Smart Metering – Monitoring und Steuerung von Energie-Erzeugung bis Verbrauch

Mit sicheren Nicht-Flüchtigen Speichern von Anvo-Systems Dresden

Presenter: Dieter Herrmann
Contents:

03 - Earth's Energy Budget – In Balance;
04 - Dynamic Energy – Renewable Sources;
05 - Balance – Generation Storage Usage;
06 - Energy – Networks and Distribution;
07 - Distribution – Star or Mesh Topology;
08 - Transform the Grid – Over 1000 Nodes/Mesh;
09 - Smart Metering – nvSRAM Application;
10 - nvSRAM Application - Heat Meter;
11 - Smart Edge Nodes – Data Rate and Distance;
12 - nvSRAM Application - Data Logger;
13 - Hibernate – Concept;
14 - Data Protection - Safety;
15 - nvSRAM – STORE and RECALL;
16 - nvSRAM Application - 1 Mbit serial SPI;
17 - nvSRAM Specification - 1 Mbit serial SPI;
18 - nvSRAM 1 Mbit serial SPI – Pin & Connection;
19 - Anvo – Systems Dresden – Product Selector;
20 - Further Apps – Smart Home and Smart Facility;
21 - Summary : Smart Metering with nvSRAM;
22 - Anvo-Systems at SEMICON Europa 2015;
23 - Thank You – Further Contacts;
24 - Questions and Discussion - Exhibition;
Earth's Energy Budget – In Balance

The Earth's energy budget describes the various kinds and amounts of energy that enter and leave the Earth system. It includes both radiative components (light and heat), that can be measured by CERES, and other components like conduction, convection, and evaporation which also transport heat from Earth’s surface. On average, and over the long term, there is a balance at the top of the atmosphere. The amount of energy coming in (from the sun) is the same as the amount going out (from reflection of sunlight) and from emission of infrared radiation.

Source: [http://science-edu.larc.nasa.gov/energy_budget/](http://science-edu.larc.nasa.gov/energy_budget/)

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Dynamic Energy – Renewable Sources

Last, Wind- und PV-Einspeisung vom 13. bis 20.08.2012 (Bayern, TenneT-Regelzone)

- Zur Mittagszeit schwankt die Einspeisung von Sonnenstrom zwischen 2,5 und 5,5 GW.
- Als Folge bewegt sich die Residuallast zwischen 0 GW und mehr als 6 GW. Diese Spitzen müssen auch in Zukunft durch flexible Kraftwerke gedeckt werden.
- Bereits heute kommt es zu Situationen, in denen die Einspeisung aus volatile Stromquellen die benötigte Last übersteigt.

Quelle: TenneT, Siemens AG
Balance – Generation Storage Usage

- **Kondensatoren** speichern elektrische Energie kurzfristig zwischen elektrostatisch geladenen Platten.
- Bei **Schwungmassenspeichern** ist die Energie in einer rotierenden Masse gespeichert. Ein Rotor wird auf hohe Umdrehungszahlen gebracht.
- **Batterien** machen sich die Wanderung unterschiedlich geladener Teilchen zunutze.
- **Pumpspeicherwerke** nutzen die Lageenergie von Wasser. Einspeichern über Pumpen, Ausspeichern über Turbinen.
- Ein **Druckluftkraftwerk** nutzt einen mit Druckluft gefüllten Hohlraum über den Einsatz von Kompressor (Laden) und Turbine (Entladen).
- **Kavernen- und Porenspeicher** nehmen chemische Energieträger in künstlichen oder natürlichen Hohlräumen unter der Erdoberfläche auf.
- **Power to Heat** speichert Strom in Form von Wärme.
- **Power to Gas** wandelt Strom in Gas um.

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Die Datenwolken geben Bereiche an, in denen sich einzelne heute bereits realisierte Anlagen in Deutschland bewegen.

*ohne Industrie und GHD; Strombedarf pro Person: 1.45 MWh/a

Quelle: TH Regensburg FENES, 2013
Energy – Networks and Distribution

Public Power Network → Power Usage Meter → Home Power Network
Power Generation Meter

Power Generator / Storage / Consumption

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Distribution – Star or Mesh Topology

a) P2P – Point to Point, between 2 Nodes

b) Star – Central Gateway, 1 Master & many Slaves

c) Tree – Central Controller Masters, multiple Masters & many Slaves

d) Mesh – Each Node is a Repeater, multiple redundant Routing

Components:
Master / Gateway (MCU, Controller, Trans-Coder)
Slave Node (Sensor, Meter, Switch, Actor)
Intra – Link (Intra – Net)
Inter – Link (LAN, WAN, Industrial Internet)
Transform the Grid – Over 1000 Nodes/Mesh

IEEE 802-15-4g, Secure IPv6, 6LoWPAN:

Wireless Area Network:
Access Points;

Smart Utility Network:
Bridges, Relays;

Smart Area Network:
Home, Building, Industrial;

Source: www.wi-sun.org; Wireless SUN - Wireless Smart Utility Network;
Smart Metering – nvSRAM Application

nvSRAM features to be used:
- nonvolatile write at bus speed
- unlimited R/W endurance
- Secure Write
- Secure Read
- block protection
- log last write address (LSWA)
- energy efficient code update

Power Line

Smart Meter

- Current Sensor
- Voltage Sensor
- ADC
- PowerLine IEC 14908.1
- System Power
- nvSRAM
- 7-Segment LCD
- CPU
- Timer
- RTC
- Card Reader
- Zigbee
- WLAN
- Modem
- LAN
- USB

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Dresden, 07.07.2015 Page 9 of 24
nvSRAM Application - Heat Meter

nvSRAM features to be used:
• nonvolatile write at bus speed
• unlimited R/W endurance
• Secure Write
• Secure Read
• block protection
• log last write address (LSWA)
• energy efficient code update
Smart Edge Nodes – Data Rate and Distance

Long Range (>10,000) Nation Wide
- Range (m)
- WAN (>1,000)
- City & Region

WAN (100)
- Local Area Wide

WPAN (10)

WBAN (1)

Low data rate TV
Whitespace M2M
STDs, e.g. Weightless

Cellular (HSXPA, LTE, LTE+, etc.)

Proprietary
Sub-GHz

Wi-Fi®
802.11.a,b,g,n, ac, ad, ah

Data Rate (Mbps)

NFC, RFID
ZigBee®
RF4CE
BTLE
Bluetooth®
Features used:
- Continuous (high speed) nonvolatile data recording
- Secure Write
- Memory lock
- Energy efficient code update

nvSRAM Application - Data Logger

Data Logger (generic)

- Physical value
- Sensor
  - Temperature
  - Humidity
  - Radiation
  - Air pressure
  - Glucose level
- Voltage
- Data
- Capture Unit
  - Adresses
  - Identifier
  - Personal-ID
  - Images
- ADC
  - Data
- nvSRAM

µC
- Interrupt
- Timer
- Counter
- ADC
- Port
- Port
- nvSRAM
- Processing unit
- Program Memory
- RTC
- Crypto unit
- Main Power
- Battery
- Energy Harvesting
- USB
- WLAN
- Ethernet
- RF
- Display

Energy Harvesting

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Hibernate – Concept

- Reduce current consumption by turning off the supply voltage for unused internal blocks

- Hibernate is entered by an Instruction (e.g. SPI), The following sequence is then executed:
  • Switch off all unused power domains
  • Monitor the /E Input for further operation

- Hibernate is left by changing the state of an IO Pin (/E)
  Restore data from non-volatile memory within 500µs

- Supply Voltage monitoring during hibernate to detect brownouts
  Guarantee returning to a known device state if supply voltage glitches
The conventional way to store non-volatile data, which changes with high frequency, is to work with a high speed volatile memory and save the data non-volatile in a Flash via a standard bus system. Due to limited speed on the bus this will take both time and energy, which are in the case of a power crash not available in many applications.

nvSRAM has for every high speed SRAM cell a shadow Flash cell as backup with a cell to cell parallel interface. The complete content of the SRAM can be stored in just 8ms.
ARCHITECTURE OF A SERIAL NVSRAM
Anvo-Systems presents:
1 Mb serial SPI nvSRAM with 66 MHz

www.anvo-systems-dresden.com
FEATURES

- Serial Peripheral Interface (SPI)
- Supports SPI Modes 0 and 3
- 66MHz clock rate
- Block Write Protection
- Write Disable Instruction for Software Data Protection
- Secure WRITE, Secure READ
- Read Last Successful Written Address
- 2Byte User Serial Number
- Hibernate Mode for low Standby Current
- Unlimited Read/Write Endurance
- Automatic Non-volatile STORE on Power Down
- Non-Volatile STORE under Instruction Control
- Automatic RECALL to SRAM on Power Up
- Unlimited RECALL Cycles
- 100k STORE Cycles
- 100-Year Non-volatile Data Retention
- 2.7V to 3.6V Power Supply
- Commercial and Industrial Temperatures
- 8-pin DFN and 16-pin 169mil TSSOP Packages
- RoHS-Compliant
SPI BUS CONNECTION

Master: Microcontroller

Slave: ANV32AA1W

PIN CONFIGURATION

PIN DESCRIPTIONS

<table>
<thead>
<tr>
<th>Signal Name</th>
<th>Signal Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td>Chip Enable</td>
</tr>
<tr>
<td>SCK</td>
<td>Serial Clock</td>
</tr>
<tr>
<td>SI</td>
<td>Serial Input</td>
</tr>
<tr>
<td>SO</td>
<td>Serial Output</td>
</tr>
<tr>
<td>VCC</td>
<td>Power Supply Voltage</td>
</tr>
<tr>
<td>VCAP</td>
<td>Capacitor Voltage</td>
</tr>
<tr>
<td>VSS</td>
<td>Ground</td>
</tr>
</tbody>
</table>

The Hold (HOLD) signal should be driven High or Low as appropriate.

8-pin SOP 150 mil or DFN and 16-pin 169 mil TSSOP
<table>
<thead>
<tr>
<th>Density</th>
<th>Organization</th>
<th>Part number</th>
<th>Interface</th>
<th>Speed</th>
<th>Store Type</th>
<th>VCC</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>64 Kb</td>
<td>8Kx8</td>
<td>Anv32A62</td>
<td>I2C</td>
<td>1 MHz</td>
<td>SoftStore</td>
<td>VCC</td>
<td></td>
</tr>
<tr>
<td>64 Kb</td>
<td>8Kx8</td>
<td>Anv32D61</td>
<td>SPI</td>
<td>66 MHz</td>
<td>ext. Cap</td>
<td></td>
<td></td>
</tr>
<tr>
<td>256 Kb</td>
<td>32Kx8</td>
<td>Anv32C81</td>
<td>SPI</td>
<td>66 MHz</td>
<td>System Cap</td>
<td></td>
<td></td>
</tr>
<tr>
<td>512 Kb</td>
<td>64Kx8</td>
<td>Anv32A91</td>
<td>SPI</td>
<td>66 MHz</td>
<td>nv WRITE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Mb</td>
<td>128Kx8</td>
<td>Anv22A88</td>
<td>parallel</td>
<td>25 ns</td>
<td>VCC 3.0…3.6 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Mb</td>
<td>128Kx8</td>
<td>Anv22AA8</td>
<td>parallel</td>
<td>25 ns</td>
<td>VCC 2.7…3.6 V</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Memory Type**
- 2 = parallel nvSRAM
- 3 = serial nvSRAM

**Version**
- A = initial

**Interface**
- 1 = SPI
- 2 = I2C
- 8 = 8 bit parallel

**Store Type**
- 1 = Instruction only
- 2 = PowerStore (ext. Cap)
- 5 = PowerStore (System Cap)
- 6 = nonvolatile WRITE

**Density**
- 64 kb
- 256 kb
- 512 kb

**Power Supply**
- A = 3.0 V… 3.6 V
- W = 2.7 V… 3.6 V

**Operation Temp. Range**
- C = 0°C … 70°C
- K = -40°C … 85°C
- A = -40°C … 125°C

**Speed**
- 66 = 66 MHz
- 25 = 25 ns

**Packing**
- R = Tape and Reel
- T = Tube
Further Apps – Smart Home and Smart Facility

- Security and Alarm
- Motion Detection
- Access Control / Door Control
- Windows Control
- Environmental Monitoring
- Light Control
- Remote Control
- Heating / Air Conditioning
- Automatic Notification
- Indoor Navigation
- Wireless Modem / Gateway
Summary: Smart Metering with nvSRAM

- Growing Demand for Energy and Decarbonisation changes the Focus to Renewable Sources;
- Sustainable Energy is mainly Sun driven, as Water, Wind, Solar, Radiation, Thermo Energy;
- These Forces are changing dynamically in Space and Time, in 24 Hours and over 365 Days;
- Dynamic Energy Generation is sometimes greater than and otherwise less than Demand;

- Must Have: Energy Storage to Smart Balance between Generation and Consumption;
- Changing the Energy Distribution from Central Power Station to more Decentral Generation;
- New Energy Networks have to be Monitored, Controlled, Optimized, Secured and Resilient;
- From Smart Metering to Smart Grid all Nodes must work Reliable and Failure save;
- Also AMR - Automated Meter Reading and AMI - Automated Metering Infrastructure;
- It is possible to enhance Safety and Functionality even at Power Loss or Communication Errors;

- Non-Volatile nvSRAM can ensure Data Integrity, System Functionality and Instant On from:
  Sensor Data, System Configuration, System State, Routing Tables, Communication Buffers;
- Non-Volatile Memories from Anvo-Systems are the Data Airbag for safe Energy Networks!
Anvo-Systems Dresden GmbH

Dresden, Germany

Booth: 2046 @

ANVO-SYSTEMS Dresden: Advanced Non-Volatile Systems

Anvo-Systems Dresden was founded 2009 as fabless semiconductor company and is 100% privately held (GmbH). We provide non-volatile standard products, IP and services to the market. The headquarter is located at Europe’s largest Semiconductor Industrial Site in Dresden.

The highly skilled team of engineers has strong memory background in nvSRAM, FLASH, SRAM and DRAM. We realize R&D, QA, Logistics, Production, Marketing and Application Support. Strategic cooperation with XFab Semiconductor Foundries AG and Melexis N.V. and the Membership in the Semiconductor Cluster Silicon Saxony ensure our long term innovation.

Core Competences also include non-volatile monolithic memory subsystems. Energy efficient high speed non-volatile communication up to embedded nvSRAM, EPROM and FLASH blocks. Anvo-Systems Dresden is specialized in monolithic highly reliable, fast, non-volatile system solutions in industrial, computational, medical, energy, and communication environments. More information is available under www.anvo-systems-dresden.com.

Press Releases

+ Anvo-Systems Dresden participates active at the 10th Silicon Saxony Day with Presentations, Exhibition and within Recruiting Events. (May 01, 2015)

+ Anvo-Systems presents 1 Mbit serial SPI nvSRAM with 66 MHz (Jun 16, 2015)

Categories

500 Factory Monitoring & Control Systems (FMCS)

• Data Collection, Building control systems
• Emergency (Fire & Security) Control Systems
• Environmental; Utility Systems & Monitoring
• Gas Monitoring Equipment, RGA’s, TGO compliance
• Logistics; Floor Control Systems
• HVAC, Temperature, Humidity, Contamination Control
• HVAC, Temperature, Humidity Systems and Control
701 Manufacturing Services or Consulting

• Automation & Robotics
• CAD CAM CM
• Circuit Design, Electronic Design Services (EDS), System Level Design (SLD)
• Facilities, Building Environmental Systems Design & Monitoring; Alternative Energy Solutions
• Factory, Industrial Control, Utilization & Automation
• Nanotechnology, Intellectual Property Development, Research
900 Support Products

• Safety
• 902 Other
• Other

901 Printed, Organic, Flexible and Large Area

• Device Manufacturing; Wearable electronics
• Services: Research and Development
902 Electronic Components

• Components: IC’s
• Components: ASIC’s
• Design: Fablists
• Design: IP Vendors
• Design: Modelling
• Components: Low Power Electronics
904 Electronic Applications

• Healthcare, Device Implants
• Security, Tracking, e-ticketing
• Energy Efficiency, Low Power Electronics

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Thank You – Further Contacts

For more information, please, visit:

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