



DEFENSE LOGISTICS AGENCY
GEM & AME PROGRAMS

EMULATION OVERVIEW

Permanent Solution | Military Quality | On-Demand | Low Volume | USA Made



Solving Your Microcircuit Obsolescence Issues Through

Generalized Emulation of Microcircuits (GEM)
Advanced Microcircuit Emulation (AME)

Microcircuit Emulation Center
PRINCETON, NEW JERSEY

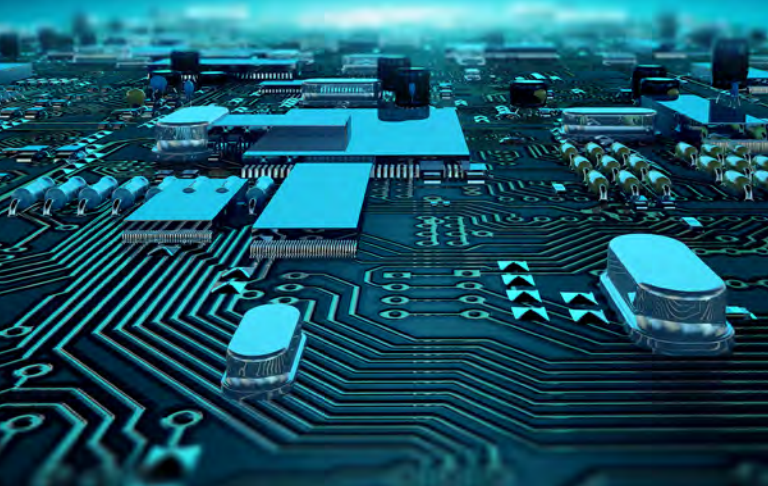
EMULATION OVERVIEW



The Defense Logistics Agency's Generalized Emulation of Microcircuits (GEM) and Advanced Microcircuit Emulation (AME) Programs provides a continuing source of Form, Fit, Function, and Interface replacements for non-procurable microcircuits. The programs deliver a permanent solution to mitigate microcircuit obsolescence and can be utilized during any phase of a weapon system life cycle.

The MEC Mission

To Maintain and Consistently Develop Microcircuit
Manufacturing Capability for the Defense
Logistics Agency and its DMSMS Customer Base to
Mitigate Obsolescence and Support U.S. Military
Weapons Systems and Readiness



Emulation Overview

*Solving Your Microcircuit
Obsolescence Issues Through...*

GEM
Generalized
Emulation of
Microcircuits

&

AME
Advanced
Microcircuit
Emulation

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Emulation Overview

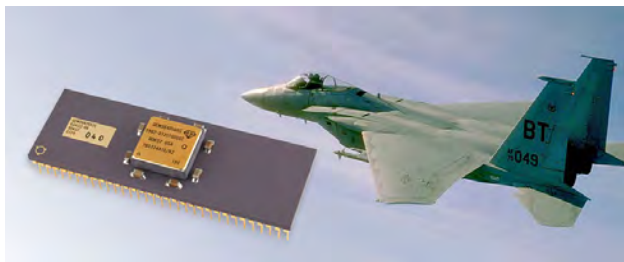
The DLA Generalized Emulation of Microcircuits (GEM) and Advanced Microcircuit Emulation (AME) programs offer a flexible technology that can be utilized during any phase of a weapon system life cycle. The programs deliver a permanent solution to mitigate microcircuit obsolescence at the component or board level while reducing total ownership cost and maintaining readiness levels.

In the late 1980s, 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 1960s and 1970s. 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,

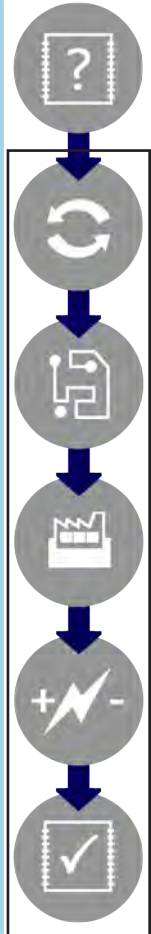
the Microcircuit Emulation Center in Princeton, NJ produces on-demand, Class Q microcircuits matching the Form- Fit- Function- Interface (F3I) criteria of the required microcircuit. DLA is developing the next generation of F3I microcircuit Emulation capability through the AME Program to further alleviate 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. The semiconductor foundry is accredited as a Department of War (DOW) Trusted Foundry supplier, and our manufacturing processes are qualified to MIL-PRF-38535.

Our foundry provides a stable manufacturing source for over 30,000 part numbers. GEM microcircuits currently support more than 560 unique weapon systems including the F-15, F-22, Aegis, Phalanx, and Bradley Fighting Vehicle.



Supplier of Last Resort

As a Government funded program, GEM does not compete with any other accepted source(s). In 1997, DLA entered into an agreement with the Semiconductor Industry Association (SIA) to ensure the GEM Program was not Emulating circuit designs still supported by the IC industry. To comply with this agreement, all RFQ responses are routed through the DLA Weapons Support GEM Program office that makes every attempt to locate an alternative source. Only when no acceptable sources can be found, will DLA authorize the GEM Emulation proposal on behalf of the GEM Program. The GEM Program is the “supplier of last resort.”



Microcircuit Emulation Process

UNAVAILABLE MICROCIRCUIT



When a request for an obsolete microcircuit is received, the GEM program begins its unique Emulation process to manufacture a Form, Fit, Function, and Interface (F3I) compliant microcircuit. Our on-demand manufacturing process significantly reduces the time to deliver a part.

REVERSE ENGINEERING



We utilize the customer's procurement specification(s), and relevant documentation such as catalog datasheets, original component manufacturer application notes, next higher assembly maintenance manuals, etc. to resolve any ambiguities or omissions in the procurement documentation. An Emulation design specification is created using this documentation augmented by electrical characterization of known, good samples of the obsolete microcircuit and physical reverse engineering processes.

EMULATION CIRCUIT DESIGN



Our in-house design center uses a suite of modern CAD tools covering all aspects of chip integration and reliability. Working closely with our co-located Trusted foundry and advanced

TCAD tools to model and characterize the fabrication process to meet our customers' requirements. Our digital and analog design capabilities cover a range of technologies (CMOS, BiCMOS, Bipolar, etc...) and feature sizes (3.0 μm and below.)

TRUSTED FOUNDRY FABRICATION



DIFFUSION:

LPCVD
 Si_3N_4 , TEOS, Poly
Wet/Dry/RH
Oxides



DEPOSITION:

Pt, Ti, TiN, AlCu
Gap Fill SiO_2 , Si_3N_4
BPSG, PSG, BSG



PHOTOLITHOGRAPHY:

DUV Stepper
I-Line Stepper



IMPLANT:

B, BF_2 , P, As
(20-200KV)



ETCH:

Dry & Wet
Metal, Poly, Oxide
Silicon, Nitride,
Trench



METROLOGY:

Wafer Inspection
Defect Analysis
Yield Improvement

The Microcircuit Emulation Center Wafer Trusted foundry occupies 25,000 square feet at the Princeton, NJ location. The Wafer Fab has ISO 4 (Class 10) and ISO 5 (Class 100) cleanrooms. The facility uses the MESA WIP tracking system which enables real time wafer lot tracking and historical record retrieval. Statistical Process Control is implemented in all process areas. Fully documented procedures and training records are the basis of audited certifications for all staff. We maintain all process equipment with vendor trained staff and service contracts where appropriate.

ELECTRICAL TEST (QML TEST AND SCREENING)



We maintain in-house capability to perform the qualification, screening, and inspection tests for quality level B and Q microcircuits. High performance Automated Test Equipment (ATE) supports parametric and functional testing over the military temp range for both wafers and packaged parts. All GEM devices are fully screened and QC inspected in accordance with MIL-PRF-38535.

Moisture Resistance	1004	Lead Integrity	2004
Steady State Life Test	1005	Vibration, Variable Freq.	2007
Salt Atmosphere	1009	External Visual	2009
Temperature Cycling	1010	Resistance to Solvents	2015
Thermal Shock	1011	Physical Dimensions	2016
Fine and Gross Seal	1014	Lid Torque	2024
Burn in	1015	Adhesion, Lead Finish	2025
Constant Acceleration	2001	Resistance Solder Heat	2036(B)
Mechanical Shock	2002	ESDS Classification	3015
Solderability	2003	Electrical Test	Device Spec.

AVAILABLE PART

Emulated parts are fully traceable and delivered with a certificate of conformance in compliance to customer procurement requirements. Emulation technology can be applied beyond individual component Emulation, to replace multiple microcircuits with a single device or redefine the function and capabilities of an existing board.

Parts Emulation Overview

The technologies offered by the Emulation Programs have been expanded over time. The initial focus was TTL (Transistor Transistor Logic) 5-Volt logic families and ECL (Emitter Coupled Logic) devices. Over time new arrays were developed to emulate higher speed and lower power variations of these families. Technologies were also developed to emulate CMOS logic devices with power supplies up to 20-Volts. Smaller node sizes were implemented to emulate more complex ASIC and programmable logic arrays and memory devices.

The current technologies can support emulations of user or field programmable devices. Programmable logic or memory devices are emulated using the metal personalization mask during the wafer fabrication. The devices are permanently programmed and verified to be the functional equivalent of the original programmed device.

PARTS DESCRIPTIONS

The following tables provide a broad representation of generic groups of microcircuits which the existing technologies can emulate. All emulated microcircuits are designed, manufactured, and tested according to the customer's procurement specification.

These specifications can be a Standard Military Drawing or any type of drawing describing the electrical, physical, and testing requirements. All parts are marked in accordance with MIL-PRF-38535 with a GEM part number, specified part number, including cage code “ODKS7”, and manufacturing code for traceability.

The part numbers listed in the following section represent a small sample of the more than 30,000 possible part emulations. It is likely a GEM part or one that is very similar is available. In cases where a new emulation is required using an existing technology a quote for development costs, lead time, and unit prices can be provided. The current GEM Parts List can be found at <https://games.com/parts/>.

Contact us for your free quote.





5 Volt TTL Logic Families:

Several generations of 5 Volt TTL logic families have been developed from various manufacturers. These families are continuous improvements of speed and power dissipation. Within each series many logic functions are available. In many cases the same logic function is available in several TTL device families. The GEM technologies have the capability to emulate all the TTL families listed in the following tables.



FAMILY	Generic No. Series	DESCRIPTION
TTL	5400	Original Series
TTL-L	54L00	Low Power Series
TTL-H	54H00	High Speed Series
TTL-S	54S00	Schottky High Speed
TTL-LS	54LS00	Low Power Schottky High Speed
TTL-ALS	54ALS00	Advanced Low Power Schottky High Speed
TTL-AS	54AS00	Advanced Schottky High Speed
TTL-F	54F00	FAST Series High Speed

The table below is a representative of examples of generic TTL family part numbers which can be emulated, organized by function.

Generic Part No.	Function	Generic Part No.	Function
9304	Adder	5233	Arithmetic Logic
5480	Adder	9440	Arithmetic Logic
5483	Adder	54F382	Arithmetic Logic
54283	Adder	54LS381	Arithmetic Logic
5482	Adder	25LS2517	Arithmetic Logic
54HC283	Adder	25LS381	Arithmetic Logic
HCS283	Adder	54LS382	Arithmetic Logic
54HCT283	Adder	54LS181	Arithmetic Logic
HCTS283	Adder	2904	Arithmetic Logic
54LS183	Adder	54S381	Arithmetic Logic
54LS83A	Adder	8830	Buffer Driver
54LS83	Adder	54365A	Buffer Driver
54LS283	Adder	54366A	Buffer Driver
54181	Arithmetic Logic	54367A	Buffer Driver

Generic Part No.	Function	Generic Part No.	Function
5416	Buffer Driver	54177	Counter
54LS40	Buffer Driver	54193	Counter
54LS240	Buffer Driver	54L93	Counter
54ALS541	Buffer Driver	54LS197	Counter
54ALS1010A	Buffer Driver	54LS461	Counter
54ALS1011	Buffer Driver	54LS491	Counter
5485	Comparator	54LS161A	Counter
9324	Comparator	54S197	Counter
7160	Comparator	9309	Data Sel/ Multiplexer
7200	Comparator	9312	Data Sel/ Multiplexer
93L24	Comparator	93L22	Data Sel/ Multiplexer
54HC688	Comparator	54L157	Data Sel/ Multiplexer
HCTS85	Comparator	7123	Data Sel/ Multiplexer
54HCT688	Comparator	54LS253	Data Sel/ Multiplexer
54HCT85	Comparator	54LS353	Data Sel/ Multiplexer
54HC85	Comparator	54LS257B	Data Sel/ Multiplexer
54HC688	Comparator	25LS157	Data Sel/ Multiplexer
54LS682	Comparator	54ALS151	Data Sel/ Multiplexer
54LS684	Comparator	54LS137	Data Sel/ Multiplexer
54ALS688	Comparator		
54LS686	Comparator		
54LS688	Comparator		
54LS682	Comparator		
54S85	Comparator		
93L16	Counter		
9310	Counter		

Generic Part No.	Function
54LS138	Data Sel/ Multiplexer
54ALS137A	Data Sel/ Multiplexer
54LS156	Data Sel/ Multiplexer
54LS248	Data Sel/ Multiplexer
54S139	Data Sel/ Multiplexer
5492	Divider
54649	Flip- Flop
5470	Flip- Flop
54H101	Flip- Flop
54175	Flip- Flop
54L78	Flip- Flop
54F803	Flip- Flop
54L20	Gate
54H04	Gate
54L86	Gate
54LS22	Gate
54LS266	Gate
54LS132	Gate
54L51	Gate
54132	Gate
54F260	Gate
54F27	Gate
8815A	Gate

Generic Part No.	Function
5454	Gate
8875A	Gate
9004	Gate
6512	Gate
8815A	Gate
54LS136	Gate
54LS00	Gate
54ALS00A	Gate
54ALS133	Gate
54LS51	Gate
54LS136	Gate
54S86	Gate
54S00	Gate
54L75	Latch
9308	Latch
9314	Latch
5475	Latch
54ALS996	Latch
54LS375	Latch
54ALS563B	Latch
54ALS29842	Latch
54ALS29843	Latch
54194	Register
54L95	Register
54LS502	Register
54LS673	Register
54S818	Register

15 Volt and 20 Volt CMOS Logic Families:

FAMILY	Generic No. Series	DESCRIPTION
CMOS 15 V	CD4000A	3 V - 15 V Power Supply
CMOS 20 V	CD4000B	3 V - 20 V Power Supply
CMOS 12 V and 15 V	300ML	Bipolar interface logic gates

The table below contains representative examples of generic high voltage CMOS family part numbers which can be emulated, organized by function.

Generic Part No.	Function
4008A	Adder
4008B	Adder
40181B	Arithmetic Logic
4009UB	Buffer Driver
4049A	Buffer Driver
4050A	Buffer Driver
4050B	Buffer Driver
301ML902	Buffer Driver
4063B	Comparator
4585B	Comparator
4020B	Counter
40102B	Counter
40103B	Counter
372ML902	Counter
4022B	Counter

Generic Part No.	Function
4017	Counter
4056B	Data Sel/ Multiplexer
4512B	Data Sel/ Multiplexer
381ML602	Demultiplexer
4018B	Divider
4022B	Divider
4033B	Divider
40174B	Flip- Flop
4095B	Flip- Flop
4096B	Flip- Flop
312ML902	Flip- Flop
4034B	Latch
4042B	Latch
4044B	Latch

Generic Part No.	Function	Generic Part No.	Function
4000A	Gate	302ML902	Gate
4000B	Gate	325ML902	Gate
4019A	Gate	326ML902	Gate
HCTS4002	Gate	333ML902	Gate
4048A	Gate	332ML902	Gate
4019B	Gate	322ML902	Gate
4069UB	Gate	342ML902	Multi vibrator
4011B	Gate		
4001B	Gate	40194B	Register
4077B	Gate	40208B	Register
4030A	Gate	40100B	Register
4086	Gate	40104B	Register

5 Volt CMOS Logic Families:

A newer generation of logic devices were manufactured using an advanced version of CMOS technology. These devices exhibited speed performance comparable to TTL family equivalent devices but with a lower power dissipation. Many of the devices were available in CMOS versions of the TTL logic families. GEM technologies have capability to emulate all the families listed in the table below.

FAMILY	Generic No. Series	DESCRIPTION
CMOS-FCT	54FCT00	Fast CMOS Technology
CMOS-ACT	54ACT00	Advanced CMOS TTL Compatible
CMOS-HCT	54HCT00	High Speed CMOS TTL Compatible

The table below is representative of generic high 5 Volt CMOS family part numbers which can be emulated, organized by function.

Generic Part No.	Function	Generic Part No.	Function
54HCT283	Adder	54HCT4017	Divider
HCTS283	Adder	54HCT107	Flip-Flop
49FCT805A	Buffer Driver	54HCT174	Flip-Flop
54FCT241	Buffer Driver	54ACT74	Flip-Flop
54ACT240	Buffer Driver	54HCT14	Gate
54HCT126	Buffer Driver	54HCT32	Gate
54HCT244	Buffer Driver	54HCT04	Gate
54HCT541	Buffer Driver	54HCT03	Gate
54FCT521A	Comparator	54HCT10	Gate
54HCT688	Comparator	54HCT11	Gate
54HCT160	Counter	54HCT27	Gate
54FCT191	Counter	54HCT08	Gate
54FCT193	Counter	54HCT86	Gate
54FCT151T	Data Sel/ Multiplexer	HCTS132	Gate
54HCT157	Data Sel/ Multiplexer	54FCT843A	Latch
54HCT251	Data Sel/ Multiplexer	54FCT299	Register
54FCT257AT	Data Sel/ Multiplexer	54HCT165	Register
		54FCT646T	Register
		54FCT823A	Register

ECL Logic Families:

One of the technologies developed to produce the smallest propagation delay in bipolar logic families was ECL (Emitter Coupled Logic). This technology relied on small signal swings using a different circuit structure compared to TTL logic families. GEM technologies have the capability to emulate members of the ECL logic families listed below.

FAMILY	Generic No. Series	DESCRIPTION
ECL	10000	ECL 10K Series
ECL	10H000	ECL 10H Series

The table below contains examples of generic ECL family part numbers which can be emulated, organized by function.

Generic Part No.	Function	Generic Part No.	Function	Generic Part No.	Function
10578	Counter	10535	Flip-Flop	10521	Gate
10538	Counter	10H586	Flip-Flop	10515	Line Receiver
10558	Data Sel/ Multiplexer	10H416	Flip-Flop	10516	Line Receiver
10564	Data Sel/ Multiplexer	10597	Gate	10524	Line Receiver
10561	Demultiplexer	10507	Gate	10525	Line Receiver
10531	Flip-Flop	10502	Gate	10H524	Line Receiver
10576	Flip-Flop	10501	Gate	10H525	Line Receiver
10586	Flip-Flop	10509	Gate	10598	Multivibrator
		10505	Gate	10541	Register

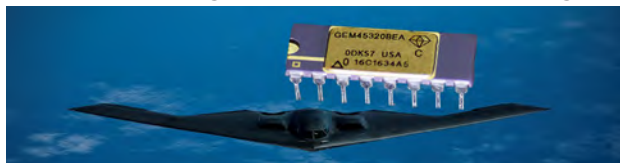
Memory Devices:

Memory devices can be used to hold a wide variety of data and 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). The GEM technologies have the capability to emulate a wide range of memory devices. Below is the list of currently available GEM emulation capabilities.

Device Type	Generic Part No.	DESCRIPTION
RAM	10513	64-bit organized as 16 X 4
RAM	2112	256-bit organized as 32 X 8
RAM	82S10	1024-bit organized as 1024 X 1
RAM	2114	1024-bit organized as 256 X 4
RAM	CY7C147	4096-bit organized as 4096 X 1
RAM	HM-6514	4096-bit organized as 1024 X 4
RAM	2167	16386-bit organized as 16384 X 1
ROM	2332	32768-bit organized as 4096 X 6
ROM	2364	65536-bit organized as 8192 X 8
Dual port RAM	CYC7132	16386-bit organized as 2048 X 8
FIFO	IDT7202	9216-bit organized as 1024 X 9

Programmable Logic Devices:

Programmable Logic Devices (PLDs) are a popular design solution due to their flexibility and cost. PLDs are manufactured as blank uncommitted microcircuits. The functionality is programmed by the user by various means. Programming can be OTP (One Time Programmable), later generations PLDs could be programmed and erased. The devices can be erased by UV light or electrically (EE). Examples of PLDs are Programmable Array Logic (PALs), Generic Array Logic (GALs), and Field Programmable Gate Arrays (FPGAs). A GEM microcircuit has the capability of emulating multiple types of programmable logic devices. The functionality of the digital logic is a hard-coded personalization in the gate array during the wafer manufacturing process. The emulation is an Application Specific Integrated Circuit (ASIC) implementation of the original programmed device. The table below is a partial list of PLDs which can be emulated using available GEM technologies.





Device Type	Generic Part No.	DESCRIPTION
PAL OTP	PAL22V10	Ten 12-wide AND-OR/AND-OR-INVERT
PAL EE	PAL-CE22V10	Ten 12-wide AND-OR/AND-OR-INVERT
PAL OTP	PAL16	16 inputs and 4, 6, or 8 outputs registered or latched
PAL OTP	PAL18	18 inputs and 4, 6, or 8 outputs registered or latched
PAL OTP	PAL20	20 inputs and 4, 6, or 8 outputs registered or latched
PAL OTP	EP310	Up to 18 inputs and 8 outputs
PAL OTP	EP1800	Configurable up to 64 inputs or 48 outputs
PAL UV	EP1810	Configurable up to 64 inputs or 48 outputs
FPGA	XC2000	Up to 1,500 logic gates available
FPGA	XC3000	Up to 7,500 logic gates available
FPGA	XC4000	Up to 62,000 logic gates available

Programmable Memory Devices

The evolution of the programmable memory device has followed a similar path as PLDs. The uncommitted blank memory devices used similar fuse and electrical programming technology to create non-volatile storage. Examples of these memory devices are Programmable Read Only Memory (PROMs), Erasable Programmable Read Only Memory (EPROMs), and Electrically Erasable Read Only Memory (EEPROM). The memory data is permanently stored using the personalization layers during the wafer manufacturing process. The table below is a partial list of programmable memories which can be emulated using available GEM technologies.

Device Type	Generic Part No.	DESCRIPTION
PROM OTP	27S18	256-bit organized as 32 X 8
PROM OTP	27S20	1024-bit organized as 256 X 4
PROM OTP	27S12	2048-bit organized as 512 X 4
PROM OTP	27S32	4096-bit organized as 1024 X 4
PROM OTP	27S180	8182-bit organized as 2048 X 4
PROM UV	2708	8192-bit organized as 1024 X 8
PROM UV	2716	16384-bit organized as 2048 X 8
PROM UV	2732	32768-bit organized as 4096 X 8
PROM UV	2764	75536-bit organized as 8192 X 8

Microprocessors and Peripherals:

Microprocessors are general purpose devices which perform sequences of built-in logic operations such as addition, subtraction, and Boolean operations. Integrated microcontrollers combine a microprocessor function together with memory and specialized interface devices to create a stand-alone computing element that can be used for customized computer control. Specialized controllers are typically utilized to provide specialized interfaces or control capability to a microprocessor system. The table below is partial list of these types of devices which are currently available or can be emulated using available GEM technologies.

Device Type	Generic Part No.	DESCRIPTION
Microprocessor Slice	2901	4-bit slice architecture
Microprocessor Slice	2903	4-bit slice architecture with extended instruction set
Microprocessor Slice	49C403	16-bit slice architecture
Microprocessor	1750	16-bit MIL-STD-1750 microprocessor
Bus Arbiter	82C89	8-bit arbiter with dual clock domains

Clock Generators and Timers:

System level hardware designs require timing circuits to clock the flow of data. The edges of these clocks need to be precise and minimum skews. Microcircuits have been developed specifically to fill this need. These devices can be configured to provide the required timing requirements. The table below has list of GEM emulations for these types of microcircuits.

Device Type	Generic Part No.	DESCRIPTION
Clock Buffer	CY7B992	Programmable skew clock buffer and generator
Phase-Locked Loop	CD4046A	CMOS Micropower Phase-Locked Loop
Timer	555	Precision Timer



Analog Microcircuits:

The current GEM technology has the capability to emulate operational amplifiers (Op Amp) and similar devices up to an absolute power supply of 20 Volts. The AME program is developing a technology which will increase the absolute power supply to 40 Volts. Additional analog microcircuits are planned as additional technologies are developed. The current GEM technology has the capability to emulate the devices listed on the table below.

Device Type	Generic Family	DESCRIPTION
Comparator	LM760	Differential Voltage Comparator, Differential Output
Differential Amplifier	CA3000	DC Amplifier
Op Amp	CA3130	BiMOS Operational Amplifier
Op Amp	CLC501	High-Speed Output Clamping Op Amp
Signal Conditioner	5521	LVDT Signal Conditioner

The Emulation programs are unique, once a part has been Emulated it will always be available. The GEM program will never discontinue a part.

Analog Emulation Development

Analog Need

The industry solutions for microcircuit obsolescence have mainly focused on digital components rather than analog. The priority to address digital logic obsolescence was based on the Diminishing Manufacturing Sources and Material Shortages (DMSMS) in the market. However, analog or linear components started to follow the digital obsolescence trend, and are now becoming exceedingly difficult to source, representing a higher risk for systems readiness. To address this industrial base shortfall, meet weapon-system requirements, and satisfy DLA's wide-ranging needs, a cost-effective, reliable source for analog or linear microcircuits is being implemented with DLA's Emulation programs.



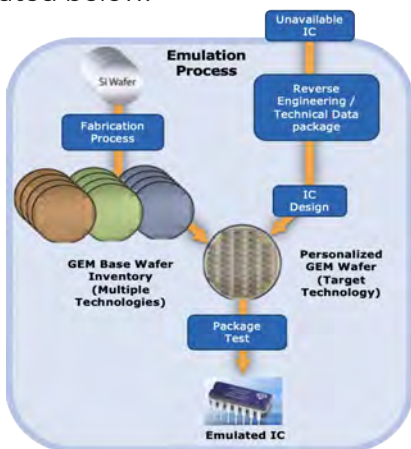
Emulation Analog Approach

The AME program is currently developing BiCMOS arrays on Silicon on Insulator (SOI) wafers, optimized for op amps (operational amplifiers) and other analog functions. The Op Amp is one of the most common linear circuit building blocks in analog electronics. A BiCMOS process was selected as it combines both bipolar and CMOS technologies on the same component. The dual technology has the advantage of the inherent benefits of each technology and offers the greatest flexibility to meet the electrical requirements of many different Op Amp microcircuits. The first 20 V analog base array is currently in production, and the 40 V array is in development. To establish additional solutions, the AME program is evaluating new technology extensions to satisfy higher absolute supply voltages and more complex analog functions.



Emulation Gate Array Process

We developed a split manufacturing process, in which wafer lots are processed through the majority of the manufacturing flow and held in inventory. This technology is based on gate arrays fabricated with predefined circuit elements (base wafers) which are interconnected by multiple levels of metal conductors (wafer personalization) and minimizes the wafer production time for emulated devices. This approach allows Integrated Circuits (ICs) that were originally manufactured in diverse technologies to be produced from a managed inventory of standardized base wafers. An overview of the Production System for emulating microcircuits is illustrated below.

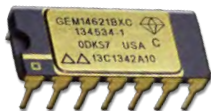


Why is Obsolescence a Problem?

Early U.S. defense requirements were the driving force in the semiconductor industry and weapon systems were designed and manufactured using state-of-the-art microcircuits. These microcircuits were made to a strict set of military specifications designed to last for decades. As the consumer electronics industry has grown during the last quarter-century, the defense sector has been eclipsed and now accounts for less than 2% of the semiconductor market. The rapid changes in technology development, in accordance with Moore's Law, has resulted in shorter microcircuit life cycles that are not compatible with the extended life cycle of Military systems. Defense microcircuit demand is neither a priority nor profitable to the global semiconductor industry given the low-volume and high-reliability requirements.

This change in focus, the long lifetime requirements of military hardware, the increased pace of developments, and foreign manufacturing outsourcing has meant defense systems are prone to microcircuit part obsolescence and counterfeits. Defense system lifetimes are often extended, and if a single microcircuit is no longer available, it can render a complete weapon system useless. This microcircuit obsolescence problem puts these systems and the warfighter at significant risk.

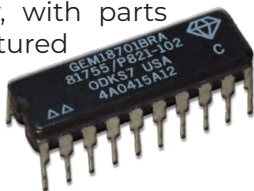
Counterfeit Prevention



Counterfeit microcircuits are an ever-increasing threat to complex weapon systems. When microcircuits are no longer available from

the original manufacturer, or its authorized distributors, parts may only be available on the gray market. At this point the supply chain is susceptible to the insertion of counterfeit parts with limited part provenance. Counterfeits can include unauthorized copies, upscaled (misrepresented), and recycled (used) parts.

As a fully integrated component manufacturer with in-house design, layout, wafer fabrication, electrical and reliability testing, the GEM program is a long-term source for military grade microcircuits, including over 1,000 standard military drawing part numbers. Using the Emulation programs avoids purchasing microcircuits on the gray market and eliminates the threat of counterfeit parts. The Emulation programs offer an on-demand manufacturing capability, with parts designed and manufactured on-shore in a Category 1A Trusted Foundry. All parts are designed and manufactured to



the customer's procurement specification, such as a Source Control Drawings (SCD), or Military Specifications (Standard Military Drawing or slash sheet), in a Trusted, DLA QML-Q accredited facility. This guarantees full traceability through the entire life of the part.

The GEM Program accounts for every microcircuit it manufactures and sells. Every GEM part order delivery is accompanied by a Certificate of Conformance. GEM parts may only be used by the U.S. military system(s) identified at the time purchase order acceptance. Use in any other system is not allowed unless approved by DLA. GEM parts are available through the GEM Program or DLA. For any sales through a third-party distributor the end user must be identified and approved by DLA and all parts must be delivered to the end customer. All parts sales are approved by DLA.



Emulation Delivery Time

The GEM Program designs and manufactures emulated devices on demand. The lead time to deliver emulations of MIL-PRF-38535 Class Q logic family type devices is typically 34 - 48 weeks after order acceptance. Lead times for emulations of memory devices, programmable logic arrays, and ASICs can be more than 52 weeks. If inventory is available of an existing GEM Emulation the delivery time is two to six weeks.

Technologies

The GEM Program employs a gate array architecture fabricated with several process technologies and node sizes. This supports the emulation of multiple generations of logic families, memory devices, and more complex ASICs. Device pin counts can be as high as 512 with power supply voltages of 3.3 V – 20 V.

Technologies Table ○ Available ● In Development							
Node (μm)	3.0	1.5	1.2	0.8	0.5	0.35	0.25
CMOS	○	○	○	○	○	○	●
BiCMOS		○	○				
Bipolar				○			
HVCMOS	○	○					
Radiation Tested	○	○	○	○			
Analog SOI HV BiCMOS	●						

The AME program is developing capabilities to emulate high voltage 40 V Analog microcircuits covering legacy Operational Amplifiers. In addition, research is ongoing to establish manufacturing capabilities for ceramic packages using Additive Manufacturing.

Programs we Support

The semiconductor foundry provides a stable manufacturing source for over 30,000 part numbers, which are listed on our GEM website <https://games.com/parts/>. The Emulation Production Program has designed, produced, and delivered class Q microcircuits to DOW weapon systems contractors and to the general defense community. The Program currently has over 1,000 parts listed on the DLA QML-38535. Over 170,000 microcircuits have been delivered for the production and sustainment of DOW systems. GEM microcircuits have supported 562 unique weapon systems.

562 Total Weapon Systems

126 Air Force Weapon Systems

71 Army Weapon Systems

63 Marine Corps Weapon Systems

302 Navy Weapon Systems

Maintaining System Readiness

The SMD P/N – 5962-9052201PA is an example of one single Emulated GEM part that is being utilized by multiple weapon systems.



Certifications

The Emulation Programs are recognized for outstanding quality and operational performance by Government Agencies and leading manufacturers in our industry. The Emulation Programs also address Microcircuit fabrication security concerns. In 2007, the DOW accredited the wafer foundry as a

Department of War (DOW) Category 1A Trusted Foundry. With this endorsement, the programs are able to offer the DOW and Government agencies a secure on-shore, QML-certified wafer foundry for military electronics. The Microcircuit Emulation Center is a certified Defense Logistics Agency Qualified Manufacturers List (QML) for MIL-PRF-38535.



Appendix 1: GEM SMD MIL-PRF-38535 Parts

MIL SMD P/N	GEM P/N	MIL SMD P/N	GEM P/N
5962-0050701QEA	GEM22101QEA	5962-8671501EC	GEM12001QEC
5962-0050701QEC	GEM22101QEC	5962-8671501FA	GEM12001QFA
5962-0150701Q2A	GEM31701Q2A	5962-8671501FC	GEM12001QFC
5962-0150701Q2C	GEM31701Q2C	5962-86723012A	GEM07501Q2A
5962-0150701QEA	GEM31701QEA	5962-86723012C	GEM07501Q2C
5962-0150701QEC	GEM31701QEC	5962-8672301RA	GEM07501QRA
5962-0721701QXA	GEM36401QXA	5962-8672301RC	GEM07501QRC
5962-0721701QXC	GEM36401QXC	5962-86723022A	GEM13302B2A
5962-0922201QEA	GEM40301QEA	5962-86723022C	GEM13302B2C
5962-8550102CA	GEM39202QCA	5962-8672302RA	GEM13302BRA
5962-8550102CC	GEM39202QCC	5962-8672302RC	GEM13302BRC
5962-86702012A	GEM07301Q2A	5962-8672601EA	GEM09301EA
5962-86702012C	GEM07301Q2C	5962-8672601EC	GEM09301EC
5962-8670201RA	GEM07301QRA	5962-8672601FA	GEM09301FA
5962-8670201RC	GEM07301QRC	5962-86881012A	GEM10801Q2A
5962-8670201SA	GEM07301QSA	5962-86881012C	GEM10801Q2C
5962-8670201SC	GEM07301QSC	5962-8688101RA	GEM10801QRA
5962-8671001RA	GEM48001QRA	5962-8688101RC	GEM10801QRC
5962-86713012A	GEM12401B2A	5962-8688101SA	GEM10801QSA
5962-86713012C	GEM12401B2C	5962-8688101SC	GEM10801QSC
5962-8671301RA	GEM12401BRA	5962-86890012A	GEM06301Q2A
5962-8671301RC	GEM12401BRC	5962-86890012C	GEM06301Q2C
5962-8671301SA	GEM12401BSA	5962-8689001CA	GEM06301QCA
5962-8671301SC	GEM12401BSC	5962-8689001CC	GEM06301QCC
5962-86715012A	GEM12001Q2A	5962-8689001DA	GEM06301QDA
5962-86715012C	GEM12001Q2C	5962-8689001DC	GEM06301QDC
5962-8671501EA	GEM12001QEA	5962-87522012A	GEM41201Q2A

MIL SMD P/N	GEM P/N
5962-87522012C	GEM41201Q2C
5962-8752201CA	GEM41201QCA
5962-8752201CC	GEM41201QCC
5962-8752201XA	GEM41201QXA
5962-8752201XC	GEM41201QXC
5962-87534012A	GEM19501Q2A
5962-87534012C	GEM19501Q2C
5962-8753401EA	GEM19501QEA
5962-8753401EC	GEM19501QEC
5962-8753401FA	GEM19501QFA
5962-8753401FC	GEM19501QFC
5962-87542012A	GEM02901B2A
5962-87542012C	GEM02901B2C
5962-8754201RA	GEM02901BRA
5962-8754201RC	GEM02901BRC
5962-8754201SA	GEM02901BSA
5962-8754201SC	GEM02901BSC
5962-87560012A	GEM41701Q2A
5962-87560012C	GEM41701Q2C
5962-8756001EA	GEM41701QEA
5962-8756001EC	GEM41701QEC
5962-8756001FA	GEM41701QFA
5962-8756001FC	GEM41701QFC
5962-8756001XA	GEM41701QXA
5962-8756001XC	GEM41701QXC
5962-87563012A	GEM38001B2A

MIL SMD P/N	GEM P/N
5962-87563012C	GEM38001B2C
5962-8756301EA	GEM38001QEA
5962-8756301EC	GEM38001QEC
5962-8756301FA	GEM38001QFA
5962-8756301FC	GEM38001QFC
5962-87590012A	GEM41001Q2A
5962-87590012C	GEM41001Q2C
5962-8759001EA	GEM41001QEA
5962-8759001EC	GEM41001QEC
5962-8759001FA	GEM41001QFA
5962-8759001FC	GEM41001QFC
5962-8764601EA	GEM37601QEA
5962-8764601EC	GEM37601QEC
5962-8770805QA	GEM38105QQA
5962-8770805QC	GEM38105QQC
5962-8770805UA	GEM38105QUA
5962-8770805UC	GEM38105QUC
5962-8775101MEA	GEM43901QEA
5962-8775101MEC	GEM43901QEC
5962-8775507Q3A	GEM32307Q3A
5962-8775507Q3C	GEM32307Q3C
5962-8775507QKA	GEM32307QKA
5962-8775507QKC	GEM32307QKC
5962-8775508Q3A	GEM32208Q3A
5962-8775508Q3C	GEM32208Q3C
5962-8775508QKA	GEM32208QKA

MIL SMD P/N	GEM P/N	MIL SMD P/N	GEM P/N
5962-8775508QKC	GEM32208QKC	5962-8779112EC	GEM12112QEC
5962-8775509QLA	GEM32109QLA	5962-87792012A	GEM17601Q2A
5962-8775509QLC	GEM32109QLC	5962-87792012C	GEM17601Q2C
5962-87769012A	GEM41801Q2A	5962-8779201EA	GEM17601QEA
5962-87769012C	GEM41801Q2C	5962-8779201EC	GEM17601QEC
5962-8776901EA	GEM41801QEA	5962-8779201FA	GEM17601QFA
5962-8776901EC	GEM41801QEC	5962-8779201FC	GEM17601QFC
5962-87791012A	GEM12101Q2A	5962-87793012A	GEM32401Q2A
5962-87791012C	GEM12101Q2C	5962-87793012C	GEM32401Q2C
5962-8779101EA	GEM12101QEA	5962-8779301EA	GEM32401QEA
5962-8779101EC	GEM12101QEC	5962-8779301EC	GEM32401QEC
5962-87791032A	GEM12103Q2A	5962-8779301FA	GEM32401QFA
5962-87791032C	GEM12103Q2C	5962-8779301FC	GEM32401QFC
5962-8779103EA	GEM12103QEA	5962-88511032A	GEM38603Q2A
5962-8779103EC	GEM12103QEC	5962-88511032C	GEM38603Q2C
5962-87791052A	GEM12105Q2A	5962-8851103EA	GEM38603QEA
5962-87791052C	GEM12105Q2C	5962-8851103EC	GEM38603QEC
5962-8779105EA	GEM12105QEA	5962-88516013A	GEM19401Q3A
5962-8779105EC	GEM12105QEC	5962-88516013C	GEM19401Q3C
5962-87791072A	GEM12107Q2A	5962-8851601KA	GEM19401QKA
5962-87791072C	GEM12107Q2C	5962-8851601KC	GEM19401QKC
5962-8779107EA	GEM12107QEA	5962-8851601LA	GEM19401QLA
5962-8779107EC	GEM12107QEC	5962-8851601LC	GEM19401QLC
5962-87791122A	GEM12112Q2A	5962-88516023A	GEM18902Q3A
5962-87791122C	GEM12112Q2C	5962-88516023C	GEM18902Q3C
5962-8779112EA	GEM12112QEA	5962-8851602KA	GEM18902QKA

MIL SMD P/N	GEM P/N	MIL SMD P/N	GEM P/N
5962-8851602KC	GEM18902QKC	5962-8856401CC	GEM14701QCC
5962-8851602LA	GEM18902QLA	5962-8856401DA	GEM14701QDA
5962-8851602LC	GEM18902QLC	5962-8856401DC	GEM14701QDC
5962-88527012A	GEM17701B2A	5962-88577012A	GEM26401Q2A
5962-88527012C	GEM17701B2C	5962-88577012C	GEM26401Q2C
5962-8852701EA	GEM17701BEA	5962-8857701EA	GEM26401QEA
5962-8852701EC	GEM17701BEC	5962-8857701EC	GEM26401QEC
5962-8852701FA	GEM17701BFA	5962-8857701FA	GEM26401QFA
5962-8852701FC	GEM17701BFC	5962-8857701FC	GEM26401QFC
5962-8853503QA	GEM32003QQA	5962-8858702VA	GEM44302QVA
5962-8853503QC	GEM32003QQC	5962-8858702VC	GEM44302QVC
5962-8853503XA	GEM32003QXA	5962-8860503QKA	GEM19303QKA
5962-8853503XC	GEM32003QXC	5962-8860503QKC	GEM19303QKC
5962-88557012A	GEM17401Q2A	5962-8860503QLA	GEM19303QLA
5962-88557012C	GEM17401Q2C	5962-8860503QLC	GEM19303QLC
5962-8855701EA	GEM17401QEA	5962-8864303XA	GEM22703QXA
5962-8855701EC	GEM17401QEC	5962-8864303XC	GEM22703QXC
5962-8855701FA	GEM17401QFA	5962-8864303YA	GEM22703QYA
5962-8855701FC	GEM17401QFC	5962-8864303YC	GEM22703QYC
5962-88560012A	GEM17501Q2A	5962-88654032A	GEM38703Q2A
5962-88560012C	GEM17501Q2C	5962-88654032C	GEM38703Q2C
5962-8856001EA	GEM17501QEA	5962-8865403RA	GEM38703QRA
5962-8856001EC	GEM17501QEC	5962-8865403RC	GEM38703QRC
5962-8856001FA	GEM17501QFA	5962-8865403SA	GEM38703QSA
5962-8856001FC	GEM17501QFC	5962-8865403SC	GEM38703QSC
5962-8856401CA	GEM14701QCA	5962-8873903QA	GEM41103QQA

MIL SMD P/N	GEM P/N
5962-8873903QC	GEM41103QQC
5962-8873903XA	GEM41103QXA
5962-8873903XC	GEM41103QXC
5962-8952305EA	GEM48905QEA
5962-8969402EA	GEM25402BEA
5962-8969402EC	GEM25402BEC
5962-8969402FA	GEM25402BFA
5962-8969402FC	GEM25402BFC
5962-8969402XA	GEM25402BXA
5962-8969402XC	GEM25402BXC
5962-8969402YA	GEM25402BYA
5962-8969402YC	GEM25402BYC
5962-89731013A	GEM43601Q3A
5962-89731013C	GEM43601Q3C
5962-8973101KA	GEM43601QKA
5962-8973101KC	GEM43601QKC
5962-8973101LA	GEM43601QLA
5962-8973101LC	GEM43601QLC
5962-89731023A	GEM43602Q3A
5962-89731023C	GEM43602Q3C
5962-8973102KA	GEM43602QKA
5962-8973102KC	GEM43602QKC
5962-8973102LA	GEM43602QLA
5962-8973102LC	GEM43602QLC
5962-9052201PA	GEM34301QPA
5962-9052201PC	GEM34301QPC

MIL SMD P/N	GEM P/N
5962-9052201XA	GEM34301QXA
5962-9052201XC	GEM34301QXC
5962-90613012A	GEM22601Q2A
5962-90613012C	GEM22601Q2C
5962-9061301EA	GEM22601QEA
5962-9061301EC	GEM22601QEC
5962-9061301FA	GEM22601QFA
5962-9061301FC	GEM22601QFC
5962-9074502Q3A	GEM38202Q3A
5962-9074502Q3C	GEM38202Q3C
5962-9074502QKA	GEM38202QKA
5962-9074502QKC	GEM38202QKC
5962-9074502QLA	GEM38202QLA
5962-9074502QLC	GEM38202QLC
5962-9151601QEA	GEM11101QEA
5962-9151601QEC	GEM11101QEC
5962-9158601Q2A	GEM31201Q2A
5962-9158601Q2C	GEM31201Q2C
5962-9158601QEA	GEM31201QEA
5962-9158601QEC	GEM31201QEC
5962-9158601QFA	GEM31201QFA
5962-9158601QFC	GEM31201QFC
5962-9222901MLA	GEM46901QLA
5962-9576103Q2A	GEM36303Q2A
5962-9576103Q2C	GEM36303Q2C
5962-9576103QRA	GEM36303QRA

MIL SMD P/N	GEM P/N
5962-9576103QRC	GEM36303QRC
5962-9576103QSA	GEM36303QSA
5962-9576103QSC	GEM36303QSC
5962-9690303Q2A	GEM42503Q2A
5962-9690303Q2C	GEM42503Q2C
5962-9690303QCA	GEM42503QCA
5962-9690303QCC	GEM42503QCC
5962-9858601Q2A	GEM22401Q2A
5962-9858601Q2C	GEM22401Q2C
5962-9858601QRA	GEM22401QRA
5962-9858601QRC	GEM22401QRC
5962-9858601QSA	GEM22401QSA
5962-9858601QSC	GEM22401QSC
5962-9953201QJA	GEM24501QJA
5962-9953201QJC	GEM24501QJC
5962-9953201QKA	GEM24501QKA
5962-9953201QKC	GEM24501QKC
5962-9953201QLA	GEM24501QLA
5962-9953201QLC	GEM24501QLC
76010012A	GEM03701B2A
76010012C	GEM03701B2C
7601001EA	GEM03701BEA
7601001EC	GEM03701BEC
7601001FA	GEM03701BFA
7601001FC	GEM03701BFC
7601501CA	GEM39901QCA

MIL SMD P/N	GEM P/N
7601501CC	GEM39901QCC
7601501DA	GEM39901QDA
7601501DC	GEM39901QDC
7601901EA	GEM15201QEA
7601901EC	GEM15201QEC
7601901FA	GEM15201QFA
7601901FC	GEM15201QFC
76036012A	GEM051012A
76036012C	GEM051012C
7603601EA	GEM05101EA
7603601EC	GEM05101EC
7603601FA	GEM05101FX
7603601FC	GEM05101FX
7700401EA	GEM08501QEA
7700401EC	GEM08501QEC
7700401FA	GEM08501QFA
7700401FC	GEM08501QFC
7700703QA	GEM06803QQA
7700703QC	GEM06803QQC
7700703ZA	GEM06803QZA
7700703ZC	GEM06803QZC
7701001CA	GEM31001QCA
7701001CC	GEM31001QCC
7701001DA	GEM31001QDA
7701001DC	GEM31001QDC
7702601EA	GEM37101QEA

MIL SMD P/N	GEM P/N
7702601EC	GEM37101QEC
7702601FA	GEM37101QFA
7702601FC	GEM37101QFC
78009012A	GEM17001Q2A
78009012C	GEM17001Q2C
7800901EA	GEM17001QEA
7800901EC	GEM17001QEC
7800901FA	GEM17001QFA
7800901FC	GEM17001QFC
78015012A	GEM13501Q2A
78015012C	GEM13501Q2C
7801501EA	GEM13501QEA
7801501EC	GEM13501QEC
7801501FA	GEM13501QFA
7801501FC	GEM13501QFC
78015022A	GEM24202Q2A
78015022C	GEM24202Q2C
7801502EA	GEM24202QEA
7801502EC	GEM24202QEC
7801502FA	GEM24202QFA
7801502FC	GEM24202QFC
78015032A	GEM13503Q2A
78015032C	GEM13503Q2C
7801503EA	GEM13503QEA
7801503EC	GEM13503QEC
7801503FA	GEM13503QFA

MIL SMD P/N	GEM P/N
7801503FC	GEM13503QFC
78015042A	GEM19804Q2A
78015042C	GEM19804Q2C
7801504EA	GEM19804QEA
7801504EC	GEM19804QEC
7801504FA	GEM19804QFA
7801504FC	GEM19804QFC
8002301EA	GEM08801QEA
8002301EC	GEM08801QEC
8002301FA	GEM08801QFA
8002301FC	GEM08801QFC
8200701RA	GEM43001QRA
8200701RC	GEM43001QRC
8200702RA	GEM43002QRA
8200702RC	GEM43002QRC
8200703RA	GEM43003QRA
8200703RC	GEM43003QRC
8202201EA	GEM41901QEA
8202201EC	GEM41901QEC
8202201FA	GEM41901QFA
8202201FC	GEM41901QFC
8405701QA	GEM06801QQA
8405701QC	GEM06801QQC
8405701ZA	GEM06801QZA
8405701ZC	GEM06801QZC
8413201RA	GEM45201QRA

MIL SMD P/N	GEM P/N
8413201RC	GEM45201QRC
8413203RA	GEM45203QRA
8413203RC	GEM45203QRC
85126022A	GEM18802Q2A
85126022C	GEM18802Q2C
8512602BA	GEM18802QBA
8512602BC	GEM18802QBC
8512602CA	GEM18802QCA
8512602CC	GEM18802QCC
8512602DA	GEM18802QDA
8512602DC	GEM18802QDC
85508012A	GEM23001Q2A
85508012C	GEM23001Q2C
8550801EA	GEM23001QEA
8550801EC	GEM23001QEC
8550801FA	GEM23001QFA
8550801FC	GEM23001QFC
8602001EA	GEM09201QEA
8602001EC	GEM09201QEC
8602001FA	GEM09201QFA
8602001FC	GEM09201QFC
8602002EA	GEM09202QEA
8602002EC	GEM09202QEC
8602002FA	GEM09202QFA
8602002FC	GEM09202QFC
86025023A	GEM10702Q3A

MIL SMD P/N	GEM P/N
86025023C	GEM10702Q3C
8602502XA	GEM10702QXA
8602502XC	GEM10702QXC
8602502YA	GEM10702QYA
8602502YC	GEM10702QYC
86030013A	GEM14101Q3A
86030013C	GEM14101Q3C
8603001XA	GEM14101QXA
8603001XC	GEM14101QXC
8603001YA	GEM14101QYA
8603001YC	GEM14101QYC
86051042A	GEM13404Q2A
86051042C	GEM13404Q2C
8605104EA	GEM13404QEA
8605104EC	GEM13404QEC
8605104FA	GEM13404QFA
8605104FC	GEM13404QFC
8605106EA	GEM31606QEA
8605106EC	GEM31606QEC
8605106FA	GEM31606QFA
8605106FC	GEM31606QFC

Appendix 2: GEM M38510 MIL-PRF-38535 Parts

M38510 P/N	GEM P/N	M38510 P/N	GEM P/N
M38510/00108BAA	GEM06601BAA	M38510/00301BBA	GEM27401BBA
M38510/00108BBA	GEM06601BBA	M38510/00301BBC	GEM27401BBC
M38510/00108BCA	GEM06601BCA	M38510/00301BCA	GEM27401BCA
M38510/00108BDA	GEM06601BDA	M38510/00301BCC	GEM27401BCC
M38510/00201BAA	GEM12601BAA	M38510/00301BDA	GEM27401BDA
M38510/00201BAC	GEM12601BAC	M38510/00301BDC	GEM27401BDC
M38510/00201BBA	GEM12601BBA	M38510/00502BAA	GEM27502BAA
M38510/00201BBC	GEM12601BBC	M38510/00502BAC	GEM27502BAC
M38510/00201BCA	GEM12601BCA	M38510/00502BBA	GEM27502BBA
M38510/00201BCC	GEM12601BCC	M38510/00502BBC	GEM27502BBC
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M38510/65752BDC	GEM06352BDC

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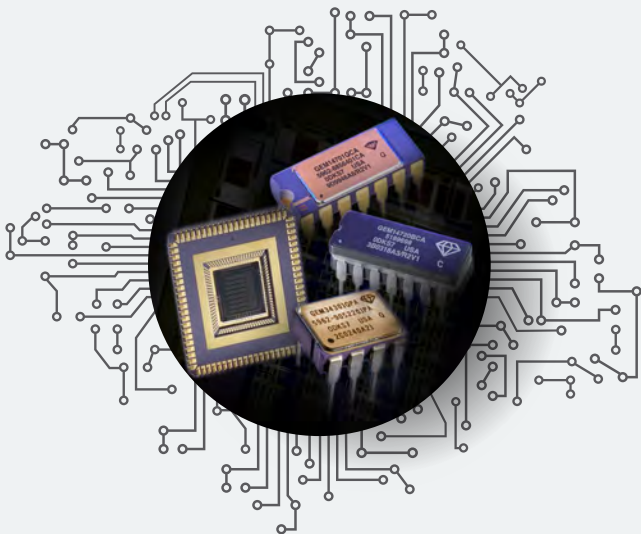
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