# AoT-News

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## AoT announces Solderable Memory Module (SMM)
A memory module with SD/MMC interface for embedded systems.

The newest addition to our range of semi-custom devices, the Solderable Memory Module, is a Solderable alternative for SD card for embedded systems in industrial environments. The SMM combines all the advantages of an SD/MMC card without having to live with their disadvantages (in particular the need for an additional card holder).

Built with SLC-NAND Flash and a Hyperstone Flash controller the SMM is about half the size of a conventional SD/MMC memory card, offers a controlled BOM and is available with different memory capacities. It can even be supplied with customised software.

For further information contact Paul Sphikas at +41 (43) 311 77 06, sphikas@aotag.ch or click here

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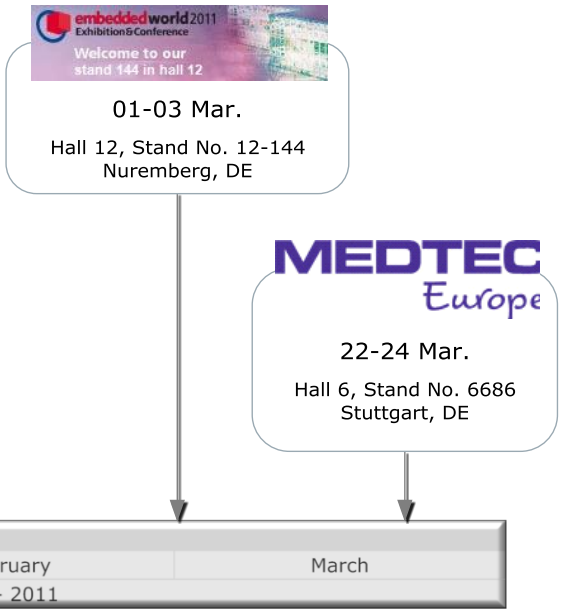

# Under the Microscope

## Second Opinion as a Consultancy Service

We are increasingly being asked by our customers to give our input to an existing product or an on-going project. We decided therefore to offer a Second Opinion service as an independent consulting service.

It's all about providing independent expert advice, without expecting a subsequent development contract or project. We want to support your existing team, not compete with them

We can offer you a second opinion on the work of your current favourite team (internal or external). We analyse the information available and provide you with information and tips regarding:

- the technologies and components used
- potential improvement or simplifications
- alternative system designs
- possible pitfalls (especially in production)

Two heads are better than one

This service can be easily combined with our Review Service.

Investors can also use this service as part of their „due diligence“ to independently and comprehensively evaluate the technical aspects of a new portfolio or project.

For further information about Art of Technology, our services and a selection of customer projects, refer to www.aotag.ch.

Art of Technology

# Tech-Corner

## Everything you wanted to know about (NAND) Flash Memory but were afraid to ask

Dr. Thomas Gillen, Technical Director

Today Flash-based memory, especially NAND-Flash memory, offers the highest storage density for non-volatile memory and as such its use for storage of large volumes of data is widespread, also in embedded systems.

Like all flash memory, a flash memory cell consists of a field-effect transistor with insulated (floating) gate. Applying high voltages, electrons can be brought to this isolated gate ("programmed") or it can be removed (“deleted”). Depending on the number of electrons on the gate, the FET is switched on or off saving one Bit.

To achieve a high density, the individual memory cells are connected in a matrix and organized in pages and blocks. Depending on the memory size, a page is 128 - 4096 (+48) bytes large, with 32 - 128 pages forming a block. Due to the space-saving-wiring of the matrix, the memory can only be programmed page by page, whereas all pages in a block are deleted together.

Programming and deleting leads to a gradual deterioration of the insulating layers of the gate, resulting in the memory cells losing their storage capacity over time. Individual memory cells may be faulty directly following the production process. A limited number of bit errors within a page can be eliminated by appropriate correction procedures. However, when the number of errors exceeds the correctable limit, the entire block of memory is marked as a bad block. Each page features additional space for the inclusion of information such as error correction checksums.

With increasing integration density, the insulating layers of the FETs become thinner and smaller and can therefore be more easily damaged. This makes it more and more difficult for manufacturers to ensure that a predetermined minimum number of memory cells are still usable following a prescribed number of write/erase cycles. As a result, the number of bit errors, that has to be corrected within a page, grows with each increase in storage density. With older types of Flash memory, only one bit error per 512 bytes had to be corrected, whereas for the latest types of Flash memory it has increased up to 8 bit errors.

NAND memory that stores only two states (a few electrons vs. a lot of electrons) in one cell is known as Single Level Cell (SLC). To increase the storage density, the number of distinguishable states can be increased to 4 or 8 within a memory cell. This is referred to as Multi Level Cell (MLC) or Triple Level Cell (TLC) that saves 2 or 3 bits per memory cell. However, this approach reduces reliability as the charge state must be more precisely maintained - on one hand, the probability of bit errors increases, while on the other the number of allowable write/erase cycles is significantly lower than with SLC technology. Due to these higher requirements MLC and TLC memory have lower write speeds than SLC-based memory.

NAND memory using SLC technology is primarily used for professional and industrial applications requiring high writing speeds, reliability and durability. Whereas consumer devices; such as USB drives, memory cards and all other storage products which are subject to cost pressure, use almost exclusively MLC or TLC technology.

Due to these technical restrictions, devices using NAND flash memory require a driver, a so-called Flash Transfer Layer (FTL), in order to operate reliably:

- Forward Error Correction (FEC): These error-correcting codes can not only detect bit errors but can, to a limited extent, correct and compensate for failures of individual memory cells.

- Bad Block Management is used to detect and replace existing or new bad memory blocks. Spare blocks are kept in a reserved area which naturally reduces the usable storage volume.

- Wear Levelling: In normal daily use, some storage areas are updated more frequently than others, while other areas are not changed at all. Due to the limited number of allowable write/erase cycles, the data must be copied again and again in order to achieve a uniform distribution of write-/ erase operations on all memory blocks. This results in a useful lifetime for Flash memory.

- Management Layer: ensures that individual sectors can be read and written without restrictions, even though only complete blocks can be erased and the number of write / erase cycles is limited.

These partially very complex processes enable flash memory to be used as if it works flawlessly and each sector can be written individually. Their implementation on smaller processors is difficult because of the complexity of the extensive FTL. Art of Technology has developed numerous solutions for various different projects and applications that we would like to share with you.

One example is the newly released Solderable Memory Module (SMM).

# Speed-Dating à la AoT

## with Attila Dogan

| | |
|---|---|
| Age | 31 |
| Occupation | HW/SW-Engineer |
| AoT Employee | since 2008 |
| Star Sign | Sagittarius |
| Lucky Number(s) | 23, 42, 137 |

### Was motivates you?
Challenges: things that I can't do: things that I don't know.

### How do you spend your free time?
I have studied my hobby and turned it into my profession, in my spare time I do similar things as at work. I am also active with open-source projects in the area of software and hardware.

### How does such a project start?
Someone has an idea, wants to realise something and publishes it on the web. Sometimes someone reacts, interested parties form a group and get involved, e.g. I am building a video card that is fully documented and open, with people from BE, DE, NL, SE, and the USA.

I recently started studying psychology...

### Why?
I'm interested in programming languages and their design. Only today almost all programming languages are written in a way that computers can be process them easily. However, the main work in programming is not the compilation that runs on the computer, but the writing and reading that the programmer, i.e. the human, has to do. While trying to figure out how a programming language written for people should be, rather than for computers, I looked at linguistics first and then cognitive psychology. Over time, I realized that I lacked the basics in psychology and that it would take very long time to develop them by only reading books.

### What else do you do in your free time?
Twice a week I train Shin Aiki, a martial art that has its roots in Aikido.

### Describe yourself in a few words?
Inquisitive (hungry for knowledge) uncomplicated, different

### If you were an animal, which animal would you be?
Something between a Chameleon and a Sloth

### What are your strengths at work?
Curiosity, I'm interested in many things which have helped me to accrue a relatively broad knowledge.