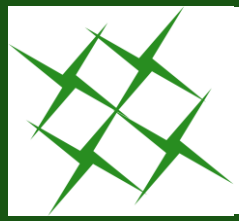


GreenArrays™

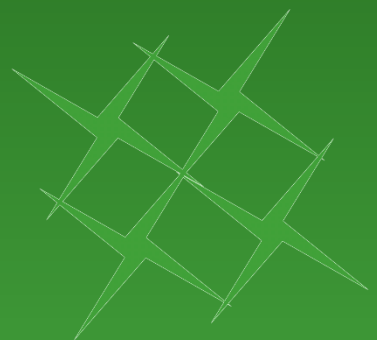
World Leader toward Efficiency

Activities During the Past Year since Forth Day 2018

Greg Bailey

SVFIG Forth Day

16 November 2019



The Past Year

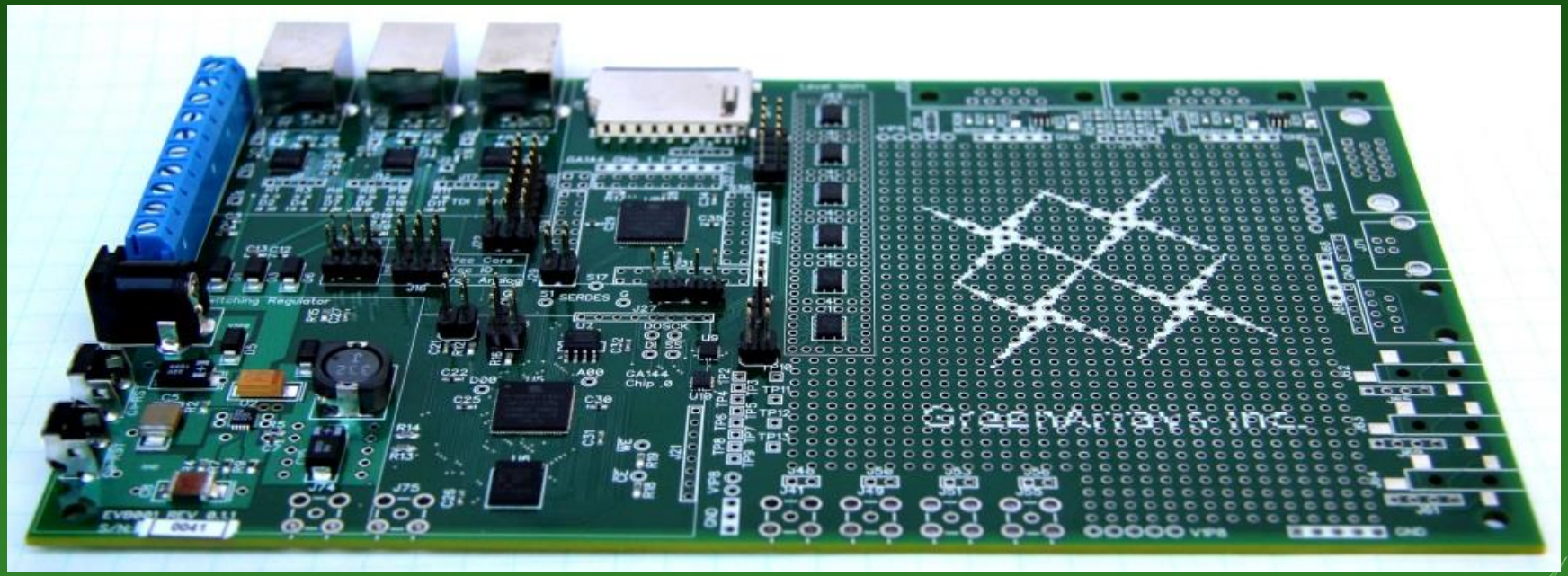
- Orientation with Michael Schuldt
- Create POLYSANCE
- Visit Switzerland: Stefan and Daniel.
- Produce and Ship EVB002
- Release Complete arrayForth 3
- Construct GPS Receiver Demonstration
- Implement GLOW as Operational CAD System
- RIP Bill Muench!

Near Grenchen Switzerland

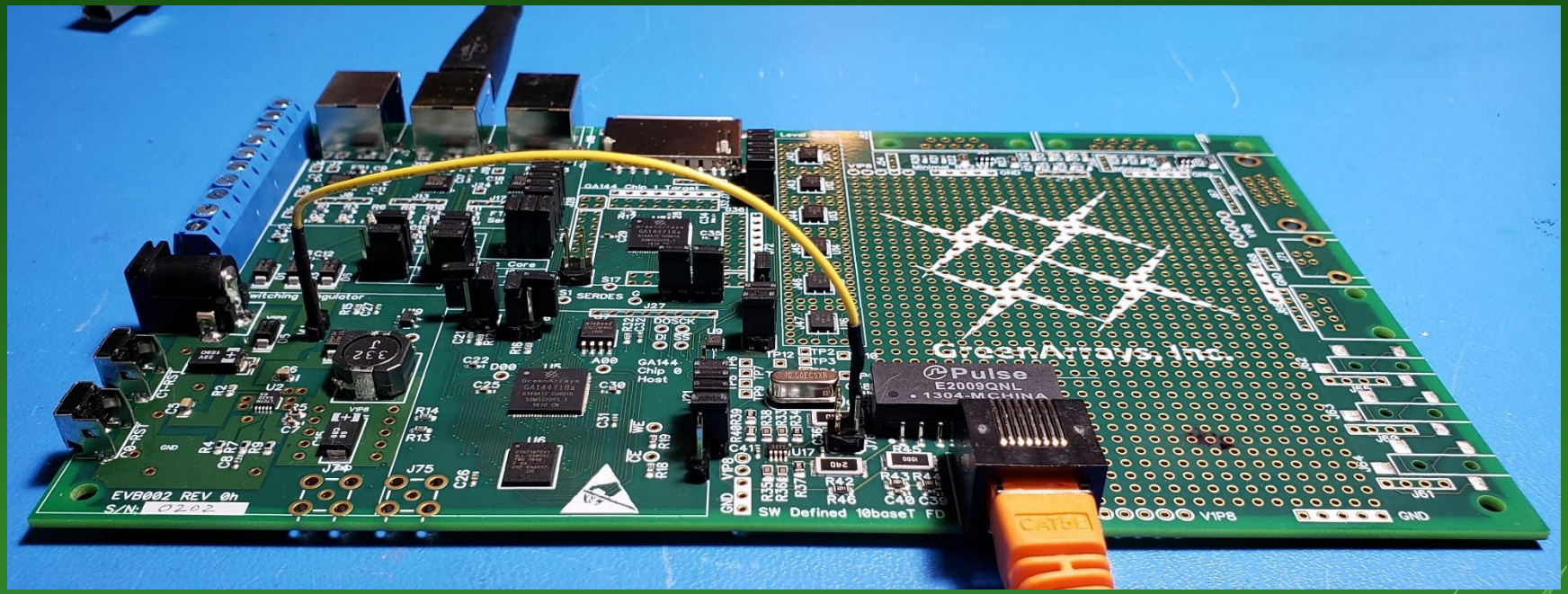
EVB002 Key Changes

- Increase SPI Flash to 16 MBytes
- Fix small errors in EVB001
  - Power regulator caps; VGA hole pattern; activity LEDS on FTDI USB devices
- Half of level shifters single ended, half push-pull
- Add watchdog/reset chip for optional use
- Add 10baseT interface electronics (xtal, op-amp, magnetics)
- EVB002 may be used as its own development system with external terminal or, later, Telnet.

EVB001 View



EVB002 View


EVB002 REV 0h
S/N: 0202
GreenArrays, Inc.
Pulse
E2009GNL
1304-MCHINA
SW Defined 10baseT FD
CAT5E
GND
V1P8

GreenArrays®
Product Data Book DB014 *Revised 5/20/19*

Evaluation Board Reference Manual

for EVB002 rev 0hb with G144A12 chips

Supported by arrayForth® Version 3

The GreenArrays EVB002 Evaluation Board is a versatile and powerful application development platform for the GA144-1.20 chips. Using arrayForth 3, the EVB002 may serve as a standalone development system with polyFORTH® running on the EVB002 directly, or may be used in conjunction with saneFORTH on x86 platforms. Its many configuration options facilitate intimate, interactive code development at all levels with one or two GA144 chips.

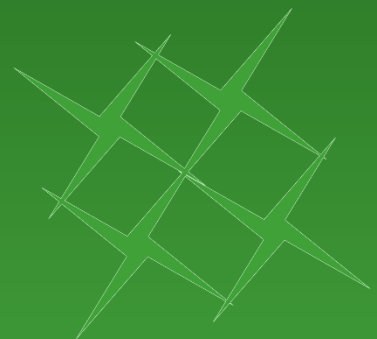
Please familiarize yourself with this information before using the Eval Board so that you will be aware of the many configuration options available to you.

In addition, please download and read the other relevant documentation such as the Programmers' Reference for the F18 computers (DB001), the G144A12 Chip Data Book (DB002), and the User's Manuals DB013 for arrayForth 3, DB005 and DB006 for polyFORTH, and other Application Notes as appropriate. The current editions of all GreenArrays documents, including this one, may be found on our website at http://www.greenarraychips.com .

It is always advisable to ensure that you are using the latest documents before starting work.

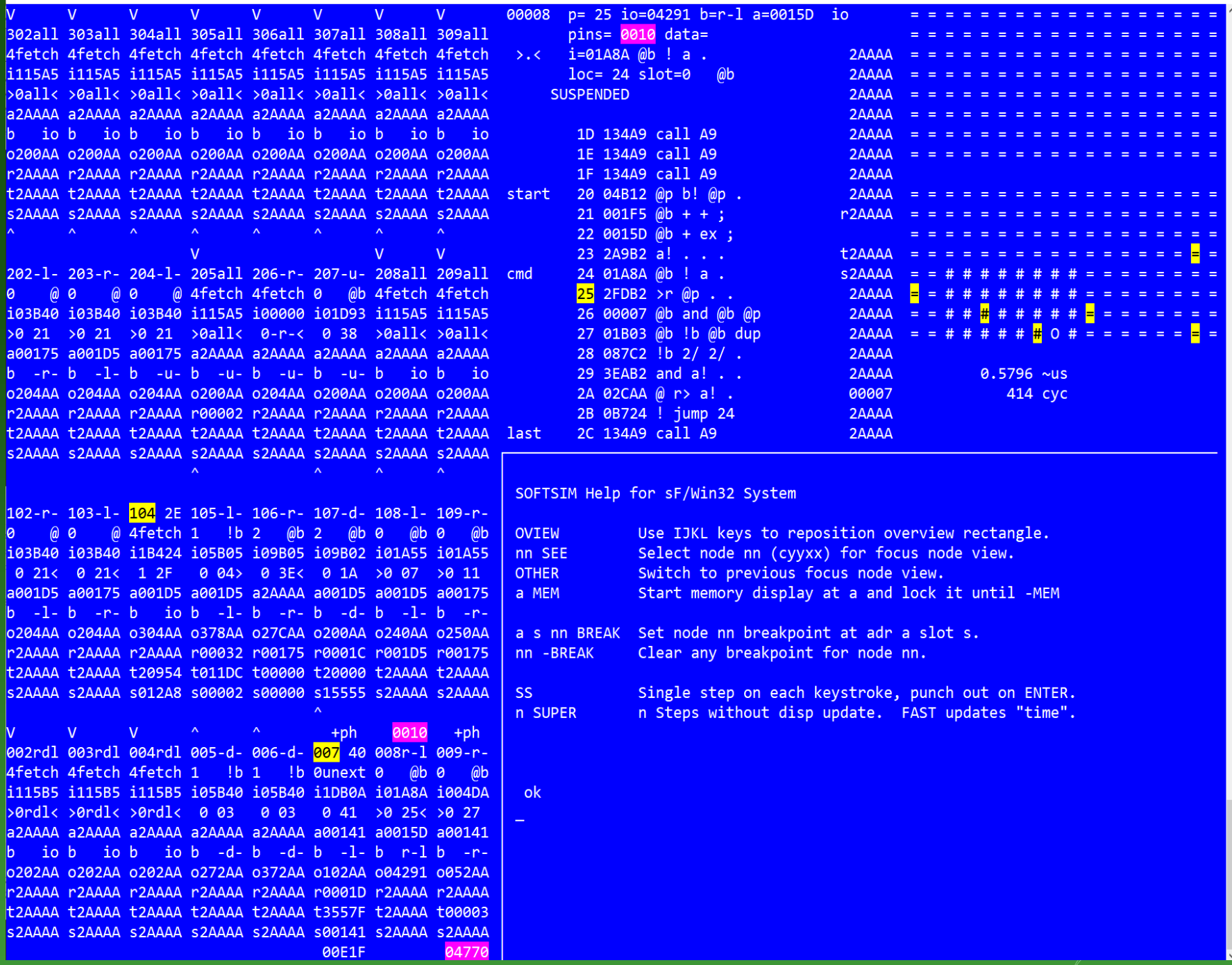
arrayForth 3

- Common syntax and utilities on both saneFORTH/x86 and polyFORTH/144 enable development from host or target systems.
- Existing F18 code, including automated test system, has been converted.
- Improved 2-chip extensible SOFTSIM.



Capabilites of Host and Target

Capability Supported	sF	pF/144
F18 native code Assembler	YES	YES
Source and object code auditing	YES	YES
Concordance and fast FIND in source code	YES	---
Support for 2-chip targets	YES	YES
External IDE	YES	tbd
Internal IDE	---	tbd
Boot stream generation	YES	YES
Boot stream auditing	YES	YES
Internal boot stream delivery (Node 207)	---	YES
Serial boot stream delivery	YES	tbd
Flash boot stream burning in target	tbd	tbd
Flash boot stream burning internal to own system	---	YES
Target Compiler for pF/144 Nucleus	---	YES
Chip test via External IDE	YES	tbd
External SRAM assembly test via external IDE	YES	tbd
ATS Chip Testing	YES	tbd
Software Simulator	BETA	---


arrayForth 3 G144A12
00008 p= 25 io=04291 b=r-l a=0015D io
pins= 0010 data=
>.< i=01A8A @b ! a .
loc= 24 slot=0 @b
SUSPENDED
1D 134A9 call A9
1E 134A9 call A9
1F 134A9 call A9
start 20 04B12 @p b! @p .
21 001F5 @b + + ;
22 0015D @b + ex ;
23 2A9B2 a! . . .
cmd 24 01A8A @b ! a .
25 2FDB2 >r @p . .
26 00007 @b and @b @p
27 01B03 @b !b @b dup
28 087C2 !b 2/ 2/ .
29 3EAB2 and a! . .
2A 02CAA @ r> a! .
2B 0B724 ! jump 24
last 2C 134A9 call A9
0.5796 ~us
414 cyc
SOFTSIM Help for sF/Win32 System
OVIEW Use IJKL keys to reposition overview rectangle.
nn SEE Select node nn (cyyxx) for focus node view.
OTHER Switch to previous focus node view.
a MEM Start memory display at a and lock it until -MEM
a s nn BREAK Set node nn breakpoint at adr a slot s.
nn -BREAK Clear any breakpoint for node nn.
SS Single step on each keystroke, punch out on ENTER.
n SUPER n Steps without disp update. FAST updates "time".
ok

GreenArrays®
Product Data Book DB013 *Revised 9/24/19*

arrayForth® 3 User's Manual

Rev 03b5+ for G144A12 chips

Running on saneFORTH™/Win32

and polyFORTH® *for* GA144

This manual is designed to prepare you for using arrayForth 3 (aF-3) in designing, implementing and testing applications of our chips.

aF-3 is a complete, interactive software development , debugging and installation environment for GreenArrays Chips. It includes an F18 Assembler, example source code including all ROM on each chip, a full software-level simulator for each chip, an Interactive Development Environment for use with real chips, and utilities for creating boot streams and burning them into flash memory. As of aF-3, colorForth is no longer used in this system.

aF-3 is written to run on polyFORTH in G144A12 environments with sufficient resources, and on saneForth for Win32 environments. These versions complement each other and each has a different emphasis of tools, reflecting their differing purposes. The principal purpose of the Win32 environment is cross-compiling for new chips, commission new boards, and simulate at high speeds. The G144A12 environment is intended for interactive development and testing, with F18 and polyFORTH source code in a single base that can be maintained by either system. In most cases, we intend that you will be using an EVB instead of a PC as the principal host for software development.

Although it is configured to support the GreenArrays EVB002 Evaluation Board, it may easily be used to program and debug our chips on the EVB001 in your own designs.

Along with the above tools, including complete source code for the Virtual Machine environments, this release incorporates the source code for our Automated Testing systems as well as that which has been used in taking the characterization measurements reflected in the G144A12 Data Book.

Your satisfaction is very important to us! Please familiarize yourself with our Customer Support web page at http://www.greenarraychips.com/home/support. This will lead you to the latest software and documentation as well as resources for solving problems and contact information for obtaining help or information in real time.

GPS Receiver Demonstration

- Why? Customer wishes to minimize overall energy per fix. 24 hour battery life completely unacceptable.
- Initial Work in June 2013
- Preparation for Demo started Dec 2018
  - SoftOSGPS (Cliff Kelley) on Sourceforge with test data and “correct” results
- Search for *suitable* RF front end chips, both available and documented, took until June 2019
- Intensive work during July and September 2019

Nature of the Signal

- All 32 satellites broadcast signal on same carrier frequency ~2 GHz. A subset visible at any time.
- Each signal AM'd with a 1023-bit PRN for each satellite, at 1.023 MHz (one PRN per ms).
- Message data bits encoded at 50 b/sec by inverting, or not, 20 consecutive PRNs (20 ms) per bit. One frame is 1500 bits, full message is 25 frames (37500 bits, 12.5 minutes)
- Signals (including modulation) affected by Doppler, Ionosphere, etc.

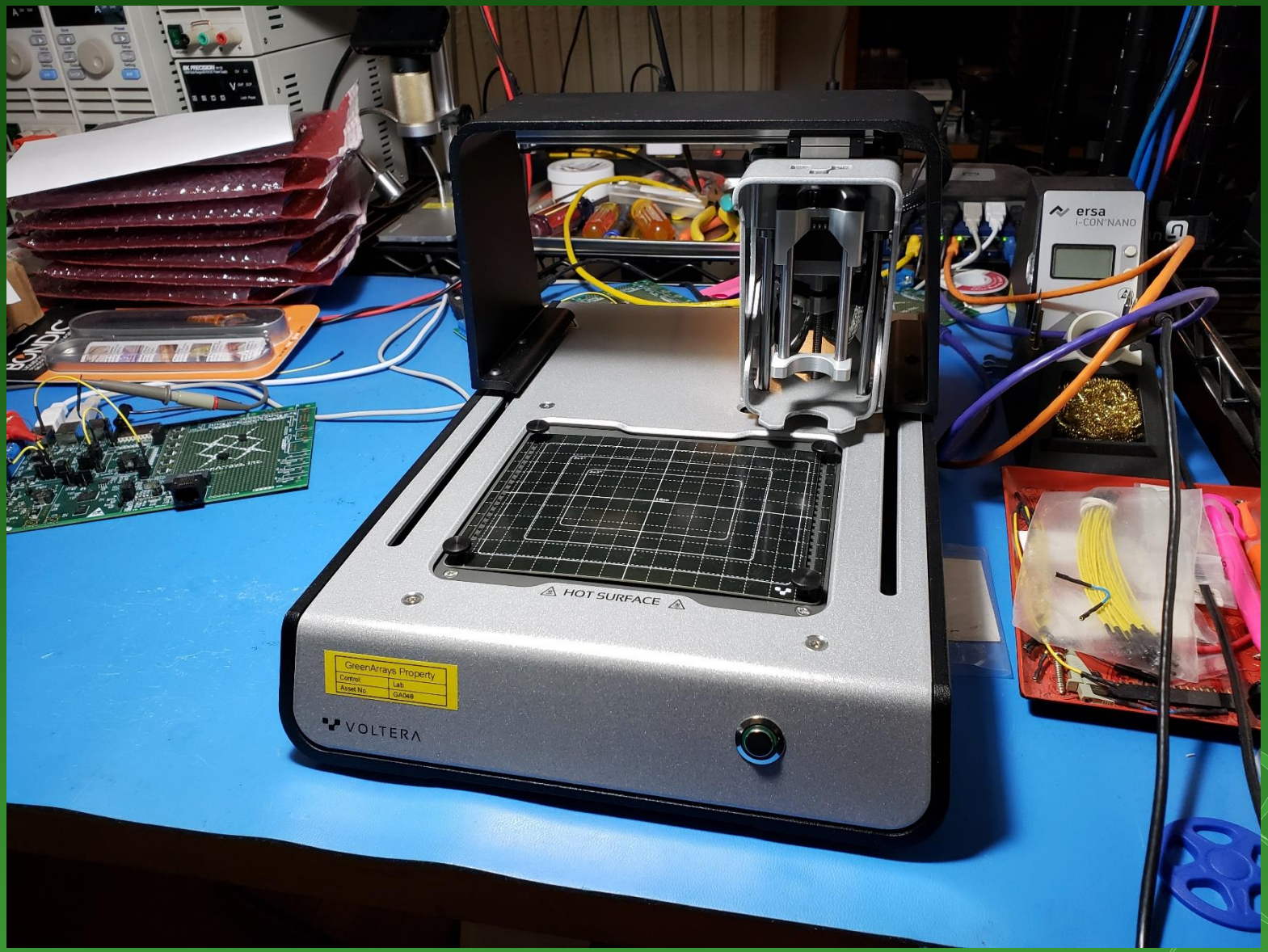
Low Level Problem Statement

- Receive 2-bit samples from IF ADC at ~5MHz
- Compute and sum four correlations on each sample for each of 12 satellites every ~200 ns
- Inject revised phase angle increments into, and receive correlation sums from, all correlators every 1 ms.
- Run low level control loops for acquisition and tracking to provide new phase increments
- Provide mechanism to configure correlators for new satellites
- Time critical in the sense that we must not drop any incoming samples.

High Level Architecture

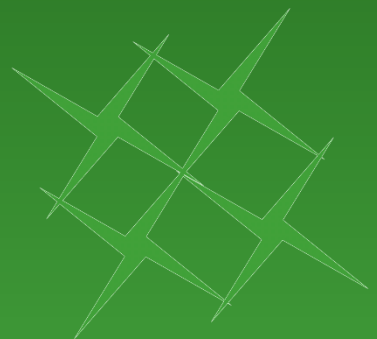
- All of the time critical parts of the 1 ms cycle implemented in F18 nodes with native code
- High level functions (such as message parsing, retrieving and storing almanac and orbital elements, computing ephemerides, deriving time and position) done in high level polyFORTH.
- Current design inhabits a single G144A12 with external SPI flash, external SRAM, and external RF front end chip.

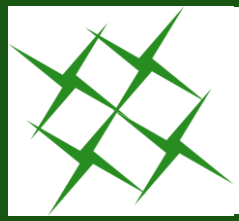
Voltera™ Rapid PCB Manufacture



For More Information on GreenArrays and These Projects

- Primary Website
  - http://www.greenarraychips.com
  - Get all documents here
- Announcement Blog
  - Technical http://www.greenarraychips.com/blog2
- Tech Support on e-mail, Skype, Phone





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World Leader toward Efficiency

Thank You!

For more information, please visit

http://www.greenarraychips.com