

# Designed Solutions Driven by Innovation

SMART Update 2023

# AGENDA

- **SMART Global Holdings**
  - SGH overview
  - Global footprint
  - Business units
- **SMART Modular Technology**
  - Key strengths and capability
  - DRAM product overview
  - Flash product overview

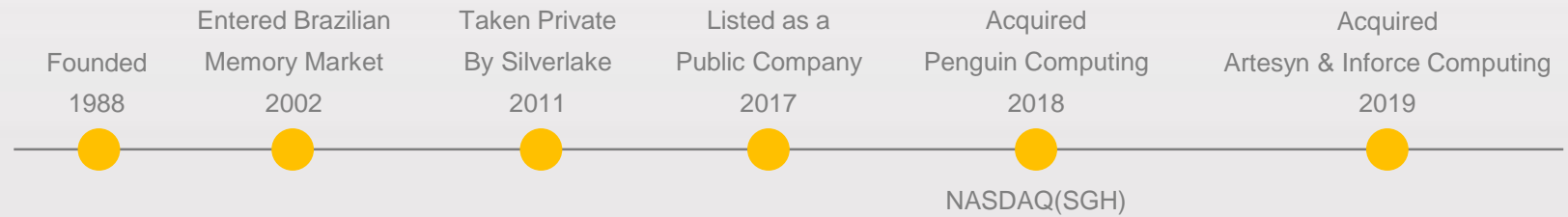


**(NASDAQ: SGH)**



SMART is a proven technology leader in the design, development and deployment of current and next-generation specialty memory, storage and compute products and solutions.

## Time Line



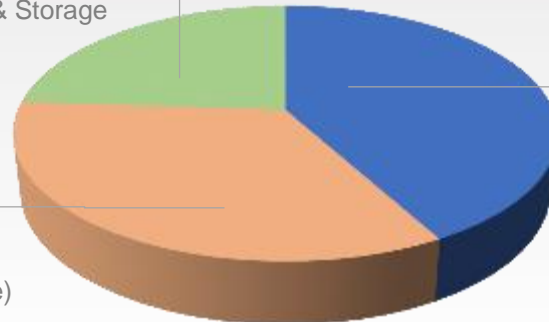
## Revenue Mix

**24%**

Specialty Compute & Storage

**34%**

Brazil (High Volume)

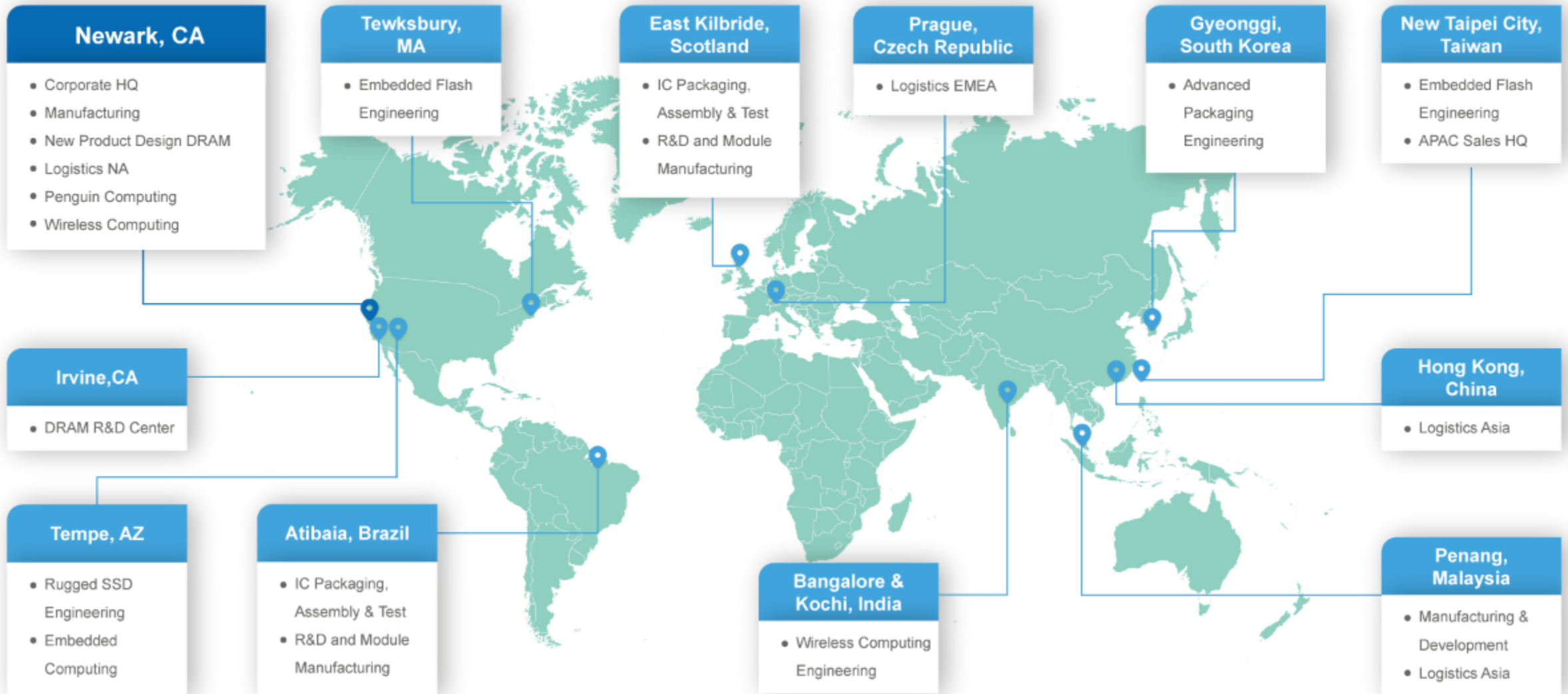


**42%**

Specialty Memory  
(High Mix)

**\$1.1  
BILLION**  
TOTAL ANNUALIZED  
NET REVENUE

# SGH Global Footprint





# SGH's Diverse Business Units



**Highly Durable & Reliable  
DRAM/Flash Solutions for  
Industrial Application**



**Blade and System  
for Edge Computing**



**SBC/SOM  
Wireless Solutions  
for IoT/AIoT**



*A subsidiary of SMART Global Holdings, Inc.*



**Open-Based Solutions for  
Enterprise, Cloud,  
Data Centers and HPC**

# Customer Base – SMART Modular Technology

## Top 5

End Customers for FY19



### System



### Mobile Memory



### Communications













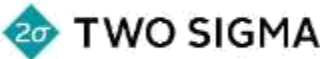







### Industrial and Defense



### Enterprise Storage & Computer




# Customer Base – Penguin Computing

Financial Services	Higher Education	Energy	Federal	Social Media
				
				
				
				



# Customer Base – SMART Embedded Computing

Military	Network Edge	Transportation	Industrial	Medical
				
				
		Serving cities in S. Korea and China through integrators such as:  유경제어(주) YOOKYUNG CONTROL INC.		
				



**SMART<sup>®</sup>**  
Modular Technologies







We are a global leader providing specialty memory solutions to OEM's focused in vertical markets including:

- **Networking**
- **Communications**
- **Storage**
- **Mobile**
- **Industrial**
- **Military**





# Supplier in Industrial DRAM/Flash Solution

Table: Global Memory Module Suppliers Rankings by Revenue, 2019

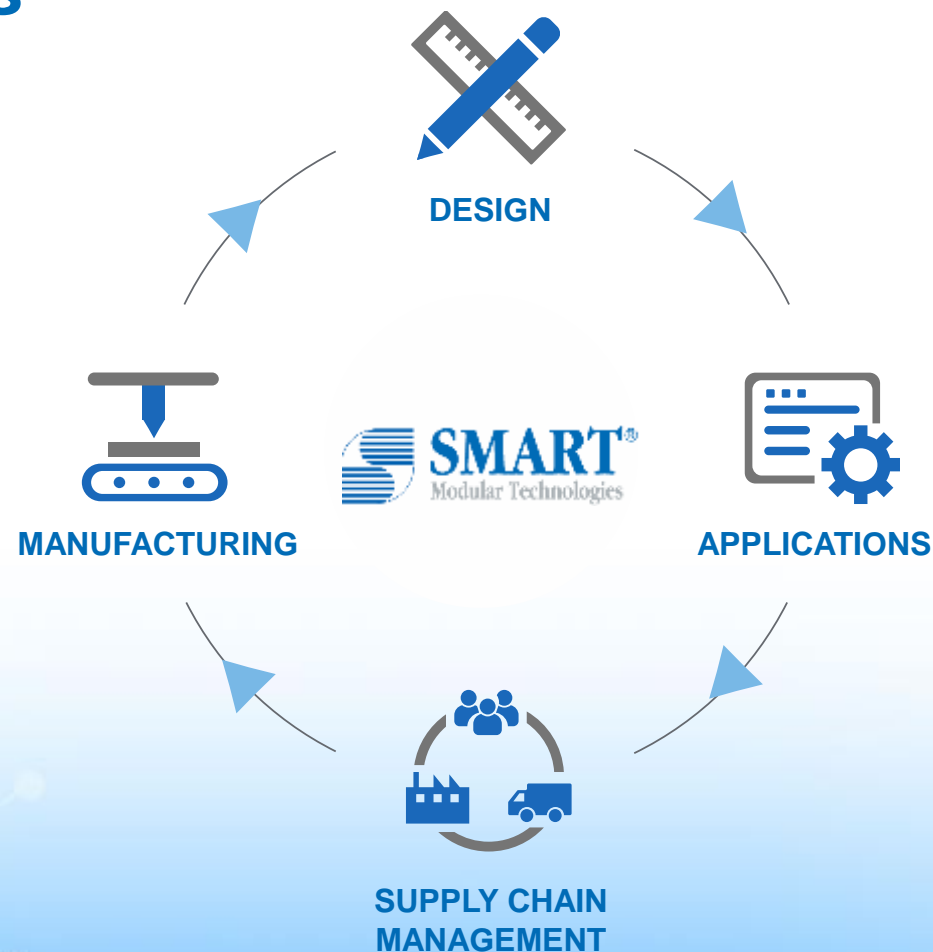
Company	DRAM Rankings		DRAM Revenue (Million USD)			DRAM Market Share (%)	
	2019	2018	2019	2018	YoY%	2019	2018
Kingston Technology	1	1	12,937	11,954	8.22%	80.33%	72.17%
Ramaxel	2	3	474	775	-38.81%	2.94%	4.68%
SMART Modular Technologies	3	2	431	839	-48.60%	2.68%	5.07%
POWEV	4	6	369	340	8.53%	2.29%	2.05%
ADATA Technology	5	4	366	644	-43.11%	2.27%	3.89%
tigo金泰克	6	5	329	345	-4.64%	2.04%	2.08%
Team Group	7	9	153	144	6.25%	0.95%	0.87%
Transcend Information	8	7	129	172	-24.83%	0.80%	1.04%
Apacer Technology	9	8	96	159	-39.43%	0.60%	0.96%
Innodisk	10	10	91	111	-18.21%	0.56%	0.67%
Others			729	1,082	-32.60%	4.53%	6.53%
<b>Total DRAM Revenue</b>			<b>16,105</b>	<b>16,564</b>	<b>-2.77%</b>	<b>100.00%</b>	<b>100.00%</b>

Note: Module makers have diverse business operations. However, this ranking is based solely on their annual DRAM module revenues.

Source: TrendForce, Aug, 2020

# Powerful Value for Our Customers

- Design and delivery expertise from 30 years of providing specialty products
- Customer base includes Fortune 500 companies and the world's leading OEMs
- Deep customer-centric engineering focus, with on-going collaboration
- Dedicated, product-specific development teams
- Long product life cycles for greater ROI
- Robust, end-to-end capabilities and application-specific solutions
- Configurable systems
- Build-to-order manufacturing





# Why SMART vs. Others



## Longevity

- Ability to weather all market cycles
- Long-term supporting all types of customers and applications
- Experienced management team



## Quality

- 100% focus on delivering high quality products
- Leading-edge manufacturing equipment and processes



## Engineering

- Leading-edge capabilities and preparation
- Continuity-of-supply solutions
- Legacy support



## Experience

- In-depth knowledge and expertise of memory technologies
- Ability to identify and solve problems
- Long-term supplier of Enterprise Memory



## Application & Product Solutions

- Wide variety of products targeted to support unique industry requirement and challenges
- Ruggedized products for high-temp applications and extreme environmental exposure



## Long-Term Partnerships with Suppliers

- Supplier buying power compared to other 3<sup>rd</sup> party module makers
- Long-term supplier relationship leverages pricing and component availability



## Enduring Relationship with Customers

- Steady, uninterrupted supply chain
- Able to provide long-term, consistent support through all market and technology cycles

# Memory Products

- DuraMemory™
- Enterprise Memory
- Rugged Memory
- Advanced Memory





# Design for Industrial Applications

***DuraMemory™***

- DRAM products designed and manufactured to meet demanding industrial workloads
- DuraMemory™ products perform to the highest degree of durability and reliability
- Differentiated value-adds: Enterprise Memory testing, 30pin Gold Finger, I-temp, Underfill, Conformal Coating





# DDR5 Revolution is Under Way

**For Advancing Next-Generation  
High Performance Computing Systems**

Command/Address and Control Bus is double data rate

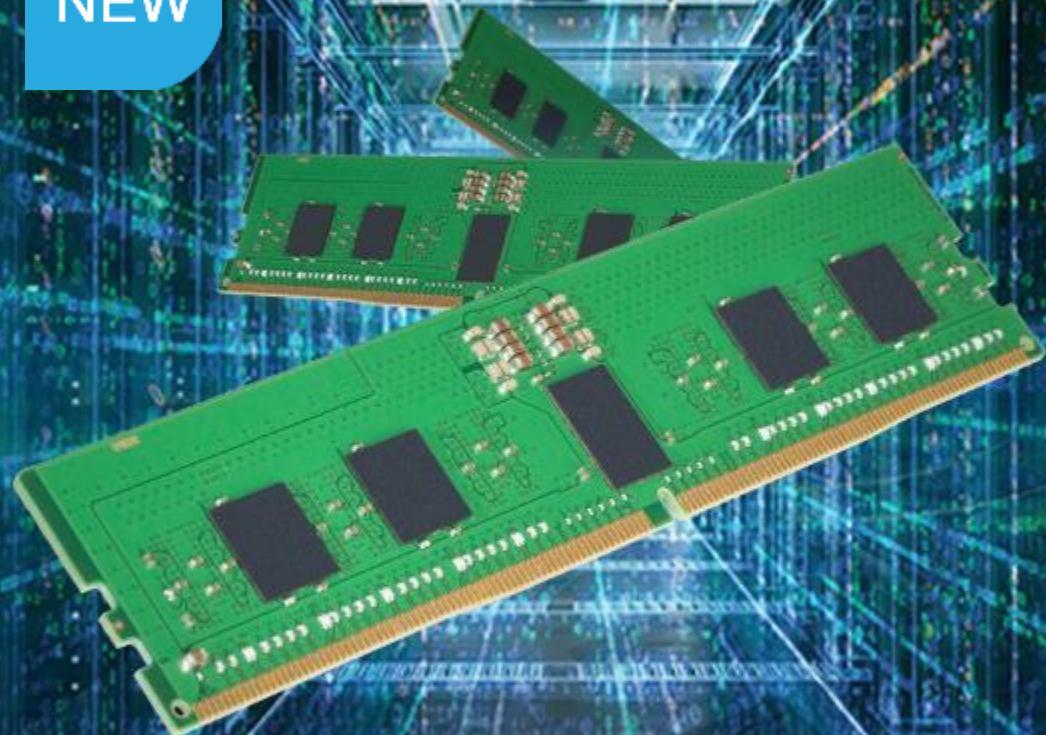
Default burst length increased to BL16 – Single burst = 64B of data

Generates CRC checksum in READ data frames

Integrated Temperature Sensor (MR4)

DDR5 DRAM contain 256 mode registers

NEW

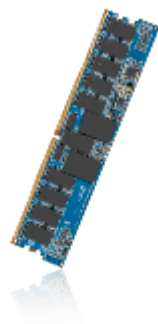




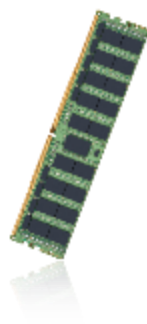
# DuraMemory<sup>™</sup> Product Line-up

DDR5 / DDR4 / DDR3

NVDIMM



LRDIMM



RDIMM



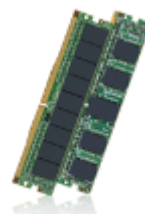
UDIMM



SO-DIMM



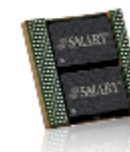
Mini-DIMM



XRDIMM



MIP





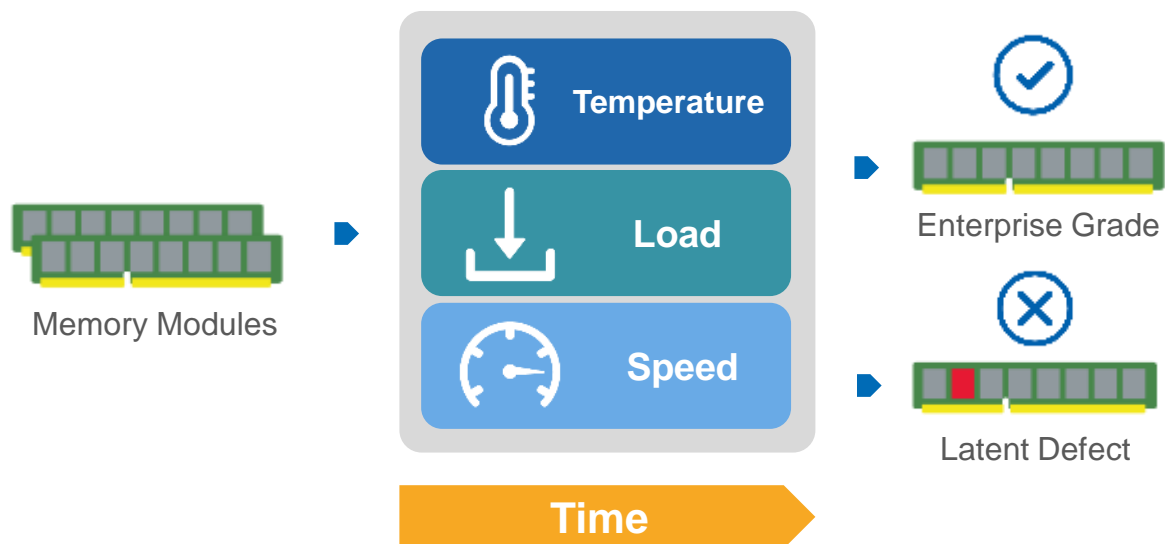


# SMART Enterprise Memory

Proven Exceptional Reliability

## Comprehensive Triple Stress Testing

Highly reliable memory modules that have gone through SMART's proven testing.



## Screening Conditions:

- ✓ Continuous DRAM operations at +70°C to +85°C
- ✓ Continuous I/O stresses
- ✓ High power consumption
- ✓ 7-10+ hours of continuous operation
- ✓ Module rated speed



Guaranteed  
Reliability



Increased  
Utilization



Minimizing  
Data Loss



Saving Cost



# SMART Rugged Memory

Taking Memory to the Extreme

**Rugged  
Memory**  
Customers

**BAE SYSTEMS**

**LOCKHEED MARTIN**



SMART Rugged Memory represents our unique ability to ruggedize products to a specific customer requirement. This includes enhanced temperature testing, component staking and die sorting, etc. The combination of these attributes allows SMART to deliver the best rugged DRAM modules in mission critical applications.

## What differentiates SMART

- High quality products
- Experience / Methodology / Equipment
- Proven long-term track record



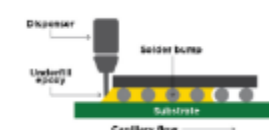
System  
Burn-in/ I-temp



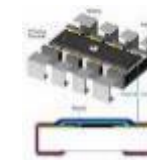
Anti Sulfur  
Resistors



Conformal Coating



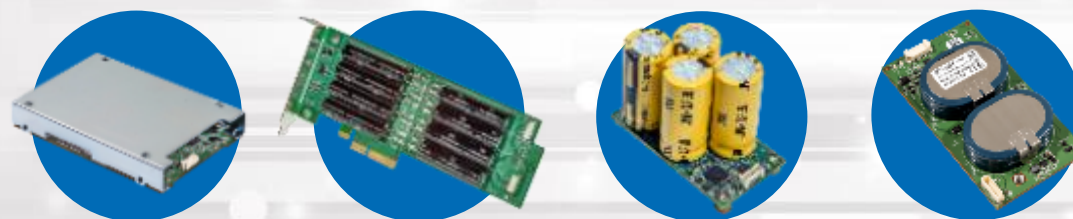
Underfill



Ruggedized Clio

# SMART Advanced Memory

## NVDIMM-N and Backup Power Modules



### Product Description

- DIMM form factor
- 16GB, 32GB
- DDR5-3200
- 1Rx4, 2Rx4, registered

### Features & Benefits

- Throughput of 25.6GB/s
- Latency ~20ns
- AES 256bit encryption
- Autonomous self refresh
- Digitally signed firmware

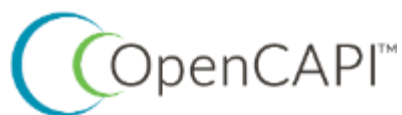
### Applications

- All flash arrays, storage servers & compute
- For very low latency tiering, caching, write buffering and meta data storage

Performance  
Acceleration

# SMART Advanced Memory

SMART participates in many industry groups providing varying levels of new interface standards and new product support



Open standard interconnect for high-speed CPU-to-device and CPU-to-memory, designed to accelerate next-generation data center performance



A high-speed processor expansion bus standard, offering low latency, high speed, direct memory access connectivity between devices of different instruction set architectures



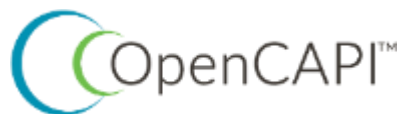
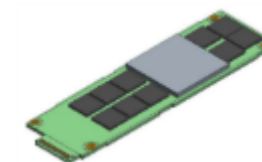
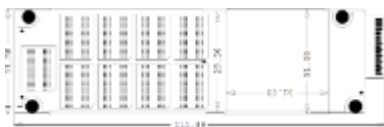
An open system interconnect designed to provide memory-semantic access to data and devices via direct-attached, switched or fabric topologies



A high-performance interconnect architecture that provides a cache coherent framework for heterogeneous system architectures

# SMART Advanced Memory

SMART's leading-edge support for new interface standards



- Open industry standard for high bandwidth, low latency interconnect
- Connectivity between host processor and accelerators / memory device / smart NIC



- 256GB of DDR4 memory with ECC
- Supports 4 x Gen-Z requestor, responder configuration



- High density up to 256GB
- Serial interface
- 25.6Gb/s of bandwidth



- Enables low-latency main memory expansion
- Extend processor cache coherency to accelerators network / storage adapters, etc.
- Supports multiple ISAs over a single interconnect standard



# Flash Products

- DuraFlash™
- Data Center/Enterprise SSDs
- RUGGED SSDs



# Design for Diverse Applications

***DuraFlash™***

- Commitment on Flash products designed and manufactured for embedded applications
- Durable and reliable
- Customization firmware options





# Advantage of DuraFlash™ SSDs

- Optimized for infrastructure and industrial applications
- Temp. Range = 0°C/+70°C and -40°C/+85°C
- Various NAND options: TLC, eTLC, MLC, SLC, and pSLC
- Low capacities available
- Extensive burn-in
- SafeDATA™ (i.e. pFail) -- advanced power loss detection circuits and controller firmware algorithm to safeguard in-flight data

**Guaranteed Volume**

**Industrial Design**

**Long Life Support**

**Quality & Reliability**

**Custom Support**

**Broad Portfolio**



# Internally Developed Flash Firmware

- Internal Firmware capabilities
- Product customization capability from concept to production
- SMART specific and S.M.A.R.T. attributes
- Robust electrical and PCB design
- NAND agnostic
- Thermal performance optimization
- Better failure analysis capability



# DuraFlash™ Product Line-up



## DuraFlash™ SSD

- mSATA
- SATA Slim
- M.2
- 2.5" & U.2
- SATA DOM

## DuraFlash™ BGA

- eMMC
- BGA NVMe

## DuraFlash™ Card

- CF Card
- Cfast Card
- SD Card
- microSD Card

## DuraFlash™ USB

- eUSB
- USB Flash Drive



# High Performance DuraFlash™ Products

- The drives are optimized for performance consistency in continuous duty cycle and workload applications
- Boot drive and data storage for networking, storage server, data communication, transportation, video surveillance market segments
- These enterprise-grade SSD products offer the quality, performance and reliability expected in business critical applications

R800

(2.5" SATA, M.2 2280 SATA)

Q400

(M.2 2280 SATA, mSATA)

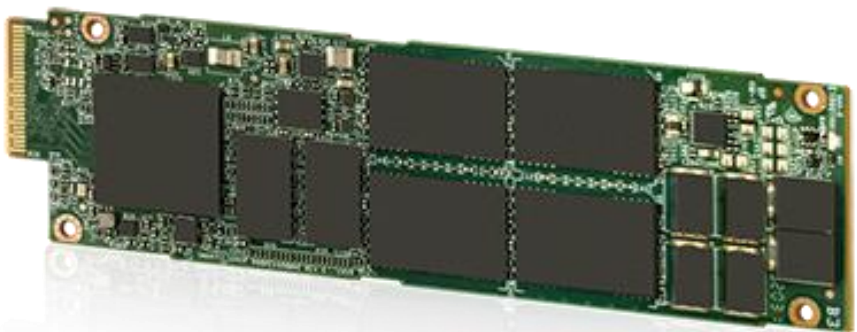
ME1/ME2

(2.5" SATA, M.2 2280 SATA)

S1800/SP2800

(M.2 2280 & U.2 PCIe NVMe Gen3 x4)





## SMART EDSFF

SMART's PCIe EDSFF SSD is a robust solid state drive specifically targeting the needs of servers, storage cache/accelerators, and data communications applications that require highly reliable internal storage with a small footprint.

## Center/Enterprise SSDs

### Data Center-Class SSDs

- Lower latency
- Lower power consumption and higher endurance
- Built for sustained performance
- Mixed workload I/O
- 24/7 consistent input/output operations
- Built-in power-loss protection

## EDSFF

### The Enterprise & Data Center SSD Form Factor

- Lower latency
- Lower power consumption and higher endurance
- Built for sustained performance
- Mixed workload I/O
- 24/7 consistent input/output operations
- Built-in power-loss protection

# High-Density RUGGED SSDs

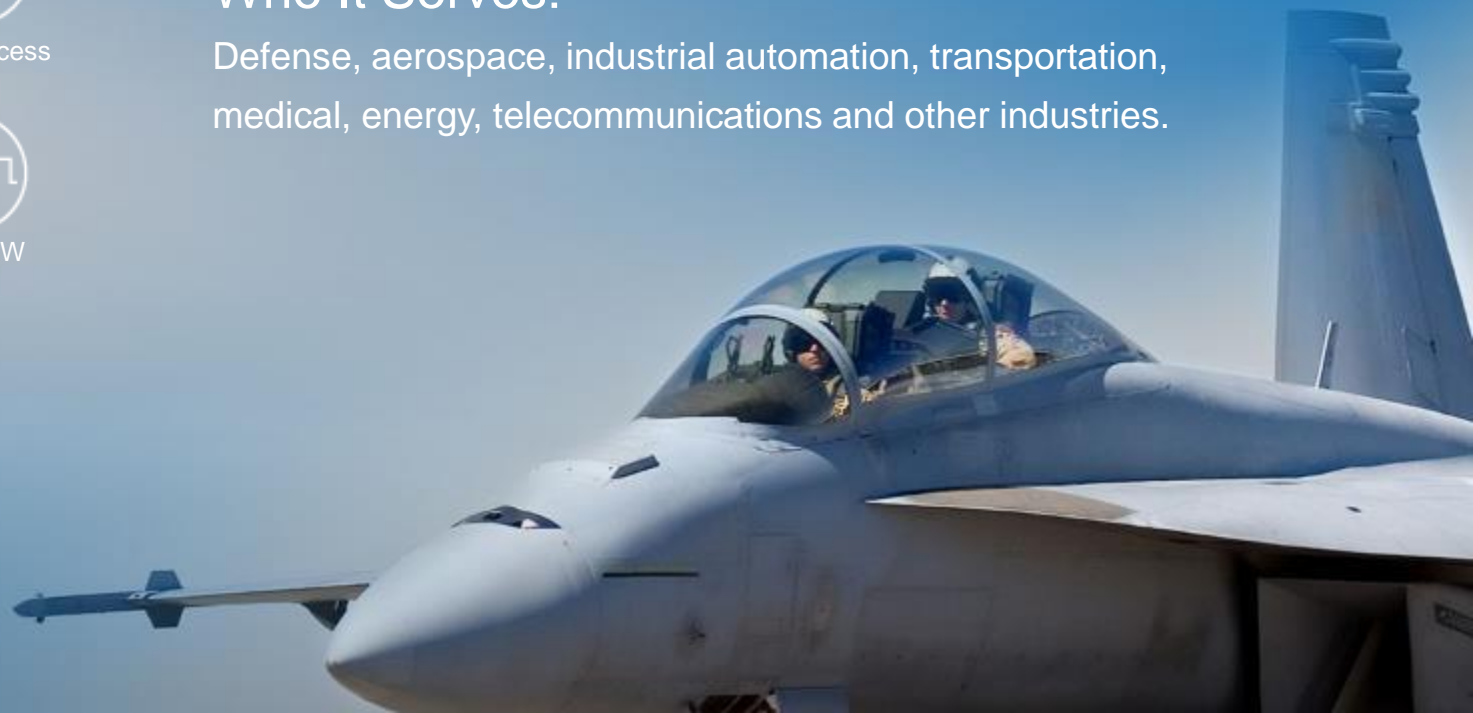


## Benefits and Features

Built for the harshest environments where memory failure is simply not an option.

## Who It Serves:

Defense, aerospace, industrial automation, transportation, medical, energy, telecommunications and other industries.



# Thank you



# STAY SAFE