Flash Memory SUMMIT

A Microchip Technology Company

Embedded Flash – Driving Down the "Memory" Lane

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Outline

- SST Overview
- Automotive Semiconductor Market
- Automotive Semiconductor Growth Drivers
- Embedded Flash Usage in Automotive Microcontrollers
- Embedded Flash Requirements
- Embedded Flash Landscape

SST's History

1989
SST Founded

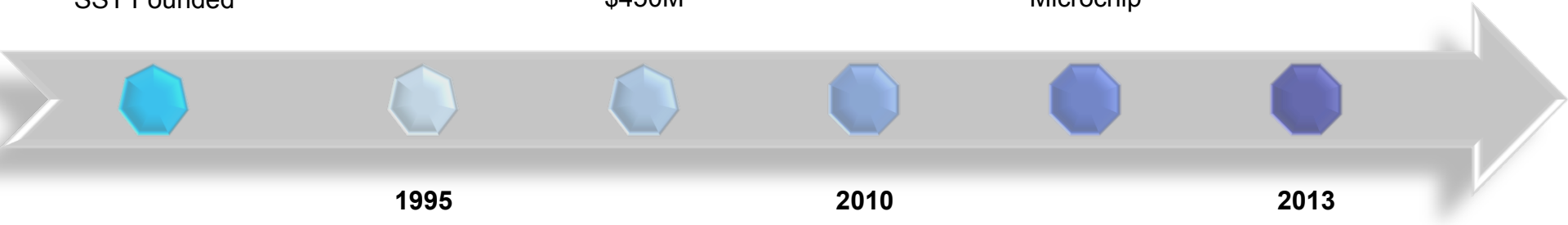
1995
Went Public

2003
Annual Revenue $450M

2010
SST was Acquired by Microchip and became a wholly owned subsidiary

2010
SST focuses on licensing for embedded Products. NOR Flash business absorbed by Microchip

2013
SST Acquired Novocell, an OTP Company



Automotive Semiconductor Market

- Semiconductor content in cars
  - Luxury car: over $1000
  - Mid-range car: over $350
- MCU and Analog are the most dominant components
- Modern cars can have up to 80 ECUs (Electronic Control Units) on boards

*Source: IHS

Automotive Semiconductor Growth Drivers

- Growing global automotive market – BRIC countries
- Government requirements for safety and emissions
- Consumer need/want for increased safety, efficiency, infotainment, comfort & luxury
- Trend toward high-efficiency HEV and EV

Automotive Semiconductor Market is poised to grow at a CAGR of 9% for next five years*

*Source: STRATEGYANALYTICS

High Entry Barrier

- High Entry Barrier for Semiconductor Suppliers Due to:
  - High degree of regulatory scrutiny and safety requirements
  - Stringent zero-defect qualification processes
  - Thorough understanding of failure mechanism
  - Extensive design-in timeframes
  - Long product life cycles

Automotive Market – Applications

- Powertrain
  - Engine and Transmission Controls, Starter, Alternator
- Safety
  - ABS, ESC, Suspension, Airbags, Power Steering, Tire Pressure, Brakes, ADAS, Traffic-Aware Cruise Control
- Body and Convenience
  - Light, Heating, AC, Door, Seat Controls
- Infotainment
  - Navigation, Multimedia Controls

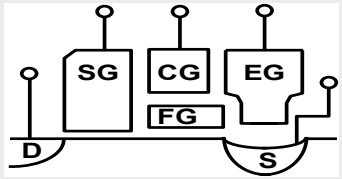
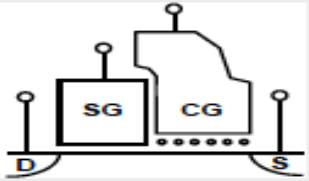
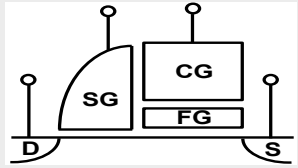
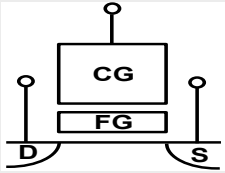
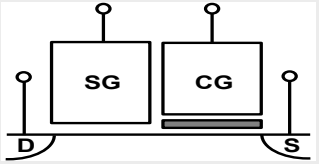
Embedded Flash Advantages

- Embedded – Secure
- Fast communication between Memory and Logic
- Custom embedded Flash can be optimized for each application
- Lower BOM, and fewer components at the system level

Automotive Market Key Requirements and Usage for Embedded Flash

- Low Failure Rate:
  - 0 ppm (0.1 ppb) over ~15 years of lifetime
- Data Retention
  - ~15 years
- Operating Temperature:
  - -40°C to up to 150°C ambient (various grades)
- Fast Code Execution:
  - Random read access: 10 ns – 20 ns
- High Endurance:
  - 500K for data array and 1K for code array
- High Density:
  - 2 MB to 16 MB

Embedded Flash Landscape

	1.5T Poly FG & EG	1.5T TFS	1.5T Poly FG	1T Poly FG	1.5T (1T,2T) ONO
					
Scaling, R&D	28 nm	28 nm	28nm	40nm	28 nm
Key drivers	SST & licensees and 100+ users	FSL	Infineon	ST Micro/FSL	Renesas, CY, Spansion,
Low VCC, fast read capability	Yes	-	Need Vread >2V (SGOX – scalling challenges)	Need Vread > 2V (to avoid over-erase)	-
P/E	SSI/FN to EG 100K-1M	SSI/FN to CG 10K-100K	SSI/FN to Channel, 10K-100K	CHEI/FN to channel 100K	FN/FN, HEI/FN, SSI/HHI, 1K-30K
1-0 VT window	>10V	~3V	~6V	~3-4V	~4V

"Emerging" Memories

	Origin	Players
EPROM/ EEPROM	1970 – EPROM, Intel 1976 – EEPROM – Hughes, Eli Harari	Too many to list
PCRAM	1960 – first patent filed	Samsung, Micron, Intel, STM Foundries, Research Institutes, Others
MRAM	1988 – Magneto-resistive effects with thin films discovered	Samsung (Bought Grandis) Hynix, Toshiba, Everspin – Motorola, Renesas – abandoned Foundries, Research Institutes, Others STT, Crocus, Avalanche
ReRAM	2000 (Various types)	Sandisk/Toshiba - Collaboration Panasonic, Sharp, STM, Samsung, Hynix Sony, Adesto (CBRAM) Rambus (Bought Unity Semiconductor), Crossbar Foundries, Research Institutes, Others
FeRAM	1952 – first work published, development began in 80s	Ramtron (Acquired by Cypress), TI, Fujitsu, Hynix, Samsung, Seiko-Epson

Note on Emerging Memories

- Embedded MRAM, ReRAM, CBRAM, FeRAM etc.
  - These technologies are promising, but we are not there yet
  - Automotive OEMs need several years of high-volume production data before a new technology can be used in automotive, due to failure rate and quality concerns

Summary

- Automotive semiconductors are a growth engine of the semiconductor industry
- MCUs are a critical component in automotive ECUs, and embedded Flash is a key component in those MCUs
- Floating-gate-based embedded Flash is the most widely deployed non-volatile memory in automotive MCUs
- Emerging Memories are not yet ready for automotive applications