

Memory Emulation

THE NEED

Because memory devices can be used to hold a wide variety of data (i.e. instruction sets, image data, etc...) they are a key component for embedded systems and legacy stand-alone data storage modules. Memory device types include Static Random-Access Memories (SRAMs), Read-Only Memories (ROMs), Dual-Port RAMs (DPRAMs) and FIFOs (First-In, First-Out).

SRAMs allow access to write or read data at various addresses in a memory array. ROMs also store addressable data; however, the data is non-volatile, non-alterable. ROMs are commonly used for data not meant to be overwritten once the component is placed in the system, such as instruction sets. DPRAMs are similar to SRAMs, except that these devices provide two distinct interfaces for accessing the stored memory.

Thus, two separate components can be reading and writing to the memory array at the same time.

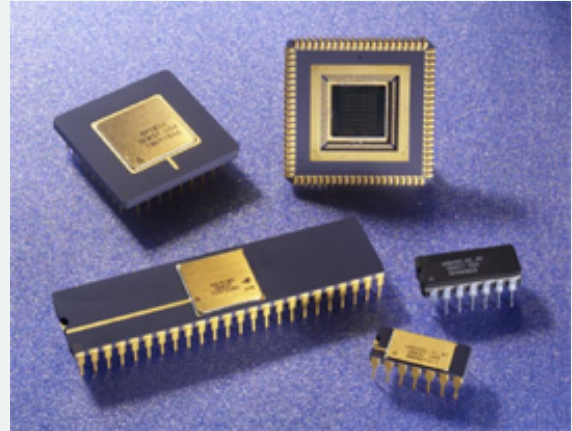
FIFOs are different from the other types of memory components by the read/write method. With only one write port and one read port, each device treats the internal memory array as a stack. The first or oldest entry becomes the "head" of the queue and is processed first, while incoming data is pushed onto the stack and becomes the "tail." FIFOs provide a "full flag" to indicate when the stack cannot allow any more data to be written to it and an "empty flag" signaling that it does not contain any data for reading. These devices are commonly used to provide a buffer (data queue) between two interfaces that may not be operating at the same speed.

Memory devices are available in all different sizes to support storage for various amounts of data. Newer systems require memory devices with the capability to store more data while using lower power supply voltages. Many types of memory devices are no longer in production because of the advancing technological shift in the semiconductor market. The need for a form-fit-function interface (F3I) replacement for obsolete memory devices has thus become necessary to support usage of legacy board designs in the field.

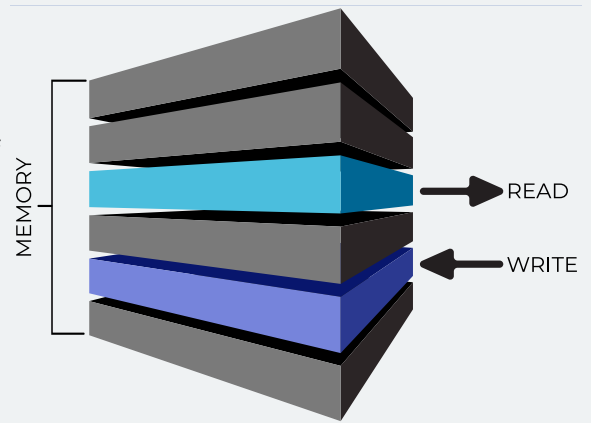
THE EMULATION SOLUTION

The Defense Logistics Agency's (DLA) Generalized Emulation of Microcircuits (GEM) Program currently has several arrays to support the design of various memory components (SRAMs, ROMs and FIFOs). These include an 18Kbit and a 64Kbit RAM array based on a CMOS technology and a 1Kbit and 4Kbit RAM array based on a BiCMOS technology. The metal programmable GEM memory arrays can Emulate Schottky TTL, TTL, NMOS or CMOS memories. The arrays were designed to fit into the same package type as the original part. The determining factors in array selection are the size of the memory, number of I/O's, memory access times and target package (i.e. skinny DIPs). A summary table of the available arrays can be seen below. The depth and width of the memory array can be changed by simply changing the metal programming pattern.

Array	I/O Pads	Max. Depth	Max. Width
1K	26	1.152K x 1	128 x 9
4K	34	4K x 1	256 x 16
18K	39	18K x 1	512 x 36
64K	202	64K x 1	1K x 64



In the case of ROMs, the Emulation solution is to provide a hard-coded ASIC memory with the data needed in the specific application. ROMs require data to be retained permanently. The customer provided ROM data is used to create a wafer fab mask. The mask is used during the wafer manufacturing with one of the RAM arrays. When programming a memory array as a ROM, the memory storage capability is double that of the normal RAM configuration. Each memory cell primitive can be programmed with two bits of ROM data so the 4K RAM memory array can store 8 Kbit of ROM data.



Depending on size and complexity FIFO memories are Emulated using CMOS and BiCMOS gate arrays. As the FIFO and speed increased over the years, industry changed from a latch based design to a memory based design. The memory based design require a dual port SRAM so a read and write function could be performed at the same time. The DLA Advanced Microcircuit Emulation (AME) Program is currently developing a new Dual port memory array to support both dual port RAMs and FIFOs that require up to 32 KB of memory. For complex design implementations, the Emulation programs can target other arrays to provide necessary embedded storage. This solution was utilized to successfully Emulate a MIL-STD-1750A-compliant microprocessor (MDC281) that contained a 84 Kbit ROM and 256 bit RAM along with substantial logic macroblocks to meet the target specification requirements.

BENEFITS

The memory device Emulation solution provides a permanent source for Form-Fit-Function-Interface (F3I) memory components for use in Military systems. Microcircuit Emulation is a cost-effective, long-term solution that provides total life cycle support for weapons systems, averting mission-impaired-capability-awaiting-parts (MICAP) incidence, production shutdowns, and maintaining weapon system readiness levels.

The background features a stylized circuit board pattern with various traces and nodes. In the center, there is a large, light-grey circular area containing text. In the bottom right corner of this area, there is a QR code.

Our Story

In the late 1980's, DLA recognized that microcircuit obsolescence threatened the readiness of many American defense systems. Numerous systems in the armed forces were designed and developed in the 1960's and 1970's. For example, the U.S. Air Force began flying the F-15 Eagle tactical fighter in 1972, and the U.S. Navy first tested the Aegis phased-array radar at sea in 1973. Because of continued advancements in semiconductor technology, the original suppliers stopped manufacturing the microelectronic components used in these and other systems. In 1987, DLA contracted with SRI to begin research and development on how to best replace obsolete microcircuits with standardized, modern integrated circuits (IC). DLA and SRI collaborated to develop the GEM Program. Using its on-site Trusted semiconductor foundry and deep knowledge of IC design/development, SRI produces on-demand, Class Q microcircuits matching the Form-Fit-Function-Interface (F3I) criteria of the required microcircuit. DLA is developing the next generation of F3I microcircuit Emulation capability through the AME Program to further alleviate growing IC obsolescence issues caused by the continued rapid advancements in technology. The new capabilities developed by AME are utilized by the GEM Program to ensure the Emulation Programs continue to meet weapons systems wide-ranging requirements. SRI's semiconductor foundry is accredited as a Department of Defense (DoD) Trusted Foundry supplier, and our manufacturing processes are qualified to MIL-PRF-38535.

