

# Innovation That Fits

## Mercury High Density Secure Memory

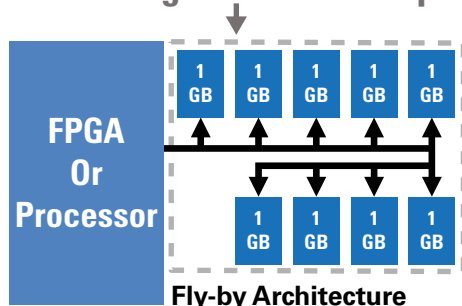
To address the broad range of perils faced by the modern war fighter, defense electronics are growing increasingly sophisticated with additional sensor subsystems detecting, analyzing, and responding to potentially threatening scenarios. To do so, each of these subsystems requires data acquisition, digitization, processing, and storage modules. These highly complex subsystems together yield a massive volume of data to be processed in short periods of time. From a system-level architecture perspective, designers face a dilemma where they must integrate additional components and circuitry into a fixed allocation of board space. Missions requiring smaller and lighter weight form factors push the designer to the challenging goal of adding even more functionality while reducing overall system size and weight. In summary, many mission objectives can only be achieved with increasingly feature-rich electronic systems more tightly packed into the smallest of physical footprints.

Mercury Systems applies its research and development expertise towards the commercialization of innovative technologies addressing the most challenging industry problems, such as the scenario described above. This technical brief examines Mercury's portfolio of High Density Secure Memory products, a unique offering delivering high-speed, military-hardened memory solutions in the smallest of form factors. The successful commercialization of our packaging technology has provided system level designers with additional board real estate without sacrificing memory performance requirements. Although ideally suited for defense electronics, our miniaturization technology has also been adopted for commercial avionics and industrial applications.

A typical system configuration includes at least one processor and/or field-programmed gate array (FPGA) with double data rate (DDR) memories, as depicted in the image below. In this particular

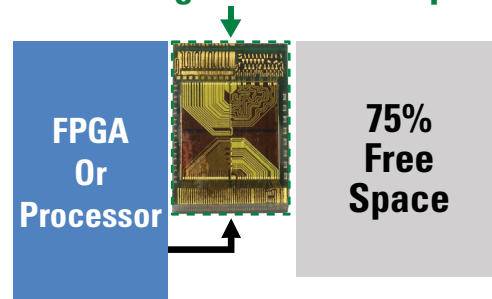
### Conventional 8GB DDR4 Solution

100% of Original DDR4 Footprint



### Mercury 8GB DDR4 Solution

25% of Original DDR4 Footprint



*Mercury Systems is a leading commercial provider of secure processing subsystems designed and made in the USA. Optimized for customer and mission success, Mercury's solutions power a wide variety of critical defense and intelligence programs.*



example, nine discrete DDR4 devices of 1GB capacity each are used to provide a total of 8GB DRAM supporting the application's processing requirements with error correcting code (ECC). The nine devices are equally distributed over the available two-dimensional board area. Mercury Systems stacking technology exploits the unused third dimension by vertically stacking and connecting memory in a low-profile, ruggedized package. By replacing nine individual 1GB DRAM devices with one Mercury memory device, space savings of 75% are achieved in this example, excluding terminations and decoupling. The system designer is now free to use the newly available 75% board space for placement of other components needed to integrate additional sensor subsystems.

Although this example demonstrates the footprint reduction for a DDR4 application, Mercury also offers a wide breadth of high-performance space-saving solutions using other classes of memory. These solutions span from legacy technologies in ceramic packages, such as EEPROM, NOR Flash, and SRAM, through DDR2 and DDR3 to 1.2V DDR4 SDRAM with speeds up to 3200 Mb/s. To meet application-specific requirements, three different grades of memory products are available: Commercial (0°C to +70°C), Industrial (-40°C to +85°C), and Military (-55°C to +125°C) grades. Where critical for performance in the smallest possible footprint, mixed memory and custom memory solutions meeting design-specific requirements are available.

## Designing Security and Trust Into Memory

Semiconductor memory is an important commodity used in the construction of our memory devices. The commercial market has no shortage of suppliers capable of producing commercial-, industrial-, and automotive-grade memory solutions in chip package form. However, the majority of these suppliers manufacture their products outside of the United States. Of particular concern, some are in close proximity to highly unpredictable foreign governments. Although this is of no consequence during extended times of peace, supply chain continuity is far from assured in the event of a military conflict in or around these tumultuous regions.

To provide the highest degree of supply chain continuity, Mercury only sources semiconductor memory from trusted domestic corporations. The same scrutiny is applied to vendors of other materials and components used in the construction of our products. Through judicious selection of supply chain vendors, Mercury builds security and trust into High Density Secure Memory products from the moment components and materials are selected and incorporated into our designs.

Security of commodity components, however, is insufficient to produce a truly secure and trusted product for a defense application. As an additional layer of security, our memory devices are designed and

manufactured in a Defense Microelectronics Activity (DMEA) trusted facility. Our facility also maintains AS9100, ISO 9001, JESTD001, and IPC 610 Class 3 certifications. Mercury's commitment to industrial security excellence is evidenced by our 2016 James S. Cogswell Outstanding Security Achievement Award from the Defense Security Service.

Mercury's memory solutions have been successfully integrated by defense prime contractor partners into many state-of-the-art military programs for more than 30 years. As such, classified data at Mercury's facilities is protected using protocols established by the Department of Defense (DoD) in full isolation from corporate network and systems. Furthermore, Mercury recognizes that its electronic records may be of interest to foreign entities. As such, we maintain and regularly update a vigilant internal cyber security program modeled after the Center for Internet Security (CIS) Critical Security Controls. Mercury is also an active member of the Defense Security Information Exchange (DSIE) and the Advanced Cyber Security Center (ACSC).

All companies take security of physical assets seriously. Mercury goes farther, embedding security and trust into product design, supply chain management, manufacturing, and electronic asset protection.

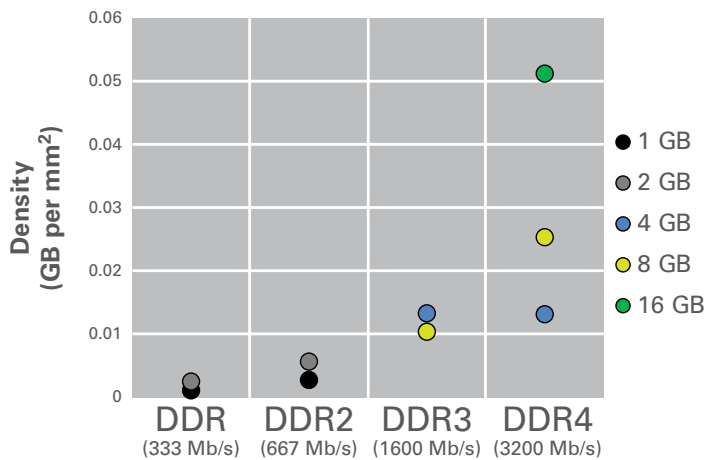
## Additional Benefits of Mercury High Density Secure Memory

Recognizing the challenges faced by system designers today, High Density Secure Memories devices are designed to fit into the tightest of spaces without compromising security or performance standards. Our miniaturization technology offers a variety of other benefits, including:

- 100% burn-in and electrical test for the highest quality assurance
- Military grade product available for the harshest of environmental conditions; Commercial and industrial grade product for less harsh operating environments but facing similar physical space constraints
- Eutectic solder balls, eliminating the possibility of strain-related failures associated with lead-free solder used on commercial memory devices
- Increased solder ball pitch, up to 1.0mm, to enhance second level board reliability compared to commercial devices with reduced pitch no greater than 0.8mm
- Up to 88% component count reduction, simplifying the supply chain while enabling higher manufacturing floor throughput
- Multiple data widths available, including x8, x16, x32, x64, and x72
- Includes address/control terminations and decoupling inside packages of DDR3 and DDR4 devices
- Available component End of Life management to provide long-term supply continuity

## Popular Mercury Systems' High Density Secure Memory

Mercury's most popular memory products are based on DDR memory technologies. With each successive generation of DDR memory, we have continued to refine our miniaturization technology to offer improved densities without compromising data transfer rates.

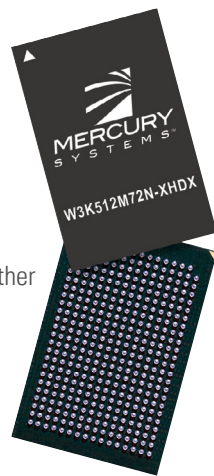


## DDR4 High Density Secure Memory

DDR4 SDRAM technology offers lower power, high-speed performance for the most demanding application requirements. Applying advanced miniaturization technology to DDR4 memory, we deliver space savings up to 87% based on double data width requirements and selected capacity. Other benefits include:

- Standard density and high density space-saving configurations
- Up to 16GB capacity
- Low profile ( $\leq 2.3$  mm)
- 1.2V supply voltage
- 3200 Mb/s data transfer speed
- X8, x16, x32, x64, and x72 data widths available
- PBGA package with 0.8 to 1.0 mm pitch
- Decoupling capacitors included
- Calibration resistors included
- Address/command terminations optional

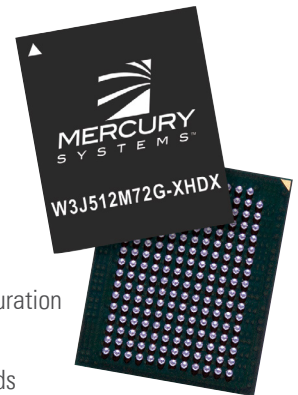
Mercury Systems is currently engaging with customers in design opportunities that require DDR4 performance levels in highly constrained physical environments or harsh operating environments. Specifications are subject to change as designs are finalized through customer engagements. Please contact Mercury Systems to participate in our DDR4 design program.



## DDR3 High Density Secure Memory

Mercury memory products manufactured with DDR3 technology provide a ruggedized memory solution to meet the most common performance requirements in a highly ruggedized, compact form factor. Space savings up to 67% are achieved, based on data width requirements and selected capacity. Other benefits include:

- Standard density and high density space-saving configurations
- Capacities of 1 to 8GB for standard density product
- 4GB capacity for high density configuration
- 1.35V or 1.50V supply voltage
- Up to 1600 Mb/s data transfer speeds
- x32, x64, and x72 data widths available
- PBGA package with up to 1.0 mm pitch
- Decoupling capacitors included
- Calibration resistors included
- Address/command terminations optional



## Other Memory Products

For legacy applications designed prior to DDR3 or DDR4 availability, our product portfolio also includes DDR and DDR2 technologies in capacities ranging from 128MB to 512MB (DDR) or 1GB (DDR2). SDRAM, SRAM, SSRAM, and NOR Flash memories are also available.

For applications requiring a hermetic seal, Mercury offers ceramic packages with SRAM, flash, and EEPROM memories. Please note that SRAM and some ceramic package products are produced off-shore due to extremely limited volumes and the maturity of the technology.

## Custom Capabilities

Though a wide variety of memory products are included in our portfolio, Mercury specializes in the design and fabrication of custom and mixed memory solutions meeting the specific criteria demanded by your application environment. We offer a wide range of custom capabilities to choose from, including:

- Thermal, mechanical, and electrical modeling expertise to optimize package design and performance
- Custom environmental test conditions, including extended temperature qualification
- Design and implementation of software test code
- System in Package (SiP) design and fabrication, achieving highly integrated, compact packages containing of components commonly found on single board computers, including processors and memories
- Secure Boot SiP, authenticating firmware integrity before system boot

- Integration of different interconnection technologies (surface mount, wire bond, and flip chip) in the same package

Contact Mercury Systems to solve your unique system integration challenges with our custom design and fabrication capabilities.

## Longevity of Support to Eliminate Obsolescence Risk

As a high-tech electronics company primarily involved in supplying the defense industry, Mercury is committed to supporting long-term platforms. We also help mitigate concerns around counterfeit electronics in the supply chain.

Although Mercury cannot guarantee indefinite availability of all products, every attempt is made to provide supply continuity until raw materials can no longer be procured. Mercury partners closely with our customers to manage component end of life notifications with last-time buy opportunities.

## Conclusions

Mercury Systems' heritage of innovation has successfully commercialized our miniaturization technology for more than 15 years, enabling more sensor functionality to be incorporated into smaller and more lightweight mission computing subsystems. Integrating security and trust through all facets of our business, Mercury successfully delivers innovations that matter to our highly valued customers. You can learn more at <https://www.mrcy.com/solid-state-drives-storage-memory-sip/memory>.

To review our High Density Secure Memory product portfolio, click on the thumbnail or link below.

[Mercury System Microelectronic Products Quick Reference Guide](#)



Category	Parameter	Mercury 16GB DDR4 Memory Device	16GB DDR4 FBGA (8 x 2GB)	Mercury Advantage
<b>Physical</b>	Area	96	640	85% Reduction
	Part Count	1	8	87% Reduction
	Solder Ball Pitch	1.0 mm	≤0.8 mm	Superior Board-Level Reliability
	Solder Ball Composition	PbSn	SnAgCu	Superior Board-Level Reliability
<b>Performance</b>	Speed	3200 Mb/s	3200 Mb/s	
	Operating Voltage	1.2V	1.2V	
	Error Correcting Code	Available	Available	
	Operating Temperature Range	Military Grade (-55 to +125°C)	Commercial Grade (0 to +95°C)	Wider Temp Range (-55 to +125°C)
<b>Security And Trust</b>	DMEA-certified On-Shore Manufacturing	Yes	No	Manufacturing Continuity
	Trusted Supply Chain	Yes	No	Supply Chain Continuity

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