Actual size

1cm x 1cm

Green Arrays™ GA144

144-Computer Chip

FEATURES

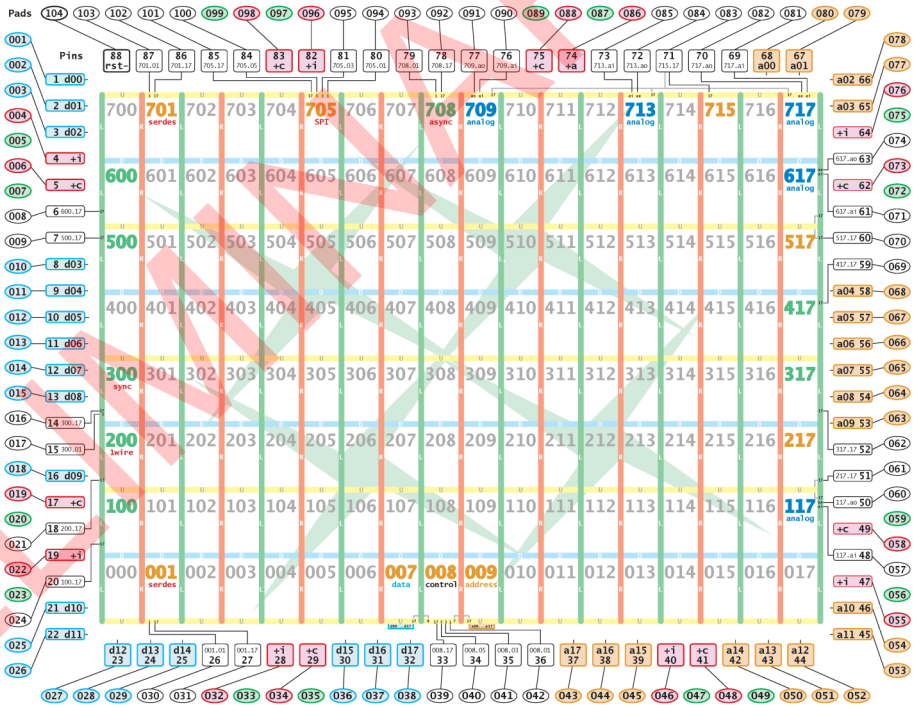
- 144 independent F18A computers
- Suitable for inexpensive, 4-layer PCBs
- Up to 96 billion operations per second
- Instantaneous power ranges from 14 microwatts to 650 milliwatts.
- Energy consumed depends on each computer's duty cycle, controlled by software and events, with granularity in picoseconds
- Negligible time and energy expended starting and stopping each node
- Suspended nodes respond to internal events in picoseconds and external events in nanoseconds
- High impedance (<3pF, >200MΩ) inputs
- Five analog inputs and five outputs
- Two 18-bit parallel interfaces
- 25 programmable digital I/O pins
- Overall digital I/O bandwidth can exceed 3 gigabits per second with software "bit banging", plus an additional 800 megabits per second when both SERDES are operating
- Bootable via SPI or any of four serial protocols; custom ROM available
- 9216 words RAM and same of ROM distributed among all nodes (equivalent of 41472 total bytes)
- Minimal external components needed to build a working system

APPLICATIONS

- Energy harvesting applications
- Portable devices
- Remote sensing and data reduction
- Ideal for parallel and/or pipelined work
- Image processing
- Complex control systems
- Cryptography
- High speed signal processing
- Simulation and synthesis
- Inexpensive, massively parallel systems for research and education
- Artificial intelligence, neural nets

OVERVIEW

This very powerful and versatile chip consists of an 18x8 array of architecturally identical, independent, complete F18A computers, or *nodes*, each of which operates asynchronously. Each computer is capable of performing a basic ALU instruction in ≈1.5 nanoseconds for an energy cost on the order of 7 picojoules. Nothing else available today comes close to that winning combination. Twenty-two of the computers on the edges of the array have one or more I/O pins and one of several classes of circuitry associated with them, as illustrated below.



Nodes numbered in green have one or two GPIO pins. Those in blue have analog I/O. Those in orange have digital I/O with specialized purposes: 001 and 701 have high speed SERDES; 705 has four pins which may be used for an SPI bus; 217, 517 and 715 have a GPIO pin whose read line is connected to one or more analog nodes for sample synchronization; and nodes 007, 8, and 9 together control two 18-bit parallel buses and four GPIO pins that may be used to control external memory chips. These and the SPI bus are of course available for other uses if desired.

All nodes are suspended after reset, prepared to execute instructions coming from any neighbor node via a comm port. Six of these are also waiting for incoming signals on their pin(s) which will be interpreted as boot frames. 001 and 701 SERDES will execute instructions received; 200 listens for high speed 1-wire protocol, 300 for 2-wire synch, 708 for RS232 framed async, and 705 can boot from an SPI flash memory device.

When product requirements for responsiveness, computing power and energy limitations collide, this superb chip is the ideal prototyping and initial product platform. As a product matures, GreenArrays can and will configure custom chips to further minimize cost and energy consumption for its customers.

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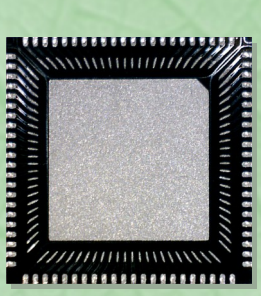
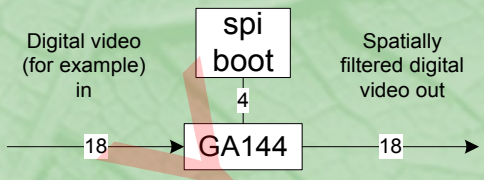


SUITABILITY: The GA144 is designed to support the largest and most demanding computing challenges that can be addressed with a modest sized die in a relatively inexpensive and easy to use package while still using well less than 650 mW in most practical applications. The geometry allows for generous numbers of parallel paths and/or pipeline stages, or for complex flowgraphs in control, simulation, or DSP applications. Clusters of nodes devoted to functions such as cryptographic algorithms are easily placed in the large array, and the cluster needed to control external memory and run a high level language from it is well out of the way but has good surface area for interaction with other functions. Use it also as a universal protoytping platform for applications destined to run on our smaller chips.

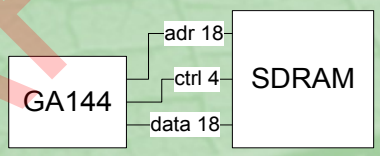
SOFTWARE SUPPORT: A complete arrayForth™ software development platform is available free of charge on our website. Included are a compiler for machine code, an interactive simulator and an interactive development and debugging environment. Complete source language is provided so that all components of this platform are extensible by the user.

When large, high-level programs are required, the GA144 supports eForth running from external SRAM or SDRAM. Typically, three to five nodes control the external memory and two nodes interpret the higher-level language.

PACKAGE: The GA144 is available in a 10x10mm, 88-pin QFN with 0.4mm pin pitch. All ground connections are made to the central Die Attach Paddle.



Two-chip high-order filter



Direct control of SDRAM or SRAM without "glue" parts

Sym	Description	Min	Typ	Max	Units	Test Condition
Cpin	I/O pin capacitance with Vdd = 0V		2.8		pF	I/O to Vss
ILI	Input leakage current (tristate)		7		nA	Vin to Vdd or Vss
IR	Effective input resistance (tristate)		250		MΩ	
ILpd	Weak pulldown current (in saturation)		38		µA	Vin to Vdd
VIH	Input high level		1.1		V	Note: No hysteresis
VIL	Input low level		0.7		V	
ISH	Max current sourced (in saturation)		41		mA	Vout to Vss
ISL	Max current sunk (in saturation)		41		mA	Vout to Vdd
ROH	Output source res. for 0.5 Vdd @ Vout		23		Ω	Vout to Vss
ROL	Output sink res. for 0.5 Vdd @ Vout		21		Ω	Vout to Vdd
ICC	Core current, all nodes running		360		mA	Vdd to VddC
ICCs	Core current, all nodes suspended	6	8	12	µA	
ICCg	Core current per running F18		2.5		mA	
ICCgs	Core current per suspended F18	41	55	83	nA	
Vdd	Supply voltage	1.6	1.8	2.0	V	Below @ these Vdd
Voh	Output high sourcing 10 mA	1.44	1.66	1.86	V	Vout to Vss
Vol	Output low sinking 10 mA	0.130	0.122	0.110	V	Vout to Vdd

For more information, visit **www.GreenArrayChips.com**

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