HP 150 Personal Computers

# HP 150 TECHNICAL Reference Manual Supplement

**Product No. 45625A**

**Personal Office Computer Division**
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# PREFACE

**CAUTION**

This document provides detailed technical information revealing internal details of the HP Touchscreen II hardware, firmware, and software.

This supplement presents technical information concerning the HP Touchscreen II Personal Computer and covers its hardware, firmware, and software subsystems.

The intent of the supplement is to aid in the development of hardware and software products which will become part of, or work in conjunction with, the HP Touchscreen II.

The *HP 150 Programmer's Tool Kit* (Product 45435A) and the *HP MS-DOS User's Guide* (Product 45624A) for complementary programming information including language and development tools.

This supplement to the *HP 150 Technical Reference Manual* documents only new information unique to the Touchscreen II.

# SUPPLEMENT OVERVIEW

This supplement consists of the following sections and appendices:

Section 1 - Introduction provides an overview.

Section 2 - Hardware Overview provides product specifications information and briefly describes each subsystem.

Section 3 - Hardware Subsystems contain detailed information on the hardware subsystems and helpful design hints.

Section 4 - Memory and I/O Mapping provides information on the memory and input/output bit mappings of the system's processor.

Section 5 - System Software provides information on the operating systems, device drivers, MS-DOS calls, AGIOS, BIOS, configuration, and disc format structure.

Section 6 - System Firmware provides mapping information on system RAM memory.

Section 7 - Programming the HP Touchscreen II contains programming information on escape sequences, MS-DOS, AGIOS, alphanumeric and graphics displays, datacomm, keyboard, HP-IB, and accessory card interfacing.

Section 8 - AGIOS Function Call Reference provides a reference list of AGIOS function calls.

Appendix A - Logic Diagrams contain schematic diagrams.

# TABLE OF CONTENTS

# TABLE OF CONTENTS (Continued)

# TABLE OF CONTENTS (Continued)

# TABLE OF CONTENTS (Continued)

# TABLE OF CONTENTS (Continued)

# TABLE OF CONTENTS (Continued)

# Introduction

SECTION 1

This section provides a general overview of the HP Touchscreen II.

CONTENTS

# INTRODUCTION

This section provides a general overview of this supplement to the *HP 150 Technical Reference Manual* as well as the HP Touchscreen II Personal Computer itself. Included is an outline of how this document is organized along with a brief description of the contents of each section. This is followed by a description of the HP Touchscreen II Personal Computer including information on product features, structure and specifications.

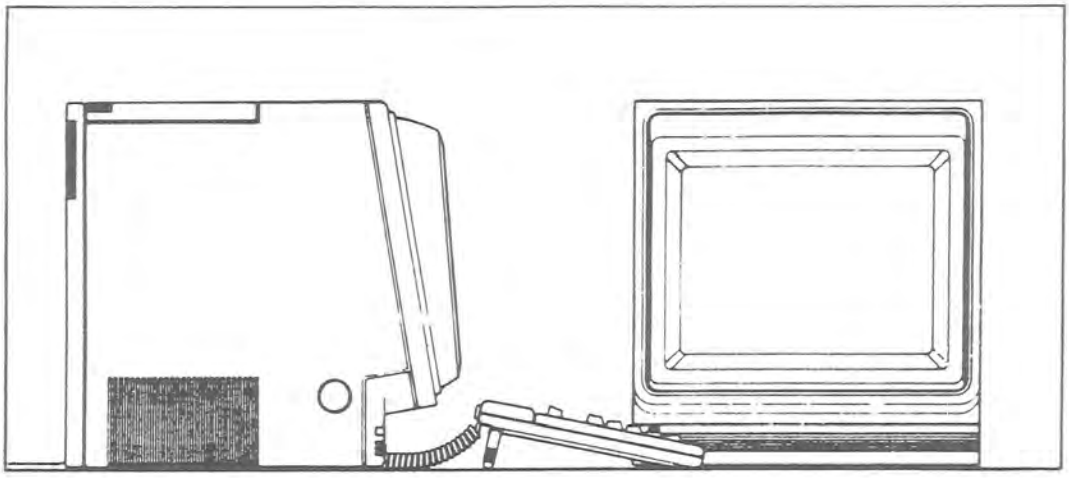


Figure 1-1. The HP Touchscreen II

# THE HP TOUCHSCREEN II

The HP Touchscreen II, an enhanced member of the HP 150 product family, offers a powerful business tool in a small, efficient package. Some of the HP Touchscreen II's features include a 12-inch display, four accessory slots, and additional graphics capabilities. The HP Touchscreen II was designed to be roughly one-third the PCA size of the HP 150 while virtually identical at the hardware bit level, and compatible with existing HP 150 software and hardware accessories. (Note that some applications may require the HP Touch accessory for correct operation.) The HP Touchscreen II system features are summarized below:

## System Architecture

- Intel 8088 (8 MHz) microprocessor
- One internal expansion slot for an 8087 Numeric Coprocessor accessory or other processor accessory
- One port for the HP Touch accessory (located behind the bezel)
- MS-DOS 2.11 operating system
- 256 Kbytes of main memory standard; 640 Kbytes maximum
- Four accessory card expansion slots
- Power to Slave dual micro-disc drive supplied by system
- Battery back-up for system configuration and real time clock

## Display

- A 12-inch display with integral tilt
- Standard high-resolution on-screen graphics display 512 x 390, or 640 x 400 alternate mode (alternate mode not available on HP Touchscreen II Terminal)
- High-resolution character display; 8 x 14 dot character cells; upper and lower case
- Display enhancements: inverse video, underline, blinking, half-bright, security and all combinations
- Two pages of 24 lines x 80 characters of display memory

## Keyboard

- Detachable, typewriter-style
- Special editing keys
- Numeric/Graphics pad
- Eight screen-labeled function keys
- HP-HIL interface
- Functionally identical to the HP 150

## Communications/Peripherals

- One RS-232/RS-422 communication port (port 1)
- One RS-232 communication port (port 2)
- One HP-IB port
- One HP-HIL device port (located on keyboard)
- Full block mode graphics terminal support

# SYSTEM ARCHITECTURE

The HP Touchscreen II uses a standard Intel 8088 microprocessor (a Numeric Coprocessor accessory can also be purchased) running at 8 MHz. The Standard System contains 256 Kbytes of RAM for the operating system, applications and user workspace, and can be expanded to 640k. The addition of the HP 9123D Slave Double-Sided Dual Micro-Disc Drive provides another 710 Kbytes of formatted mass storage per double-sided 3.5" disc. Since the HP 9123D is powered directly from the HP Touchscreen II, it doesn't require an additional AC outlet. The system's battery powered non-volatile RAM feature allows the user to preserve configurations whenever the system's main power source is shut off.

In addition to the above capabilities, the HP Touchscreen II is also a customer expandable system. The HP Touch accessory can be added and is compatible with all existing HP 150 Touchscreen software. There are also four expansion slots, accessible through the top of the unit, which allow the customer to add accessory cards (such as additional memory) to the system without requiring the assistance of an HP representative or dealer. Installation of accessory cards is a simple operation, requiring an average of 5 to 10 minutes.

The HP Touchscreen II uses MS-DOS 2.11 (TM) from Microsoft Corporation as the standard operating system. MS-DOS is a single-user, single-task operating system for which many third-party software packages have been developed. The operating system resides on disc and upon initialization MS-DOS is loaded into the processor's main memory.

The MS-DOS operating system is an easy-to-understand facility to help the user execute commands. P.A.M. (Personal Applications Manager) provides simple intuitive menus for the most frequently used system commands. With P.A.M.'s clearly labeled menus to guide the user, starting applications, creating directories, deleting files and listing existing files is easy. The HP Touch accessory can make using P.A.M. as easy as touching the screen. For more advanced users, the standard MS-DOS command facility is also available.

# DISPLAY

The HP Touchscreen II displays both alphanumeric and graphics on the standard 12" diagonal green phosphor screen. The alphanumeric display consists of a 27 line by 80 column format. The 25th and 26th lines are used for the screen labeling of function keys (and all are automatically "touchable" with the HP

Touch accessory), and the 27th line is for system status and error messages. The screen memory stores 2 pages of text, which allows off-screen storage of the display. High resolution characters with true descenders are generated in an 8 X 14 dot cell with half-dot shift.

The graphics display has a resolution of 512 dots horizontally by 390 dots vertically. A built-in 640 by 400 alternate graphics mode is also available, but only accessible from applications software. A programming example is provided in Chapter 7.

## KEYBOARD

The HP Touchscreen II keyboard (an HP-HIL input device) is designed to provide a familiar, easy-to-use interface to the system, with functions and labels identical to the HP 150 Keyboard. The low-profile keyboard shape, the sculptured keycaps and the dished "Home" keys help to make the keyboard comfortable to use. The 107-key keyboard contains the full local editing keys such as cursor control keys, display scrolling keys, "Next" and "Prev" keys for scrolling by pages and "Insert" and "Delete" keys for inserting or deleting characters or entire lines.

The numeric keypad also serves as the graphics keypad, allowing the customer to turn on and off the alpha display, turn on and off the graphics display or transfer the graphics display to one of the HP graphics printers. It also displays the graphics cursor and allows it to be moved around the screen.

The function keys have corresponding screen labels used by the system and by application programs to increase the ease of use of the system. With the HP Touch accessory, all function keys can be selected by pressing the key itself or by touching the corresponding label on the screen.

There is also an HP-HIL device port located on the rear of the keyboard, next to the keyboard cable port. Supported HP-HIL devices (such as the HP Mouse, Bar Code Readers, and Tablets) may be connected to this port in a daisy-chain fashion and used without additional configuration, or power cords.

## COMMUNICATIONS/PERIPHERALS

Two RS-232-C ports (port 1 is also capable of RS-422 communication) may be used to connect the system to a remote computer or to serial devices (such as printers or plotters). Flexible protocols allow the use of either hardware or software handshaking and communication speeds can range from 110 to 19,200 baud.

One HP-IB port can be used to communicate with any supported HP-IB disc drives, printers or plotters. The HP-IB port allows you to connect one, or daisy-chain more than one device to your computer.

One HP-HIL port is located on the rear of the keyboard and can be used for supported HP-HIL devices.

The HP Touchscreen II emulates the HP 2623 Graphics Terminal feature set and can run HP 3000 software which currently runs on that terminal. This includes block mode for V/3000 software and graphics applications such as HPEasychart and HPDraw as well as line-drawing and math character sets, "security" fields, transmit-only fields, edit checks and Tektronix 4010/4014 emulation.

CONTENTS

# INTRODUCTION

The HP Touchscreen II hardware performs the logic functions of a 16 bit personal computer with screen graphics. It consists of a Processor PCA which includes video, memory, serial communications, and HP-HIL subsystems, a Power Supply/Sweep PCA, a Touchscreen PCA, and a keyboard PCA within the Keyboard itself. Operation of the Touchscreen II is based on an 8088 microprocessor running at 8 MHz.

The Processor PCA is essentially a one board computer. It provides input/output and data processing functions, 256K bytes of dynamic RAM for system and user memory, up to 160K bytes of ROM, video signal generation, and communications controllers for serial interface to external peripherals as well as HP-HIL devices. Four accessory slots are provided allowing for installation of various accessories including a numeric coprocessor and user-designed special purpose PCA's.

The Power Supply/Sweep PCA contains the system power supply and all analog video and sweep functions.

# PRODUCT STRUCTURE

## Product Number — Description

**45850A** — **THE HP TOUCHSCREEN II TERMINAL**

The Standard HP Touchscreen II Terminal consists of CPU/terminal (HP2623 features - block mode with graphics), 256 Kbytes of memory, one RS232/RS422 port, one RS-232 port, one HP-IB port, a system port (for the HP Touch accessory), an HP-HIL device port (located on keyboard), a 12" tilting display, four accessory slots, an HP-HIL extended keyboard, a power cord, a Terminal User's Manual.

**45851A** — **THE HP TOUCHSCREEN II BASE SYSTEM**

The standard HP Touchscreen II Personal Computer base system consists of a CPU/terminal, a power cable, a disc drive cable, a Getting Started manual, Using Your HP Touchscreen II manual, and the following applications on 3.5" discs: MS-DOS 2.11 Operating System Master and Work Master.

Also included standard are 256 Kbytes of memory, one asynchronous RS-232/RS-422 port, one asynchronous RS-232 port, one HP-IB port,

one internal expansion slot (for Numeric Coprocessor accessory), one system port (for HP Touch accessory), one HP-HIL device port (located on keyboard), an HP-HIL extended keyboard, a 12" tilting display, and four accessory slots.

For localized products the product number will contain one of the following designators (i.e. 45850AF is a French HP Touchscreen II Terminal, and 45851AF is a French HP Touchcsreen II PC).

| | | | |
|---|---|---|---|
| AB | European version of U.S. | AP | Swiss German |
| AC | French Canadian | AQ | Swiss French |
| AD | German | AS | Swedish |
| AE | European Spanish | AU | United Kingdom |
| AF | French | AW | Dutch Azerty (Belgian) |
| AH | Dutch | AX | Finnish |
| AK | US/ICON | AY | Danish |
| AL | English Canadian | AZ | Italian |
| AM | Latin American Spanish | | |
| AN | Norwegian | | |

## Disc Drives

| Disc Drive | Fixed Disc Capacity | Flexible Disc Size | Double-sided or Single-sided Format and | |
|---|---|---|---|---|
| 9123D | | Dual 3 1/2" | Double-sided 710K byte | Note 1 |
| 9122D | | Dual 3 1/2" | Double-sided 710K byte | |
| 9122S | | Single 3 - 1/2 inch | Double-sided 710K byte | |
| 9153A | 10M bytes | Single 3 - 1/2 inch | Double-sided | |
| 9154A | 10M bytes | | | |
| 9133H | 20M bytes | Single 3 - 1/2 inch | Double-sided 710K byte | Note 2 |
| 9134H | 20M bytes | | | Note 2 |
| 9133L | 40M bytes | Single 3 - 1/2 inch | Double-sided 710 byte | Note 2, 3 |
| 9134L | 40M bytes | | | Note 2, 3 |

| | | | | |
|---|---|---|---|---|
| 9142A | 15 or 60M bytes | | 1/4" Mag tape | Note 4 |
| 9144A | 16.7 or 67M bytes | | 1/4" Mag Tape | Note 5 |
| 9125S | | Single 5 - 1/4" | IBM Format 360K byte | |
| 9133D | 14.8M bytes | Single 3 - 1/2 inch | Double-sided 710K byte | |
| 9134D | 14.8M bytes | | | |

Please review the following notes:

Note 1:

*NEW 9123D DISC DRIVE

9123D 3 1/2", dual double-sided microfloppy, 710 K bytes formatted capacity each.

The 9123D is powered directly off of the Touchscreen II, it does not require an additional AC outlet; it has no power switch; the Touchscreen II supplies power to the 9123D through a DIN connector power cable. It's HP-IB address is hardwired to be 0. It has no fan.

The 9123D must always be plugged in to the Touchscreen II before the Touchscreen II is powered up. If the 9123D is plugged-in after the Touchscreen II is powered-on, the Touchscreen II will reset.

| | | | | |
|---|---|---|---|---|
| Size: | Height | 76mm (2.99 in) | Weight: | Net 3.5 kg (8 lbs) |
| | Width | 325 mm (12.8 in) | | 6.8kg (15 lbs) |
| | Depth | 285mm (11.2 in) | | |

Note 2:

Context MBA will not work with 20 or 40M byte drives (9133H/9134H or 9133L/9134L).

Note 3:

Not supported as a single volume on the 3COM Ether Series Local Area Network. Supported as two 20M byte volumes on 3COM. (3COM cannot run on a disc with a 1 K byte sector size). The Pfs

Series software works with the 40 M byte drives only when configured as two 20 M byte volumes.

Note 4:

9142A Stand-alone 1/4" Cartridge Tape Drive, 15 and 60M byte formatted cartridge capabilities.

Features:

- 50% data redundancy.
- User flexibility - image and file by file store and restore.
- HP-IB Interface CS80/Protocol.
- Built-in diagnostics.

Software Option 150 Rev C.01.00 is required.

Cartridge tapes compatible with the 9142A: 92242S, 92242L.

Note 5:

*9144A Stand-alone 1/4" Cartridge Tape Drive, 16 and 67 Mbyte cartridge capacities.

Features:

- Immediate read-after write. Automatic Error Correction on read.
- 2 Mbyte/minute transfer rate with Immediate Response (system dependent)
- Streaming device with gentle tape handling.
- HP-IB Interface/CS80 Protocol
- Built-in diagnostics.
- 7908 Disc/Tape cartridge compatible.

Software Option 150 Rev C.01.00 is required.

Cartridge tapes compatible with the 9144A: 88140L, 88140LC, 88140S, 88140SC.

## Printers

| | opt | |
|---|---|---|
| 2225A | | ThinkJet Dot Matrix Printer |
| | | HP-IB Interface |
| 2225B | | ThinkJet Dot Matrix Printer |
| | | HP-IL Interface |
| 2225C | | ThinkJet Dot Matrix Printer |
| | | Centronics |
| 2225D | | ThinkJet Dot Matrix Printer |
| | | RS-232 Interface |
| 2601A | | Daisywheel Serial Printer |
| | 242 | RS-232 Interface |
| 2602A | | Low Cost Daisywheel Printer |
| | Std | RS-232 Interface |
| | 046 | HP-IB Interface |
| 2686A | | LaserJet Printer |
| | | RS-232 Interface |
| 2932A | | Dot Matrix Printer |
| | Std | RS-232 Interface |
| | 046 | HP-IB Interface |
| 2933A | | Dot Matrix Printer |
| | Std | RS-232 Interface |
| | 046 | HP-IB Interface |
| 2934A | | Dot Matrix Printer |
| | Std | RS-232 Interface |
| | 046 | HP-IB Interface |
| 82905B | | Dot Matrix Printer |
| | 240 | RS-232 Interface |
| | 340 | RS-232 Interface (220V) |
| | 440 | RS-232 Interface (240V) |
| | 002 | HP-IB Interface |
| | 003 | HP-IB Interface (220V) |
| | 004 | HP-IB Interface (240V) |
| 82906A | | Dot Matrix Printer |
| | 002 | HP-IB Interface |
| | 003 | HP-IB Interface (220V) |
| | 004 | HP-IB Interface (240V) |

## Plotters

| | opt | |
|---|---|---|
| 7470A | | Graphics Plotter - 2 pen |
| | 001 | RS-232 Interface |
| | 002 | HP-IB Interface |
| 7475A | | Graphics Plotter - 6 pen |
| | 001 | RS-232 Interface |
| | 002 | HP-IB Interface |
| 7550A | | Graphics Plotter - 8 pen |
| | --- | Dual HP-IB/RS-232 |

## Accessories

| Accessory | order Part No. | Description | Also Requires |
|---|---|---|---|
| 256K RAM Memory | 45631A | 256K RAM Memory Board | Must be placed in Slot 1 |
| 384K RAM Memory | 45632A | 384K RAM Memory Board | Must be placed in Slot 1 |
| Internal Modem | 45640B | 1200/300 baud internal modem board | One built-in RS-232C port |
| Touchscreen 3278 Emulation Accessory with File Transfer | 45641B | IBM 3278 emulation accessory | |
| EtherLink/150 | 45644A | EtherLink local area network card | |
| EtherStart/150 | 45649A | Plug-in Module for a discless Ethernet Node | Plugs onto Ether Link card |
| Language Board | 45635A | Non-English language board (for localization) | Must be placed in slot 1 |
| Language Board with 256K RAM | 45637A | Non-English language board (for localization) | Must be placed in slot 1 |
| 8087 Co-processor Accessory | 45885A | Intel 8087 numeric co-processor board | Must be HP Field installed |
| Extended I/O Accessory | 45643A | Extended I/O board that adds Centronics and HP-IL interfaces | Centronics cables (HP-IL cables included) |
| HP Mouse | 46060A | Mouse input device | HP-HIL Port is standard on Touch-screen II. HP 150s require HP-HIL accessory board (45914A or 45915A) |

| | | | |
|---|---|---|---|
| Graphics Tablet | 46087A | Graphics tablet input device (A-size) | HP-HIL port is standard on Touchscreen II. HP 150s require HP-HIL accessory board |
| HP-HIL Board | 45914A | HP-HIL accessory board adds HP-HIL port to HP 150s | |
| HP-HIL and 384Kb RAM Memory | 45915A | HP-HIL acccessory board adds HP-HIL port to the HP 150 with 384Kb of RAM Memory | |
| HP Touch Accessory | 35723A | Touch bezel | User installable |

**NOTE**

Memory or language accessories must be installed into accessory slot #1.

## Cables

| | |
|---|---|
| 13242D | Centronics Cable for the Extended I/O accessory |
| 13242G | RS-232 Cable (male connector) |
| 13242M | European Modem Cable |
| 13242N | U.S. Modem Cable |
| 13242P | RS-422 Interface Cable for HP 3000 Advanced Terminal Processor (ATP) |
| 13242X | RS-232 Interface Cable for HP 3000 Advanced Terminal Processor (ATP) |
| 17355A | RS-232 Interface Cable |
| 17455A | Eavesdrop Cable |
| 17255D | RS-232 Cable (male connector) (for stand-alone use with 7550A Plotter) |
| 10833A | HP-IB Cable (1 meter) |
| 10833B | HP-IB Cable (2 meter) |
| 10833D | HP-IB Cable (.5 meter) |
| 82167A | HP-IL Cable (.5 meter) |
| 82167B | HP-IL Cable (1 meter) |
| 92220R | HP-IB Cable (30 cm) (disc drive interconnect cable) |
| 92221M | RS-232 Modem Cable |
| 92220E | Disc Data Cable (60 cm) |

## Additional Documentation/System Software

| | |
|---|---|
| 45435A | HP 150 Programmer's Tools |
| 45624A | HP 150 MS-DOS 2.0 User's Guide |
| 45876A | MS-DOS 3.0 User's Guide |
| 45848-60001 | HP Touchscreen II Terminal Manual |
| 45847A | PC Upgrade Kit (which upgrades a terminal to a PC and includes: PC manuals, plus System Master, and Work Master 3.5" Micro-Discs) |

# PRODUCT SPECIFICATIONS

## General Description

| | |
|---|---|
| SYSTEM PROCESSOR: | Intel 8088 microprocessor operating at 8 MHz |
| MAIN MEMORY: | 256 Kbytes of RAM memory |
| SCREEN SIZE:<br>Alphanumeric<br>Graphics<br>High Resolution Graphics | 12-inch diagonal<br>196.9mm (W) X 152.0mm (H)<br>210.0mm (W) X 156.8mm (H)<br>196.9mm (W) X 160.8mm (H) |
| SCREEN CAPACITY: | 24 lines X 80 columns, 25th and 26th lines for labeling of function keys, 27th line for system status/error messages |
| CHARACTER GENERATION: | 6 X 9 enhanced dot matrix with 1/2 dot shifting; 8 X 14 dot character cell; noninterlaced raster scan. |
| CHARACTER SIZE: | 1.7mm (W) X 3.2mm (H) (greater than 50% aspect ratio) |
| CHARACTER SET: | Roman8, line-drawing, math standard (also bold and italic usable by applications only) |
| CURSOR: | Blinking underline or blinking square |
| DISPLAY ENHANCEMENTS: | Inverse video, underline, blinking, half-bright, security and all combinations. |
| REFRESH RATE: | 60 Hz |
| TUBE PHOSPHOR: | Green P31 |
| IMPLOSION PROTECTION: | Tension band |
| KEYBOARD: | Full ASCII code keyboard, eight screen-labeled function keys, auto-repeat, N-key rollover, cursor controls, 18-key numeric pad, detachable with a 2.43 m (8 ft.) coiled cable, and one HP-HIL device port. |

## Physical Specifications

| | |
|---|---|
| SYSTEM PROCESSOR WEIGHT: | 12.27 Kg (27.0 lbs.) |
| KEYBOARD WEIGHT: | 2.14 kg (4.7 lbs.) |
| SYSTEM UNIT DIMENSIONS: | 325mm (W) X 370mm (D) X 342mm (H)<br>12.8 in. (W) X 14.6 in. (D) X 13.4 in. (H) |
| SYSTEM FOOTPRINT:<br>(without keyboard) | 1.3 square feet |
| KEYBOARD DIMENSIONS: | |
| Flat | 456mm (W) X 225mm (D) X 35mm (H)<br>[18.0 in. X 8.9 in. X 1.4 in.] |
| Standing | 456mm (W) X 225mm (D) X 63mm (H)<br>[18.0 in. X 8.9 in. X 2.5 in.] |
| DISPLAY TILT RANGE | 0 to 20 degrees from vertical position |

## Environmental Conditions

TEMPERATURE (Free Space Ambient):

| | |
|---|---|
| Non-operating | -40 to +70 C (-40 to +158 F) |
| Operating | +5 to +40 C (+41 to +104 F) |

| | | | |
|---|---|---|---|
| HUMIDITY: | 5% to 95% (noncondensing) | | |
| *VIBRATION: | Functional Random | .0001GG/Hz | 5-350Hz |
| | | -6dB/octave | 350-500Hz |
| | Survival Swept Sine | .5G (0 to pk) | 5-200-5Hz |
| | | (+ 5 min. Resonant dwells) | |
| | Survival Random | .015 GG/Hz | 5-100Hz |
| | | -6dB/octave | 100-137Hz |
| | | .0080GG/Hz | 137-350Hz |
| | | -6dB/octave | 350-500Hz |
| *SHOCK: | 1/2 sine < 3msec, velocity change = 65 in/sec<br>trapezoidal 30G, velocity change = 266 in/sec | | |

* Type tested to qualify for normal shipping and handling in original shipping carton.

## Product Regulations

This product will be meeting the requirements of the following agencies standards for EDP equipment or office equipment in the following countries (contact your local Hewlett-Packard sales representative for more up-to-date information):

| | |
|---|---|
| SAFETY: | CSA - Canada<br>UL - United States<br>TUV - Germany<br>IEC - International 380/435 (pending)<br>FI - Finland (pending)<br>NEMCO - Norway (pending)<br>KEMA KEUR - Holland (pending)<br>SEV - Switzerland (pending) |
| RFI: | VDE Level B - Germany<br>FCC Class B - United States<br>RPM - Radio Protection Mark (pending) |
| DATACOMM: | Approvals for RS-232 connection:<br>Australia (pending)<br>Belgium (pending)<br>Finland (pending)<br>Germany (pending<br>Japan (pending)<br>Switzerland (pending)<br>U.K. (pending) |
| ERGONOMICS: | German Standard ZH1/618 (pending) |

## Power Requirements

| | |
|---|---|
| INPUT VOLTAGE: | 115 V (+10%, -25%) at 50 - 60 Hz (+-5%)<br>230 V (+10%, -15%) at 50 - 60 Hz (+-5%) |

POWER CONSUMPTION:

| | | |
|---|---|---|
| 45850A | 180 Volt Amps | 300 BTU/per hour |
| 45851A | 160 Volt Amps | 330 BTU/per hour |

## Communications

| | |
|---|---|
| DATA INTERFACES: | 1 HP-IB, 1 RS-232/RS-422, 1 RS-232, 1 HP-HIL |
| HP-IB INTERFACE: | Bus used only for specified HP peripherals |
| RS-232 INTERFACE: | General asynchronous communications |
| HP-HIL INTERFACE: | One port on keyboard for supported HP-HIL devices |
| DATA RATE (RS-232): | 110, 150, 300, 600, 1200, 2400, 4800, 9600 and 19200 baud |
| PORT 1: | EIA standard RS-232-C and CCITT V.24; hardware and XON/XOFF handshaking available. Also RS-422 communication capability |
| PORT 2: | EIA standard RS-232-C and CCITT V.24; hardware and XON/XOFF handshaking available |

## Display Specifications

The Touchscreen II uses the same Raster Scan Technology as the HP 150 (refer to the HP 150 Technical Reference Manual for an overview of this technology).

The Touchscreen II Display Specifications include the following:

- -Display Modes
- -Frame Formats
- -Character and Cell Formats
- -Graphics Modes
- -Graphics and Alpha Display Geometry
- -Aspect Ratios

The details of how the Display Specifications are implemented in the product are described in section 3.

## VIDEO FRAME FORMAT

| | | |
|---|---|---|
| Touchscreen II display modes: | alphanumerics | - 640 x 378 |
| | graphics | - 512 x 390 |
| | 640 mode graphics | - 640 x 400 |
| HP 150 display modes: | alphanumerics | - 720 x 378 |
| | graphics | - 512 x 390 |

Touchscreen II display formats: alphanumerics, graphics, 640 mode

| | | | |
|---|---|---|---|
| start scan lines - | 17 | 12 | 6 |
| active scan lines - | 378 | 390 | 400 |
| extra scan lines - | 11 | 4 | 0 |
| vertical retrace lines - | 19 | 19 | 19 |
| total lines/frame - | 425 | 425 | 425 |

HP 150 frame formats:

| | | |
|---|---|---|
| start scan lines - | 11 | 6 |
| active scan lines - | 378 | 390 |
| extra scan lines - | 7 | 0 |
| vertical retrace lines - | 19 | 19 |
| total lines/frame - | 415 | 415 |

**NOTE**

- the vertical sweep frequency is always 60Hz
- previously there were 415 total scan lines, now there are 425 (this corresponds to a change in the horizontal scan frequency from 60 X 415 = 24.9Khz to 60 X 425 = 25.5kHz)
- vertical retrace is allocated 19 lines (although only a portion is actually used during retrace)
- the start and extra scan lines are used in unequal amounts to increase the active (visible) scan line total to create displays of different line lengths (eg. +0,378,+0 => 378; +5,378,+7 => 390; +11,378,+11 => 400)

- the minimum number of (blanked) start scan lines is 6

  (this is needed to allow the raster scan display to stabilize, after retrace, before it is displayed - unblanked)

- the minimum number of extra scan lines is 0 (before retrace begins)

- there is a correction to the previous Technical Reference Manual - for the HP 150 alphanumeric display the number of start scan lines and extra scan lines are, respectively, 11 and 7 not 12 and 6 (the total of the two is, nevertheless, 18); 390 = +5,378,+7 not 390 = +6,378,+6 as the previous manual implies

- therefore, alphanumerics and graphics are not centered vertically, but are offset by one line - this remains true for the HP 150 II - (alphanumerics and 640 mode for HP 150 II are centered with respect to each other)

## ALPHA SCREEN AND CHARACTER FORMAT

Screen format: the row format does not change.

Alpha characters: the method of displaying alpha characters does not change.

Character cell format:

total character cell - Touchscreen II -- 8 X 14
- HP 150 ---------- 9 X 14

character definition - Touchscreen II -- 6 X 9
HP 150 ---------- 7 X 10

the character cell has the following components -

| row | Touchscreen II | HP 150 | |
|---|---|---|---|
| 1 | x x x x x x x x | x x x x x x x x x | x = inter row/col spacing |
| 2 | x x x x x x x x | x o o o o o o o x | |
| 3 | x o o o o o o x | x o o o o o o o x | o = character dots |
| 4 | x o o o o o o x | x o o o o o o o x | s = space |
| 5 | x o o o o o o x | x o o o o o o o x | cu= top half of double cursor, underline or underhang |
| 6 | x o o o o o o x | x o o o o o o o x | |
| 7 | x o o o o o o x | x o o o o o o o x | |
| 8 | x o o o o o o x | x o o o o o o o x | |
| 9 | x o o o o o o x | x o o o o o o o x | c = bottom half of double cursor or inter-row spacing |
| 10 | x o o o o o o x | x o o o o o o o x | |
| 11 | x o o o o o o x | x o o o o o o o x | |
| 12 | x s s s s s s x | x s s s s s s s x | |
| 13 | c u c u c u c c | c u c u c u c u c | |
| 14 | c c c c c c c c | c c c c c c c c c | |
| | 1 2 3 4 5 6 7 8 | 1 2 3 4 5 6 7 8 9 | : column |

differences - note one less column
- note change of dot row 2 usage
- math characters, italics, and Roman extention characters may exceed these bounds

summary of alpha video rates -

| | | Touchscreen II | HP 150 |
|---|---|---|---|
| frame rate (frames/second) | - | 60 | 60 |
| scan line rate (lines/frame) | - | 425 | 415 |
| character rate (char/line) | - | 115 | 115 |
| dot rate (dots/char) | - | 8 | 9 |
| alpha dot rate (dots/sec) | - | 23.46Mhz | 25.7715Mhz |

note - there are 80 visible (unblanked) characters and 35 blanked characters per scan line (=>115char/line)

summary graphics video rates -

| | | Touchscreen II | HP 150 |
|---|---|---|---|
| frame rate (frames/second) | - | 60 | 60 |
| scan line rate (lines/frame) | - | 425 | 415 |
| graphics dot rate (dots/line) | - | 690 | 690 |
| graphics dot rate (dots/sec) | - | 17.595Mhz | 17.181Mhz |

note - there are 512 visible (unblanked) graphics dots and 178 blanked graphics dots per scan line (=>690/line)

summary 640 mode video rates -

| | | Touchscreen II |
|---|---|---|
| frame rate (frames/sec) | - | 60 |
| scan line rate (lines/frame) | - | 425 |
| 640 dot rate (dots/line) | - | 920 |
| 640 mode dot rate (dots/sec) | - | 23.46Mhz |

note - there are 640 visible (unblanked) 640 mode dots and 280 blanked 640 mode dots per scan line (=>920 dots/line)
- 640 mode dots and alpha dots are "the same" - (115 char/line X 8 alpha dots/char => 920 alpha dots/line and 80 visible char/line X 8 alpha dots/char => 640 visible alpha dots/line which is the same as for 640 mode)

## ALPHA VIDEO ENHANCEMENTS

note - all alpha dots are stretched by approximately 50% to produce "rounder" dots (and therefore more appealing alpha characters) - this is called "half dot stretch" (and applies to both Touchscreen II and the HP 150).

- in this respect 640 mode dots are not the "same" as alpha dots, since they are not stretched

## GRAPHICS DISPLAY

Graphics dots are 4/3 as "thick" horizontally as alpha dots (before "half dot" stretching) - as the ratio of the respective dot rates would indicate from the previous sections. This ratio had been 3/2 on the HP 150.

Because the graphics dots are wider, the 512 graphics dots take up more room than the 640 alpha dots (the overlap consists of 32 graphics dots or 42 2/3 alpha dots). This overlap had been 32 graphics dots or 48 alpha dots on the HP 150.

On the HP 150 II and HP 150 these two displays are still mismatched horizontally the same amounts (in terms of graphics dots) see figure 2-1.

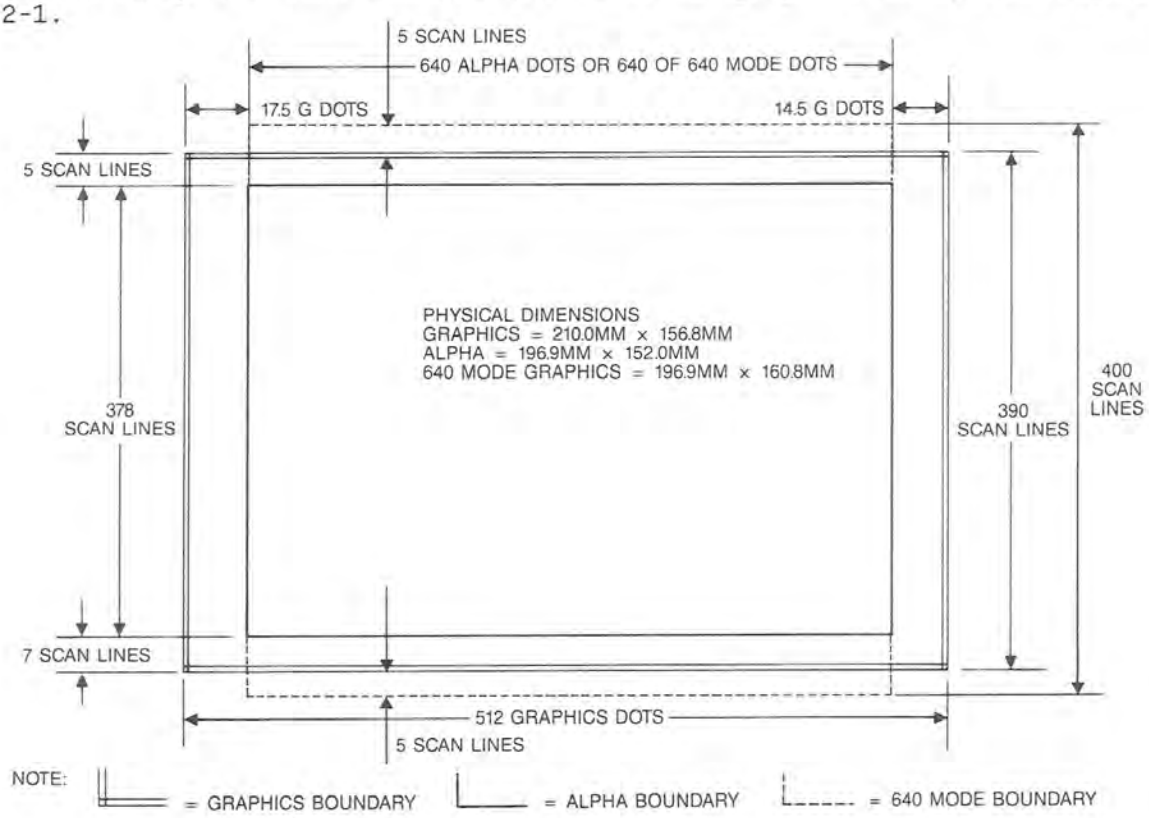



Figure 2-1. Display Specifications

## ASPECT RATIO CONSIDERATIONS

Display sizes are as follows:

| | Alpha | Graphics | 640 Mode |
|---|---|---|---|
| width - | 196.9mm | 210.0mm | 196.9mm |
| height - | 152.0mm | 156.8mm | 160.8mm |

Character aspect ratio (character definition width to height):

| | |
|---|---|
| Touchscreen II | -- 53% |
| HP 150 | ---------- 46% |

Graphics aspect ratio:

| | |
|---|---|
| Touchscreen II | -- 98.0% |
| HP 150 | ---------- 97.6% |

note - < 100% => width > height
> 100% => width < height

640 mode aspect ratio (without scaling):

Touchscreen II = 130.7%

**NOTE**

In this mode, images to be displayed will need to be scaled by software in order to show a 100% displayed aspect ratio (so circles do not look like ellipses).

Tolerances:

The graphics display size tolerances are +/- 4mm (width and height). The tolerances for the other displays are scaled from this directly. Therefore, the aspect ratios can vary somewhat depending upon the actual (not nominal) size.

## Subsystem Power Requirement

The figures below are the available power levels from the power supply/sweep assembly for all the various subsystems. The total shall not exceed 80W (not including the 25W which the sweep subsystem and fan may consume).

| Voltage | Current | |
|---|---|---|
| +5V | 10.2A | |
| +5VP | 1.6A | |
| +12V | 2.0A | ("P" denotes peripheral DIN connector) |
| +12VP | 1.0A | |
| -12V | .5A | |

The figures below are the specified power consumption limits for the various subsystems. The option slot power consumption shall not exceed 7.5W per slot (for a total of 30W) - this is based upon a primary total power limit, not upon secondary power limits.

| Voltage | CPU & 8087 | HP-HIL | Peripheral | Option Slots(All) | Total |
|---|---|---|---|---|---|
| +5V | 4.2A | | | 6.0A | 10.2A |
| +5VP | | | 1.6A | | 1.6A |
| +12V | .1A | .5A | | 1.4A | 2.0A |
| +12VP | | | 1.0A | | 1.0A |
| -12V | .1A | | | .4A | .5A |

# COMPATIBILITY WITH THE HP 150

## Firmware Rev F

An overview of Rev F firmware is provided here. For additional details, refer to Chapter 6. The REV D (HP 150) firmware was modified to get the REV F (Touchscreen II) firmware. The REV F code can run on both the HP 150 and the Touchscreen II. All five ROMs were updated and the changes to REV D that affect the user interface are highlighted here.

## OPTION HANDLER

There are now 4 hardware option slots in the Touchscreen II compared to the earlier HP 150 models.

The slot addresses are decoded as follows:

| | Touchscreen II | HP 150 |
|---|---|---|
| Slot 1 | 90000H (64K) | 90000H |
| Slot 2 | A0000H (16K) | A0000H |
| Slot 3 | A4000H (16K) | NA |
| Slot 4 | A8000H (16K) | NA |

(a) in global config "ACCESSORY 3" and "ACCESSORY 4" were added in the Op Sys Dev field to accomodate acc 3 and acc 4 as boot devices.

(b) the "accessory config" soft key barrel now includes "acc 3 config" and "acc 4 config" in f3 and f4 respectively if the hardware is the Touchscreen II. (f3 and f4 will be blank in the HP 150B).

If a language card is installed the new strings in (a) and (b) above are translated to the selected language.

In both the 150 and the Touchscreen II there are a maximum of 8 options all together (hardware and software).

In the HP 150, the software options are assigned option numbers after the hardware options, i.e. the first software option will start at option 3 because 1 and 2 are dedicated for hardware. This scheme leaves room for 6 software options in the HP 150 and only 4 in the Touchscreen II. To maximize the number of software options, unused hardware options are made available for software options in the REV F firmware.

## BOOT UNIT IN GLOBAL CONFIG

A new boot unit field is added in the global config menu next to the OP SYS DEV field. The values in this field range from 0 to 3. This scheme makes it easier to change units without having to change the switches in an HP9133/9122/9153 type drive. The user will be able to specify unit numbers for all HP-IB addresses and for the accessories as well, should one of them be chosen as the boot device.

## RESET TO DEFAULT CONFIGURATION (Clear CMOS)

If the user currently wants to go back to default config values, it is necessary to remove the batteries and wait for up to an hour. With REV F firmware to avoid this wait, a key sequence of CNTRL LEFT SHIFT RIGHT SHIFT STOP can be pressed simultaneously, to clear the CMOS RAM.

## TEK MODE

### 74th CHARACTER CHOP

With REV F firmware, the Touchscreen II will chop the 74th character of a line of text while in TEK mode. Characters 75 and beyond will be wrapped around the next line. In previous revisions of firmware characters 74 and beyond would be wrapped to the next line. The Touchscreen II does not support a full TEKTRONIX terminal screen; the Touchscreen II allows 73 characters per line while a TEKTRONIX terminal allows 74.

### SOFT RESET TEK MODE

The soft resetting of the machine, with REV F firmware, while in TEK mode will cause the machine to stay in TEK mode, resetting the proper TEK variables. In previous revisions of firmware, the HP 150 would only partially reset TEK mode on a soft reset.

## TOUCHSCREEN ALIGNMENT

The touchscreen alignment was changed to work with the Touchscreen II as well as the HP 150. A cross hair is now displayed across the center of the screen instead of the four lines on the edges of the screen.

## FRENCH/BELGIAN/ITALIAN KEYBOARD

A change was made in REV F firmware for the French/Belgian/Italian keyboard processing the CAPS key. The CAPS key now acts as a shift-lock key. All keys are shifted while with previous revisions of firmware only the number keys would be shifted. Exceptions to this shift-lock are the following keys: Reset/Break, User/Menu, Tab, Del/Esc, Print/Enter.

## SCALED VECTORS

The Touchscreen II will allow Scaled Vector scales of 1-255 (MOD 16). In previous revisions of firmware, any scale after MOD 16 resulting in 0 would cause a firmware malfunction. Now any scale of 0, after MOD 16, will be recognized as an illegal scale and ignored (the previous scale will be used).

## TELECOM BUG FIX

With previous revisions of firmware, if the following escape sequences were programmed in one of the soft keys and the programmed key executed repeatedly, the HP 150 would hang between passes 30 and 50.

```
escS ..... roll up
escG ..... move cursor to left margin
esc&d@ ... end enhancements
```

```
esc[ ..... start unprotected field
esc] ..... clear display

string ... any string
esc&dD ... underline
esc] ..... end protected field
```

With REV F firmware the system will not hang nor lose video when the above escape sequences are sent from a host computer.

## Utilities

Here is a summary of the enhancements made to the utilities that were available with the HP 150. These are shipped standard with the Touchscreen II.

### FORMAT

1. Can format hard discs with capacity of up to 64MB.

2. Support for CS/80 disc drives (versus Subset 80).

3. Creation of IBM Compatible disc on 9125S.
   To support the 9125S 5 1/4" disc drive, two new softkeys appear in the FORMAT OPTIONS level:
   f2 "IBM DOS 1.0" f3 "IBM DOS 2.0"
   This allows the user to access an IBM compatible format available on the 9125S.

4. Yes/No response to continue when files are found on a disc are now softkeys instead of keyboard Y/N entry:
   f1 "YES" f8 "NO"

5. Command line interface available.
   A command line mode for the program has been added to provide a covenient way for users to format and clear discs; a key advantage is to use this feature in batch files.

   Note: Backup files are not recognized by FORMAT and thus are not recognized by the command line version of FORMAT. Backup discs cannot be cleared; they must be reformatted and if a clear is attempted, the same message that is used in the regular FORMAT program will be displayed.

6. FILEDATA.SYS contains the names of all the files required to make a bootable operating system disc.

## INSTALL

A user can create a batch file of MS-DOS commands and install it as an application in P.A.M. Because batch files utilize COMMAND.COM which can only be run from the root directory, they can only be installed in the root directory.

## NEW SAVERAM UTILITY

New SAVERAM utility allows the user to save and restore the contents of the Touchscreen II Ram Disc. Interfaces are provided for P.A.M., MS-DOS batch and interactive access.

SAVERAM copies the entire contents of the Ram Disc into a single user specified file. The user may restore the image later. For each Ram Disc image created, a P.A.M. .IN$ file is created which appears as an application and automatically restores the Ram Disc when selected.

## COPY/BACKUP

1. The program determines how much memory is available and determines the maximum number of files it can handle accordingly.

2. The program will be recompiled for the "D" model of the Lattice C compiler, using up to a megabyte of data space.

3. The "Select By Date" softkey is replaced by a "Other Selects" softkey which takes the user to another menu of file selection criteria.

   The keys at the new level are:

   - CHANGED FILES, NON-DUPLICATES, SELECT ALL, UNSELECT ALL BUT, SELECT BY DATE, UNSELECT BY DATE, HELP, PREVIOUS MENU

4. The amount of disc space (in K) on the destination required for all currently selected files is now displayed. For example, SELECTED FILES REQUIRE 458K ON DESTINATION.

**NOTE**

This message does not appear if destination is a CP/M disc.

## SYS

1. May copy system from/to same disc even if system files will not all fit in memory at once.

2. Common code shared with FORMAT to copy system.

3. Can handle hard discs with capacity of up to 64MB.

## DEVICE CONFIG

Support with BIOS of eight instead of four installed drives.

Device Config distinguishes between 150 and Touchscreen II hardware. *Internal 2674A printer is not allowed on the Touchscreen II. Distinguishes between REV E and prior revisions of firmware. *Boot units for Accessory slots are not allowed on 150.

Drive A reflects boot-unit as configured in OP SYS DEV in Global Config.

Disc drive fields will toggle through a new device option if it is installed (i.e. the 9125S).

Accessories 1 to 4 will show up in Drive A if they are configured as the boot up device in OP SYS DEV in Global Config.

## EASY CONFIG

1. EASY CONFIG now only support the following models:

   9121D
   9122D
   9123D
   9133D
   9133H
   9153A

   The previous version of EASY CONFIG supported the following drives:

   82901M
   9121D
   9122D
   9133D
   9133A/V/X/XV

2. EASY CONFIG does not support a RAMDISC and will set any RAMDISC to NO DEVICE but will correctly save the RAMDISC size. Only drive B's address will be modified and all other drives will be set to NO DEVICE.

3. There is no longer a PREVIOUS MENU or a NEXT MENU softkey function to flip between printer menus. Instead, there is now a softkey labeled MORE PRINTERS and PRINTER CHOICES allowing the user to flip between printer menus.

4. For the Touchscreen II, EASY CONFIG does not allow users to choose an Internal Printer for a PRN, LST or AUX device, since the Touchscreen II does not support an Internal Printer.

5. The back plane drawing of the Touchscreen II is different from the HP 150. Therefore the menus for the interfaces were changed to the following devices:

| | |
|---|---|
| AUX | - auxiliary device interface |
| COM1 | - primary host interface |
| COM2 | - secondary host interface |
| LST | - secondary printer interface |
| PRN | - primary printer interface |
| PLT | - plotter interface |

6. The keyboard buffer is now flushed after each read of key stroke so menus do not flip by the user's eyes too rapidly.

7. A longer delay was made so that when an error message is displayed on the screen, it can be seen before EASY CONFIG returns back to P.A.M.

8. The default configuration for drive C is no longer address 2 but set to NO DEVICE.

9. The EASY CONFIG program can distinguish between the HP 150 and the Touchscreen II, so that the drawing of the interface connectors will be correct for each computer.

10. ICONS

    New disc drive icon for main menu.

    New LaserJet and Thinkjet icons on printer menu.

    New HP-IB connector icon.

    New disc drive icons for the disc menu. These were made because of the left and right-hand floppies on the hard disc units.

# Software

### HP 9125S DRIVER

The HP 9125S driver is added to the system as an installable, optional device driver. The 9125S is a single 5 1/4" disc drive that reads HP formatted and IBM formatted discs; since the HP BIOS does not support IBM formatted discs, an installable driver was developed.

Note: This driver is shipped with the HP9125S disc drive and can be used with the HP 150 and the Touchscreen II.

# BIOS

The Touchscreen II BIOS Changes are listed below.

### READ TERMINAL CONFIG FUNCTION

Two new fields have been added to the READ TERMINAL CONFIG function, the PC-ID and the BOOT UNIT. The PC-ID indicates whether it is a HP 150 A/B, or a Touchscreen II. The BOOT UNIT indicates the unit of the OP SYS DEVICE from which the system will boot. The format of the 4-word buffer returned from the READ TERMINAL CONFIG FUNCTION is:

```
(,iiirrpst)              i = PC-ID (000=A/B, 001=C)
                         r = reserved
                         p = set if remote port 2
                         s = set if softkeys on
                         t = set if touch screen off

(keyboard language)
(string language)
(rrrrrrrruuhhhaaa)       r = reserved
                         u = op sys unit (0 - 3)
                         h = op sys hardware code
                             0 = HPIB
                             1 = Accessory
                         a = op sys dev addr (0 - 7)
```

### BOOT UNIT

Added support to allow booting from unit 0 - 3, and accessories.

### COMPUTE BIOS SIZE

This facility is added to compute the size of the BIOS during bootup. This allows the Touchscreen II to boot from disc drives with allocation blocks that are greater than 4 K.

### I/O CONTROL

Logical devices LPT1, LPT2, and DSK are now supported by I/O control. Currently the BIOS will not support I/O control of these devices, but the attribute change allows installable device drivers to support I/O control for these devices.

### RAM DISC

A bounds check has been added to the RAM Disc to prevent access to system memory beyond the RAM Disc.

### DEVICE LIST

The standard device list has been re-ordered to conform to the standard approved by MICROSOFT.

```
Old order - CON, COM1, COM2, AUX, PRN, CLOCK, LST
New order - CON, AUX, PRN, CLOCK, COM1, COM2, LST
```

### REV CODE

The BIOS revision code has been changed to 3. This rev code is returned with the pointer to the fixed variable area when an I/O control read from the HPIBDEV is performed. The double word pointer is returned in bytes 0 -3 and the rev code is returned in byte 4.

### CACHE BUFFER

1 K byte of space has been added to the cache buffer for MS-DOS.

## Application Software

The HP Touchscreen II is compatible with all of the proprietary application software packages running on the HP 150 except for the following three items.

### CONTEXT MBA

The P-system, that runs underneath Context, cannot run on a disc with a sector size greater than 256 bytes. This means that the product will not run on a double sided micro floppy that has been formatted double sided, (512 byte sector size.) Also it will not run on the new 9133H or the 9133L Hard Disc Drive.

### BOLD PRINT

The algorithm for generating the bold character display was changed from firmware to hardware on the Touchscreen II. Due to the way the algorithm was implemented, any horizontal character, such as the "=", "-", and "_" will not appear in bold on the display. This affects two products. MultiMate uses the bold "=" to signify decimal tab positions. On the Touchscreen II the "=" will appear as a normal character display. In MemoMaker the three characters described above will not show as bold on the display, when using the change to bold feature, the printed document will have the bold character.

### CHARACTER WIDTH

The character width was changed from 9 pixels wide to 8 pixels wide on the Touchscreen II. This change was necessary for support of the 640 graphics plane. The last character in an inverse video field, when bold, will sometimes appear to be cut off (for example a "d" will look like a "c").

**NOTE**

Application software packages like Financial Calculator which make extensive use of Touch, should be used with the HP Touch Accessory.

## Electrical

The electrical differences between the HP 150 and the Touchscreen II are:

### VIDEO CONTROL BUFFER

1. The screen format is not programmable on the Touchscreen II.

   The alpha display of the HP 150 is controlled by the SMC9007 CRT controller. This is a general purpose part which can be programmed to support any number of different screen formats by writing the desired format

into the appropriate register on the chip. The Touchscreen II's alpha display is controlled by a chip which was designed to support the HP 150 family screen format: 27 rows by 80 columns. No other formats are supported by this chip.

If a user attempts to change the screen format by writing to the screen format registers, nothing will happen; the 27 rows by 80 columns format will remain.

2. The Vertical Retrace Interrupt cannot be disabled on the Touchscreen II. The HP 150 hardware allows the user to disable the vertical retrace interrupt through the use of a register on the SMC9007.

3. The CRT Controller on the Touchscreen II cannot be reset through a software command. The 150 software can reset the SMC9007 by writing to its reset register.

4. The Table Start Address cannot be changed on the Touchscreen II. The Table Start Address is programmable on the HP 150 through two registers on the SMC9007.

5. The Cursor Registers cannot be read on the Touchscreen II. The cursor position registers are Read/Write on the HP 150 through the SMC9007. On the Touchscreen II these are write only.

6. The Touchscreen II's Video System does not support a Light Pen. The SMC9007 on the HP 150 supports a light pen input and can generate a light pen interrupt.

## COMPOSITE VIDEO SIGNALS

The Composite Sync and Composite Blank signals (figure 3-25) are accessible on the Touchscreen II at the edge of the CPU card near the removable back panel. Their timing was designed to work with HP monitors, however an interface box is necessary which is not supported by HP.

These signals were also available on the HP 150 from the SMC9007, though their timing is different and they are not easily accessible.

## SCREEN RESOLUTION

640 x 378 pixel, alphanumeric screen resolution
512 x 390 pixel, bit-mapped graphic display
640 x 400 pixel, alternate graphics resolution (not supported by firmware/terminal mode; accessible through hardware)

## CHARACTER CELL DEFINITION

The HP 150 uses 7 X 10 characters within a 9 X 14 cell on a 9 inch tube. The Touchscreen II uses 6 X 9 characters within a 8 X 14 cell on a 12 inch tube.

The Character height change from 10 dots to 9 (along with the tube change from 9 inch to 12 inch) will yield characters with a slightly better aspect ratio.

The character cell width change from 9 to 8 dots forces the character width to change from 7 to 6 dots. The loss of a dot in the width makes some characters look different on the Touchscreen II than they did on the HP 150: most notably are the "M", "m", "N", "n", "W", "w", and "*".

## CHARACTER ERGONOMICS

The ROMAN character set of the Touchscreen II meets all of the requirements for character ergonomics set by the German Standard DIN-66234.

The two most important requirements of this standard, character height and character aspect ratio, are shown below for the two products.

| | Char. Ht. (mm) | Aspect Ratio (%) |
|---|---|---|
| HP 150 | 2.74 | 46 |
| Touchscreen II | 3.22 | 53 |
| DIN-66234 Req. | 2.60 (min.) | 50 (min.) |

## INTEL 8087 COPROCESSOR ACCESSORY

This accessory provides the addition of the Intel 8087 processor as a companion to the Intel 8088 to increase the speed and precision arithmetic, logarithmic and trignometric functions. When the co-processor board carrying the 40-pin, ceramic, 8 MHz 8087 and the 8088 operating in MAX mode is installed, the 8088 on the processor board is put into a "HOLD" condition and all of its outputs are floated while the coprocessor board with the 8088/8087 becomes the CPU for the Touchscreen II. The Intel 8087 can multiply 32 bit and 64 bit floating point numbers approximately 100 times faster than the 8088 using software routines.

The coprocessor plugs into a "special" socket on the Touchscreen II processor board; it does not take up an I/O slot. Thus it cannot be retrofitted in the HP 150 owing to hardware limitations, although two vendors offer an upgrade.

The coprocessor is transparent to the user and is designed to be 100% compatible with existing 150 application programs. It requries new or revised user/application software to take advantage of the added capability of the 8087 product.

The Pascal, Lattice C and Fortran Compilers offered on the HP 150 also run with the 8087 coprocessor.

The coprocessor is a field installable board-level accessory for the Touchscreen II and must be installed by an HP customer engineer.

### 50-PIN MALE CONNECTOR

This connector is located near the center of the processor board and is available for customers who wish to design their own accessory cards. (This is not one of the four I/O slots).

**NOTE**

When the 8087 coprocessor accessory card is purchased, it uses this socket: customers designing their own accessory cards should allow for an equivalent function in their own system design.

### NO DOUBLE HIGH/DOUBLE WIDE CHARACTERS

The Touchscreen II does not support DOUBLE HIGH/DOUBLE WIDE characters.

### EXTENDED BATTERY LIFE

The Touchscreen II uses a 7-10 year life battery to back-up non-volatile RAM that preserves configurations whenever the system's main power source is shut off. Unlike the HP 150 alkaline battery, the Touchscreen II's battery is not customer replaceable.

### REAL TIME CLOCK STANDBY INTERRUPT

The Standby Interrupt of the Real Time Clock is not supported by the Touchscreen II. This feature is provided by the MM58167 Real Time Clock chip used by the HP 150.

## Mechanical

The mechanical differences between the HP 150 and the Touchscreen II are:

### DISPLAY

The Touchscreen II uses a 12-inch diagonal green phosphor (P31) cathode ray tube

| | | |
|---|---|---|
| Screen Size | Alphanumerics: | 196.9 mm X 152.0 mm |
| | Graphics: | 210.0 mm X 156.8 mm |
| | 640 mode: | 196.9 mm X 160.8 mm |

### BUILT-IN DISPLAY TILT

This feature enables you to adjust the 12-inch display for optimal viewing; thus decreasing eye, neck and back strain.

### EASY ACCESS CONTROLS

Operator controls are now more convenient:

- Front panel power switch
- Side panel brightness control
- Side panel keyboard connection

### ADDED EXPANSION SLOTS

There are now four vertical expansion slots for memory and other hardware accessories. These are accessible from the top and compatible with HP 150 accessory cards.

### STURDIER CARD GUIDES

The card guides for the accessories are now metal. If card design guidelines are not followed, shorts will occur.

### ACCESSORY SLOTS COVER

This cover is plastic or metal and snaps into place without screws.

### NEW CABLE COVER SYSTEM

The new cable cover system allows the Touchscreen II to sit flush against a wall, concealing cables for a more pleasing appearance.

### CABLES

Cables can be run upwards or downwards allowing you to set a disc drive or a printer on top of the CPU.

### USER INSTALLABLE TOUCH ACCESSORY

### NEW PROCESSOR BOARD

This board replaces five PCAs on the HP 150 (processor, video, memory, front plane, datacomm).

## NEW POWER SUPPLY/SWEEP BOARD

This board replaces two PCAs (power supply and sweep) on the HP 150.

## CONTRAST FILTER OPTION

The CRT plate can now accommodate an accessory contrast filter. These are not available from HP, but can be purchased from outside vendors to reduce glare:

- Sun-flex
  Tel. No. (415) 883-1221
- 3M, Los Angeles
  Tel. No. (213) 726-6300
- Polaroid Company Polarizer Division
  One Upland Road
  Norwood, MA 02062
- HGL Homalite, Delaware
  Tel. No. (302) 652-3686

## COOLING PATH

Cool air enters from the front and side and exits from the top of the rear. (In the HP 150, air enters th bottom of the rear and exits from the top of the rear.)

## CONVENIENCE AC OUTLET DELETED

## OPERATING TEMPERATURE

The operating temperature of the Touchscreen II is +5 to +40 degrees Celsius vs 0 to +55 degrees Celsius on the HP 150.

## THERMAL PRINTER DELETED

## HP-HIL PORT

The HP-HIL (HP Human Interface Link) allows easy connection of a variety of input devices without having to reconfigure the system. A simple port, similar to a telephone jack, on the Touchscreen II keyboard lets you daisy-chain up to seven different devices without changing computer setups or configurations while the computer's power remains on. The devices can be used separately or together, and since each device connects to the last one, new devices do not need extra ports on the computer.

Current HP-HIL input devices include the HP Mouse (46060A), and the Graphics Tablet (46087A).

The Touch Accessory and the Touchscreen II keyboard also use the HP- HIL interface, although the Touch accessory has a dedicated interface. (The HP 150 has a MITF keyboard.)

For the Touchscreen II, the HP-HIL interface is provided as a standard feature, whereas it is available only as an optional accessory card (45914A) on the HP 150.

HP-HIL on the Touchscreen II can be used without special software, with certain limitations. Without special software, only touchscreen and keyboard like devices can be used. Input devices that give coordinate data, such as the mouse and graphics tablet, are not supported in terminal mode. However, the Touchscreen II Terminal can support up to seven devices like the keyboard.

Applications software that was written for the HP 150 and the HP-HIL accessory card will run on the Touchscreen II provided that the Touchscreen II has been equipped with an HP-HIL accessory card. However, applications software that is intended to make use of the Touchscreen II's standard HP-HIL interface must use a new set of commands that are written to the Touchscreen II keyboard controller chip.

## Accessory Cards

The following are changes between the HP 150 accessory cards and the Touchscreen II:

A. The 3COM EtherLink/150 (45644A) card does not work in slots 3 and 4 in the Touchscreen II.

B. The Ven Tel Modem (45640A) requires a longer (160 cm) cable which will be available through the HP Corporate Parts Center (P/N 45640-80202).

**NOTE**

This cable is only required for Internal Modems purchased prior to the availability of the Touchscreen II.

C. The short HP-IB cable (92220R) with the right angle cannot be used with the Touchscreen II. The cable length is too short and the right angle hits the back cable cover. A 60 cm disk cable (HP-IB compatible) will be shipped with the Touchscreen II PC Kit and will also be available (92220E).

## Documentation

Comparison of the Documentation written for the HP 150 and the Touchscreen II.

**HP 150**

1. Getting Started with Your HP Touchscreen Personal Computer
2. Using Your HP Touchscreen Personal Computer
3. Using Your HP Touchscreen Personal Computer as a Terminal
4. Service Manual
5. Self-Paced Learning Guide
6. MS-DOS 2.1 User's Guide
7. Programmer's Tools
8. Technical Reference Manual

**TOUCHSCREEN II**

1. Getting Started With Your HP Touchscreen II Personal Computer
2. Using Your HP Touchscreen II Personal Computer
3. Using Your Touchscreen II Personal Computer as a Terminal
4. Service Manual
5. Self-Paced Learning Guide
6. MS-DOS 2.1 User's Guide (Update includes 2.11 information)
7. Programmer's Tools (No change)
8. Technical Reference Supplement (this update)
9. HP-HIL Technical Reference Manual (Product No. 45918A)
10. HP-HIL Development Tools for the Touchscreen PC (Product No. 45919A)

Brief description of documentation:

"Getting Started" is written for first-time computer users. It uses numerous illustrations to show how to set the voltage switch; connect the keyboard; install the disc drives, accessory cards etc.

"Using Your Touchscreen" is written for first-time computer users. It explains in detail how to use the keyboard, load the operating system, and connecting selected printers and plotters.

"Using Your Touchscreen As A Terminal" describes the terminal's built-in editing, text creation, graphics, printing capabilities, and the interface between the terminal and the host computer.

The "Touchscreen II Service Manual" is written for field service to guide Customer Engineers in the repair of malfunctioning units. It contains technical information on: theory of operation, troubleshooting etc.

The "Self-Paced Hardware Training Guide" is written for field service. It is a self-training document for Customer Engineers and dealers.

"HP 150 MS-DOS User's Guide" covers not only MS-DOS commands, files, directory structure and utilities but also sections on programming considerations and programming the HP 150

Programmer's Tools include:

* Microsoft "MS-DOS Operating System User's Guide" which is similar to the HP 150 MS-DOS User's Guide but is more general.

* Microsoft "Macro-Assembler" describes macro-assembler language, MS-Link and utilities such as CREF, DEBUG and LIB

* Microsoft "MS-DOS Programmer's Reference Manual" describes MS-DOS System calls, interrupts, device drivers etc.

* "HP 150 Programmer's Reference Manual" describes AGIOS and escape sequences

* "IAPX 88 book" describes the 8088 instruction set

"The Technical Reference Manual" is written for programmer's and and engineers who wish to develop their own hardware and software accessories for the HP 150 family.

The "HP-HIL Technical Reference Manual" is written for advanced users who are developing custom software and hardware for any HP-HIL system.

The "HP-HIL Development Tools for the Touchscreen PC" is written for advanced users who are developing HP-HIL application programs for the HP 150.

## Touchscreen II Configurations

| Configuration | Order Part No. | System Description |
|---|---|---|
| Touchscreen II Personal Computer | 45851A | CPU with Personal Computer Kit<br>* HP 150 II CPU<br>* System Work Disc (with MS -DOS 2.11 operating system, PAM, system utilities<br>* "Getting Started with Your HP Touchscreen II Personal Computer"<br>* "Using Your HP Touchscreen II Personal Computer"<br>* 12-inch green phosphor display<br>* HP-HIL Keyboard with HP-HIL port<br>* 256K bytes of RAM<br>* One RS-232C/RS-422 port<br>* One RS-232C port<br>* One HP-IB port<br>* One 92220E Disc Drive Cable (60cm)<br>* Four I/O Accessory Slots<br>* One Power Cord |
| | 35723A | HP Touch Accessory (user installable bezel) |
| | 9123D | Dual 3 1/2" Microfloppy disc drive |
| Touchscreen Max II | 45851A | CPU with Personal Computer Kit (same as above) |
| | 35723A | HP Touch Accessory (user installable bezel) |
| | Choice of three hard disc options | |
| | 9153A | 10M byte disc drive with one 3 1/2-inch microfloppy disc drive |
| | 9133H | 20M byte disc drive with one 3 1/2 inch microfloppy disc drive |

| | | |
|---|---|---|
| | 9133L | 40M byte disc drive with one 3 1/2 inch microfloppy disc drive |
| Touchscreen II Terminal (without disc drive) | 45850A | CPU with Terminal Kit<br>* CPU<br>* "Using Your HP Touchscreen II Personal Computer as a Terminal"<br>* 12-inch green phosphor display<br>* HP-HIL Keyboard with HP-HIL port<br>* 256K bytes of RAM<br>* One RS-232C/RS-422 port<br>* One RS-232C port<br>* One HP-IB port<br>* Four I/O Accessory Slots<br>* One Power Cord |
| | 35723A | HP Touch Accessory (user installable bezel) |

**NOTE**

MemoMaker, Personal Card File, Winning Deal and the system demo were included in the HP 150; these are not included in the Touchscreen II.

Please contact your Sales Representative for information regarding our new Networking bundles including the Discless Network Node.

# TOUCHSCREEN II PRINTED CIRCUIT ASSEMBLIES

## Introduction

The HP Touchscreen II in its standard configuration consists of three PCAs, they are the Processor, Power Supply/Sweep and the Keyboard. In addition there is an optional Touchscreen PCA, the block diagram shows each of the PCA's in the Touchscreen II system.

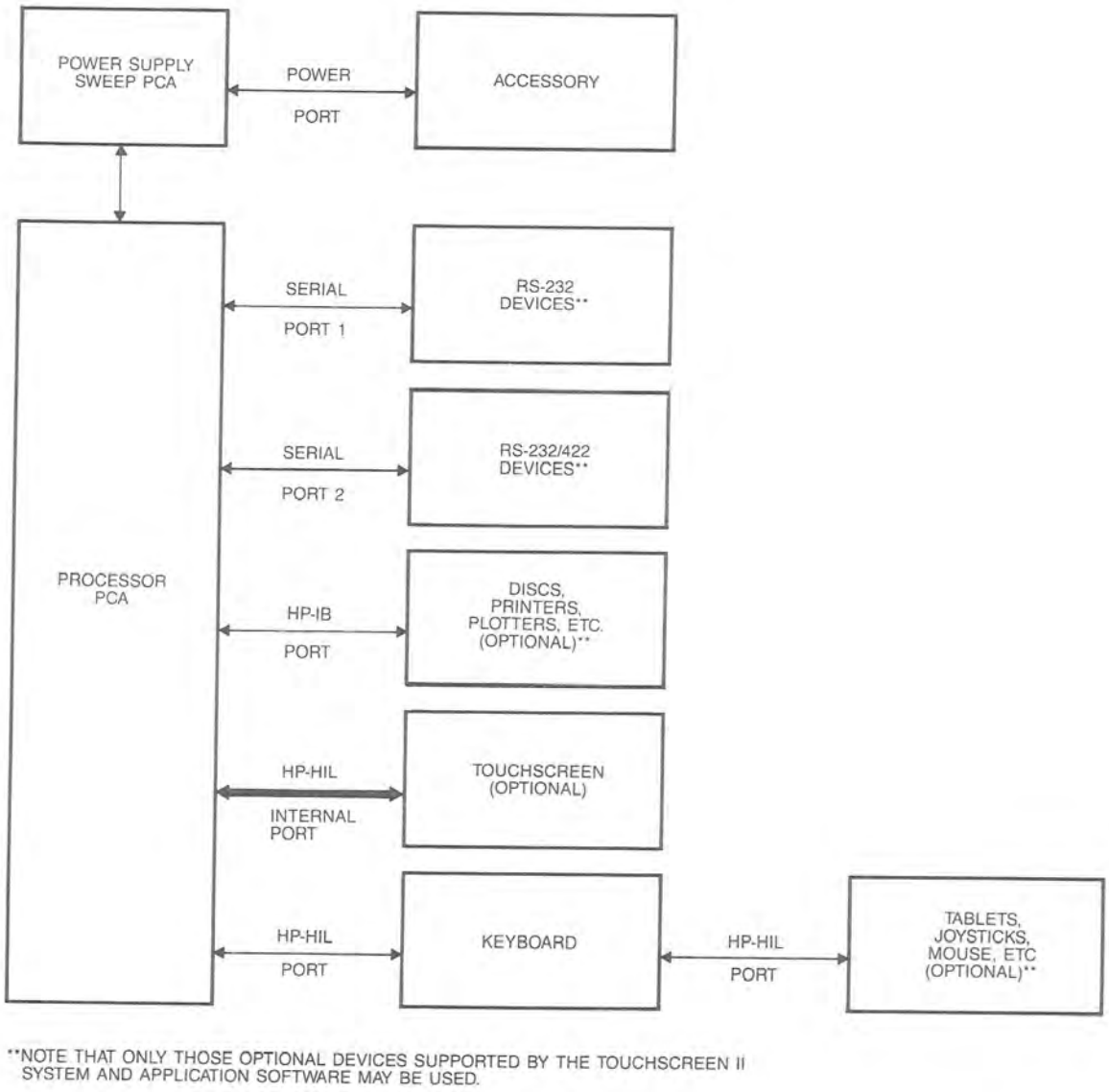



Figure 2-2. Touchscreen II System Block Diagram

**NOTE**

**Only those optional devices supported by the Touchscreen II system and application software may be used.

## Power Supply/Sweep PCA

The power supply used in the HP Touchscreen II is a 105W (80W external + 25W sweep and fan) switching supply that provides +5V, +12V, and -12V to the system components, the accessories (option boards and HP-HIL devices), and the peripherals (e.g. 9123 disc). The entire analog PC assembly is mounted vertically to the side of the metal chassis. It supplies power through an internal 20 pin connector and through an external 5 pin DIN type connector (for peripherals). An overview of the supply is presented in Section 3.

The sweep PCA accepts video and synchronization signals and drives the CRT/yoke to produce the visual display. It provides focus, brightness, vertical and horizontal centering controls to the user. Brightness limit, vertical and horizontal hold, and vertical linearity controls are accessible after removal of the top plastic covers. An overview of the sweep is presented in Section 3.

## Digital PCAs

There are three PCA's (one of which is optional) and six custom LSI IC's which make up the standard digital part of the Touchscreen II system. Optional PCA's are not described here.

### PROCESSOR PCA

The Processor PCA consists of five subsystems:

PROCESSOR SUBSYSTEM. The system processor is the 8088-2, the subsystem has a 50 pin connector which can be used for an 8087-2 Coprocessor PCA or other processor accessory. The subsystem also has four 70 pin connectors for memory or communication interface accessories. The processor interrupt controller the 8259A and the clock generator the 8284A are also located in this subsystem. The I/O Controller IC contains the real time clock, battery backed-up 1K static RAM, baud rate generator, I/O system decoder, wait state generator, go generator, and datacomm clock.

MEMORY SUBSYSTEM. The Memory Controller IC is the memory controller and memory system decoder. The subsystem contains 256K bytes of processor RAM and 160K bytes of processor ROM (5- 32K byte ROM's).

VIDEO SUBSYSTEM. The alpha and graphics displays are generated by this subsystem. The Graphics Controller IC is the graphics memory controller and video clock generator, it has an external 16K word graphics memory and shift register. The Alpha Controller IC is the alphanumeric display processor and Sweep timing generator, it also combines the graphics and alpha video dot streams. The Alpha Controller also controls access of the external 16K Alpha memory.

HP I/O SUBSYSTEM. This subsystem contains the HP developed industry standard interfaces. The 9914A HPIB controller is used to interface to fast devices such

as printers, discs, and plotters. The HP-HIL Master Controller IC is the HP-HIL system master controller used to interface to human input devices such as mice, keyboards, tablets, and touchscreens. The 8042 keyboard and touchscreen controller interfaces the HP-HIL Master Controller IC to the processor bus, and is also used for some Keyboard and Touchscreen specific functions.

SERIAL I/O SUBSYSTEM. The 7201 UART and the 1489/1488/75179 datacom drivers and receivers provide one port for RS-232 and one port for RS-232/422 communication.

### KEYBOARD PCA

This is an HP-HIL device and contains an HP-HIL port for additional devices. The HP-HIL slave controller is used to interface to the human interface link.

### TOUCHSCREEN PCA (OPTIONAL)

This is an "internal" HP-HIL device. It uses the same HP-HIL slave controller as does the keyboard, and is normally the first device in the HP-HIL chain (the keyboard is the next device). The keyboard becomes the first device in the HP-HIL chain when the touchscreen is not present.

## Accessory PCAs

The Accessory slots provide for Extended Memory, Local Language, and other options not described here.

# Hardware Subsystems

SECTION 3

This section provides a system overview of the HP Touchscreen II.

CONTENTS

# INTRODUCTION

The HP Touchscreen II, in its standard configuration, consists of three Printed Circuit Assemblies (referred to as PCA's from now on). The three PCAs are: the Processor, Power Supply/Sweep, and the Keyboard. Other PCA accesories, such as accessory cards, numeric coprocessor, and HP Touch can easily be added to the system. The Processor and Power Supply/Sweep PCAs can be further broken down into the subsystems contained on each. Included on the Processor PCA are the Processor, Video, Memory, Serial I/O, HP-IB, and HP-HIL subsystems. The Power Supply/Sweep PCA contains the Power Supply and CRT/Sweep analog subsystems.

Below is a block diagram of the HP Touchscreen II system showing each of the PCA's and how they interact with each other. The sections that follow will describe each of the PCA's and their subsystems in more detail.

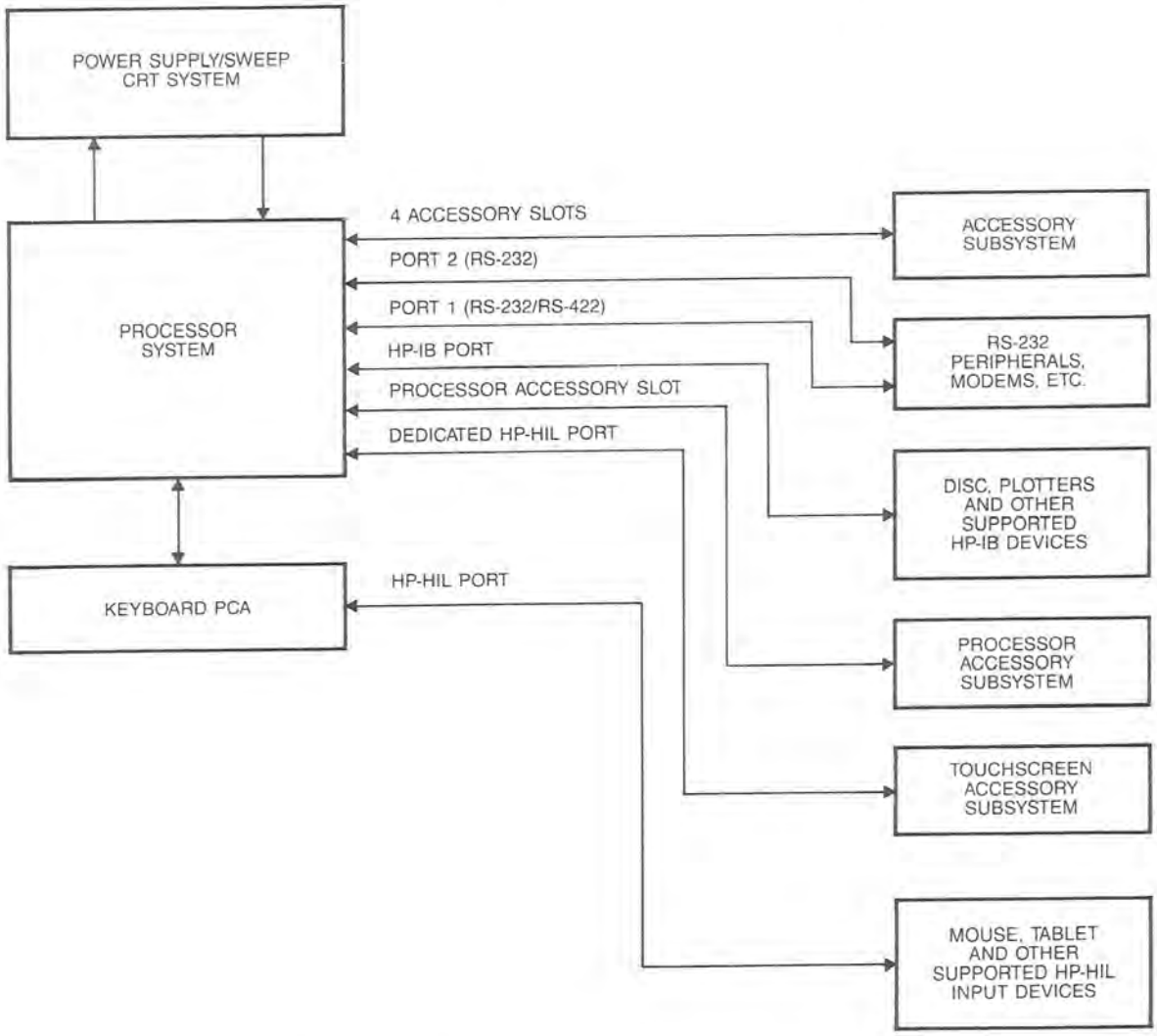



Figure 3-1. HP Touchscreen II Block Diagram

# POWER SUPPLY/SWEEP - CRT SYSTEM

The HP Touchscreen II utilizes a specially designed Power Supply/Sweep PCA which contains two subsystems, the CRT/Sweep, and the Power Supply. (The Power Supply/Sweep PCA, along with the CRT/Yoke assembly, are both included in the Monitor Assembly.) The CRT/Sweep Subsystem takes signals from the Video Subsystem and converts them to a viewable image on the screen. The Power Supply Subsystem converts wall-socket AC voltage to the proper DC voltages which it supplies to the electrical components of the HP Touchscreen II. Figure 3-2 shows the interaction between the Power Supply/Sweep's two subsystems. The following sections describe each subsystem in more detail.

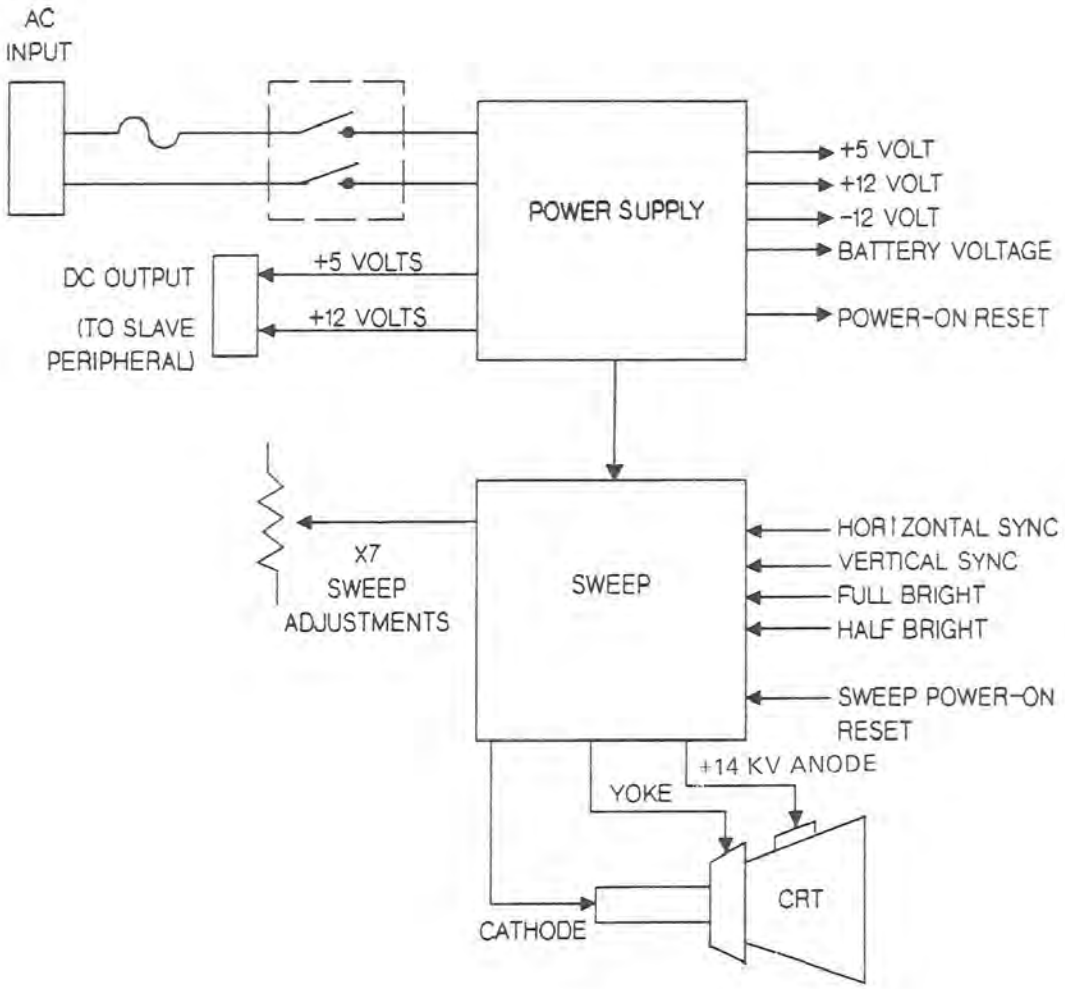



Figure 3-2. The Power Supply/Sweep Block Diagram

## The Power Supply Subsystem

The HP Touchscreen II Power Supply Subsystem takes wall-socket AC voltage and converts it to three different DC voltages: +5, +12 and -12. A block diagram of the HP Touchscreen II Power Supply is shown below in figure 3-3. Basic operation of the Power Supply Subsystem is discussed in the following paragraphs.

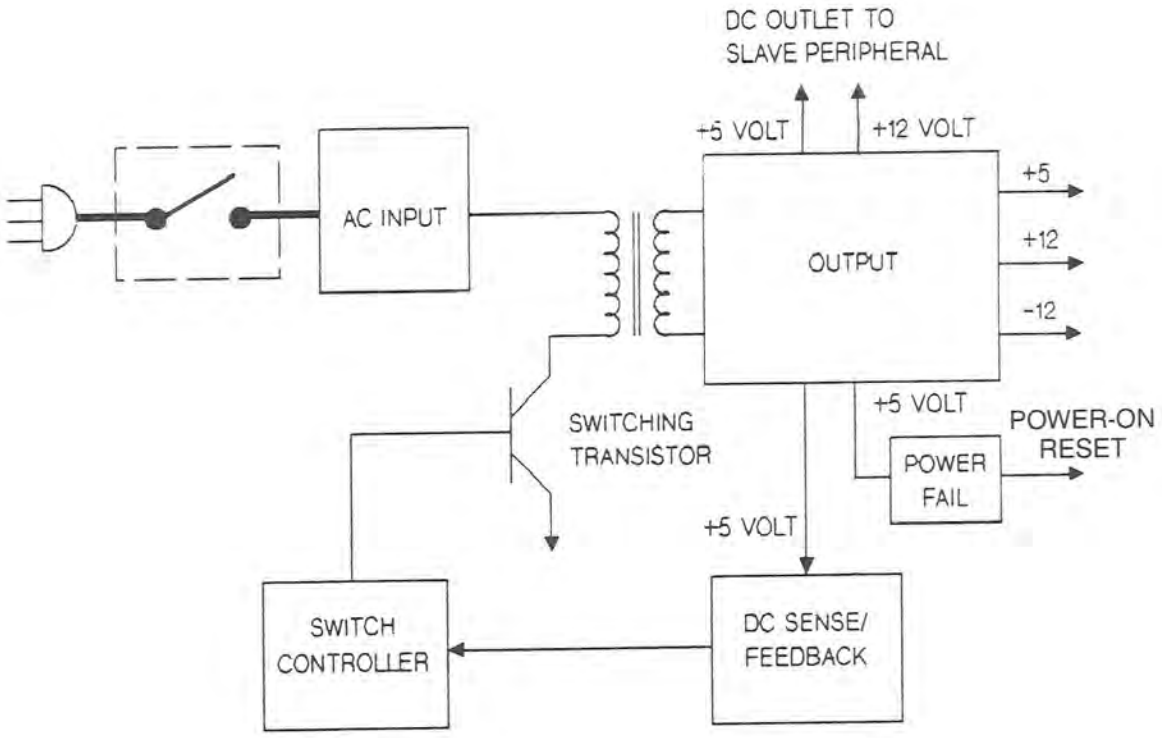



Figure 3-3. Power Supply Subsystem Block Diagram

During normal operation, the input to the AC input circuitry is a 115 or 230 AC line voltage. This voltage is converted by the AC input circuitry (which consists of a RFI filter, rectifier and smoothing filter) to a DC voltage. During the "on" state of the switching transistor the energy generated by the DC voltage is transferred from the primary side of the transformer to the secondary side. This energy is then converted by the output circuitry to voltages required by the rest of the HP Touchscreen II (+5, +12 and -12 volts), and also any peripherals plugged into the HP Touchscreen II's DC peripheral outlet (+5, +12 volts).

The "on" and "off" state of the switching transistor is controlled by the switch controller and DC sense/feed-back circuitry. The DC sense/feed-back circuitry uses an opto-coupler on the +5 volt line to sense the energy needs of the output circuitry. When more energy is required by the output circuitry the switch controller keeps the switching transistor "on" for a longer period of time. When the energy requirements of the output are met the switch controller turns the switching transistor off. This switching frequency is typically around 47kHz.

The power-fail circuit senses when the AC input voltage has been removed or has dropped to a insufficient level. When either of the above conditions are detected, a signal is sent to the system by the power-fail circuitry to warn of impending power loss.

If a short circuit or overvoltage condition is sensed on the +5 volt line the switch controller will turn the supply off. To reset the power supply the power switch must first be turned off. Then, you can reset the power supply by touching the two reset pads (see illustration at the end of Chapter 8) with the tip of an insulated flatblade screwdriver. Otherwise, the power supply must remain off for approximately 2 minutes before turn-on can be attempted. In the case of the + or -12 volt output, if a short circuit condition exists the regulators within the + or -12 volt circuitry will shut down the + or -12 volt output. The + or -12 volt output will return to normal operation as soon as the cause of the fault condition is removed.

## The CRT - Sweep Subsystem

The HP Touchscreen II display is a raster scanned CRT which utilizes magnetic deflection and is refreshed at a rate of 60 Hz. The CRT/Sweep Subsystem receives the horizontal sync, vertical sync and video drive signals from the Video Subsystem and uses these signals to provide the appropriate operating voltages to the CRT.

The four basic functions of the CRT/Sweep Subsystem are:

1. To generate the current required for the vertical deflection of the electron beam.

2. To generate the current required for the horizontal deflection of the electron beam.

3. To supply the grid voltages and the accelerating potential for the electron beam.

4. To amplify the video signals to the voltage level required to drive the cathode of the tube.

In order to accomplish the above, the CRT/Sweep Subsystem contains three main circuits. They are the video amplifier circuit, the vertical drive circuit and the horizontal drive circuit (see figure 3-4).

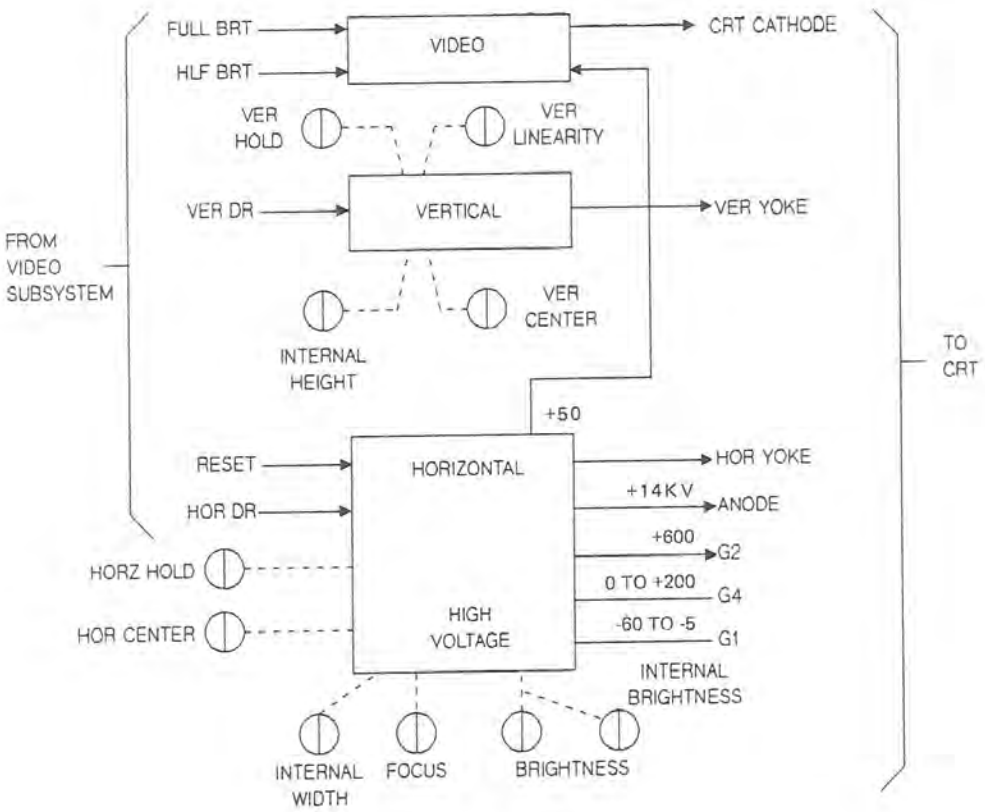



Figure 3-4. CRT/Sweep Subsystem Block Diagram

**VIDEO AMPLIFIER CIRCUIT.** The video amplifier circuit is responsible for amplifying the signals from the Video Subsystem to the voltage level required by the CRT. The video amplifier converts the FULL BRT and HALF BRT TTL level inputs to one of three outputs: +50 volts (beam off), +15 volts (full-bright) and +25 volts (half-bright).

**VERTICAL DRIVE CIRCUIT.** The vertical drive circuit generates the current required for the vertical deflection of the CRT. This circuit converts the input (NVSYNC) from the Video Subsystem to the current output to the vertical yoke winding which controls the vertical deflection of the electron beam. Four potentiometers in this circuit control the vertical adjustment of the CRT. One of these potentiometers is the vertical center adjustment, which can be found along the top edge of the HP Touchscreen II just under the top cable cover, and is user adjustable. The others; the height, the vertical hold, and the vertical linearity adjustments can be found along the top edge of the HP Touchscreen II under the top cover, and are preadjusted at the factory (they are not user adjustable). The vertical hold adjustment is similar to the vertical hold adjustment on a television set. The vertical linearity adjustment adjusts screen proportioning, i.e., expands the top half and compresses the bottom half, or compresses the top half and expands the bottom half to achieve display symmetry.

**HORIZONTAL DRIVE CIRCUIT.** The horizontal drive circuit generates the current required by the CRT for horizontal deflection of the electron beam. This deflection is produced by a resonant circuit which oscillates at the same frequency as the horizontal sync signal. Each oscillation corresponds to a horizontal scan across the CRT.

Also generated in the horizontal drive circuit are voltages required by the CRT and video amplifier circuit. A flyback transformer is used to generate the following voltages:

1. A positive voltage of 14 kilovolts for electron acceleration (anode voltage).
2. A -60 to -5 volts for grid G1 (brightness).
3. A positive 600 volts for grid G2.
4. A 0 to +200 volts for grid G4 (focus).
5. A positive 50 volts for the video amplifier circuit.

There are six potentiometers located within the horizontal drive circuitry. The horizontal center, focus, and brightness adjustments are user adjustable controls which are located underneath the top cable cover (except for the brightness knob which is located on the outside of the system near the front). The other three adjustments, the width, the brightness limiter, and the horizontal hold are located under the top cover and are preadjusted at the factory (non-user adjustable) (see figure 3-4). The horizontal hold adjustment is very similar to the the horizontal hold adjustment on a television set.

## The Processor System

The Processor PCA is the "heart" of the HP Touchscreen II and is responsible for the transfer and processing of data throughout the system. The block diagram shows the interaction between the Processor's five digital subsystems (Processor, Video, Memory, Serial I/O, HP-IB and HP-HIL). In addition are the Keyboard, Touchscreen, Processor Accessory and up to 4 Accessory Subsystems.

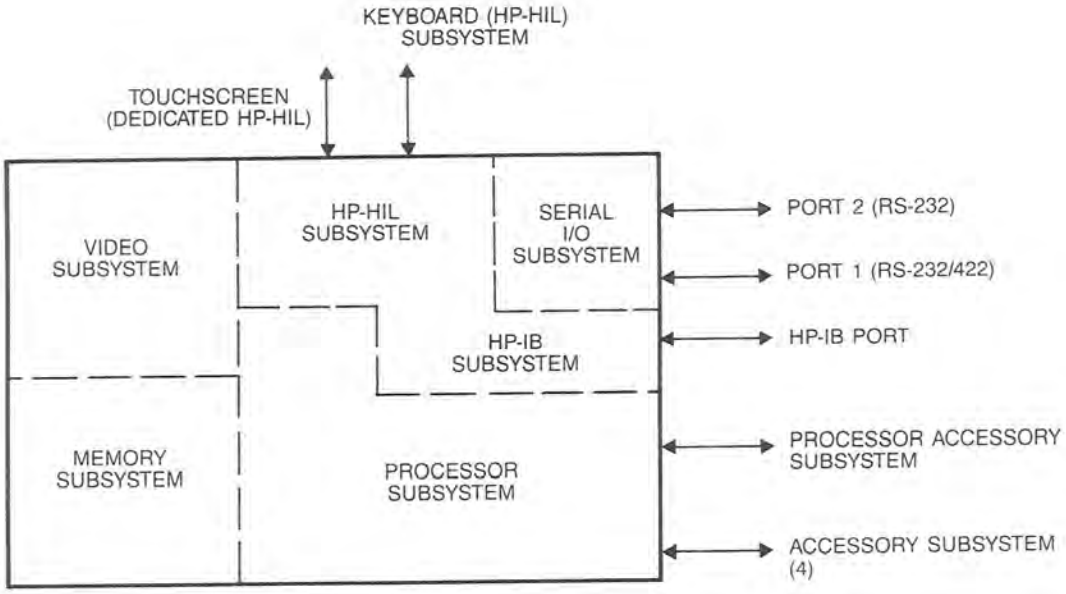



Figure 3-5. Processor PCA Block Diagram

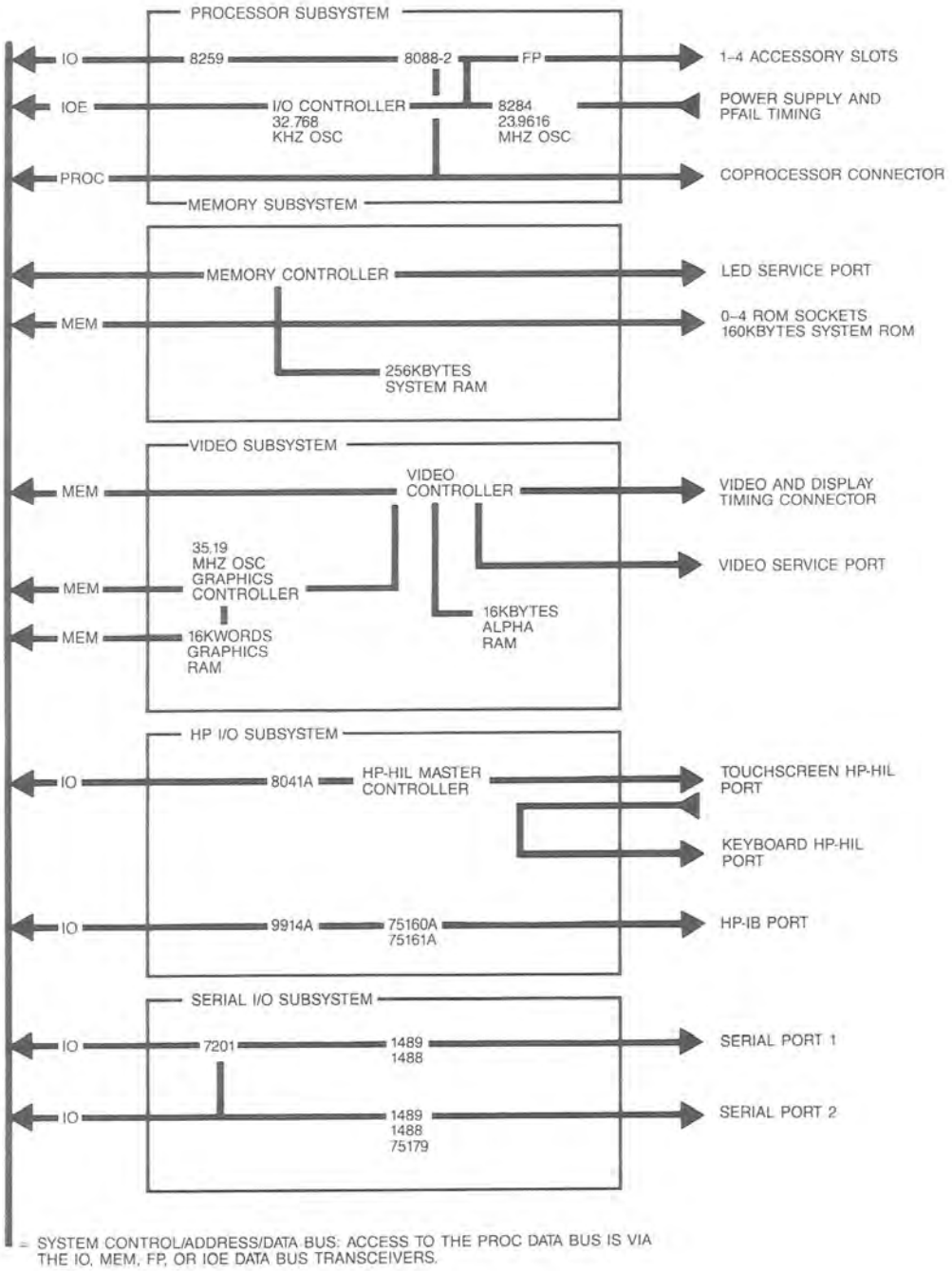



Figure 3-6. Touchscreen II Processor PCA Interface Block Diagram

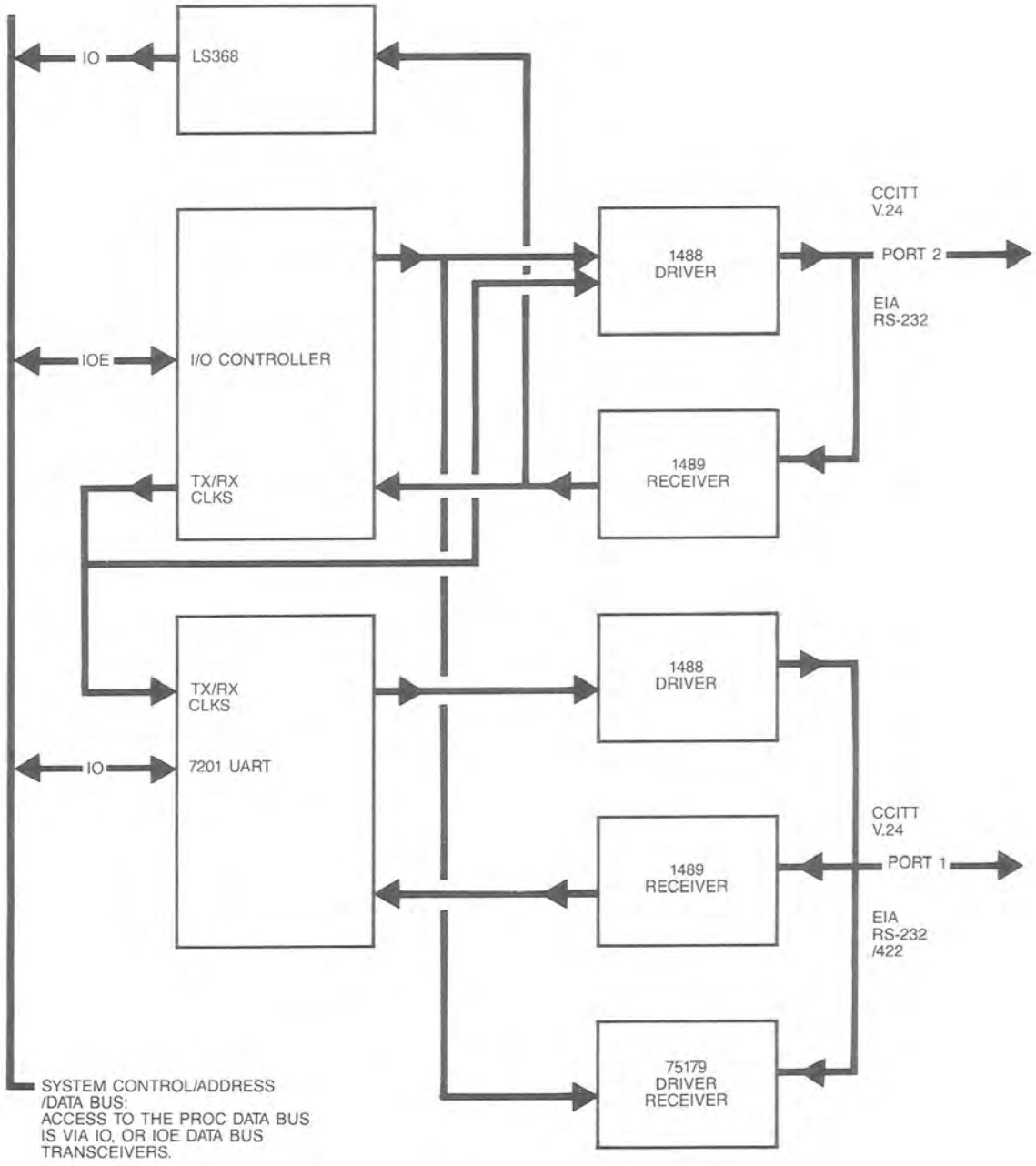



Figure 3-7. Touchscreen II Data Communications Block Diagram

# PROCESSOR SUBSYSTEM INTERCONNECTIONS

## General

This section describes the Processor Connectors, Sockets, Service Port LED's, Test Points, and Configuration Jumpers.

The specific items described are:

- Power Supply/Sweep Connector (J11)
- Processor Accessory Card Slot Connector (J7)
- Accessory Card Slot Connectors (J3-6)
- ROM Sockets 0-4 (ROM0-4)
- LED Service Port (LED1)
- Video Test Points (TP5-8)
- Power Supply Test Points (+12V, -12V, +5V, and GND)
- HP-IB Connector (J10)
- Touchscreen Connector (J8)
- Datacom Port1 Connector (J1)
- Datacom Port2 Connector (J2)
- Configuration Jumpers (W1-2)
- Keyboard HP-HIL Connector (J9)

Refer to figure 3-8 for the locations on the Processor Subsystem PCA.

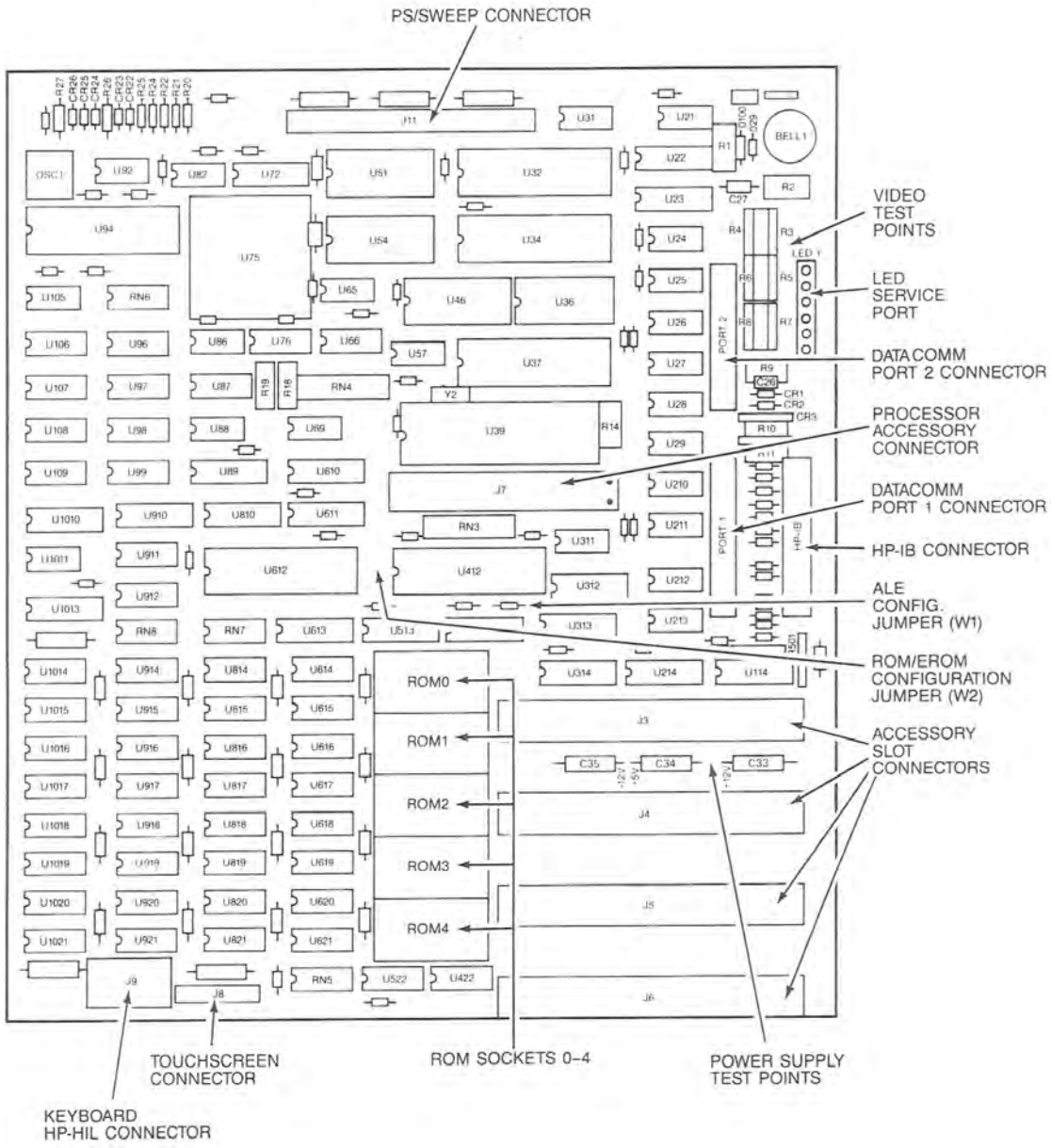



Figure 3-8. Processor Subsystem Interconnections

## Power Supply/Sweep Connector (J11)

The Power Supply/Sweep System connects to the Processor System via a 22 pin connector. Signal/Pin assignments are listed below:

| Pin | Signal | Definition |
|---|---|---|
| 0 | Guide Pin | |
| 1 | NFB | Buffered Full-Bright. Active low serial alpha-graphics dot stream. |
| 2 | SGND | Signal Reference Ground. |
| 3 | NHB | Buffered Half-Bright. Active low serial alpha-graphics dot stream. |
| 4 | HSYNC | Buffered Horizontal Synchronization. Active low synchs the horizontal sweep circuit. |
| 5 | NVSYNC | Buffered Vertical Synchronization. Active low synchs the vertical sweep circuit. |
| 6 | NRESET | Buffered System Reset. Active low, not used on current PS/Sweep system. |
| 7 | NPFAIL | Power Fail. Active low, indicates Power Supply outputs are not at valid levels. |
| 8 | VBAT | Battery Output. +3.5V min to +5.5V max |
| 9 | +12V | Power. +11.4V min to +12.6V max |
| 10 | GND | Power and Signal Reference Ground. |
| 11 | GND | |
| 12 | GND | |
| 13 | GND | |
| 14 | GND | |
| 15 | GND | |
| 16 | +5V | Power. +4.75V min to 5.25V max |
| 17 | +5V | |
| 18 | +5V | |
| 19 | +5V | |
| 20 | -12V | Power. -11.4V min to -12.6V max |
| 0 | Guide Pin | |

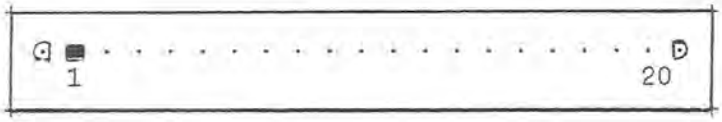



Figure 3-9. Power Supply/Sweep Connector (J11)

## Processor Accessory Card Slot Connector (J7)

The Processor Accessory Subsystems connect to the Processor via a 50 pin connector. Signal/Pin assignments are listed below.

| Pin | Signal | Definition | Pin | Signal | Definition |
|---|---|---|---|---|---|
| 1 | GND | Power & Signal Ground Ref. | 26 | Not Used | |
| 2 | A14 | | 27 | A15 | |
| 3 | A13 | | 28 | A16 | Processor |
| 4 | A12 | Procesor | 29 | A17 | -- Address |
| 5 | A11 | - Address | 30 | A18 | Data Bus |
| 6 | A10 | Data Bus | 31 | A19 | |
| 7 | A9 | | 32 | NSS0 | Processor Status Line |
| 8 | A8 | | 33 | NRSET | Buff. Proc Reset. Active Low. |
| 9 | AD7 | | 34 | NRD | Proc Read. Act Low |
| 10 | AD6 | | 35 | GND | Pwr & Sig Gnd Ref |
| 11 | AD5 | | 36 | +5V | PS,4.75V to 5.25V |
| 12 | AD4 | Processor | 37 | NWRT | Proc Write. Act Low |
| 13 | AD3 | - Address | 38 | IO/NM | Proc Status |
| 14 | AD2 | Data Bus | 39 | DT/NR | Proc Data Xmit & Rec |
| 15 | AD1 | | 40 | NDEN | Proc Data Enbl.Act Low |
| 16 | AD0 | | 41 | NCLK | Buf Proc Clock. Invert |
| 17 | KRST | Keyboard Reset | 42 | NINTA | Proc Int Ack. Act Low |
| 18 | INTR | Proc Int Req | 43 | GND | Pwr & Sig Gnd Ref |
| 19 | CLK | Proc Clock | 44 | RDY | Processor Ready |
| 20 | GO | | 45 | RST | Processor Reset |
| 21 | ASCHOLD | Asyn Int, Hold Reset FF | 46 | HOLDA | Proc Hold Ack |
| 22 | PRHOLD | Preset Hold | 47 | PRHOLD | Preset Hold Req FF |
| 23 | CLRSHOLDA | Clear Hold Ack | 48 | NNPINT | Num Proc Int. Act Low (Not used on TS II) |
| 24 | GND | Pwr & Sig Gn Ref | 49 | +5V | 4.75V to 5.25V |
| 25 | ALE | Proc Addr Latch Enbl, Max Mode | 50 | MINALE | Proc Addr Latch Enbl. Min Mode only. |

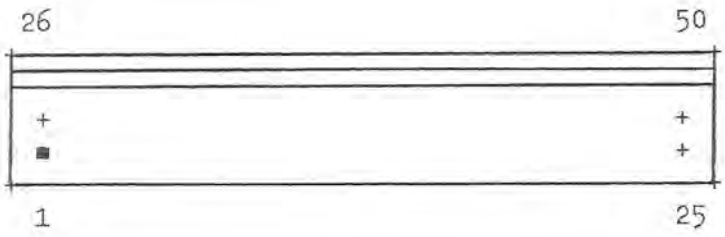



Figure 3-10. Processor Accessory Connector (J7)

## Accessory Card Slot Connectors (J3-J6)

The accessory boards plug into the bottom of the card cage. The system signals available to the modules are listed below.

J3-6. Accessory Board Front Plane Connector Pinout and Signals

| | | | | | |
|---|---|---|---|---|---|
| 1 | FPA 0 | Buffered/ Latched Processor Address Bus | 36 | (RESERVED)* | |
| 2 | FPA 1 | | 37 | NPFAIL | Power Fail. Active Low, PS levels are not valid |
| 3 | FPA 2 | | 38 | (RESERVED)* | |
| 4 | FPA 3 | | 39 | FPNRST | Buf Proc Reset. Act Low |
| 5 | FPA 4 | | 40 | +5V | |
| 6 | FPA 5 | | 41 | GND | |
| 7 | FPA 6 | | 42 | GND | |
| 8 | FPA 7 | | 43 | NOCINT | Acc Slot Open Circuit Interrupt Line. Act Low |
| 9 | ABUS 8 | Buffered Processor Address Bus | 44 | GND | |
| 10 | ABUS 9 | | 45 | NOCWAIT | Acc Slot Video Opn Ckt Wait Line. Active Low |
| 11 | ABUS 10 | | 46 | (RESERVED)* | |
| 12 | ABUS 11 | | 47 | BIO/NM | Buff Proc Status |
| 13 | FPA 12 | | 48 | +5V | |
| 14 | FPA 13 | | 49 | -12V | |
| 15 | FPA 14 | | 50 | NDCOCINT | Acc Slot Datacom Opn Ckt Interrupt Line. Act Low |
| 16 | FPA 15 | Buffered Processor Address Bus | 51 | GND | |
| 17 | FPA 16 | | 52 | -12V | |
| 18 | FPA 17 | | 53 | SHOLDA | |
| 19 | FPA 18 | | 54 | FPGO | Buff Proc Memory GO |
| 20 | FPA 19 | | 55 | +5V | |
| 21 | GND | Pwr Gnd & Signal Ref | 56 | GND | |
| 22 | GND | | 57 | FPCLK | Buff Proc Clock |
| 23 | FPD 0 | Accessory Slot Transceiver Data Bus | 58 | (RESERVED)* | |
| 24 | FPD 1 | | 59 | GND/FULLMEM* | |
| 25 | FPD 2 | | 60 | +12V | |
| 26 | FPD 3 | | 61 | GND | |
| 27 | FPD 4 | | 62 | BIO/NM | |
| 28 | FPD 5 | | 63 | +12V | |
| 29 | FPD 6 | | 64 | FPNWRT | |
| 30 | FPD 7 | | 65 | +5V | |
| 31 | GND | | 66 | FPDT/-R | |
| 32 | FPNRD | Buff Proc Read | 67 | GND | |
| 33 | GND | | 68 | FPNSSO | |
| 34 | +5V | | 69 | GND | |
| 35 | BATV | Battery Output 3.5V to 5.5V | 70 | NSLOTSELX** | |

*Pin 59 is FULLMEM on J3 only. On J4-6, Pin 59 is GND, connections to this pin and all pins labelled RESERVED should not be made.

Memory Accessory subsystems can only be used in slot 1.

**NSLOTSELX will be slot 1, 2, 3, or 4 depending on which connector (J3, 4, 5, or 6) the accessory card in plugged into.

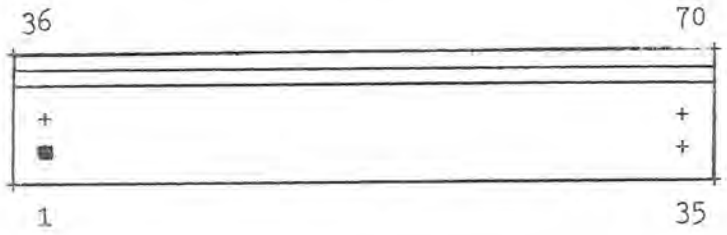



Figure 3-11. Accessory Card Slot Connector (J3-6)

Pictorial view of option module front plane connector with pin assignment (as viewed from component side of front plane board)

## ROM Sockets

The ROM's connect to the Processor Memory Subsystem via these sockets to allow for firmware code updates and special system development. ROM0 is high memory and ROM4 is low memory address. The ROM's or EPROM's conform to socket pinout and datasheet specifications:

| | | | | | | |
|---|---|---|---|---|---|---|
| 4.75V - 5.25V | +5V | 1 | 28 | +5V | | |
| | ABUS 12 | 2 | 27 | ABUS 14 | | |
| | ABUS 7 | 3 | 26 | NABUS 13 | Buff | |
| | ABUS 6 | 4 | 25 | NABUS 8 | -Proc | |
| Buffered | ABUS 5 | 5 | 24 | NABUS 9 | Add Bus | |
| Processor | ABUS 4 | 6 | 23 | NABUS 11 | | |
| Addr Bus | ABUS 3 | 7 | 22 | NBRD | Buf Prc Read | |
| | ABUS 2 | 8 | 21 | NABUS 10 | Buf Prc Ad Bus | |
| | ABUS 1 | 9 | 20 | NROM SELECT | ROM Slct | |
| | ABUS 0 | 10 | 19 | D7 | | |
| Memory | D0 | 11 | 18 | D6 | Memory | |
| Transcvr | D1 | 12 | 17 | D5 | Transceiver | |
| Data Bus | D2 | 13 | 16 | D4 | Data Bus | |
| Pwr Gnd & Sig Ref | GND | 14 | 15 | D3 | | |

(D0-D7 is the Memory Transceiver Data Bus)

**NOTE**

Refer to Signetics 23256A Data Sheet (or equivalent) for ROM specifications.

## LED Service Port

This port consists of 6 LED's (viewed from the rear of the product).

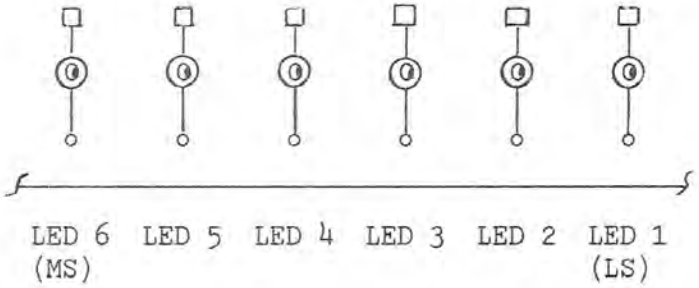
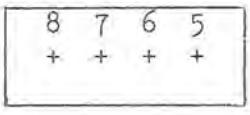



Figure 3-12. LED Service Port

## Video Test Points

A production test system connects to these test points via test probes in order to test the Processor Video Subsystem output.

| | Signal | Description |
|---|---|---|
| TP 8 | NFB | Buffered Full Bright. Active low serial alpha-graphics dot stream. |
| TP 7 | SGND | Signal Reference Ground |
| TP 6 | CSYNC | Buffered Composite Sync. Used to synchronize the horizontal and vertical sweep circuit to an external monitor. |
| TP 5 | NHB | Buffered Half Bright. Active low serial alpha-graphics dot stream. |




Test Points (TP)

Figure 3-13. Video Test Points

## Power Supply Test Points

The Power Supply Test Points allow measurement of the power supply voltages without disassembling the product. They are located in the Accessory Card Slot connector area.

| Test Point | | Normal Range |
|---|---|---|
| GND | - | Reference |
| +12V | - | +11.4V minimum, +12.6V maximum |
| -12V | - | -11.4V minimum, -12.6V maximum |
| +5V | - | +4.75V minimum, +5.25V maximum |

## HP-IB Connector (J10)

The supported HP-IB peripherals connect to the Processor HP-IB Subsystem via a 24 pin connector. Signal/pin assignments are listed below.

| | | | | | |
|---|---|---|---|---|---|
| 1 | B1 | Bus Data (MSB) | 13 | B5 | Bus Data |
| 2 | B2 | Bus Data | 14 | B6 | Bus Data |
| 3 | B3 | Bus Data | 15 | B7 | Bus Data |
| 4 | B4 | Bus Data | 16 | B8 | Bus Data (LSB) |
| 5 | XEOI | End or Identify | 17 | XREN | Remote Enable |
| 6 | SDAV | Data Valid | 18 | SGND | --+ |
| 7 | NXRFD | Not Ready for Data | 19 | SGND | \| |
| 8 | NXDAC | Data Not Accepted | 20 | SGND | \| Signal Reference |
| 9 | XIFC | Interface Clear | 21 | SGND | \|- Ground |
| 10 | XSRQ | Service Request | 22 | SGND | \| |
| 11 | XATN | Attention | 23 | SGND | \| |
| 12 | SHIELD | Chassis Ground | 24 | SGND | --+ |

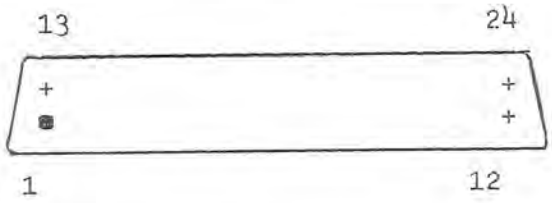
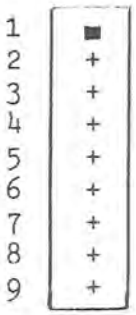



Figure 3-14. HP-IB Connector (J10)

## Touchscreen Connector (J8)

The Touchscreen Subsystem connects to the Processor HP-HIL Subsystem via a 9-pin connector. Signal/pin definitions are listed below.



| Pin | | Description |
|---|---|---|
| 1 | GND | - Power Supply and Signal ground reference |
| 2 | RO | - Return data out; data passed on to the previous device |
| 3 | GND | - Power Supply and Signal ground reference |
| 4 | RI | - Return data in; driven by RO of the next device |
| 5 | GND | - Power Supply and Signal ground reference |
| 6 | SO | - Serial data out; data passed to the next device |
| 7 | +12V | - Positive supply, Touchscreen consumes 200 mA max. |
| 8 | SI | - Serial data in; data driven by SO on the previous device |
| 9 | NTS | - Ground if the Touchscreen is installed, open if not |

Figure 3-15. Touchscreen Connector (J8)

## Datacomm Port1 Connector (J1)

The supported modems, hardware connections and RS-232 peripherals connect to the Processor Serial I/O subsystem via the 25 pin connector. Pin/signal definitions on this connector are listed below.

| Pin No. | Description | CCITT | RS-232-C |
|---|---|---|---|
| 1 | Cable Shield | 101 | AA |
| 2 | Transmit Data | 103 | BA |
| 3 | Receive Data | 104 | BB, RD.A (RS-422) |
| 4 | Request to Send | 105 | CA |
| 5 | Clear to Send | 106 | CB |
| 6 | Data Set Ready | 107 | CC |
| 7 | Signal Ground | 102 | AB |
| 8 | Receiver Ready | 109 | CF |
| 9 | Transmitted Data A | --- | SD A (RS-422) |
| 10 | Transmitted Data B | --- | SD B (RS-422) |
| 12 | Secondary Receiver Ready | 122 | SCF |
| 15 | Transmitter Signal Timing (DCE) | 114 | DB |
| 17 | Receiver Signal Timing (DCE) | 115 | DD |
| 18 | Received Data B | --- | RD. B (RS-422) |
| 19 | ** Secondary Request to Send | 120 | SCA |
| 20 | Data Terminal Ready | 108.2 | CD |
| 22 | ** Ring Indicator Ready | 125 | CE |
| 23 | Data Signal Rate Select | 111 | CH |

Pins 11, 13, 14, 16, 21, 24, and 25 are not connected.

* European Modem Cable Connector, HP Part Number 13242M

** Used only for testing with loop-back test hood

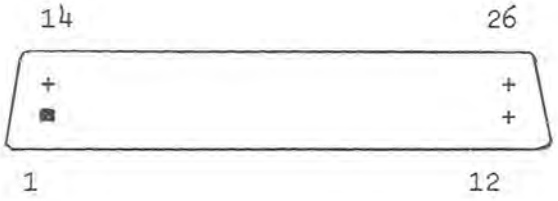



Figure 3-16. Datacomm Port1 Connector (J1)

## Datacomm Port2 Connector (J2)

The supported modems, hardware connections and RS-232 peripherals connect to the Processor Serial I/O subsystem via the 25 pin connector. Pin/signal definitions on this connector are listed below.

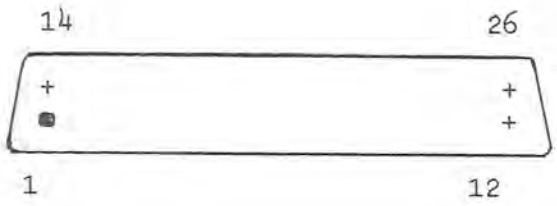
| Pin No.* | Description | CCITT | RS-232-C |
|---|---|---|---|
| 1 | Cable Shield | 101 | AA |
| 2 | Transmit Data | 103 | BA |
| 3 | Receive Data | 104 | BB |
| 4 | Request to Send | 105 | CA |
| 5 | Clear to Send | 106 | CB |
| 6 | Data Set Ready | 107 | CC |
| 7 | Signal Ground | 102 | AB |
| 8 | Receiver Ready | 109 | CF |
| 12 | Secondary Receiver Ready | 122 | SCF |
| 19 | ** Secondary Request to Send | 120 | SCA |
| 20 | Data Terminal Ready | 108.2 | CD |

| | | | |
|---|---|---|---|
| 22 | ** Ring Indicator<br>Ready | 125 | CE |
| 23 | Data Signal Rate<br>Select | 111 | CH |

Pins 9-11, 13-18, 21, 24, and 25 are not connected.

* European Modem Cable Connector, HP Part Number 13242M

** Used only for testing with loop-back test hood




Datacomm Port2 Connector (J2)

## Configuration Jumpers (W1, W2)

W1 - ALE Jumper

This is a wire (zero ohm resistor) jumper which is removed when the Coprocessor accessory subsystem is installed in J7. When removed, it allows ALE (Address Latch Enable) to be supplied from the 8088 on the Coprocessor subsystem.

W2 - ROM Jumper

This is a PC trace jumper which is removed to add one wait state to each ROM access. It is used only in development systems where EPROM's having an access time more than the normal ROM access time (200 ns) are used.

Holes are provided so that a zero ohm resistor jumper can be inserted if the trace has been cut.

## Keyboard HP-HIL Connector (J9)

The HP-HIL Keyboard Subsystem connects to the Processor Subsystem via a 4 pin connector.

| Pin | | | Description |
|---|---|---|---|
| 1 | +12V | - | Power supply to the HP-HIL system |
| 2 | RI | - | Return data in; driven by RO on the next device |
| 3 | SO | - | Serial data out; driven by SO on the next device |
| 4 | GND | - | Power supply and signal ground reference |

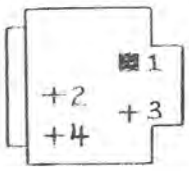



Figure 3-17. Keyboard HP-HIL Connector (J9)

# PROCESSOR SUBSYSTEM

## General

The area occupied by the Processor Subsystem on the Processor PCA is shown in Figure 3-18, while a block diagram of the Processor Subsystem is illustrated in Figure 3-19.

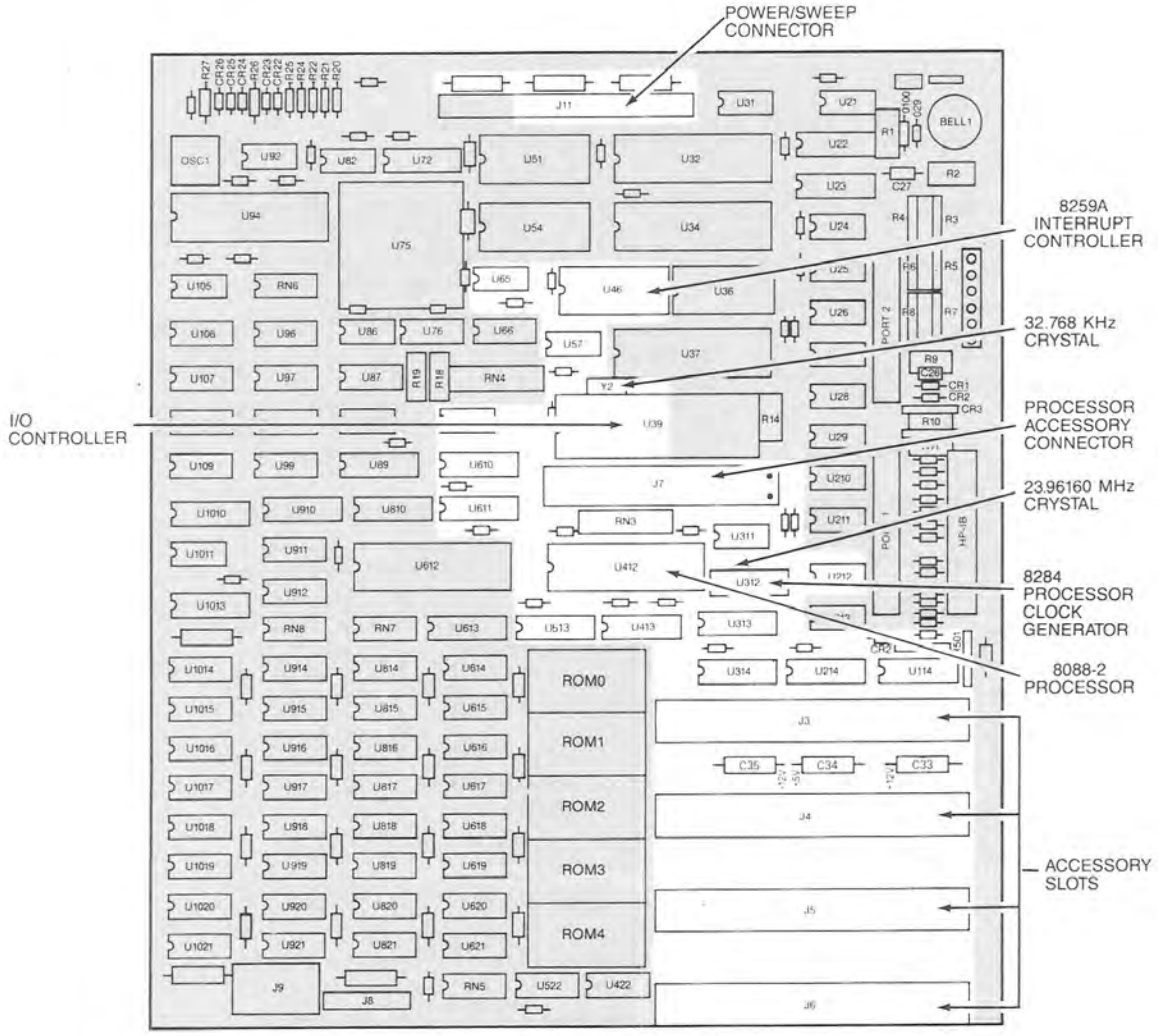



Figure 3-18. Processor Subsystem

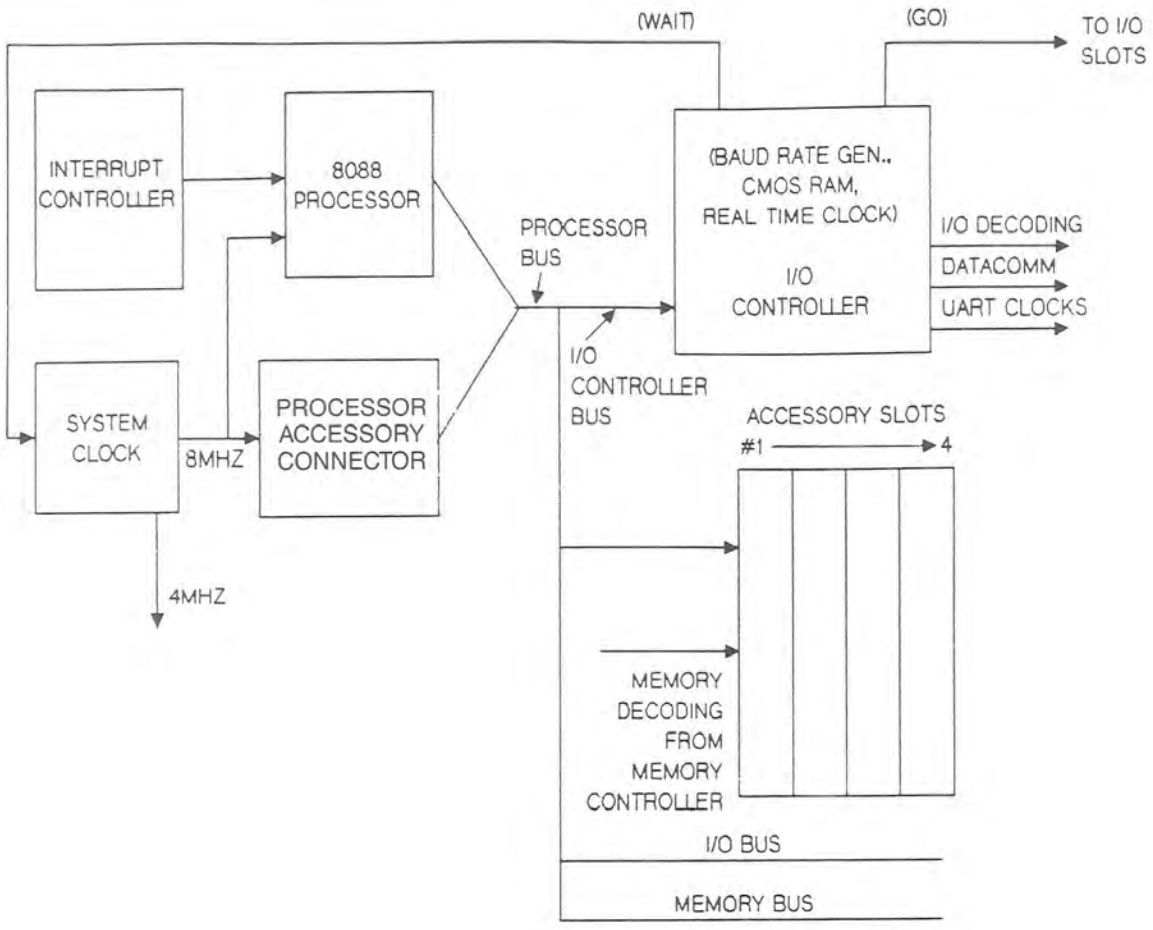



Figure 3-19. Processor Subsystem Block Diagram

The main Processor Subsystem components consist of the following:

-8259A Interrupt Controller [U46].

-8088-2 Processor [U412].

-8284A Clock Generator [U312] and 23.96160MHZ Crystal [Y1].

-Hold Logic [U212].

-Processor Accessory Connector [J7].

-I/O Controller I.C. [U39] and 32.768KHZ Crystal [Y2].

-System Control, Clock, Address, and Data Buffers.

-Accessory Slot Connectors [J3-6].

The I/O Controller I.C. contains the following:

-CMOS RAM.

-I/O Decoding Logic.

-Wait State Logic.

-Memory GO Timing.

-Real Time Clock

The above subsystem components are functionally identical and software compatible with those in the HP 150, the only differences are as follows:

-Provision is made for disabling the 8088-2 from the Processor Accessory Slot by means of the direct set and clear inputs on the Hold Logic [U212]. This means that after the Power up sequence the Processor Accessory Subsystem Card which is plugged into the Processor Accessory Card Slot [J7] will have complete control of the Touchscreen II Processor Subsystem.

The Processor Accessory Subsystem Card which can contain a Processor and Coprocessor<s> must have a compatible 8088-2 "Min Mode" interface at the J7 Connector as described in the HP 150 Technical Reference Manual.

-There are four Accessory Card Slots in Touchscreen II compared with two in the HP 150, the memory address mapping for these is described in the Processor Memory Subsystem - Memory Controller I.C.

# MEMORY SUBSYSTEM

## General

The Memory Subsystem components consist of the following:

-Memory Controller [U612].
-64K X 1 dynamic user RAM [U614-621, U814-821, U914-921 U1010-1021].
-Dynamic RAM refresh address counter and driver [U1011, U1013].
-Dynamic RAM controller signal driver [U613].
-Dynamic RAM row and colum address multiplexer [U911, U912].
-Dynamic RAM signal damping resistor network [RN6, RN8].
-32K X 8 ROM [ROM0-ROM4].
-LED data register [U422].
-LED array [LED1].
-Data tranceiver [U810].

The memory subsystem consists of user dynamic RAM, ROM and the system status LEDs. The memory subsystem is build around the Memory Controller (1820-3957) chip, a semi-custom CMOS integrated circuit. Memory Controller is the memory controller chip. Even through controlling dynamic RAM (DRAM) is one of its features, its main function is to manage Touchscreen II's memory mapping activities. Figure 3-20 illustrates the Memory Subsystem on the Processor PCA.

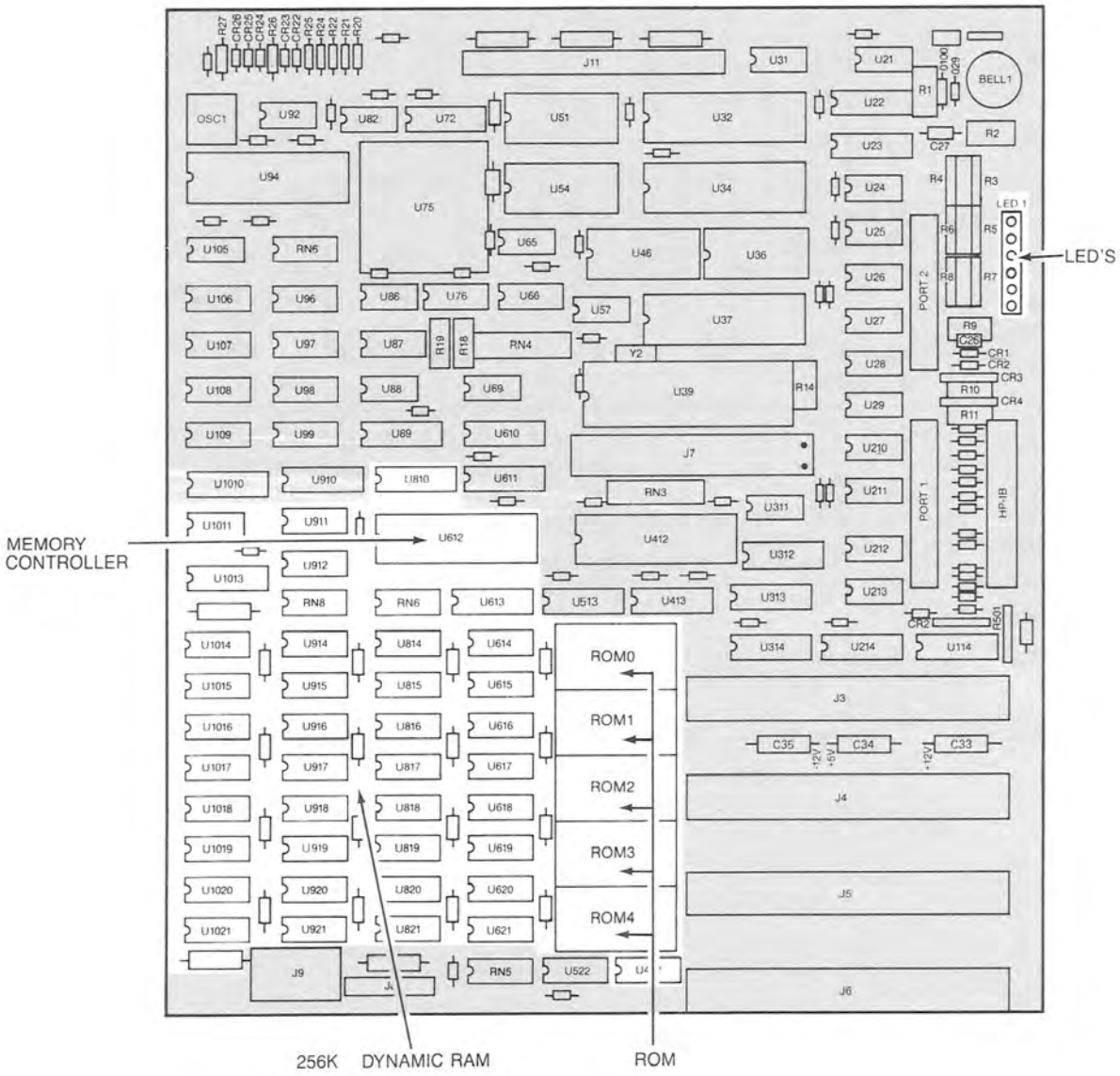



Figure 3-20. Memory Subsystem Location

A block diagram of the memory subsystem is shown in figure 3-21.

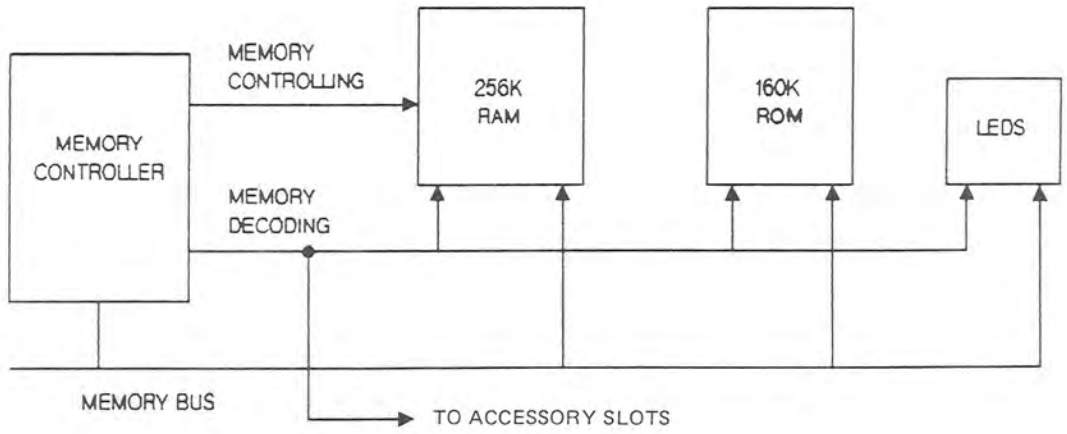



Figure 3-21. Memory Subsystem Block Diagram

# ROM

**ROM DECODING.** Five 32K x 8 ROMs contain the system firmware used by the Touchscreen II. These ROMs are located in the memory map as follows:

| ROM | Memory Address |
|---|---|
| ROM 0 | 0F8000H - 0FFFFFH (Self Test ROM) |
| ROM 1 | 0F0000H - 0F7FFFH |
| ROM 2 | 0E8000H - 0EFFFFH |
| ROM 3 | 0E0000H - 0E7FFFH |
| ROM 4 | 0B0000H - 0B7FFFH |

For a particular ROM to be selected, an address within the memory space allocated to it must be generated by the 8088, the 8088 control signal IO/NM (becomes BIO/NM after buffering for the memory) must be low, and NBRD (buffered read strobe control signal from the 8088-2) must be asserted (active low). The Memory Controller Chip (U612) decodes address lines ABUS 19, 18 17, 16, 15, and 14 when BIO/NM is low and assert the chip select input of the ROM whose contents is at the address generated by the processor. The 8088 receives data from the memory (or writes to RAM or the LED register) through a transceiver (U810). This transceiver is enabled when the memory mapped devices are accessed (i.e., ROMs, dynamic user RAMs, LEDs, the video subsystem controller ICs and memories).

**WAIT STATE DISABLE.** Every bus cycle (memory or I/O operation) of an 8088 consists of four system clocks unless logic external to the 8088 dictates that the cycle be extended by some integer number of additional clocks. The wait state generation circuitry in the I/O Controller PCA (U39) inserts a minimum of 1 additional clock period into all bus cycles unless a ROM access is being made.

**ROM TIMING.** The memory address from the 8088 becomes available to the memory PCA 85 nsec after the beginning of T1. The propagation delays until data is available to the processor is as follows:

| ROM Access | |
|---|---|
| address valid | 75 nsec |
| chip select delay | 57 nsec |
| ROM access time | 200 nsec |
| buffer delay | 12 nsec |
| total delay | 344 nsec |

The cycle is 375 nsec long (T1 + T2 + T3). The data setup time for the 8088 is 20 nsec. Therefore, the data read margin is 375 - 20-344 = 11 nsec. Note that the output enable inputs to the ROMs have been asserted worst case 120 nsec after the beginning of T2 so that ROM address access time, not ROM output enable time, is the limiting factor in ROM access timing.

## Dynamic RAM

The 256K of dynamic RAM requires a considerable amount of support circuitry. In the Touchscreen II, all required support circuitry is integrated into the Memory Controller Chip (U612). This section will describe the decoding, control signal generation, and RAM timing. The next section will cover the refresh mechanism used on this PCA.

**DECODING.** The 256K of dynamic user RAM is organized as four banks of 64K byte each. The memory space allocation is:

| | | |
|---|---|---|
| Bank 0 | 00000H - 0FFFFH | (U614 - U621) |
| Bank 1 | 10000H - 1FFFFH | (U814 - U821) |
| Bank 2 | 20000H - 2FFFFH | (U914 - U921) |
| Bank 3 | 30000H - 3FFFFH | (U1024 - U1021) |

When a memory cycle is initiated by the 8088 (BIO/NM is low) and an address within one of the four memory regions listed above is generated, the Memory Controller chip asserts one of four RAM bank selections, NRAS0, NRAS1, NRAS2, and NRAS3.

The Memory Controller generates the RAS, CAS, H/NL (RAM address multiplexing) signals that are necessary to control the RAMs. Both RAS and CAS signals are buffered by a AS244 [U613] for drive purpose. Each buffered RAS signal drives one bank of RAMs. There are two buffered CAS signals each of which drives two banks. The H/NL signal is used to control the two LS257s [U911, U912] to multiplex the row and column address for the RAMs.

**DYNAMIC RAM REFRESH.** In order to retain the data that has been written into a dynamic RAM, a periodic refresh cycle must occur. The refresh cycle consists of placing a row address on the address input pins of the dynamic

RAM (DRAM) and then bringing the RAS input low for a specified amount of time and then raising it back high. Each row address within the RAM must be refreshed as described within a time period specified by the RAM manufacturer in order for the data to be retained in the RAM. Dynamic RAM used on the Touchreen II requires each of its 128 row addresses to be refreshed no less than every 2 milliseconds. This specification is typical for most DRAMs. Some DRAMs have 256 row addresses and require all row addresses to be refreshed no less than every 4 msec. The Memory Controller on the memory subsystem is capable of meeting the requirements of both types of DRAM.

Normally, the processor's address is enabled onto the DRAM address bus through the LS257 (U911, U912) by the SHOLDA signal. When it is time to refresh the DRAMs, the Memory Controller chip gnerates the ASCHOLD request to the processor. The processor then holds off all its activity and responds by asserting SHOLDA to high and NSHOLDA to low. These two signals disable the LS257s and enable the LS244 (U1013) which drives the DRAMs' address bus with the refresh address taken from the refresh address counter (LS393) (U1011). The Memory Controller chip then goes through 4 refresh cycles each of which is 4 clock long. The Memory Controller will drive all the RAS lines low for two clocks and high for the other two clocks. When the RAS lines rise from low to high, the RINC signal goes from high to low and increments the refresh affress counter. The RINC signal will go from low to high when the RAS lines change states from high to low. After 4 such cycles, the Memory Controller will disable the ASCHOLD signal and allow the processor to resume operation.

The refresh scheme used on the user DRAM refreshes 4 row addresses every 56 usec. Thus, all the rows are refreshed within 1.8 msec The entire refresh process takes about 2.5 usec including latencies due to the synchronizing flip-flops. Therefore, the refresh process consumes about (2.5 usec/56 usec) x 100% = 4.6% of the system bandwidth.

## LEDs

Six LEDs are positioned on the memory subsystem to report power-on test results. The LEDs are memory mapped at 0B8000H - 0BBFFFH. Any memory write within this range will access the LEDs. The LEDs are accessed on the lower six bits of the data bus.

**LED DECODING.** When the LED address is present, a memory write cycle is in progress, and when GO is deasserted, the LEDSELECT line "NLED" is asserted by the Memory Controller Chip. The LED register (U422) will be clocked by NLED with data from the CPU. The LEDs will display the complement of the register contents (i.e., a "zero" turns an LED on, a "one" turns an LED off).

## Slot Selection Generation In The Memory Space

The HP Touchscreen II package provides four PCA slots for handling optional module PCA devices. The HP Touchscreen II architecture provides a flexible interface to the accessory slots. Accessories can be accessed through either memory or I/O access (see memory and I/O maps in Section 4).

I/O addresses XX80 through XXFF have been reserved for accessory module use. This provides 128 I/O ports that can be decoded and used for processor and auxiliary device intercommunication. The most flexible arrangement that can be used for accessory module device interfacing to the 8088 is the memory mapped interface with slot select. A memory address within the 90000 - 9FFFF range causes Slot Select #1 to be asserted and an address within A0000 - A3FFF causes Slot Select #2, A4000 - A7FFF causes Slot Select #3, and A8000 - ABFFF causes Slot Select #4 to be asserted. The Slot Select line is pin 70 of the Accessory Card connector (J3, 4, 5, and 6). The 8088 accesses the data from the accessory slot via the Data Transceiver LS245 (U314).

What does the slot select scheme provide? An accessory PCA may choose to use or not to use the slot select line. If a device does not utilize slot select, a decode of at least the most significant four address bits must be done to detect a CPU access. More decoding of the least significant 16 address bits must be done depending on the nature of the PCA and its circuitry. In addition, the user must never plug PCAs into Slots #1 and #2 which become selected on the same address range. When fully decoding the address space, boards must be designed for a specific accessory slot.

Using the slot select lines, a more limited decode is required on the accessory PCA since the four most significant bits are decoded by the CPU in asserting the slot select line. Therefore, an accessory PCA can detect an access by decoding slot select and the appropriate subset of the least significant 16 address bits. The decoding of slot select ensures that no contention will occur between accessory modules #1, #2, #3, or #4 since only one slot select signal will be active at one time.

The slot select thereby eliminates the need for a designer of an accessory module to be aware of all the addresses used by other existing or future accessory modules. It also limits the hardware required for decoding.

Since the accessory modules are in the 8088 address space, firmware ROMs can be placed on the accessory modules to be executed by the 8088. Drivers for each accessory can be located in ROM on the accessory PCA and at power-on, when the terminal operating system does a logical system generation, the drivers for the modules will be used when needed for module stimulation.

Another benefit of having the accessory modules in memory space is that block transfers of data between CPU and accessory module can take place quickly with little CPU software overhead and with the enhanced flexibility of the memory access instruction set of the 8088 over the I/O instructions. Thus, a softcard CPU can be added cleanly to the system without the hardware and particularly the processor intercommunication path hampering performance.

# VIDEO SUBSYSTEM

## General

The Video Subsystem is responsible for converting display information, received from the Processor Subsystem, to control signals used by the CRT/Sweep Subsystem to generate the alpha and graphics display. The video display, in general, is generated by scanning the face of the CRT with a electron beam. The beam scans horizontally from left to right (as the user sees the screen) moving progressively downward, from top to bottom. The Video Subsystem generates the signals which control the horizontal and vertical motions of the electron beam as well as the on/off state of the beam as it scans horizontally across the CRT.

The location of the Video Subsystem on the Processor PCA is shown in Figure 3-22, while a block diagram is illustrated in Figure 3-23.

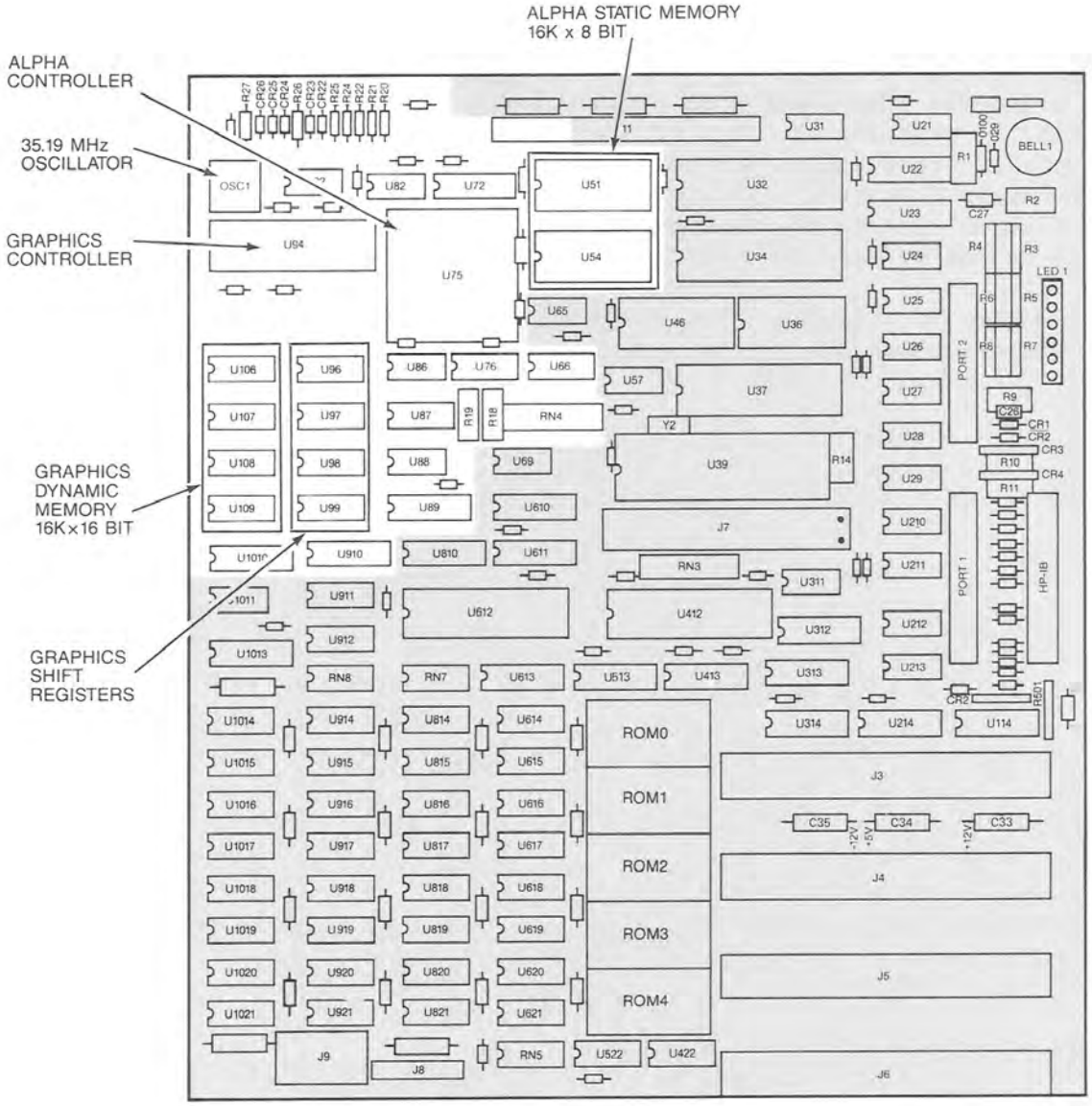



Figure 3-22. Video Subsystem Location on the Processor PCA

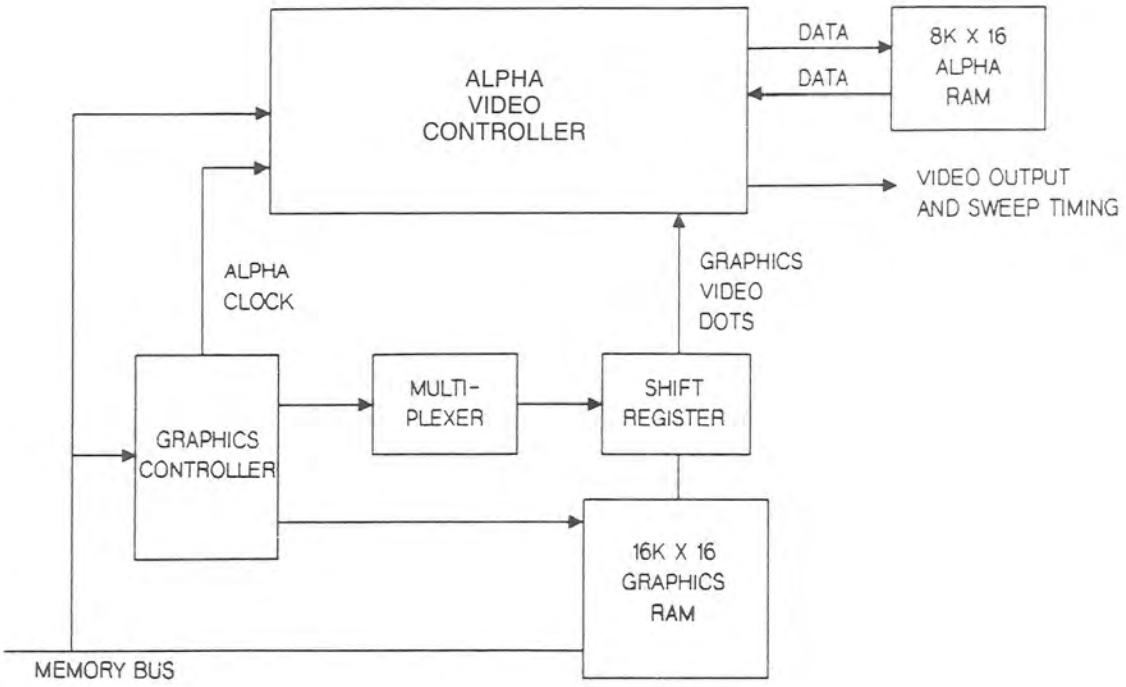



Figure 3-23. Video Subsystem Block Diagram

## Processor - Video Digital Subsystem

The Digital Video Subsystem components consist of the following:

-Alpha Video Controller [U75].
-Graphics Controller [U94].
-8K X 8 static Alpha RAMs [U51, U54].
-16K X 16 dynamic Graphic RAMs [U106-U109].
-Graphic dots shift registers [U96-U99].
-Graphic memory address multiplexer [U66, U76].
-Graphic memory data latch [U910]
-Graphic memory data transceievers [U89, U1010].
-Graphic resolution select multiplexer [U87].
-Video subsystem signal drivers [U88, U82, U72].
-Graphic oscillator [OSC].

The video subsystem is functionally identical to the HP 150 video board, and most of the SSI chips are replaced by two HP designed ICs - Alpha Video Controller and Graphic Controller.

The function of the video subsystem is divided into alpha and graphic sections and are described in the following paragraphs.

ALPHA SECTION. The alpha video section is centered around a custom NMOS integrated circuit [U75] (Alpha Video Controller). The Alpha Video Controller has an on-chip character generator, video timing and control generation, alpha memory interfacing, processor interface circuitry, character enhancement processing and alpha/graphic dot merging.

Clock Shaping: because of specific requirement of the Alpha Video Controller, the clocks generated by the Graphic section have to go through clock-shaping circuitry to minimize rise and fall times as well as the level of the clocks. This circuitry consists of the S04 [U82] to buffer the clock signals, the three 1K resistors (R31, R32 and R34) to 12V to allow for the fast RC rise times of the signals, and the 6 diodes (CR30-CR35) to clamp the clock waveforms to 5V.

Alpha Memory Interface: Because of the high access rate of the alpha memory and the nature of the alpha memory organizations, two 8K X 8 static RAMs are used [U51, U54]. The whole memory is organized as 8K X 16. The Alpha Video Controller outputs the address of the memory and reads the character data into the chip to perform character processing. However, during a write cycle, only 8-bit portion of the 16-bit word is modified one at a time.

Processor Interface: Similar to the Graphics Controller chip, handshake between the processor and the Alpha Video Controller is through the use of the WAIT line. Every time the processor requests access to alpha memory, the Alpha Controller asserts the WAIT line [U92, U88]. If the request is for a write cycle, the Alpha Controller latches in the data and deassert WAIT. The data then written into RAMs as soon as the RAMs are free. If the request is for a read cycle, the Alpha Controller will keep on asserting the WAIT until it has obtained the necessary data from RAMs.

During screen retrace time, the Alpha Controller generates an interrupt to the processor indicating the screen retrace operation.

Graphic Section Interface: The Alpha Controller has an internal register which the processor can write, to switch the graphic mode between low resolution and high resolution. This register information is output to the graphic section as the NLORES signal.

As a synchronization signal between the alpha screen and graphic screen, the Alpha Controller generates the NGSOF signal during vertical retrace time. After receiving NGSOF, the Graphics Controller will be able to synchronize itself with the Alpha Controller.

Video Interface: The Alpha Controller outputs the four signals to go to the sweep board: NFB, NHB, HSYNC and NVSYNC. These four signals are buffered by LS244 [U72]. Two 100 ohm resistors (R29, R30) in series with the NFB and NHB signals at the outputs of the buffer are used to terminate the reflection of the high speed video signals and therefore to minimize the RF emissions.

Composite Video: The CSYNC signal, NFB and NHB signals from the Alpha Controller also go to the buffer LS244 (U72). The outputs of these buffered signals are routed to the back edge of the board for composite video use. The PC traces have a controlled impedance of about 130 ohms. The ends of the traces are terminated by 130 ohm impedance (R2-R7) to minimize the reflections and therefore RFI emissions.

**GRAPHICS SECTION.** The graphics section is centered around a semi-custom ECL gate array [U94], the Graphics Controller. This chip provides all the necessary clock generation for the video subsystem and also graphics screen controlling operations. For detail information refer to the Graphics Controller data sheet.

Clock Generation: The basic clock frequency is generated by a 35.19MHZ oscillator [OSC1]. The output of the oscillator is in series with a 33 ohm resistor (R36) and then goes into the Graphics Controller OSC35 input. This resistor is used for the PC trace impedance match. Inside the Graphics Controller, the clock is divided down to generate 23.46MHz (CLK640), 17.60MHz (CLK512), 2.93MHz(CCLK), 7.04MHz (NCPUC). Only CLK640, CLK512 and CCLK are used in the Touchscreen II video subsystem.

Both CLK640 and CLK512 go to the multiplexer S257 [U87] pin 6 and pin 5. Depending on the state of the control (NLORES), either CLK640 or CLK512 is gated onto the output pin 7. This output is the main graphic clock (GCLK).

Screen Refresh: After receiving the graphic start-of-frame (NGSOF) signal from the alpha controller, the Graphics Controller outputs the memory addresses to go to the graphic RAMs [U106-U109]. It also generates the necessary memory control signals such as RAS, CAS, and the GLOAD signal to load the 16-bit memory outputs in parallel to the video shift registers [U96-U99].

The same multiplexer S257 [U87] used in the GCLK selection is also used to select the way the graphic data is shifted in the shift registers. In the low resolution graphics mode (HP 150 compatible: 512 dots by 390 lines), the 16-bit graphic dots are shifted left with the LSB coming out of the shift registers

first (from QA of U96). In the high resolution graphics mode (640 dots by 400 lines), the 16-bit graphic dots are shifted right with the MSB coming out of the shift registers first (from QD of U99). The two outputs (shift right and shift left) are again selected by the same multiplexer depending on the NLORES control. The truth table for the S0 and S1 controls of the shift registers is listed as follows:

| NLORES | GLOAD | S0 | S1 |
|---|---|---|---|
| 0 | 0 | 0 | 1 |
| 0 | 1 | 1 | 1 |
| 1 | 0 | 1 | 0 |
| 1 | 1 | 1 | 1 |

The selected GDOT stream is then inputs to the Alpha Controller chip which merges the graphic dots and alpha dots together.

Processor Interface: The processor's accesses to graphics memory [U106-U109] are interlaced with the screen refreshes from the Graphics Controller. After the screened data is loaded into the video shift registers [U96-U99], the memory cycle is then added to the processor's access. For the graphics memory access, the processor first outputs the address which is decoded by the Memory Controller chip [U612]. The chip select pin (NCS) is then driven low by the Memory Controller indicating a processor's access. The Graphics Controller responds by asserting the WAIT signal to the I/O Controller [U39] to extend the processor cycle. When the graphics memory is free for the processor, the Graphics Controller asserts NADOE to the address multiplexer LS257 [U66,U76] to put bit 1 to bit 8 of the address bus onto the graphic address bus as the row and column address for the graphic RAMs [U106-U109]. The Graphics Controller then goes through the memory access operations: (RAS, NAMUX, NDEN, CAS).

Since the graphics memory is organized by 16 bits, the processor's access to this memory must be in two separate accesses, the upper bank and the lower bank. A0 of the processor address is used to select which bank the processor is addressing. The selection is accomplished by 4 OR gates (LS32) [U105] and the two transceivers (LS245) [U89, U1010]. Depending on the state of A0, one or the other transceiver is enabled. During a write cycle, either the upper or lower bank of memory is enabled to accept data.

Because of the timing between the WAIT signal and the memory data for the processor occurs during a read cycle, the data is latched into LS374 [U910] by the NDEN signal from the Grahpics Controller. The output of the latches are enabled by NRDEN to match the timing of the processor read operation.

# Video Timing Signals

ALPHA TIMING

640 MODE TIMING
(High Resolution Graphics Mode)

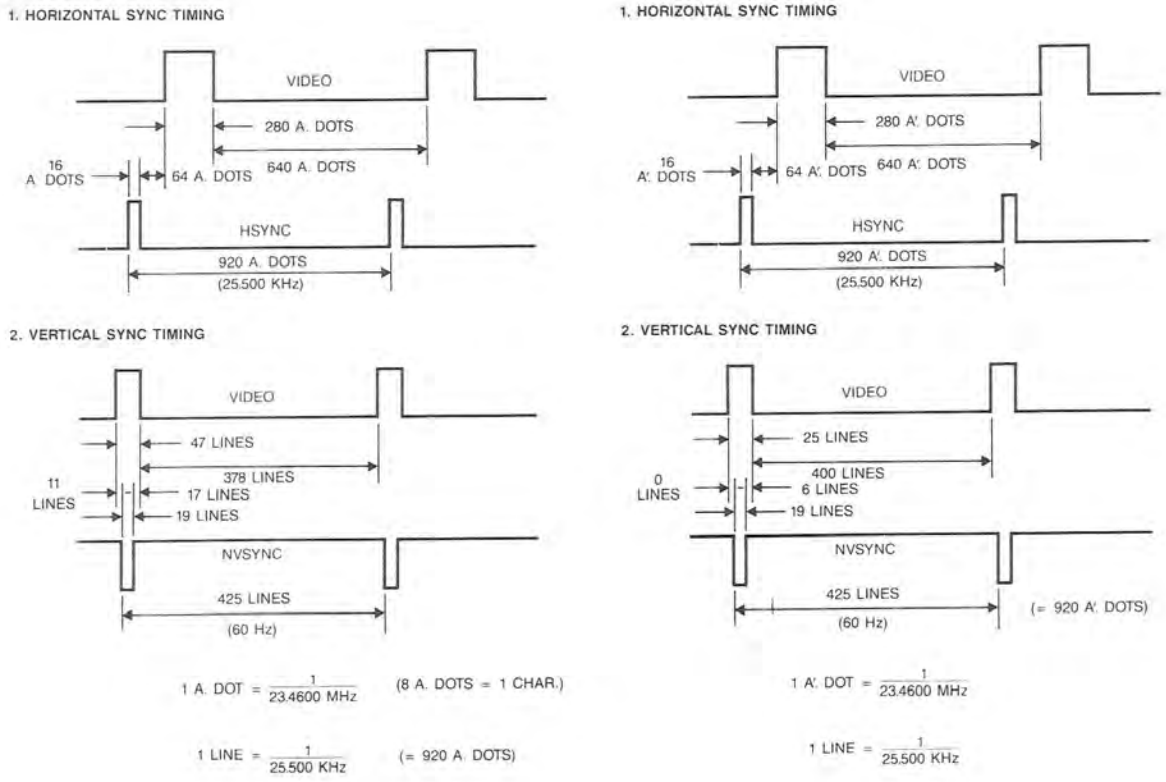
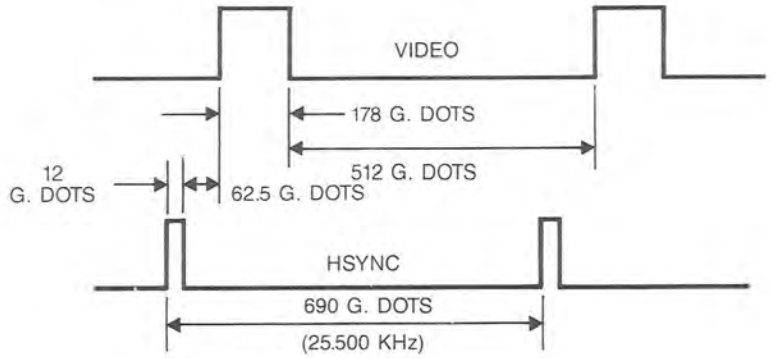


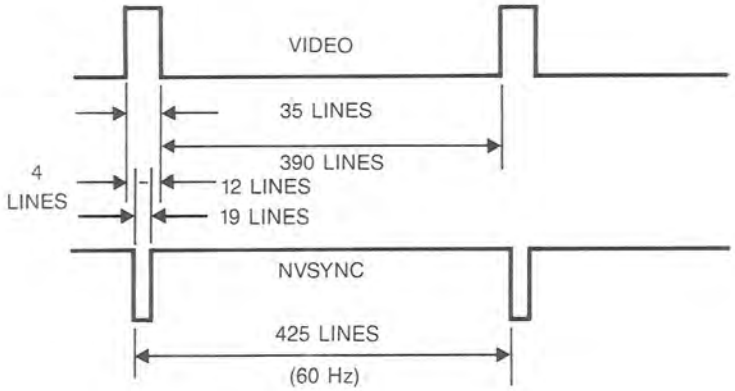

Figure 3-24. Horizontal and Vertical Sync Timing

GRAPHICS TIMING
(Low Resolution Graphics Mode)

**1. HORIZONTAL SYNC TIMING**




**2. VERTICAL SYNC TIMING**




$$1 \text{ G. DOT} = \frac{1}{17.5950 \text{ MHz}}$$

$$1 \text{ LINE} = \frac{1}{25.500 \text{ KHz}} \quad (= 690 \text{ G. DOTS})$$

Figure 3-24. Horizontal and Vertical Sync Timing (Continued)

## COMPOSITE SYNC TIMING

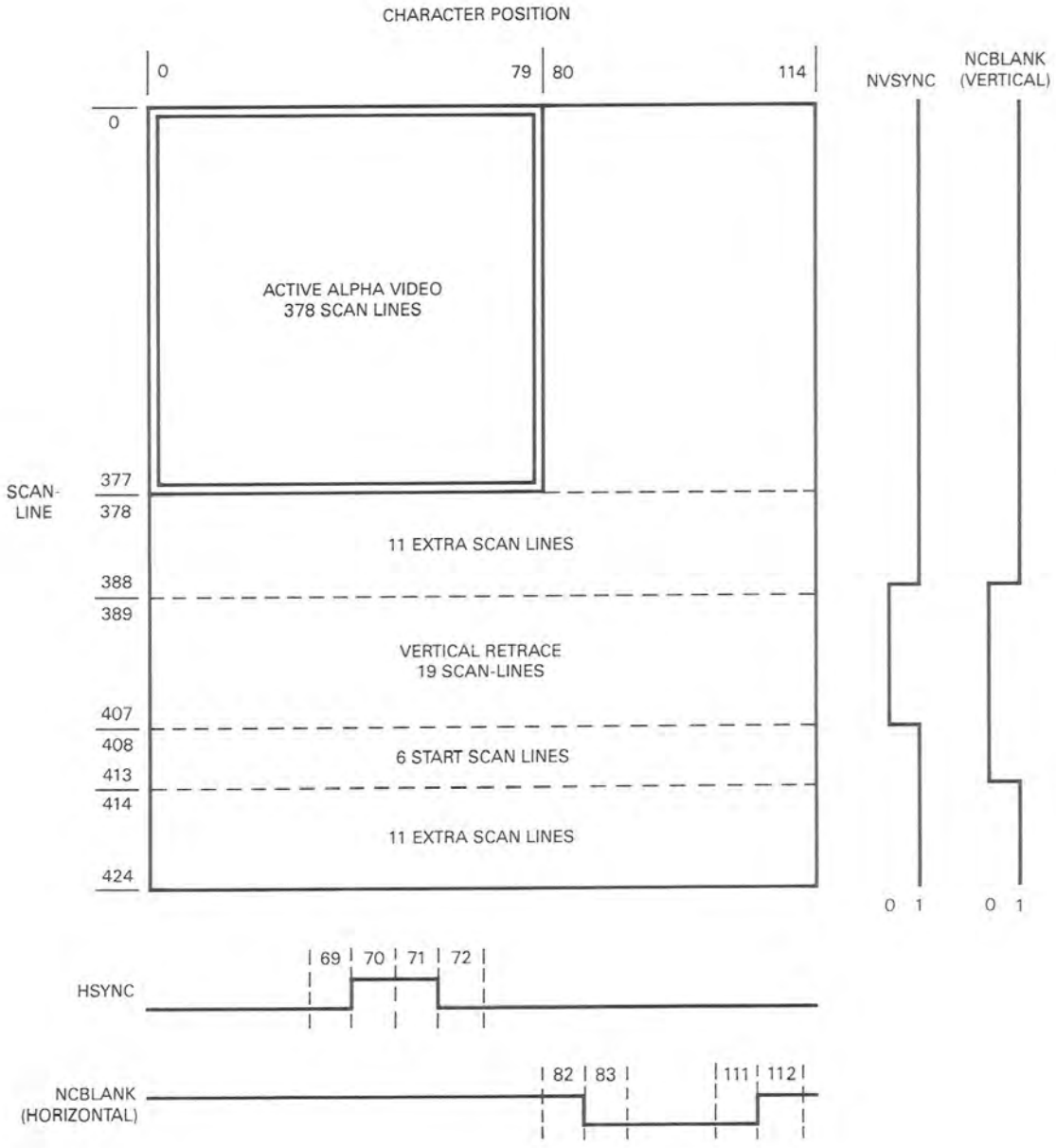
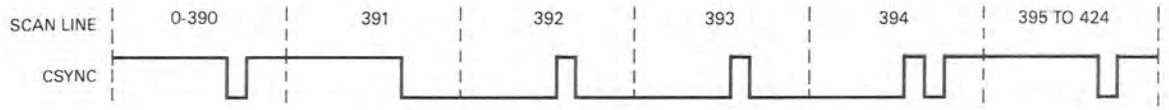



Figure 3-25. CSYNC Timing

COMPOSITE SYNC TIMING (Continued)




CSYNC Waveform

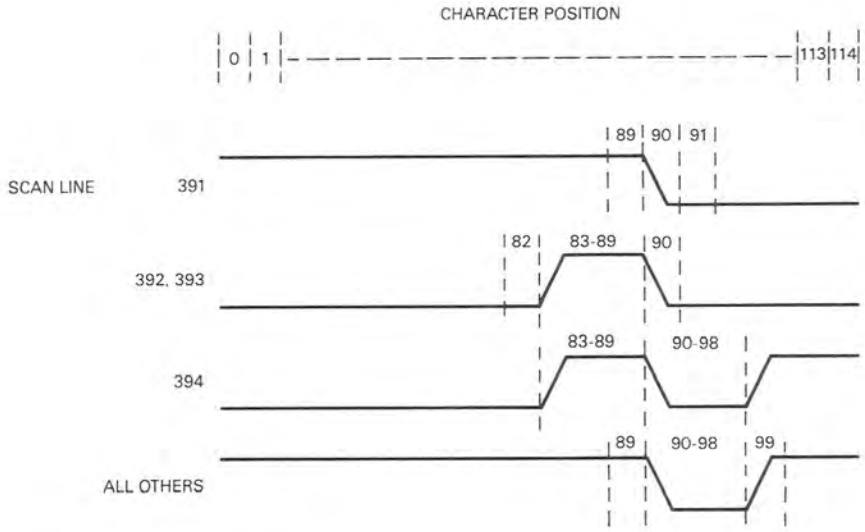



Figure 3-25. CSYNC Timing (Continued)

# SERIAL I/O SUBSECTION

## General

This subsystem uses the NEC 7201 Multiprotocol Serial controller, (from now on called the "UART") and three other drivers and receivers (the 1489, 1488 and 75179) to provided one port for RS-232 and one for RS-232/422 asynchronous communications. Figure 3-26 shows the location of this subsystem on the Processor PCA, while Figure 3-27 illustrates the block diagram.

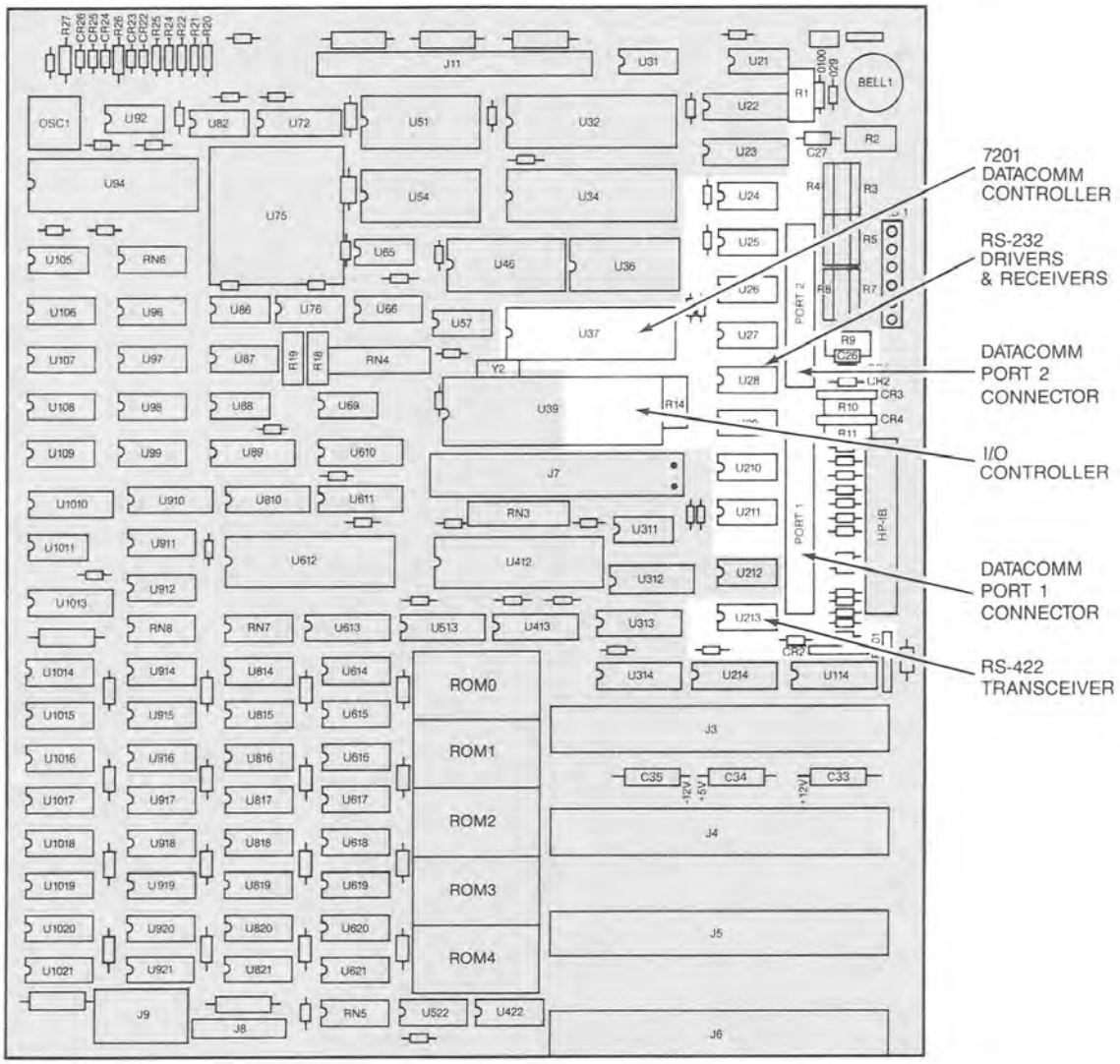



Figure 3-26. Serial I/O Subsystem Location on the Processor PCA

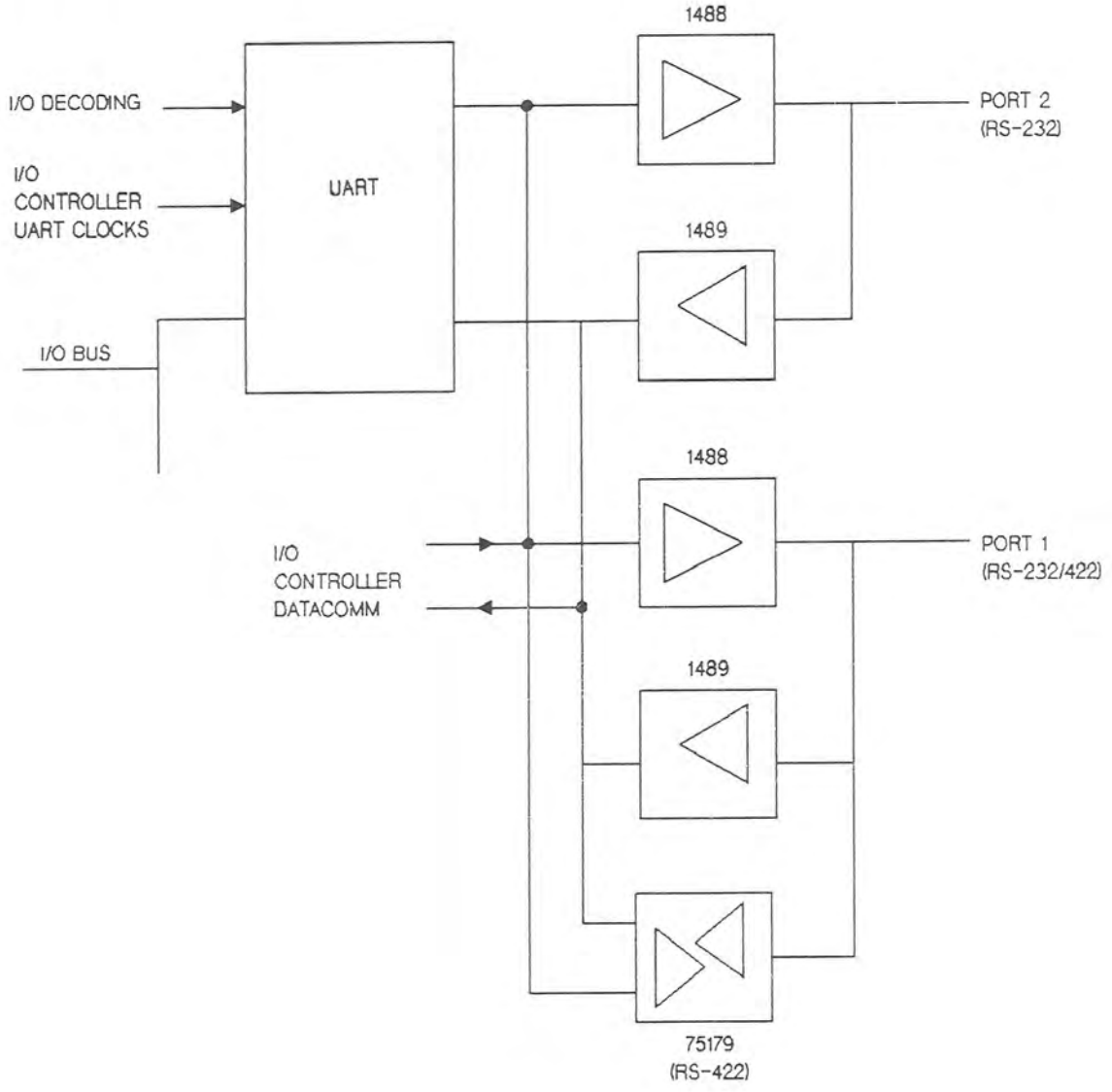



Figure 3-27. Serial I/O Subsystem Block Diagram

## Serial I/O Subsystem

The main Serial I/O Subsystem Components are as follows:

-7201 UART [U37]

-1488 and 1489 RS232 Drivers and Receivers [U26,211,26,25,210,28].

-75179 RS422 Transceiver [U213].

-Slew Rate Capacitor Networks [CN1-3].

-Protection Networks.

-Status Register[U24].

-I/O Controller I.C.[U39].

-Datacomm Port 1 [J1].

-Datacomm Port 2 [J2].

The I/O Controller I.C. contains the following:

-Dual Baud Rate Generator.

-Clock select Logic.

-Hardware Handshake Logic.

The above subsystem components are functionally identical, and software compatible with those in the HP 150.

Using the RS232 and RS422 Ports on the Touchscreen II and HP 150

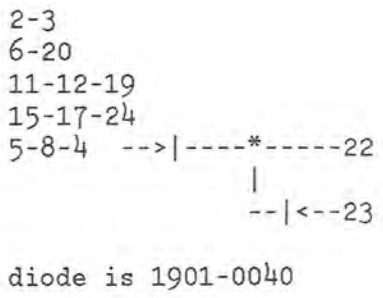
RS232 and RS422 are interface standards and not communication protocols therefore to use them all that is needed is to select the correct interface cables and testhoods.

The RS232 interface is an unbalanced system and relies on capacitors to control the slew rate or rise/fall times of the signal lines. The RS422 interface is a balanced system which uses differential drivers and receivers and is capable of operating at much higher Baud rates, and at much longer distances than the RS232 Interface. In general, RS232 is more suited to local connections i.e. RS232 Modems and Peripherals, whereas RS422 is more suited to remote hardwired connections i.e. remote computers where the cables are routed in a duct with other utility cables, and the cable length can be up to 4000 ft.

RS232 Cables and Test Hoods

The RS232 Test hood HP Part Number is 02620-60062

The RS3232 Test hood schematic is:



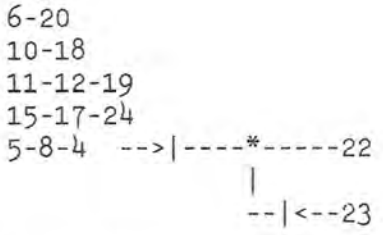

The RS232 Cables are:
13242G- RS232 Printer Cable
13242M- European Modem Cable

13242X- RS232 Interface Cable for HP3000

RS422 Cables and Test Hoods

The RS422 Test Hood HP Part Number is 5061-3248

The RS422 Test Hood schematic is:




The RS422 Cable is 13242P (RS422 Cable for HP 3000)

# HP-IB AND HP-HIL SUBSYSTEM

## General

The HP-IB and HP-HIL Subsystem and their components are identified in Figure 3-28. A block diagram of the subsystem is illustrated in Figure 3-29.

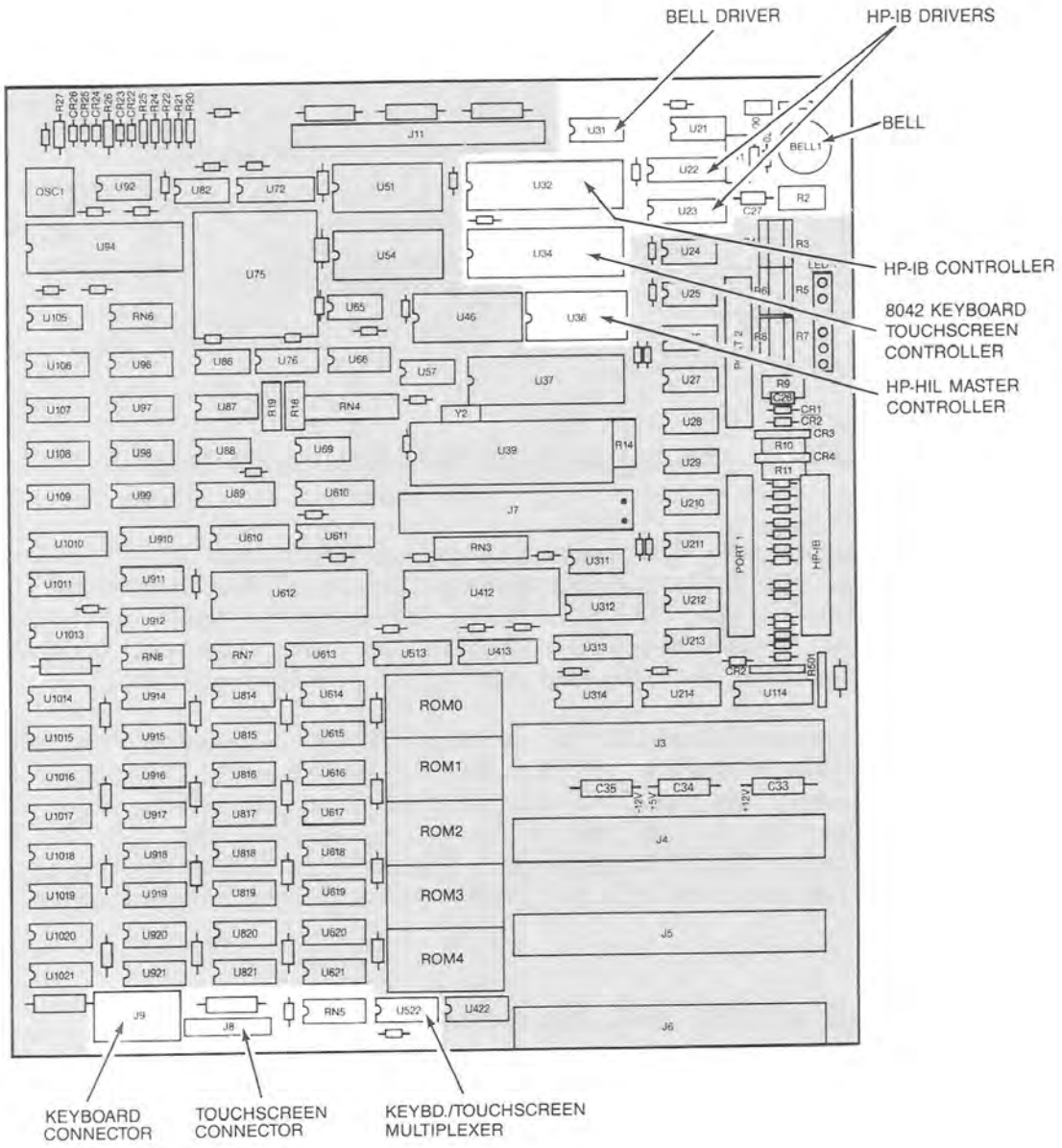



Figure 3-28. HP-IB and HP-HIL Subsystem Location on the Processor PCA

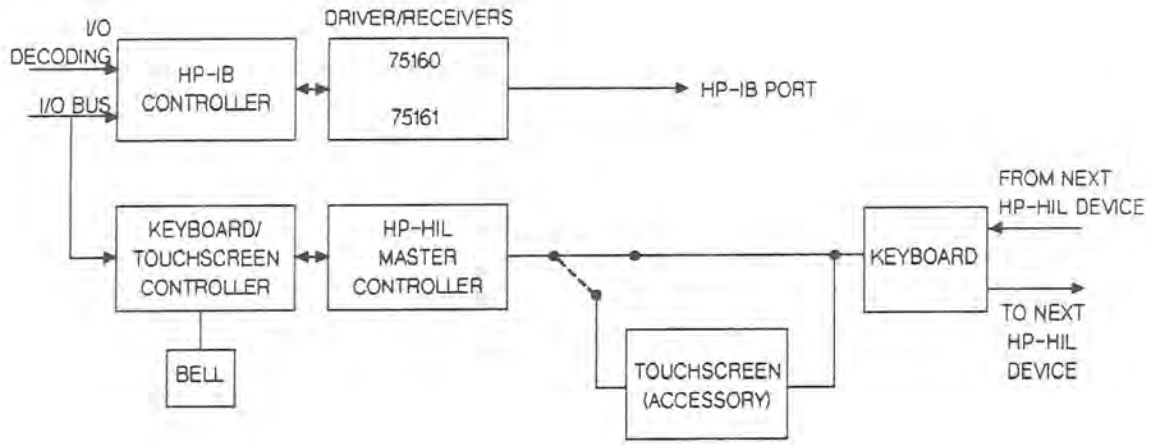



Figure 3-29. HP-IB and HP-HIL Subsystem Block Diagram

The HP developed interfaces are contained in the HP-IL and HP-HIL Subsystems. The HP-IB Controller (TI 9914A General Purpose Interface Bus Controller) is used to interface between the HP-IB (IEEE 488-1975/78 bus) and the 8088 microprocessor. The HP-IB Controller handles the data, status, handshake and control functions required to implement the HP-IB standard protocol.

The Keyboard/Touchscreen Controller is an Intel 8042A Peripheral Controller IC. The 8042 serves as an interface between the HP Touchscreen II's input devices (Keyboard, Touchscreen, and other HP-HIL devices) and the 8088. When a key is pressed or the screen is touched the input device signals the 8042 via the HP-HIL Master Controller. The 8042 transmits the data to the 8088 for processing (for more information refer to the Keyboard and/or Touchscreen sections of this chapter).

## Processor HP-IB and HP-HIL Subsystems

The HP-IB Subsystem components consist of the following:

-9914A HP-IB Controller [U32].

-75160 and 75161 HP-IB interface drivers and receivers [U22-23].

-HP-IB Connector [J10].

The above HP-IB system components are functionally identical and software compatible with those in the HP 150.

The HP-HIL Subsystem components consist of the following:

-8042 Keyboard and Touchscreen controller [U34].

-Bell driver [U31] and Bell [BELL2].

-HP-HIL Master Controller I.C. [U36].

-Touchscreen Connector [J8].

-Keyboard/Touchscreen Switch [U522].

-Protection Network.

The above HP-HIL system components differ from the ones used in the HP 150 in the following way:

-The Touchscreen and Keyboard custom interfaces in the HP 150 are replaced by a standard interface known as the Hewlett-Packard Human Interface Link which supports an HP-HIL Keyboard, Touchscreen, and up to five other HP-HIL input devices such as Tablets, Mice, or barcode readers. These devices are connected in "Daisy Chain" fashion to the HP-HIL accessory connector located at the back of keyboard.

-The Keyboard/Touchscreen Controller emulates the HP 150 Keyboard and Touchscreen at the Processor interface. It also provides a "Pass through mode" to the HP-HIL Master Controller which allows an application program to access the HP-HIL Master controller directly. This is described in the Keyboard and Touchscreen subsystems section.

-The HP-HIL Master Controller is the communication controller which accepts commands from the Keyboard /Touchscreen controller, or directly from the application software, which transmits messages through the HP-HIL with the proper format. It can also poll the input devices, collect data entered by the user and relay it to the Touchscreen II System or Application software. The HP-HIL Master Controller uses the NVSYNC from the Processor Video Subsystem to generate the Auto Poll and uses the 8 MHZ Processor clock [NCLK].

-The Keyboard/Touchscreen Switch connects the Keyboard or the Touchscreen to the HP-HIL Master Controller. In a system with no Touchscreen installed the NTS line is high which makes the connection directly to the Keyboard which is then the first device in the HP-HIL Chain. If the Touchscreen is installed the the NTS line is low and the Touchscreen becomes the first device connected to the HP-HIL Master Controller by means of the Touchscreen Connector [J8]. The Touchscreen is then connected

to the Keyboard by means of the Touchscreen Connector and Keyboard Connector [J8 and J9].

-The Protection Network is the standard one used in the HP-HIL System it's purpose is to protect the Keyboard/Touchscreen Switch from ESD damage, and to hold the input line at a high or idle state, in a system which does not use a Keyboard.

# KEYBOARD AND TOUCHSCREEN HP-HIL SUBYSTEMS

## The Keyboard

The Keyboard is the third PCA of the HP Touchscreen II system. The Keyboard is the interface between the user and the system processor. Commands from the Keyboard are sent to the processor which, in turn, interprets the commands and displays the information in a form which the user can identify.

The Keyboard is also an HP-HIL (Hewlett-Packard Human Interface Link) device,to which other supported HP-HIL devices (such as the HP Mouse, bar code readers and tablets) can be connected in a daisychain fashion.

The Hewlett-Packard Human Interface Link (HP-HIL) is the HP standard for interfacing terminals, workstations, and personal computers to their human-input devices. HP-HIL provides a simple, asynchronous serial communications protocol that enables the user to select a set of input devices, connect them to his or her computer product, and work with an application program with ease. This concept virtually eliminates the need to hunt for an I/O slot, power cord, interface box, the right switch settings, or system configuration commands.

HP-HIL is a master slave interface system. The master controller is typically a personal computer; such as the Touchscreen II. The master controller has the responsibility of transmitting commands and collecting data from input devices (slaves) connected to the link. These devices (up to seven at a time) are connected in a "daisy-chain" fashion to the computer and to each other via four-conductor shielded cables. These cables are designed for electro-static discharge immunity and low radio frequency interference levels.

Two custom integrated circuits were designed by Hewlett-Packard to support HP-HIL. First the HP-HIL Master Controller (1RD2-6001) provides the interface between the Touchscreen II and its input devices, accepting commands from the 8042 input device controller and transmitting and receiving messages with the HP-HIL frame format.

Together, the HP-HIL Master Controller and the 8042 are responsible for configuring the link, processing input device data, performing error recovery, and generally the HP-HIL protocol. Secondly, an HP-HIL Slave Controller (1RC8-6001) resides in each of the input devices, serving as the interface between the device controller, the Touchscreen II, and other input devices.

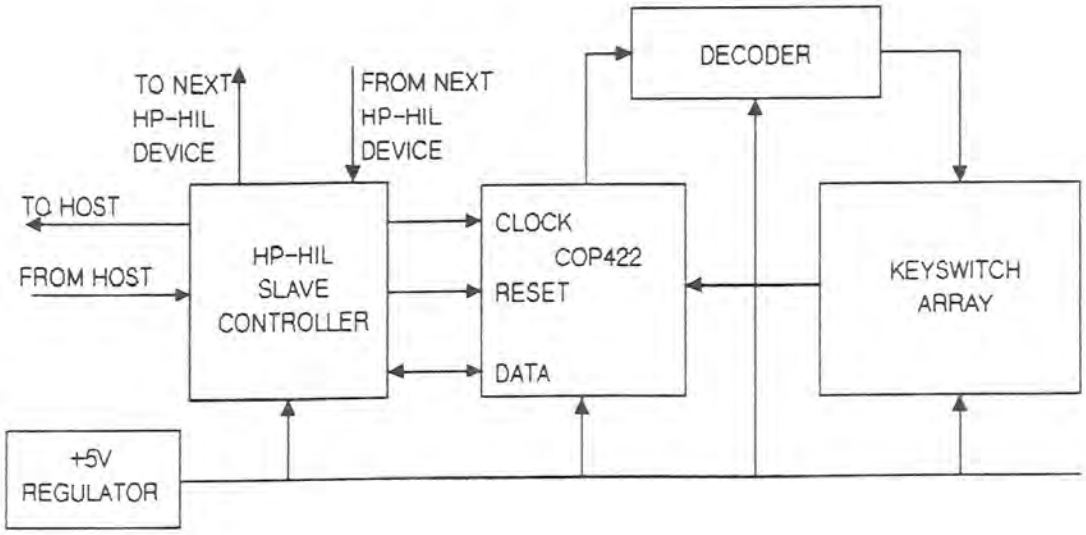



Figure 3-30. Keyboard Block Diagram

When the HP Touchscreen II is powered on, the +12 volts of power sent to the Keyboard is converted for internal use by the Keyboard's +5 volt regulator. The HP-HIL Slave Controller IC, in conjunction with the 8 MHz Resonator Circuit, generates the clock signal for the COP422 Keyboard micro controller, and the reset signal at power-on. The COP422, in conjunction with the Decoder Circuit, scans the Keyswitch Array. The HP-HIL Slave Controller IC provides a means for the COP422 to transmit data to the HP-HIL Master Controller IC in the correct HP-HIL frame format, and also reads incomming HP-HIL data.

# The Touchscreen

HP Touch (to be referred to here as the Touchscreen) is a user-installable accessory which provides an extremely friendly user interface. Through the use of Touchscreen software the user can send commands to the application program by simply pointing to a particular labeled function on the screen.

The Touchscreen uses infrared LEDs and phototransistors. An opto pair are mounted to face one another, and flux emitted by the LED irradiates its corresponding detector. There are 29 devices on each long side, and 23 on the short sides, resulting in 104 devices total. A finger, or pen used as the pointing device must cross an X and a Y beam in order for the Touchscreen to identify its position. If two adjacent beams are crossed in either the X or Y direction, then the Touchscreen resolves to an imaginary point between the two beams. Hence, the resolution is not 23 by 29, but 45 by 57.

The opto devices are mounted at 7.5mm centers. The width of the beam is 2mm. At least half of the beam must be blocked to guarantee the circuit will detect a crossed beam, therefore the minimum size of a pointing device must be at least 7.5mm of cross-sectional width.

The main components of the Touchscreen are shown in the block diagram illustrated in figure 3-31.

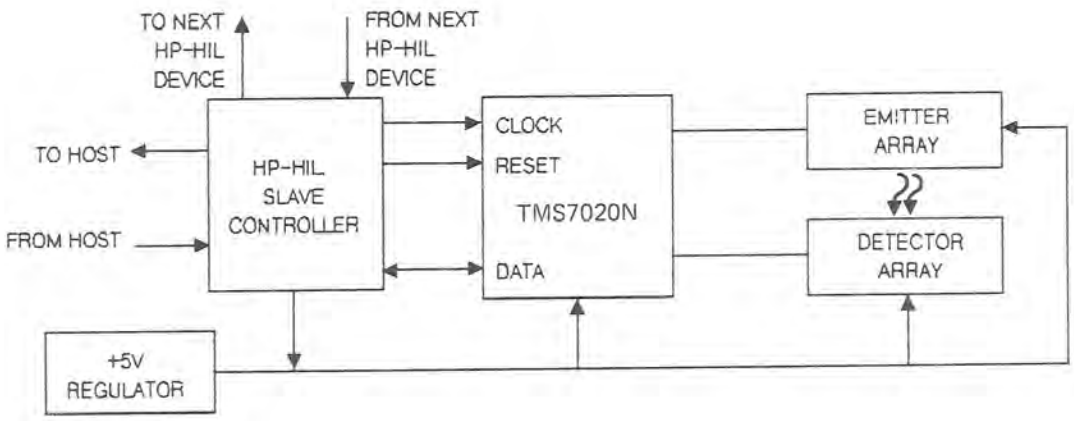



Figure 3-31. Touchscreen Block Diagram

Once installed, the Touchscreen (an HP-HIL device) automatically becomes the first device in the Link (the Keyboard is the next device). It contains many of the same system interface components common to other HP-HIL devices. The Touchscreen receives +12 volts from its internal connection on the Processor PCA. A +5 volt regulator is used to supply the internal circuitry which operates from +5 volts. The HP-HIL Slave Controller IC, in conjunction with the 8 MHz Resonator Circuit, generates the clock signal at power on. The TMS7020N micro controller has 2 Kbytes of ROM and 128 bytes of RAM. It provides timing for the circuit, scans the Emitters and Detectors for crossed beams, and reports them to the host via the HP-HIL Slave Controller IC.

# 8042 INPUT DEVICE CONTROLLER

## General

The 8042 peripheral processor is used to control the operation of the input devices which are interfaced to the Touchscreen II via the Hewlett-Packard Human Interface Link (HP-HIL). A description of the operation of the 8042 follows as does a description of the commands used to control the 8042.

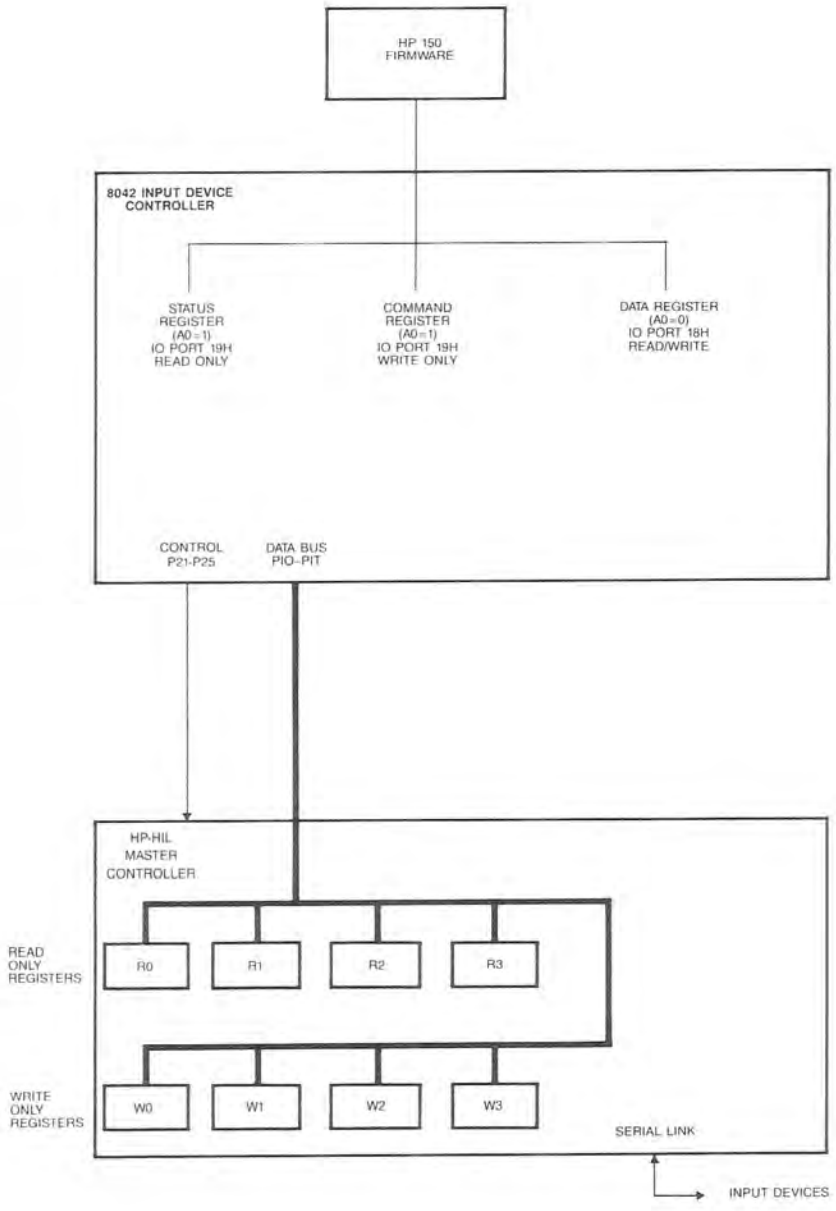



Figure 3-32. 8042 and HP-HIL Subsystem Block Diagram

## Theory of Operation

By replacing the 8041A keyboard controller in the 150, the Touchscreen II 8042A provides a keyboard and touchscreen controller that accomplishes two goals: 1) maintains compatibility with 150 firmware and applications, and 2) provides the enhanced capability of the HP-HIL input device interface.

In order to accomplish its goals the Touchscreen II 8042A has three modes of operation:

1) HP 150 mode
2) HP-HIL Pass Thru Mode
3) Modified HP-HIL Pass Thru Mode

The 8042A defaults to HP 150 Mode upon power-on and after receiving the RESET command. The other two modes are invoked by sending special commands to the 8042A. (Commands described below in the next section.)

The text in this document describe only the differences between the 8042A and its ancestor, the 8041A. For more basic information on operation, see the documentation on the 8041A in the HP 150 Technical Reference Manual.

### HP 150 MODE

HP 150 MODE allows the Touchscreen II to be compatible with the existing HP 150 Keyboard and Touchscreen firmware as well as to existing applications that directly access the 8042A in the 150. In this mode of operation, all interfaces to the 8042A work identically to the interfaces to the 8042A in the HP 150 The firmware uses this mode of operation exclusively.

Unlike the 8041 in the HP 150, which performs all keyboard and touchscreen scanning, the 8042 controls HP-HIL, which is the interface to the HP-HIL keyboard and the HP-HIL touchscreen. (All input devices perform their own scanning and report the results via HP-HIL).

When the 8042A is in HP 150 Mode, the HP-HIL keyboard keycodes are translated into 262X Extended Keyboard keycodes. Also, the data from the 12" Touchscreen II is translated into 150 compatible touchscreen data.

Additional HP-HIL input devices may be connected to the link, and they will be configured upon power-on or after a hard reset (under direction of the firmware). But only certain kinds of data received from these devices will be passed to the firmware. Besides touchscreen data, only HP-HIL set 1 keycodes (excepting those in the range of 80H to 8FH) will be translated to 2X keycodes and passed to the firmware. All other kinds of data (i.e., XY coordinate data) are ignored by the 8042.

Device disconnections and link errors are handled by the 8042A and are, except in the most catastrophic cases, transparent to firmware. Reconnections, or the addition of new input devices to the link, are not routinely handled by the

8042A. This function only occurs upon reconfiguration resulting from a reset command or a power-on reset.

## HP-HIL PASS THRU MODE

HP-HIL Pass Thru Mode allows full HP-HIL capability by allowing total access to the read and write registers of the HP-HIL Master Controller chip. In this mode of operation, the user program must do everything to configure, poll, and maintain the HP-HIL link because HP-HIL data and status from the HP-HIL Master Controller via the 8042 are not compatible with the HP 150 firmware.

This includes modifying the Keyboard interrupt service routine to differentiate between the data from different input devices. Note that this implies taking control of the keyboard and the touchscreen, if present. Unlike HP 150 Mode, no automatic translation of HP-HIL set 1 keycodes or touchscreen data takes place.

When this mode is used, the integrity of the link and of the link configuration cannot be guaranteed by the 8042A firmware; it must be taken care of by the user program.

Using this mode of operation requires a detailed knowledge of the HP-HIL protocol and of the Master Controller Chip. Refer to the *HP-HIL Technical Reference Manual* and the *HP-HIL Development Tools for the Touchscreen PC* for more information.

## MODIFIED HP-HIL PASS THRU MODE

In this mode of operation, as in Pass Thru Mode, the read and write registers of the HP-HIL Master Controller chip are accessible. And, as in Pass Thru Mode, the user program must do everything to configure, poll, and maintain the HP-HIL link, including servicing interrupts.

The differences between Pass Thru Mode and Modified Pass Thru are contained in the additional features of Modified Pass Thru Mode which will allow increased performance and convenience for the user program. These include the following:

- -ability to read the entire contents of the HP-HIL Master Controller FIFO without having to do repeated and time-consuming HP-HIL Master Controller register reads.

- -ability to do PUT KEY and PUT TOUCH functions, allowing the maintenance of a HP 150 compatible keyboard and touchscreen firmware interface simultaneously with other input devices.

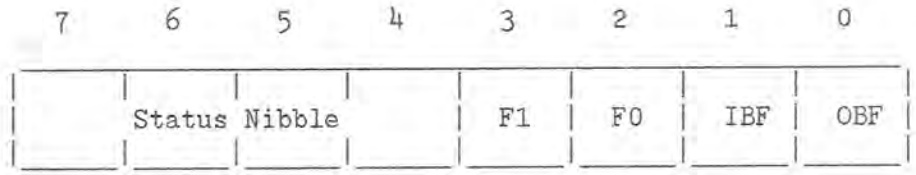
When this mode is used, the integrity of the link and of the link configuration cannot be guaranteed by the 8042A firmware; it must be taken care of by the user program.

Using this mode of operation requires a detailed knowledge of the HP-HIL protocol and of the HP-HIL Master Controller Chip. Refer to the *HP-HIL Technical Reference Manual* and the *HP-HIL Development Tools for the Touchscreen PC* for detail.

## 8042 Registers

### STATUS REGISTER (I/O PORT 0019H) - READ ONLY

The 8042 status register contents are obtained by reading from the 8042 at I/O port address 0019H. It has the following format:




| Bit | Interpretation |
|---|---|
| 7 - 4 | Four status bits controlled by the 8042 program. These are used to qualify the data values sent to the HP 150 processor by the 8042. |
| 3 | F1 flag. Used internally by the 8042. |
| 2 | F0 flag. Used internally by the 8042. |
| 1 | IBF flag. Set when the HP 150 processor writes to the 8042 and cleared when the 8042 accepts the data. |
| 0 | OBF flag. Set when the 8042 has data available for the HP 150 processor and cleared when the host reads from the data buffer of the 8042 (I/O Port 0018H). |

Status Nibble

0000 - Key address. If bit 7 of the data byte is 0, the key was depressed, else the key was released.

Exception: If the data is in response to an Identify Keyboard command, then 0000 means the touchscreen is not connected.

0001 - Power on (valid until first write).

0010 - Reset (valid until first write).

0011 - Touchscreen release code. Data is 0.

0100 - Touchscreen row address. Same as screen row.

0101 - Touchscreen column address. Same as screen column/2.

0110 - Loop Fail Status

0111 - Pass Thru or Modified Pass Thru Interrupt

1111 - Only occurs after Identify Keyboard command; indicates that touchscreen is connected.

**NOTE**

These status bits are valid only when data is available (OBF flag = 1). The only exception to this is the power-on/reset status which become valid 200 microseconds after reset or power-on and remains valid until the first write to the 8042.

## DATA REGISTER (I/O PORT 0018H) - READ/WRITE

The data register is a read/write register. Keyboard, touchscreen, and read register command data may be read from it. Data for the put key and put touch commands are written to this register.

Note that data can be written to the data register (I/O port 0018H) or to the command register (I/O port 0019H) only after verifying that the Input Buffer Full (IBF) flag of the Status Register is clear. This indicates that the 8042A is ready to accept a new command or data byte. Similarly, data should be read from the 8042A data register only when the Output Buffer Full (OBF) flag of the Status Register is set, indicating that valid data is available.

After reading the 8042A data register, the host MUST send a release interrupt command to the 8042A to acknowledge receipt of the data. This is true except in the case of self-test results, touchscreen bad pair addresses, and read register commands, which are reported without setting interrupt lines.

## COMMAND REGISTER (I/O PORT 0019H) - WRITE ONLY

Commands must be written to the 8042 command buffer (I/O port 0019H).

| Command Code | Function |
|---|---|
| 08H | Stop bell immediately. Next bell will function normally. |

| | |
|---|---|
| 10H | Release interrupt line. 8042 will negate its interrupt request to the host. |
| 20H | Hard reset. 8042 will assert its reset output to the HP 150 processor and initialize itself to power-on state with the exception of 8042 status flags (see preceding discussion on 8042 status register). Scanning must be re-enabled for keyboard or touchscreen input. |
| 21H | Identify keyboard. 8042 will respond with either 7FH or FFH depending on whether the keyboard identification diode is present or not. The 8042 generates an interrupt to the host when the ID is ready. Status bits 7-4 will be 0000 if touchscreen is defective and non-zero if the touchscreen is working. |
| 22H | Keyclick off. 8042 will not make keyclick sound when keys are pressed. |
| 23H | Keyclick on. 8042 will make keyclick sound when keys are pressed. |
| 24H | Enable Scanning. After power-on or hard reset, 8042 will not scan keyboard or touchscreen until this command is given by the host. |
| 25H | Initialize 8042 to power-on state except for status flags. Scanning must be re-enabled by HP 150 processor for keyboard or touchscreen input. This command does not reset the HP 150 processor. |
| 26H | Self-test 8042. The 8042 will test its RAM and ROM and respond with F9H if it passes or F8H if it fails. No HP 150 processor interrupt will be generated; the status register must be polled until data is available. |
| 28H | Stop key repeat. Any key on the keyboard will auto repeat after 500 ms if held down. If the HP 150 processor does not want the current key to auto repeat, it must send this command to stop it. |
| 2AH | Disable hard reset. This command will disable the hard reset that is initiated by the control/ shift/reset combination. |
| 2BH | Enable hard reset. This command enables the keyboard hard reset. (Default) |
| 30H - 3FH | Beep bell. The bell duration is about 100 ms and its period is determined by the lower four bits of the command code. With a 5 MHz 8042 clock, the frequency is about 290 Hz for 30H and about 1.7 KHz for 3FH. |
| 40H | Do one keyclick immediately. Ignored if keyclick is disabled. |

60H Touchscreen detector pairs report. This command is used to determine if any LED/Transistor pairs appeared to be blocked or bad during initialization. Two data bytes are always returned after this command is given. If either or both are not 0FFH, then their values are the addresses of the blocked pairs. If both are 0FFH, then there are no blocked pairs. No interrupt is generated for these two bytes; the 8042 must be polled for them. This command must be given after initialization and before scanning is enabled because it will interfere with the interrupt system if the 8042 is attempting to report keycodes.

The following commands are used to invoke HP-HIL Pass Thru Mode and Modified HP-HIL Pass Thru Mode.

80H MODIFIED PASS THRU MODE. This command is used to invoke Modified Pass Thru Mode in the 8042A. It must be preceded by an initialize command and a 200 ms delay.

81H PASS THRU MODE. This command is used to invoke Pass Thru Mode. It must be preceded by an initilaize command and a 200 ms delay.

The following commands are used when either the HP-HIL Pass Thru Mode or the Modified HP-HIL Pass Thru Mode has been invoked.

01H-03H PASS THRU WRITE TO REGISTER N. This is a command used to write directly to the registers in the HP-HIL Master Controller chip. This is a two byte command. The first byte is the data (could be a device address or link command) to be written to the HP-HIL Master Controller register. The second byte written is the 8042 command byte. The lower two bits of the command indicates which register is being addressed (0-3).

04H-07H PASS THRU READ FROM REGISTER N. This is a command used to read directly from the registers in the HP-HIL Master Controller chip. The lower two bits of the command indicate which register is being addressed (0-3).

To use this command, the host processor must poll the 8042A Output Buffer Full flag (OBF) after writing the command to the 8042A. When the flag becomes true, the data from register N is available at the Output Buffer register of the 8042A. No interrupt is generated.

The following commands are valid only in Modified Pass Thru Mode.

98H PUT KEY. This commnad causes the 8042 to accept an HP-HIL keyboard keycode (set 1) and translate it into a 150-recognizeable keycode. A keyboard interrupt to the 8259 interrupt controller is caused. The HP-HIL keycode should be written to the 8042 data register (I/O port 0018H) immediately before the PUT KEY command is written to the 8042 command register (I/O port 0019H). Valid keycodes are in the range 0 to 7FH and 90H to 0FFH.

94H PUT TOUCH REL. This command is similar to the PUT KEY command except that it requires no data byte. It takes an HP-HIL touchscreen touch release command and translates it to HP 150-recognizeable information. A keyboard interrupt to the 8259 interrupt controller is caused.

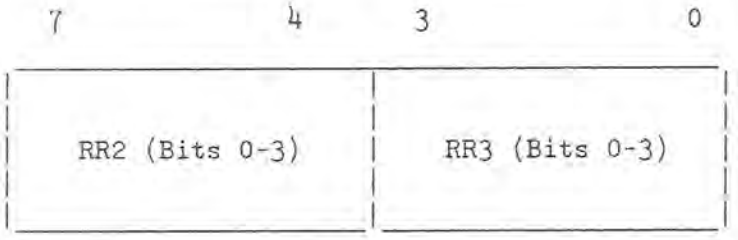
91H PUT TOUCH COL. Translates HP-HIL touchscreen column data to 150-recognizeable touchscreen column data. (Needs to be followed with PUT TOUCH ROW command.)

This is a two-byte command. The raw HP-HIL touchscreen column (0-56) data should be written to the 8042 data register (I/O port 18H) immediately before the PUT TOUCH COL command is written to the 8042 command register (I/O port 19H.)

90H PUT TOUCH ROW. Translates HP-HIL touchscreen row data to 150-recognizeable touchscreen row data. The raw HP-HIL touchscreen row data (0-42) should be written to the 8042 data register (I/O port 18H) immediately before the PUT TOUCH ROW command is written to the 8042 command register (I/O port 19H). This command must be preceded by a PUT TOUCH COL command. Notes on Pass Thru and Modified Pass Thru Mode:

In Pass Thru Mode and Modified Pass Mode, a variety of interrupts may occur. These are identified by the contents of the 8042 status register at the time the interrupt occurs. As noted in the section of the status register, the upper byte of the status register indicates the type of interrupt.

Upon receipt of a pass thru interrupt (status nibble =7) from the 8042 in either pass thru mode or modified pass thru mode, the data register of the 8042 (I/O port 18H) contains the contents of the HP-HIL Master Controller status registers RR3 and RR2 (see figure below).




In pass thru mode, this is the end of the data. The programmer must use the read register commands to obtain the contents of the HP-HIL Master Controller FIFO.

In modified pass thru mode, the first data byte containing the HP-HIL Master Controller register RR3 and RR2 is followed by the rest of the Controller FIFO. Read the 8042 status register (I/O port 19H). Bits 4-7 of this register will contain bits 0-3 of the HP-HIL Master Controller register RR1. (Bit 0 = 1 of the status register indicates additional data.

Then, reading the 8042 data register (I/O port 18H) will yield the contents of the HP-HIL Master Controller register RR0 (data/command).

The entire contents of the FIFO may be read in this manner, alternately reading the status register and the data register of the 8042 unit bit 0 (Output Buffer Full) of the status register is 0, indicating that no more data follows.

An exception to this is when a link error has been received by the HP-HIL Master Controller and the FIFO data is meaningless. In this case, the link error will be flagged in RR2, and no FIFO data will be dumped to the 8042 registers.

The other kinds of interrupts possible in Pass Thru Mode and Modified Pass Thru Mode are interrupts that result from using the PUT KEY and PUT TOUCH commands. These interrupts consist of keyboard or touchscreen data that are ready to be passed to the HP 150 firmware (as in HP 150) Mode.)

## Initialization

The following actions leave the 8042 in its initialized state:

- Power on
- Hard reset from keyboard
- Hard reset command from HP 150 processor
- Initialization command from HP 150 processor

After initialization, the 8042 will not poll the keyboard or touchscreen until an "enable scanning" command is given. About 200 us after initialization commences, status bits 7-4 will be 0001 if the reset was from power-on or 0010 otherwise. The entire initialization takes up to 200 ms.

The recommended start-up procedure (HP 150 mode only) for the 8042 after any of the four initialization actions listed above is:

1. Wait 200 milliseconds for the 8042 to initialize itself and check the touchscreen. Read the data register (I/O Port 0018H) to clear the status bit.

2. Send self-test command and wait for result to come back.

3. Send identify keyboard command and wait for results to come back.

4. Enable scanning.

# ACCESSORY CARD HARDWARE AND ELECTRICAL

## Electrical Design

The same rules used for designing HP 150 Accessory cards apply to the Touchscreen II System.

The exceptions are as follows:

If the Coprocessor Accessory Subsystem is installed the timing of the BIO/NM and FPNSSO Accessory Connector signals is different the Accessory card must be designed to work with either timing.

The battery is a Lithium type with a 7 year-life that is soldered in. Although it is connected to the accessory card connector, a separate battery on the Accessory Card should be used for applications requiring battery back-up.

The Accessory Card Slots 2-4 have 16K Address blocks available, unlike Slot 1 which is still 64K.

Slot 1 Slot Select Address H90000-H9FFFF [64K]
Slot 2 Slot Select Address HA0000-HA3FFF [16K]
Slot 3 Slot Select Address HA4000-HA7FFF [16K]
Slot 4 Slot Select Address HA8000-HABFFF [16K]

## Mechanical Design

The same rules used for designing HP 150 Accessory Cards apply to the Touchscreen II system.

The exceptions are as follows:

## Cable and Hood Design

Since the product package is different the cables used to connect between the Port 1 and 2 connectors and the Accessory Cards must be made longer than the ones used on the HP 150.

The Accessory Card Cable must be designed so that Connector Hood/Strain relief/Cable bend combination does not exceed a height limit of 60mm above the Accessory Card I/O Panel.

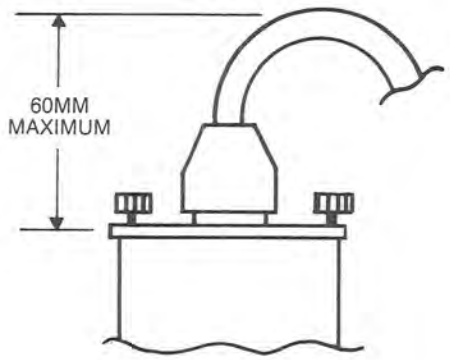



Figure 3-33. Accessory Card Cable and Hood Considerations

# ACCESSORY SUBSYSTEM

## General

The same specifications and limitations for the HP 150 apply to the Touchscreen II system.

**WARNING**

Follow the accessory subsystem guidelines to prevent short circuits with the metal card guides.

## Accessory Loading Restrictions

| Signal | Available Source Current | Available Sink Current |
|---|---|---|
| BATV | 0uA | 0uA |

## Signal Timing

| Symbol | Parameter | Min | Max |
|---|---|---|---|
| Tao | FPNSSO delay from clock rising edge | 73 nSec | 122 nSec |
| Tan | BIO/NM delay from clock rising edge | 73 nSec | 122 nSec |

## Power Requirements and Thermal Limits

Each of the four accessory slots have the following available power:

| Voltage | Current |
|---|---|
| +5V | 1.50A |
| +12V | .35A |
| -12V | .10A |

Because of thermal reasons and total power limits the amount of power consumed from the three outputs above should not exceed 7.5W per slot (whether dissipated inside or outside the package).

The total amount of power available for the four accessory slots (and the total amount of power that can be dissipated inside the package) is 30W.

The peripheral DIN connector output has the following available power:

| Voltage | Current |
|---|---|
| +5P | 1.60A |
| +12P | 1.00A |

This power is to be dissipated outside of the package.

## CMOS Power

This pin is at approximately 5.0V when power is applied to the system and it falls to approximately 3.0V - 5.5V when the power is turned off.

It is recommended that this output not be used (> 1/4 uA) in order to guarantee long life of the permanent battery.

# PROCESSOR ACCESSORY SUBSYSTEM

## Processor Accessory Design Guidelines

The Touchscreen II provides a special accessory connector, J7, in the center of the processor board. Note that this is not one of the 4 standard I/O slots. This connector provides +5 Vdc, ground and the signal lines from the 8088 microprocessor. The following paragraphs provide guidelines and specifications needed by designers to interface this connector with the system hardware.

## Mechanical Specifications

The processor accessory connector interfaces to the system through a 50 pin connector which is next to the 8088 on the processor board. Mechanical drawings for the processor accessory are included in this section. The board is secured in the Touchscreen II by plastic tabs on the inside of the front rim chin and by a screw on the rear panel. The following hardware and connector is needed for the processor accessory board.

| | | | |
|---|---|---|---|
| 1) | Plastic Insert Nut:<br>(For securing board to rear panel) | Manufacturers Part #<br>F1-10-104-13 | Address<br>SOUTHCO INC<br>CONCORDVILLE, PA |
| 2) | Screw: 4-40 x .375 " long<br>(For the above plastic nut) | | |
| 3) | 50 Pin Female Connector: | Manufacturers Part #<br>102585-3 or equiv. | Address<br>AMP INC<br>HARRISBURG, PA |

## Power Available

| Voltage | Max Current |
|---|---|
| +5 Vdc | 1 A |

## Processor Accessory Loading Limitations

Proper adherence to the AC and DC loading restrictions on this connector are required for proper performance of the Touchscreen II. Table 3-1 lists the loading restrictions for the processor accessory connector.

Table 3-1. Processor Accessory Loading Restrictions

| Signal | Available Source Current | Available Sink Current | Maximum Capacitive Loading ** |
|---|---|---|---|
| AD0-A19,INTR,KRST NNPINT (INPUTS) | 800 uA | 3.5 mA | 25 pf |
| AD0-A19, MINALE,ALE,NINTA DT/NR,NSSO,IO/NM,NDEN NWRT,NRD,NRST,NCLK ASCHOLD,HOLDA,GO (OUTPUTS) *** | 40 uA | 800 uA | 25 pf |
| PRHOLD,CLRSHOLDA, PRSHOLDA * (INPUTS) | 800 uA | 12 mA | 35 pf |
| CLK,RDY,RST (OUTPUTS) | 100 uA | 2.0 mA | 25 pf |

* These signals should be driven by an open collector driver.

** To estimate capacitive loading, one can use 2 pf per connector pin, 5 pf/inch of PC trace, and 5-10pf per gate terminal.

*** ALE signal can not be floated by asserting HOLD high. All other 8088 outputs can be floated high by grounding the PRHOLD pin which asserts HOLD high.

## Processor Accessory Connector

The processor accessory PCAs plug into connector J7 which is in the center of the Touchcsreen II processor board. The signals that are available to the designer are in listed Table 3-2.

Table 3-2. Processor Accessory Pinouts

| Pin # | Signal | Pin # | Signal |
|---|---|---|---|
| 1 | GND | 26 | NC |
| 2 | A14 | 27 | A15 |
| 3 | A13 | 28 | A16 |
| 4 | A12 | 29 | A17 |
| 5 | A11 | 30 | A18 |
| 6 | A10 | 31 | A19 |
| 7 | A9 | 32 | NSSO |
| 8 | A8 | 33 | NRST |
| 9 | AD7 | 34 | NRD |
| 10 | AD6 | 35 | GND |
| 11 | AD5 | 36 | +5 V |
| 12 | AD4 | 37 | NWRT |
| 13 | AD3 | 38 | IO/NM |
| 14 | AD2 | 39 | DT/NR |
| 15 | AD1 | 40 | NDEN |
| 16 | AD0 | 41 | NCLK |
| 17 | KRST | 42 | NINTA |
| 18 | INTR | 43 | GND |
| 19 | CLK | 44 | RDY |
| 20 | GO | 45 | RST |
| 21 | ASCHOLD | 46 | HOLDA |
| 22 | PRHOLD | 47 | PRSHOLDA |
| 23 | CLRSHOLDA | 48 | NNPINT |
| 24 | GND | 49 | +5 V |
| 25 | ALE | 50 | MINALE |


Pictorial view of the processor Accessory Connector. Pins 25 & 50 are towards rear of Touchscreen II.

## Processor Accessory Signal Descriptions

The processor accessory signals are described in the Hardware Subsystem portion of this manual. Table 3-3 contains a description of signals that have not previously been described.

Table 3-3. Signal Descriptions

| | |
|---|---|
| NNPINT | 8259A Interrupt 6 signal. Touchscreen II firmware contains a return interrupt instruction for this interrupt pin: the interrupot is not used by any existing accessory cards. |
| PRHOLD | Set pin for U212 D flip-flop. This signal can be used to asynchronously set the 8088 HOLD high. |
| PRSHOLDA<br>CLRSHOLDA | Set and clear pins for U212 D flip-flop. These signals can be used to asynchronously control the 8088 HOLDA signal. |
| MINALE | This is the processor board 8088 ALE signal. Jumper W1 connects MINALE to ALE. If another processor is to replace the 8088 on the processor accessory board, jumper W1 must be cut and the ALE on pin 25 should be used by the processor accessory board. |

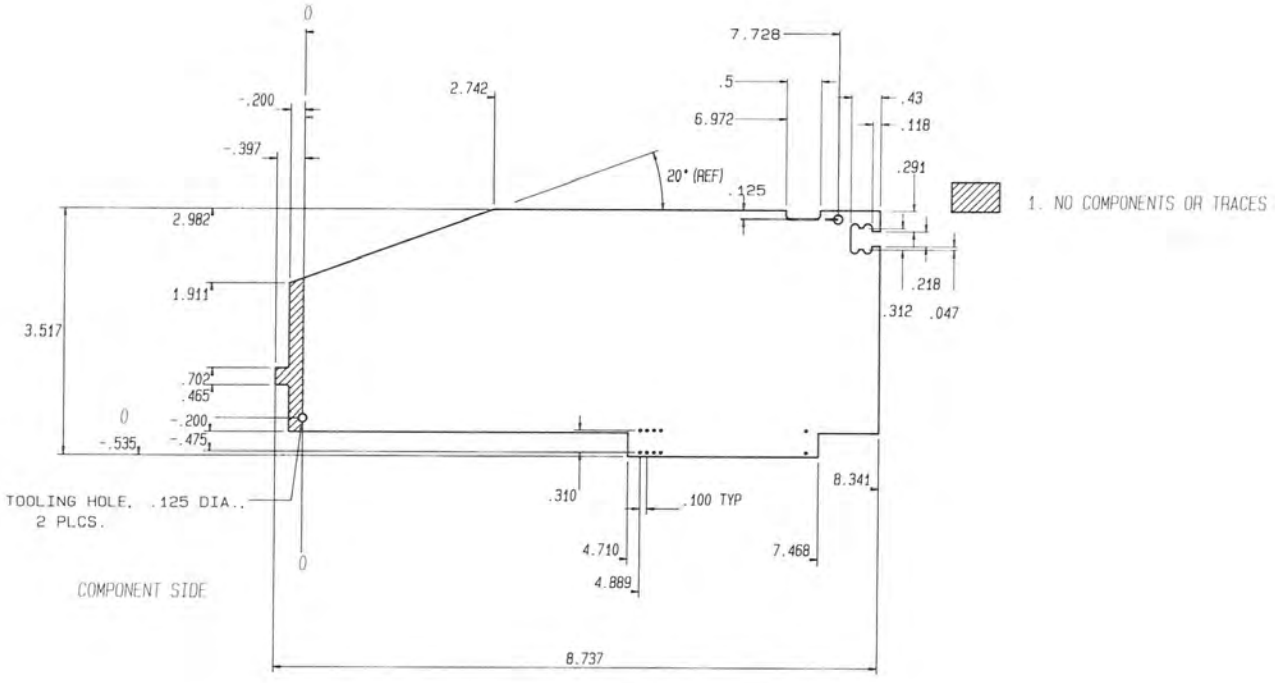



Figure 3-34. Processor Accessory Board Mechanical Details

# COPROCESSOR ACCESSORY SUBSYSTEM

## Theory Of Operation

The 8087 coprocessor board is a hardware accessory for the Touchscreen II that increases speed of mathematic operations by performing calculations in hardware rather than in software subroutines. The coprocessor board contains an 8088/8087 operating in MAX mode which performs as a single microprocessor. The 8087 performs numeric tasks while the 8088 executes other types of instructions. The 8087 coprocessor board has a total of 13 IC's and plugs into connector J7 of the Touchscreen II processor board and does not occupy an I/O slot. The general architecture of the processor /coprocessor interface is depicted in the figure below.

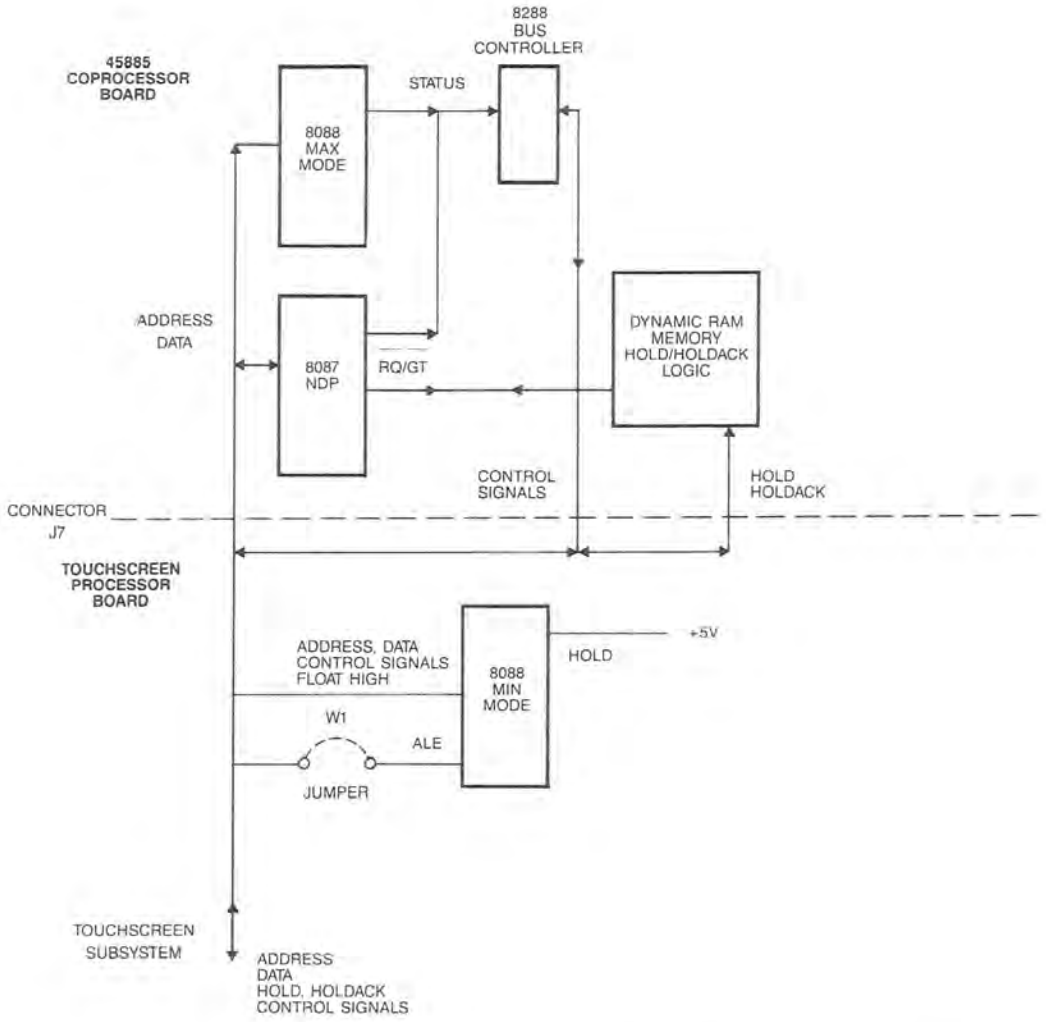



Figure 3-35. 45885A Coprocessor Accessory Block Diagram

**PROCESSOR BOARD MIN MODE 8088.** Without the coprocessor board installed, the 8088 on the Touchscreen II processor board provides address/data lines and control signals, NRD, NWRT, ALE, NDEN, IO/NM, DT/NR, NSSO and NINTA in MIN mode configuration. However, an 8088 operating in MIN mode will not support the 8087 coprocessor. (See the 8088/8087 data sheets for details) Since the 8088 on the Touchscreen II processor board is not needed, its outputs are floated by asserting HOLD high when the coprocessor board is installed. A ground originating on the coprocessor board, PRHOLD, is connected to the SET pin on the processor HOLD flip-flop U212 which forces the processor board 8088 to be in the HOLD state starting from power up. The 8088 MIN mode ALE signal is not floated during HOLD and is a logic 0. A jumper wire on the Touchscreen II processor board must be cut during installation of the co- processor board to disable the MIN mode 8088 ALE line. If this jumper is not cut, the MAX mode ALE signal can not reach a valid 1 level.

**COPROCESSOR BOARD MAX MODE 8088.** The 8088 on the processor board is replaced by an 8088 operating in MAX mode on the coprocessor board. Signal timing is the same as the standard Touchscreen II except for the NSSO and IO/NM signals. (See figure 3-36) The 8088 on the coprocessor board provides control signals in the form of status lines NSO, NS1, NS2 which connect to an 8288 Bus Controller and form signals ALE, DT/NR, DEN, NINTA, NAIOWC and NAMWC. The DEN signal from the 8288 Bus Controller is inverted to form NDEN. NAIOWC and NAMWC are logically ORed together to form NWRT. NRD signal is provided by the MAX mode 8088 and has the same timing as the MIN mode 8088 NRD signal. ALE, DT/NR, and NINTA have the same timing as the standard Touchscreen II.

The 8288 Bus Controller does not provide timing signals IO/NM and NSSO needed by the Touchscreen II and are generated from the NS2 and NSO signals. The IO/NM control signal is the logical inversion of the NS2 signal while the NSSO control signal is logically equivalent to the NSO signal. However, all status lines NSO, NS1, NS2 go to the passive state (ie:1's) in the timing state right before T4 cycle. Touchscreen II Memory and I/O read/write operations require IO/NM & NSSO to be valid thru the falling edge of the T4 clock. The coprocessor board stretches these two signals into the T4 cycle by first clocking them into a flip-flop using the rising edge of ALE in T1 cycle. When the status signals NSO, NS1, NS2 all go to 1 in T3, a flip-flop is cleared during the falling edge of T4. This flip-flop NQ output, which is now a 1 level, tri-states the flip-flops which hold IO/NM and NSSO. Their outputs are pulled to the 1 state by pullup resistors on the Touchscreen II processor board. Control signals NRD, NWRT, NDEN, IO/NM, DT/NR, NSSO are all high during T4 to ensure proper dynamic RAM refresh. The status signals go to active values before ALE goes high during T1, and the outputs of the flip-flops holding IO/NM and NSSO are re-enabled early in the T1 cycle.

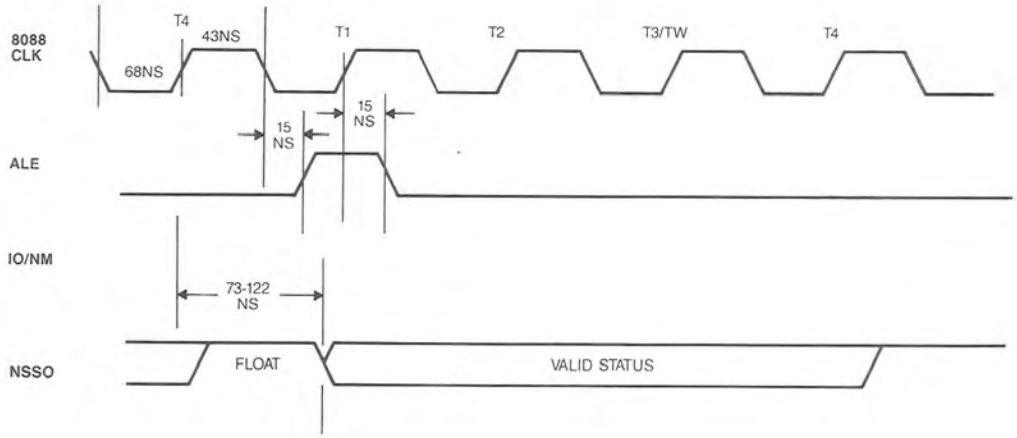



Figure 3-36. 45885A Coprocessor Accessory ALE, IO/NM and NSSO Timing Diagram

**8087 NUMERIC DATA PROCESSOR.** The 8087 is connected to the 8088 and 8288 in the standard MAX mode configuration. (See Intel data sheets for details). It decodes instructions simultaneously with the 8088 and will take over the bus when it receives 8087 type instructions. The 8087 error reporting interrupt signal, INT, is ORed with the keyboard hard reset, KRST signal, and is input into the 8088 NMI input. The 8088 LOCK pin is not used and is left floating.

**DYNAMIC RAM REFRESH. (NO COPROCESSOR BOARD INSTALLED)** The Touchscreen II must refresh its dynamic RAM every 56 usec. The period of time required to refresh the memory is about 2.8 usec. For every memory refresh cycle, the processor board informs the 8088 microprocessor to float its outputs by asserting the HOLD line high. Once the processor has completed its current bus cycle, it floats all output lines, except ALE, and asserts HOLDACK high. When dynamic RAM has finished refreshing, the processor board releases the high on the HOLD line, the 8088 drops HOLDACK and starts a new bus cycle.

**DYNAMIC RAM REFRESH. (COPROCESSOR BOARD INSTALLED)** The 8088/8087 operating in MAX mode on the coprocessor board does not have HOLD/HOLDACK pins. Instead, a bi-directional REQUEST/GRANT pin on the 8087 coprocessor is used to disable BOTH processors during dynamic RAM refresh. The RQ/GT pin on the 8088 was not used because it will not disable the 8088 whenever the 8087 is in command of the bus until the current 8087 instruction cycle is complete. Since 8087 instructions can take as long as 100 usec, 56 usec dynamic RAM refresh rate can not be guaranteed (see the 8088 Users Manual for more details).

The coprocessor board has a synchronous state machine with a HOLD input line, a HOLDACK output line (i.e., CLRSHOLDA) and an open collector RQ/GT line for the 8087. The Synchronous state machine generates a REQUEST pulse one clock period wide when the dynamic ram refresh HOLD goes high. This pulse is passed from the 8087 to the 8088 and both processors float all their output lines, except ALE, at the end of the current bus cycle. The 8087 sends out a GRANT pulse one clock period wide when BOTH processors are off the bus. Upon receipt of the GRANT pulse, the synchronous state machine on the co- processor board asserts HOLDACK. Once the 2.8 usec memory refresh is complete, the Touchscreen II processor board drops the HOLD line. This causes the synchronous state machine to send out a RELEASE pulse one clock period wide to allow the 8088 or 8087 to reclaim control of the bus. This completes one cycle of the dynamic RAM refresh. (The Intel iAPX 86,88 User Manual has a complete timing diagram of this circuit) In all other respects, the coprocessor dynamic RAM refresh is identical to the Touchscreen II without a coprocessor board.

## Software Implications

The 45885A coprocessor accessory was designed to be compatible with the Microsoft PASCAL and FORTRAN compilers and the Lattice-C compiler. When using the PASCAL or FORTRAN compilers, verify that the runtime library you are using to link with your object code has the SHRX87 register set to a NONZERO value. (See your compiler manual) This register informs the runtime library that it shares the 8087 INT with another device. The 8087 INT is used to report 8087

math errors to the 8088 processor. This interrupt is shared with the Touchscreen II keyboard hard reset, (SHIFT, CTRL, RESET) on interrupt vector 2 which is the 8088 NMI pin. Note, if the SHRX87 register is set to zero, you will not be able to stop your executable program from running with keyboard hard reset. In addition, it will lock up your keyboard after the program is finished executing instructions. The Touchscreen II must then be turned off and on to reset.

The LOCK prefix is available for use with the 8088 microprocessor instruction set to stop all other bus controllers from gaining access to the bus until the current instruction has finished executing. The LOCK prefix should not be used with the 8088 instruction set because some 8087 instructions are longer than 56 usec and dynamic RAM refresh would not be guaranteed.

## Other Vendors

OTHER HP 150 COPROCESSOR BOARD VENDORS:

Other vendors make 8087 coprocessor accessories for the 150, however, these products are not supported by Hewlett Packard. Here are two vendors:

1) IRIS SYSTEME SCIENTIFIC
   Siege Social: Zone d'Activite' d'Orsay
   Avenue de Copenhague, 91946 Les Ulis Cedex
   France

2) CLINICAL MICROSYSTEMS INC
   P.O. Box 36-1055
   Melbourne, Florida 32936-1055

# Memory and I/O Mapping

SECTION 4

This section contains the differences in the memory and I/O mapping between the Touchscreen II and the HP 150.

CONTENTS

# TOUCHSCREEN II MEMORY MAP

The Touchscreen II memory map is shown in figure 4-1. Two accessory slots are added with 16 Kbytes of addressable space each. The remainder of the memory map allocation is identical to the HP 150 memory map. Since the video controller in the Touchscreen II differs from the one used in the HP 150, some of the video registers are not supported in Touchscreen II. Detailed description of the differences is described in the next subsection.

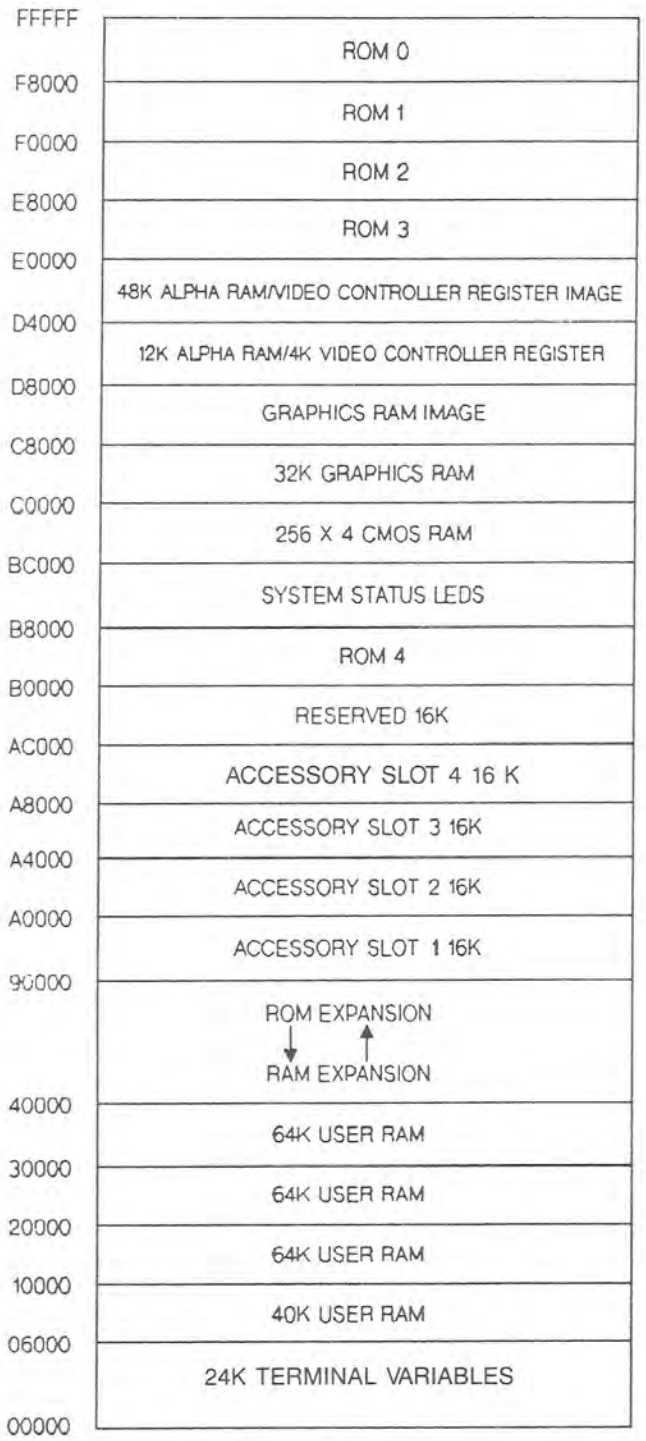



Figure 4-1. The Touchscreen II System Memory Map

## Video Registers

This subsection presents the Video Register Maps of both the Touchscreen II and the HP 150. Also included are the bit assignments for the Touchscreen II video registers.

The following notes apply to the table below.

Notes:

(1) These 256 locations are replicated in the 4K address space on every 100(Hex) boundary in both the HP 150 and Touchscreen II.

(2) Entries labeled "X" indicate locations which are not used by the HP 150.

(3) Blank entries indicate locations not used by Touchscreen II.

(4) ROM and/or PLA programmable functions in Touchscreen II's video controller.

(5) Features not supported by Touchscreen II.

(6) Row Pointer Table Start Address ROM programmable in Touchscreen II's video controller.

(7) Not used except for setting single height and width character rows. Touchscreen II's video controller supports only single height and width character rows.

(8) Not used by HP 150.

(9) Feature not supported by the HP 150.

The 8088 address A0 should be a logic "0" whenever accessing any location in the 4K address space D3000-D3FFF (except for location D303F and its' imaged locations). If A0 is a logic "1" while writing to the D3000-D3FFF address space, garbage will be written into the corresponding low byte (except for location D303F and its' imaged locations). The HP 150 has a similar restriction of writing only to even bytes in this address range.

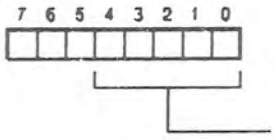
Writing to D303E or any of its' imaged locations will not affect the GMODE register (location D303F).

| 8088 Addr(1) (Hex) | SMC Reg (2) | HP 150 VIDEO Register | Touchscreen II VIDEO Register(3) |
|---|---|---|---|
| D 3000 | R0 | Raster Timing | (4) |
| D 3002 | R1 | Raster Timing | (4) |
| D 3004 | R2 | Raster Timing | (4) |
| D 3006 | R3 | Raster Timing | (4) |
| D 3008 | R4 | Raster Timing | (4) |
| D 300A | R5 | Raster Timing | (4) |
| D 300C | R6 | Pin config/Skew Reg | (5) |
| D 300E | R7 | Raster Timing | (4) |
| D 3010 | R8 | Raster Timing | (4) |
| D 3012 | R9 | Raster Timing | (4) |
| D 3014 | RA | DMA Cntl Reg | (5) |
| D 3016 | RB | Control Reg | (5) |
| D 3018 | RC | Table Start | (6) |
| D 301A | RD | Table Start | (6) |
| D 301C | RE | Aux Reg (7) | |
| D 301E | RF | Aux Reg (7) | |
| D 3020 | R10 | Seq Break Reg (8) | |
| D 3022 | R11 | Data Row Start | START SMOOTH SCROLL |
| D 3024 | R12 | Data Row End | END SMOOTH SCROLL |
| D 3026 | R13 | Aux Adrs Reg (8) | |
| D 3028 | R14 | Aux Adrs Reg (8) | |
| D 302A | R15 | Start Command | (5) |
| D 302C | R16 | Reset Command | (5) |
| D 302E | R17 | Smooth Scroll Off | OFFSET SCAN LINES |
| D 3030 | R18 | Vert Cur Reg (Wr) | CURSOR ROW |
| D 3032 | R19 | Horz Cur Reg (Wr) | CURSOR COLUMN |
| D 3034 | R1A | Int Enable Reg | (5) |
| D 3036 | X | | |
| D 3038 | X | | |
| D 303A | X | | |
| D 303C | X | | |
| D 303F | X | (9) | GMODE |
| D 3040 | X | | |
| D 3042 | X | | |
| D 3044 | X | | |
| D 3046 | X | | |
| D 3048 | X | | |
| D 304A | X | | |
| D 304C | X | | |
| D 304E | X | | |
| D 3050 | X | | |
| D 3052 | X | | |
| D 3054 | X | | |
| D 3056 | X | | |
| D 3058 | X | | |
| D 305A | X | | |
| D 305C | X | | |
| D 305E | X | | |
| D 3060 | X | | |

| 8088 Addr(1) (Hex) | SMC Reg (2) | HP 150 VIDEO Register | Touchscreen II VIDEO Register(3) |
|---|---|---|---|
| D 3062 | X | | |
| D 3064 | X | | |
| D 3066 | X | | |
| D 3068 | X | | |
| D 306A | X | | |
| D 306C | X | | |
| D 306E | X | | |
| D 3070 | R38 | Vert Cur Reg (Rd) | (5) |
| D 3072 | R39 | Horz Cur Reg (Rd) | (5) |
| D 3074 | R3A | Status Reg | COMMANDS |
| D 3076 | R3B | Vert Light Pen (8) | |
| D 3078 | R3C | Horz Light Pen (8) | |
| D 307A | X | | |
| D 307C | X | | |
| D 307E | X | | |
| D 3080 | VATT | Vid Att Latch | SCREEN INFORMATION |
| D 3082 | VATT | Vid Att Latch | SCREEN INFORMATION |
| D 3084 | VATT | Vid Att Latch | SCREEN INFORMATION |
| D 3086 | VATT | Vid Att Latch | SCREEN INFORMATION |
| D 3088 | VATT | Vid Att Latch | SCREEN INFORMATION |
| D 308A | VATT | Vid Att Latch | SCREEN INFORMATION |
| D 308C | VATT | Vid Att Latch | SCREEN INFORMATION |
| D 308E | VATT | Vid Att Latch | SCREEN INFORMATION |
| D 3090 | VATT | Vid Att Latch | SCREEN INFORMATION |
| D 3092 | VATT | Vid Att Latch | SCREEN INFORMATION |
| D 3094 | VATT | Vid Att Latch | SCREEN INFORMATION |
| D 3096 | VATT | Vid Att Latch | SCREEN INFORMATION |
| D 3098 | VATT | Vid Att Latch | SCREEN INFORMATION |
| D 309A | VATT | Vid Att Latch | SCREEN INFORMATION |
| D 309C | VATT | Vid Att Latch | SCREEN INFORMATION |
| D 309E | VATT | Vid Att Latch | SCREEN INFORMATION |
| D 30A0 | VATT | Vid Att Latch | SCREEN INFORMATION |
| D 30A2 | VATT | Vid Att Latch | SCREEN INFORMATION |
| D 30A4 | VATT | Vid Att Latch | SCREEN INFORMATION |
| D 30A6 | VATT | Vid Att Latch | SCREEN INFORMATION |
| D 30A8 | VATT | Vid Att Latch | SCREEN INFORMATION |
| D 30AA | VATT | Vid Att Latch | SCREEN INFORMATION |
| D 30AC | VATT | Vid Att Latch | SCREEN INFORMATION |
| D 30AE | VATT | Vid Att Latch | SCREEN INFORMATION |
| D 30B0 | VATT | Vid Att Latch | SCREEN INFORMATION |
| D 30B2 | VATT | Vid Att Latch | SCREEN INFORMATION |
| D 30B4 | VATT | Vid Att Latch | SCREEN INFORMATION |
| D 30B6 | VATT | Vid Att Latch | SCREEN INFORMATION |
| D 30B8 | VATT | Vid Att Latch | SCREEN INFORMATION |
| D 30BA | VATT | Vid Att Latch | SCREEN INFORMATION |
| D 30BC | VATT | Vid Att Latch | SCREEN INFORMATION |
| D 30BE | VATT | Vid Att Latch | SCREEN INFORMATION |
| D 30C0-30FE | VATT | Vid Att Latch | SCREEN INFORMATION |

# Touchscreen II Video Register Description

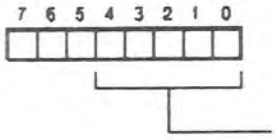
## Start Smooth Scroll




START SMOOTH SCROLL ROW

- VALID RANGE IS 0-31
- BITS 5-7 ARE DON'T CARE
- BIT4 = MSB, BIT0 = LSB

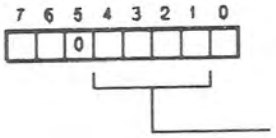
## End Smooth Scroll




END SMOOTH SCROLL ROW

- VALID RANGE IS 0-31
- BITS 5-7 ARE DON'T CARE
- BIT4 = MSB, BIT0 = LSB

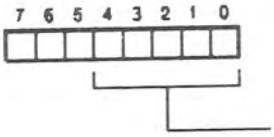
## Offset Scan Lines




SCANLINE OFFSET FOR SMOOTH SCROLL

- VALID RANGE IS 0-13
- BIT5 MUST BE SET TO LOGIC '0'
- BITS 0, 6 AND 7 ARE DON'T CARE
- BIT4 = MSB, BIT1 = LSB

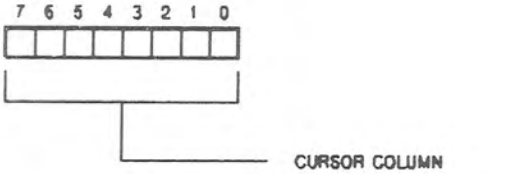
## Cursor Row




CURSOR ROW

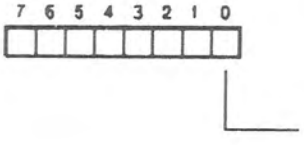
- VALID RANGE IS 0-31
- BITS 5-7 ARE DON'T CARE
- BIT4 = MSB, BIT0 = LSB

## Cursor Column



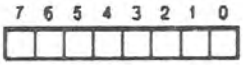

- VALID RANGE IS 0-255
- BIT7 = MSB, BIT0 = LSB

## Graphics Mode

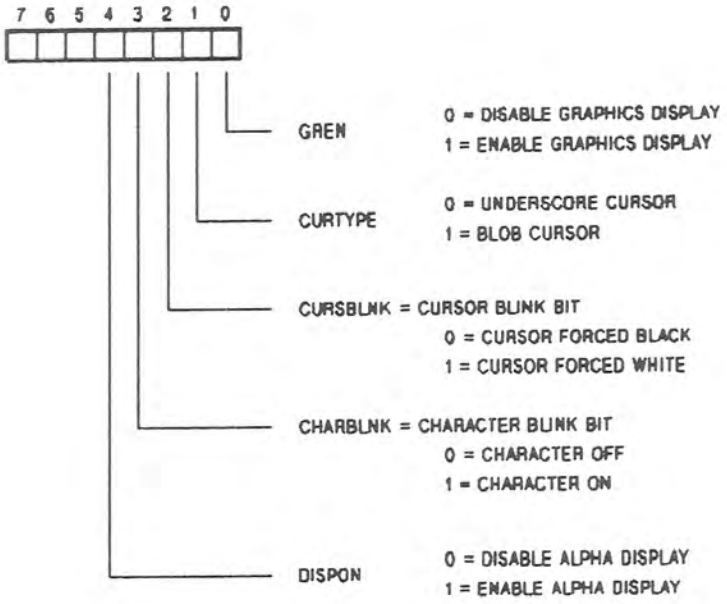



0 = 640 HORIZONTAL DOTS
1 = 512 HORIZONTAL DOTS

## Commands




## Screen Information



# TOUCHSCREEN II I/O MAP

The Touchscreen II uses the same I/O map that is used in the HP 150 except the integral printer interface (XX30H - XX3FH) is not supported in Touchscreen II.

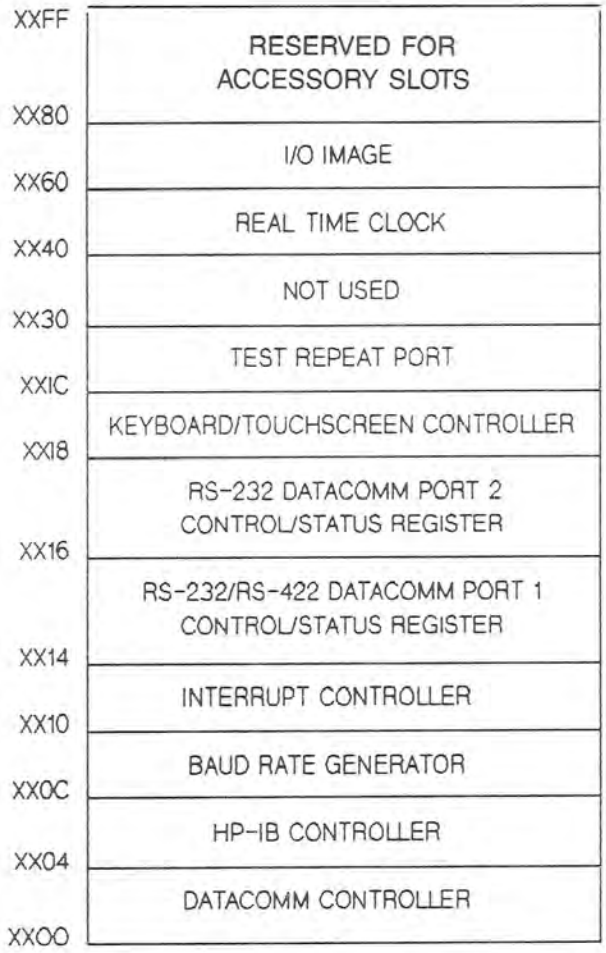



Figure 4-2. HP Touchscreen II I/O Map

CONTENTS

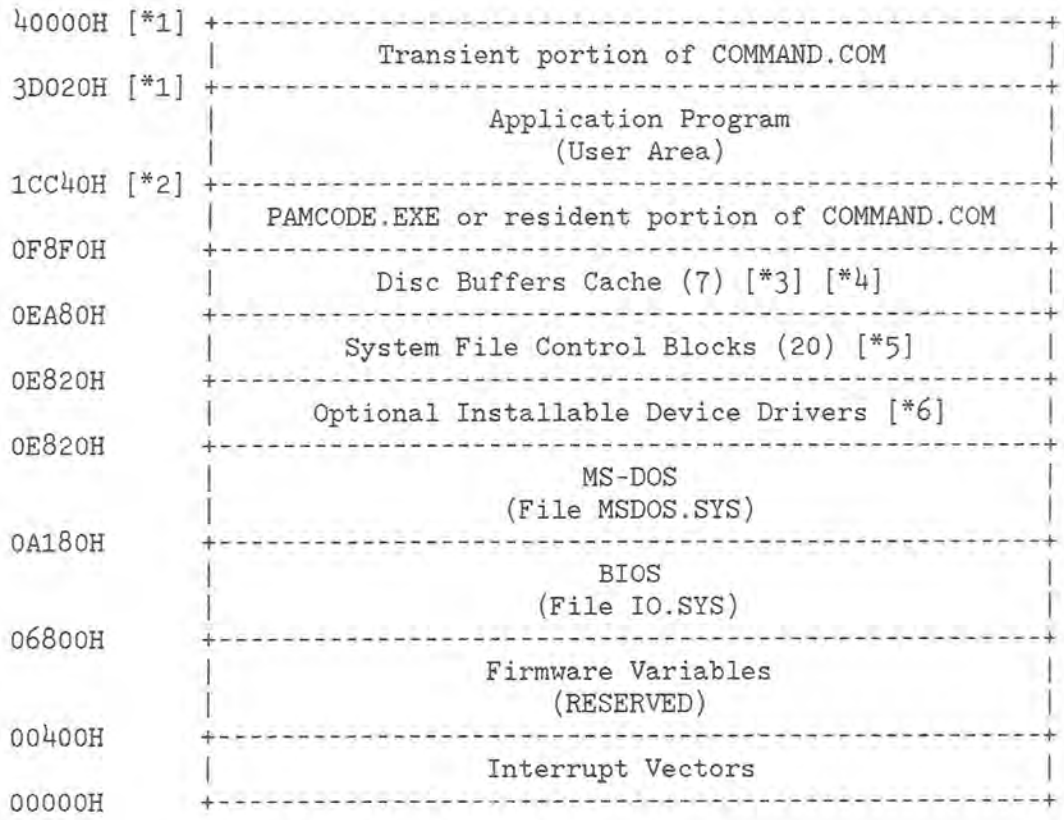
# SYSTEM SOFTWARE

Touchscreen II changes to the HP 150 software environment basically involve additions to existing tables and associated details describing these additions. Only the affected tables are included in this section. For additional information, refer to Section 5 of the *HP 150 Technical Reference Manual*.

# OPERATING SYSTEM MEMORY USAGE

## Operating System Memory Map

BIOS C.01.02, MS-DOS 2.11 and P.A.M. C.01.00 with 256K byte of RAM using the default configuration.




NOTES: *1 Value depends on the size of the RAM DISC allocated and amount of optional expansion RAM installed.

*2 Value is 10480H if COMMAND.COM is used instead of P.A.M.

*3 Eight disc buffers are provided. The first Disc Buffer is contained within MS-DOS.

*4 Number of Disc Buffers can be changed with the BUFFERS command in the CONFIG.SYS file. The buffer size is defineded in the Device Configuration Utilitiy (DEVCONFG.EXE).

*5 Number of System File Control Blocks can be changed with with FILES command in the CONFIG.SYS file.

*6 Optional Device drivers are loaded with the DEVICE command in the CONFIG.SYS file.

# System Software

SECTION 5

This section provides the system software differences between the HP 150 and the Touchscreen II.

# DISC FORMAT AND DIRECTORY STRUCTURE

## Physical Disc Format

HP 150 disc media are partitioned physically into "tracks" which in turn are each partitioned into "sectors". Each sector is a physical portion of a track commonly containing 256 bytes of information.

Sectors are numbered 0, 1, 2, 3, ..... and so on. This is not to say that sector 1 follows sector 0 physically on the disc. Sector "staggering" is employed to improve disc read and write efficiency.

The disc drive takes care of logical to physical mapping and as such the programmer need only be concerned with logical sector numbering, above.

## Disc Media Storage Capacity

The following table shows the storage capacity in sectors and number of kilobytes for different types of disc drives available on the HP 150.

| Media Type | Total Sectors | Total Kbyte |
|---|---|---|
| 3-1/2" Single Sided Microfloppy | 1,056 | 264 |
| 3-1/2" Double Sided Microfloppy | 1,386 ** | 693 |
| 5-1/4" Double Sided Minifloppy | 1,056 | 264 |
| 8" Floppy (HP Format) | 4,500 | 1,125 |
| 8" Floppy (IBM Format) | 2,002 * | 250 |
| "5MB" Winchester | 18,848 | 4,712 |
| "10MB" Winchester | 39,088 | 9,772 |
| "15MB" Winchester | 56,730 | 14,182 |
| "20MB" Winchester | 38,912 ** | 19,456 |
| "40MB" Winchester | 39,080 *** | 39,080 |

* Sector size is 128 bytes.
** Sector size is 512 bytes.
*** Sector size is 1024 bytes.
All other media have 256 byte sectors.

## Header Record

The header record contains disc dependent data. It is always the first logical disc record. The header record is structured as follows.

| ENTRY REFERS TO | DISC TYPE | | | | |
|---|---|---|---|---|---|
| | 3" & 5" single | 3" dbl. sided | RAM disc | HP 8" | IBM 8" |
| EBH, 1CH,90H (3 Bytes) | All discs contain this information | | | | |
| "HP150 " (8 Bytes) | All discs contain this information | | | | |
| bytes per sector (W) | 256 | 512 | 512 | 256 | 128 |
| sectors per cluster* (B) | 4 | 2 | 1 | 16 | 8 |
| reserved sectors (W) | 2 | 2 | 2 | 2 | 1 |
| number of FATs (B) | 2 | 2 | 1 | 1 | 2 |
| number of DIR entries (W) | 128 | 128 | 128 | 256 | 68 |
| total sectors (W) | 1,056 | 1,386 | ** | 4,500 | 2,002 |
| media type = FAH (B) | All discs use this value | | | | |
| sectors per FAT (W) | 3 | 3 | NA | 3 | 6 |
| sectors per track (W) | 16 | 9 | NA | 30 | 26 |
| number of heads (W) | 2 | 2 | NA | 2 | 1 |
| # of hidden sectors = 00H (W) | All discs use this value | | | | |

| ENTRY REFERS TO | DISC TYPE | | | | |
|---|---|---|---|---|---|
| | 5 MB | 10 MB | 15 MB | 20 MB | 40 MB |
| EBH, 1CH,90H (3 Bytes) | All discs contain this information | | | | |
| "HP150 " (8 Bytes) | All discs contain this information | | | | |
| bytes per sector (W) | 256 | 256 | 256 | 512 | 1,024 |
| sectors per cluster* (B) | 16 | 16 | 16 | 16 | 16 |
| reserved sectors (W) | 2 | 2 | 2 | 1 | 1 |
| number of FATs (B) | 2 | 2 | 2 | 2 | 2 |
| number of DIR entries (W) | 1,024 | 1,024 | 1,024 | 1,024 | 1,024 |
| total sectors (W) | 8,848 | 39,088 | 56,730 | 38,912 | 39,080 |
| media type = FAH (B) | All discs use this value | | | | |
| sectors per FAT (W) | 9 | 15 | 21 | 8 | 4 |
| sectors per track (W) | 31 | 28 | 31 | 32 | 8 |
| number of heads (W) | 4 | 2 | 6 | 4 | 5 |
| # of hidden sectors = 00H (W) | All discs use this value | | | | |

* Also referred to as an allocation unit.

# System Firmware

SECTION 6

This section addresses those aspects of the Touchscreen II firmware that differ from the standard 150 firmware. These differences generally involve enhancements.

CONTENTS

# SYSTEM FIRMWARE

The following enhancements were made with the following two firmware releases. The REV F firmware is needed for the Touchscreen II, but both the REV E and REV F versions can run on the HP 150. The "Identify ROMs" softkey label displays the following part numbers for the two revisions:

| REV E | REV F |
|---|---|
| 1818-3527 | 1818-3649 |
| 1818-3531 | 1818-3531 |
| 1818-3530 | 1818-3530 |
| 1818-3529 | 1818-3529 |
| 1818-3528 | 1818-3648 |

The above sets of firmware added these enhancements, as compared to the previous release of HP 150 firmware.

## Option Handler

There are 4 hardware options in the Touchscreen II compared to only 2 in the HP 150. In the HP 150 firmware, hardware options were assigned numbers 1 and 2 (whether there is hardware installed or not) and software options took numbers 3 through 8.

That scheme allowed up to 6 software options to co-exist in the system. If the same scheme were followed in the Touchscreen II, there would only be a maximum of 4 software options. To maximize the number of co-existent software options, a software option can now take the number of an empty hardware slot thus allowing upto 8 software options to be installed simultaneously in the Touchscreen II and the HP 150 with REV E or later version firmware.

The presence of a hardware option is determined by reading an ID byte at the starting address of the option slot. If the ID byte is 0FFH or the HARDWARE_DETECT bit (Bit 6) in the ID byte is HIGH, then that slot number can be assigned to a software option. Otherwise, that slot number is dedicated to the installed hardware option with the specified ID.

NOTE: Some hardware cards physically occupy a slot but do not take an option number. Their ID's are 0FFH and a software option can take their slot number. Examples of such cards are:

- Ventel Modem
- Memory card
- Extended I/O accessory card, etc.

Examples of software options:

- EtherLink/150
- Vt100 emulator, etc.

The slot addresses are decoded as follows:

| Slot No. | Touchscreen II | HP 150 |
|---|---|---|
| 1 | 90000H - 9FFFFH (64K) | 90000H - 93FFFH (64K) |
| 2 | A0000H - A3FFFH (16K) | A0000H - A3FFFH (16K) |
| 3 | A4000H - A7FFFH (16K) | Not available |
| 4 | A8000H - ABFFFH (16K) | Not available |

Due to the increase of option slots, "global config" was modified to include "ACCESSORY 3" and "ACCESSORY 4" in the Op Sys Dev field. If a language card that does not contain the above strings is installed, the firmware translates those strings to the selected language.

## Boot Unit Field In Global Config

A new "boot unit" field is added in the global config menu next to the Op Sys Dev field. The values in this field range from 0 to 3. This makes it easier to change units without having to change the "unit select" switches in the HP 9133/9122/9153 type drives. The user will be able to specify unit numbers for all HP-IB addresses and accessories. Refer to "AGIOS calls" section for information on how to access this from the BIOS.

## PC ID

Since the REV E and later versions of the firmware can also be used in the HP 150, there is a PC ID byte to identify whether the PC is the HP 150 or the Touchscreen II.

Refer to "AGIOS calls" section on how to access this byte.

## Reset Non-Volatile RAM To Default Values

With pre-REV E versions of the HP 150 firmware, if the user wants to go back to default config values, it is necessary to remove the battery pack and wait for upto an hour. With REV E and later versions, a key sequence of CTRL, LEFT SHIFT, RIGHT SHIFT and STOP can be pressed simultaneously to clear the CMOS RAM.

## French/Belgian/Italian Keyboard Shift Lock

With the French/Belgian/Italian keyboards, the CAPS key acts as shift lock key. All keys are shifted while with previous revisions of firmware only the number keys would be shifted. Exceptions to this shift-lock are the following keys:

Reset/Break
User/Menu
Tab
Del/Esc
Print/Enter

# Programming the Touchscreen II

SECTION 7

Changes to system level functions from the standard HP 150 affect only the Sample Keyboard Driver, which replaces that described in Section 7 of the *HP 150 Technical Reference Manual*.

CONTENTS

# PROGRAMMING THE TOUCHSCREEN II

## Sample Keyboard Handler

The following program demonstrates how one might use keycode mode. The main routine initializes the HP 150 by saving the state of RAW/COOKED and keycode modes prior to setting them on. It then loops printing keyboard statistics for each key pressed until the 'stop' key is encountered. The main routine will reset the HP 150 to its original mode of RAW/COOKED and keycode before exiting back to the shell.

```
        ; GENERAL EQUATES.

STDIN     =     0
STDOUT    =     1
STDERR    =     2
ISDEV     =     80H             ;DOS INT 21 FUNC 4400. DEVICE ATTRIBUTES
RAW       =     20H             ; "   "   "  "     "     "          "
SPECIAL   =     80H             ;SPECIAL KEY BIT IN QUALIFIER FLAG BYTE
GETKC_FC  =     44              ;AGIOS GET KEYCODE FUNCTION CODE.
SETKC_FC  =     43              ; "    SET    "       "       "
INTRCPT_FC=     40              ; "    INTERCEPT FUNCTION CODE.

DATA    SEGMENT PARA PUBLIC 'DATA'

KEYBUFF LABEL   BYTE            ;BUFFER FOR KEYBOARD INPUT.
FLAGS   DB      0               ; FOUR BYTES PER KEY.
ID      DB      0
KEYCODE DB      0
UNUSED  DB      0

GETKCPB DW      GETKC_FC        ;AGIOS PARAMETER BLOCK TO GET
        DW      KC_MODE         ; KEYCODE MODE SETTING.
GETKCDS DW      0

SETKCPB DW      SETKC_FC        ;AGIOS PARAMETER BLOCK TO SET
SETKCMD DB      1               ; KEYCODE MODE ON/OFF (CURRENTLY ON).

INTRCPT DW      INTRCPT_FC      ;AGIOS PARAMETER BLOCK TO SET
CHARACT DW      2               ; KEY INTERCEPT ON/OFF (CURRENTLY ON
KEYCOD  DW      0FEH            ;  FOR ALL KEYS).

CO_MODE DB      0               ;CONSOLE MODE RAW/COOKED.
KC_MODE DB      0               ;KEYCODE MODE ON/OFF.

ERRMSG  DB      'ERROR: stdin is a disk file.',0DH,0AH
ERRMSGL =       $ - ERRMSG
```

```
MSG     DB      'Keyboard data: FLAGS ['
O_FLAGS DB      0,0,'], ID ['
O_ID    DB      0,0,'], KEYCODE ['
O_KCODE DB      0,0,']',0DH,0AH
MSGL    =       $ - MSG

DATA    ENDS

STACK   SEGMENT STACK
        DB      40H DUP ('STACK.')
STACK   ENDS

CODE    SEGMENT PARA PUBLIC 'CODE'
        ASSUME  CS:CODE, DS:DATA, ES:DATA, SS:STACK

BEGIN   PROC    NEAR
        MOV     AX,DATA
        MOV     DS,AX
        MOV     ES,AX

        ; GET STDIN INFORMATION.

        MOV     AX,4400H
        MOV     BX,STDIN
        INT     21H
        MOV     CO_MODE,DL

        ; DO NOT ALLOW INDIRECTION.

        TEST    DL,ISDEV
        JNZ     STDINOK
        LEA     DX,ERRMSG
        MOV     CX,ERRMSGL
        MOV     BX,STDERR       ;STDOUT MAY BE REDIRECTED.
        MOV     AH,40H
        INT     21H
        MOV     AX,4C01H
        INT     21H

STDINOK:

        ; GET KEYCODE MODE AND SAVE IT FOR EXIT TIME.

        MOV     GETKCDS,DS
        LEA     DX,GETKCPB
        MOV     CX,6
        CALL    IOCTL

        ; MAKE SURE THAT THE CONSOLE IS IN RAW MODE.

        MOV     AX,4401H
        MOV     BX,STDIN
        MOV     DL,CO_MODE
        OR      DL,RAW
```

```
        XOR     DH,DH
        INT     21H

        ; SET INTERCEPT FOR ALL KEYS.

        LEA     DX,INTRCPT
        MOV     CX,6
        CALL    IOCTL

        ; SET KEYCODE MODE ON.

        LEA     DX,SETKCPB
        MOV     CX,3
        CALL    IOCTL

        ; READ KEYBOARD AND DISPLAY KEY INFORMATION.

AGAIN:
        MOV     AH,3FH
        MOV     BX,STDIN
        MOV     CX,4            ;EACH KEY IS 4 BYTES.
        LEA     DX,KEYBUFF
        INT     21H

        ; PUT THE INFORMATION IN A DISPLAYABLE FORMAT.

        LEA     DI,O_FLAGS
        MOV     AL,FLAGS
        CALL    B2HEX
        LEA     DI,O_ID
        MOV     AL,ID
        CALL    B2HEX
        LEA     DI,O_KCODE
        MOV     AL,KEYCODE
        CALL    B2HEX

        ; WRITE IT TO THE CONSOLE.

        MOV     AH,40H
        MOV     BX,STDOUT
        MOV     CX,MSGL
        LEA     DX,MSG
        INT     21H

        ; IF THE 'STOP' KEY WAS NOT PRESSED THEN DO ONE MORE KEY.

        CMP     KEYCODE,58H
        JNZ     AGAIN
        TEST    FLAGS,SPECIAL   ;WAS IT REALLY THE 'STOP' KEY.
        JZ      AGAIN           ;IT MUST HAVE BEEN THE 'X' KEY.

        ; RESTORE THE ENVIRONMENT.
        ; START BY RESTORING THE KEYCODE MODE.
```

```
        MOV     DL,KC_MODE
        MOV     SETKCMD,DL
        LEA     DX,SETKCPB
        MOV     CX,3
        CALL    IOCTL

        ; SET INTERCEPT OFF FOR ALL KEYS.

        MOV     CHARACT,0
        LEA     DX,INTRCPT
        MOV     CX,6
        CALL    IOCTL

        ; AND FINALLY PUT THE CONSOLE BACK IN ITS ORIGINAL MODE
        ; OF RAW/COOKED.

        MOV     AX,4401H
        MOV     BX,STDIN
        MOV     DL,CO_MODE
        XOR     DH,DH
        INT     21H

        MOV     AX,4C00H                ;EXIT TO THE SHELL.
        INT     21H
BEGIN   ENDP

        ; PERFORM CHARACTER IOCTL ON STDIN.

IOCTL   PROC    NEAR
        MOV     BX,STDIN
        MOV     AX,4403H
        INT     21H
        RET
IOCTL   ENDP

        ; CONVERT A BYTE TO HEXADECIMAL DISPLAY CODE.

B2HEX   PROC    NEAR
        MOV     AH,AL
        MOV     CL,4
        ROL     AL,CL
        CALL    N2HEX
        MOV     AL,AH
        CALL    N2HEX
        RET
B2HEX   ENDP

        ; CONVERT A NIBBLE TO HEXADECIMAL DISPLAY CODE.

N2HEX   PROC    NEAR
        AND     AL,0FH
        DAA
        ADD     AL,0F0H
        ADC     AL,040H
```

```
        STOSB
        RET
N2HEX   ENDP

CODE    ENDS
        END     BEGIN
```

## 640 By 400 Graphics Mode

This example turns on the 640 by 400 graphics mode and paints the screen white. It then draws alternating bars before returning to MS-DOS.

Some 4K of alpha variable table should be copied out of graphics memory (0C7000H to 0C7FFFH) if 640 by 400 mode is to be used. Before 640 by 400 is terminated, the alpha variable table must be copied back to addresses 0C7000H through 0C7FFFH. No alpha operations should be attempted when 640 by 400 is being used.

```
                                        /*AGIOS function codes for*/
char    homeup[]        ={ 0 x 10, 0, `H' }; /*cursor home up*/
char    clear[]         ={ 0 x 10, 0, `J' }; /*clear display*/
char    alphaoff[]      ={ 6, 4 };           /*alpha mode off*/
char    alphaon[]       ={ 4, 4 };           /*alpha mode on*/
char    graphicon[]     ={ 3, 4 };           /*graphics mode on*/
char    graphclr[]      ={ 1, 4 };           /*graphics display clear*/

char    buffer [0 x 1000];

int     i, j, k;


/****************/
/* main         */

main ()
{

        agios(&homeup,3);
        agios(&clear,3);
        agios(&alphaoff,2);
        agios(&graphicon,2);

        copy (0xc700,0x0,getds(),buffer); /*Save original data*/

        mode640(); /*Turn on 640 mode*/

        for (i=0x0; i<0x7ffe; i=i+2) copy1(i,0xffff); /*Paint screen white*/

/*Rough delay to view screen patterns*/

        for (i=0; i<20000; i++)
         {
              k = i + j;
```

```
            k = i - j;
            k = i * j;
        }
        for (i=0x0; i<0x7ffe; i=i+2) copy1(i,0x00ff); /*Paint screen with*/
                                                      /*alternating black*/
                                                      /*and white bars*/
        for (i=0; i<20000; i++)
        {
            k = i + j;
            k = i - j;
            k = i * j;
        }

        for (i=0x0; i<0x7ffe; i=i+2) copy1(i,0x0000); /*Paint screen black*/

        copy(getds(),buffer,0xc700,0x0); /*restore original data*/

        mode512(); /*Turn on 512 mode*/

        agios(&alpha on,2);
        agios(&graph clr,2);


}
;assembly routines called by the C program above

pgroup  group   prog
prog    segment byte public `PROG'
        assume  cs:pgroup

        public  copy,copy1,mode640,mode512
        public  agios,doscall,getds
;
;
;
;getds: gets a value for register DS
;
;
;

getds   proc    near
        mov     ax,ds
        ret
getds   endp


;
;
;
;AGIOS: performs AGIOS calls
;
;
;
```

```
agios           proc    near
                push    bp
                mov     bp,sp
                mov     dx,[bp+4]
                mov     cx,[bp+6]
                mov     bx,1
                mov     ax,4403h

                int     21h

                mov     ax,dx
                pop     bp
                ret
agios           endp



;
;
;
;copy1(offset,worddata): copy specified data to graphics area
;
;
;

copy1   proc    near
        push    bp
        mov     bp,sp

        mov     bx,[bp+4]
        mov     ax,[bp+6];      data

        push    ds
        mov     cx,0c000h; 0c0000H is start of graphics memory
        mov     ds,cx
        mov     [bx],ax
        pop     ds

        pop     bp
        ret
copy1   endp


;
;
;
;copy(fromseg,fromoff,toseg,tooffset): called to save or restore
;                                      original data
;
;
;

copy    proc    near
        push    bp
        mov     bp,sp
```

```
        push    ds
        push    es

        mov     di,[bp+10];     to offset
        mov     es,[bp+8];      to segment
        mov     si,[bp+6];      from offset
        mov     ds,[bp+4];      from segment

        mov     cx,1000h;       4K bytes to be copied
        cld
        rep     movsb   ;       move the data

        pop     es
        pop     ds
        pop     bp
        ret
copy    endp

;
;
;
;mode640
;writes 0 to mode register in video chip
;
;

mode640 proc    near
        push    ds
        mov     ax,0d300h
        mov     ds,ax
        mov     bx,03fh
        xor     ax,ax
        mov     [bx],ah
        pop     ds
        ret
mode640 endp



;
;
;
;mode512
;writes 0FFH to mode register in video chip
;
;

mode512 proc    near
        push    ds
        mov     ax,0d300h
        mov     ds,ax
        mov     bx,03fh
        mov     ah,0ffh
        mov     [bx],ah
```

```
        pop     ds
        ret
mode512 endp


PROG            ends
        end
```

## CHANGES TO SECTION 7

The following changes should be incorporated into Section 7 of the *HP 150 Technical Reference Manual*.

| Change | Description |
|---|---|
| 1 | Page 7-3. Replace *"ASSUME DS:GROUP"* with *"ASSUME DGROUP"* |
| 2 | Page 7-16. Add *"PUSH DS;save caller's DS"* immediately after *"PROC NEAR"* |
| 3 | Page 7-16. Delete *"MOV DX,0"* and *"PUSH DX"* just before *"CALL yield"* |
| 4 | Page 7-16. Add *"POP DS"* and *"RET"* directly after *"CALL yield"* |
| 5 | Page 7-16. Bottom of page, add *"(page 7-28)"* to the comment *"The yield routine is described elshwhere"* |
| 6 | Page 7-17. Add *"PUSH DS;save caller's DS"* immediately after *"PROC NEAR"* |
| 7 | Page 7-17. Delete *"MOV DX,0"* and *"PUSH DX"* just before *"CALL yield"* |
| 8 | Page 7-17. Add *"POP DS"* and *"RET"* directly after *"CALL yield"* |
| 9 | Page 7-17. Bottom of page, add *"(page 7-28)"* to the comment *"The yield routine is described elshwhere"* |
| 10 | Page 7-34, last paragraph, second sentence. Change "Port1" and "Port2" to "Port2 and "Port1", respectively. |

11 Page 7-53, paragraph "MS-DOS IOCTRL FUNCTION CALL". Change *"DX,DX"* to *"DS,DX"*

12 Page 7-58. Add *"char tab_init();"* to the bottom of the page.

13 Page 7-61. In the first part, change *"x, y, status;"* to *"x, y, status);"*

14 Page 7-61. In the second part, add a *"{"* (left brace) to the end of *" if (buf[0] != `9' "*. When completed, it should read *"if (buf[0] != `9') {"*

15 Page 7-62. In the second part, fourth line, change *"System Function Call /*"* to *"System Function Call */"*

16 Page 7-64. Above *"PUBLIC data_seg"*, add *"Prog Segment Public `prog'"* and *"Assume cs: prog"*

17 Page 7-64. At the end of the program, add *"End"*

18 Page 7-65. Immediately following the title of the first paragraph, add the following note: "Refer to the firmware portion of the *HP 150 Technical Reference Manual Supplement* for more information.

# Agios Function Call Reference

SECTION 8

This sections covers only the Touchscreen II unique changes to the standard HP 150 Alpha Graphics Input/Output System (AGIOS). For additional information, refer to Section 8 of the *HP 150 Technical Reference Manual*.

CONTENTS

# AGIOS FUNCTION CALL REFERENCE

## Read Terminal Configuration

This function reads the current terminal configurations.

(0,24) Function Code.

((BUFFER)) A word pointer to the buffer where the current configuration is returned.

When this function is complete, BUFFER contains:

(,IIIRRPST) III = Hardware ID, *
0 = HP 150 (9 inch screen)
1 = HP 150 II (12 inch screen)
2 - 7 are reserved
R = reserved bits,
P = set if remote port 2,
S = set if softkeys on,
T = set if touchscreen off.

(KEYBOARD LANGUAGE)

| Code | Country | Global Configuration |
|---|---|---|
| 0 | United States | USASCII |
| 1 | Sweden | SVENSK |
| 2 | Finland | SUOMI |
| 3 | Denmark | DANSK |
| 4 | Norway | NORSK |
| 5 | Germany | DEUTSCH |
| 6 | Great Britain | UK |
| 7 | Spain | ESPANOL EUR. |
| 8 | Latin America | ESPANOL LAT. |
| 9 | Netherlands | NEDERLANDS |
| 10 | Switzerland - German | SCHWEIZTASTE |
| 11 | Switzerland - French | SUISSE ROMAN |
| 12 | Canada - French | CANADIEN |
| 13 | France | FRANCAIS |
| 14 | Italy | ITALIANA |
| 15 | Belgium - Flemish | VLAAMS |

(STRING LANGUAGE)

(OP SYS DEVICE) Bits 0- 2: HP-IB address (0-7),
Accessory slot (0 - 3).
Bits 3- 5: Device 0 = HP-IB,
1 = Accessory.
Bits 6- 7: Unit code (0 - 3). **
Bits 8-15: Reserved

* Value will always be 0 for HP BIOS verisons A and B.

** Value will always be 0 for firmware datecodes 2333, 2343 and 2419.

## Get AGIOS Entry Point Address

This function gets the AGIOS function processor entry point address (not available in HP BIOS version A).

(0,25) Function Code.

((BUFFER)) A pointer to the 4 byte buffer where the offset followed by the segment of the entry address of the AGIOS function processor is stored.

By calling this entry point directly, a programmer can bypass the overhead of the MS-DOS console driver. The parameter buffer address is passed DS:DX and the corresponding length in CX. Registers AX and BX are not used.

Registers AX, BX, CX, DX, SI, DI and BP are NOT preserved for the caller when invoking the AGIOS function processor directly. This is different from using the IO Control Write to the console through MS-DOS to access the AGIOS functions.

## Terminal Mode

This function causes the HP 150 to enter Terminal Mode and return to the application in Computer Mode only when the user presses SHIFT STOP (not available in HP BIOS version A).

(0,26) Function Code.

## Read Console Keycode

This function performs a single keystroke console input and returns the keycode and qualifier, whether keycode mode is on or off (not available in HP BIOS version A).

(0,46) Function Code.

((BUFFER)) A pointer to the 4 byte buffer where the qualifier and keycode are stored.

When this function is complete, BUFFER contains:

(QUALIFIER)

| Bits | Meaning |
|---|---|
| 15-8 | Input Device ID:<br>0C0H = keyboard,<br>080H = touchscreen,<br>000H = terminal internal. |
| 7 | Special key. If set,the data is a non-ASCII Keycode. |
| 6 | Reserved. |
| 5 | Left extend char - set when down. |
| 4 | Right extend char - set when down. |
| 3 | Control - set when down. |
| 2 | Left shift - set when down. |
| 1 | Right shift - set when down. |
| 0 | Repeating key when set. |

(KEYCODE) ASCII character code when Qualifier bit 7 is clear or keycode when Qualifier bit 7 is set.

# LOGIC DIAGRAMS

APPENDIX

A

Schematic diagrams for the HP Touchscreen II are provided in this appendix.

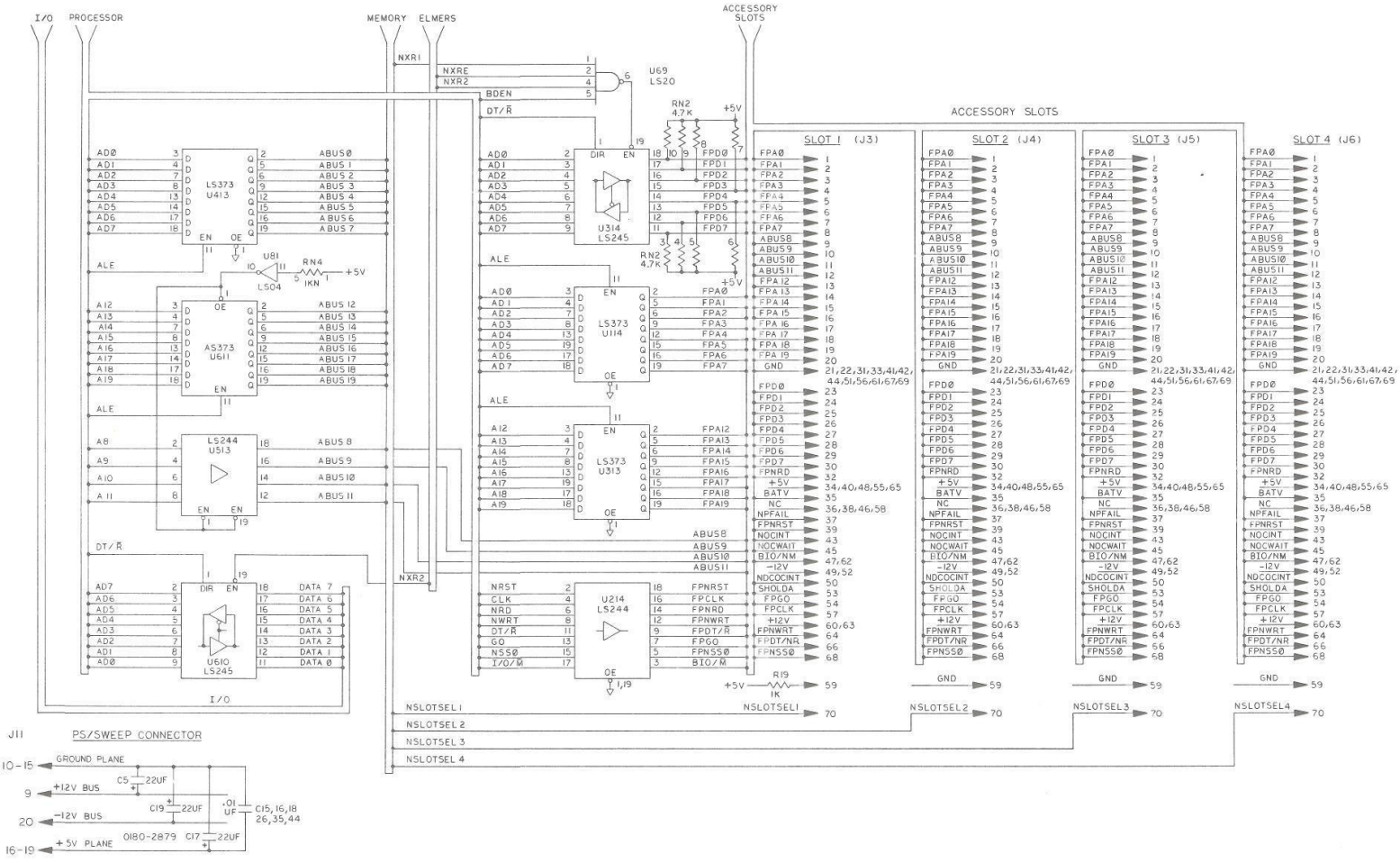



Figure A-1. Processor Subsystem (Sheet 1 of 2)

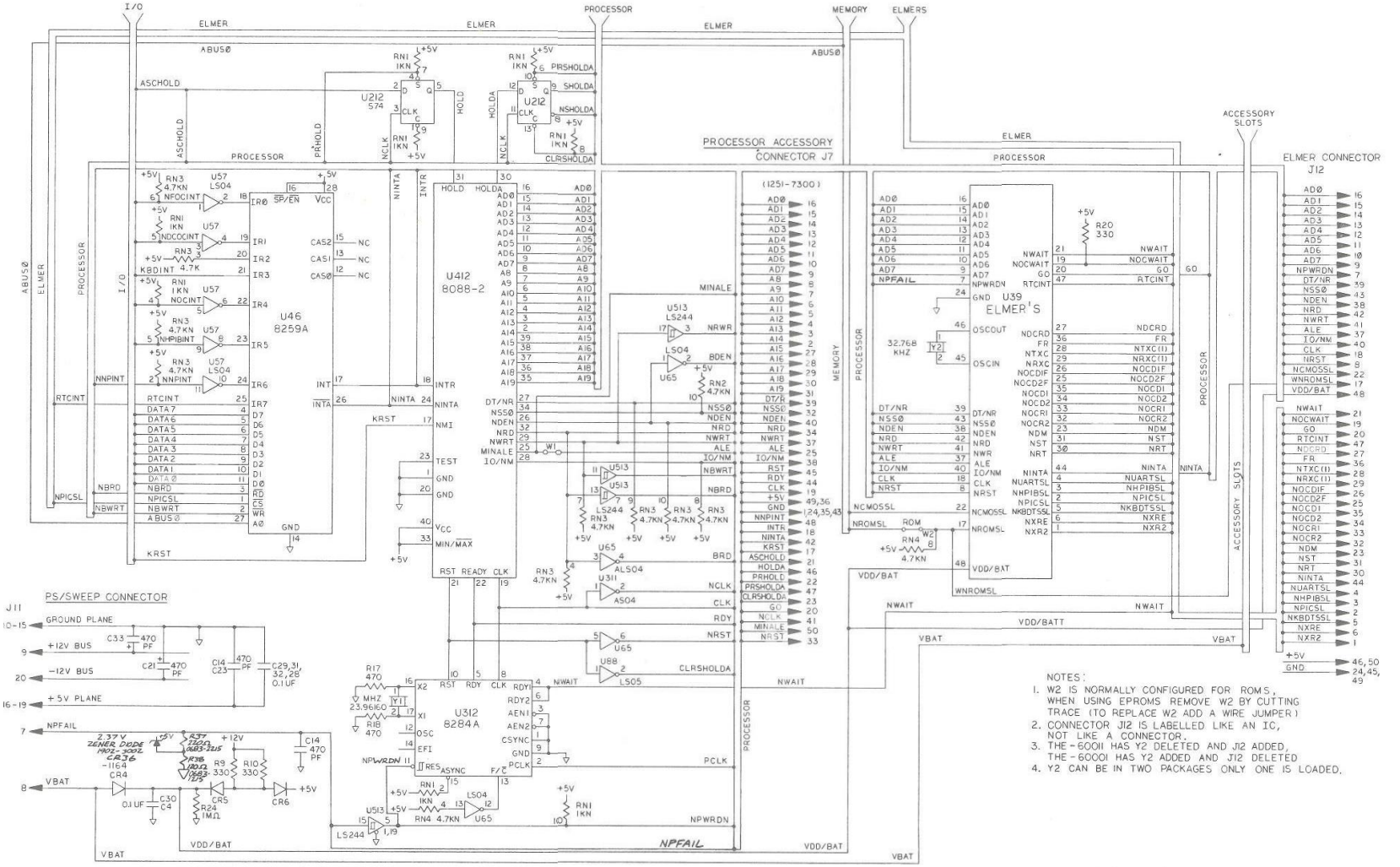



Figure A-1. Processor Subsystem (Sheet 2 of 2)

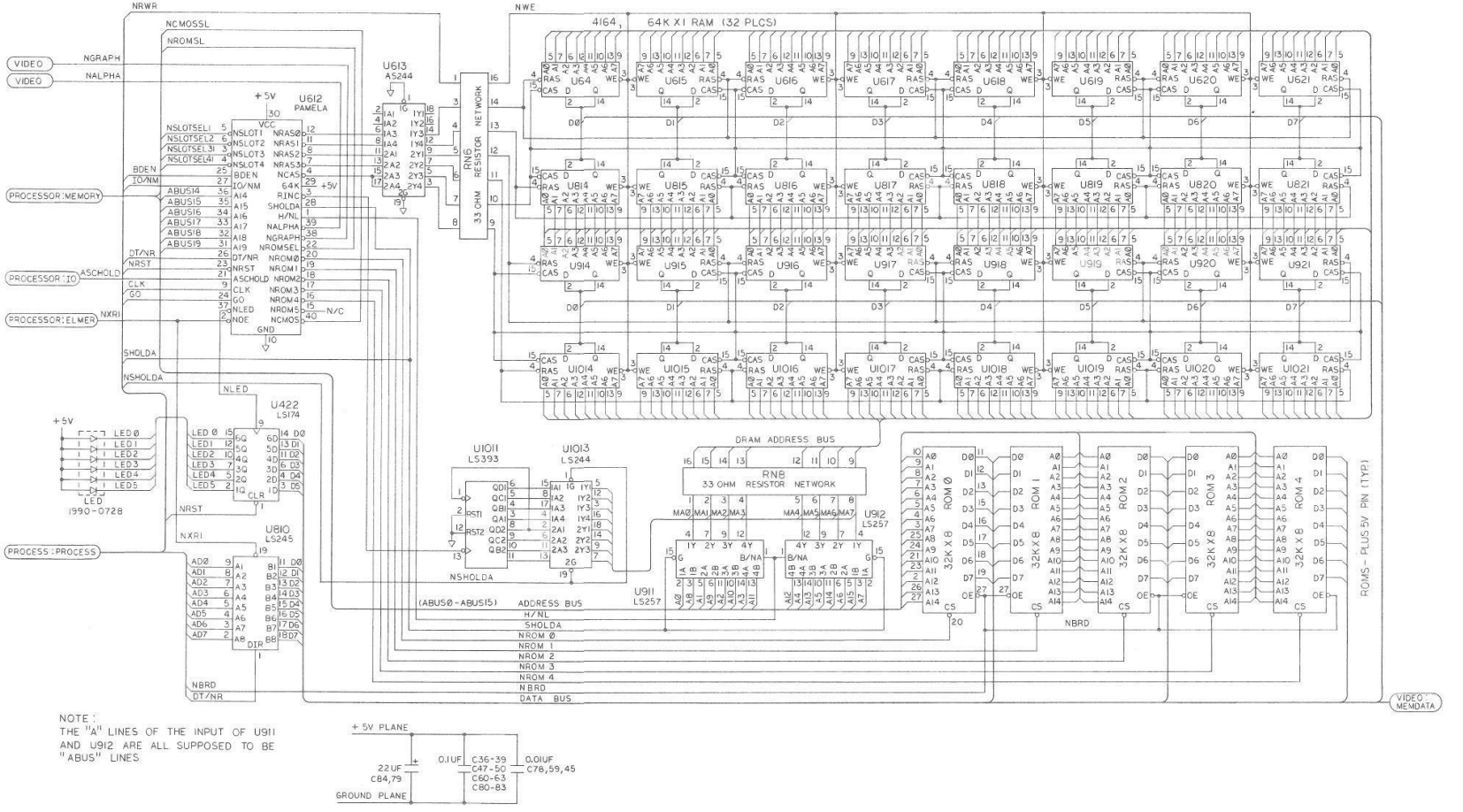



Figure A-2. Memory Subsystem

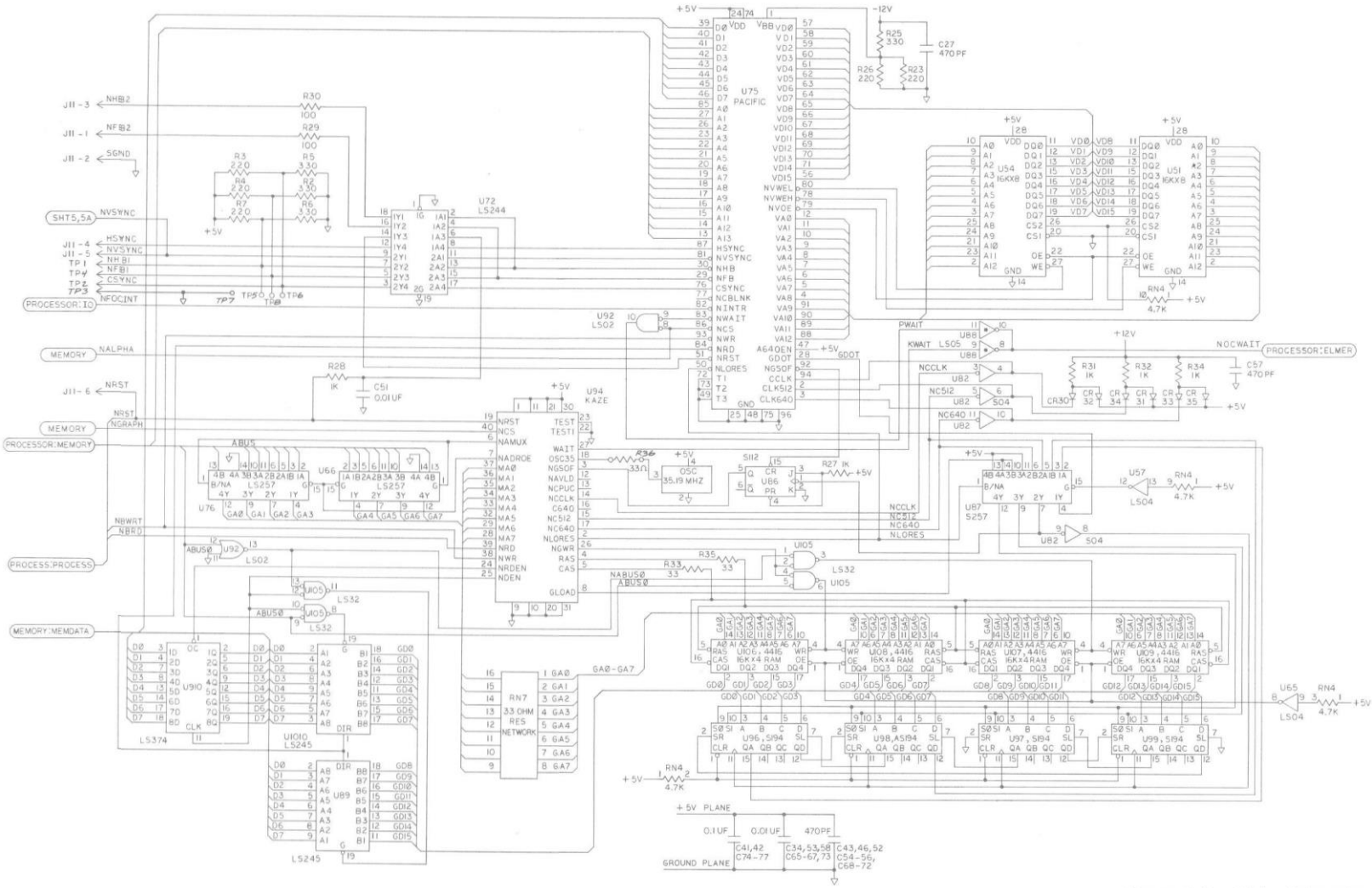



Figure A-3. Video Subsystem

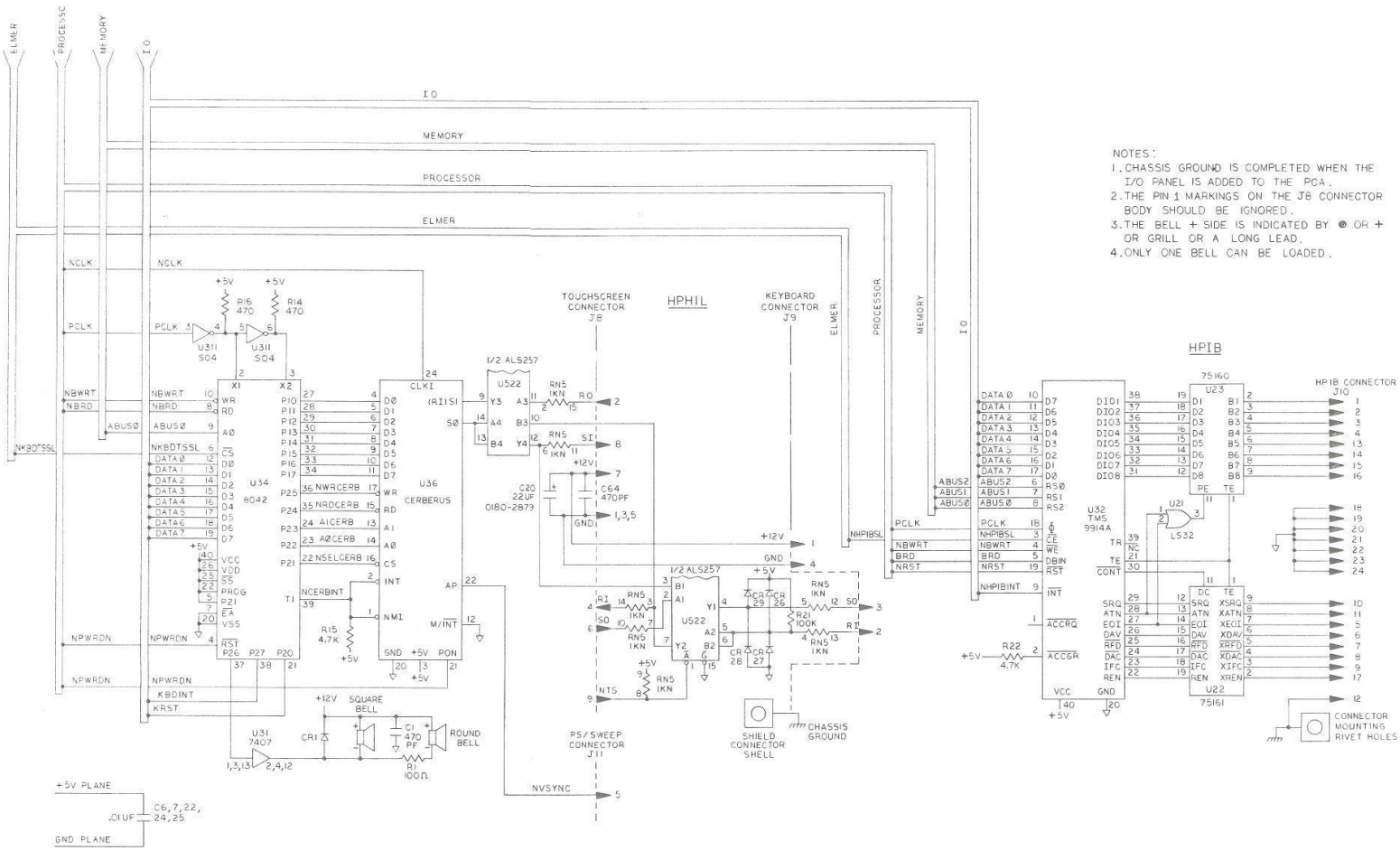



Figure A-4. HP-HIL/HP-IB Processor Subsystem

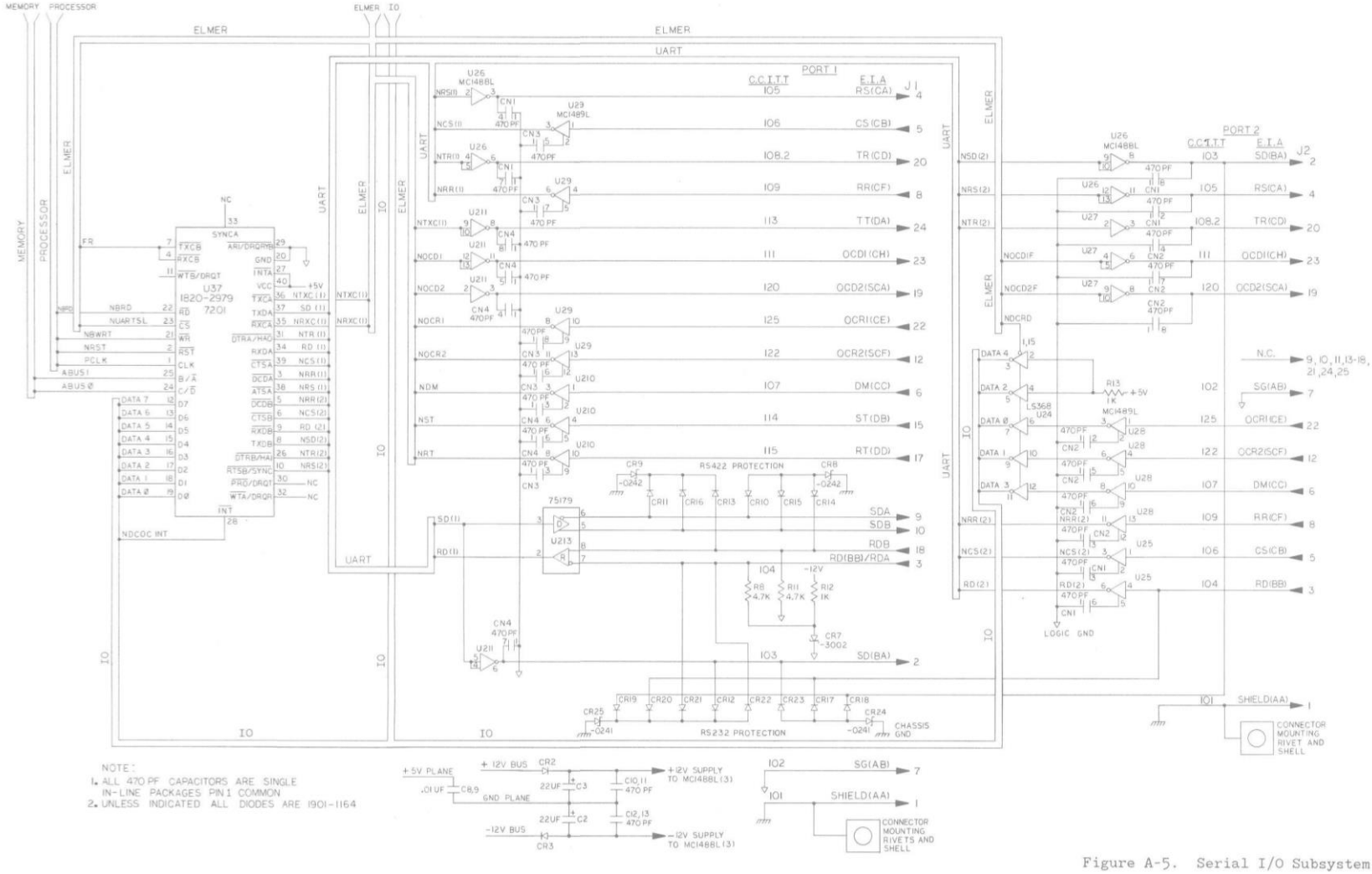



Figure A-5. Serial I/O Subsystem

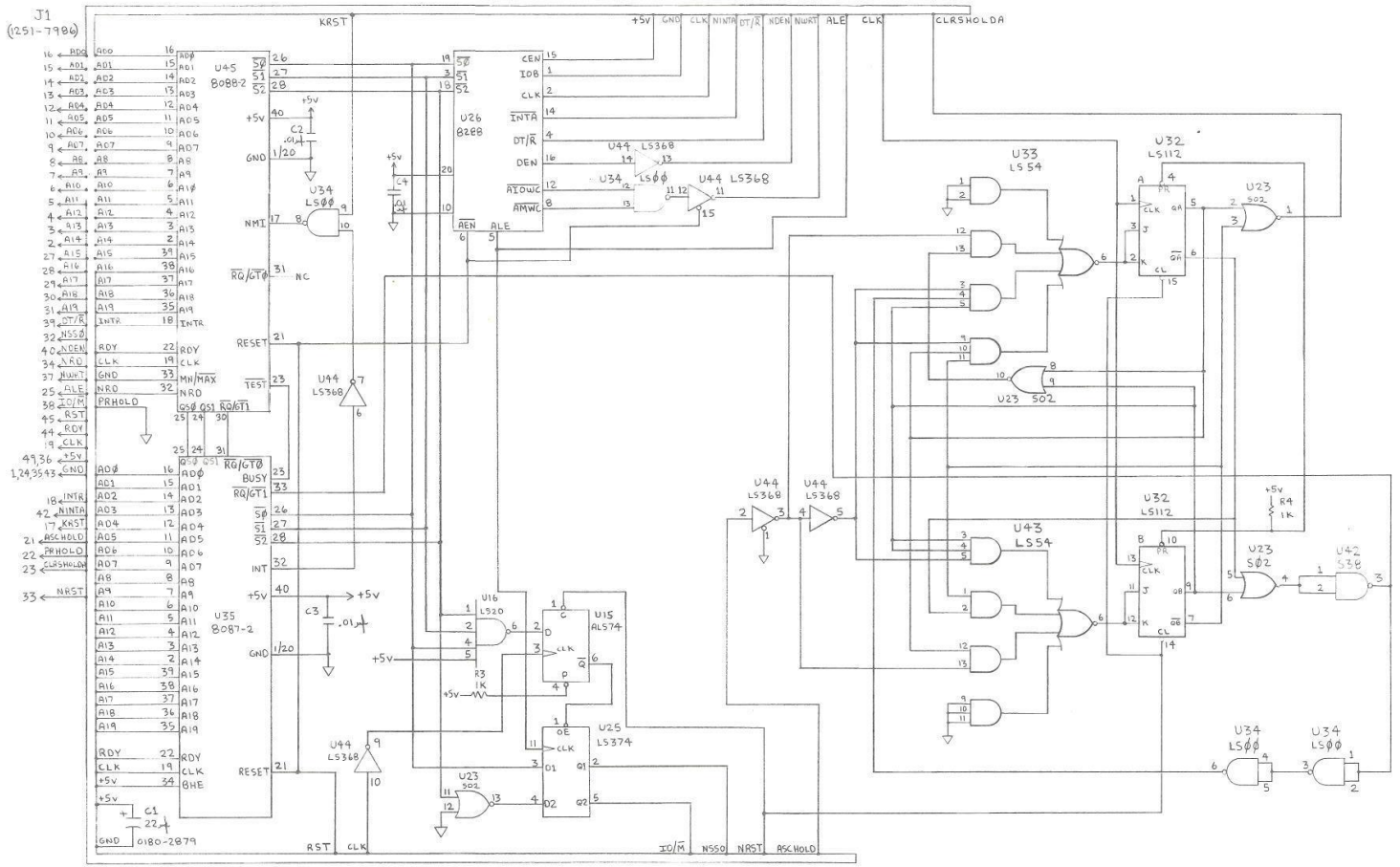



Figure A-6. Touchscreen II's Coprocessor

# INDEX

## A



## B



## C

## D



## E



## F

## G



## H



## I



## K



## L

## M



## N



## O



## P

## R



## S



## T

## U



## V



## W

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45625-90002 November 1985

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