



Agile Reader Reference Platform

Program Update

Matt Reynolds



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Agenda



- The RFID Reader Manifesto
- Agile Reader Project Goals
- Team introduction
- Scheduling / current status
- Design Overview
- Next Steps



The Reader Manifesto



The RFID Reader of the Future will:

1. Operate in 13.56MHz, 868/915MHz, 2.4GHz bands
2. Speak Internet protocols natively
3. Be part of a distributed, client-server system
4. Incorporate agent-like behavior to manage a tag population at a fine grained level
5. Not require human intervention to fix problems

The RFID Reader of the Future must have flexible software to match its flexible hardware.



Project Goals



Provide a practical reference design for an RFID reader which:

1. Operates in 13.56MHz, 868/915MHz, 2.4GHz bands
2. Provides a flexible back-end network interface (TCP/IP)
3. Interfaces well with the Savant architecture
4. Is manufacturable at reasonable cost (<\$100 OEM, 100K units)

Resulting in a reproducible, open reference platform



Value of Reference Platform



Auto ID Center

- Research platform that is easily modified and completely open

RFID Hardware Vendors

- Direct engineering applicability
- Open standards

RFID Integrators and Service Firms

End Users

- RF level interoperability standards
- Software/Network level interoperability standards
- Benefits of a common platform



Reader Project Team



- ThingMagic
 - Matt Reynolds (RF and system architect)
 - Joey Richards (DSP lead)
 - Bernd Schoner (DSP, project management)
 - Ravi Pappu (DSP)
- Auto ID Center
 - Sanjay Sarma, Peter Cole, Kevin Ashton, and Auto ID Center team



Project Scheduling



- Design work started August 2001
- Project duration 9 months
ends Q1 2002
- Major intermediate milestone
preliminary demo at November meeting
- Reference design (primary deliverable)
to be published beginning Q2 2002



Current Status



- Alpha prototype hardware running at 915 MHz
- 2.4GHz and 13.56MHz hardware in test stage
- Alpha code running (CCAG 8.x support 90% complete)

- "First tag" read 11/12/01



The "Demo"



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Reader system overview



Design philosophy: flexibility and low cost

- Maximum of component and system reuse to reduce cost
- High level of inter-band integration, both hardware and software
- Make good use of DSP techniques
- Provide a standard, well documented TCP/IP interface to the outside world



General data handling approach



Two processors:

- Digital signal processor (DSP)
Performs real time signal processing tasks
- Network processor (Bamboo™ Linux platform)
Handles data, schedules reads, interacts with TCP/IP network
Acts as a Savant agent



General RF design approach

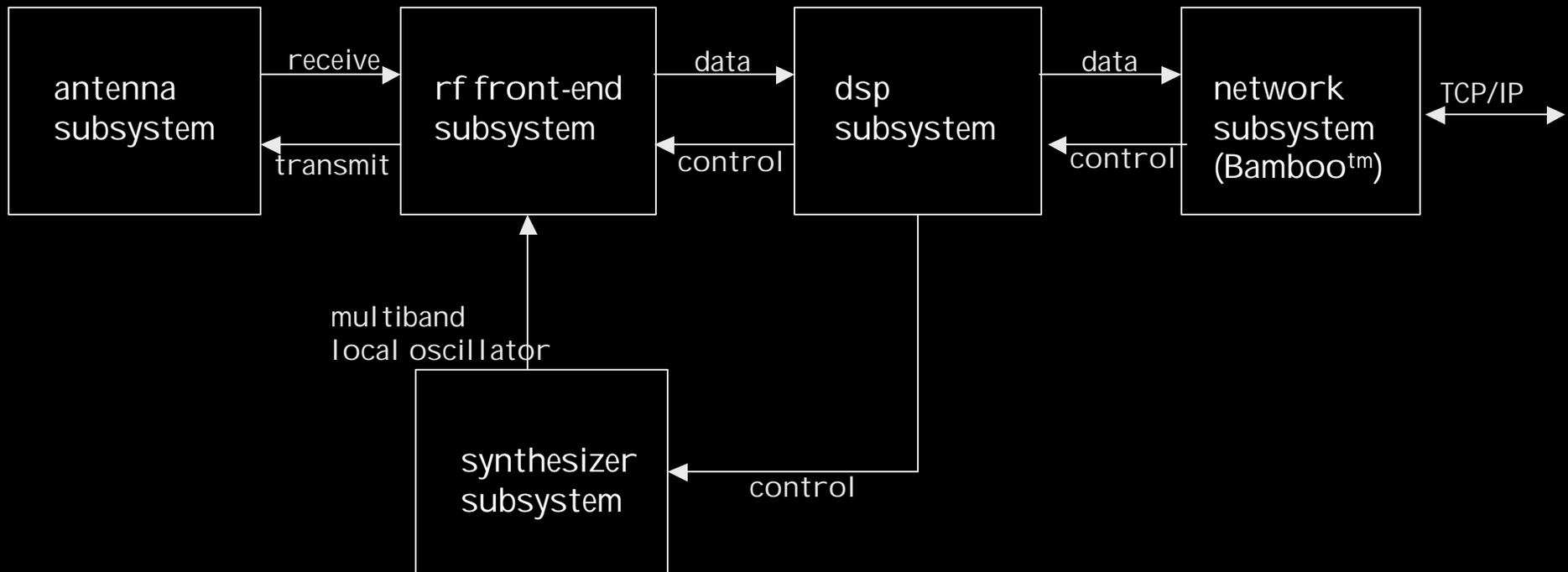


Technically: an IF-DSP multiband superheterodyne transceiver

- Convert all incoming bands to one common “intermediate frequency” (IF)
- Digitally process all signals at this intermediate frequency



Reader block diagram





Antenna Subsystem Overview



antenna

rf frontend

synthesizer

dsp

bamboo

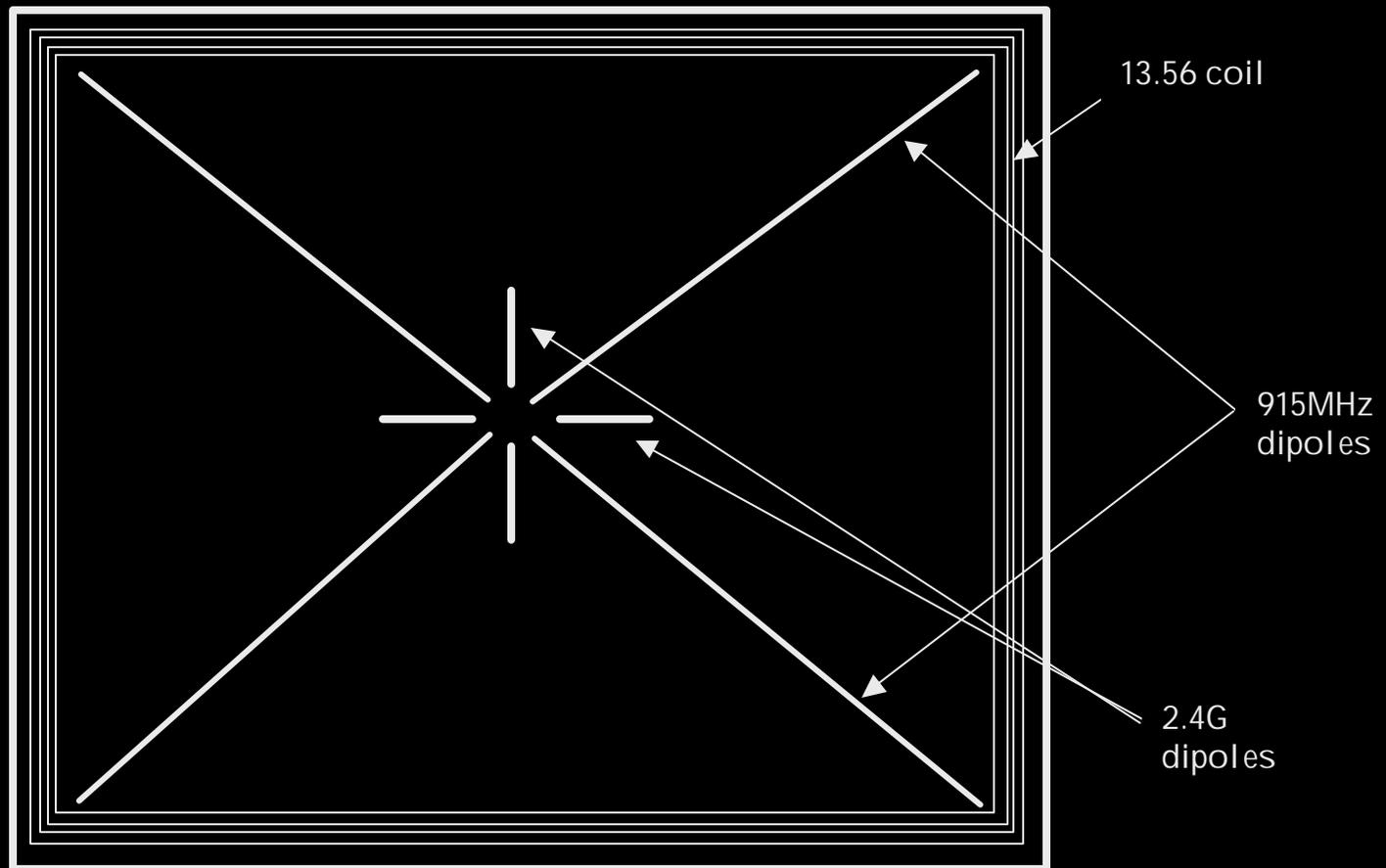
- Design must be thin (preferably planar), inexpensive, and repeatable
- Design must cover all three bands
- Circular polarization desired for tag orientation insensitivity



Antenna Subsystem: Concept



- antenna
- rf frontend
- synthesizer
- dsp
- bamboo

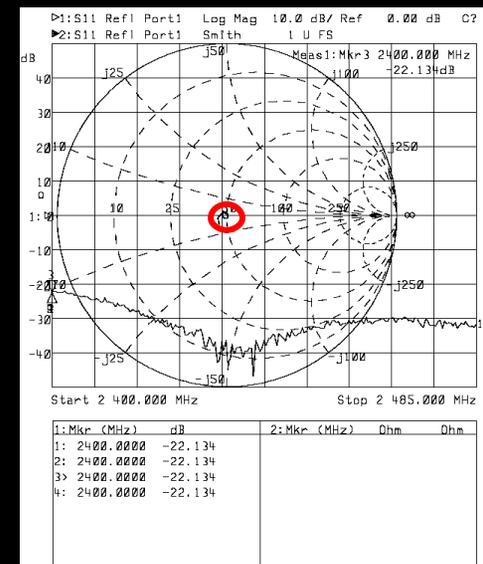
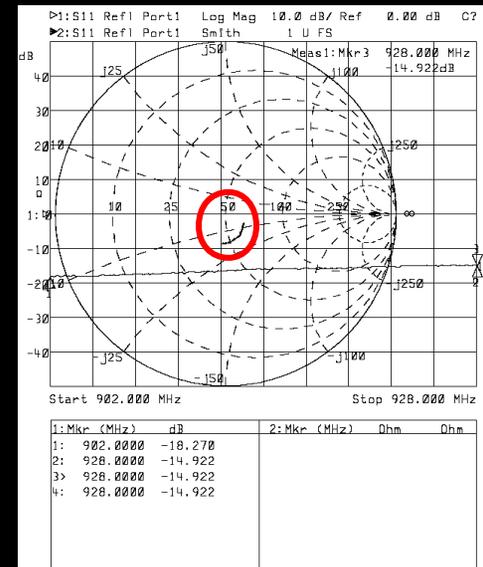
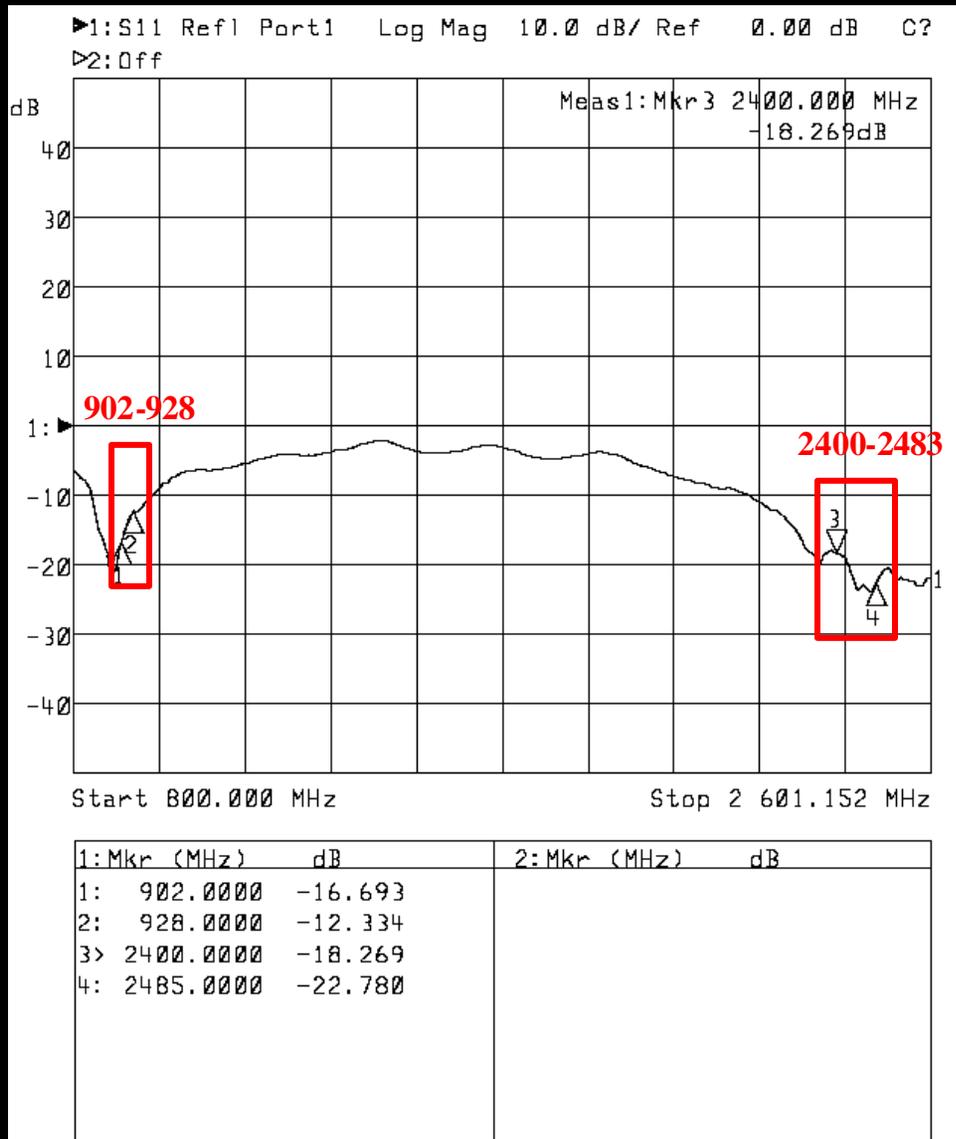


not to scale

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Dual-Band Antenna (Measured)

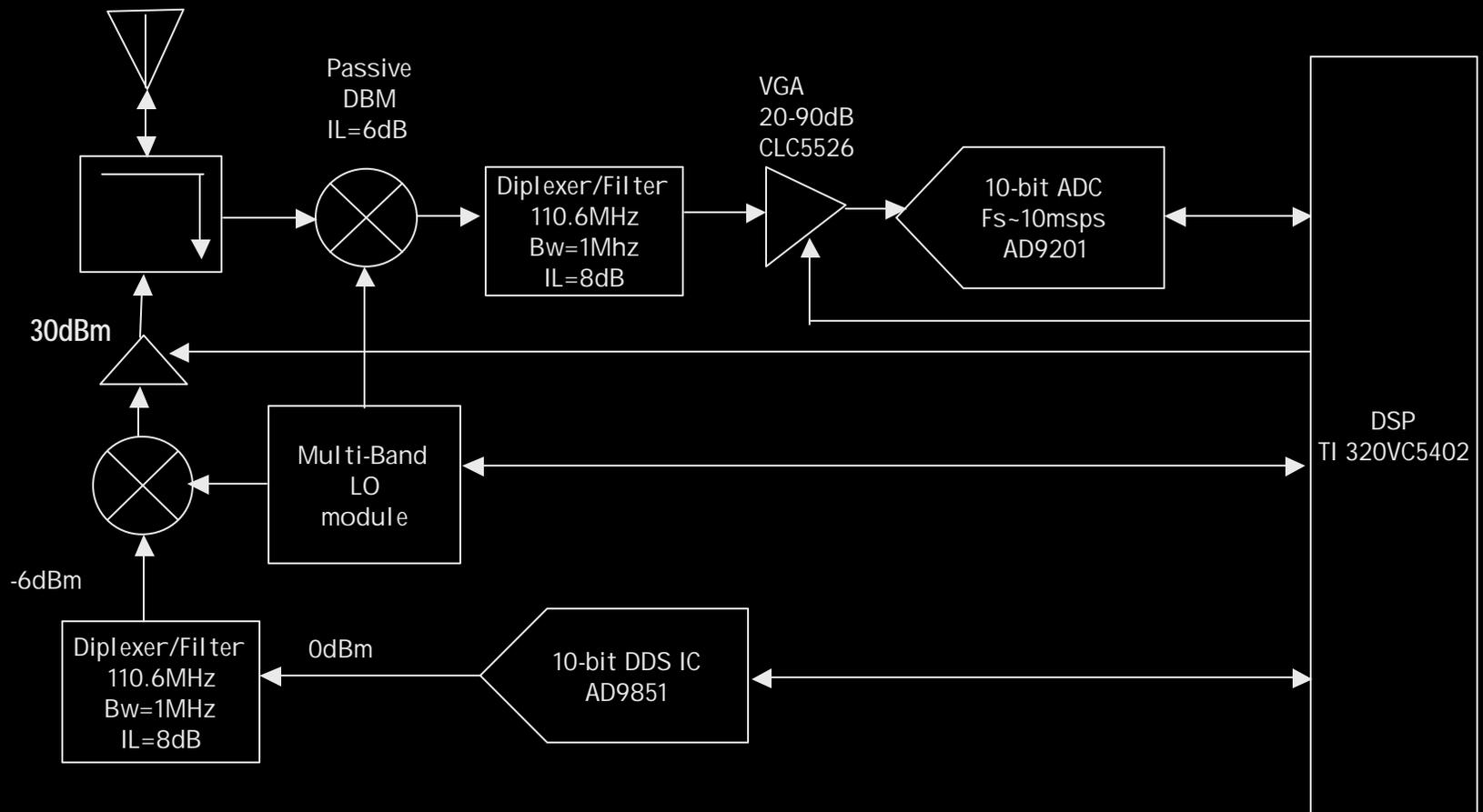




RF Front-End Architecture

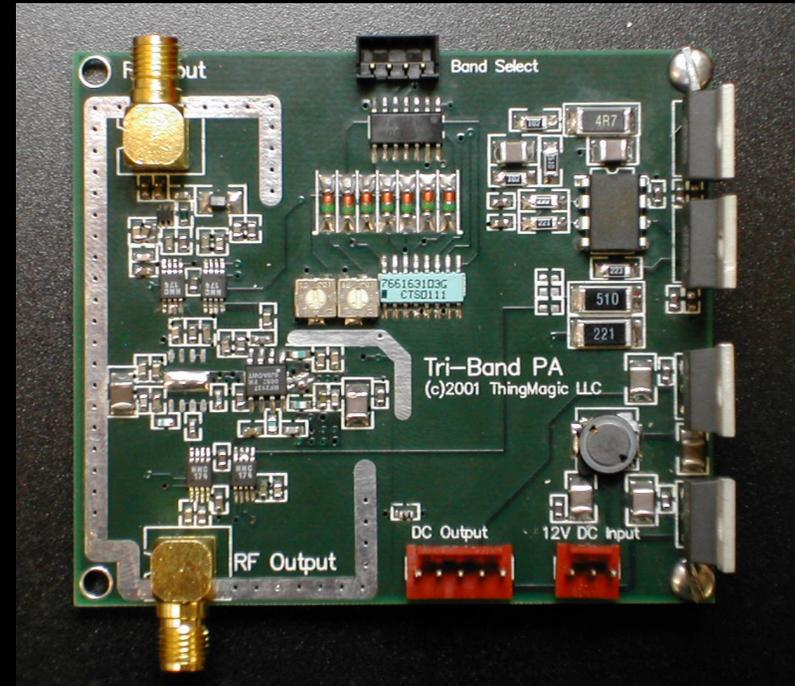
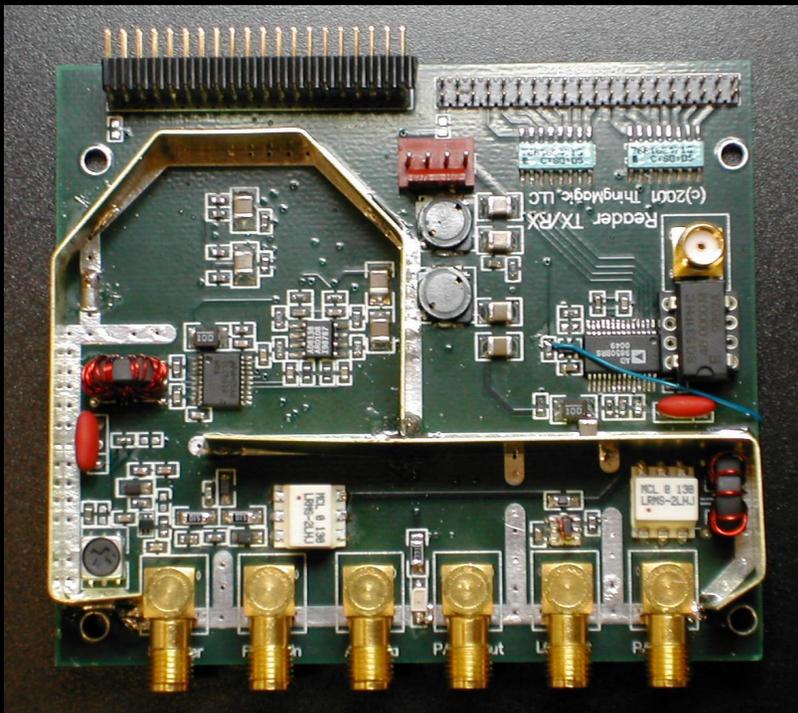


- antenna
- rf frontend
- synthesizer
- dsp
- bamboo





RF Front-End Hardware



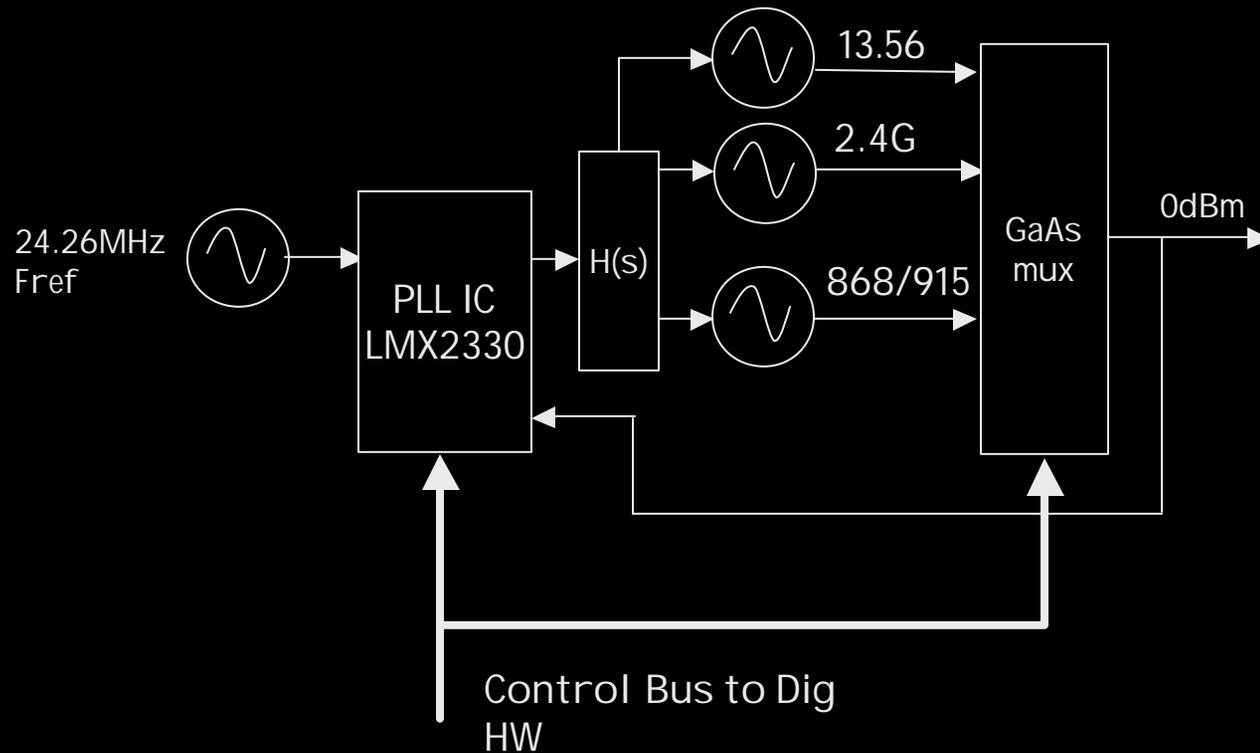
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Frequency Synthesizer

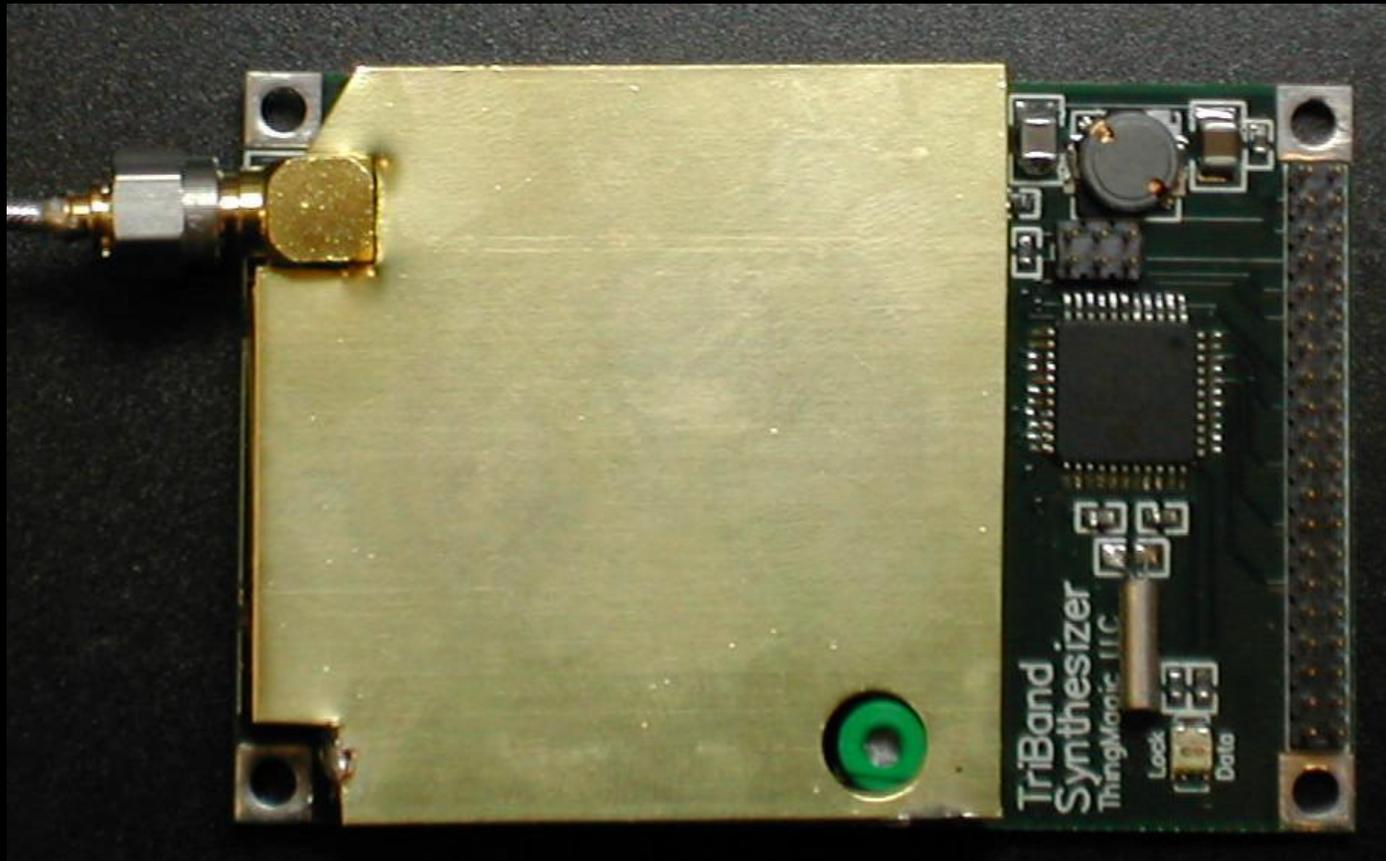


- antenna
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- synthesizer**
- dsp
- bamboo





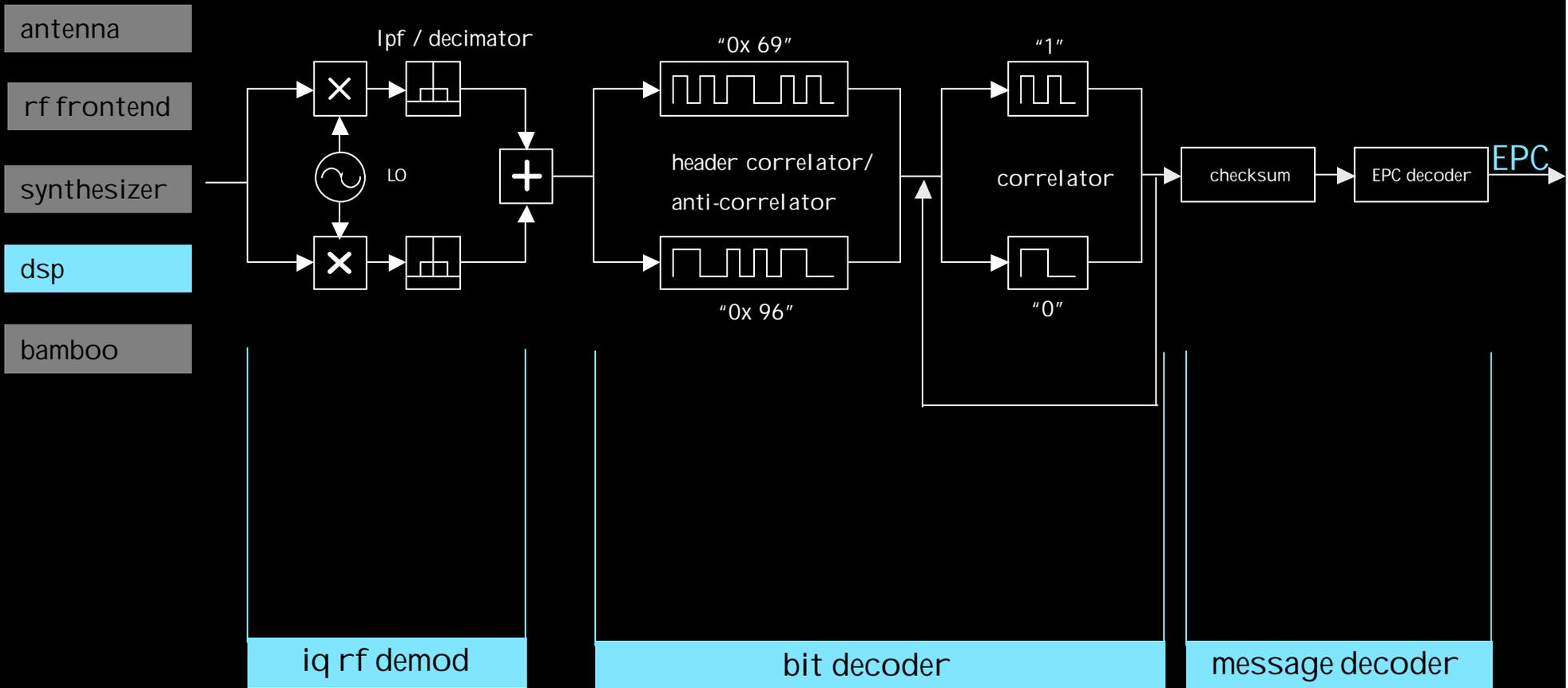
Synthesizer



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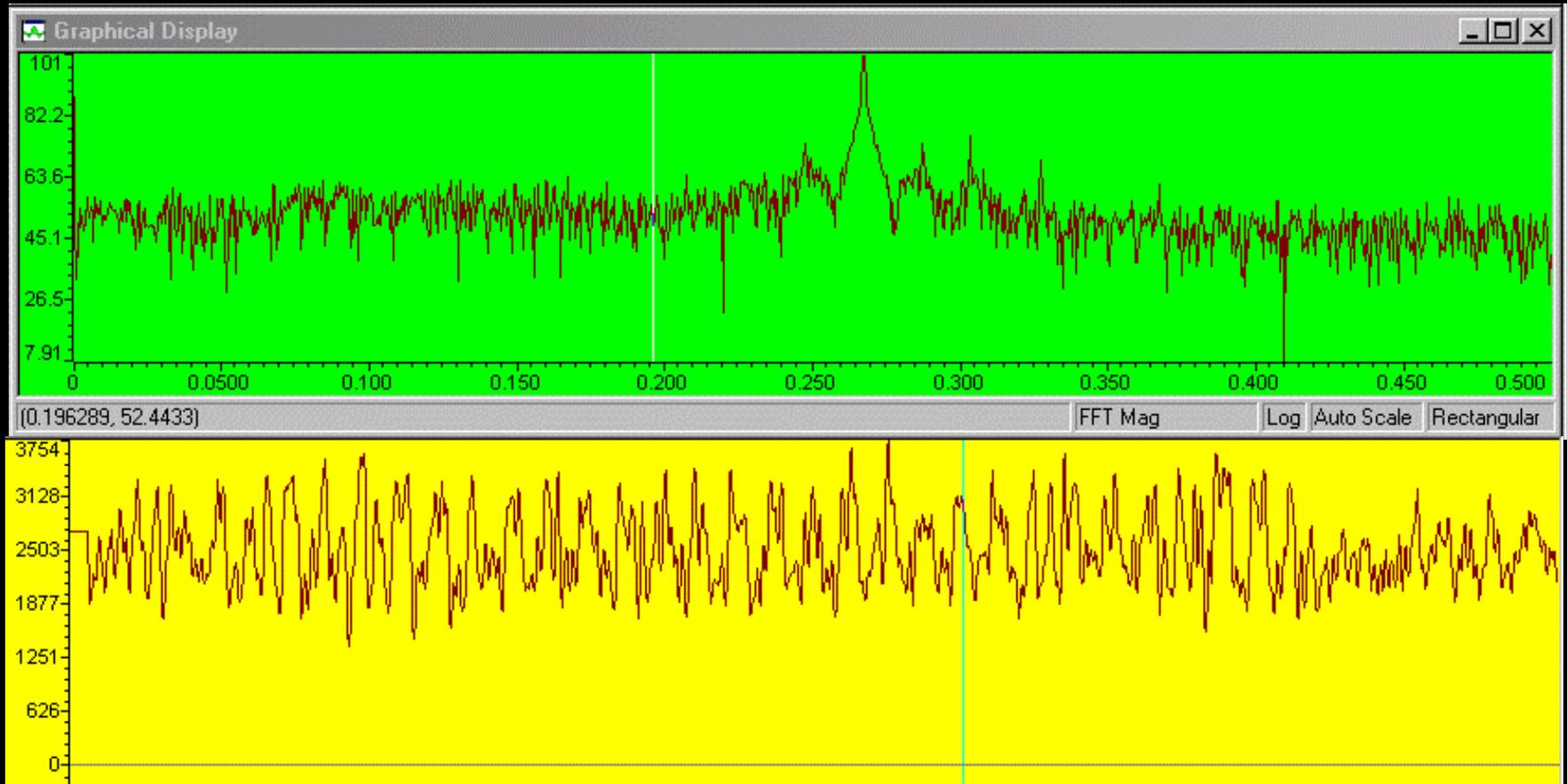


DSP Signal Chain





Digitized Signal @915MHz (CCAG)

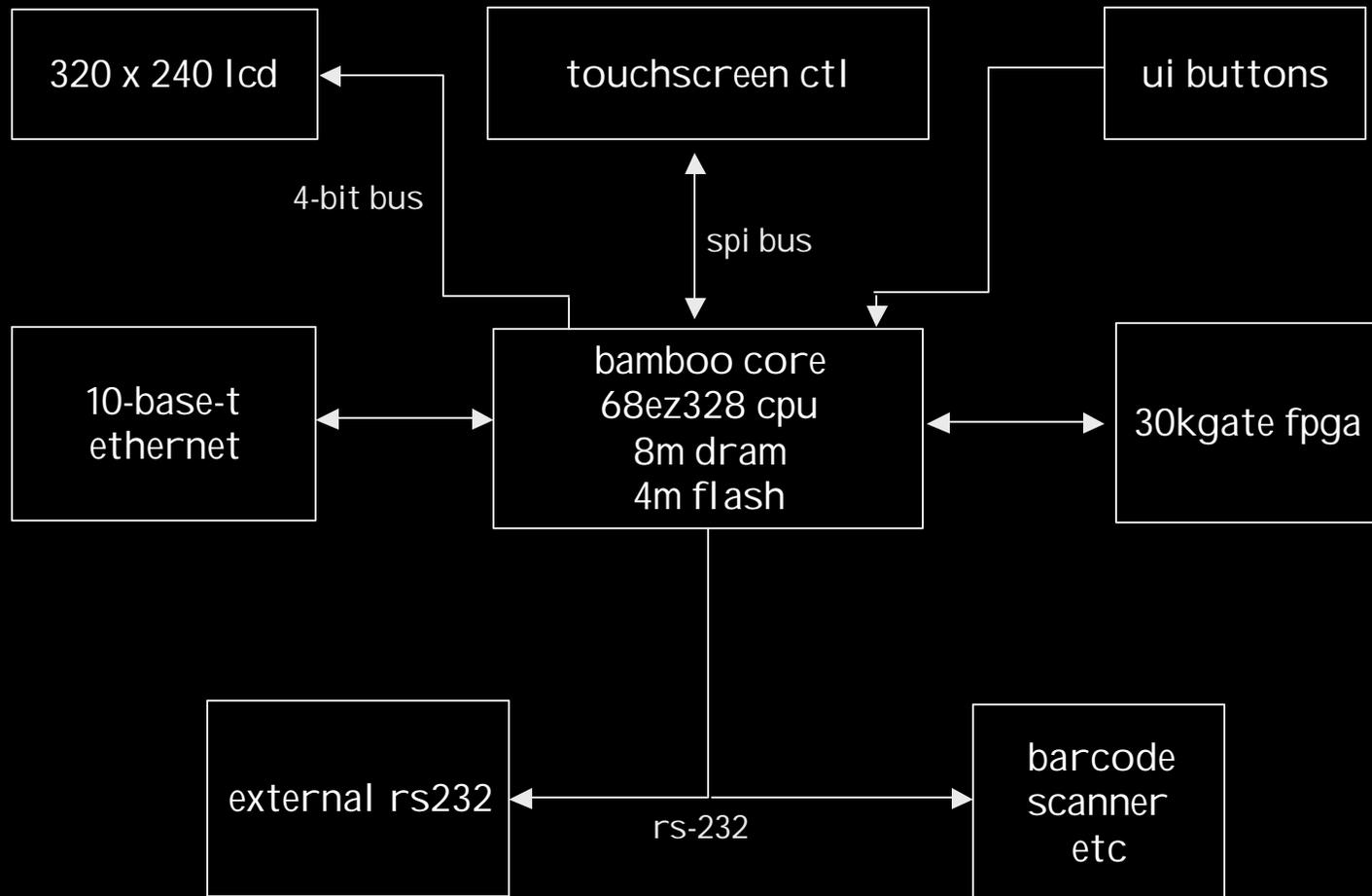




Bamboo Block Diagram

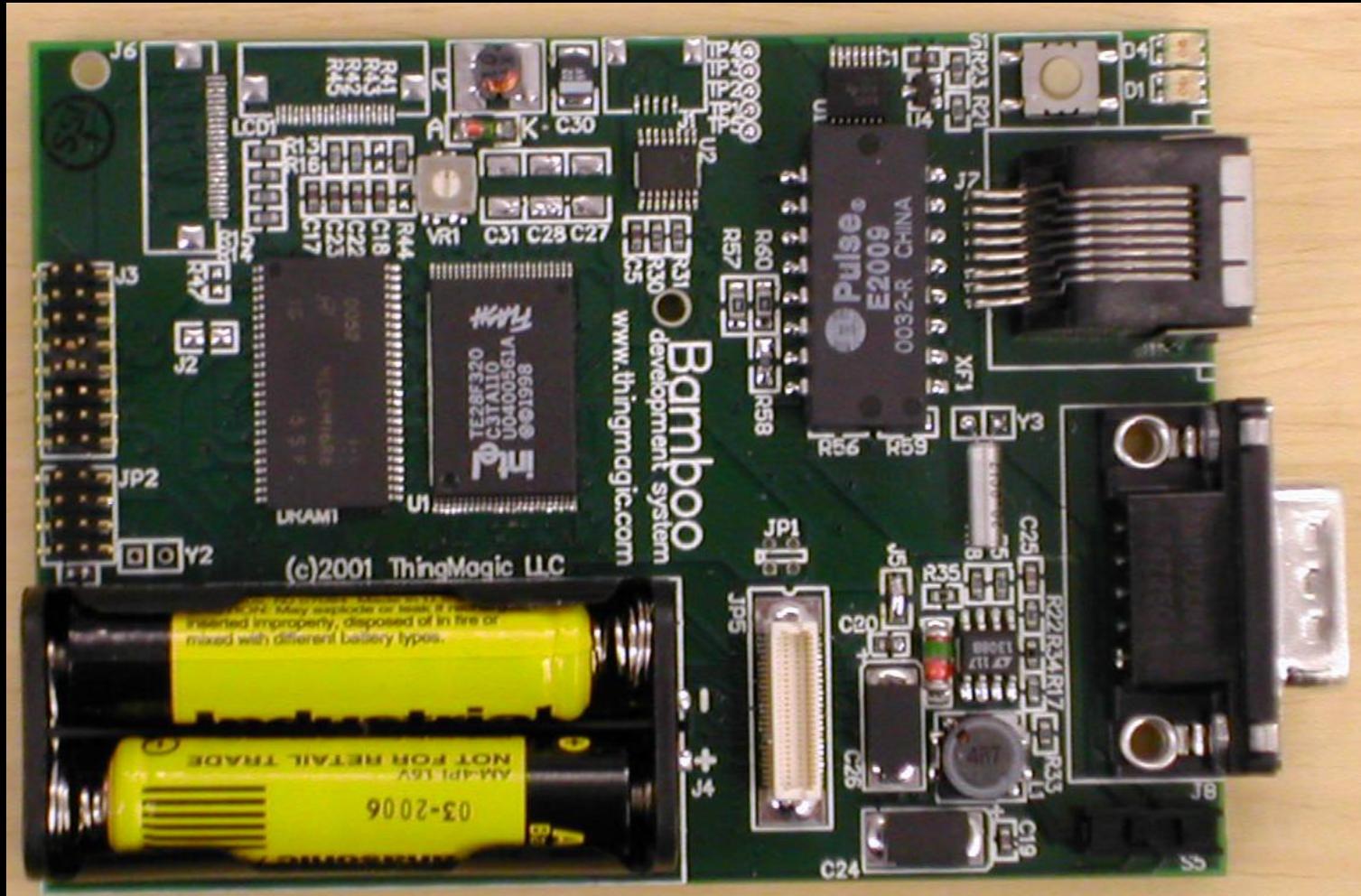


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Bamboo Hardware



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Bamboo Command Line Interface



http://10.0.0.131/demo.html - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Forward Stop Home Search Favorites History Print Refresh Stop

Address <telnet://10.0.0.131> Go Links »

ThingMagic  TriBand Multi-Protocol Reader V0.5

[configure](#)

[java r/w](#)

[reader CLI](#)

[warm restart](#)

[cold restart](#)

```
10.0.0.131 - SecureCRT
File Edit View Options Transfer Script Window Help

2 3 4 46 5 6
cmdline cpuinfo devices dma filesystems interrupts
ioports kcore kmsg loadavg locks meminfo
mounts net scsi self serial stat
sys uptime version
# cat cpuinfo
CPU: MC68EZ328
MMU: none
FPU: none
Clocking: 14.3MHz
BogoMips: 1.79
Calibration: 896000 loops
# cat meminfo
          total:        used:        free:    shared:    buffers:    cached:
Mem:  8065024 1286144 6778880         0  294912  421888
Swap:         0         0         0
MemTotal:    7876 kB
MemFree:    6620 kB
MemShared:         0 kB
Buffers:    288 kB
Cached:    412 kB
SwapTotal:         0 kB
SwapFree:         0 kB
#
```

Ready Telnet 24, 3 24 Rows, 80 Cols VT100

Internet

Screenshot of Live System



Bamboo Java Interface



http://10.0.0.131/demo.html - Microsoft Internet Explorer

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rx_level: 2099
agc_level: 5
00070992000108330005000000000000

 0 915 MHz	 1 915 MHz	 2 915 MHz	 3 915 MHz
 4 2.4 GHz	 5 2.4 GHz	 6 2.4 GHz	 7 2.4 GHz

Done Internet

Screenshot of Live System



Bamboo <-> Savant Interface



Two modes of interface, using standard Internet protocols:

1. Configuration via SNMP (Simple Network Management Protocol)
2. Real Time Data Exchange via UDP (Unreliable Datagram Protocol)

Simple transport, reliability added via the Savant architecture



Questions/Comments?

