

VIRTIUM PRODUCT GUIDE

Design and Manufacture the most reliable industrial memory and storage products with the highest longevity, consistency, and quality for the advanced digital network infrastructure and embedded systems.



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ABOUT VIRTUUM




Virtium has been the leading supplier of solid-state storage and memory solutions for over two decades. The company focuses on serving the industrial embedded markets for networking, telecommunications, industrial, transportation, medical, rugged computing systems, and other key markets that require data-storage integrity. Virtium's mission is to provide markets with the most reliable industrial-grade solid-state storage and memory modules with the greatest durability, highest consistency, and longest product availability.

All Virtium products are designed, built and manufactured to meet a broad range of industrial applications which require high reliability and consistent performance under harsh and robust environments (shock, vibration, humidity, wide temperature and others).

 **Made in the USA**

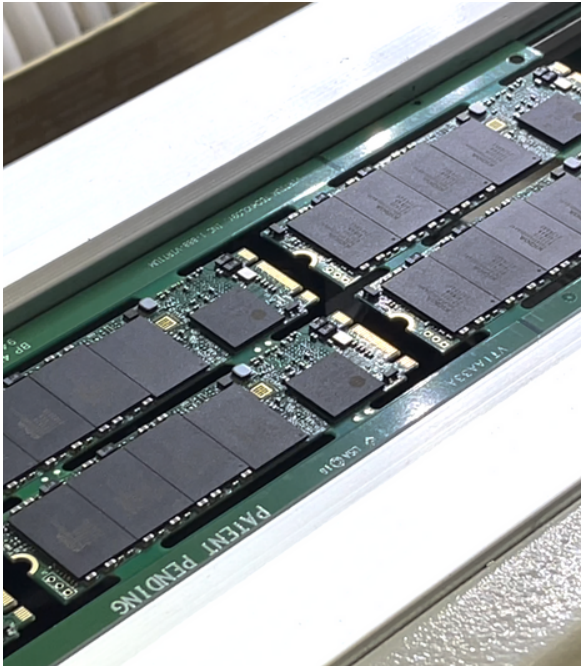


HEAD QUARTER

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WHY VIRTUUM



- Virtium is differentiated from other suppliers by offering extended product life-cycles beyond the rapidly changing industry average. Virtium product availability and life cycles can be up to 10 years, which help to minimize qualifications and PCNs.
- Virtium provides extensive technical support for design-in assistance, lifecycle management, and root cause analysis for field issues from design to end of life.
- Virtium quality is exemplary. All products are 100% burn-in, power-cycle tested over the full range of operating temperatures before shipping.
- Virtium has consistently provided customers one of the lowest DPPM rates in the industry

SOLUTIONS, SERVICES AND SUPPORT

TECHNOLOGY STACK

Tailored to specific applications

Value-added features leveraging mainstream technology

Optimized for longevity, cost, and performance

QUALITY SYSTEMS

Highest reliability in design, production, and delivery

Extensive technical support from design to end-of-life

Multi-site manufacturing for business continuity

LIFECYCLE SOLUTIONS

Longest product availability

Consistent and sustainable

Maximize customers' economic value and ROI

MARKET AND APPLICATIONS



**SOLUTIONS FOR WORLD'S
ADVANCED DIGITAL
NETWORK INFRASTRUCTURE**

NETWORKING AND TELECOM

The Networking and Telecom industry has undergone a remarkable evolution, necessitating the development of new architectures and enhanced equipment. These advancements are crucial in order to meet the ever-growing demands for high speed, low latency, and high-capacity data traffic. The industry recognizes the need to continually innovate and upgrade infrastructure to ensure seamless connectivity and support the increasing requirements of modern communication networks.

KEY FEATURES

- Industrial temperature support (-40°C to +85°C)
- Wide range of capacities: 1GB to 8TB (and more)
- Multiple interfaces and form factors
- Multiple architectures for varied performances and workloads, endurance and power
- Balanced sequential and random read/write
- Data protection against unexpected power loss
- AES Encryption and TCG Opal Authentication
- Legacy support
- ROHS and REACH compliance

Applications	Virtium's Products
Switches, Routers, Optical Transmission System, Base station , RAN, ORAN, Broadband Access, Wireless Access, Cyber Security, Network Edge Computers, Data Centers	M.2 NVMe, M.2 SATA, 2.5" SATA, E1.S, U.2, mSATA, eUSB, SD, MicroSD, CFast, CF, DDR5, DDR4, DDR3, DDR2

MARKET AND APPLICATIONS



INDUSTRIAL AUTOMATION

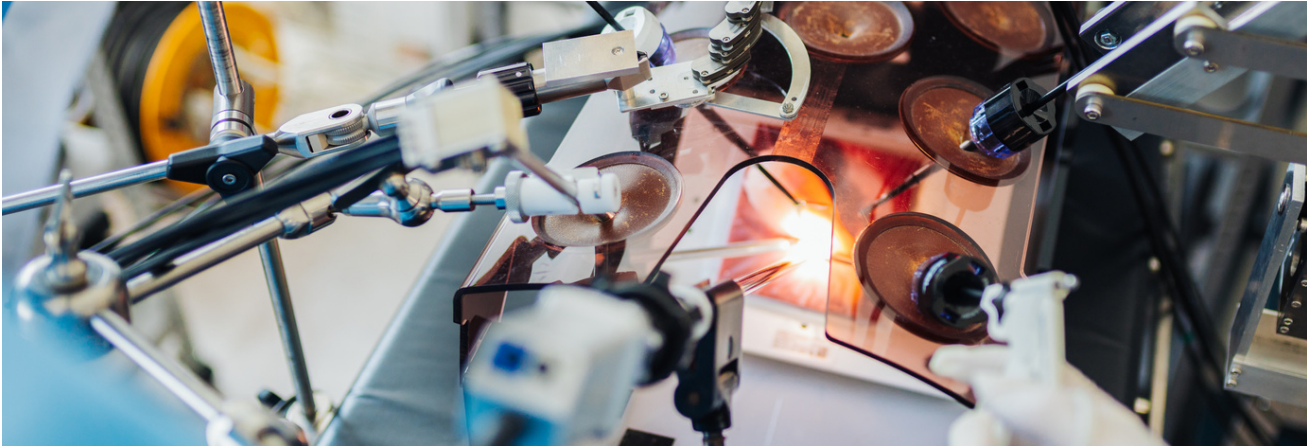
The realm of Industrial Automation encompasses various sub-segments, each characterized by unique form factors, mechanical profiles, endurance, and capacity requirements. These applications play a crucial role in factory automation, robotics, autonomous mobile robotics (AMR), test and measurement, energy, farming, and numerous other industries. To cater to these diverse fields, the products must be designed with components capable of withstanding industrial temperature ranges spanning from -40°C to +85°C. This ensures optimal performance and reliability in demanding industrial environments across a wide range of applications.

KEY FEATURES

- Industrial temperature support (-40°C to +85°C)
- Wide range of capacities: 1GB to 8TB (and more)
- Multiple interfaces and form factors
- Multiple architectures for varied performances and workloads, endurance and power
- Low power & Long-life cycles
- Data protection against unexpected power loss
- Legacy support
- ESD, vibration and humidity resistance
- ROHS and REACH compliance

Applications	Virtium's Products
Industrial PC and Edge Computer, Factory Automation, Robotics, Test and Measurement, Energy, Gaming, Security / Camera, Gateway, Switches, Routers, Drones	M.2 NVMe, M.2 SATA, 2.5" SATA, mSATA, SlimSATA, eUSB, SD, MicroSD, CFast, CF, DDR4, DDR3, DDR2, eMMC

MARKET AND APPLICATIONS



MEDICAL

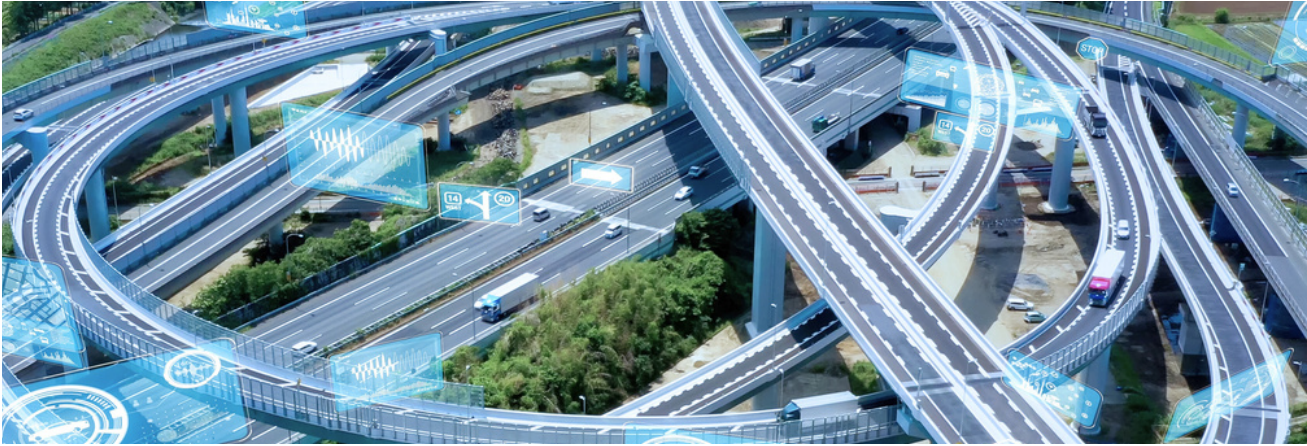
In the healthcare sector, numerous medical companies are actively exploring the potential of Artificial Intelligence (AI), Machine Learning (ML), and cloudification to enhance their products and services. These cutting-edge technologies have paved the way for the development and introduction of a wide array of new devices and services within the healthcare industry. By harnessing the power of AI, ML, and cloud computing, medical companies aim to improve patient care, diagnostics, treatment outcomes, and overall operational efficiency.

KEY FEATURES

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- Wide range of capacities: 1GB to 8TB(and more)
- Multiple architectures for varied performances and workloads, endurance and power
- Balanced sequential and random read/write
- Long-life cycles
- AES Encryption and TCG Opal Authentication
- Data protection against unexpected power loss
- Legacy support
- ROHS and REACH compliance

Applications	Virtium's Products
Imaging, Monitoring, Surgical Robots, Pharmaceutical, DNA Analysis, Medical Analysis, Industrial PC, Edge Computer, Hospital Gateway, Router & Switches,	M.2 NVMe, M.2 SATA, 2.5" SATA, SD, MicroSD, CFast, CF, DDR5, DDR4, DDR3, DDR2

MARKET AND APPLICATIONS



TRANSPORTATION

The transportation industry has experienced a significant influx of new market players, driven by the introduction of artificial intelligence, machine learning, and other emerging technologies. This wave of innovation has attracted upcoming leaders who are bringing forth a diverse range of services and introducing new business models to meet the growing expectations of customers. These dynamic entrants are reshaping the transportation landscape by offering innovative solutions, improving efficiency, and providing enhanced customer experiences.

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- Multiple interfaces and form factors
- Multiple architectures for varied performances and workloads, endurance and power
- Low power & Long-life cycles
- AES Encryption and TCG Opal Authentication
- Data protection against unexpected power loss
- Legacy support
- ESD, vibration and humidity resistance
- ROHS and REACH compliance

Applications	Virtium's Products
Industrial Mobile PC and Edge Computer, Gateway Switches, Routers, Drones, IFE / Avionics, Rail Monitor, Automotive, Maritime	M.2 NVMe, M.2 SATA, 2.5" SATA, mSATA, SlimSATA, eUSB, SD, MicroSD, CFast, CF, DDR4, DDR3, DDR2, eMMC

MARKET AND APPLICATIONS



RUGGED COMPUTING SYSTEMS

Rugged computing systems have been continuously undergoing rapid digitalization with the advances in artificial intelligence and computer processing power. These advancements encourage the ever-growing demands for smarter, more robust, and higher-performance systems. In addition, these systems must maintain fully functional and deterministic under harsh conditions like high humidity, extreme temperatures, shock, altitude, and vibration.

KEY FEATURES

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- Wide range of capacities: 1GB to 8TB(and more)
- Multiple architectures for varied performances and workloads, endurance and power
- Low power & Long-life cycles
- AES Encryption, Secure Erase and TCG Opal
- Data protection against unexpected power loss
- ESD, vibration and humidity resistance
- ROHS and REACH compliance

Applications	Virtium's Products
Base station , Satellite Routers & Switches, Ground Computing systems, Airborne Computing systems, Space Computing systems and Naval Computing systems	M.2 NVMe, M.2 SATA, 2.5" SATA, E1.S, U.2, mSATA, eUSB, SD, MicroSD, CFast, CF, DDR5, DDR4, DDR3, DDR2, eMMC

MARKET AND APPLICATIONS



VIDEO AND SIGNAGE

The ongoing digital transformation is poised to drive substantial growth in the realm of video and digital signage applications in the coming years. With the advent of advanced technologies and changing consumer preferences, businesses and organizations are increasingly embracing video and digital signage as powerful tools for communication, advertising, and engagement.

KEY FEATURES

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- ESD, vibration and humidity resistance
- ROHS and REACH compliance

Applications	Virtium's Products
Transportation Advertising platforms, Retail Business Display applications, Augmented Reality applications, High-Definition Video Recording, Video and Wall Screen applications	M.2 NVMe, M.2 SATA, 2.5" SATA, SD, MicroSD, CFast, CF, DDR4, DDR3, DDR2, eMMC

MARKET AND APPLICATIONS



INDUSTRIAL IOT

The convergence of Industry 4.0 and digital transformation has paved the way for seamless integration of various technologies, including 5G cloud services, Artificial Intelligence (AI), Machine Learning (ML), and Industrial Internet of Things (IoT) solutions. These advancements have revolutionized industrial processes by enabling real-time data collection, analysis, and automation. With the integration of 5G cloud services, industrial systems can leverage high-speed connectivity and massive data processing capabilities, unlocking new levels of efficiency and productivity.

KEY FEATURES

- Industrial temperature support (-40°C to +85°C)
- Wide range of capacities: 1GB to 8TB (and more)
- Multiple interfaces and form factors
- Multiple architectures for varied performances and workloads, endurance and power
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- Data protection against unexpected power loss
- AES Encryption and TCG Opal Authentication
- ESD, vibration and humidity resistance
- ROHS and REACH compliance

Applications	Virtium's Products
Smart City, Smart Farming, Factory Automation, Inventory and Data Tracking, Security Monitoring, Smart Energy, Oil, and Gas, Smart Building and Agriculture	M.2 NVMe, M.2 SATA, 2.5" SATA, mSATA, SlimSATA, eUSB, SD, MicroSD, CFast, CF, DDR5, DDR4, DDR3, DDR2, eMMC

STORAGE AND MEMORY SOLUTIONS



**LEADING THE INDUSTRY IN
PRODUCT LONGEVITY AND
RELIABILITY**

PRODUCTS OVERVIEW

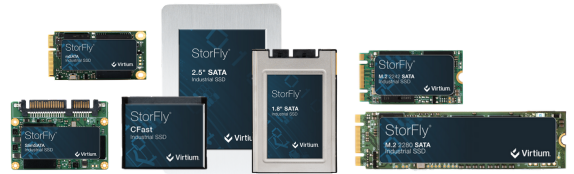
Virtium designs and manufactures solid-state storage and memory products for industrial embedded applications that require the most reliable products with the greatest durability, highest consistency, and longest product availability.

Virtium also offers the most diversified portfolio of memory and storage products which cover a wide range of different interfaces, form factors and capacities. The five groups of Virtium products are summarized next page.

VIRTUUM PRODUCT OVERVIEW

StorFly® SATA

- Industry's broadest capacity offering: 8GB to 4TB
- Multiple architectures for varied workloads
- vtGuard power loss protection
- AES Encryption, Crypto Erase, and optional TCG Opal
- Support SLC, pSLC, and 3D TLC NAND



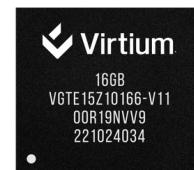
StorFly® NVMe/PCIe

- Wide range of capacity up to 8TB
- Multiple architectures for varied workloads
- vtGuard power loss protection
- AES Encryption, Crypto Erase, and TCG Opal
- Support pSLC and 3D TLC NAND



Galent™

- eMMC up to 32GB
- NVMe BGA SSD, [eUFS]



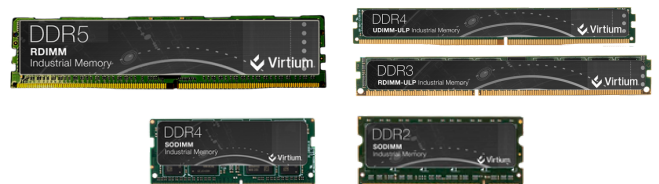
TUFFDRIVE®

- Low power and Small form factors
- Interfaces: SD/uSD, USB, CF
- Support SLC, pSLC, and 3D TLC NAND



MEMORY

- DDR5, DDR4, DDR3, DDR2 Data rate
- Form factors: RDIMM, SODIMM, UDIMM
- Low profile options: ULP / VLP, Mini
- Ultra-rugged options – conformal coating, underfill



STORAGE SOLUTIONS



WIDE RANGE OF CAPACITIES, INTERFACES & FORM FACTORS

Virtium’s StorFly® and TuffDrive® solid state storage solutions are ideal for heavy-duty industrial embedded applications which includes boot drives, data logging, caching, and backup storage.

Virtium’s SSDs are made for extreme conditions in industrial embedded applications. Virtium’s SSDs are available with industrial temperature ratings (-40°C to +85°C) and different performances based on SLC, MLC, 3D TLC, and pSLC NAND components.

INTERFACES & FORM FACTORS

NVMe

M.2 NVMe
E1.S
CFexpress

USB

USB Module
USB Key

SATA

2.5"
1.8"
M.2 SATA
mSATA
Slim SATA
CFast

SECURE DIGITAL

Secure Digital
MicroSD

OTHERS

Compact Flash
eMMC/UFS

STORAGE SOLUTIONS

MULTIPLE ARCHITECTURES FOR VARIED WORKLOADS

For the popular interfaces – NVMe and SATA, Virtium offers multiple architectures which are designed to deliver the optimized performances and workloads, endurance and power

StorFly® Series 3

StorFly® Series 3 SSDs are mainstream industrial storage solutions designed for the best blend of performance, power, form-factor and capacity support, and cost. The SSDs are available to support industrial temperatures (-40°C to +85°C), extended endurance (pSLC) and are the lowest power solutions in the StorFly family.

StorFly® Series 6

StorFly® Series 6 SSDs are industrial storage solutions designed for heavier duty workloads requiring higher performance and provide the best blend of steady-state performance and higher endurance. The SSDs are available with extended endurance (pSLC) and are the overall highest performing solutions in the StorFly® family.

Product Information			
	StorFly	TuffDrive	Galent
Interface	Series 3/6/9 PCIe, SATA	SD, uSD, eUSB, CF	BGA (NVMe), eMMC *eUFS*
Form factors	E1.S, M.2, U.2 *[U.3], 2.5" SATA, mSATA, SlimSATA, 1.8", CFexpress	SD Card, microSD, eUSB (10-pin module), USB key, CF Card	BGA (chip down)
Operating Temp	I-Temp by design C-Temp option		I-Temp standard Optional automotive temp
Ideal for	Modular solutions with long lifecycle, I-temp, enhanced networking, telecom and industrial feature set		Chip down for size/weight, shock/vibration
Warranty	3-5 years	5 years	3-5 years
Expected product lifecycle	> 5 years		
Adv. power loss protection	Option	No	Option (off-module)
TCG Opal	Supported	No	Option
HW WP + secure erase	Option	No	Option

NVMe PORTFOLIO

Virtium’s StorFly® NVMe Industrial SSDs are designed for the unique capacity, workload and product longevity requirements of a broad range of embedded systems. As rugged storage solutions, StorFly® NVMe products are specifically designed for harsh environments prone to high and low temperatures, shock and vibration, and even inconsistent power sources.

NVMe SERIES 3 AND 6 AT A GLANCE

Product Information		
	Series 3	Series 6
Interface	G3/4 x4; x2 option	G3/4 x4
Topology	DRAMless w/HMB support	DRAM, 4/8-ch
Form factors	M.2 2230, 2242, 2280, and CFexpress	M.2 2280, E1.S, and, U.2
Capacities (3D TLC)	60 – 3840GB	240 – 1920GB
Capacities (pSLC)	20-1280GB	Custom
Performance	Fast	Faster
Power	Lowest (4W max)	Lower (6W max)
Security options	TCG Opal	TCG Opal
Power loss protection	vtGuard vtGuard+ option	vtGuard vtGuard+ option
Other features	E2E	
Use case	Lower capacity and power, ideal for boot drive applications	Balance of performance and power for system drive and mixed workload applications; focus on best steady-state performance (DTLC, throttle mitigation)

NVMe PORTFOLIO

StorFly® M.2 NVMe

Interface: NVMe / PCIe

NAND: 3D TLC, pSLC

Capacities: 8GB – 2TB

Form Factors: M.2 2230, 2242, 2260, and 2280



Virtium's StorFly® M.2 NVMe Industrial SSDs are designed for the unique capacity, workload and product longevity requirements of a broad range of embedded systems. As rugged storage solutions, StorFly® M.2 NVMe products are specifically designed for harsh environments prone to high and low temperatures, shock and vibration, and even inconsistent power sources.

These SSDs are particularly well-suited for use in robotics, transportation, and process monitoring, as well as in the telecommunications and networking sectors that are heavily focused on the rapidly expanding 5G and optical networking markets.

StorFly® CFexpress

Interface: NVMe

NAND: 3D TLC

Capacities: Up to 960GB



StorFly® CFexpress PCIe Gen 4.0 Removable NVMe SSDs enable sealed, industrial-grade solid-state storage in applications requiring both the flexibility of compact, removable media and the high performance of NVMe.

Additionally, the new CFexpress SSDs are resistant to environmental factors that can compromise the drives and their data, and feature Industrial Temperatures (I-Temp) support that ensures consistent operation between -40°C to +85°C.

NVMe PORTFOLIO

StorFly® E1.S

Interface: PCIe/NVMe

NAND: 3D TLC

Capacities: Up to 4TB



Virtium's StorFly® Series 6 E1.S NVMe PCIe solid-state drives are mainstream productivity solutions designed to provide the ideal balance of power, performance, endurance, reliability, long ordering life, and cost all in a rugged industrial design suitable for environmental extremes.

SATA PORTFOLIO

Virtium’s StorFly® SATA Industrial SSDs deliver an optimal solid-state storage solution for embedded and industrial systems that require more legacy SATA support in a small form factor. SATA SSDs require less power and generates less heat (versus NVMe SSDs), which improves the devices’ reliability in systems where space is limited and airflow minimal, if not absent entirely.

SATA SERIES 3 AND 6 AT A GLANCE

Product Information		
	Series 3 (S3x)	Series 6 (S6x)
Interface	SATA 6G	
Topology	DRAMless	DRAM, 4-ch
Form factors	mSATA, M.2 2242, SlimSATA	2.5", 1.8", mSATA, M.2 2242/2280, SlimSATA
Capacities (3D TLC)	30GB - 2TB	240GB – 8TB
Capacities (pSLC)	16GB - 160GB	80GB - Custom
Performance	Fast	Faster
Power	Lowest	Lower
TCG Opal	No	Option
Power loss protection	vtGuard	vtGuard vtGuard+ option
Other features	E2E	
Use case	Boot and light system logs	Mixed workload

SATA PORTFOLIO

StorFly® 2.5" SATA

Interface: SATA

NAND: SLC, pSLC, MLC, and TLC

Capacities: 30GB – 8TB



StorFly® 2.5" SATA industrial SSDs are designed for the unique capacity, workload and product longevity requirements of a broad range of embedded systems.

As rugged storage solutions, StorFly® 2.5" products meet MIL-STD-810F standards for shock, vibration and altitude.

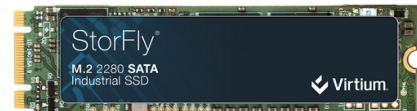
StorFly® M.2 SATA

Interface: SATA

NAND: 3D TLC, pSLC, SLC

Capacities: 8GB – 2TB

Form Factors: M.2 2230, 2242, 2260, and 2280



StorFly® M.2 SATA Industrial SSDs deliver an optimal solid-state storage solution for embedded and industrial systems that require more legacy SATA support in a small form factor.

M.2 requires less power and generates less heat, which improves the devices' reliability in systems where space is limited and airflow minimal, if not absent entirely. This provides system designers with the capability to scale their capacity by allowing integration of multiple SSDs all within a limited power budget or system footprint.

These SSDs are particularly well-suited for use in robotics, transportation, and process monitoring, as well as in the telecommunications and networking sectors that are heavily focused on the rapidly expanding 5G and optical networking markets.

SATA PORTFOLIO

StorFly® mSATA

Interface: SATA

NAND: SLC, pSLC, MLC, and 3D TLC

Capacities: 30GB to 960GB



StorFly® mSATA (MO-300) Industrial SSDs are designed for the unique capacity, workload and product longevity requirements of a broad range of embedded systems. As rugged storage solutions, StorFly® mSATA products meet MIL-STD-810F standards for shock, vibration and altitude.

StorFly® CFast

Interface: SATA

NAND: SLC, pSLC, and MLC

Capacities: 8GB to 480GB



StorFly® CFast SATA industrial SSDs match the storage requirements of industrial automation, networking and medical applications that demand high performance in a small framed form factor.

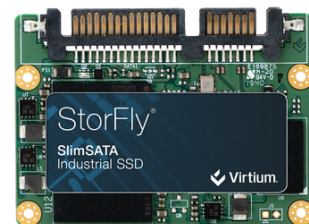
CFast is the same footprint as a CompactFlash but offers a plug-in SATA interface. CFast SSDs can be used in either fixed or removable devices, but unlike moving to SD, most ATA-based software can be directly leveraged into new CFast designs.

StorFly® Slim SATA

Interface: SATA

NAND: SLC, pSLC, MLC, and 3D TLC

Capacities: 8GB to 480GB



StorFly® Slim SATA (MO-297) industrial SSDs are ideal for networking, embedded, industrial and Advanced TCA applications that implement a standard SATA 3Gbps socket but require a form factor with a volume that is roughly 15% that of a 2.5-inch SSD.

SATA PORTFOLIO

StorFly® 1.8" SATA

Interface: SATA

NAND: SLC, pSLC, MLC, and 3D TLC

Capacities: 8GB to 960GB



StorFly® 1.8" SATA industrial SSDs deliver an optimal solid-state storage solution for embedded and industrial systems that may require a high-reliability replacement to hard-to-find 1.8" HDDs. StorFly® 1.8" SSDs are also smaller, thinner, ejectable alternatives to 2.5" SATA SSDs that provide the benefit of enhanced serviceability without the need for a hot-swap carrier. At a 5mm thickness, StorFly® 1.8" SSDs are ideal for 1U server and blade applications where airflow and cooling are high priorities.

SMALL FORM FACTOR PORTFOLIO

Virtium’s StorFly® SATA Industrial SSDs deliver an optimal solid-state storage solution for embedded and industrial systems that require more legacy SATA support in a small form factor. SATA SSDs require less power and generates less heat (versus NVMe SSDs), which improves the devices’ reliability in systems where space is limited and airflow minimal, if not absent entirely.

SMALL FORM FACTOR AT A GLANCE

Product Information					
	SFF NVMe/PCIe	SD	USB	eMMC	eUFS
Chipset support	All	Many	All	Many	Few, but growing
Package Size	2230, 2242 M.2 11.5x13mm, 16x20mm 28x28 and other derivatives BGA	microSD Full size card	10-pin module Key	11.5x13mm BGA	
Interface	PCIe G3/G4 2,4 lanes	SD 6	USB 3	eMMC 5.1	eUFS 4.0
TLC Capacities	60GB – 1TB	Up to 256GB	N/A	[64GB]	256GB
pSLC capacities	8-320GB	16, 32GB, Custom	SLC: 4-32GB pSLC: 8-64GB	16GB	N/A (scoping)
Standards body	PCI-SIG (M.2 spec) JEDEC (automotive) NVMexpress.org	SD Association	USB-IF	JEDEC JC-64	
Performance	Fastest	Fast			Faster
Power	Low	Lower			Lowest*
Target Market	Client, networking, telecom, datacenter, industrial	Consumer, legacy telecom, industrial	Telecom, industrial	Legacy smartphone, tablet, industrial, telecom, automotive	Smartphone, wearables, automotive

SMALL FORM FACTOR PORTFOLIO

TuffDrive® eUSB

Interface: USB 3.1

NAND: : SLC, MLC, and 3D TLC

Capacities: 2GB to 128GB



TuffDrive® eUSB embedded USB 2.0 and 3.0 industrial SSDs are ideal solutions for networking, embedded and industrial applications that require a modest amount of storage and utilize Altera, Cavium, Freescale, Renesas, Xilinx, or other chipsets that may not have an integrated SATA interface.

TuffDrive® USB KEY

Interface: USB 3.1

NAND: SLC, MLC, and 3D TLC

Capacities: 2GB to 128GB



TuffDrive® Long and Short Key USBs are ideal solutions for operating system and file storage and system level diagnostics in applications that utilize chipsets that may not have a SATA interface.

Even if a host system has integrated SATA, many engineers find that eUSB modules are beneficial for storing configuration information and for providing a backup repository for data in DRAM in the event of a system-level power down.

SD CARD

Interface: Secure Digital

NAND: SLC, pSLC, MLC, and 3D TLC

Capacities: Up to 128GB



Virtium's TuffDrive® industrial SSDs are designed for the unique capacity, workload and product lifecycle requirements of a broad range of embedded systems including networking, industrial automation, medical and gaming equipment as well as point-of-sale terminals, military data recorders and wearable computers. TuffDrive® SD cards deliver a stable storage configuration for long product life cycles, can operate over a wide temperature range and eliminate the need for frequent product re-qualification.

SMALL FORM FACTOR PORTFOLIO

MICRO SD

NAND: pSLC, 3D TLC
Capacities: Up to 256GB



Virtium's TuffDrive® MicroSD card is a small form factor non-volatile memory card which provides highly reliable storage media in a very small space. The simplicity of the SD and SPI protocols allows easy host design and integration. The Virtium's MicroSD card support a high security level of copyright protection and an easy to implement interface.

COMPACT FLASH

Interface: PATA/PCMCIA
NAND: SLC, MLC, and 3D TLC
Capacities: 128MB to 128GB



TuffDrive® CompactFlash (CF) industrial SSDs are optimal storage solutions for the rugged requirements of single board computers and a variety of embedded systems ranging from point of sale terminals to networking equipment to industrial automation. They include field upgradeable firmware functionality. Despite some companies exiting the CompactFlash business, Virtium is committed to this form factor in the industrial embedded market.

GALENT PORTFOLIO

eMMC

NAND: pSLC

Capacities: 8GB and 16GB



Virtium's Galent® eMMC products follow the JEDEC eMMC 5.1 standard. It is an ideal universal storage solution for many electronic devices, including smartphones, tablets, PDAs, eBook readers, digital cameras, recorders, MP3, MP4 players, electronic learning products, digital TVs and set-top boxes. eMMC encloses the 3D-64 Layers NAND and eMMC controller inside as one JEDEC standard 153 ball FBGA(TFBGA) package, providing a standard interface to the host. The eMMC controller directly manages NAND flash, including ECC, wear-leveling, IOPS optimization and read sensing.

HIGH CAPACITY SSDs PORTFOLIO

StorFly® 2.5" SATA

Interface: SATA
NAND: 3D TLC and pSLC
Capacities: up to 8TB (16TB soon)

StorFly® 2.5" SATA industrial SSDs are designed for the high capacity, workload, and product longevity requirements of a broad range of embedded and enterprise systems.



StorFly® M.2 SATA (M.2 2280)

Interface: SATA
NAND: 3D TLC and pSLC
Capacities: up to 2TB

StorFly® M.2 2280 SATA Industrial SSDs deliver an optimal solid-state storage solution for embedded and industrial systems that require more legacy SATA support and high capacity.



StorFly® M.2 NVMe (M.2 2280)

Interface: PCIe/NVMe Gen3/4x4
NAND: 3D TLC and pSLC
Capacities: up to 2TB (4TB soon)

StorFly® M.2 2280 NVMe Industrial SSDs deliver an optimal solid-state storage solution for embedded and industrial systems that require PCIe interface, high capacity and performance.



StorFly® E1.S

Interface: PCIe/NVMe Gen3/4x4
NAND: 3D TLC
Capacities: 2TB to 4TB

Virtium's StorFly® Series 6 E1.S NVMe PCIe solid-state drives are mainstream productivity solutions designed to provide the ideal balance of power, performance, endurance, reliability, and cost all in a rugged industrial design suitable for environmental extremes.



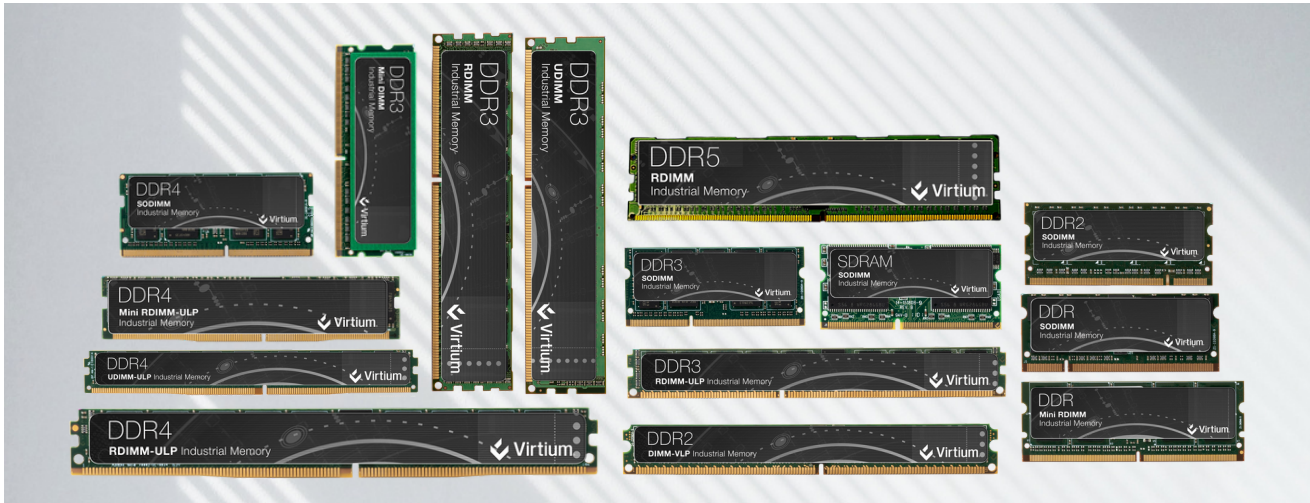
StorFly® U.2 NVMe

Interface: PCIe/NVMe Gen3/4x4
NAND: 3D TLC and pSLC
Capacities: up to 4TB (8TB soon)

StorFly® U.2 NVMe Industrial SSDs deliver an optimal solid-state storage solution for embedded and industrial systems that require PCIe interface, high capacity and performance.



MEMORY SOLUTIONS



MEMORY SOLUTIONS

Virtium's 25-plus years of business legacy started with memory. We have perfected the process with our patented advanced chip placement and stacking techniques, enabling higher densities in smaller footprints.

DDR5, DDR4, DDR3, and DDR2 memory modules are designed to meet mission-critical, extreme temperature (-40°C to +85°C), high-reliability, and long-life requirements for the most demanding embedded designs.

INTERFACES & FORM FACTORS

ECC MINI-DIMM	DDR5
ECC SODIMM	DDR4
ECC UDIMM	DDR3
MINI-RDIMM	DDR2
RDIMM	DDR
SO-UDIMM	SDRAM
SO-RDIMM	
SODIMM	
UDIMM	

Virtium offers standard VLP and ULP heights and many options such as 30µ" gold finger, thermal heat spreaders, conformal coating, thermal sensors, anti-sulfuration and under fill. Memory modules carry five-year warranties.

MEMORY PRODUCT SUMMARY

Virtium’s DRAM memory modules are designed to meet mission-critical, extreme temperature, high-reliability, and long life requirements for the most demanding embedded designs. Our extensive engineering expertise enables us to deliver small-form-factor memory in the highest density, lowest profile, and smallest form factors possible. Virtium has applied patented design and component stacking techniques to improve system reliability and increase MTBF.

Form Factor		SDRAM	DDR	DDR2	DDR3	DDR4	DDR5
ULP/UDIMM		✓	✓	✓	✓	✓	✓
ECC UDIMM		✓	✓	✓	✓	✓	✓
SODIMM		✓	✓	✓	✓	✓	✓
ECC SODIMM				✓	✓	✓	✓
SO-RDIMM			✓	✓	✓	✓	
SO-CDIMM		✓	✓				
ULP/RDIMM		✓	✓	✓	✓	✓	✓
MINI-RDIMM				✓	✓	✓	
ECC MINI-DIMM				✓	✓	✓	
Data Transfer Rate		PC100 PC133	PC2100 PC2700 PC3200	PC2-3200 PC2-4200 PC2-5300 PC2-6400	PC3-12800 PC3-10600 PC3-8500	PC4-2133 PC4-2400 PC4-2666 PC4-2933 PC4-3200	PC5-4800 PC5-5600
Capacities	Min	1GB	256MB	1GB	4GB	4GB	8GB
	Max	8GB	4GB	8GB	32GB	64GB	256GB

MEMORY MODULE CONFIGURATIONS

	4GB	8GB	16GB	32GB	64GB	128GB	256GB
DDR5		16Gb 1Rx16	16Gb 1Rx8	16Gb 2Rx8 16Gb 1Rx4	16Gb 2Rx4	16Gb 3DS 2H: 4Rx4	16Gb 3DS 4H: 8Rx4
DDR4	4Gb 1Rx8	8Gb 1Rx8	16Gb 1Rx8 8Gb 2Rx8 8Gb 1Rx4	32Gb 2Rx8 16Gb 2Rx8 16Gb 1Rx4 8Gb 2Rx4	32Gb 4Rx8 32Gb 2Rx4 16Gb 2Rx4		
DDR3	4Gb 1Rx8	4Gb 2Rx8 4Gb 1Rx4	8Gb 2Rx8 4Gb 4Rx8 4Gb 2Rx4				

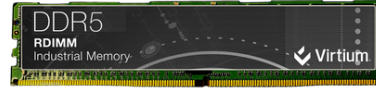
MEMORY PORTFOLIO

DDR5

Form Factors: RDIMM, UDIMM, and SODIMM

Capacities: 8GB to 256GB

Height: Standard, VLP, and ULP



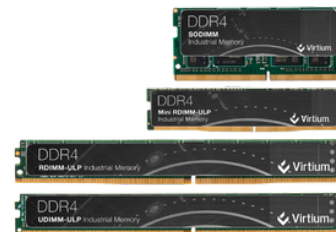
Virtium industrial DDR5 memory modules support Intel's 12th-generation Alder Lake mobile processors, Intel's Sapphire Rapids and AMD's AM5 platform and Zen4 Genoa processors. Virtium offers both 4800MT/s and 5600MT/s solutions, longest product availability, and lower cost of ownership over time. In addition, the new high-capacity DDR5 memory modules provide better power efficiencies than those of DDR4.

DDR4

Form Factors: DIMM, SODIMM, and Mini-DIMM

Height: Standard, VLP, and ULP

Capacities: 4GB to 64GB



As one of the first manufacturers to offer industrial DDR4 memory, Virtium enables embedded industrial OEM customers early test and development access to the lower power, high bandwidth and density benefits of this latest DRAM technology.

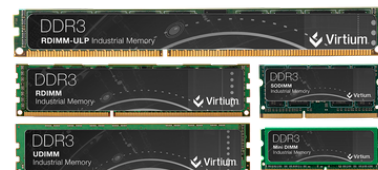
Delivering significant power savings of up to 40% and up to twice the bandwidth over DDR3, Virtium's industrial DDR4 modules are excellent solutions for server blades, networking and telecom applications.

DDR3

Form Factors: DIMM, SODIMM, and Mini-DIMM

Height: Standard, VLP, and ULP

Capacities: 4GB to 32GB



Virtium Industrial DDR3 memory modules are available in densities up to 32GB in a variety of form factors and heights.

Virtium DDR3 modules deliver higher memory bandwidth and lower power consumption and are supported by leading-edge CPU processors.

MEMORY PORTFOLIO

DDR2 & SDRAM

Form Factors: DIMM, SODIMM, and Mini-DIMM

Height: Standard, VLP, and Blade VLP

Capacities: 1GB to 8GB



Industrial DDR2 SDRAM improvements over first gen. DDR included: reduced clock speed resulting in higher bus speed. Operating voltage was reduced from 2.5 volts to 1.8 volts to reduce power consumption and facilitate the use of smaller semiconductor fabrication processes. Virtium contributed to the advancement of the DDR2 generation with the development of ECC VLP RDIMM targeted at AdvancedTCA applications.

DDR

Form Factors: DIMM, SODIMM, and Mini-DIMM

Height: Standard, VLP, and Blade VLP

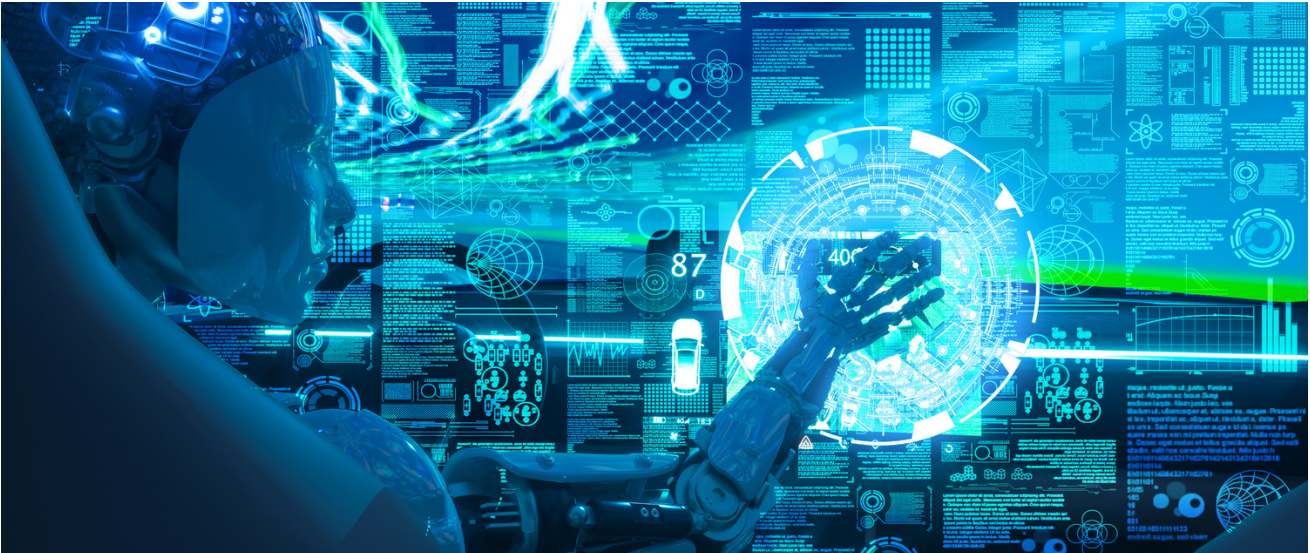
Capacities: 256MB to 4GB



DDR SDRAM was the follow-on technology to SDRAM and is the predecessor to subsequent generations of DDR2 and DDR3. DDR provides a lower voltage level and higher data transfer compared to SDRAM. The voltage level is reduced from 3.30 volts to 2.50 volts and the memory module provides a data transfer on both transitions of the clock signal. This produces more data transfers for a given clock speed, but with the drawback of increased latency.

Virtium supports industrial DDR modules in a wide range of configurations and features that are available in 184 and 200 pin DIMM and 200 pin SODIMM form factors.

VIRTUUM TECHNOLOGY ADVANTAGES



Virtium's leadership position in the embedded memory market is supported by the long list of industry-first products and is enhanced by our enduring commitment to be last out with legacy products. Virtium understands that OEMs require multiple sources for their SSD and memory products, so our engineering management team is actively involved in driving standards through the CompactFlash Association, JEDEC, PICMG and the SFF-SIG.

Our team of engineers is developing feature sets specifically targeted at embedded systems and our test engineering team is characterizing our SSD and memory products over varying workloads and temperatures.

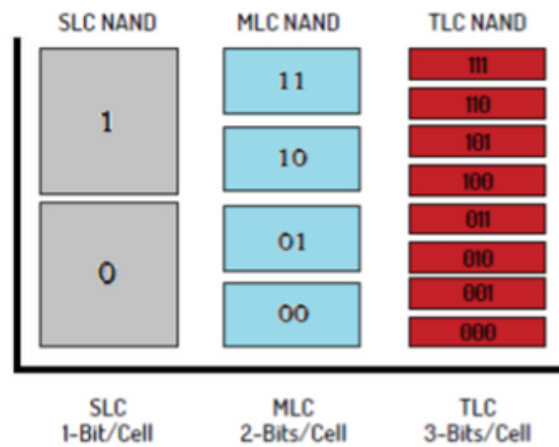
Key Highlights

- Value-added features leveraging mainstream technology
- Optimize architecture and PCB design for longevity, cost, and performance
- Design for consistent and sustainable performance over the temperature range and life cycle

VIRTUUM TECHNOLOGY HIGHLIGHTS

Virtium CE, XE, and PE Industrial SSD Comparisons

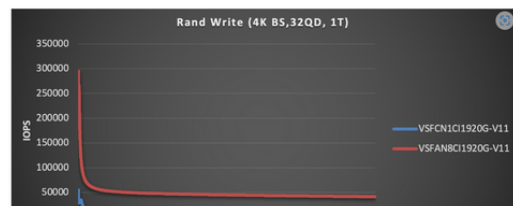
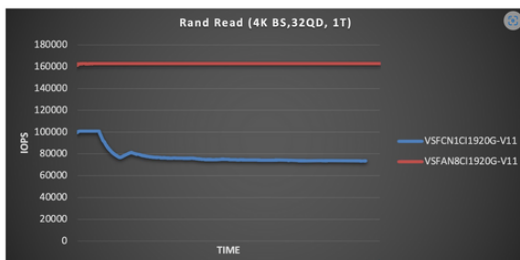
SSDs are the dominant future choice for storage because of their performance and size. They are based on various types of NAND flash which contributes to the SSDs' capacities and endurance. In the past, SLC and MLC NAND flashes were the popular choices for industrial applications. However, 3D-TLC and pSLC are getting traction in industrial system deployments. Key differentiation of the NAND flashes are the endurance and in this paper Virtium will organize our SSD products based on three classes of endurance: CE, XE and PE...[Read more >>>](#)



How to Select Between DRAM vs. DRAM-less SSDs

Virtium offers both DRAM and DRAM-less SSDs

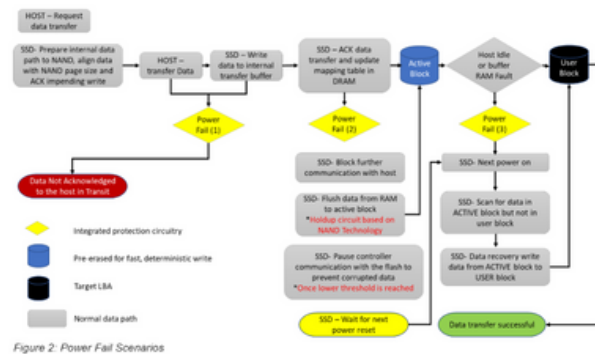
The DRAM on an SSD is used to store data mapping tables, which keeps track of logical blocks and their physical locations in NAND. On DRAM-less SSDs this mapping table is stored in NAND. Since NAND is slower than DRAM, DRAM-less SSDs' performance may be slower than SSDs with a DRAM cache. However, Virtium's engineering analysis concludes that SSD performance highly depends on the specific workload...[Read more>>>](#)



VIRTUUM TECHNOLOGY HIGHLIGHTS

Virtium vtGuard Power Loss Protection

Power failure threats for embedded systems can range from power spikes to brownouts. These less-than-ideal conditions are the cause of data corruption resulting in field failures, which lead to the potential loss of revenue from equipment returns.



One key design challenge SSD vendors face is the susceptibility of an SSD to data corruption from an unexpected power failure. Virtium offers vtGuard technology that will handle these data-loss conditions and ensure the systems are operating reliable...[Read more>>>](#)

Thermal Concepts Enhance DRAM Memory Subsystem Designs

Memory designers can mitigate heat and design better memory subsystems using a range of simple but powerful thermal concepts.

Controlling thermal issues related to the CPU is often atop priority for embedded systems designers; however, the memory module is not necessarily less important. Thermal management problems present challenging design considerations within embedded environments, requiring knowledge, precision, and creativity to diagnose and overcome memory subsystem design parameters...

[Read more>>>](#)

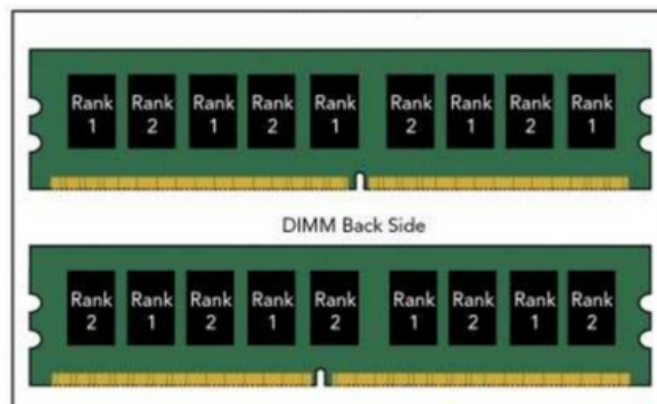


Figure 2: Alternating DRAM ranks

WORLDWIDE PRESENCE

Virtium provides technical and sale support worldwide, the company has consistently won many service and technical support awards from many customers.




AWARDS HISTORY


Virtium has received awards for innovation, leadership, service, and support from industry leaders, and most importantly our customers.





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