of the bars (length and width) imply any consequences and/or links? Consider this.
- As derivative to illustrate business opportunities: display the expected investment costs and size of the target group in a graph. The bulk of the business probably lies in the DMM sector.
- The roadmap should be the pivot of the discussion, it forms the foundation of the presentation.
- The circumstances of use / environments need to be displayed; there are not just business opportunities for portability in dirty industrial environments, there are also business opportunities for portability in clean environments. For example: Tektronix operates on the advanced equipment

Benchmark electronics

market, think of hospital equipment that suffers from similar (size) issues as industrial equipment when it comes to measuring.
- The question: "What is the main device" should be considered; what is the aim? In line with this question it should be considered to feature the iFluke development on the roadmap (with a more neutral name).
- Perhaps direction 1b should be moved slightly to better indicate its relationship (and importance) with the other directions.

Direction 1a remarks:
- A clear separation between universal terms and application specific terms needs to be made in order to reduce redundancy.
- Consider replacing some terms by the word "leverage", such as "new commercial high speed low power" -> "leverage commercial high speed low power".
- Indicate for each component how costs can be reduced:
  - Integrated analog front end with an off-the-shelf digital back end processor.
  - An off-the-shelf display would most likely cut costs significantly.

Direction 1b remarks:
- The background image needs to be replaced with an image that better fits the USB market. Consider using one from Pico's website.
- The image on the bar shows a USB device with a display; the display needs to be removed.
- Emphasise on the fact that the market already exists and that the product is already well-known, and that a new innovative product could exploit this foundation and lead to a winning positioning.
- "Leverage existing technology".

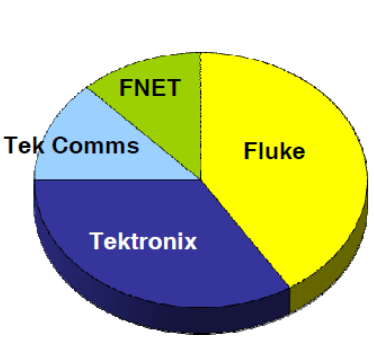
Direction 2 and 3 remarks:
- There may be an overload of information; consider removing the industrial analytical section. Product impressions of the service sector and the analytical sector can be combined.
- Multiple components give the impression of redundancy and extra costs; as such the accessory retro-fit section may not be suitable for the presentation. Discuss with Henk Koppelmans about whether or not to keep it in the presentation.

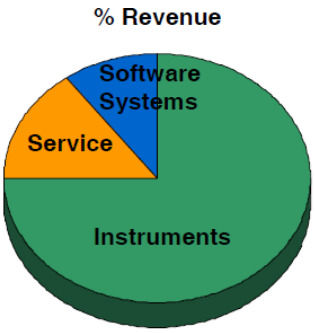
Danaher

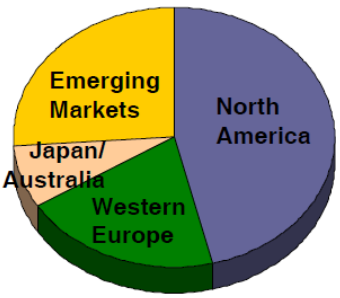
Information regarding test and measurement equipment

The following information is taken from a recent investor and analyst meeting by Danaher, regarding their test and measurement equipment section. The most relevant images have been selected and taken into account during the project.

Source: McGrew, M., Comas, D., Lico, J., Aghdaei, A., McBee, R., *Tektronix & Danaher - Investor & Analyst Meeting*, 08 September 2010








Fluke 233 Remote Display Digital Multimeter


Fluke 376 Clampmeter


Fluke 810 Vibration Tester


Video Waveform Monitor


Bench Power Supply


Ultra High Performance Mixed-Signal Oscilloscope


G-Series Collection Agents and IRIS applications


AirCheck Wi-Fi Tester

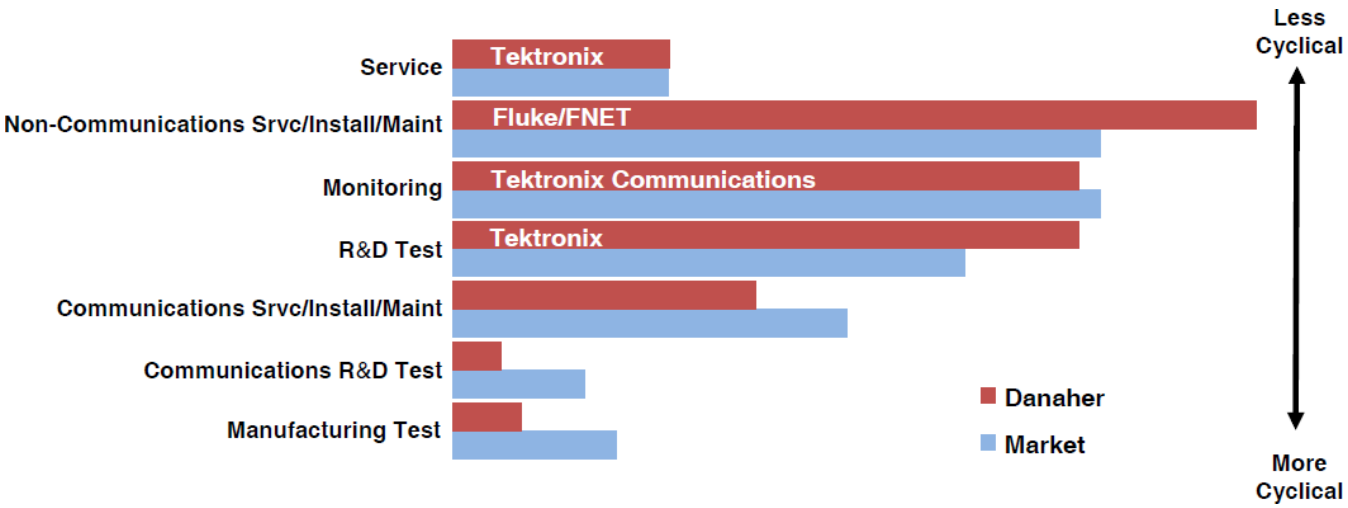

OptiView Management Suite

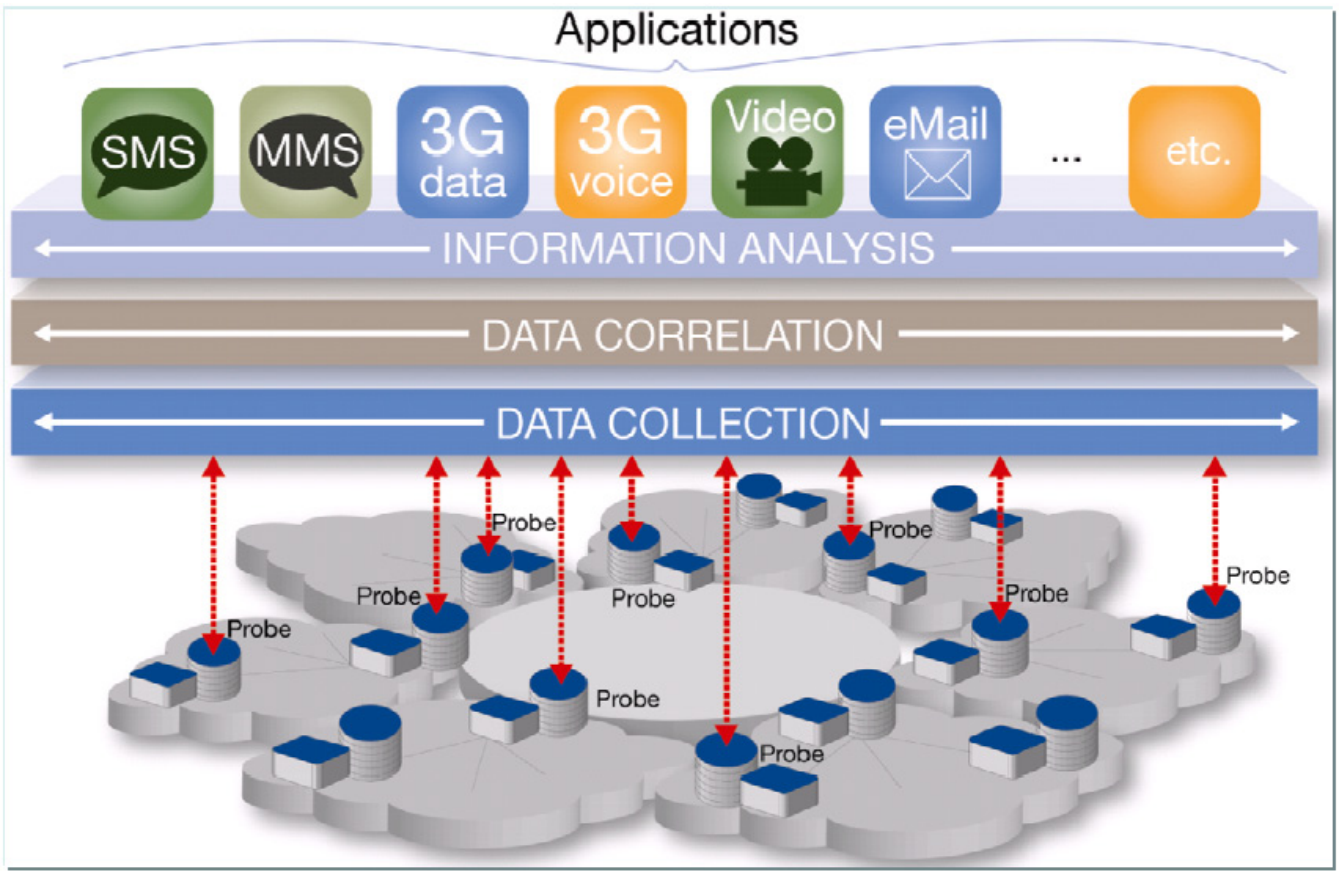

Spectra 2U


Arantech's OpenPlatform suite


AirMagnet Enterprise


Visual Performance Manager


Service
Non-Communications Srvc/Install/Maint
Monitoring
R&D Test
Communications Srvc/Install/Maint
Communications R&D Test
Manufacturing Test
Tektronix
Fluke/FNET
Tektronix Communications
Tektronix
Danaher
Market
Less Cyclical
More Cyclical

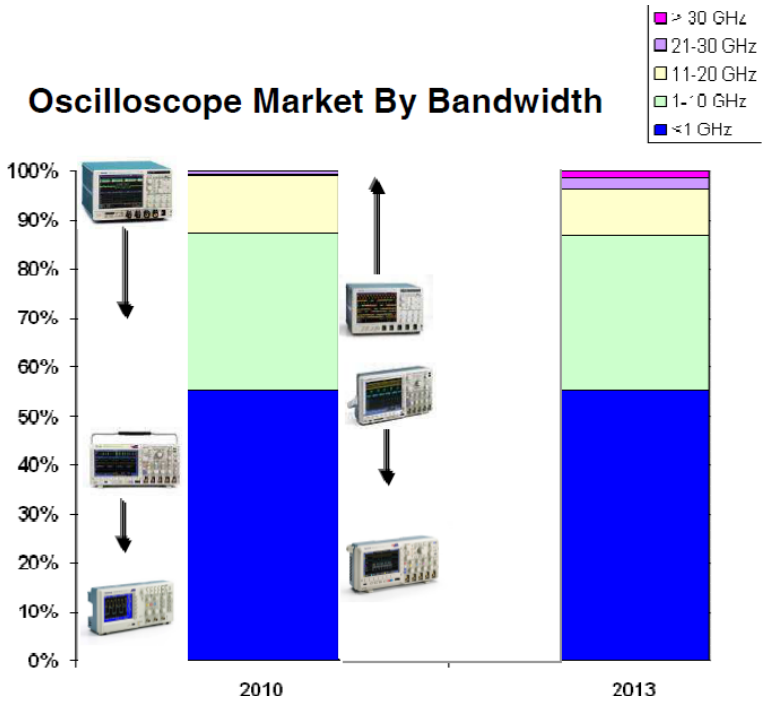

Applications
SMS
MMS
3G data
3G voice
Video
eMail
...
etc.
INFORMATION ANALYSIS
DATA CORRELATION
DATA COLLECTION
Probe
Probe
Probe
Probe
Probe
Probe
Probe
Probe
Probe

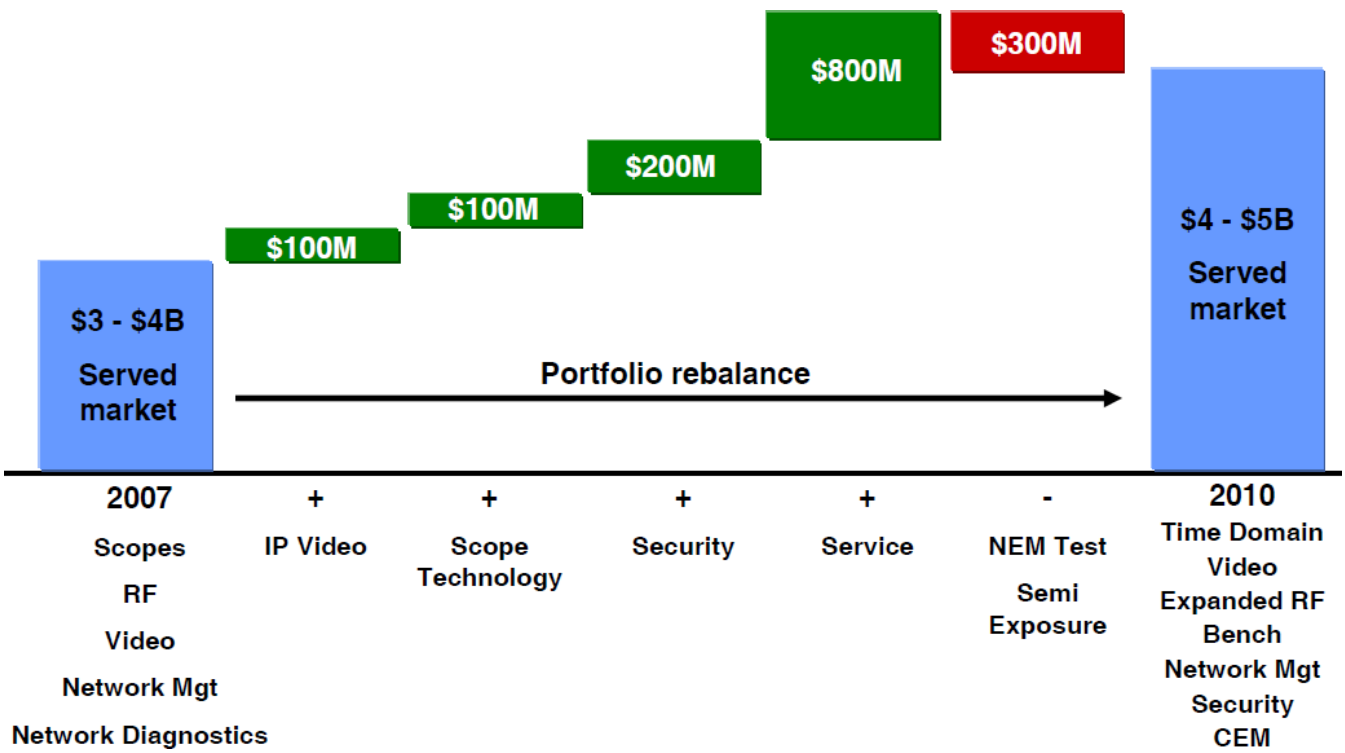
Top left:
An overview of Danaher's assets in comparison to the market as a whole, touching on the different market segments.

Bottom left:
An illustration of the opportunities regarding roaming and wireless technologies.

Top right:
A short term extrapolation of development of the oscilloscope market by bandwidth. The lower bandwidth segments will remain the largest by far.

Bottom right:
An overview of the portfolio of Danaher: service is by far the largest segment for revenue. Emerging markets however show much promise.

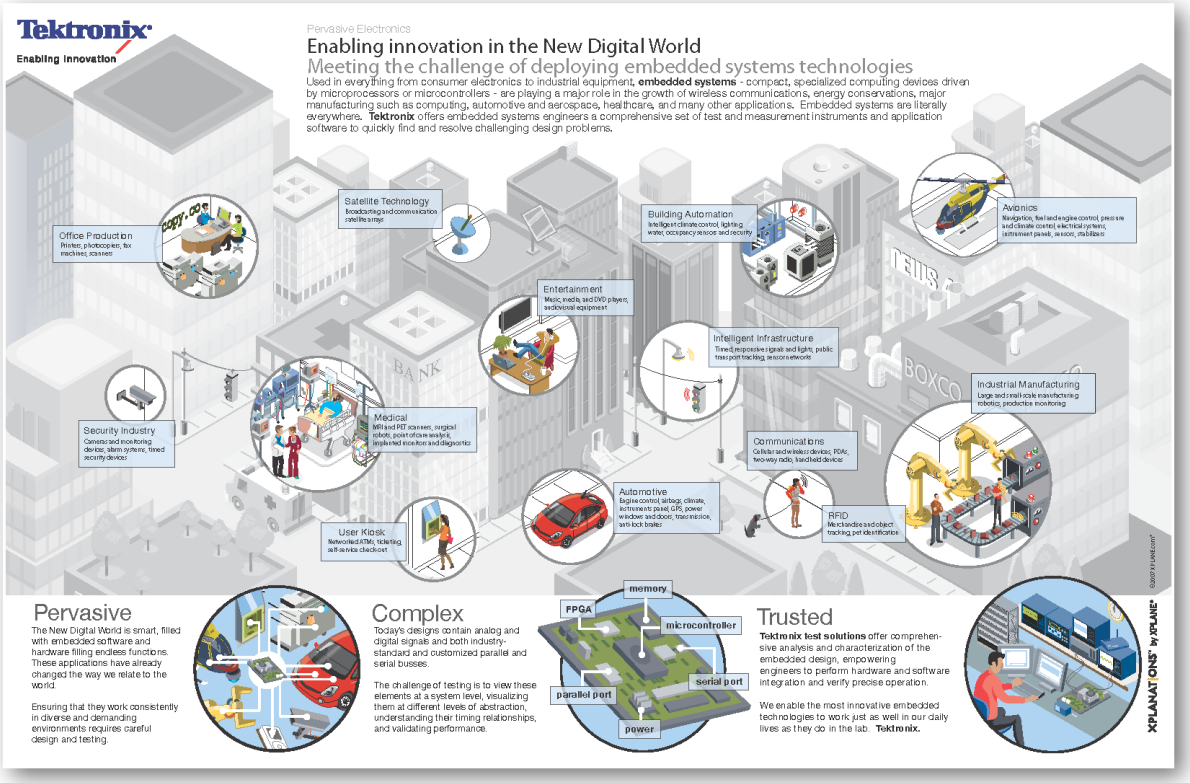




CASE STUDY: TEKTRONIX

Driving alignment for product repositioning

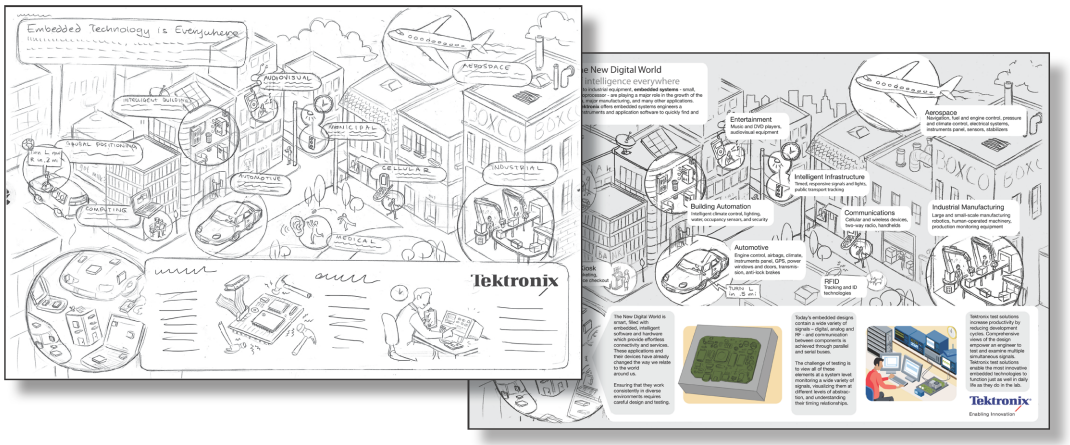
Industry: **Test and Measurement** Deliverables: **Company-wide positioning and segment visualization maps**



FACILITATED VISUAL COLLABORATION SESSIONS DISTILLED VAST AMOUNTS OF COMPLEX INFORMATION INTO A SIMPLIFIED CORPORATE POSITIONING.

Through its visual methodology XPLANE helped Tektronix achieve an umbrella positioning for the company and for each of its strategic market segments.

source: XPLANE XPRESS newsletter » July 2008.url, http://www.xplane.com/wp-content/xpress/07-2008/, URL accessed on the 17th of December 2010



LEFT
Napkin and blueprint stages of one of Tektronix' six market segment maps.

BELOW
Facilitated visualization sessions drive creativity, teamwork and alignment around a common goal.

CHALLENGE Tektronix had recently acquired a significant communication business, forcing the company to be reorganized around two platforms – the instruments business and the communication business. During this process Tektronix did not want to devolve the Tektronix brand, story and overall position. It realized a need to simplify the overarching positioning and articulate its position within its market segments. To start, Tektronix decided to create segment-specific marketing campaigns, and brought in XPLANE to turn one of those campaigns into a visual market segment map. That project's success brought a fast realization of a larger need to turn all of the segment campaign positioning into compelling visuals. However, before this could be achieved, internal agreement around corporate positioning had to be reached.

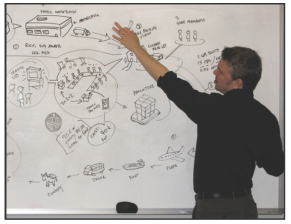
ACTION XPLANE facilitated a series of strategic consulting sessions with Tektronix to better understand the key elements of the industry-specific messages Tektronix wanted to tell. Each session built on the progress achieved in the previous consultation, and helped to create momentum around redefining the corporate positioning at a strategic level and aligning key internal parties on the new visual approach.

Once the new corporate-wide positioning was agreed upon, XPLANE focused on getting each of Tektronix' segments distilled down to a single concept in order to clearly communicate the value propositions in a visual map. XPLANE and Tektronix developed six visual maps for each of the key market segments as a way to accelerate, clarify, distill and simplify the messaging and take a more relevant position in the industry.

RESULTS What started as a request for one XPLANE deliverable turned into an ongoing consultative relationship between the two companies. Tektronix elevated its corporate story to a more compelling and relevant narrative, ensuring better dialogue with customers and more interest and understanding with the media and industry analyst audiences.

"Going into the engagement with XPLANE we were experimenting with the notion of visualization. However through the XPLANE facilitated visualization sessions we were able to turn complexity into both visual tools and a far more relevant and compelling narrative at both the company and segment level."

-Martyn Etherington, vice president of marketing, Tektronix



XPLANE® | the visual thinking company®

www.xplane.com
inquiries@xplane.com
UNITED STATES +1 866 750 6467
EUROPE +34 915 635 835
MEDIA +1 503 467 7771
media@xplane.com

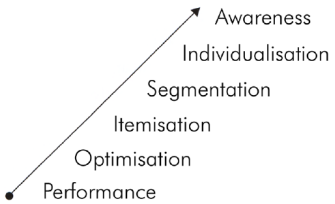
Fluke ScopeMeters

Designs throughout the years

Product phases

To acquire a better understanding of the oscilloscope and its development, the oscilloscope's product phases will be analysed based on the research done and using the ten characteristics as described in the product phase theory provided by prof. dr. eng'r. A.O. Eger.

The ten product characteristics are:
01. Newness
02. Functionality
03. Product development
04. Styling
05. Number of competitors
06. Pricing
07. Production
08. Promotion
09. Service
10. Ethics



Before we start of: in the begin stages of the oscilloscope, bandwidth of the oscilloscope was expressed in cycles per second, this was substituted in 1960 with the unit hertz (Hz).

Performance phase

Period: 1897 - 1938

The product is brand new in this phase and results from a technology push; in case of the oscilloscope the product was made possible due to the development of the CRT by Karl Ferdinand Braun (1897). Prior to this development, oscillograms were hand drawn or (stroboscopically) photographed.

Form giving is not important at all in this stage; the CRTs are quite large as it is. Performance is still poor and prices for the oscilloscopes are quite high. Increasing performance of the oscilloscope is the main goal in this phase.

This phase shows up quite clearly on the timeline in the form of a wide variety of shapes and techniques employed by the different brands to create the oscilloscope models.

Optimisation phase

Period: 1930 - 1982

In this phase product development is aimed at improving performance, better reliability, improvement of ergonomics and safety. Form giving is not really important.

The second world war gave a massive impulse to the oscilloscope's development; the oscilloscope was at the basis of any effective RADAR system.

Tektronix, founded in 1947, set a new standard with its model 511, both in design and functionality with its 10 mc/s, at a price of $795.-. It became an archetype for all models to follow.

By comparison, the HP 130A introduced in 1956 cost $450.- and featured a bandwidth of 300 kc/s.

Itemisation phase

Period: 1946 - current

In the itemisation phase product development is mainly aimed at improving performance, reliability, ergonomics, human interfaces and safety. There is a tendency to develop extra features and accessories, as well as special editions catered to specific target groups and/or niches.

The phase is characterised by the recognisable form factor of the oscilloscope, which is used from this point onwards.

Functionality however is still relatively poor and the product's form factor is large and heavy. One can see a development to try and create portable oscilloscopes, but the efforts are limited by the CRT's large size. It is not until the introduction of the first DSO in 1985, with a transition from analogue to digital, that the form factors are free to change.

With the introduction of the digital oscilloscopes, you see renewed effort in trying to exploit the new technology to its fullest. Different form factors appear, new target groups

aimed at, and new submarkets emerge.

Segmentation phase

Period: 1991 - current

The segmentation phase calls in a new era: the addition of extra features and accessories has reached the end of its development. The performance offered becomes more than the performance that is required.

In fact, unnecessary functions are added to the product, as an attempt of the producer to create a unique product and tempt the user to select their product above that of the competition. Sometimes the offered functions are actually detrimental to the functionality of the product.

The HP 1700M from 1972 is a good example hereof: aimed at military purposes, it can be completely submerged, a feature that the average user does not need or appreciate.

Digital oscilloscopes were gradually introduced around 1980. As a result of the digital oscilloscope´s market dominance, since 2005 barely any new analogue oscilloscopes hit the market. The digitalisation opened up a lot of new opportunities, as can be witnessed on the timeline as well: a lot of derivative directions emerge, such as handheld, pocket and USB oscilloscopes.

The introduction of the Fluke ScopeMeter in 1991 is an excellent example of the segmentation phase: Fluke has managed to cater to a specific target group. This change is not just an exterior one, it also applies to the manner data is processed and presented to the user.

Another interesting development in this era is the creating of the digital phosphor oscilloscope, effectively emulating the analogue's oscilloscope's intensity grading effect.

At the moment, there are a fair amount of oscilloscope brands out there, with performance ranging from 1 MHz to 80 GHz, and prices ranging between a few tens of euros to several tens of thousands of euros.

Individualisation phase

In the individualisation phase product development is aimed at mass customisation or co-creation, allowing the customer to influence the final result. The oscilloscope market does not exactly allow for such an extreme development, especially considering the relatively low sales figures. The individualisation phase however has not yet been reached.

This phase is an extrapolation of the segmentation phase, where continuous fine tuning of products on smaller target groups ultimately leads to an individualised product.

With the development of a waveform device in combination with an iPad-ish dedicated base station (iFluke), the functionality of the waveform devices can be catered to the needs of each individual, thus ushering in a new phase.

Also, the base station could act as a universal work station capable of interacting with a plurality of Fluke products.

Awareness phase

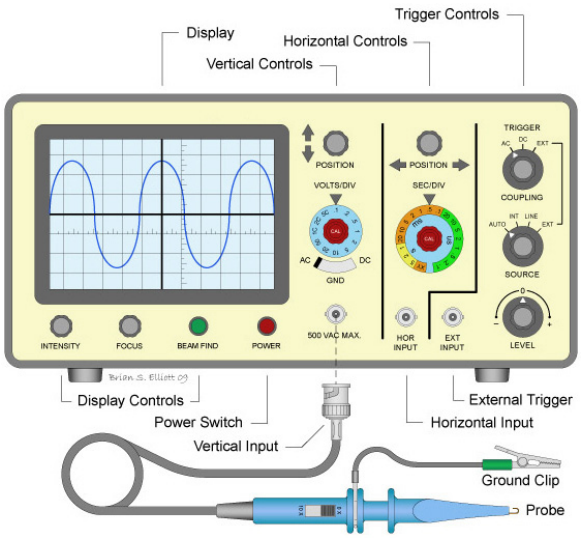
The awareness phase is not yet reached with the oscilloscope. However, as Fluke demonstrates, the image of the brand does make a big difference.

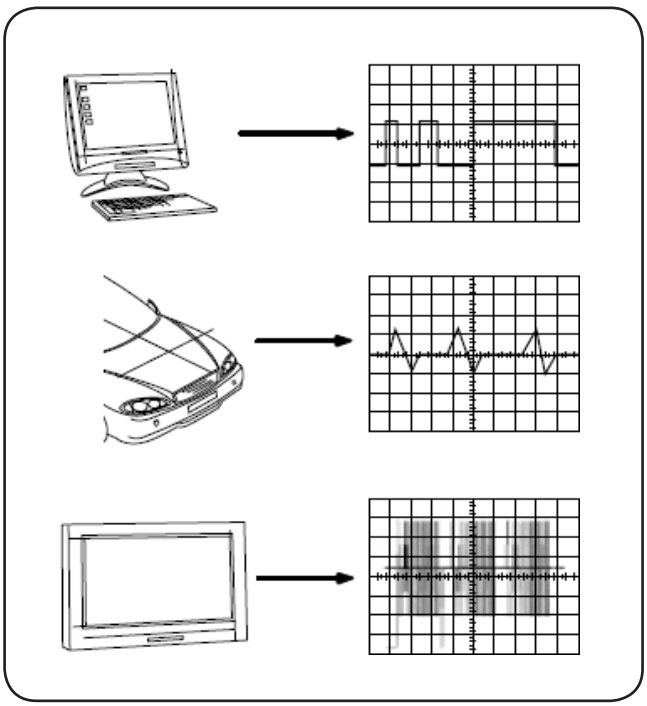
Conclusions

Overall, one can spot a few trends on the oscilloscope market:

- The bandwidth steadily increases;
- The number of channels increases;
- Less bench models, more portable models;
- Smaller models;
- Lower prices.

Source: Eger, A.O., Evolutionaire Product Ontwikkeling (Evolutionary Product Development), publisher Lemma BV, The Hague, ISBN 978-90-5931-054-4, 2007


Trigger Controls
Display
Horizontal Controls
Vertical Controls
POSITION
VOLTS/DIV
AC
DC
GND
POSITION
SEC/DIV
TRIGGER
COUPLING
SOURCE
LEVEL
INTENSITY
FOCUS
BEAM FIND
POWER
500 VAC MAX.
HOR INPUT
EXT INPUT
Display Controls
Power Switch
Vertical Input
External Trigger
Horizontal Input
Ground Clip
Probe



Basic functionality

The oscilloscope is basically a device that is capable of displaying a graph of an electrical signal. In most applications, the graph shows how signals change over time, where the vertical axis (or Y axis) represents voltage and the horizontal axis (or X axis) represents time. The intensity or brightness of the display is sometimes referred to as the Z axis, as is relevant for (digital) phosphor displays.

Controls

The basic oscilloscope consists of multiple systems: the vertical system; the horizontal system; trigger system; display system; and the probes. The vertical and horizontal systems are vital for displaying the data in a convenient manner and allow the user to control the position and volts/div or sec/div respectively. The trigger system stabilises the signal by adapting the horizontal time interval to ensure that the sweep begins at the same point of a repeating signal, resulting in a clear picture.

Next to the vital controls there are also user setting related controls, such as brightness and contrast of screen, help, product information, etc.

Fluke divides the functional controls into three categories:

- *Primary controls*; basic frequently used functions, as well as main menu and navigation controls.
- *Secondary controls*; controls that modify basic functions, change the state of an instrument, modify the display or provide extra information/ functionality.
- *Tertiary controls*; backlight, save & print, and information/assist belong to this category.

Waveforms

The waveforms are key to understanding the measured data. The shape of the waveform reveals a lot about the measured signal.

For the user it is important to measure and catalogue signals when their equipment and systems are fully functional. This data will then act as material for comparison for later measurements and will facilitate troubleshooting the equipment and systems. Manuals supplied by Fluke often already contain examples of waveforms and include their (possible) meaning.

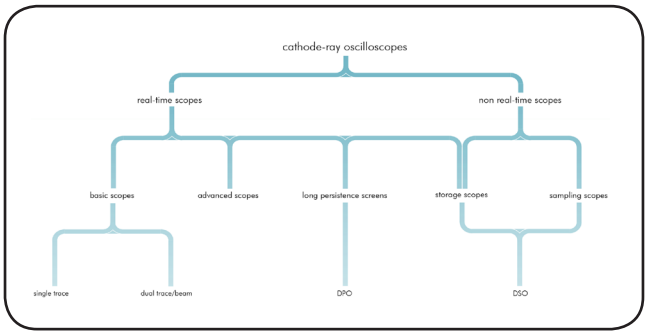
Signal interpretation is something that requires training, it requires knowledge and expertise - it is not as accessible as understanding parametric data. To illustrate: a very experienced oscilloscope user will not just be able to locate the area of the problem by looking at the signal data, they most likely will also be able to tell you the nature of the problem.

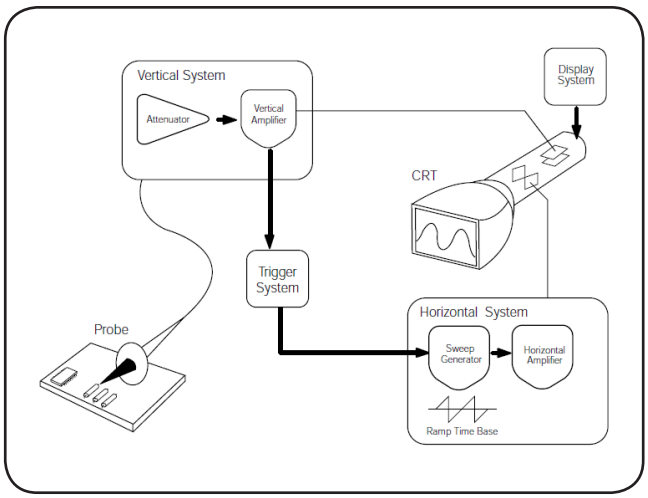
Herein lies an opportunity for Fluke; by reducing the threshold required to interpret the data the product becomes more accessible to the average blue collar worker.

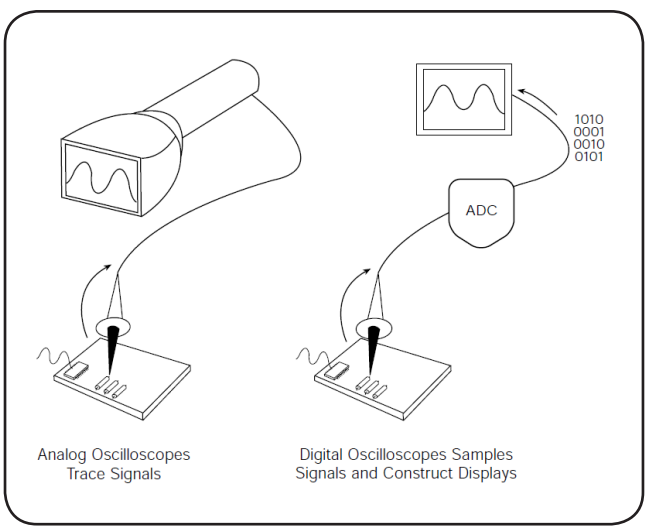
Sources:

01. Primer - XYZs of Oscilloscopes, Tektronix, December 2009

02. Fluke - User Interaction Design Guidelines, version 1.2, 03 October, 1997


cathode-ray oscilloscopes
real-time scopes
non real-time scopes
basic scopes
advanced scopes
long persistence screens
storage scopes
sampling scopes
single trace
dual trace/beam
DPO
DSO


Vertical System
Attenuator
Vertical Amplifier
Display System
CRT
Trigger System
Probe
Horizontal System
Sweep Generator
Horizontal Amplifier
Ramp Time Base


1010
0001
0010
0101
ADC
Analog Oscilloscopes
Trace Signals
Digital Oscilloscopes Samples
Signals and Construct Displays

Different types of oscilloscopes

An overview of the different types of oscilloscopes and description thereof can be seen below.

Analogue oscilloscopes

Analogue oscilloscopes were the first commercially viable oscilloscopes. Analogue oscilloscopes trace signals, while digital oscilloscopes sample signals and construct displays. The characteristics of the phosphorous display of analogue oscilloscopes allow for different applications; e.g. a long persistence phosphor is ideal for detecting transients. However, such oscilloscopes cannot switch modes and the CRT made up the bulk of the product which limited downsizing the product further. Digital oscilloscopes made further downsizing of the product possible.

Digital oscilloscopes

A digital oscilloscope uses an analogue-to-digital converter to convert the measured voltage into digital data, as opposed to an analogue oscilloscope. The waveform is acquired as a series of samples; the digital oscilloscope stores these samples until it accumulates enough samples to describe a waveform and can re-assemble the waveform for display on the screen. There are three distinct types of digital oscilloscopes on the market, namely the digital storage oscilloscope or DSO; the digital phosphor oscilloscope or DPO; and the digital sampling oscilloscope.

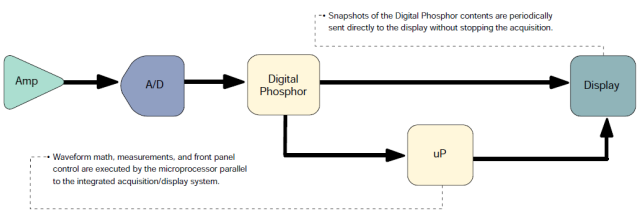
Digital Storage Oscilloscope (DSO)

A conventional digital oscilloscope is commonly known as a digital storage oscilloscope, from this point onward referred to as a DSO. Instead of relying on luminous phosphor it uses a raster-type screen. Due to the digital nature of the waveform information the information can be stored and analysed when desired by the user. As added benefit hereof, transient events are more likely to be captured. The information can also be easily transferred to a secondary medium such as a laptop. The waveform also need not be continuous; it can still be displayed even when the signal disappears. DSOs offer a permanent signal storage and extensive waveform processing over their analogue counterpart; however, DSOs typically have no real-time intensity grading and are therefore incapable of expressing varying levels of intensity in the live signal.

Digital Phosphor Oscilloscope (DPO)

Unlike the DSO which employs a serial-processing architecture to capture, display and analyse signals, a DPO uses a parallel-processing architecture to perform these functions. The DPO architecture utilises ASIC hardware to acquire waveform images, allowing a DPO to capture waveforms at a higher rate resulting in a higher level of signal visualisation. This higher performance increases the probability of witnessing transient events, especially ones that occur in digital systems.

With this technology a DPO efficiently emulates the best display attributes of an analogue oscilloscope, displaying the signal in three dimensions: time, amplitude and the distribution of amplitude over time, all in real time. Unlike the analogue oscilloscope's reliance on chemical phosphor, a DPO emulates the characteristics of said phosphor with a continuously updated database.



Digital Sampling Oscilloscopes

When measuring high-frequency signals, an oscilloscope's sampling rate may not be high enough to collect enough samples in a single sweep. A digital sampling oscilloscope is able to accurately capture signals whose frequency components are much higher than the oscilloscope's sample rate. This allows the digital sampling oscilloscope to achieve bandwidth and high-speed timing ten times higher than other oscilloscopes for repetitive signals. However, the trade-off for this high bandwidth is that the sampling oscilloscope's dynamic range is limited.

Probes

In order to be able to perform any measurements at all, the oscilloscope needs to interact with the device-under-test (DUT) – probes make this interaction possible. Probes must not just match the requirements of the oscilloscope and the DUT; they must convey the signal cleanly to the oscilloscope, amplify it if necessary and preserve it for the greatest signal integrity and measurement accuracy. With high frequency signals, as is more and more common in current circuitry, the impedance of the input becomes more important. Fluke uses a plastic bus to enhance the perception of safety, but this could cause too much reflection of the signal – a metal bus is recommended in such cases.

Probes are an input device for the oscilloscope. Probes usually consist of a pointed metal tip for making electrical contact with a circuit element, a lead to connect to the circuit's ground reference, and a flexible cable for transmitting the signal and ground to the oscilloscope. The electronics for attenuation are contained in the plug rather than the probe. The cable is a coaxial cable; it contains a flexible, tubular insulating layer, surrounded by a tubular conducting shield, in order to shield it from surrounding influences. One can infer that the longer the cable is, the more exposed it is to interference.

The inner conductive cable is very thin in order to reduce disturbances. However, its thickness does make it vulnerable to breaking, hence why users have to be careful when storing their probes to prevent causing a kink in the cable.

It needs to be kept in mind that probes actually become part of the circuit, introducing resistive, capacitive and inductive loading that inevitably alters the measurement. Hence for the most accurate results, the goal is of course to select a probe with minimal loading. Another consideration in the selection of the interaction with the DUT is the probe's form factor. For example: small probes provide easier access to today's densely packed circuitry.

Lastly, the contact points of the probes require precise motor skills to operate. This is a characteristic that affects the maximum weight of a probe redesign.

Active vs. passive

There are two types of probes: active and passive.

Passive probes are cheap and easy-to-use and will perform perfectly fine under most circumstances. Passive probes usually have an attenuation or magnification factor; a higher attenuation factor tends to reduce circuit loading and thus interference, a problem especially apparent for higher frequency and/or higher impedance signals. However, because a higher attenuation factor reduces the amplitude, low voltage signals will be harder to look at. Some probes contain separate sets of circuitry and are able to switch between different attenuation factors during use.

Active probes are required when dealing with load sensitive circuitry or signals with very fast rise times. Such circumstances demand probes that pre-process the signal more than passive probes do; namely at a higher rate and with less loading effects. Active probes require an additional power source as opposed to passive probes, further exacerbating the probe connection.

Source: *Primer - XYZs of Oscilloscopes*, Tektronix, December 2009

Attention in perception and manipulation

The area of attention of the ScopeMeter differs for perception and manipulation; the user needs to adjust the probes and keep them in place while checking the display for a readout of the measured data. The product should cater to this limitation of human attention rather than exacerbate a limitation that already represents one of the most formidable bottlenecks in human information processing.

Physical limitations

Visual sampling is at the basis of this form of selective attention. The eye fixation system can only perceive detail in a very small region of the visual field. This region, the fovea, is only about two degrees of the visual angle. If a foveal task is more difficult, information about the periphery is processed less well, further limiting the useful field of view.

The behaviour used to scan areas of interest and switch back and forth between areas of attention is called saccadic behaviour. Saccadic movements are discrete, jerky movements that jump between stationary points of fixation in the visual field. Visual input is suppressed during the saccadic movement and can only be attained during fixation. This fixation is characterised by a location (centre of the fixation), a useful field of view (diameter around the centre of fixation) and a dwell time (how long the eye remains at that location).

Level of control

The switch between the fixation points 'probes' and 'display' can be regarded as supervisory control; the user scrolls through areas that he knows contain information. Supervisory control lies in the design of the product and requires understanding of the user's activities.

Scanning the DUT for measurement points however would be regarded as a target search; the user scans the visual world looking for something at an unknown location, such as a failure in a circuit board. A target search is less amenable to optimal modelling compared to supervisory con-

trol; the visual scan pattern is far less structured, though a number of characteristics can still be identified and addressed. For instance: environmental expectancies are amongst the cognitive factors relevant for a target search. An experienced user will first check components that are prone to failing or check the weak spots in the circuit's design, depending on the information the user wants to extract.

A product could cater to a target search by guiding the user to the locations where the user is most likely to extract the information they desire, and by limiting the user interface by highlighting the areas relevant for the user's search. For example, this could be done with an abrupt stimulus onset, as the visual system is very susceptible to new perceptual objects. Attention could be directed implicitly in an interface by highlighting a subset of items if the system infers this subset is relevant and needs to be attended. One does need to be careful to not make such a feature too distracting or have it disrupt the extraction of information by the user.

The attention switch does not just apply to the display and the DUT; it also applies to the display and the button interface. To change measurements or displayed information, one has to switch attention between the buttons and the display. This is not a problem in case of displayed information since the areas of perception and manipulation are very close together, but it is a problem when the user desires to change the type of measurements done. The latter involves putting down the probes temporarily to change settings on the device, which is a similar issue to the original problem.

Optimality of attention and signal detection

Optimality of attention can be defined in terms of behaviour that will either maximise expected value or minimise cost. The aim is to prevent critical events from occurring, such as incorrect measurements, short-circuiting the DUT, or even an arc flash. On a less critical note the aim is to make it easier to perform measurements, shorten the time it takes (as well as dwell time), and lessen the effort it requires. Depending on the user's expertise and experience, they form (efficient) mental models to guide them through the troubleshooting process, adapting to the limitations of the product they are using.

In general, the solution to fix the issue is quite straightforward: facilitate parallel processing by simply ensuring that area of perception and manipulation are one and the same. Or in other words: high processing proximity requires high display proximity, low processing proximity requires low display proximity. However, the situation does not always allow for high proximity in display.

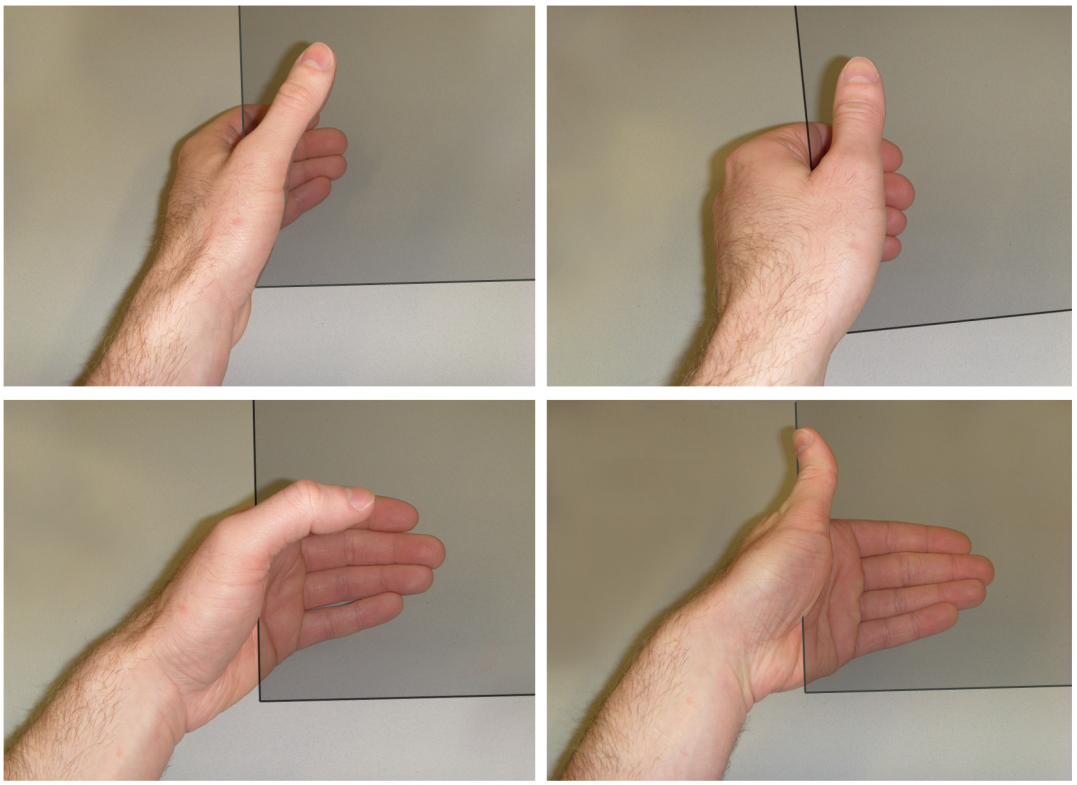
In the latter case one could superimpose a secondary view on the main view and thus effectively facilitate selective attention between two channels of information, though one needs to be aware of the risks of cognitive tunnelling. Such a superimposed view could be in the form of a heads-up display (HUD), conformal symbology like augmented reality (AR), display projection techniques (such as a beamer), or if the information transaction is very basic: omnidirectional auditory signals.

Other solutions include catering to the sequence of events; to be more precise one could pair up items that are checked sequentially. Another thing that has to be kept in mind is man's predisposition for horizontal scans rather than diagonal or vertical with regards to information or operation.

Lastly, one could improve response time and efficiency by employing multimodality. Communication between human and machine commonly takes place through a very narrow channel, one has to be aware of this bottleneck that could be improved with multimodality. As added advantage, multimodal interfaces can compensate for the decrease in sensitivity of the sensory system (e.g. due to age) and increase the 'natural feel' of the interface. Practical applications could be in the form of an auditory feedback system when the user has placed the probes on the circuit, an auditory warning in case of danger, etc.

01. Wickens, C.D., Hollands, J.G., Engineering Psychology and Human Performance, third edition, ISBN 0-321-04711-7, 1999
02. Endert, G., Me, you and the machine too, Design research in multimodal interaction with portable devices, Cologne, 09 August 1998

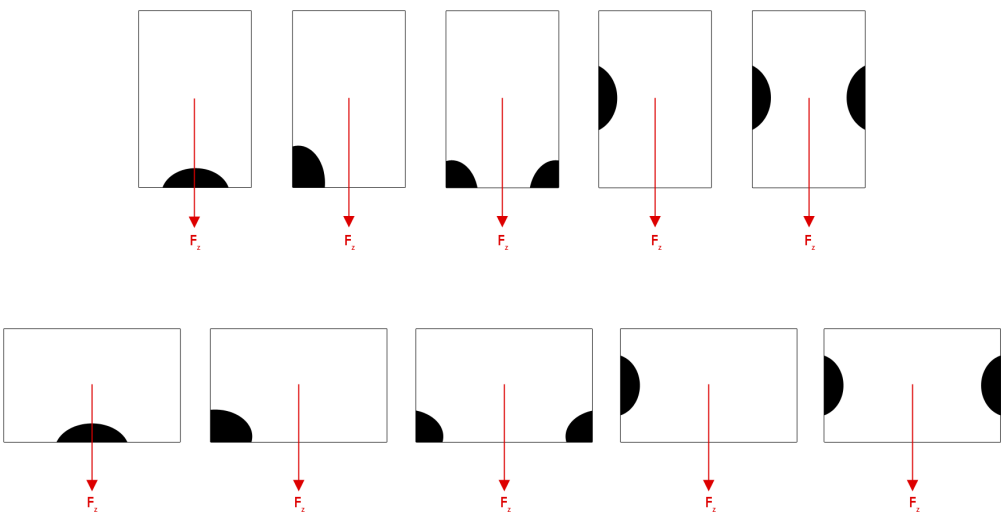
PORTRAIT



THICK

THIN

LANDSCAPE



Holding and strain

The different hand positions and resulting strain while holding products

Holding position and strain

The manner of holding the scopemeter is always an issue, mostly due to its weight and size. The position of the hand and the arm, as well as the distance of the product from the body, determines the strain imposed on the user.

As reference, within context of the project 60 mm is considered a thick product to hold (equivalent to the current Fluke 190 series ScopeMeter), while 15 mm is considered a thin product to hold (equivalent to an iPad). As weight: 2 kgs is considered heavy, while 750 grams is considered to be lightweight.

Position

The orientation of the product (landscape or portrait) and its thickness (thick or thin) affect the way the user holds the product. An overview of images, showing the position of the hand for four basic situations, can be found on the adjacent page. The positions can be mirrored horizontally to produce results for users with a different dominant side.

- Portrait & thick

The wrist is extended with a slight ulnar abduction and the fingers are flexed. The position of the thumb is also interesting, probably more so from the perspective of the product than the user: as can be seen the thumb extends quite far onto the surface of the product.

- Portrait & thin

The position looks comparable to the "portrait & thick" case, though the angle of ulnar abduction is greatly reduced, putting less strain on the user. The position of the thumb is also more favourable considering it extends less far onto the surface of the product.

- Landscape & thick

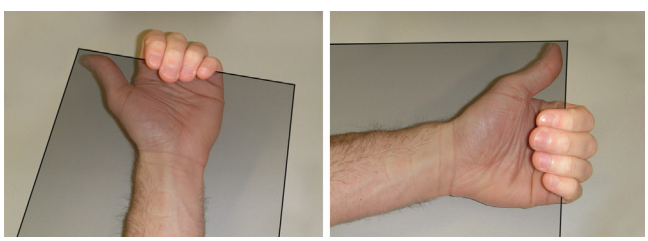
The wrist is still extended, with a slightly increased ulnar abduction compared to the "portrait & thick" case, and the fingers are extended. Next to that, the wrist endo-rotates to accommodate to the landscape shape of the product in an attempt to increase the contact area of the hand with the product. The thumb is flexed to ensure grip on the product.

- Landscape & thin

The position looks comparable to the "landscape & thick" case, though the wrist has endo-rotated slightly further to accomodate for the thinner product. Also, the thumb does not need to cover the surface area of the product as much because grip is less of an issue due to the larger contact area underneath the product.

Strain

Another option is to rest the product on your arm. In case of a portrait shape, one would hold the top side of the product with a hand of choice, resting the product on the inside of the lower arm, as illustrated on the left in the image below. In case of a landscape shape, one would hold the left side of the product with their right hand, or vice versa, as illustrated on the right in the image below. Such a position would greatly reduce the strain imposed on the user, though it is not a position one would prefer as the main manner of holding.



Another factor in the holding position is the use of straps, as is the case with the Fluke ScopeMeter 190 series and the Fluke 810 Handheld Vibration Tester (see the images below). With the use of a strap, one can guide the user to the best location to grab the product. The strap also reduces strain on the user by allowing the user to loosen their grip on the product and instead let it rest on their hand via a lever principle.

Fluke DMM 233

User feedback on the Fluke 233 Remote Display Multimeter

User feedback - Fluke DMM 233

Due to the interesting nature of the remote display of the Fluke 233 multimeter, both from a user perspective and the perspective of Fluke as a company, a closer look has been taken at the wireless display feature.

Responses from users regarding the wireless display feature of the Fluke DMM 233 were gathered and the main ones are listed below in order of occurrence (ranging from frequent to infrequent).

- It is very handy to be able to take off the display and put it in a better visible location or even measure from a distance;
- The wireless connection should be Bluetooth or Wi-Fi and be compatible with other products owned by the user, such as phones and laptops;
- The magnet feature is highly appreciated;
- The distance of communication between display and meter should be increased to several miles, or even via long-distance signal such as the internet;
- It would be nice to include a locator for the display, in case the user does not remember where they left it;
- Its battery usage is on the high side.

Sources:

01. Fluke 223 Meter - Electrician Talk - Professional Electrical Contractors Forum, http://www.electriciantalk.com/f14/fluke-223-meter-12160/, URL accessed on the 7th of January 2011

02. Amazon.com: Fluke 233 Remote Display Multimeter: Home Improvement, http://www.amazon.com/Fluke-233-Remote-Display-Multimeter/dp/B002X7ZX00/ref=sr_1_1?ie=UTF8&s=hi&qid=1294743083&sr=8-1, URL accessed on the 7th of January 2011

03. Test and Measurement Tool Users Community - Do you ever wish you could read your device's display from further away?, http://www.flukecommunity.com/forums/showthread.php?t=2260&highlight=fluke+233, URL accessed on the 7th of January 2011

Ideal situation

A portrait of the ideal electrical troubleshooting scenario

SOLVE PROBLEM

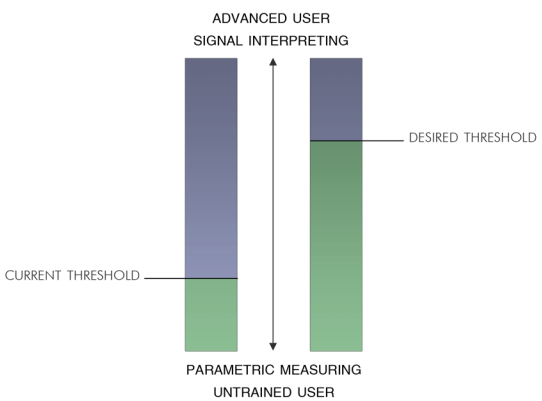
DETECT PROBLEM

To remain visionary, one should sometimes abandon the bottom-up approach to product design and step outside the binding box of technology; a top-down approach offers a much needed aim for ambition.

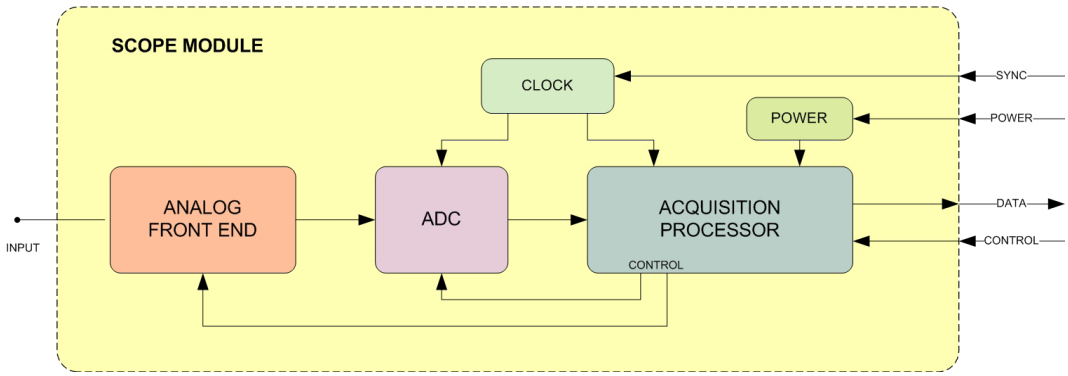
In an ideal world, electrical equipment would not require maintenance, let alone break down. However, this is not a realistic scenario. A more realistic scenario would be “problem solving: anyplace, anytime”. The problem is detected using built-in (dedicated) systems, after which the problem is resolved at a central location far away from the problem area.

Such a scenario calls for several major advances; built-in (dedicated) systems, wireless worldwide communication, and a certain level of expertise from workers on site. Herein lie opportunities for Fluke. For example, their products could lower the threshold of required knowledge for users by letting their product take over part of the diagnostic process (instead of presenting raw data, interpreted processed information is presented, for instance compared to a database).

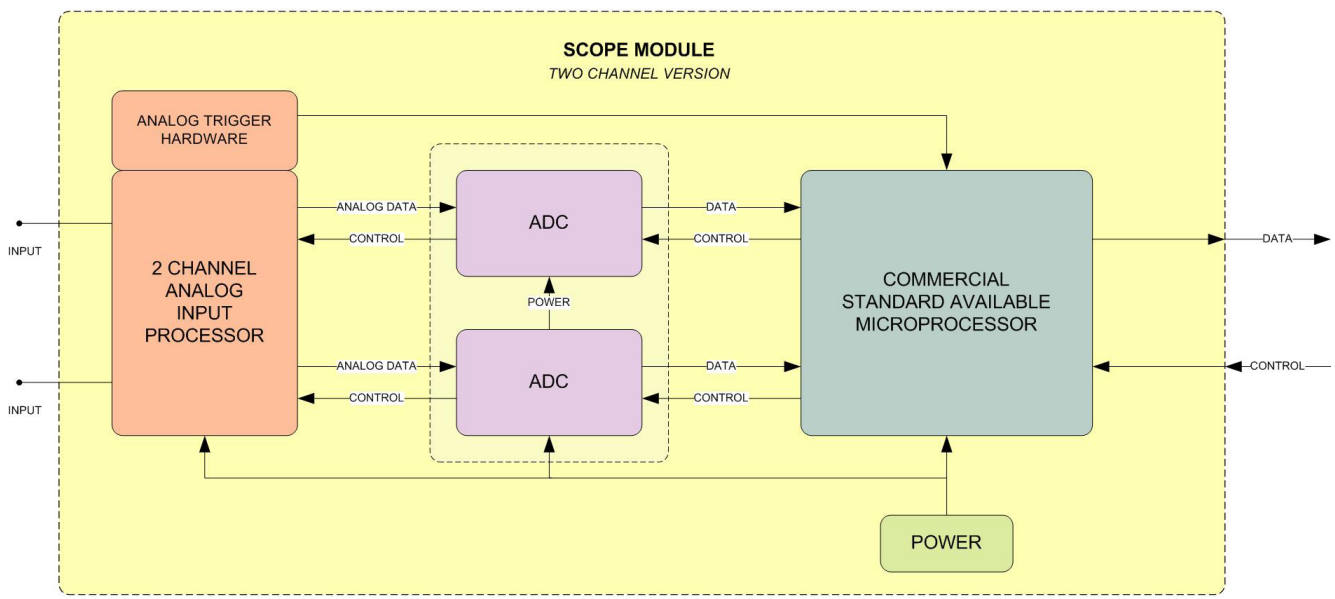
Wireless communication and built-in systems (or as intermediary product: in the form of disposables), are the other main changing factors that Fluke needs to aim towards.



00. Scope module; single channel



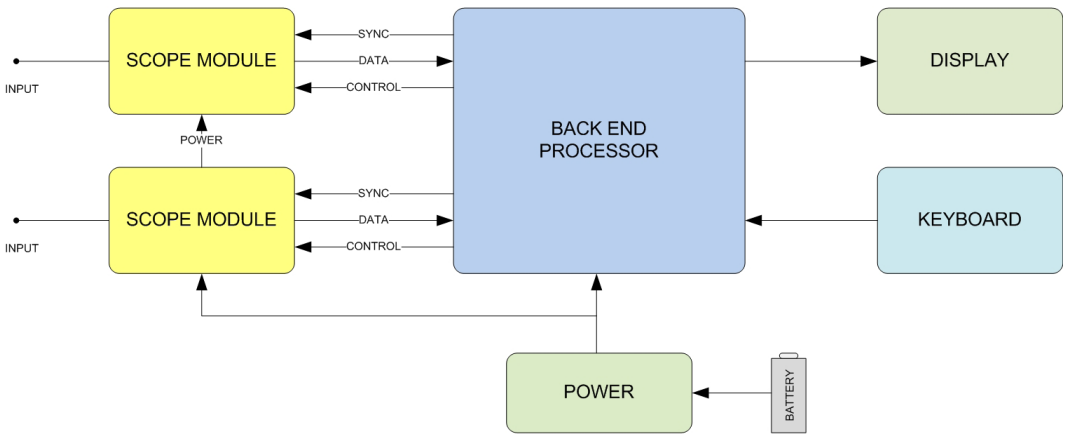
00. Scope module; dual channels



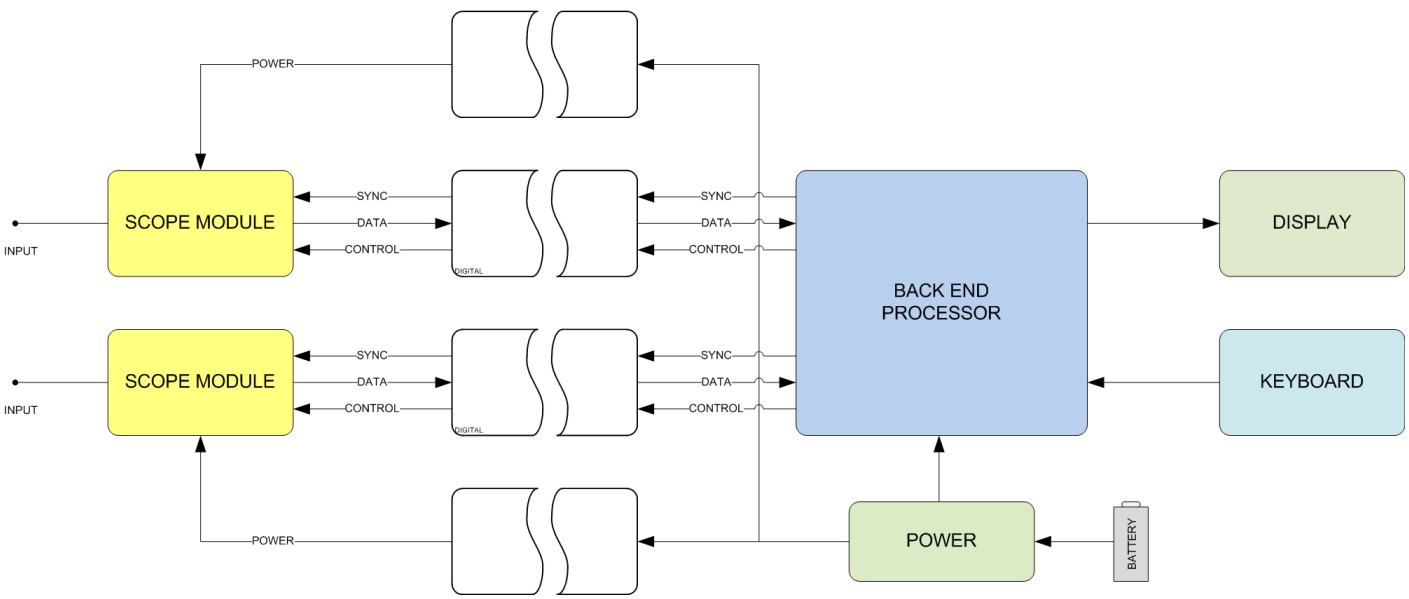
Scope module

Architecture designs to display the wide variety of opportunities

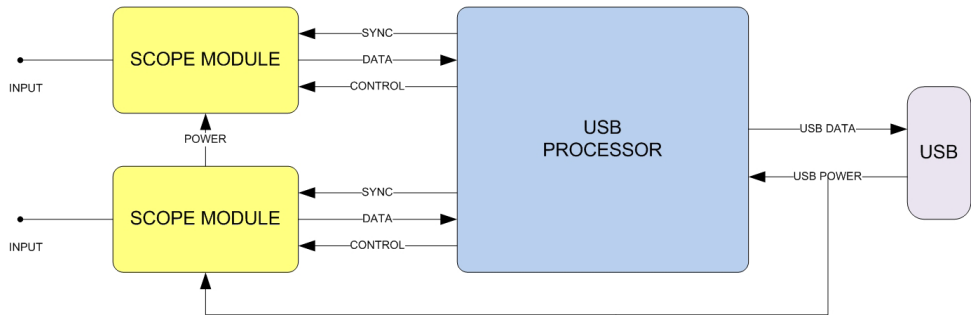
01. Basic integral instrument



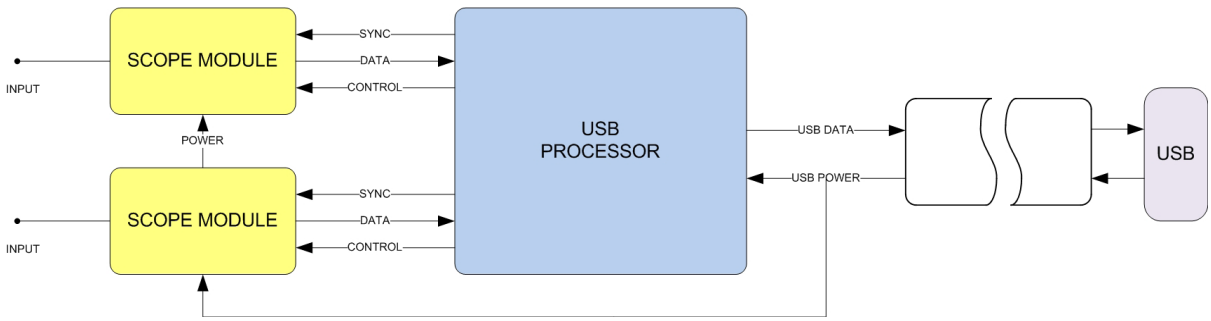
02. Integral float instrument



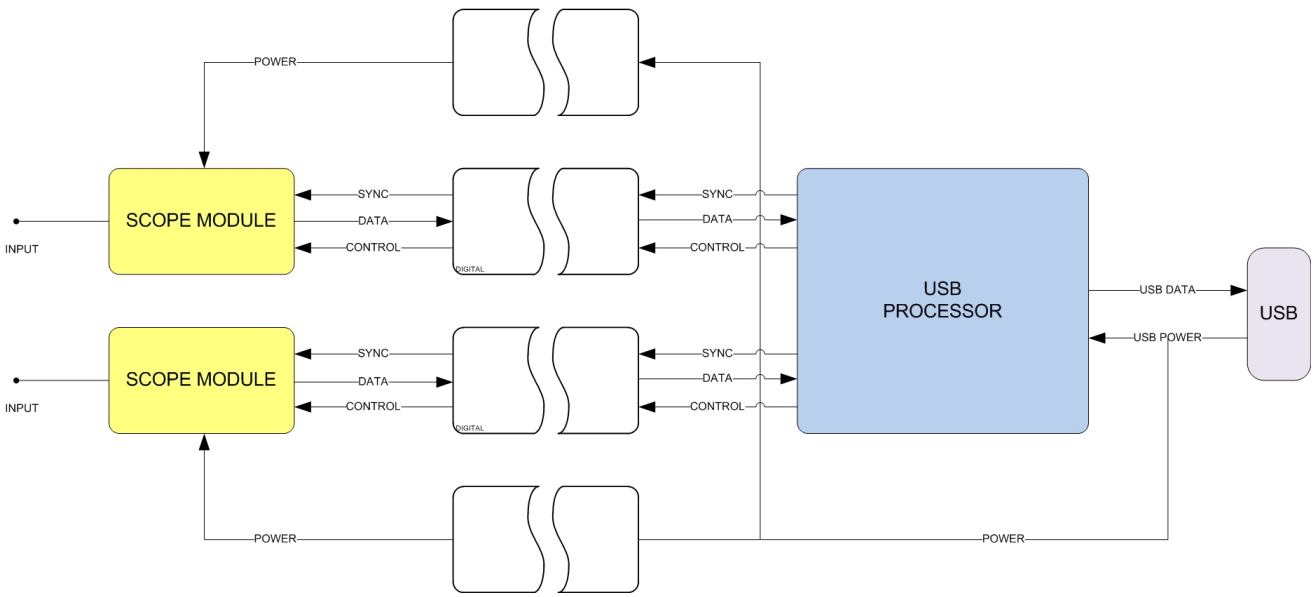
03. Basic USB instrument



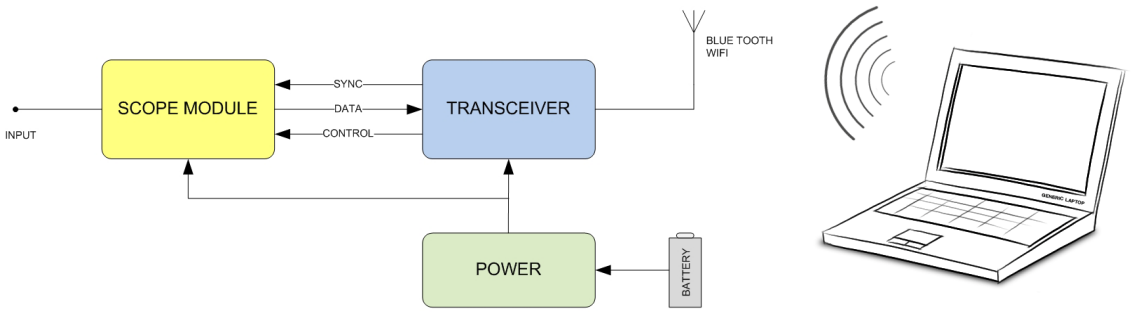
03. Basic USB instrument (isolated)



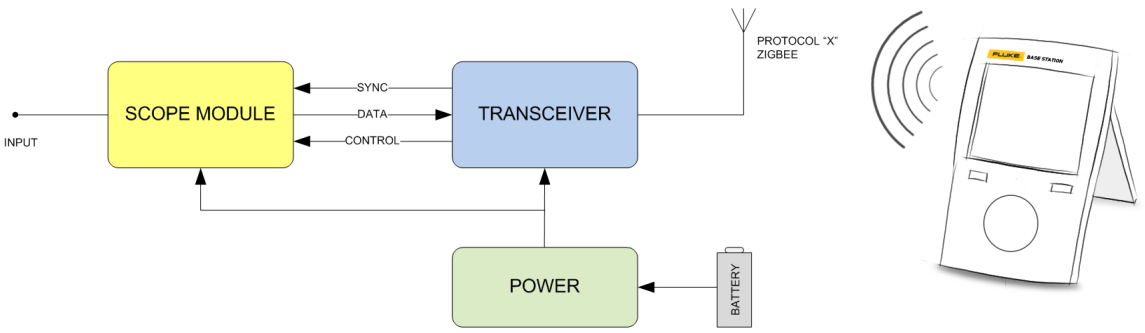
04. USB float instrument



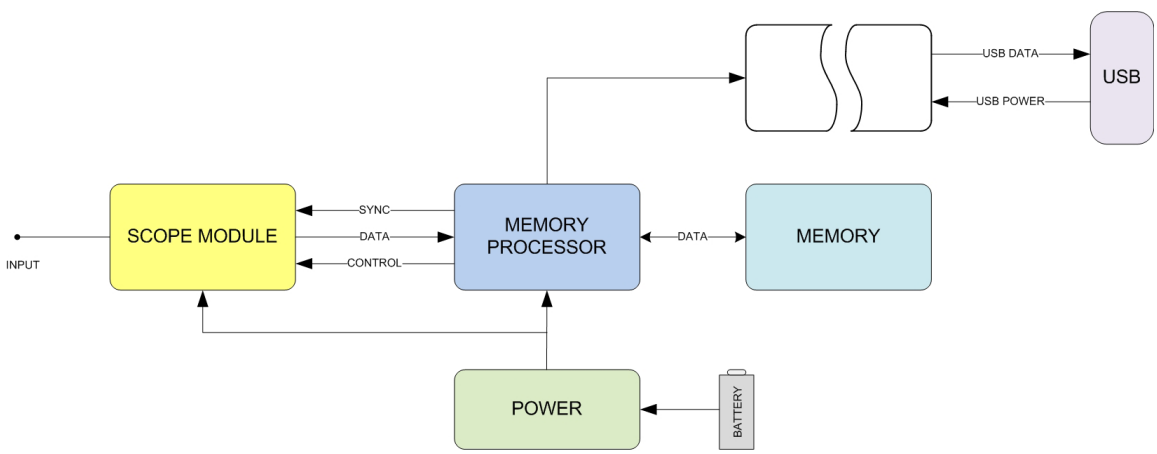
05. Wireless probe - PC back-end



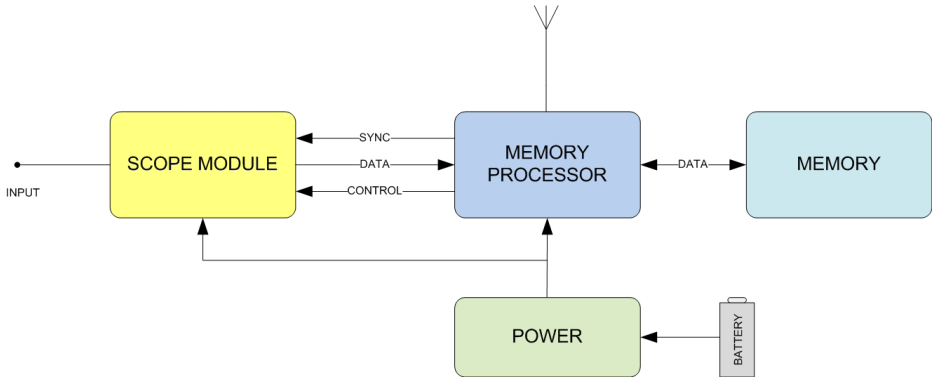
06. Wireless probe - base station back-end



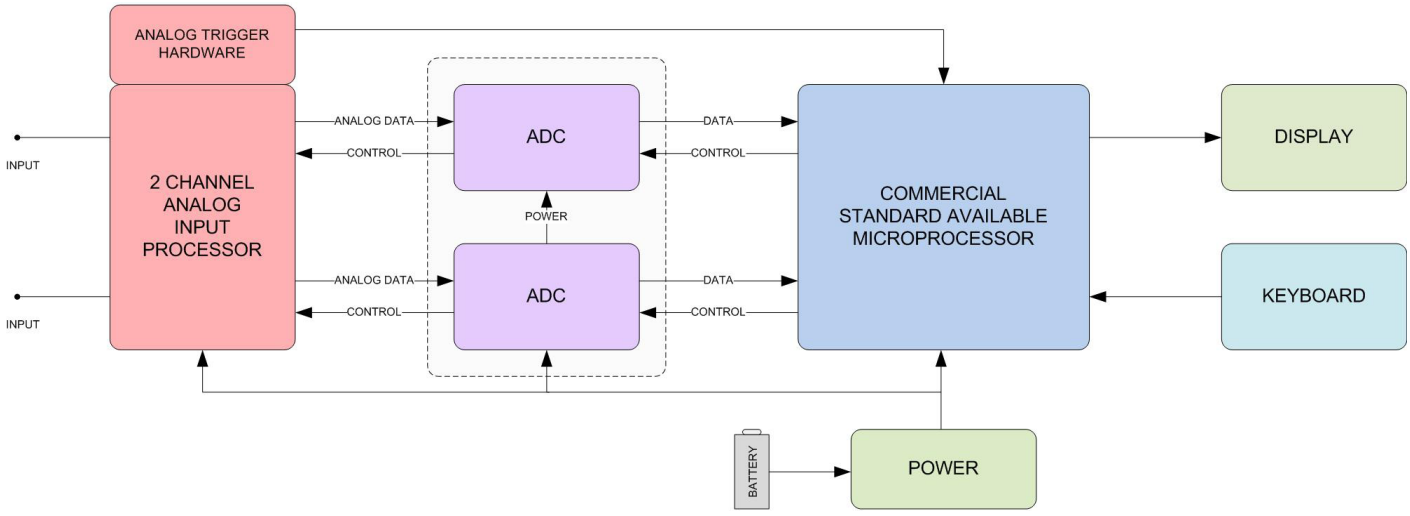
07. Memory probe (USB)



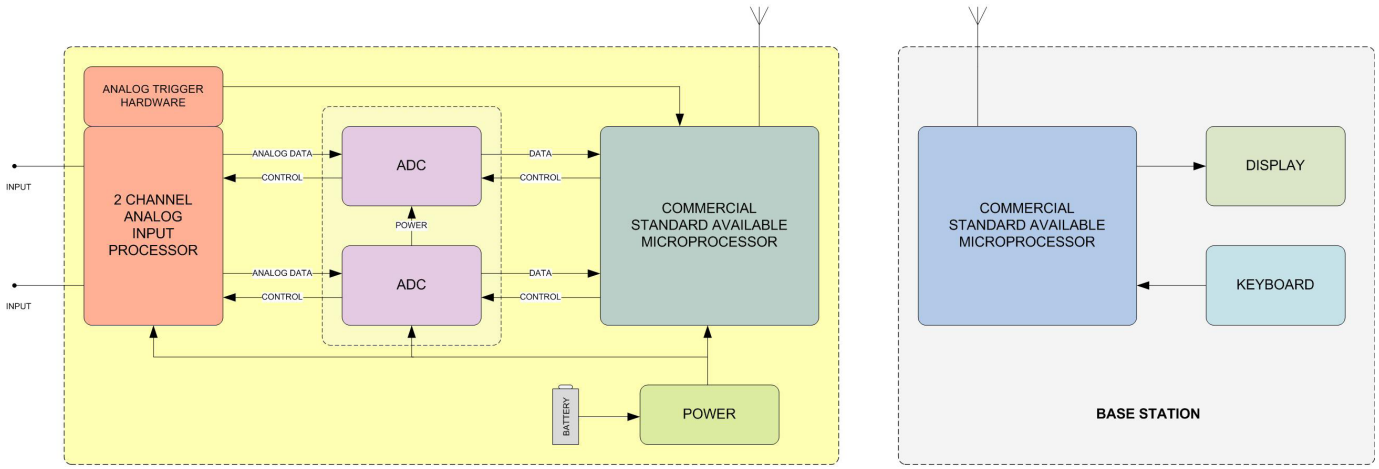
07. Memory probe (wireless)



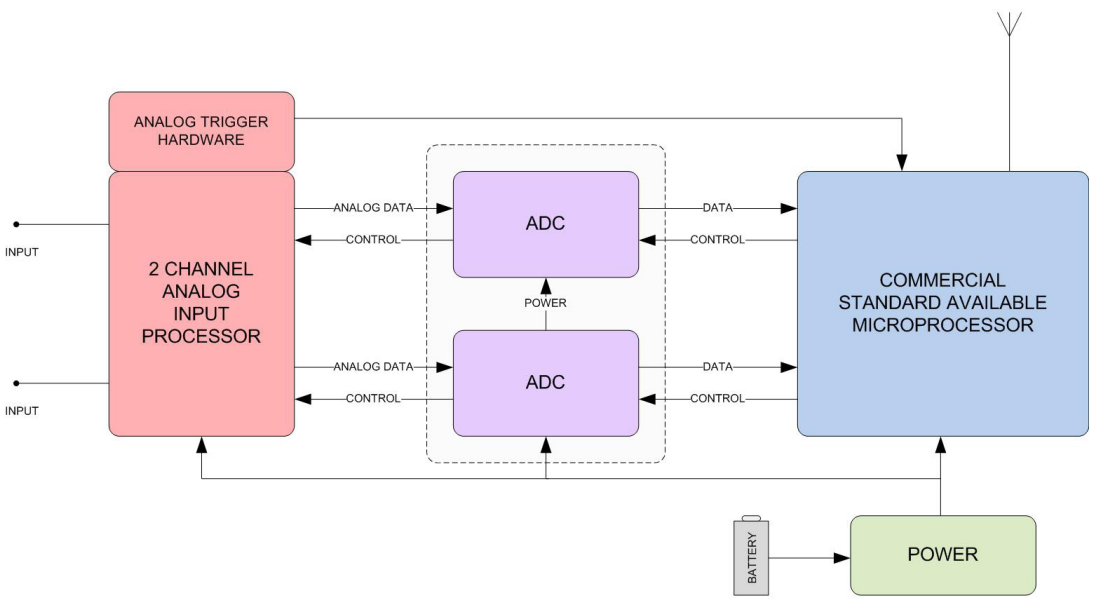
08. SM123 successor (two channels)

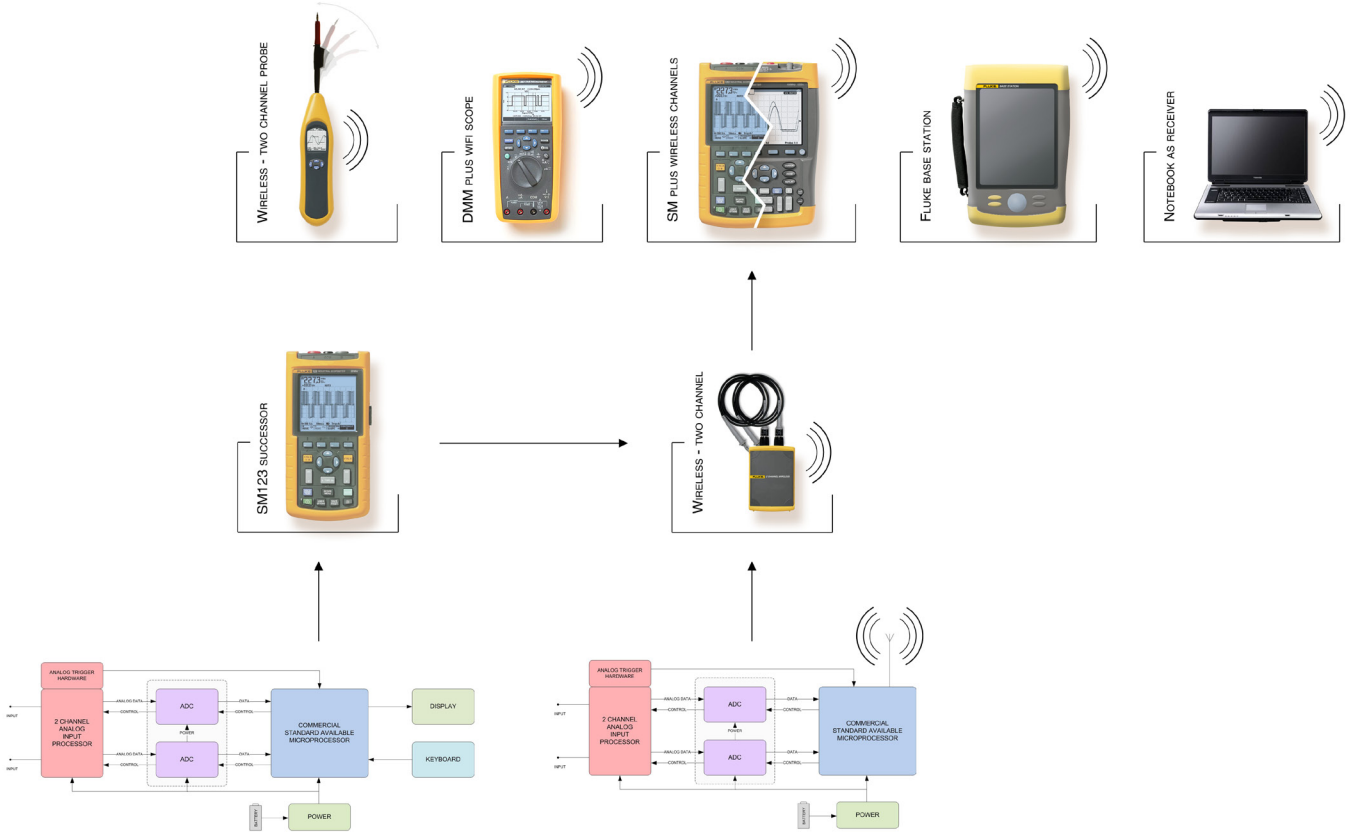


09. Two channels wireless - base station back-end



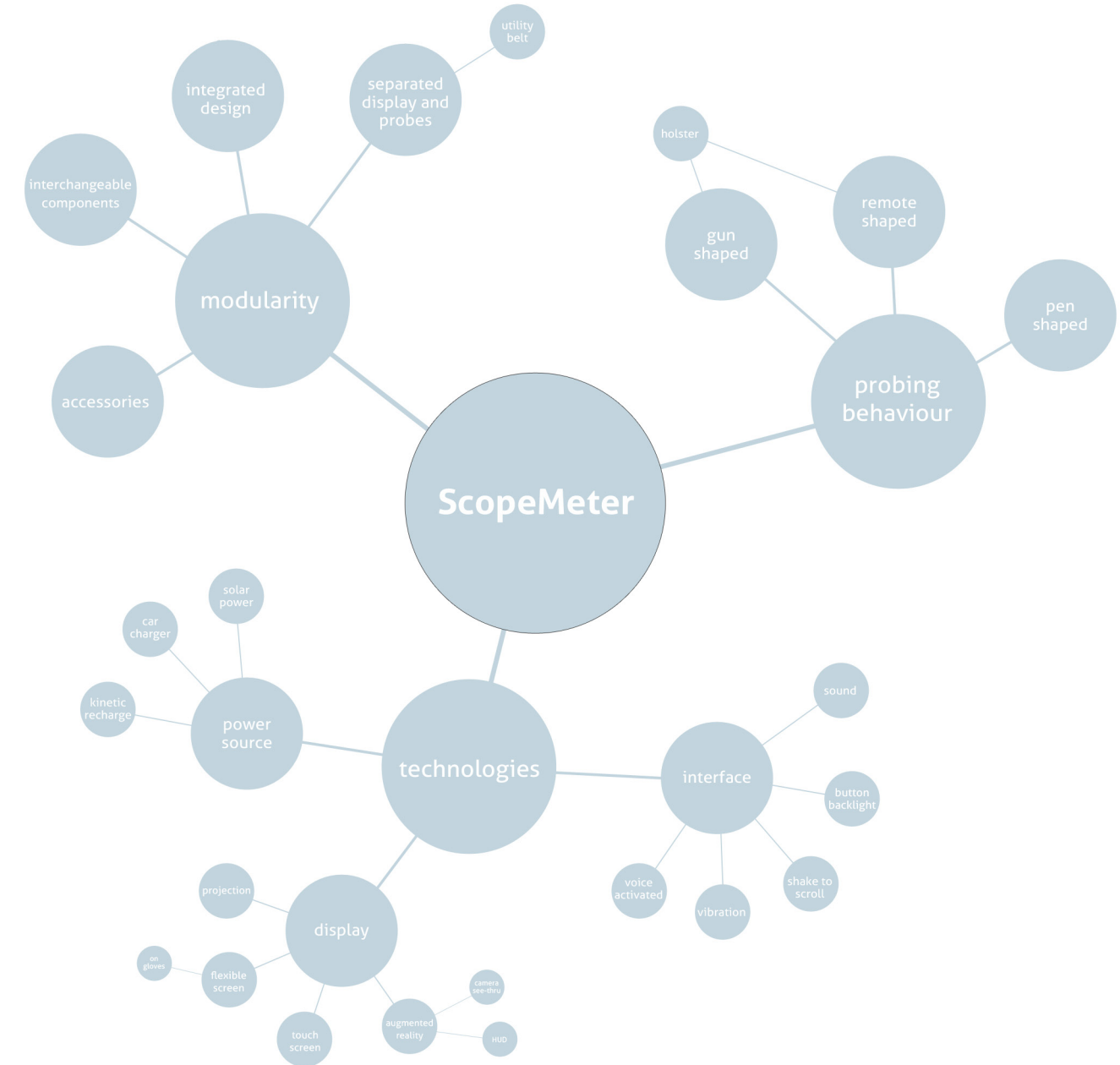
09. Two channels wireless - universal

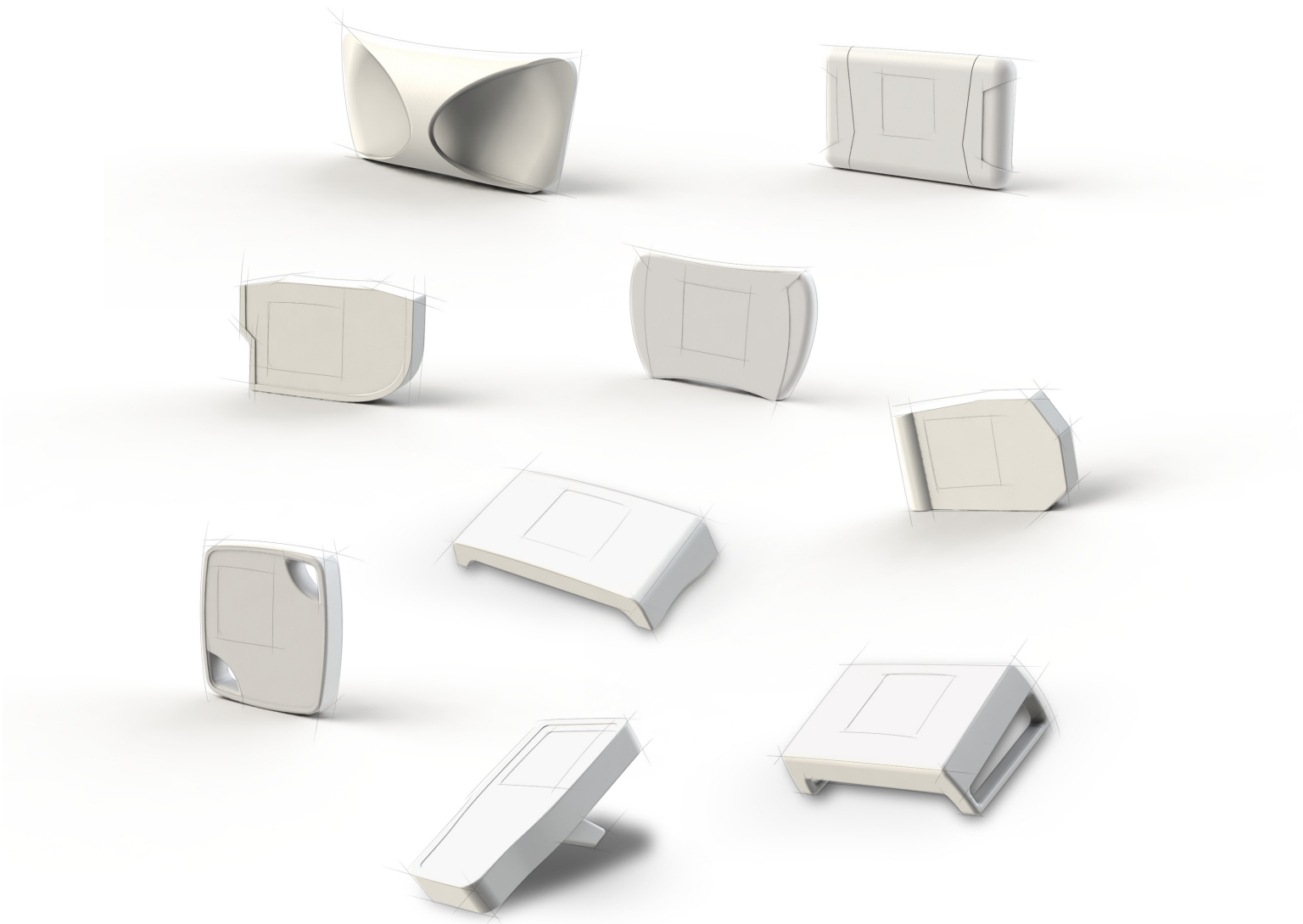




Above: Product possibilities based on product architecture.
Right: Associative idea generation process.

Idea generation by association

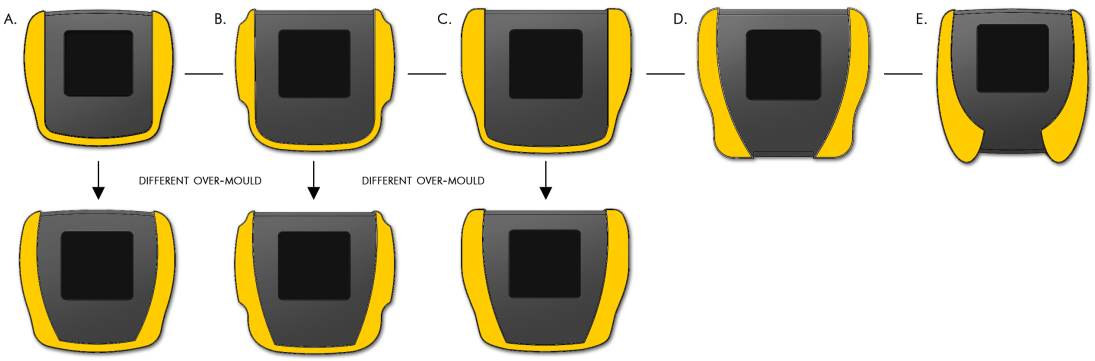


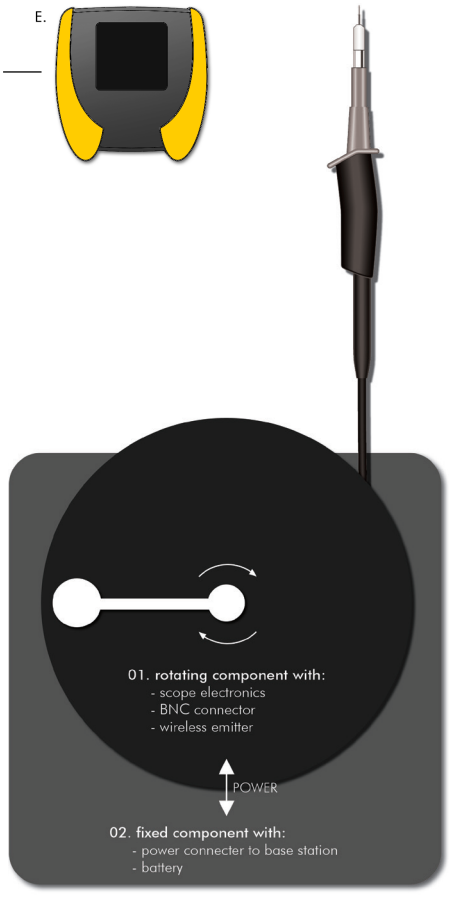


Above: Shape designs for the base station.
Right: Morphological overview.

Morphological overview

	01	02	03	04	05	06	07	08	09	10	11
Cable storage	[disclaimer: only for power]								N/A		
Probe module											
Module coupling	slide	clip	magnets	snap-on	rotate	clamp					
Display/control							touch	slide	flip	rotate	separate
Grip/holding	one hand		one or two hands								
Carrying	instrument only							case			
Resting/hanging											
Battery pack											
Recharging			crank	shake	car charger						



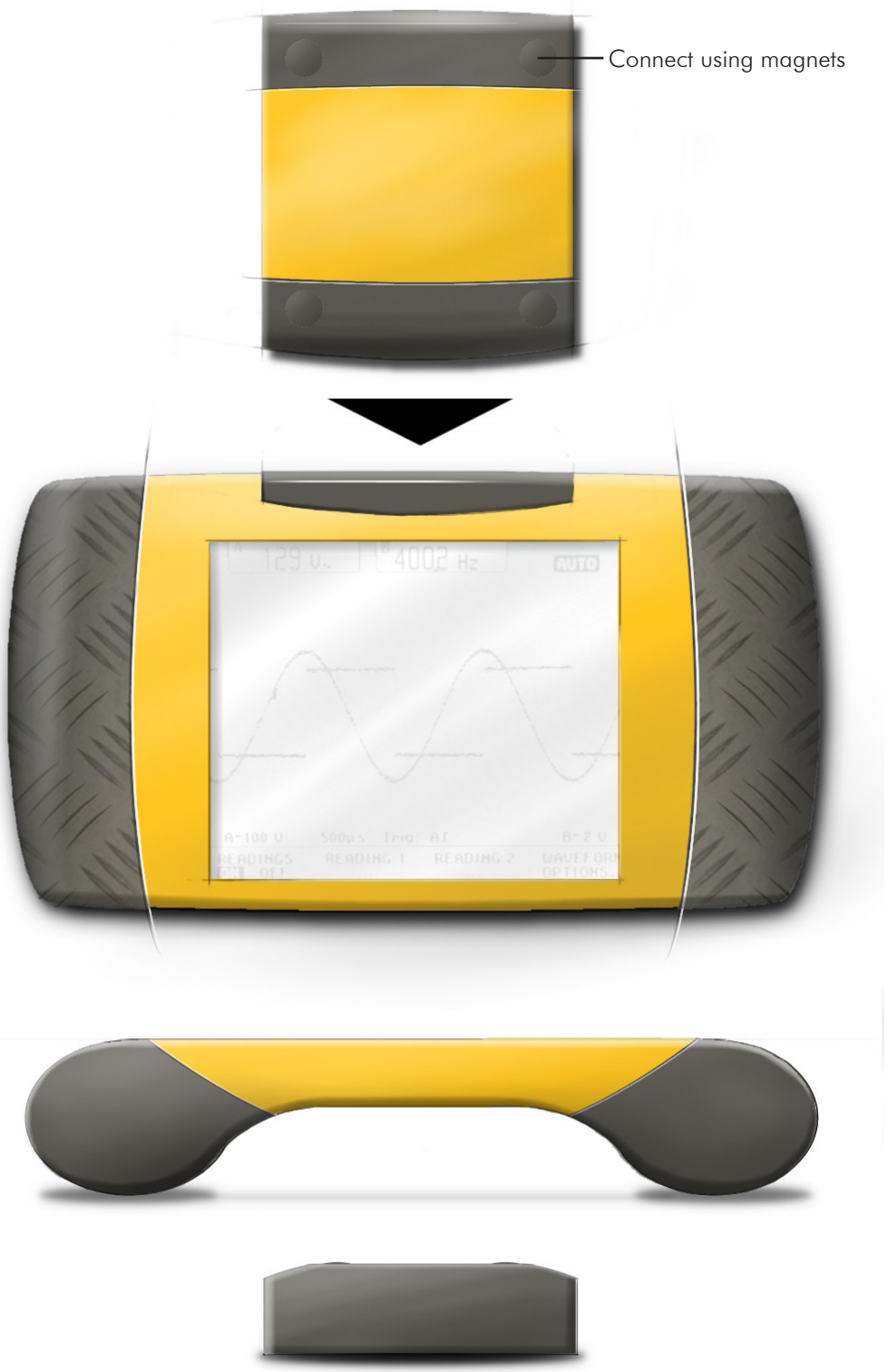


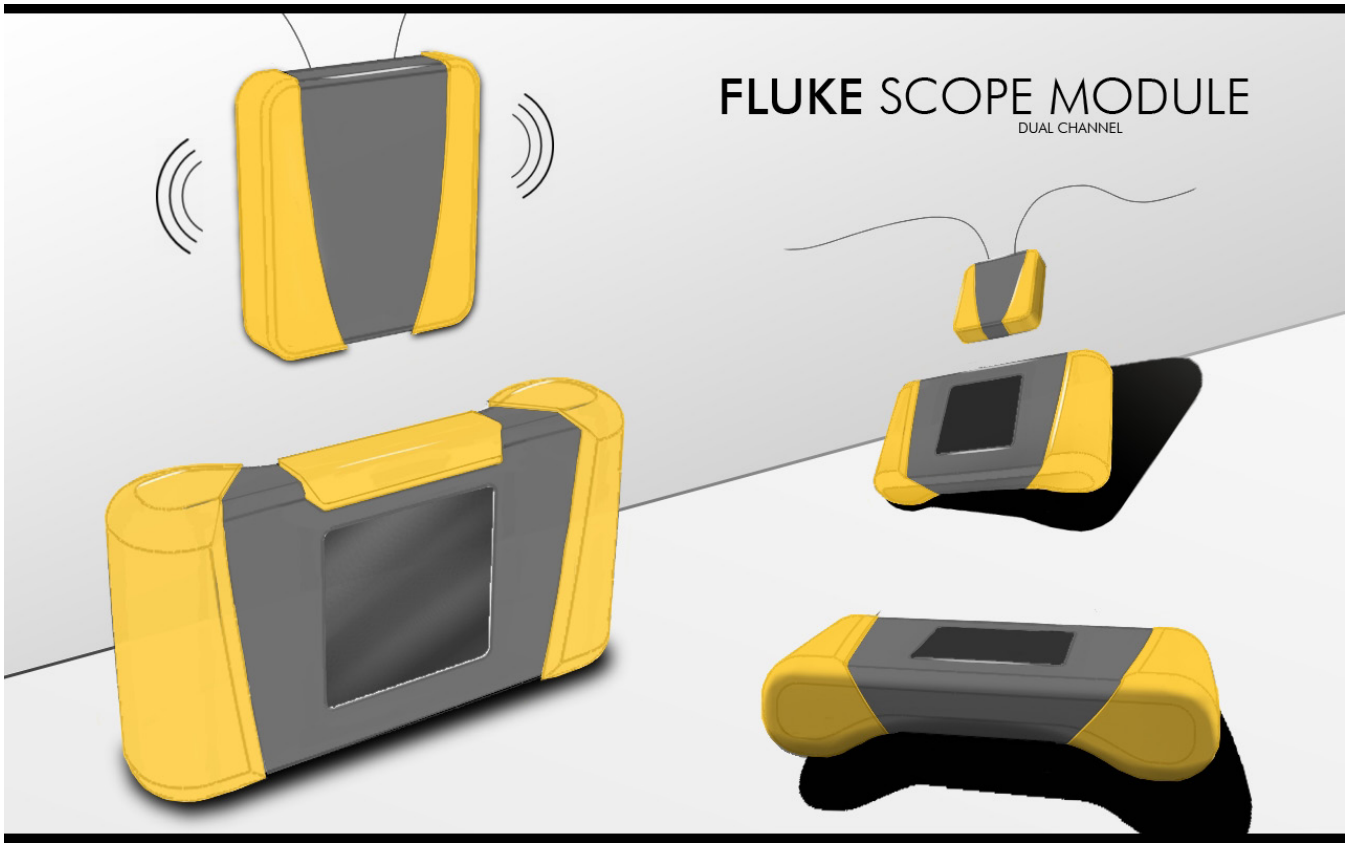
Top: Unilateral shape design options for the base station.

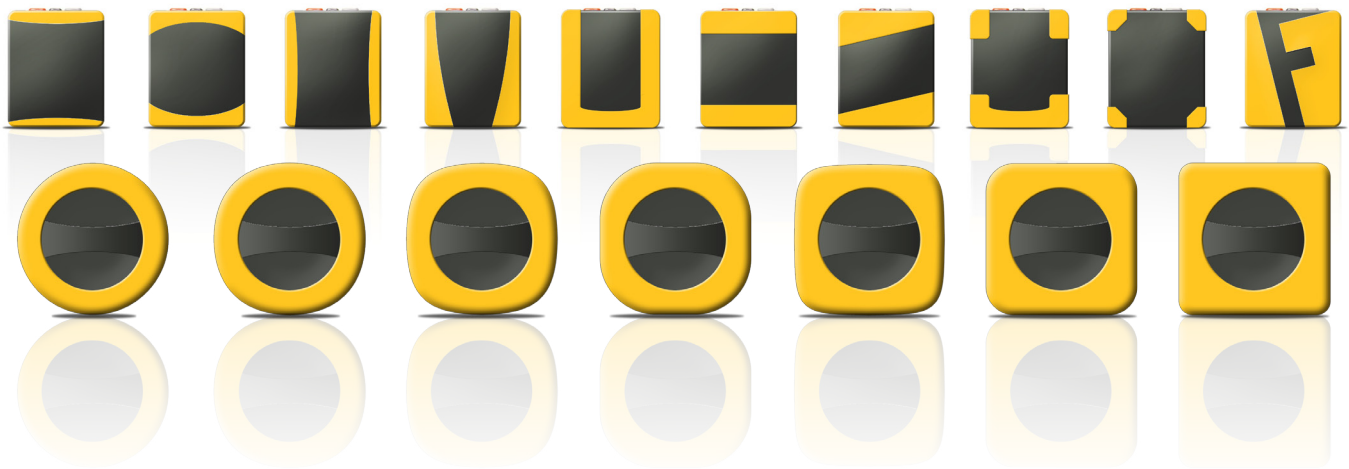
Left: Impression of a preliminary design for a touchscreen version alongside current models.

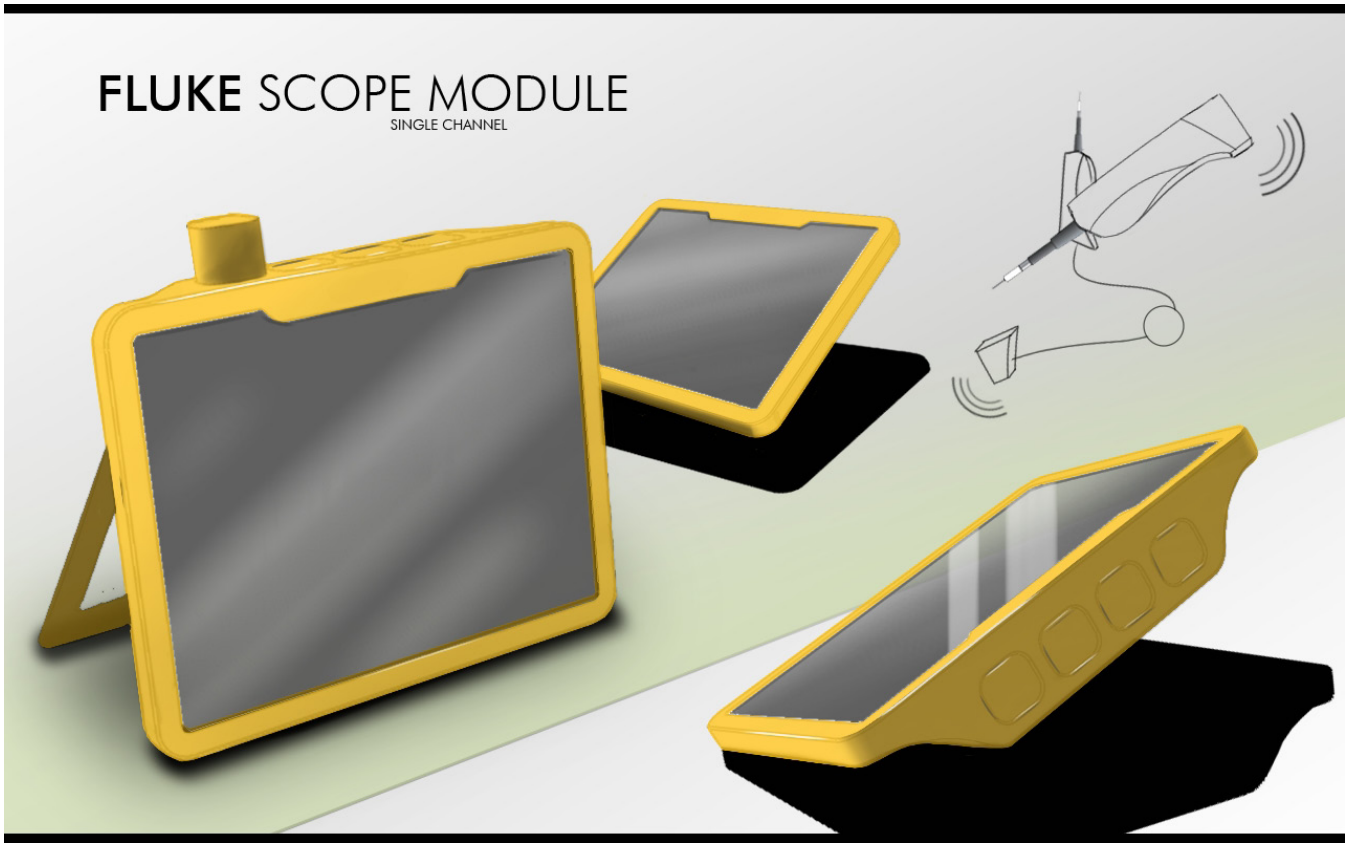
Right: Schematic of an idea of how drag contacts can be used in the scope module to facilitate winding up the cable. Explanation: unfortunately, drag contacts as listed in the morphological overview cannot be used for probe cables, however, there is a possibility to merely use the drag contact for energy transfer to the scope module while keeping the rest of the components within the main rotational component. This solution was not favoured by the production department however due to the round casing for the electronics, which would be an inefficient solution.

Adjacent page: A preliminary design for a base station with a detachable scope module.


Connect using magnets
AUTO
READINGS
READING 1
READING 2
OPTIONS


FLUKE SCOPE MODULE
DUAL CHANNEL





Shown here are some concept sketches. The left page shows a concept sketch for the dual channel scope module integrated in the scopemeter.

Below the impression of the dual channel idea on the adjacent page, some ideas for the scope module are displayed. The top row features designs for oblong shaped scope modules, the bottom row features omnidirectional designs for the scope module. The omnidirectional designs require a twisting or pushing potion to connect to the base station. The designs are intended to facilitate winding up the cable.

On this page a concept sketch is shown of the single channel scope module. The single channel scope probes are integrated in the housing of the display.

Wireless communication

Wireless communication between components is the key to enable completely different form factors for Fluke products, without creating an environment obscured by wires and cables that could interfere with the user's freedom of movement.

Fluke has experimented with wireless communication between components in one of their products, to be specific: the Fluke 233 Remote Display Multimeter. This digital multimeter makes use of a low power RF communication channel at 2.4GHz ISM Band 10 with a range of 10 metres (ZigBee). In the product patent is referred to two other examples, namely U.S. Pub. No. 2003/0137310 to Holzel and U.S. Pat. No. 7,304,618 to Plathe.

The wireless communication techniques available are:

- Radio frequency communication;
- Microwave communication;
- Infrared communication.

Microwave and infrared both rely on directionality, requiring a clear line of sight between sender and receiver. This characteristic makes these two methods less than desirable for applications such as the Fluke 233 Remote Display Multimeter. Hence in this DMM is chosen for an RF technique: ZigBee, which operates in the 2.4GHz ISM band and does not have to rely on directionality.

However, one has to be aware of the difference between sending parametric data and sending a complete signal. The latter requires a much higher data rate and thus more energy. Though of course there are ways to compromise in order to cut down the data rate. For example, one could decide to only transmit display information; such an approach would cut down the data rate significantly, at the cost of shifting (pre)processing from the receiver to the transmitter.

ZigBee

ZigBee is a low-cost, low-power, wireless mesh networking standard that use small, low-power digital radios based

on the IEEE 802.15.4-2003 standard for Low-Rate Wireless Personal Area Networks (LR-WPANs). The technology defined by the ZigBee specification is meant to be simpler and less expensive than other WPANs, such as Bluetooth. ZigBee can be easily mass produced at a low cost, hence why it is often picked over Bluetooth by manufacturers. However, it is not compatible with Bluetooth and thus the device with the ZigBee protocol will not be able to communicate with Bluetooth devices. While the users consider this a disadvantage, for Fluke it means the user will be restricted to Fluke products for reading out the data, which could increase revenue for Fluke.

It is also possible to further customise the ZigBee networking standard by adding a layer that allows Fluke to encrypt the data sent and received.

ZigBee is focused on control and automation and with its fast response times it is perfect for remote control and monitoring purposes: for example ZigBee can respond within 30 ms even in sleep mode, while Bluetooth protocols need up to 3 seconds. However, ZigBee can only manage a maximum data rate of 250 kb/sec; while this suffices for parametric data, it may not suffice for real time signal data.

Bluetooth

Bluetooth is often used as a wire-replacement communications protocol due to its low power consumption and short range capabilities. There are three classes of Bluetooth devices, those are:

Class	Maximum permitted power		Approximate range
	mW	*dBm*	
Class 1	100	20	~100 metres
Class 2	2.5	4	~10 metres
Class 3	1	0	~1 metre

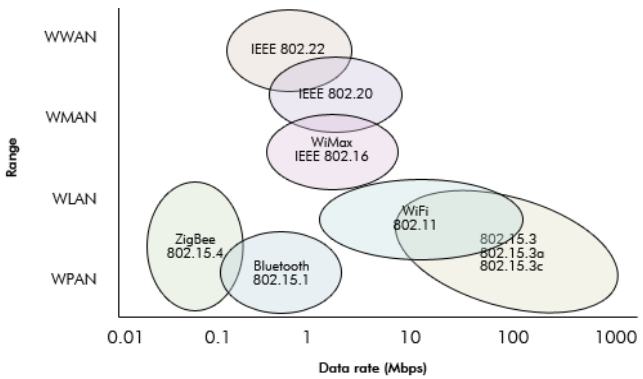
It is of course possible to tweak the implementations on a case-to-case basis, to acquire the desired range or power consumption. An added benefit of Bluetooth for Fluke products is that Bluetooth is a universal protocol and thus could also fulfil the purpose of transmitting data to a laptop or computer, though Fluke may perceive this as detrimental to their business. The maximum data rate of Bluetooth v2.0 is currently 2.1 Mbit/sec.

Considering the different nature of ZigBee and Bluetooth, it would be perfectly possible to apply both techniques, employing them for different purposes.

Wi-Fi

Wireless Fidelity (Wi-Fi) is not a technical term, but rather a collective term for a narrow range of connectivity technologies. Wi-Fi builds on IEEE 802.11 standards, which is a set of standards carrying out wireless local area network (WLAN) computer communication in the 2.4, 3.6 and 5 GHz frequency bands.

Wi-Fi is capable of a data rate of up to 54 Mbit/s, making it the most likely candidate for large amounts of data, as could be the case with a live trace signal. However, this would also consume exorbitant amounts of energy.



Context

It is not a simple case of taking the technology used for the wireless display of the Fluke DMM 233 and applying it to the ScopeMeter. Parametric data can be sent at a very low data rate, signal data however requires a data rate that is much higher. Thus the energy requirements will also be higher, exacerbating issues related to battery life.

Source: *Wireless Technologies :: Radio-Electronics.Com*, http://www.radio-electronics.com/info/wireless/index.php, URL accessed on the 22nd of February 2011

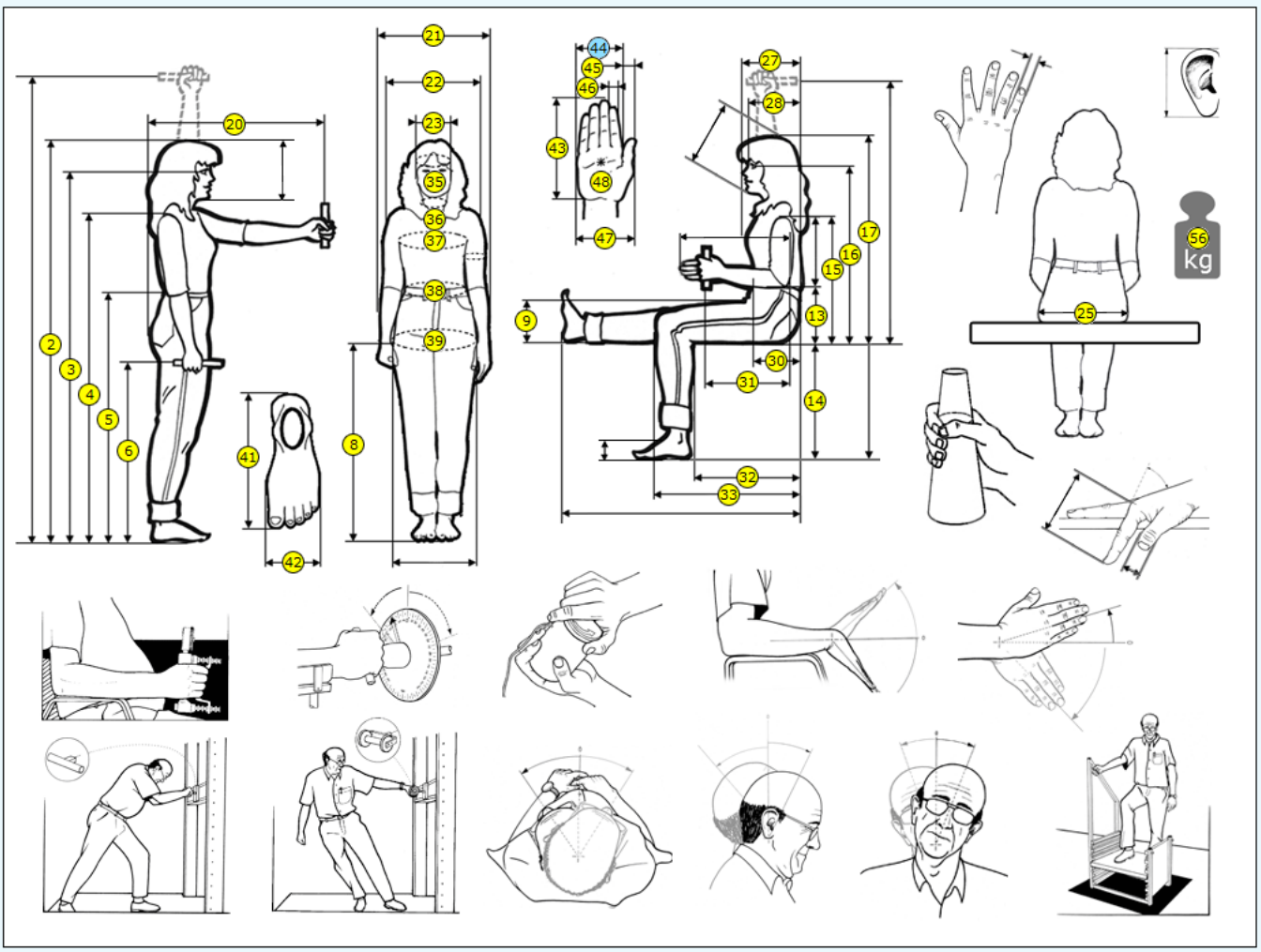
TUDelft

Dataset 'Dutch adults', Population 'DINED 2004 (20-60 years)'

Nederlands | English

Avalable populations in 'Dutch adults'
DINED 2004 (20-30 years)
DINED 2004 (31-60 years)
DINED 2004 (60 plus)
DINED 2004 (20-60 years)

Tip to remember when using these data:
Data in this table is assumed to be gaussian or normal distributed, although in some case this might be discutable. Examples are all not long bone measurements, like body weight, body joint motion forces, thigh thickness, etc In these more or less less normal-distributed data the right halve of the distribution can be larger then the left have. This means that P95-P50> P50-P5, but as far as we know now, the data are reasonable expectations.
If you falsify this assumption, please mail us: Johan Molenbroek.



Anthropometric data

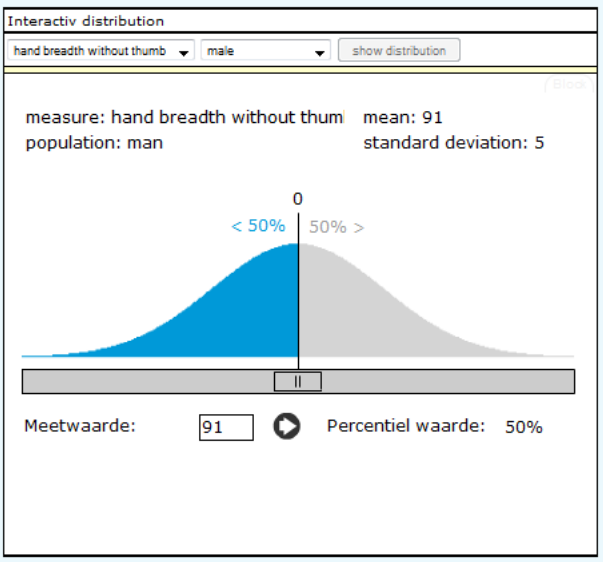
Anthropometric data regarding the blue collar target group

The following infographic and table contain anthropometric data regarding the blue collar target group. Blue collar job positions are mainly male dominated, ranging from age 16 – 65. The data has been utilised during the 'concept detailing' phase of the project, in specific for the space required between the handle and the base station. Said space is verified using Rhode & Schwartz's FSH3 Spectrum Analyzer that features a similar handle.

Source: *DINED*, http://dined.io.tudelft.nl/en,1,dined2004,304#tabledata, URL accessed on the 21st of February 2011

Data

label	name	male MEAN	male SD	female MEAN	female SD	unit
body measures						
2	stature	1817	83	1668	67	mm
3	eye height (standing)	1705	81	1563	63	mm
4	shoulder height	1494	76	1365	61	mm
5	elbow height	1134	59	1034	51	mm
6	fist height standing	817	47	755	41	mm
8	hip height	1022	61	939	46	mm
9	thigh clearance	150	15	148	14	mm
13	elbow height, sitting	261	28	243	30	mm
14	popliteal height	491	32	436	26	mm
15	shoulder height sitting	621	32	574	31	mm
16	eye height sitting	833	37	772	34	mm
17	sitting height	945	38	877	38	mm
20	arm length	758	45	682	35	mm
21	breadth over the elbows	499	39	457	43	mm
22	shoulder breadth (bi-deltoid)	468	24	421	24	mm
23	head breadth	153	6	143	6	mm
25	hip breadth sitting	394	28	405	29	mm
27	chest depth	299	38	303	33	mm
28	head depth	199	8	188	8	mm
30	abdominal depth	277	45	263	48	mm
31	elbow-grip length	359	22	322	17	mm
32	buttock-popliteal depth	515	28	495	26	mm
33	buttock-knee depth	645	32	609	30	mm
35	head circumference	575	17	551	16	mm
36	neck base circumference	492	35	442	34	mm
37	breast circumference	1024	95	997	114	mm
38	waist circumference	926	101	845	125	mm
39	hip circumference	1027	74	1060	95	mm
41	foot length	268	15	242	11	mm
42	foot breadth	101	6	92	5	mm
43	hand length	196	11	178	8	mm
44	hand breadth without thumb	91	5	80	4	mm
45	thumb breadth	24	2	21	2	mm
46	forefinger breadth	18	2	16	2	mm
47	hand breadth (with thumb)	112	5	93	6	mm
48	hand thickness	29	3	27	5	mm
force excercise						
56	body mass	83.1	13.5	68.1	11.4	kg
label	name	male MEAN	male SD	female MEAN	female SD	unit



Cross-referencing design with the list of requirements

The list of requirements as used during the ideation phase is compared to the final wireless ScopeMeter design. A simple colour scheme indicates how well the design adheres to the listed requirements.

- General
  - v Minimum product display features (72x72 mm, 240x240 px)
    The lens size is 100x120 mm, which falls well within the requirements.
  - ? Maximum component size (256x169x64 mm)
    The design fits within a box with the size 200x185x38 mm, which is slightly wider than intended due to its unilateral shape.
  - v Weight (<1kg per component)
    An extrapolation of components infers the product will be lighter than the current ScopeMeter 123, mainly due to advances with battery technology.
  - v Exterior has to express Fluke's characteristics: robust, ruggedness, quality, compactness
    The shapes and the components adhere to Fluke's guidelines. The stand up however still requires some improvement.
  - v Exterior has to adhere to Fluke's design and colour guidelines
    The colour scheme and details such as the overmould's ridges and 'flow' adhere to Fluke's guidelines.
  - ? Product must be suitable for production of at least 10,000 per year
    The assumption is that it should be suitable for such a production figure, though since the design is still in the concept stage this cannot be verified.

- Power source
  - v Battery operating time (currently ±4 hours)
    The lithium-ion batteries suggested have a higher energy capacity and a lower weight than the current batteries used.
  - v Battery (re)charging time (currently ±4 hours)
    The lithium-ion batteries suggested should be able to perform at this level.
  - v Must be rechargeable
    Lithium-ion batteries are rechargable, though require a new adapter compared to Fluke's current adapter. Suggestions have also been made with regards to a shape change for the connector.
  - x Interchangeable battery (with the need of additional tools)
    No room has been incorporated for a battery hatch due to it not being perceived as entirely necessary. Fluke may desire otherwise however.

- Colours[29]
  The product adheres completely to Fluke´s strict colour guidelines.
  - v Fluke yellow (Munsell 9YR 7.36/14.6) for the overmoulded holsters
  - v Fluke handheld grey for the casing (grey 8; Munsell 7.1B 3.51/0.3)
  - v Grey 7 (Munsell 2.4B 4.49/0.18 CIE 48.69,-0.48,-0/14) or grey 9 (Munsell 2.49B 2.62/0.23) for emphasis, such as soft material in grip area
  - v The Fluke logo should be black (Munsell N 0.5/) and surrounded by yellow (Munsell 9YR 7.36/14.6)

- Product text[29]
  The product adheres completely to Fluke´s strict graphics guidelines.
  - v Must display the Fluke logo
  - v Product number (10 pt. Helvetica Bold Oblique)
  - v Product descriptor (7.5 pt. Helvetica Regular Oblique, all caps)

- Materials
  The product utilises the same materials for the different components as the current product range, making it a perfect fit within Fluke's product range.
  - v Silicon pads for the buttons
  - v PC/ABS/V0 for casing

v TPU for overmoulded holsters

- Circumstances of use[32]
  Most of these cannot be tested as they apply to the final product, though there is no reason why the design should not be able to live up to these requirements considering the extrapolated components and techniques.
  ? Temperature
    - Operating temperature: 0 °C to +50 °C
    - Storage temperature: -20 °C to +60 °C
  ? Vibration (sinusoidal) 3g according to MIL-PRF-28800F Class 2
  ? Shock (30g)
  ? Brightness of display (80 Cd/m^2)
  ? Moist (protected against water jets, current IP rating; IP51 according to IEC529)
  ? Dust protected (current IP rating; IP51 according to IEC529)
  ? Impact height (for a Fluke product between 0 – 6.8 kgs the survivable impact height is 91.44 cms)
  v Electric shock (core needs to be well isolated; CAT III: distance of 8 mm from between circuit board and casing)
  The design is suitable for CAT III (8 mm), however does not adhere to CAT IV (16 mm).
  ? Must function in an electromagnetically 'dirty' environment
  This requires further testing, but the design caters to it in the best way possible.

- Probes
  v The product should feature either BNC or ScopeMeter 123 connectors
  The product uses ScopeMeter 123's connectors, but could easily be made compatible with BNC connectors

- User interface
  v Size of buttons (currently between 50 mm^2 and 200 mm^2)
  The size of the buttons in the design is between 50 mm^2 and 320 mm^2 (combined dual button) to cater to use while wearing thick gloves, so this requirement is fulfilled.
  ? Force required to press (currently ±2500 mN)
  This cannot be verified, but the method used is the same as that of the current scopemeters, hence there is no reason why it should not adhere to this requirement.
  v Shape (if possible, use Fluke conventions)
  v Texture (matte finish)
  v Colour (Fluke conventions, refer to Fluke's graphic manual)
  v Function related to sensitivity (e.g. power button placed level with casing surface)
  The function keys are mapped and integrated in the lens, the power button is placed on top and is level with the surface of the casing, the tertiary buttons are also level with the surface of the casing.
  v Actions should have feedback (sound, light, motion, display)[11]
  The design features multimodality in the form of button feedback; to be specific LEDs are placed under certain buttons to provide the user with information regarding their actions. Tetra uses a similar feature.

Overall the product fulfills all main requirements. The few points that require attention are:

- Quality of the stand up;
- Possibility for a CAT IV rating;
- Lack of a battery hatch.

Presentation

The work as presented to representatives of Tektronix and Fluke at Beaverton, US

About a month into the bachelor assignment to create future concepts for the Fluke ScopeMeter, Benchmark decided to actively pursue a joint investment by Tektronix and Fluke. Benchmark has a lot of experience with Fluke products and requirements thereof, however Benchmark has only just begun to explore the needs of Tektronix (see project Ruby).

Benchmark decided to present the possibilities to both Fluke and Tektronix after an engineering convention at Beaverton at the end of March. A progressive timeline of developments was presented, outlining the benefits for both brands. In order to appeal to needs expressed by Tektronix regarding establishing brand loyalty, a quick and dirty USB oscilloscope design was presented as well, fitting within the overall progressive timeline of developments.

The presentation was created by Benchmark's lead designer Christian Suurmeijer. Visualisations for opportunities two, three and four, as well impressions of the current market and brand differentiation, were created by me.

Benchmark electronics

design develop deliver **advanced technology**

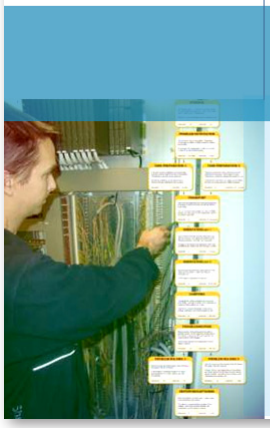
Contents

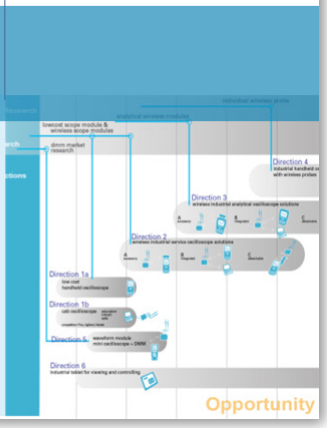


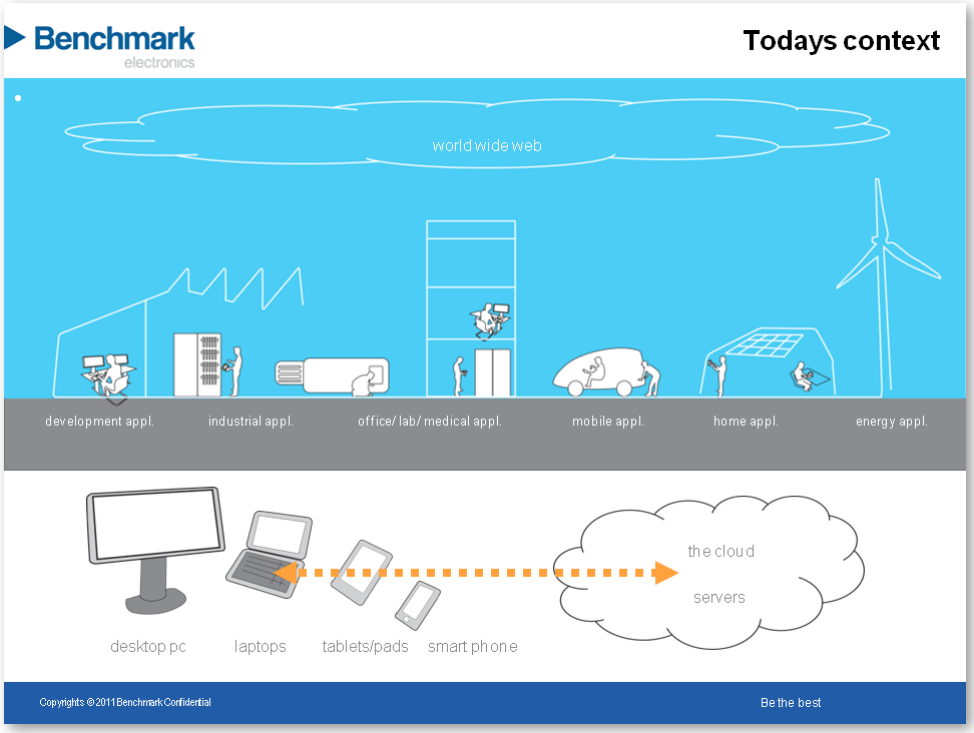

Benchmark electronics

Approach

- customer visits
  web research
  task analysis
- ideation & envisioning
  technology concepts
- road mapping
  concept visualisation
  challenge determination



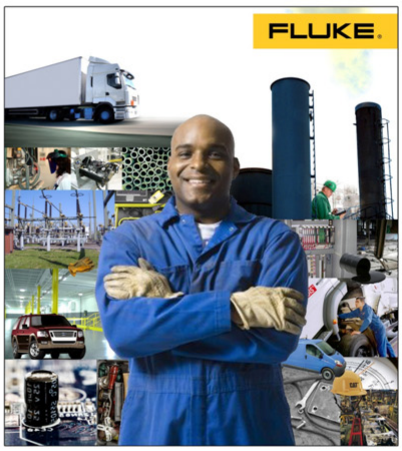


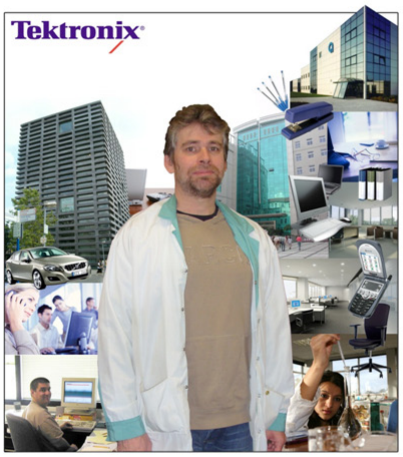

Benchmark
electronics
Todays context
world wide web
development appl.
industrial appl.
office/ lab/ medical appl.
mobile appl.
home appl.
energy appl.
the cloud
servers
desktop pc
laptops
tablets/pads
smart phone
Copyrights © 2011 Benchmark Confidential
Be the best


Benchmark
electronics
Strategy Directions in Marketplace
HANDHELD
WHITE COLLAR
BLUE COLLAR
BENCH
1.
CURRENT OSCILLOSCOPE MARKET COVERAGE
2.
TEKTRONIX
FLUKE
4.
Copyrights © 2011 Benchmark Confidential
Be the best

Benchmark electronics

Brand Differentiation

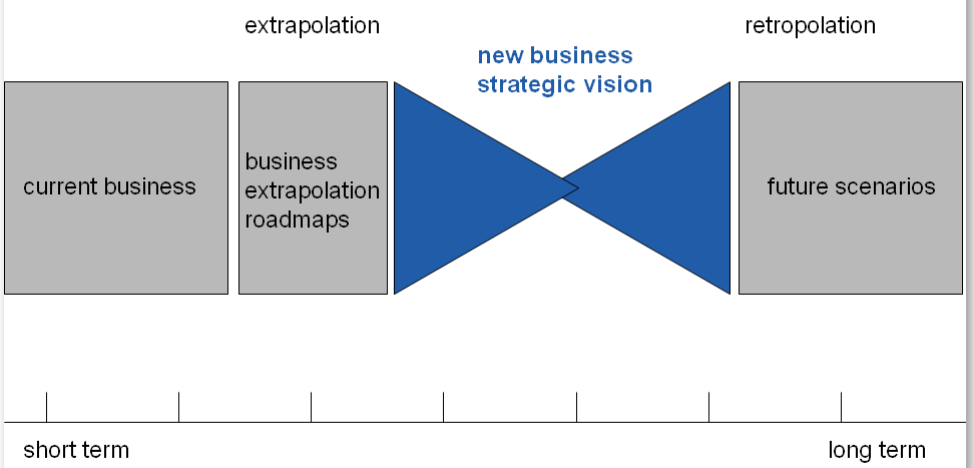




Benchmark electronics

Benchmark electronics

Approach



Benchmark electronics

Consumer Trends to Leverage

integrated services: (google, itunes, amazone)

robust & cosmetic housings

advanced display innovations

smart interfaces & interactions

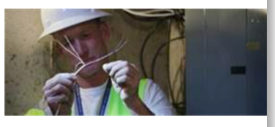
wireless solutions

Benchmark electronics

Industry Trends Overview

- Increasing Safety Regulations
- Increasing Efficiency Focus
- Less Trained Users
- Robust Solutions
- More Performance for the same Price
- Price Erosion
- Sustainable Power Quality and Efficiency
- Increasing Complexity of Situations
- Increasing use of www and wireless connectivity
- Extending Functionalities and Communication on Smart phones




Benchmark electronics

"I hate working in the rain and cold"


Benchmark
electronics
"I want to do measurements at a safe and convenient distance"


Benchmark
electronics
'the wire mess makes it inefficient and unsafe"

Benchmark electronics

''Wires restrict flexibility''

Benchmark electronics

Technical boundaries and possibilities of Wireless Oscilloscopes

- We thought it was difficult but it is just hard work:
  - A Scope picture at a distance
    - 2 traces
    - 640 points/trace
    - 8 bits/point
    - 10 updates/second

= 102.4 kbit/sec

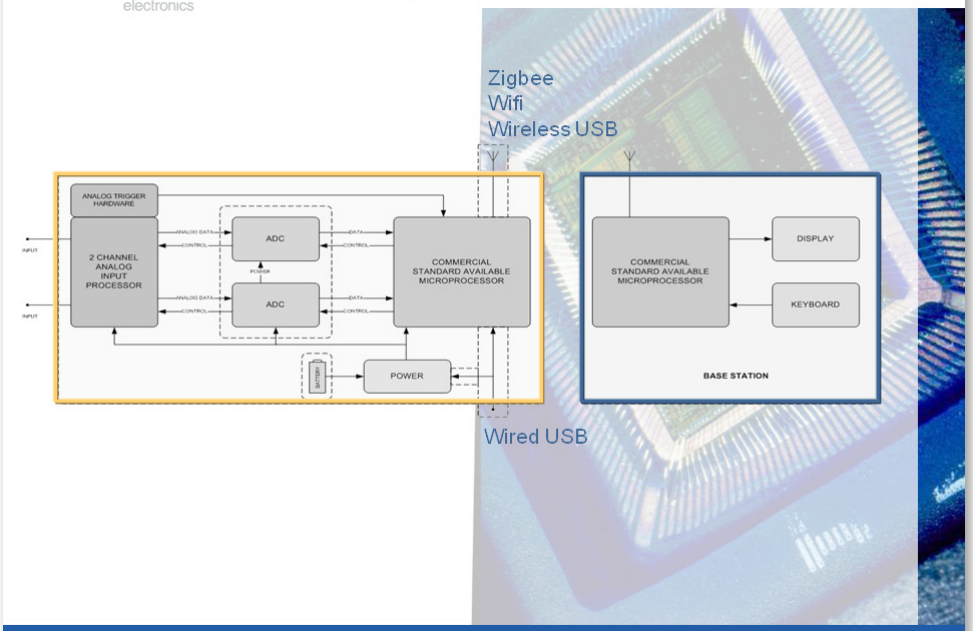
- Innovation breakthrough, New IP, Opportunities
  - Synchronizing multiple wireless scope channels
    - Synchronize individual clocks before measurement
    - Timestamp samples
    - Line-up samples at display unit
    - How precise can we get? µs? ns?


Basic Handheld
Oscilloscope
Benchmark
electronics


Benchmark
electronics
Gimmick or Trend? : Pocket Oscilloscopes
Android Bluetooth Oscilloscope (nfsy)
DS Nano 1,2 and concept $89
Pocket Oscilloscope DS0203 (nfsy)
Copyrights © 2011 Benchmark Confidential
Be the best

Benchmark electronics

Integrated Solution for Wireless/USB Oscilloscope



Be the best

How do we make a < 500$ Scope?

Danaher performance at Chinese prices

Reuse prove display technology

Use latest integrated technology

Develop innovative user centred solutions

Basic Handheld Oscilloscope

- Low Cost, Safe, Basic Handheld, Oscilloscope
- Highly Integrated Analog Technology (One Chip Solution)
- Commercial High Speed Low Power Microcontrollers
- Integrated Graphical Controllers

USB Oscilloscope

Benchmark
electronics

USB Market

- Many players: Agilent, Pico, Hantek, Rigol, Chauvin Arnoux, ….
- Many models > 50 models at local distributor Conrad
- Prices: from €200 (Hantek DSO-2090, 2CH/40MHz)
  to €9700 (Pico 9211, 2CH/12GHz)
- Differentiators: Price
  Performance
  Extra functions (Arb.Gen.)
  (wireless) LAN
- *Opportunities:* *Safe & Robust (User Error Proof)*
  Floating Channels (Industrial)
  Wireless USB?

Benchmark electronics

USB Oscilloscopes

Pen-Scope
PicoScope 2104
174,04 EUR
10MHz

Velleman
USB-
oscilloscoopadapter
PCSU1000
409,32 EUR
60 MHz

Visascope
708,05 EUR
20 MHz

Agilent
20 MHz USB
arbitraire-
functiegenerator
U2761A
1549,38 EUR
20MHz

PicoScope
Serie 9211
$ 9739,14
12GHz

Be the best

Wireless connection ensures safety of equipment and user - ideal for educational purposes

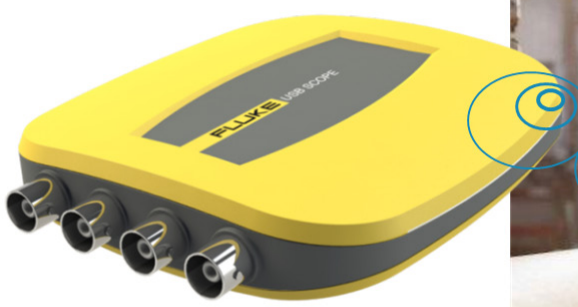
Worry free experimenting

Safe Wireless/Usb Oscilloscope

- Take over market with something better.
- No concept sell needed
- Safe Industrial Cat III USB Scope (User Error Proof Instrument)
- Floating Input USB Scope
- Leverage existing technology

Now you can make an Oscilloscope of your Notebook. If you have to travel off site and only want to take hand luggage, use the new robust Wireless Module

Scope On the Go



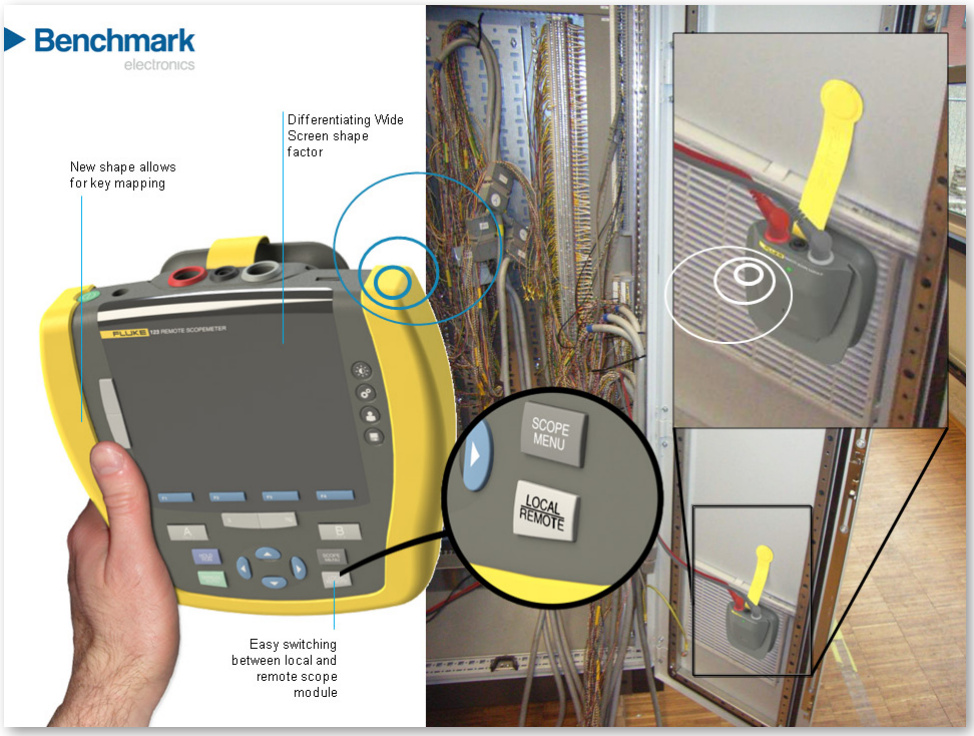
Robust Wireless Oscilloscope

- Take over market with something better.
- No concept sell needed
- Safe Industrial Cat III Wireless Scope (User Error Proof Instrume
- Floating Input USB Scope
- Leverage existing technology

Detachable Oscilloscope Module

Benchmark electronics

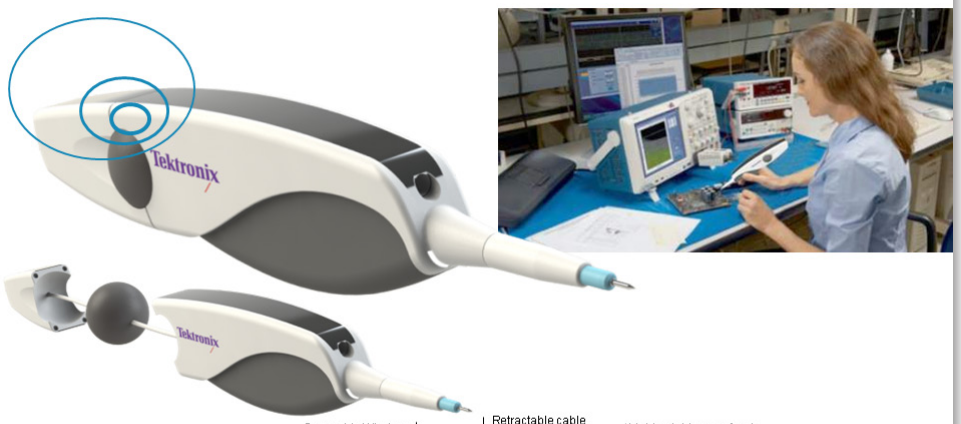

Now you can do your measurements at a safe distance out of the cold and rain
Detachable Oscilloscope Module
Customer visits show interest
Short Distance Remote Service Scope Measurements

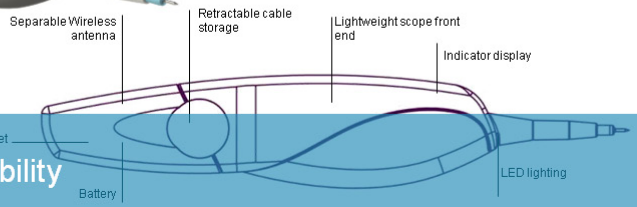

Benchmark
electronics
New shape allows for key mapping
Differentiating Wide Screen shape factor
SCOPE MENU
LOCAL REMOTE
Easy switching between local and remote scope module


Handheld Oscilloscope
with Wireless Probes
Benchmark
electronics


Wireless connection ensures safety of equipment and user
Now you can do your measurements
in a less messy and more flexible way
Probe Dock at rear of
ScopePad serves as
Synchronizing
"BrowseProbe"
• wireless signal probing
• spot light
• threshold indicator
"ScopePad"
• viewing,
• sharing,
• sending,
• restore
Handheld
Oscilloscope with
Wireless Probes
True Multi-Channel Wireless Scope Measurements
Simultaneous Measurement of Spatially Separated Signals
Reading & Controlling at a Distance
Very High User Safety

Benchmark
electronics





Freedom & Flexibility

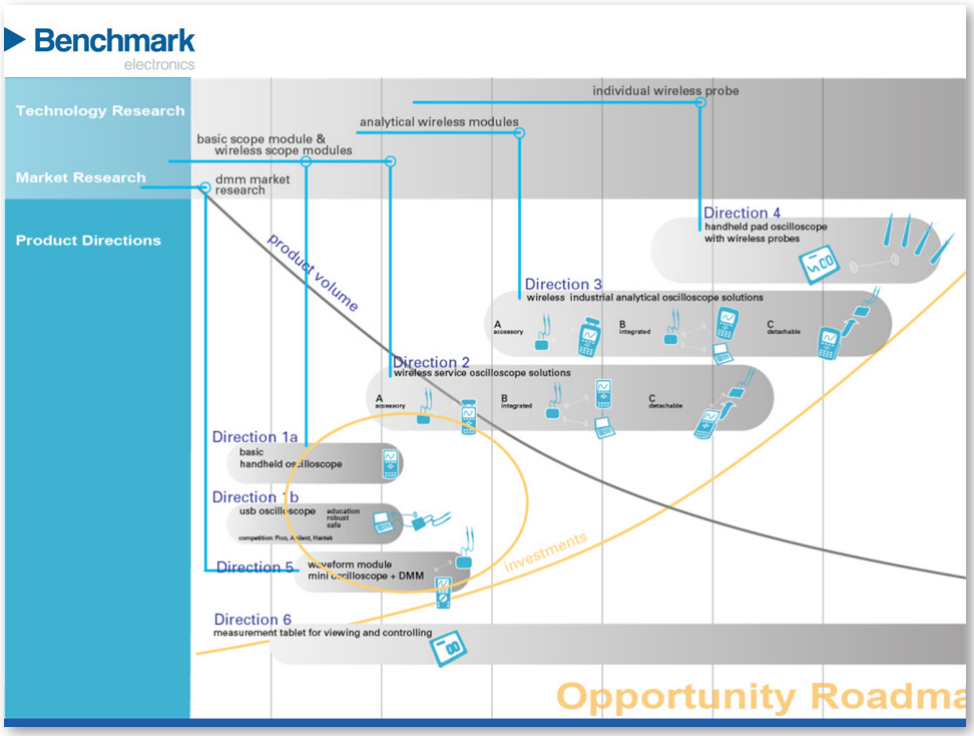
Wireless connection ensures safety of equipment and user

Now you can do your measurements at a safe distance out of the cold and rain

Handheld Oscilloscope with Wireless Probes

- True Multi-Channel Wireless Scope Measurements
- Simultaneous Measurement of Spatially Separated Signals
- Reading & Controlling at a Distance
- Very High User Safety


Benchmark
electronics
Separable Wireless antenna
Retractable cable storage
Lightweight scope front end
Safety & Easy of Use


Benchmark
electronics
Technology Research
Market Research
Product Directions
individual wireless probe
analytical wireless modules
basic scope module & wireless scope modules
dmm market research
product volume
Direction 4
handheld pad oscilloscope with wireless probes
Direction 3
wireless industrial analytical oscilloscope solutions
Direction 2
wireless service oscilloscope solutions
Direction 1a
basic handheld oscilloscope
Direction 1b
usb oscilloscope
Direction 5
waveform module mini oscilloscope + DMM
Direction 6
measurement tablet for viewing and controlling
investments
Opportunity Roadma

Benchmark electronics

Opportunities Overview

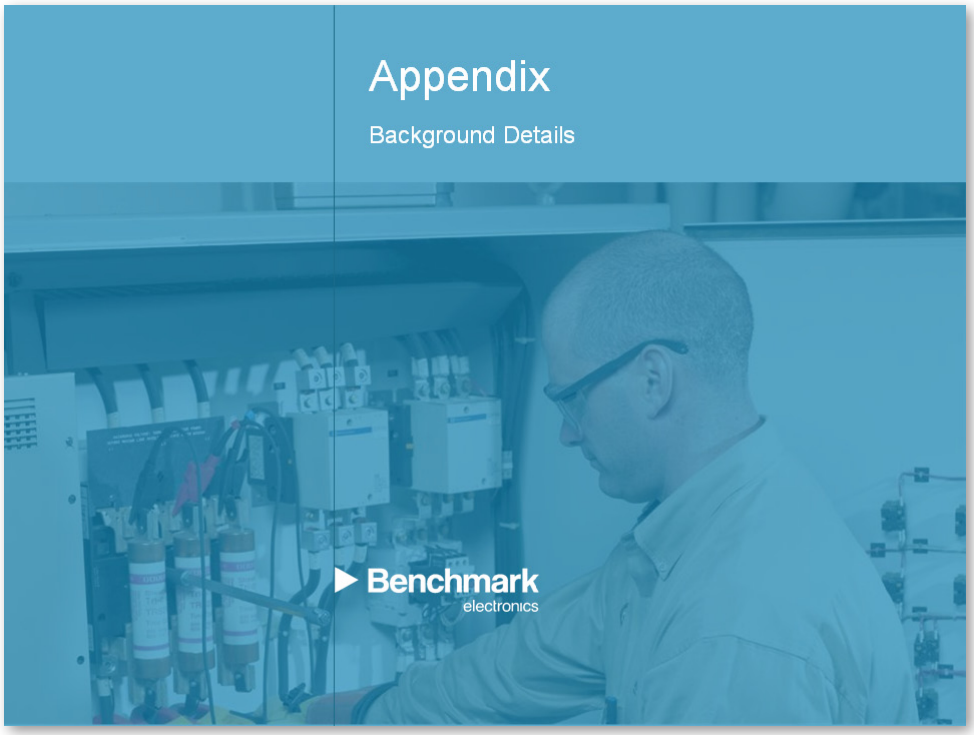
Trends	Solution characteristics	Opportunities
Increasing Safety Regulation	*Wireless technology*	Basic Oscilloscope: competing in the Chinese market with professional solutions — 1
Efficiency Focus	Innovative solutions	Wireless Scope Module: *safe* scope modules to connect to laptops, pc's, smart phones — 2
Less Trained Users	Robust and safe design	Detachable Wireless Scope Module: improve quality of life by optimized integration — 3
Robust Solutions	Smart products	Wireless Probes: transforming to a health assistant — 4
More value for Money		
Sustainable Solutions		

Be the best

Thank you for your interest. We are looking forward to working with you on new opportunities

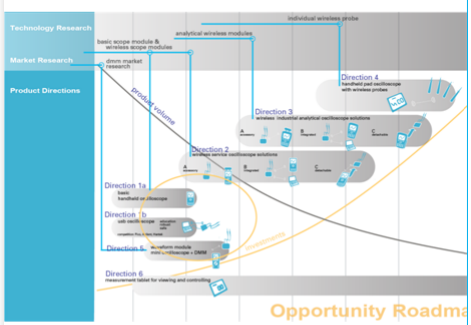
Tektronix

FLUKE.



Benchmark
electronics

Research Effort



Technical:

- Determine if a commercial Digital Back-end with integrated Graphical Processor is feasible. (Direction 1)
- Investigate existing Radio Protocols on Data Rate, Reliability and Power Consumption. (Direction 2 and 3)
- Investigate Multi Probe Timing Synchronization for various Radio Links. (Direction 4)
- Determine the Theoretical Performance Limit for a Wireless Scope Probe (Direction 4)

Benchmark electronics

basic
handheld oscilloscope

Direction 1a

Product Opportunity

- Basic, Safe, Handheld, Service Oscilloscope
- Highly Integrated Analog Technology (One Chip Solution)
- Leverage Commercial High Speed Low Power Microcontrollers
- Leverage Integrated Graphical Controllers
- Open Asian market

Challenges

- Reduce Price significantly
- Increase Bandwidth > 50 MHz
- Reduce Power Consumption
- Use Integrated Graphical Power
- Build Flexible Digital Back-end

Benchmark electronics

usb oscilloscope
education
robust
safe

competition: Pico, Agilent, Hantek

Direction 1b

Product Opportunity

- Take over market with something better.
- No concept sell needed
- Safe Industrial Cat III USB Scope (User Error Proof Instrument)
- Floating Input USB Scope
- Leverage existing technology

Challenges

- Winning market position
- Re-use Direction 1a Technology
- Design Low Cost Floating Inputs
- Keep Power < 5V, 500mA
- Create a good PC SW Package

Benchmark electronics

Direction 2

Product Opportunity

- Customer visits show interest
- Short Distance Remote Service Scope Measurements
- Re-use Direction 1a Technology
- Wireless Scope Market Exploration (Scenario A)
- 2 in 1 Solution (Scenario C)

Challenges

- Re-use Direction 1a Technology
- Investigate Suitable Radio Protocols
- Manage Remote Unit Power
- Manage Remote Unit Control (Scenario A)
- Avoid Timing Problems

Benchmark electronics

Direction 3

Product Opportunity

- Short Distance Remote Analytical Scope Measurements
- Re-use 190-204/Ruby Technology
- Retro-Fit Solution A
- 2 in 1 Solution C

Challenges

- Re-use 190-204/Ruby Technology
- Investigate Suitable Radio Protocols
- Manage Remote Unit Power
- Manage Remote Unit Control (Scenario A)
- Avoid Timing Problems

Benchmark electronics

Direction 4

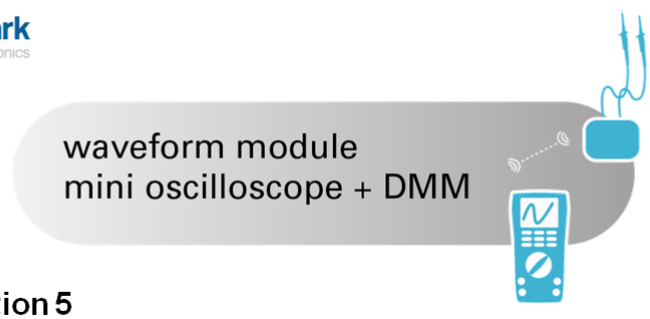
Product Opportunity

- True Multi-Channel Wireless Scope Measurements
- Simultaneous Measurement of Spatially Separated Signals
- Reading & Controlling at a Distance
- Very High User Safety

Challenges

- Probe Synchronisation
- Maximum Probe Performance
- Suitable Radio Protocols
- Intelligent Probe Power Management (Sleep & Wake-Up Modes)

Benchmark electronics



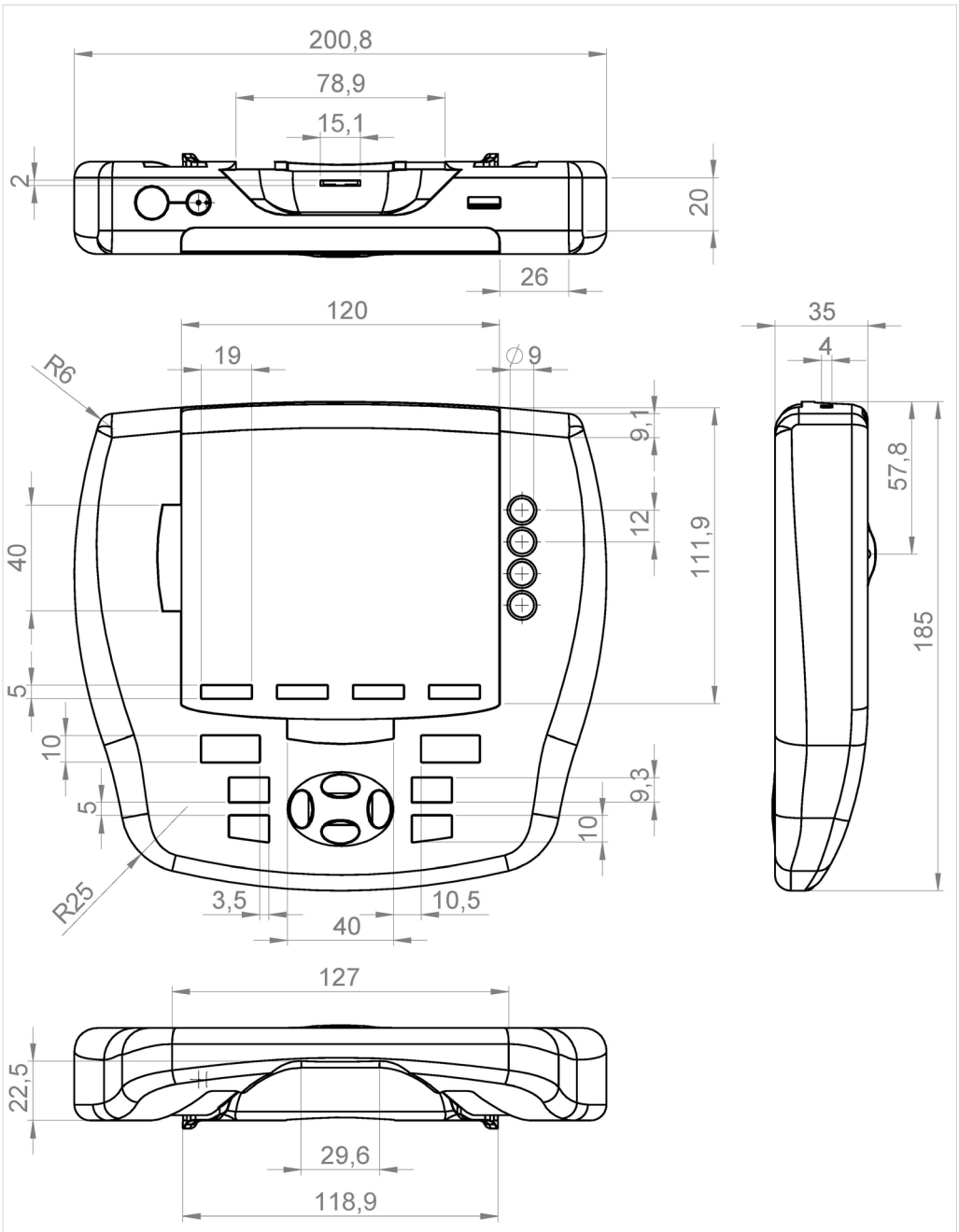
Direction 5

Product Opportunity

- Low Cost, Leave Behind, Electrical Waveform Probes (< 100 kHz)
- Signal Monitoring Device for Intermittent Electrical Failures (Capture & Store Exceptions)
- Low Cost Handheld Signal Tracer with Graphical Display (Mini Scope)

Challenges

- Make it really Low Cost & Compact
- Battery Lifetime
- Usable with existing Wireless Devices
- Mini Scope Performance

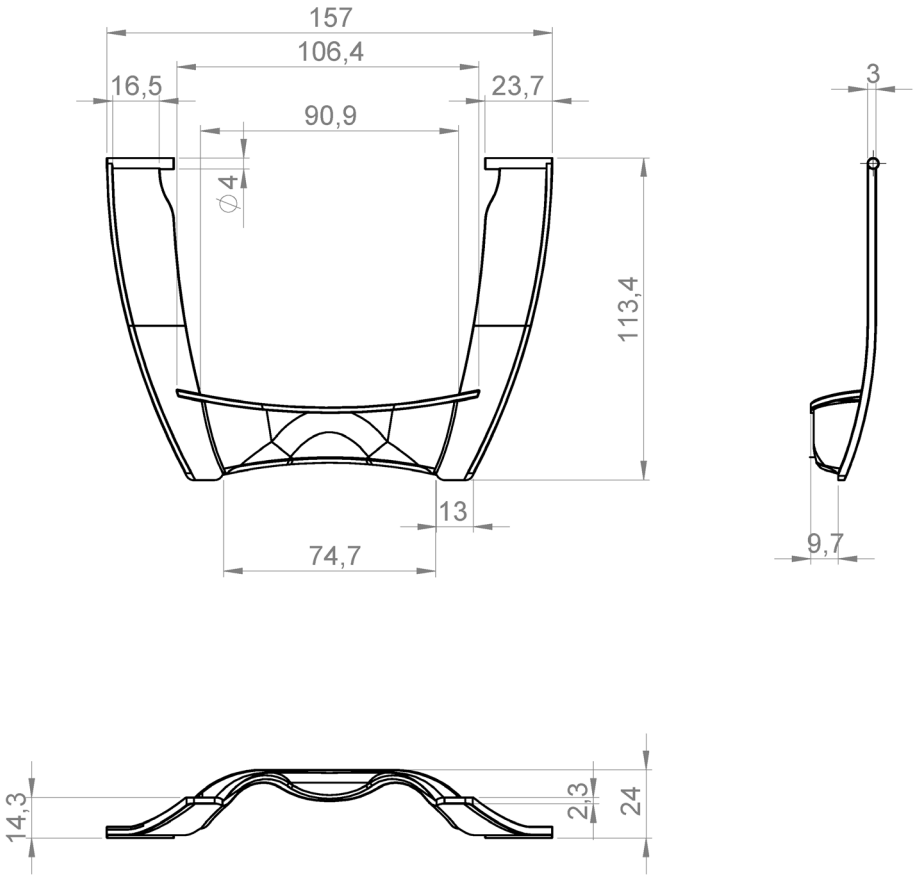


PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	M.B.C. Grob	DATE	04-04-2011
		CHECKED	--	SCALE	1:2

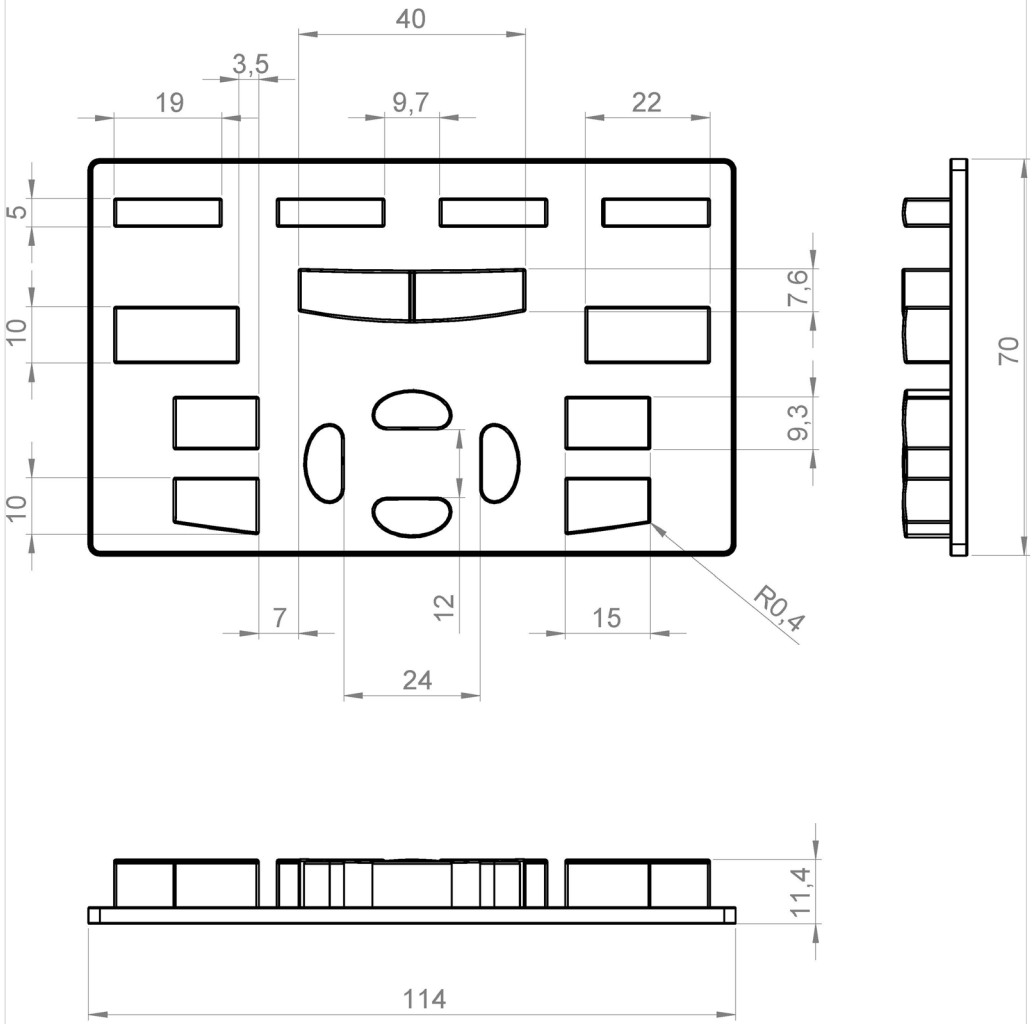
UNIVERSITEIT TWENTE.

FACULTY OF ENGINEERING

MATERIAL: PC/ABS/V0	TITLE: base_station	REV.: 01
	DRAWING NO.: 01	A4
SURFACE FINISH: --	FILE / PART NAME: main_module_v9	
DIMENSIONS IN MILLIMETERS		SHEET 1 OF 1

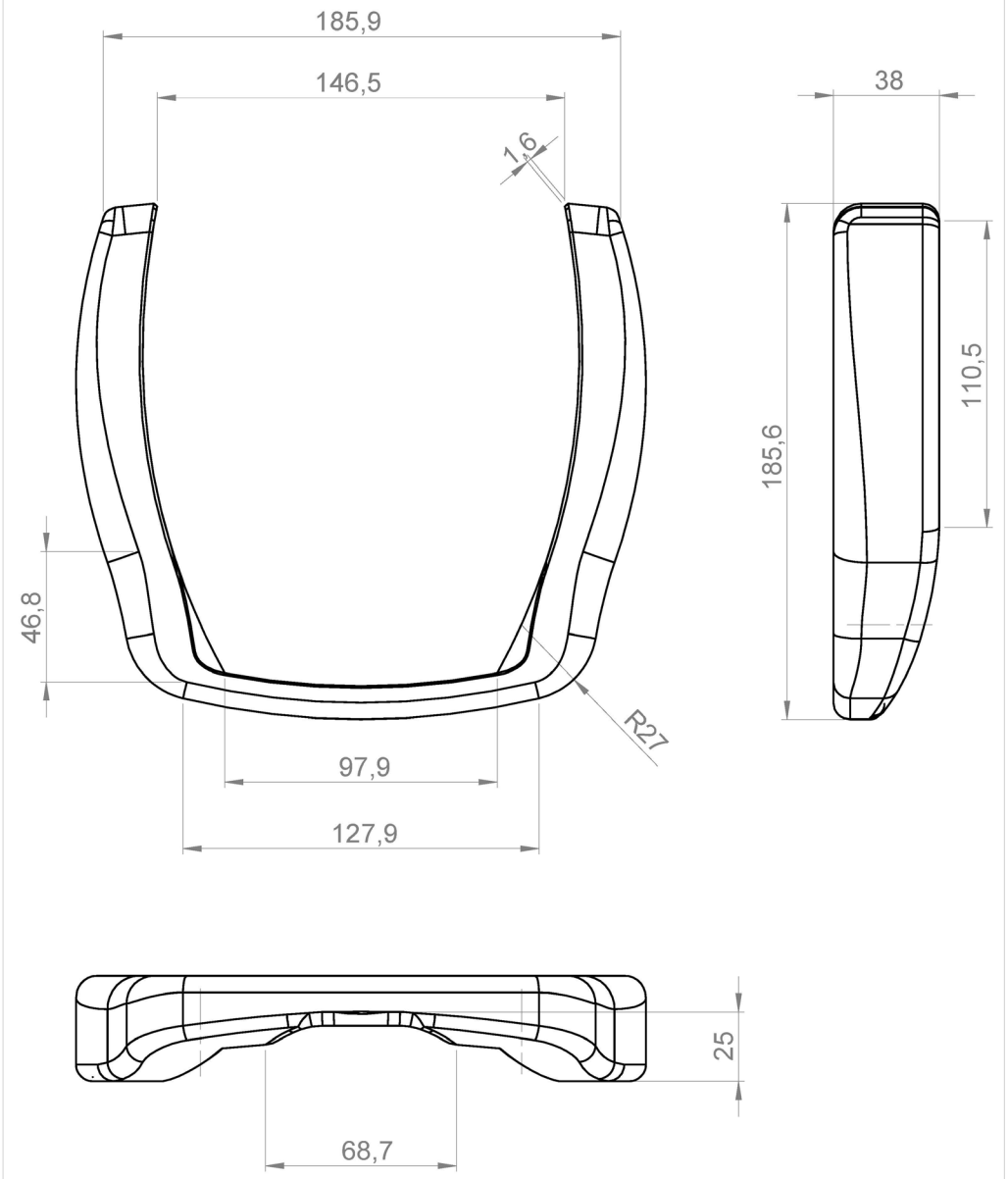


PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	M.B.C. Grob	DATE	04-04-2011
		CHECKED	--	SCALE	1:2
UNIVERSITEIT TWENTE.	MATERIAL: PC/ABS/V0	TITLE: stand_up			REV.: 01
	SURFACE FINISH: --	DRAWING NO.: 02			A4
		FILE / PART NAME: stand_up_v2			
FACULTY OF ENGINEERING	DIMENSIONS IN MILLIMETERS			SHEET 1 OF 1	

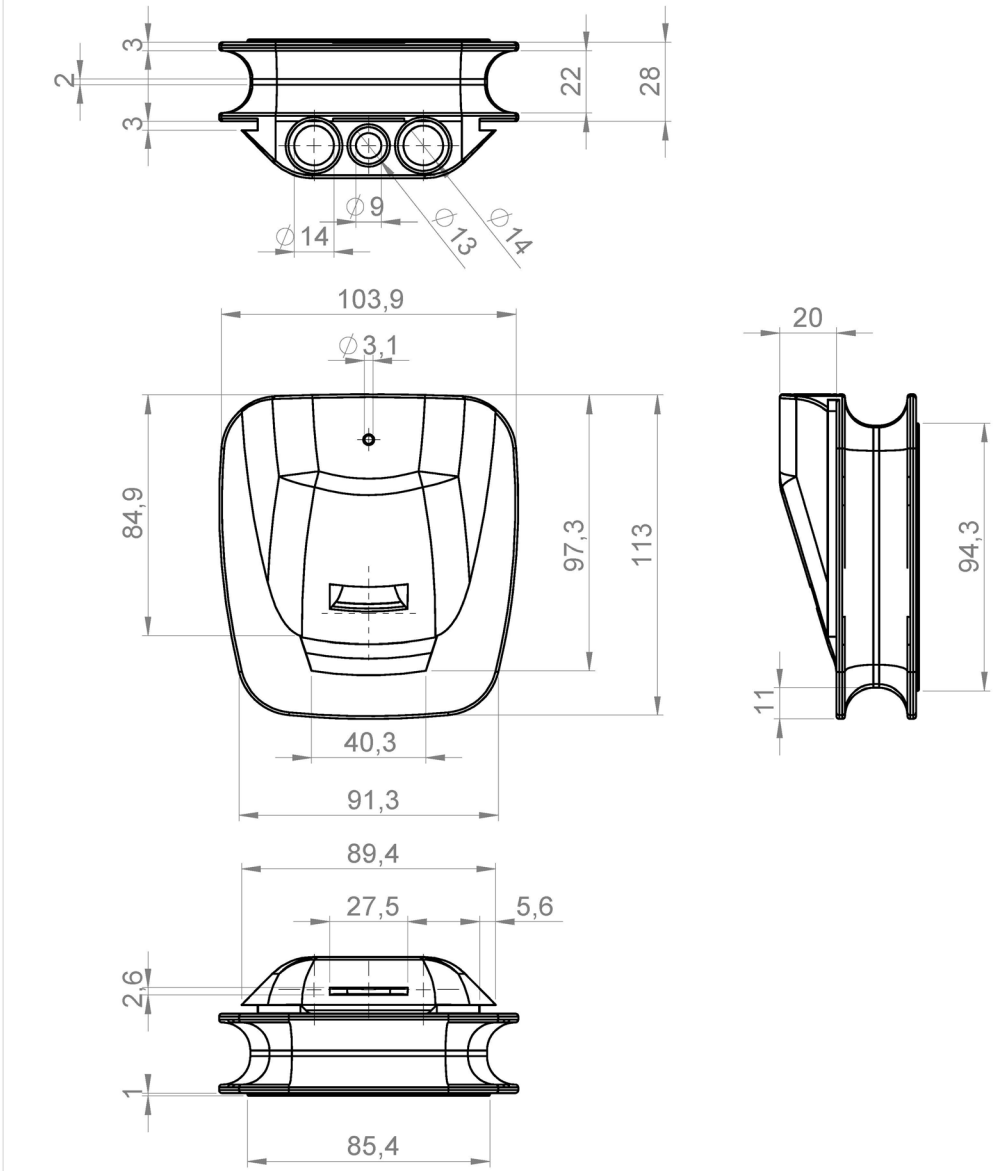


PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	M.B.C. Grob	DATE	04-04-2011
		CHECKED	--	SCALE	1:1

UNIVERSITEIT TWENTE.	MATERIAL: silicon	TITLE: main_keypad	REV.: 01
		DRAWING NO.: 03	A4
	SURFACE FINISH: --	FILE / PART NAME: keypad_v3	
FACULTY OF ENGINEERING	DIMENSIONS IN MILLIMETERS		SHEET 1 OF 1

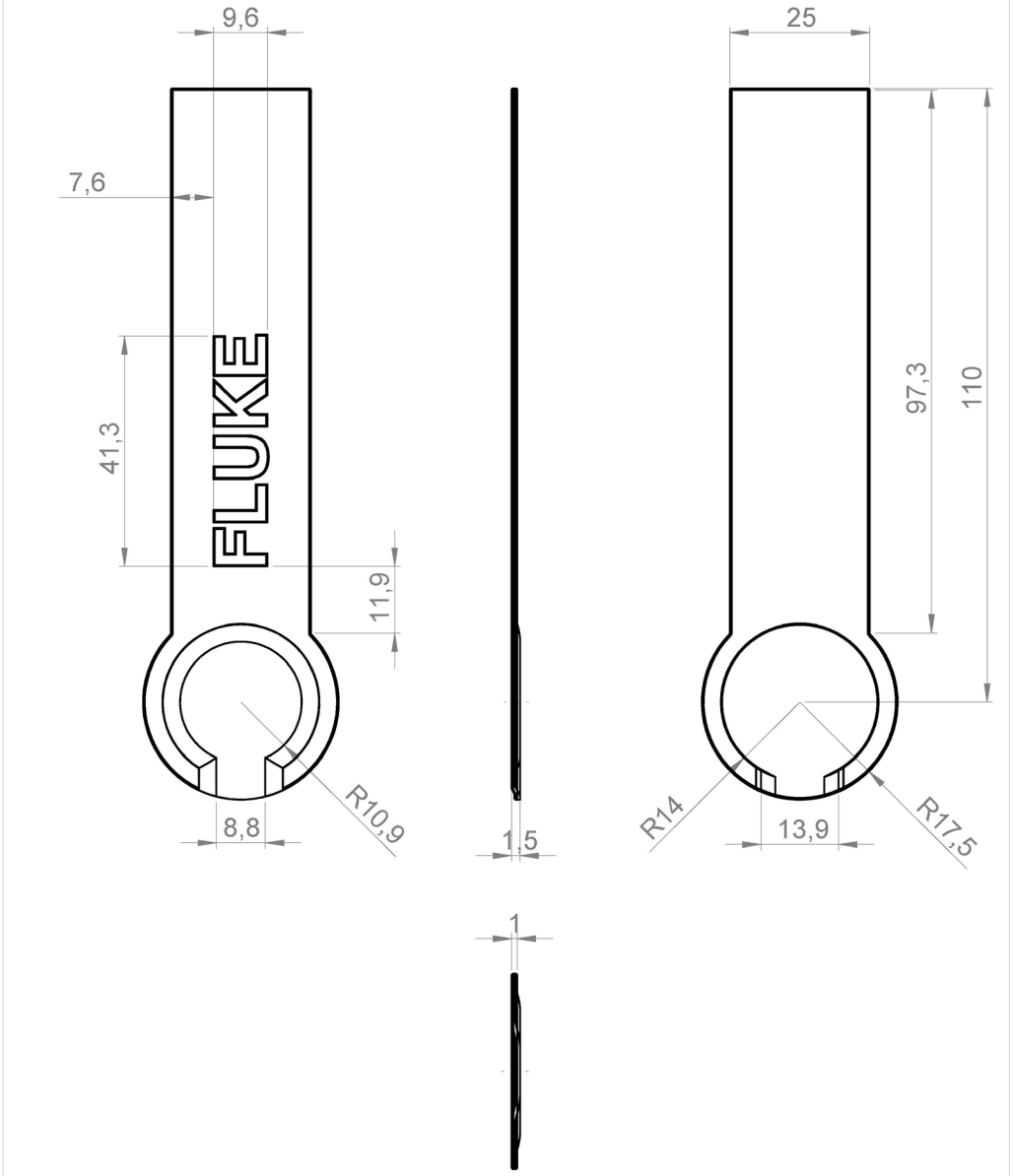


PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	M.B.C. Grob	DATE	04-04-2011
		CHECKED	--	SCALE	1:2
UNIVERSITEIT TWENTE. FACULTY OF ENGINEERING	MATERIAL: TPU	TITLE: overmould			REV.: 01
	SURFACE FINISH: --	DRAWING NO.: 04			A4
		FILE / PART NAME: overmould_v4			
	DIMENSIONS IN MILLIMETERS			SHEET 1 OF 1	



PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	M.B.C. Grob	DATE	04-04-2011
		CHECKED	--	SCALE	1:2

UNIVERSITEIT TWENTE.	MATERIAL: PC/ABS/V0	TITLE: scope_module	REV.: 01
	SURFACE FINISH: --	DRAWING NO.: 05	A4
		FILE / PART NAME: scope_module_v2	
FACULTY OF ENGINEERING	DIMENSIONS IN MILLIMETERS	SHEET 1 OF 1	



PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	M.B.C. Grob	DATE	04-04-2011
		CHECKED	--	SCALE	1:1

UNIVERSITEIT TWENTE.	MATERIAL: TPU	TITLE: scope_module_strap	REV.: 01
	SURFACE FINISH: --	DRAWING NO.: 06	A4
		FILE / PART NAME: scope_module_strap_print_v2	
FACULTY OF ENGINEERING	DIMENSIONS IN MILLIMETERS		SHEET 1 OF 1