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E1485
Digital Signal Processor

&

HP35635T
VXI Programmer's Toolkit

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Lake Stevens Instrument Division
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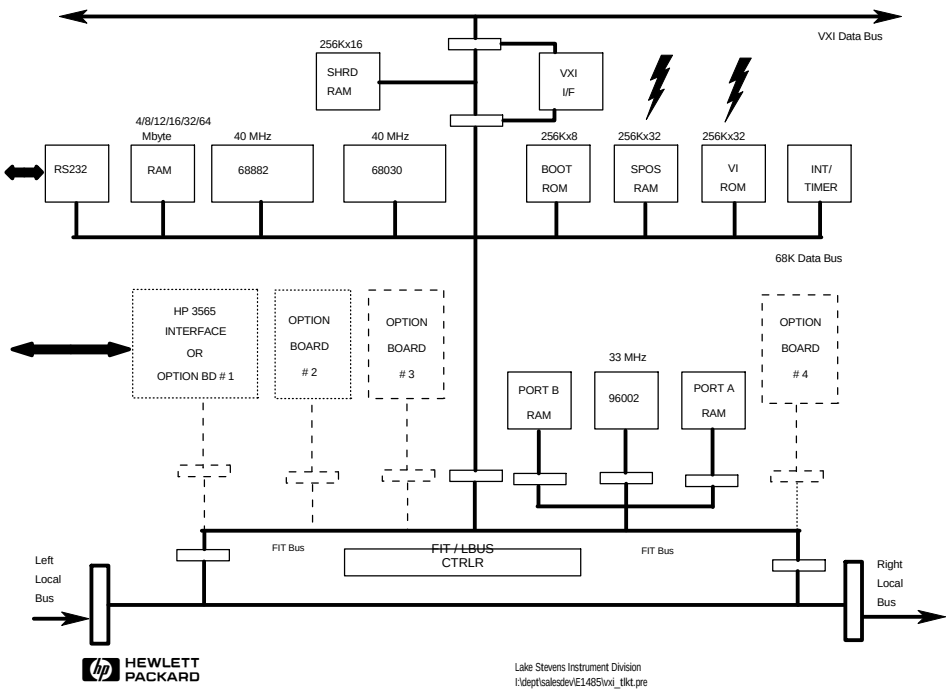
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E1485A Features

- 40MHz 32 Bit Motorola Processor.
- Up to 64 MBytes of RAM.
- Fixed or Floating Point DSP.
- Up to 5 DSP per E1485.
- HP35635 Programming Environment.

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E1485A Digital Signal Processor



CPU
Manages communication with the host, initializes and monitors DSP operations and data transfers, and controls other VXI modules.

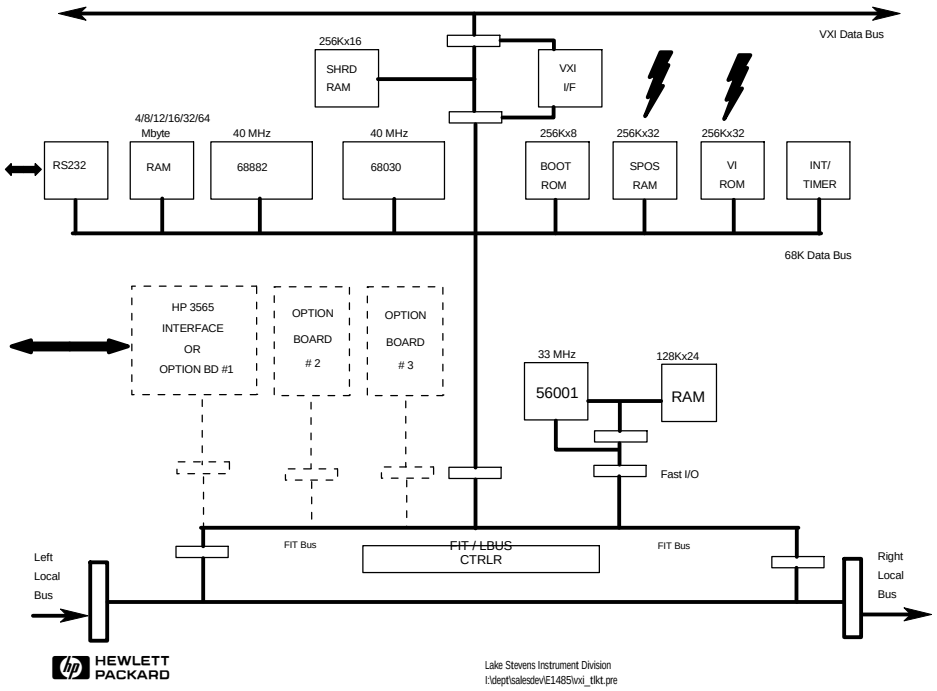
DSP
For FFT speed and computational dynamic range, select the HP E1485A.
1,024-point, complex FFT in under 2 ms.
For economy, select the HP 1485B.
1,024-point, complex FFT in under 4 ms.

FIT
Speed data transfer. It moves data between the CPU, the DSP assemblies, and the high-speed local bus at rates as high as 20 MB/s.

High Speed Local Bus
HP has implemented a high-speed module-to-module transfer protocol using the VXI P2 connectors. Between ajacent modules at rates as high as 100 MB/s.

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E1485B Digital Signal Processor



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Specifications

CPU

Main CPU	Motorola 68EC030, 40 MHz
Floating point unit	Motorola 68882, 40 MHz
RAM	4 MB (upgradable to 8,12,16,32,64)

VXI Interface

Message-Based Commander/Servant	
Programmable Interrupt Handler	
Supports A16/A24, D32/D16/D08 (EO)	
Master/Slave	
Shared RAM	128 K x 32 static RAM

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Specifications (cont.)

Data Transfer

FIT bus cycle time	150 ns (32 bits every 150 ns)
FIT transfer rate	6.67 MHz
Local bus passthrough rate	Up to 100 MB/s
Local bus to DSP rate	16 MB/s to 96000 RAM
	26.6 MB/s in some situations

	Motorola 96002 DSP	Motorola 56001 DSP
Clock speed	33.33 MHz	33.33 MHz
Operation rate	49.5 MFLOPS, peak	16.5 MIPS
FFT speed (1,024 complex with windowing & bit reversal)	< 2ms	< 4 ms

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Why VXI Programmer's Toolkit

Programmer's Toolkit is a software development environment for people developing:

- Custom, high performance VXI based systems.
- Systems requiring very fast FFT based processing.
- High channel count FFT based measurement systems.
- Signal capture and analysis software.
- Systems needing multiple DSP processors.

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What Does VXI Toolkit Provide?

The Programmer's Toolkit provides tools and libraries for writing code which executes inside of HP's E1485A/B Digital Signal Processing Module.

- Signal Processing Operating System (SPOS).
- Signal Processing Interface Library (SPIL).
- Shared RAM FIFO library.
- DSP Algorithm Library.
- Software development and debugging tools.
- Hands-on, factory training.

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LSID Supported VXI Products

- E1485 - Digital Signal Processor
- E1430 - 10 MSample/sec ADC, with filtering & memory
- E1562 - 2 to 4Gbyte Data disk with optional DAT
- E1431 - 8 Channel 25.6 KHz ADC
- Any message based VXI Card

Note: Register based cards require a downloadable
C Library for the 68k, or direct register programming

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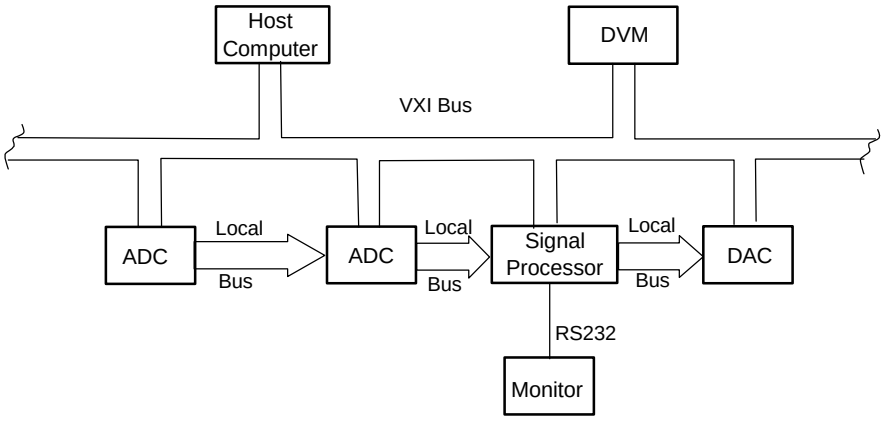
Measurement Control & Signal Processing

Programs for the E1485A are developed on a HP series 300/400/700 workstation using standard ANSI C software tools:

- Easy access to the Motorola 96002 or 56001 processors.
- The ANSI C Compiler is used to generate host code.
- The GNU C cross compiler (included) is used to generate Motorola 68k code.
- Programs can be stored in E1485A flash rom for stand-alone applications.

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BasicComponents of a Typical VXI Measurement System



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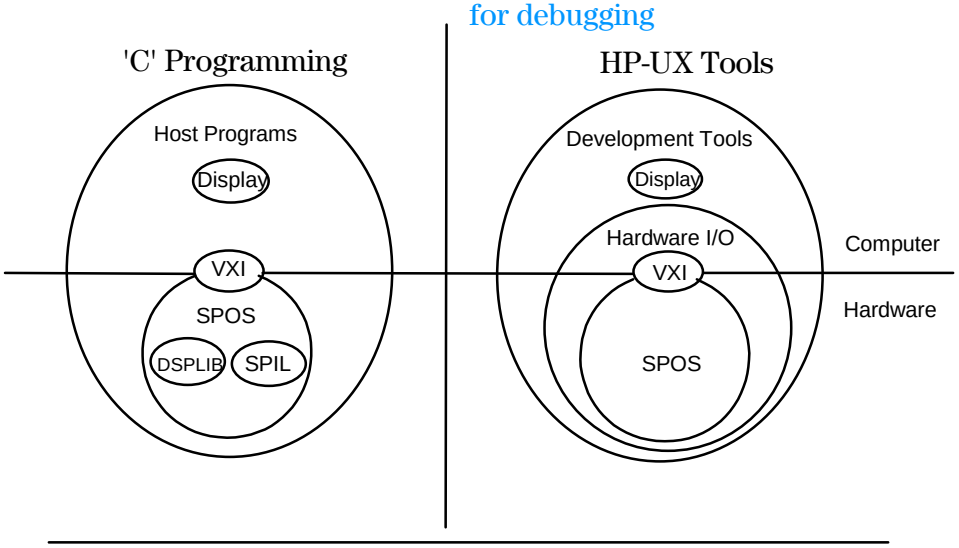
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How the Pieces Fit Together

Faster - more complicated

Slower - easier to use - good for debugging



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The Signal Processor Operating System (SPOS)

The operating system for the E1485

- The runtime environment for the E1485A DSP Module
- A signal processor interface library (SPIL).
- DSP Library.
- ASCII command interpreter.
- Message communication and interpretation.
- A downloaded user process for the Motorola 96K or 56K.
- A debug process.

SPOS is usually loaded from the E1485A ROM on power on.

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Signal Processor Interface Library (SPIL)

SPIL facilitates the development of downloadable code with C function calls that hide the hardware complexity from the user. These functions handle:

- VXI I/O for control of other VXI devices.
- Host communication messages.
- DSP control and status.
- Local Bus and VME data transfers.
- Internal data transfers (FIT bus).
- Time operations, software signaling, math functions and program debugging.

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DSP Library

- A library of completed/assembled algorithms for the Motorola DSP chips on the E1485A DSP Module:

add	average	bit reverse	block constant
conjugate	convt to flt	copy block	cross power
end loop	FFT	FFT I/O	FIT in Olap
FIT Wait	flip	histogram	loop
mag. sqr.	mult	offset	phase
rand	scale	subtr	usr window
window	zoom		

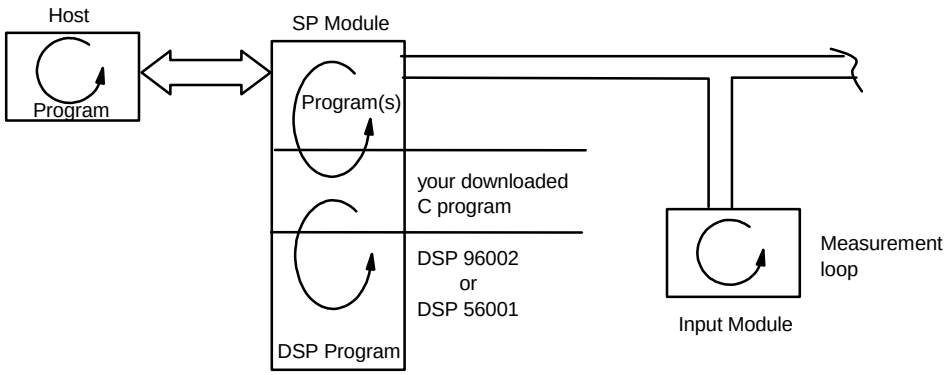
- Tools for adding user written algorithms to the Library
- Support for user algorithms via Motorola's 96K/56K assembly development software (available from Motorola)

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DSPILB Programming Surface



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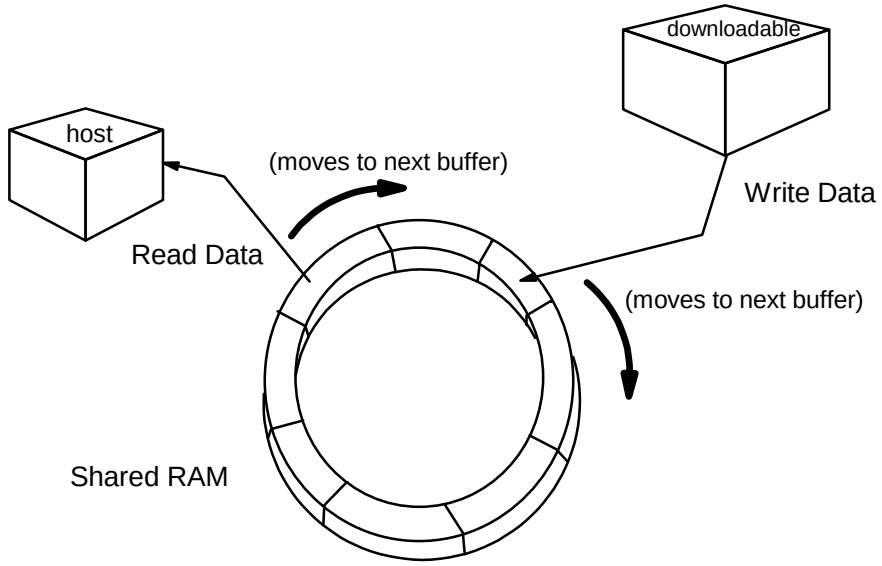
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Shared RAM FIFO Library

- Provides use of E1485A shared RAM with the host as FIFO memory with overlapping reads and writes
- Improves data tranfer rates from E1485 to the host computer.
- Uses SICL (Standard Instrument Control Library) for mapping FIFO memory into user's process.

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Shared RAM Diagram

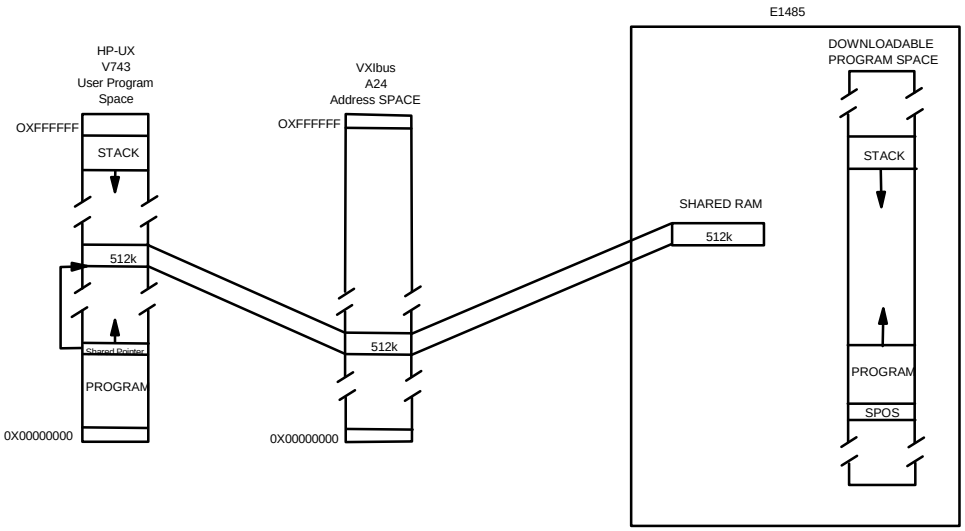


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Shared RAM Memory Mapping

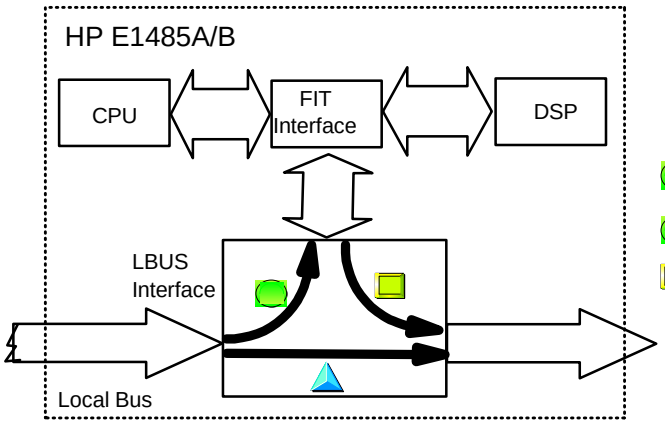


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Local Bus



- Consume Mode
- Pipe Mode
- Generate Mode
- Transform Mode
- Eaves Drop Mode
- Append Mode

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Software Development Tools

- Debugging tools:
  - Read/write to E1485A registers and RAM locations.
  - E1485A external RS232 debug monitor port.
- X11 windows graphing functions for data visualization. (XPLOT)
  - source code for XPLOT is included.
- HPUX Command Line Interface for hardware (HWIO)
- Tools to download compiled programs into the E1485A (HWDLD).
- Data type conversion tools (CONV).

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Three Day Training Course Included
35635T Programmer's Toolkit

- Hands on at the HP Lake Stevens , WA (Seattle) factory.
- Training covers:
  - E1485 and E1430 hardware fundamentals.
  - SPIL programming.
  - Program debugging.
- Class size is limited to 5 persons.
- Each participant selects from advanced topics including:
  - Multiple DSP processing .
  - User interfaces.
  - High speed displays . . .

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Class Agenda

- Module 1:
  - Class Overview
- Module 2:
  - VXI Overview
- Module 3:
  - Development Environment
- Module 4:
  - Review of C and HP-UX
- Module 5:
  - Host Functions
- Module 6:
  - Data Transfer
- Module 7:
  - Hardware Concepts
- Module 8:
  - Processing Data
- Module 9:
  - Local Bus and FIT Bus
- Module 10:
  - Multiple-input Data Processing
- Module 11:
  - Interfacing with HP 3565
- Module 12:
  - Using the DSP 56001

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Assumed Background Knowledge

To optimally absorb the large amount of material presented in the class, candidates should be experienced 'C' programmers, especially in the areas of:

- UNIX (HP-UX) operating environment
- 'C' Programming Language
  - Pointers
  - Structures
- Dynamic Signal Analysis (DSA) fundamentals
- VXI fundamentals
- HP-IB fundamentals

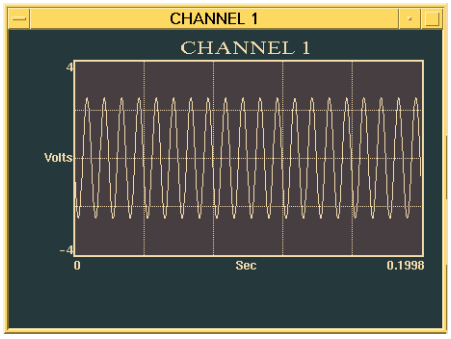
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Miscellaneous

- Software Upgrades
  - New revisions to software will be offered for sale.
  - Registered owners will be notified of upgrades.
- Export License
  - High FFT speeds and potential surveillance applications cause the US Government to require an individual export license for sales into non-COCOM countries.

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Time Capture Demo (timecap)



Time Capture data acquired from the HP E1430 input module.

This program demonstrates data acquisition from an HP E1430 over the Local Bus. The SPIL program acquires data continuously until the memory in both the E1430 and E1485 modules is full. The data is then transferred to the host program to be displayed.

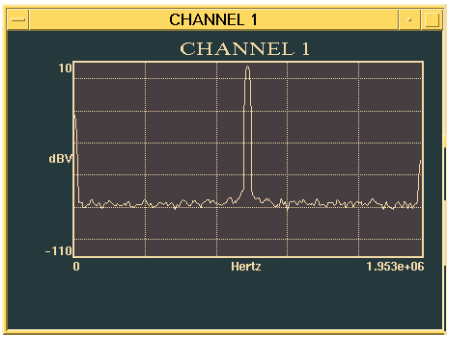
Performance	Updates/Sec
V382 - 25 Mhz	20
715 - 50 Mhz	80
V743 - 100 Mhz	190

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56K DSP Demo (dsp56)



Magnitude-Squared spectrum from data acquired from the HP E1430 input module.

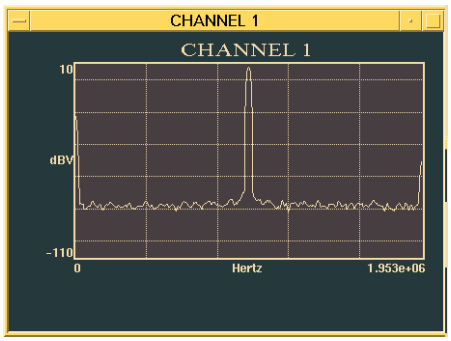
This program demonstrates the use of the DSPLIB libraries for the MC56000 DSP. The program acquires time domain data from the E1430, performs an FFT, Average and then sends the results to the Host program to be displayed.

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FIT Bus Demo (fitbus)



Magnitude-Squared spectrum from data acquired from the HP E1430 input module.

This program demonstrates the use of the FIT bus to transfer data from main RAM to DSP and back again.

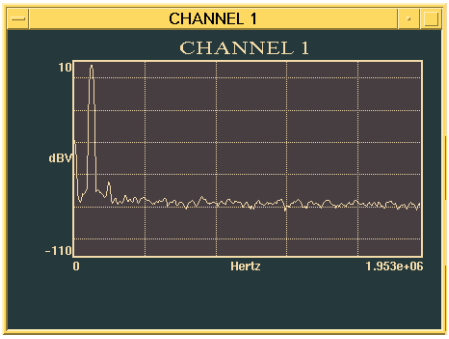
Performance	Updates/Sec
V382 - 25Mhz	21
715 - 50 Mhz	16
V743 - 100 Mhz	15

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Multiple DSP DEMO (multdsp)



Magnitude-Squared spectrum from data acquired from the HP E1430 input module.

This program demonstrates the use of multiple MC96002 DSP's. The program uses one DSP for averaging, and the rest for performing FFT's.

Performance	Updates/Sec
V382 - 25 Mhz	23
715 - 50 Mhz	16
V743 - 100 Mhz	14

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More Demos

HP 3565 Demo (hp3565)

This program shows how to make measurements with a 3565 system Controlled by an E1485 module. The program has a number of options that allow zoomed or baseband measurements in either the time or frequency domain. A sine wave can also be generated by the 35653A source module to provide an input signal.

Meter Demo (meter)

This program contains a downloadable SPIL program that controls a digital multimeter (E1410A). The program finds the meter in the E1485's servant area, takes readings from the meter and prints them to the E1485 monitor

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HP 3565 DEMO:
With no command line options specified, the program will make baseband measurements with a 1.6 Khz span. Only Time domain data will be displayed, and the source will be set to output a 100Khz sine wave.

Options are: -f (FFT), -h (Hann), -s <src freq>,
-u (Uniform), -z (Zoom)

METER DEMO:
This program will start taking reading from the E1401 and print them to the debug monitor.

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More Demos (Con't)

Custom 96K DSP User Programs (userprog)

This program can be downloaded into the signal processor. It demonstrates how to integrate a custom 96002 DSP program into the E1485 enviroment.

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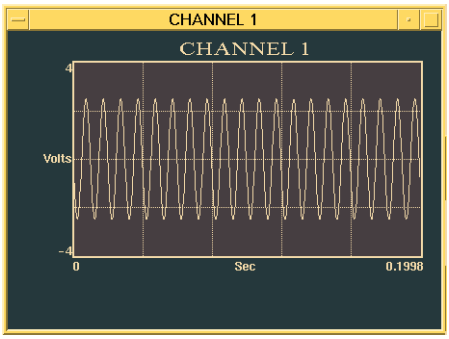
This sample DSP program is user.asm which has been assembled to produce the user.lod file. This was done using the Motorola DSP96000 development environment running on a PC. The simple downloadable program, user_d.c shows how to integrate this custom DSP program.

The DSP program converts a packed array of 16 bit fixed point numbers resident in the 96000's X memory into an array of 32 bit floating point numbers residing in the 96000's L memory (alternating X and Y)

The values in the input array and output array are displayed on the debug monitor.

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Data Lab (data_lab)



Time Capture data acquired from the HP E1430 input module.

This program demonstrates the setup and data acquisition from an E1430 analog input module.

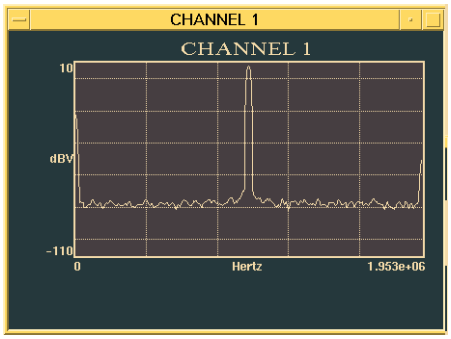
Performance	Updates/Sec
V382 - 25 Mhz	32
715 - 50 Mhz	75
V743 - 100 Mhz	90

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96K DSP Lab (dsp96_lab)



This program demonstrates the use of the DSPLIB96 libraries. The program acquires time domain data from an E1430 analog input module, performs an FFT on the data and sends the resulting magnitude-squared spectra to the host program for display.

Magnitude-Squared spectrum from data acquired from the HP E1430 input module.

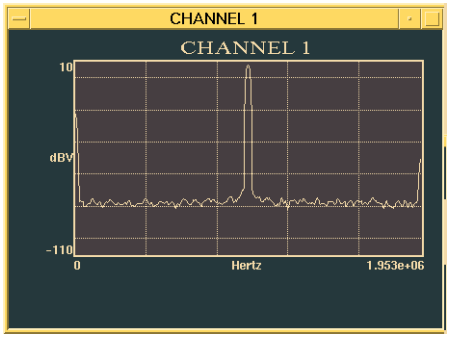
Performance	Updates/Sec
V382 - 25 Mhz	20
715 - 50 Mhz	16
V743 - 100 Mhz	14

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Local Bus Lab (lbus_lab)



Magnitude-Squared spectrum from data acquired from the HP E1430 input module.

This program demonstrates data acquisition from the E1430 analog input module over the Local Bus.

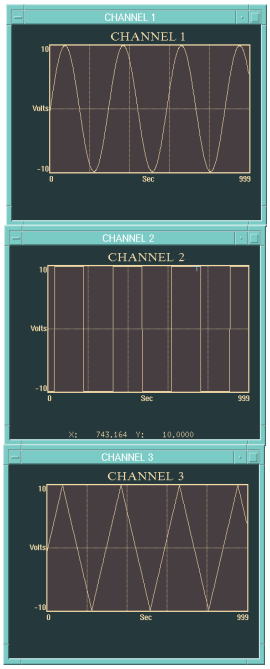
Performance	Updates/Sec
V382 - 25 Mhz	32
715 - 50 Mhz	32
V743 - 100 Mhz	32

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Shared Ram FIFO Lab (srf_lab)



This program demonstrates data transfer from an HP1485 to a controller using Shared Ram. The Sine, Square and Triangle waves are all generated within the E1485.

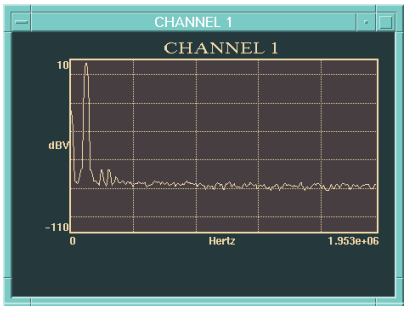
Performance	Updates/Sec
V382 - 25 Mhz	32
715 - 50 Mhz	62
V743 - 100 Mhz	67

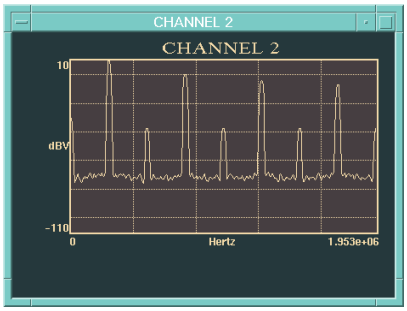
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Multiple E1430 Lab (multi__lab)





This program acquires and processes data from multiple E1430 input modules simultaneously.

Performance	Scans/Sec
V382 - 33 Mhz	24
715 - 50 Mhz	18
V743 - 100 Mhz	15

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More Labs

Communication Lab (comm_lab)

This lab demonstrates how messages can be used to communicate between the downloadable and host.

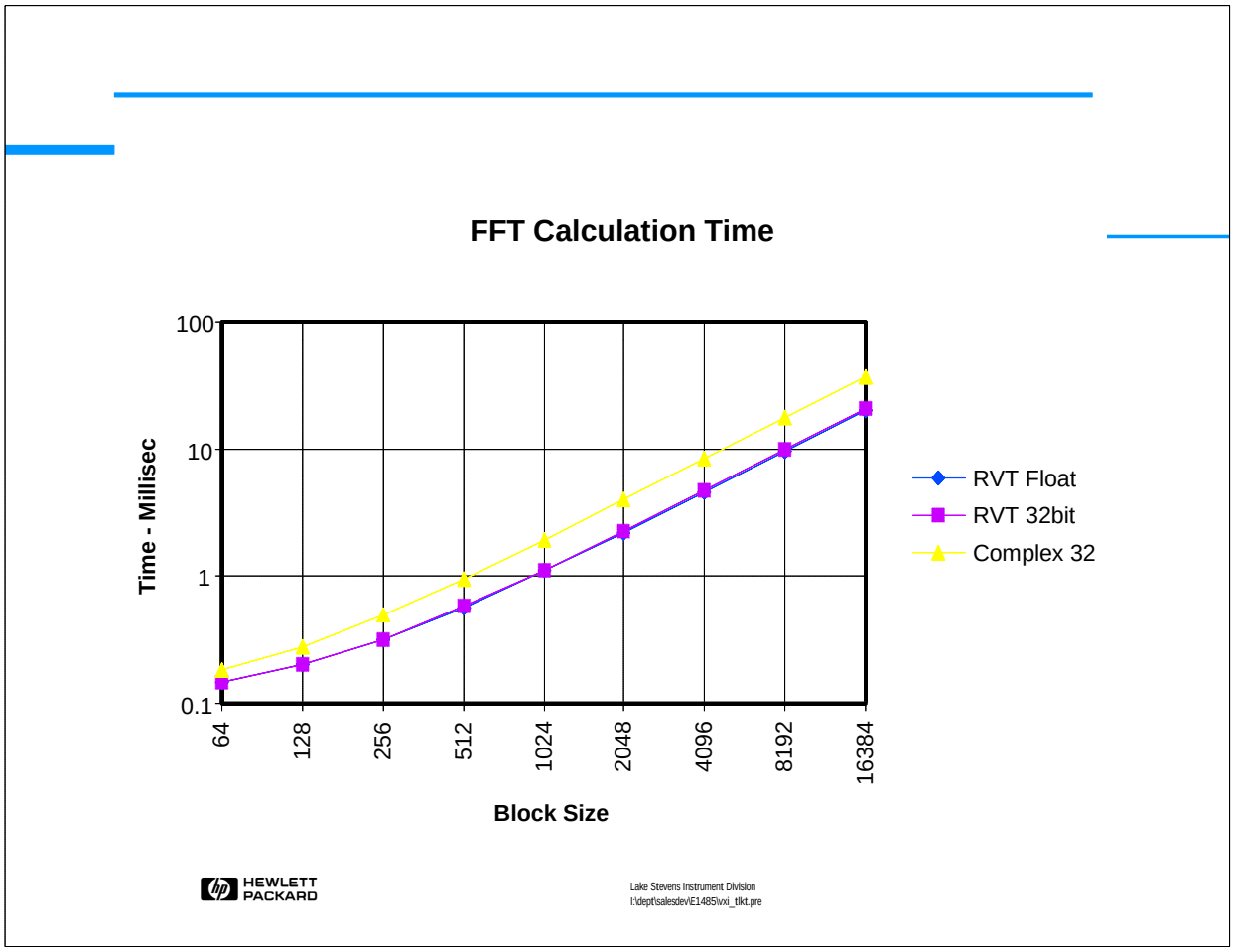
Message Lab (msg_lab)

This program demonstrates data transfer from the E1485 to a host program using messages.

Host Lab (host_lab)

This lab demonstrates how some typical host functions work for the set up and download of a target program into the E1485. The results can be seen on the system monitor.

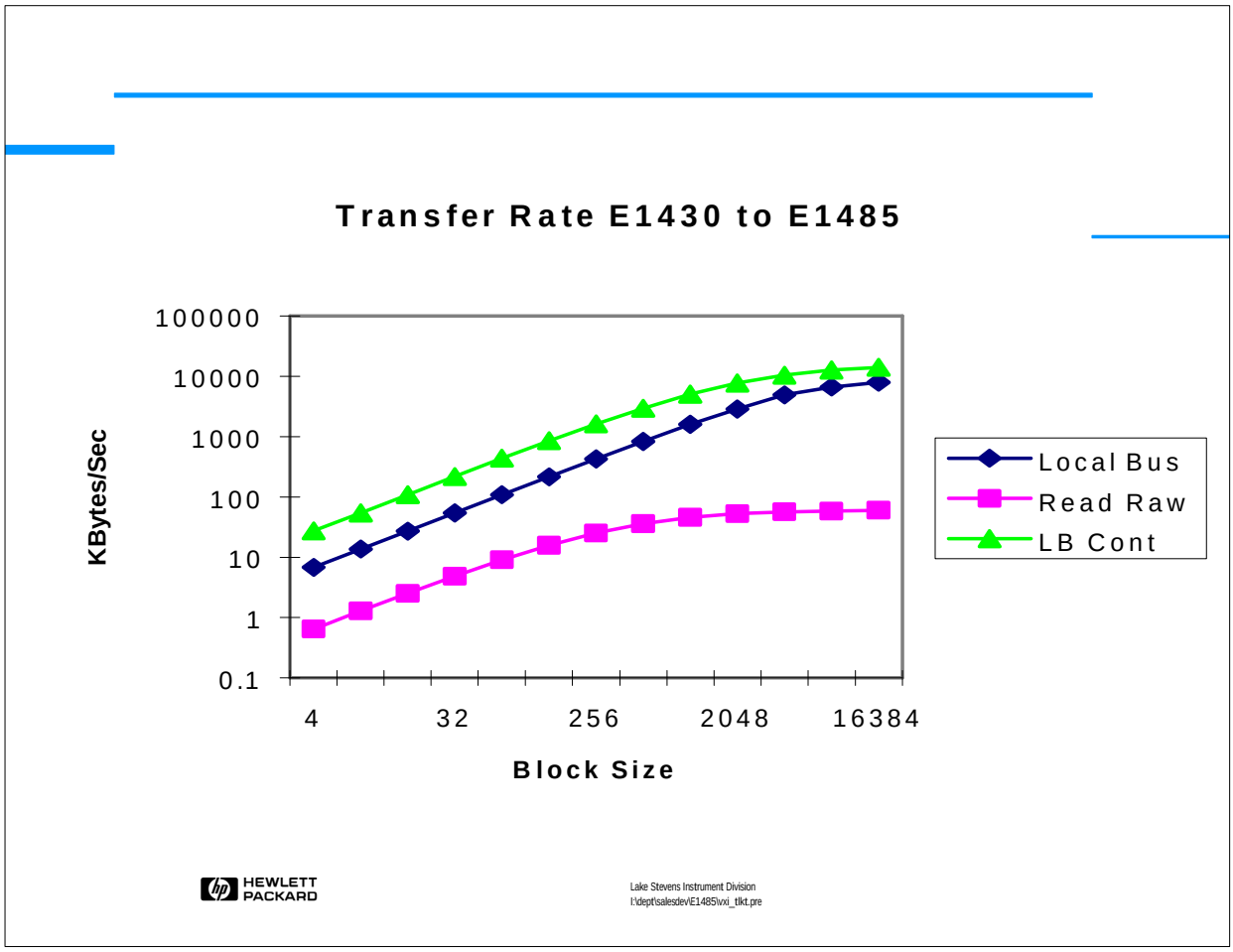
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FFT Calculation Time

The computational times associated with the FFT for a real 32 bit floating point transform, a real 32 bit integer transform and a complex 32 bit floating point transform include the time required to perform windowing.

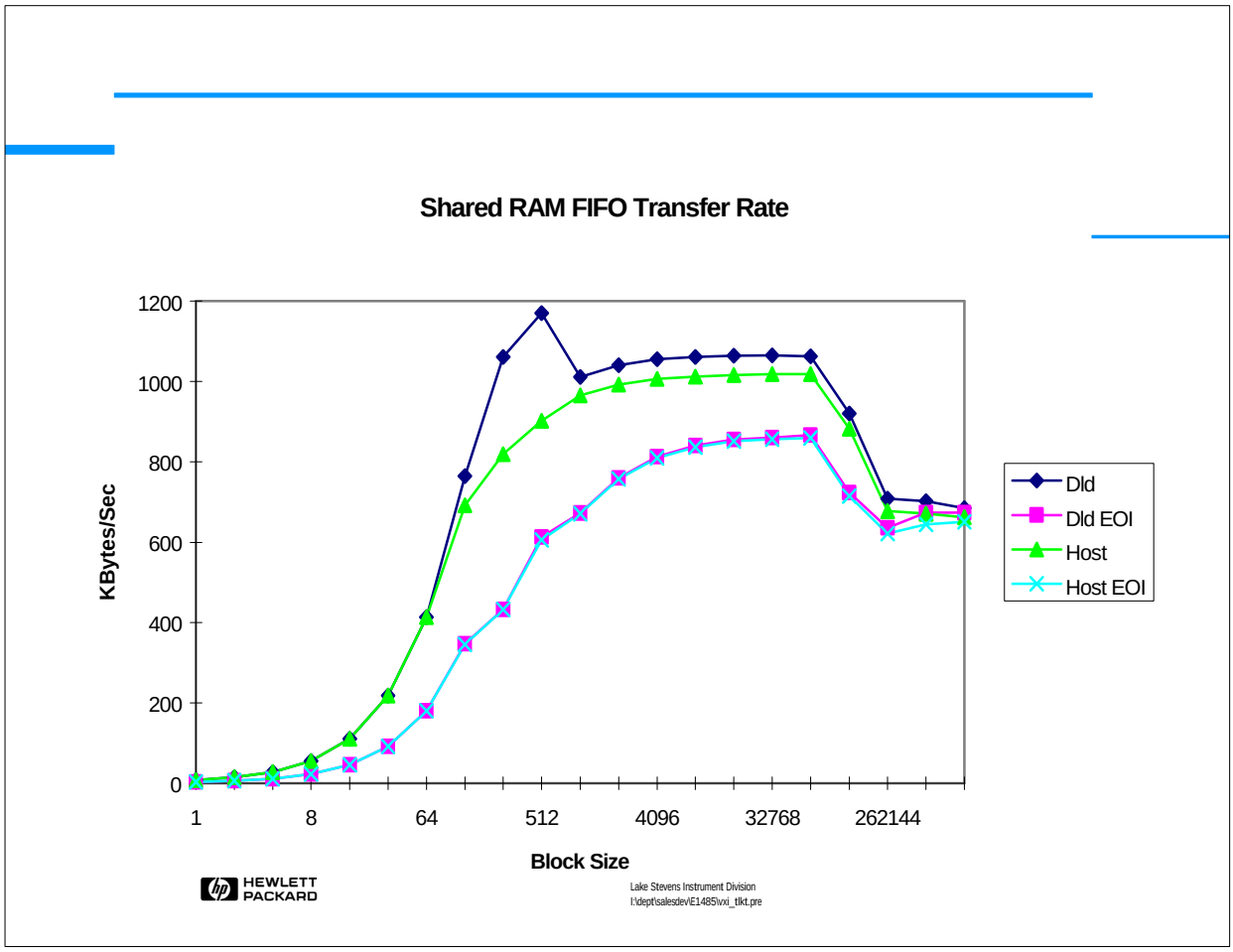
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Data Transfer Rates over Local Bus

The data transfer rates from the HP 1430A to the HP 1485A/B using local bus and raw reads show the performance improvements of local bus transfers.

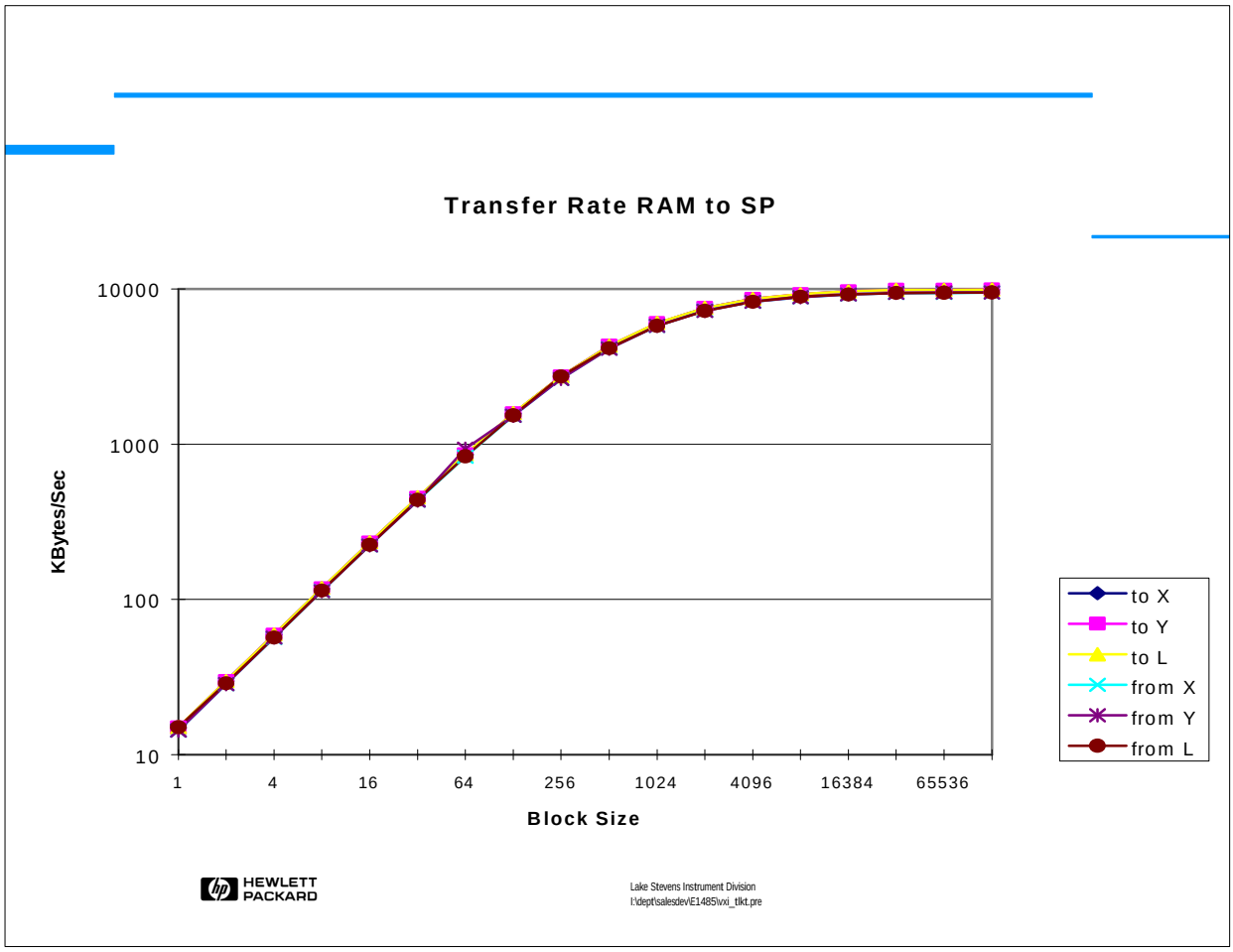
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Shared RAM FIFO Transfer Rates

The transfer rates between the host and shared RAM FIFO were determined using a series 700 workstation with a MXI interface.

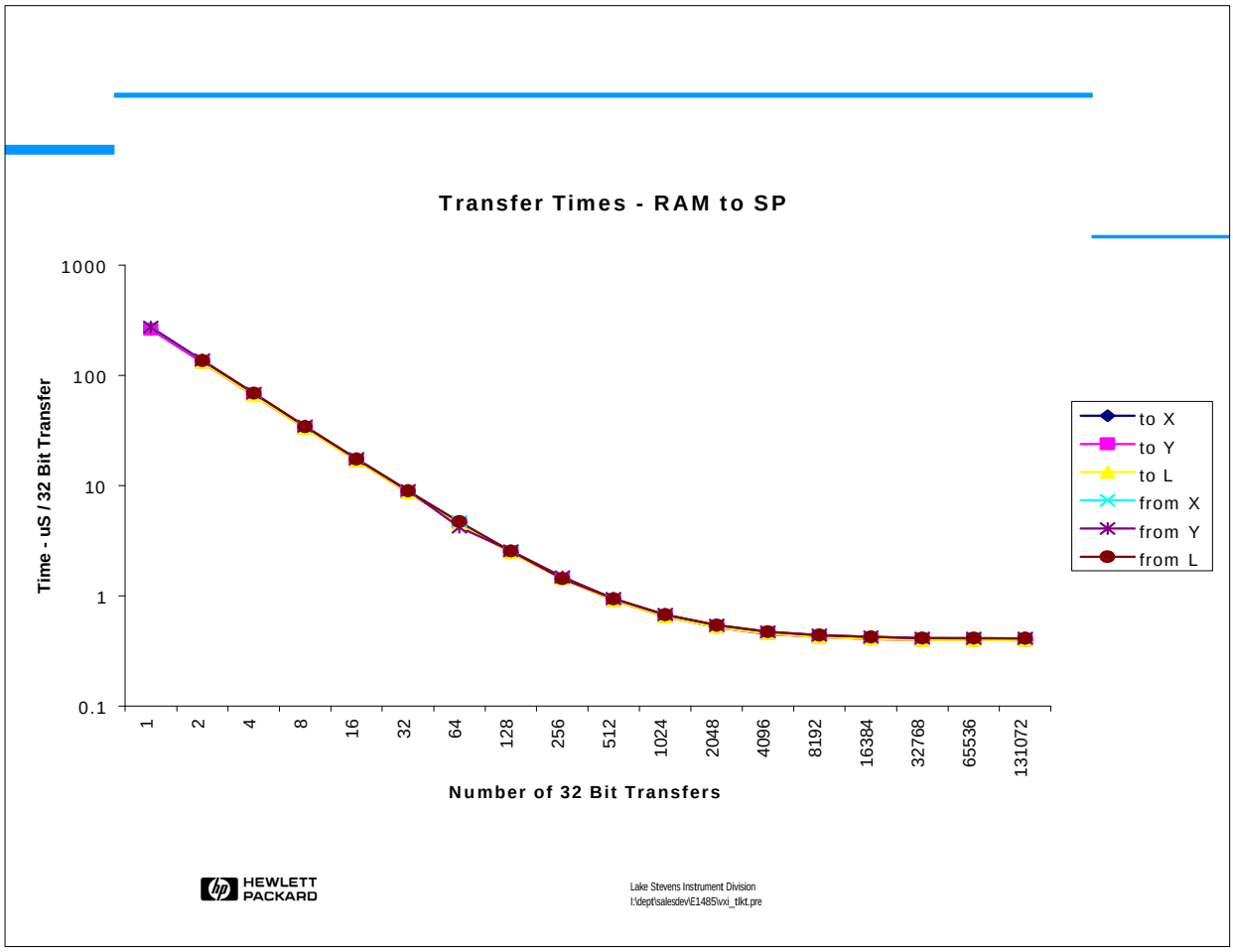
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Data Transfer Rates

The data transfer rate between the Motorola 68030RAM to the 96002 signal processor RAM is dependent upon the block size because of the associated overhead to setup a block transfer. The read and write times between the X, Y and L memories are approximately equal.

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Transfer Times for 32 bit Transfers

The time associated with transferring data between the Motorola 68030 and 96002 processor RAM are in microseconds per 32 bit transfer as a function of the block size. Again, the transfer times are approximately equal for the X, Y and L memories.

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