Power & Smart Power Solutions

Matteo Lo Presti
General Manager, IMS System Lab & Technical Marketing

Key Topics

- Power management in IMS today
- Vision and awareness
- Innovation in technologies and products
- System innovation
Power Discrete: Strong Market Position

Power Discrete Ranking 2009

<table>
<thead>
<tr>
<th>Key product family</th>
<th>Key target applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>HV Power MOSFETs</td>
<td>Power supply, lighting, solar</td>
</tr>
<tr>
<td>Rectifiers</td>
<td>Power management</td>
</tr>
<tr>
<td>ACS switches</td>
<td>Home appliances</td>
</tr>
<tr>
<td>Protections &amp; IPAD</td>
<td>Mobiles, USB/HDMI interfaces, wired data transfer</td>
</tr>
</tbody>
</table>

Competitive Advantages:

- The widest range of power technologies and packages from low to very high voltage (MOSFET, IGBT, Bipolar, IPAD, Rectifiers) offering the highest efficiency in the most demanding applications
- Expertise in composite materials (SiC, GaN) for high frequency and very high temperature applications (Electric Cars, Photovoltaic Converters, Wind Generators)
- Extremely competitive manufacturing machine (Singapore, Long Gang, Shenzhen)

Source: iSuppli, ST

Power Management ICs: Pillar of IMS

Power Management Ranking 2009

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<td>Off-line converter ICs</td>
<td>Power supply, lighting</td>
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<tr>
<td>Mixed Signal ICs</td>
<td>Mobiles, peripherals, portable medical</td>
</tr>
<tr>
<td>Battery Management ICs</td>
<td>Mobiles, PDAs, e-books</td>
</tr>
<tr>
<td>LED Driver ICs</td>
<td>Street lighting, building, panel arrays</td>
</tr>
</tbody>
</table>

Competitive Advantages:

- Innovative System Solution combining Smart Power ICs, Power Discretes and Microcontrollers on a single board or in a single package
- Mixed technologies (digital, signal and power, low and high voltage) to develop advanced Smart Power ICs
- System know-how enabling the design of dedicated Smart Power ICs for complex applications

(*) Power Management includes: Voltage Regulator/Reference, Industrial & Other Analog ASSP, Power RF Transistor, Bipolar PT, FET PT, IGBT, Thyristor, Rectifier & Power Diodes
Source: iSuppli, ST
Power Management Today
Key Areas of Strength

- High voltage power MOSFETs
- Ballast driver ICs
- Ultrafast diodes
- Application specific ICs

Consolidated IMS Key Areas

- SMPS
- Lighting (high-frequency ballast)
- Motor Control
- Motherboard & Set-Top-Box
- Mobile (including battery charger)
- Mobile (including battery charger)
- Power transistors
- ACS switches
- VIPers
- Microcontrollers
- Driver ICs
- Power transistors
- ACS switches
- IPADs
- OLED controllers
- VIPers

Vision and Awareness

Population and building density increase → Energy demand is increasing drastically → Post Kyoto protocols on reducing greenhouse gas emissions

A Global Commitment

Moving forward in Eco Sustainability...
- Reducing power consumption through system efficiency
- Reducing oil combustion and pollution through renewable energies and hybrid electric vehicles

... for a better day-by-day life
- Building automation, surveillance & safety through sensor networks and remote monitoring
- Intelligent use of energy through smart systems
- Home healthcare through portable devices
Strategies for Energy Efficiency

Advanced Semiconductor Technologies and Innovative Products

Two main paths

New Solutions and Smart Power Systems for Intelligent use of Energy, Remote Control, Healthcare and Automation

STMicroelectronics

Leveraging Smart Power ICs & Power Discretes

Power management ICs, off-line converter ICs, integrated PoE ICs, mixed digital/signal/power ICs

Power transistors and rectifiers

Cutting power losses through power discrete technology

Power Management TAM (2009) = $22B
CAGR (2010~2013) = ~8%

Source: iSuppli
Innovation in Technologies & Products

Innovation in Power Technologies

- Ultra-low power technologies
- Harvesting and thin film batteries

- 3D heterogeneous integration/ TSV
- Innovative wire bonding
- Advanced packaging & system-in-package

- Advanced BCD, BCD-SOI
- New materials: SiC & GaN
Innovation in Power Technologies

Ultra-Thin Wafers
60um wafers for advanced IGBT devices become flexible

90V GaN RF Power Transistors
Wafers for GaN devices become transparent

New smart power systems integrating ST current and future technologies

Power Section (MDmesh V)
Controller (BCD8)

Ultra Smart Power ICs

ASIM
Application Specific Integrated Modules
A Wave of New Products

- IPAD™ (Integrated Passive & Active Devices) solution
- Ultra-small and energy-saving intelligent power switch
- Monolithic active matrix OLED display power supply
- Advanced battery chargers and gas gauge monitoring
- New HV power MOSFET family featuring worldwide best $R_{D\text{son}}$

System Innovation
SmartGrid: Power conversion and connectivity for an intelligent use of energy

STMicroelectronics

Power Conversion in SmartGrid

ST offers complete solutions from low-power applications to high-power energy conversion

Energy 2013 TAM: $5B
CAGR 2010-2013: 7%

Source: Semicast (including Power Energy and Transportation)
Smart Power Solutions
LED Street Lighting Control

Energy saving:
*dimming* based on available natural light

Comfort:
*color changing* (cool/warm) based on location and time of day

Architectural/fashion:
creating different effects using the same lights

Lighting control:
for specific applications like theater, stage lighting

**Key Products**

- Driver ICs
- Power transistors
- Power factor ICs

ST Solution

Lighting 2010 TAM: $1B
CAGR 2010-2015: 9%

Source: Semicast

Smart Power Solutions
Smart Meters

Gas Meter
Electronic flow meter

Energy Meter

Concentrator
provides info to the consumer on energy and gas usages

**Key Products**

- Motor control ICs
- Power line modems
- Energy meter ICs

ST Solution

Smart Electricity Meters
TAM 2009: 76M units
CAGR 2010-2013: ~18%

Source: ABI Research
Smart Power Solutions
Hybrid and Electric Vehicles

Plug-in battery charger for HEV
Combine an electric motor and an internal combustion engine
Reduce air pollution from greenhouse gases
Operating cost equivalence: 20¢ US/liter**

ST Solution

Key Products
- Power transistors
- Driver ICs
- 32-bit microcontrollers

Source: (*) Strategic Analytics, (**) US Dept of Energy

Smart Power Solutions
Photovoltaic

ST Solution: One microinverter module per panel

Key Products
- Cool bypass switch
- Power transistors
- MPPT (Max Power Point Tracker)

Remote Monitoring & PV Panel Control

Maximizing energy output (MPPT)
Energy monitoring (daily, monthly, yearly, etc.)
Diagnostic, anti-theft and anti-tearing protection
Reducing operation costs due to modularity

Source: European Photovoltaic Industry Association, ST

Electronics on panel value from $1.50 to $15
PV energy production growth
- 2010 → about 7 GW
  (about 35 million single photovoltaic panels)
- 2020 → about 56 GW
Smart Power Solutions
Energy Harvesting

Integrating harvesting in smart systems
Enabling wireless sensors for energy autonomy

STMicroelectronics and Micropelt demonstrate ‘Perpetual Energy’ thermoharvesting power supply

The Future is Here

A “Virtuous” Circle

Smart Power ICs
Develop Solutions

System Approach
Acts as a Flywheel

Product Innovation
Customer Endorsement