MICROCOMPUTER DEVELOPMENT PRODUCTS

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8049	***6803***	***Z8001***
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8039	***6809***	***TMS9900***
8021	***6809E***	***SBP9900***
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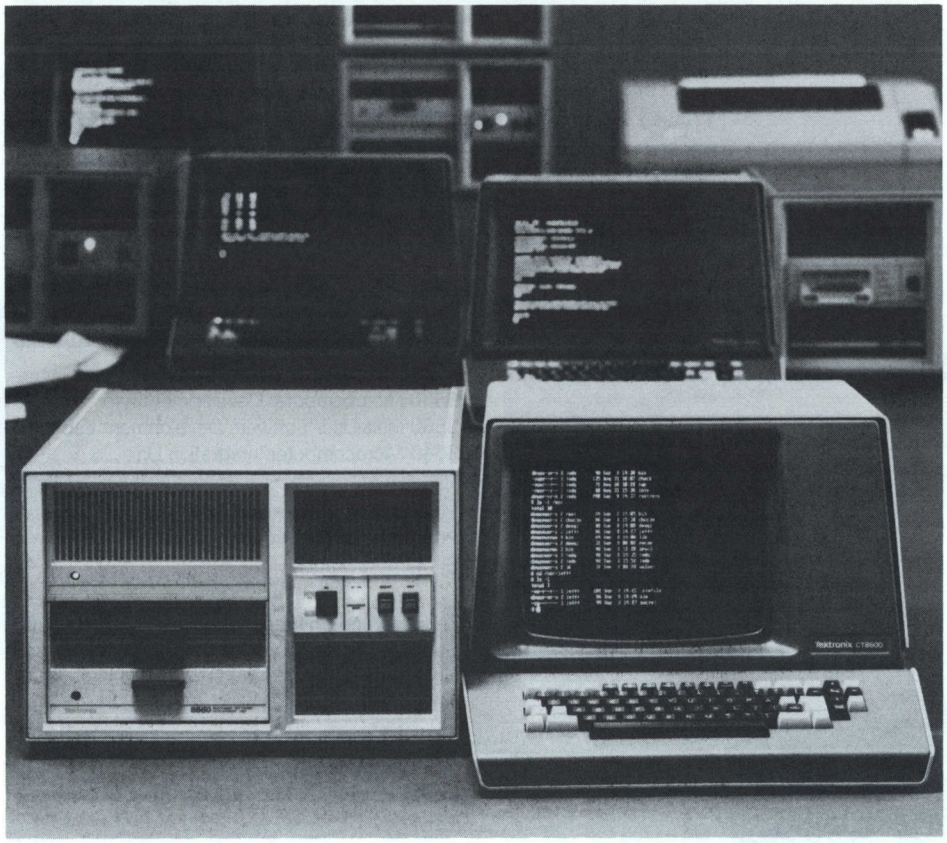
Tektronix Microcomputer Development Products offer the broadest range of quality multiple microprocessor support available today. Tektronix won't lock you into one microprocessor family or vendor. Plus, every Tektronix MDL is backed with over 30 years of design experience. We test our Development Labs thoroughly to ensure performance and reliability. Each one provides complete development capability and the Tektronix commitment that guarantees you'll keep abreast of the fast paced microprocessor technology.

Call your local specialist today to find out more about the Tektronix 8550 MDL Systems.



Three Basic Design Environments

Microcomputer design is currently performed in three basic work environments. These are the single-user environment, the multi-user environment, and the host computer environment. The Tektronix 8500 Series of Microcomputer Development Labs offer a full complement of development tools for all three microcomputer design environments. In each case, the most advanced technology available has been incorporated into an 8500 Series Microcomputer Development Lab that gives maximum performance in its intended setting. In this manner, Tektronix provides unmatched support for both microcomputer software development and hardware/software integration, no matter where it occurs.

The 8550 Microcomputer Development Lab for the Single User Environment

The 8550 is a self-contained Microcomputer Development Lab that gives complete support to one user at a time. Important features of the 8550 Microcomputer Development Lab include: Guide, an optionally-invoked, menu-driven approach to system operation; high level language and assembly support with symbolic debugging for both 8-bit and 16-bit chips; emulation to install developed software in prototype hardware; and the powerful real-time debugging tool: the Trigger Trace Analyzer for 8-bit and 16-bit designs.

The 8560 Multi-User Software Development Unit for the Multi-User Environment

The 8560 is a full microcomputer software development lab that supports up to eight separate work stations. Multi-user support is accomplished using the 8560's powerful TNIX* operating system, tailored specifically for team-oriented microcomputer development work. TNIX includes a fast, flexible filing system for effective data base management, advanced command capability for streamlining software development tasks, and several optional utility packages such as text processing. The 8560 uses a 16-bit CPU to control system resources. Software work stations consist of CRT terminals and the 8540 Integration Unit which has full emulation and debugging capability. Or, the 8550 can be used for hardware/software integration.

The 8540 Integration Unit for the Host Computer Environment

In the host computer environment, a general purpose computer is used to support microcomputer-based design projects. The host computer's timesharing capability allows a number of designers at CRT terminals to simultaneously use the computer's facilities. Each designer has access to microcomputer development tools such as editors, assemblers, and compilers. The 8540 Integration Unit extends the host computer's microcomputer development support to include the task of hardware/software integration. While the 8560 or other host computer supports the software development task, the 8540 is used to integrate, test and debug the prototype hardware. The 8540 uses real-time emulation, a fast and efficient integration technique that employs an emulator processor identical in function to the one targeted for the prototype. For added real-time debugging, a 62-channel Trigger Trace Analyzer is available as an option.

TNIX is a trademark of Tektronix. TNIX is a derivation of Bell Lab's UNIX Operating System Version 7.

8550 Microcomputer Development Lab

The 8550 is a completely self-contained microcomputer development system that gives full support to both software development and hardware/software integration. For software development, the 8550 provides a wide range of sophisticated tools for fast, effective code generation. These include many 8-bit and 16-bit assemblers that support symbolic debugging, produce relocatable code and have powerful macro capabilities. High-level language support includes both Pascal, Microcomputer Development Lab/μ compilers, and an enhanced form of BASIC with many microcomputer-oriented extensions. A line-oriented editor is included and an optional Advanced CRT-Oriented Editor.

The 8550 provides features carefully designed to save you time while increasing your efficiency. One feature reduces the time lost by new users as they learn to operate the system. To bring new users quickly up to speed, the 8550 includes a special menu-driven program called Guide, which offers a friendly interface for the beginner, but does not hinder the advanced user. Guide employs a series of menus that shows the user a well-documented pathway through system operations. At any time, the user can escape Guide and return to the conventional command format. In this way, the new users benefit, but not at the expense of the advanced user.

When you're experienced enough to move beyond Guide, you'll find a whole set of advanced features at your command. You'll be able to build special command files that are invoked through a few simple keystrokes to automatically execute system routines. The system will be working for you instead of you working for the system.

Program Development and Data File Management

The 8550's DOS/50 operating system helps the designer manage all phases of program development and debugging. DOS/50 supervises general I/O, file creation and maintenance, program assembly and compilation, program execution, monitoring and debugging.

8550

Multiple Microprocessor Support

In-Circuit Emulation

Real-Time Prototype Analysis

Assembly and HLL Support

The 8550's assembler packages provide full code-development support for a wide range of 8-bit and 16-bit chips. Powerful macros allow the designer to access frequently used sets of code by name reference. The linker, working with the relocating features of the assembler, links and locates multiple-code segments into a complete executable program. Additionally, a conditional assembly feature allows the designer to customize the final program by testing conditions to determine which of certain code segments are to be assembled into the final program. Extensive English language diagnostics provide easy-to-understand error messages and locate the line in which the error has occurred. When assembly is completed, the assembled code is stored on disk in a binary format file.

For selected chips, high level language support is available to increase your development power. One language offered is Microcomputer Development Lab/μ, a BASIC-like language created specifically for microcomputer design. Another is Pascal, with its structured approach that readily adapts to microcomputer software development. For both languages, Tektronix has added a full complement of extensions that allow code manipulation at the microprocessor level, including access to microprocessor interrupt vectors, individual memory locations and I/O ports.

All software tools and files are managed by a highly flexible filing system that allows nesting to any level a project requires. Included are a linker and library generator to assist in modular code development. The 8550's two 1 megabyte floppy disks provide more than adequate mass storage.

Line Printer Spooling Keeps the System Constantly Accessible

One drawback of many development systems is that the system is not available to you when the printer is outputting a program listing. The system CPU directs all its attention to the operation and cannot service other system operation. Since program printouts may be frequently required, this can mean a considerable loss in productivity.

The 8550 solves the problem through line printer spooling, which keeps your CRT fully operational even while printing is in progress. You have unhindered access to the system, resulting in a significant productivity increase.

Time-Saving Debugging Tools

The 8550 gives you Real Emulation for each of its modular emulator processors. This means that the emulator processor is truly identical in function to the processor targeted for your prototype. With no restrictions on interrupts, no reserved code space and no hidden hardware requirements. It also means true real-time emulation up to the processor's full specified operating speed. No need for stretched clock pulses or added wait states that cause hidden timing bugs in your final product.

For 16-bit and 8-bit designs, the Trigger Trace Analyzer uses a high speed trace buffer capable of working with bus cycle speeds up to 8 MHz. The buffer is 62 bits wide to capture 16 data bits, 24 address bits, 14 emulator-dependent bits, and 8-bits from external hardware. Up to four independent triggers can be combined in both logical and sequential combinations to form a breakpoint or data storage trigger. The individual triggers themselves can be defined from a combination of bus data, pass delay counters, and an external qualifier. Each trigger can also initiate its own external output to trigger other instruments such as oscilloscopes and logic analyzers.

The Trigger Trace Analyzer offers a powerful and diverse set of debugging operations. For instance, the real-time length of an interrupt service routine can be measured while simultaneously counting the number of assertions from a second interrupt source. Or, the maximum depth of a stack-during-program execution can be determined. To optimize code performance, the read or writes within any given address range can be isolated and counted, thus identifying heavily used areas for code optimization.

Real Time Emulation — Three Emulation Modes

After an error-free assembly listing has been obtained, the resulting object code may be executed in system emulation Mode 0 on the optional emulator processor. The emulator processor is identical in function to the microprocessor that will finally be installed in the user's prototype. Execution is performed under control of the debug system; during execution, program steps can be traced, software breakpoints can be set, and memory can be examined and changed as required. Should an error be discovered, that portion of the program can be corrected at the source level using the text editor. It then can be reassembled and executed again. This procedure continues until the program is correct.

After the software has been debugged, it may be exercised on the prototype circuitry in the partial emulation mode (Mode 1). During partial emulation, control may be released from the 8550 to the prototype in stages. The development software runs using 8550 memory space and prototype I/O and clock. The 8550 memory mapping feature allows code to be gradually mapped over to the prototype's memory in manageable blocks. Throughout partial emulation, the user has access to prototype circuitry through the debugging system. This allows the user to trace, set beakpoints, examine and change memory and register contents.

In full emulation (Mode 2), the program is run on the prototype, but program execution is still under the complete control of the debug system. All I/O and timing functions are directed to the prototype; all memory has been mapped over to the prototype; and only the prototype control probe is still in place, emulating the target microprocessor. Although the prototype is effectively free-standing, the user may still direct program activity from the 8550.

Transform the 8550 into a general purpose computer

Often, you will have professional and personal pursuits besides microcomputer design that lend themselves to computerization. So Tek has made it easy to transform the 8550 into the realm of general purpose computing.

It's done through an operating system package called RT-11/50, which Tek offers as an 8550 option. RT-11/50 opens the door to a wide range of third party applications software. And with it, the 8550 can quickly become a project management computer, an engineering computer, a personal computer or a small business bookkeeper. Many other useful, cost-effective applications are possible with the addition of RT-11/50.

8550 CHARACTERISTICS

The 8550 consists of an 8301 Microprocessor Development Unit and an 8501 Data Management Unit.

8301 MICROPROCESSOR DEVELOPMENT UNIT

Dimensions	mm	in
Width	430	17.0
Height	280	11.0
Depth	585	23.0
Weight	**kg**	**lb**
Net	27.0	60.0

ENVIRONMENTAL CHARACTERISTICS

Operating Temperature — +32°F to +122°F (0°C to +50°C).

Humidity — 90% at +86°F to +140°F (+30°C to +60°C).

Altitude — Operating: 0 to 4500 m (15,000 ft). Storage: 0 to 15 000 m (50,000 ft).

AC POWER

Line Voltage Ranges — 115 V ac (90 V ac to 132 V ac); 230 V ac (180 V ac to 250 V).

Line Freqency Range — 48 to 66 Hz.

8501 DATA MANAGEMENT UNIT

Dimensions	mm	in
Width	424	16.8
Height	267	10.5
Length	597	23.5
Weight	**kg**	**lb**
Net	25.0	55.0

ENVIRONMENTAL CHARACTERISTICS

Operating Temperature — +50°F to +104°F (+10°C to +40°C)

Humidity — 20% to 80% relative noncondensing

Altitude — Operating: 0 to 2500 m (8,000 ft) Derate maximum operating temperature by +1°C for each 300 m above 2400 m. Storage: 0 to 15 000 m (50,000 ft).

AC POWER

Line Voltage Ranges — 115 V ac (90 to 127 V RMS); 230 V ac (180 to 250 V RMS).

Line Frequency Range — 50 Hz ±1% or 60 Hz ±1%.

Overload Protection — Automatic current limit foldback.

FLEX DISK CHARACTERISTICS

Encoding — IBM compatible single or double density. Format must qualify as follows: MFM sectors = 256 bytes. FM sectors = 128 bytes.

Diskette Type — Single or double sided, soft sectored.

Capacity — Double sided, double density: 1,021,696 bytes. Single sided, double density: 509,184 bytes. Single sided, single density: 256,256 bytes.

Order 8550 Microcomputer Development Unit **$17,000**

8560

256 kb Memory Expandable to 1 Mb

Multi-Chip Design Support for up to 8 Users

TNIX Operating System

The Tektronix 8560 is a multi-user software development system. When used in conjunction with an 8540 Integration Unit, the 8560 provides facilities to support the entire microcomputer design process from software development through hardware/software integration. At the same time, it allows maximum design flexibility by supporting a broad range of 8-bit and 16-bit chips. The 8560's multiuser capability offers numerous advantages to the design team, such as lower cost per user, shared software and hardware resources, unified project management and enhanced security.

The heart of the 8560 is a minicomputer executing the TNIX* operating system. The CPU is a DEC** PDP-11/23 that operates in conjunction with two I/O processors for high performance throughput. A separate board is included to control two spooling line printers. System memory is 256 kilobytes (expandable to 1 megabyte), and mass storage includes a 1 megabyte floppy disk (formatted) and a 35.6 megabyte Winchester hard disk. The I/O processors support baud rates up to 9600 bps, providing wide flexibility when interfacing with various terminals.

Software work stations each consist of a standard CRT terminal, with the Tektronix CT8500 being recommended. In this manner, the system's software development capability can be expanded by simply adding terminals. Possible integration stations include a Tektronix 8540 Integration Unit, which has built-in, high-speed serial communications with the 8560, or an 8550 Microcomputer Development Lab.

*A trademark of Tektronix.
** Digital Equipment Corporation

For added flexibility, the 8560 can be configured with 8540's and 8550's in several different communications modes. The 8540 can be connected in-line with a terminal to a single 8560 port, or without a terminal to a separate port. In either configuration, a user can control any 8540 in the system including several units at the same time. In addition, it is possible to use many of the 8560's powerful command resources when debugging with the 8540. This includes the ability to use the 8560's hardware and software for I/O simulation in the early stages of debugging.

The 8560 will support up to two line printers, with the Tektronix 4643 being recommended. The line printers operate in the spooling mode, so users' terminals are still operable while printing.

TNIX Operating System

Running under the TNIX operating system, the 8560 can include a wide variety of software design tools offered by Tektronix. These include macro assemblers and compilers for both 8-bit and 16-bit chips; linkers/loaders to combine object files into executable object code; and several types of editors including an advanced screen-oriented version. Also there is a text processing package that can be a valuable aid to software documentation, and a number of utility packages to expand system capabilities in various ways.

The 8560's TNIX operating system was derived directly from Bell Laboratories' UNIX Operating System; an operating system that has gained widespread acceptance throughout the computer world. TNIX takes all the proven advantages of UNIX and applies them directly to the specific tasks required during microcomputer design.

TNIX includes a hierarchical file management system that greatly enhances the ease and speed of file operations. It is organized with a "root" directory on top and descending levels of subdirectories underneath. Each level may contain either files or directories that point to more files on a lower level.

TNIX also provides a sophisticated system of read/write protection that guards user material but retains the interfile access needed to enhance productivity. Each user can specify read, write, or execute protection on any of three levels: a user, a group of users, or all users. In this way files can first be completely protected while under initial development, then released to those working on related sections of the program, and finally released to the entire project after debugging is completed. To enhance communication between users, TNIX includes a system of electronic mail that lets team members send messages to one another. It also allows direct communication between two users at separate terminals, plus the ability to broadcast a single message to all terminals. These various communications modes can be a valuable asset to both team members and team management.

Powerful Command Structures Simplify Software Development and Integration

TNIX uses an extremely flexible command structure, one that permits effective programming at the expert level as well as the beginner level. In all cases, TNIX commands let the user concentrate on software design instead of system manipulation. One simple but very powerful TNIX command operation is pipelining. It permits the output of one command to act as the input to another. At an even higher level of refinement, TNIX permits the construction of intelligent command files that perform varying functions depending on the number or value of parameters being passed.

Other TNIX command features include keyboard read-ahead which lets the user type in commands as fast as possible, without waiting for previous commands to finish. Another time saver is multitasking, which lets the user concurrently run several jobs that may be at different levels of priority. For instance, a compilation could be detached and run in the background while the user started to edit a new source file. This feature saves time while making more intelligent use of the system's resources.

To minimize system learning time, TNIX includes a special user interface called GUIDE, that combines the best features of both menu-driven and command-driven systems. GUIDE lets the user select any system operation from a menu display, and then automatically performs the operation. At any time, the user can exit from GUIDE and escape back to TNIX and its direct entry command format. This way, the user can employ the menu as a learning tool, but is able to depart to the regular TNIX command format for more sophisticated operation.

Automatic Module Combination Cuts Complexity

During debugging, software modules that exhibit defects must have corrections entered into their original source code files. Before debugging can resume, all files affected by the changed source modules must be recompiled or reassembled into new, updated object code modules. Otherwise, new and old versions of the interdependent object modules will be mixed.

TNIX includes a special feature called "Make" that uses a control file to oversee the modular combination process and ensure that all modules are the most recent version when combined for execution. "Make" can cut recompiling or reassembling time to an absolute minimum by performing these operations only on files that actually require it.

Advanced Software Development Tools

The 8560 Microcomputer Development Lab system offers a large selection of software development tools that can be run under TNIX. These include a variety of 8-bit and 16-bit assemblers with features such as macro capability, conditional assembly, and relocatable code. Also 16-bit compilers with features like structured constants, bit manipulation, and re-entrant code.

Other specialized tools include a loader/linker and a library generator. Also two types of editors, including an Advanced CRT-Oriented Editor that allows fast, efficient text manipulation at both the line and character level.

In addition, there are a number of 8560 system utility packages available that offer advanced support to microcomputer design projects. Among these are a text processing package that can be a valuable aid when documenting software, and a native programming package for developing your own 8560 software.

Hardware/Software Integration

To handle hardware/software-designed integration tasks, the 8560 uses the Tektronix 8540 Integration Unit as a peripheral work station. Once code for the prototype has been assembled or compiled and linked into executable object modules, it is loaded into the 8540's program memory via a high-speed interface. The code can now be gradually introduced to the hardware using real-time emulation, a powerful debugging method that employs a processor identical in function to the one selected for the prototype.

Data captured by the 8540 during debugging and testing can be displayed on the console terminal, the line printer, or stored in an 8560 file for further processing.

Real-time emulation takes place in three progressive modes, all under the control of the 8540's debug software. During the first mode, all code is executed out of the 8540's program memory, with I/O simulated by software insertions that use 8560 peripherals or files for input and output. In this manner prototype software debugging can begin even before the hardware becomes available. During the second mode, I/O and clock functions are transferred from the 8540 to the prototype, and code can be mapped over to the prototype memory in manageable blocks as it is debugged. A control probe now connects the emulator processor to the vacant processor socket on the prototype board. During the final mode, all code is installed in the prototype memory, as well as clock and I/O functions. Through the control probe, the 8540 now exercises prototype hardware in the same manner that it will function when standing alone.

During all three modes of emulation, the 8540's powerful debug software can be applied. Breakpoints can be set using mnemonic symbols for key program locations. The status of processor registers can be examined on a cycle-by-cycle basis. All registers and memory locations can be examined and modified. And for detailed analysis of real-time execution on the prototype bus and selected hardware points, an optional Trigger Trace Analyzer is available with four trigger channels that allow highly selective data acquisition.

For added power during debugging, the 8540's resident command set is also included as part of the TNIX command set. This allows the full range of TNIX command manipulation features to be applied to 8540-based operations. It is even possible to intermix conventional TNIX and 8540 commands in a single command line.

CHARACTERISTICS

ENVIRONMENTAL CHARACTERISTICS

Ambient Temperature — Operating: +10°C to +40°C. Storage: −10°C to +65°C.

Relative Humidity — Operating: 20% to 80% (noncondensing). Storage: 10% to 80% (noncondensing).

Temperature Rate of Change — Operating: 1°C/5 minutes maximum. Storage: 24°C/hour maximum.

Operating Altitude — Sea level to 2500 m (8,000 ft). Derate maximum temperature by 1°C for each 300 m above 2400 m.

Storage — Sea level to 12 200 m (40,000 ft).

Static Discharge Operating — 0 to 12.5 kV without effect on equipment operation. 0 to 12.5 kV without hard failures.

AC POWER

Line Voltage Ranges — 115 V ac (90 to 132 V RMS); 230 V ac (180 to 250 V RMS).

Line Frequency Range — 48 to 66 Hz.

Power Consumption — 430 W maximum.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	282	16.8
Height	267	10.5
Depth	646	25.4
Weight	**kg**	**lb**
Net	33	72.5

Order 8560 Multi-User Software Development Unit **$28,000**

OPTIONAL ACCESSORIES

Flex Disks (box of 10). Order 119-1182-01 **$175**

RS-232 Connecting Cable (15 ft).
Order 012-0757-00 ..... **$140**

HSI Connecting Cable (8 ft/2.4 m).
Order 012-1009-00 ..... **$55**

HSI Connecting Cable (20 ft/6.1 m).
Order 012-1008-00 ..... **$90**

HSI Connecting Cable (50 ft/15.2 m).
Order 012-1007-00 ..... **$125**

HSI Connecting Cable (250 ft/76.2 m).
Order 012-1010-00 ..... **$395**

8540

Multiple Microprocessor Support

Real-Time Emulation

Trigger Trace Analysis

8560 Compatible

The Tektronix 8540 Integration Unit is used with a 8560 Multi-User Software Development Unit or a general host computer, to integrate, test and debug microprocessor-based software. The 8540 supports the hardware and software integration phase of a microprocessor/microcomputer based design. The Tektronix 8560 or other host computer supports the software development task.

Application

8540 support is employed when the software has been developed to the object code level and is ready to be tested with the hardware. The object code binary program is downloaded to the 8540 and stored in its resident program memory or, if available, in the prototype's own memory. If the prototype hardware is not available, the software can be executed on the 8540 emulator processor using Mode 0 emulation.

A wide variety of emulators are available for in-circuit testing and debugging. For in-circuit testing, the emulator probe replaces the microprocessor chip in the prototype. In emulation Mode 1 or Mode 2, the software can interact directly with the prototype hardware.

The designer controls and monitors the testing process via a CRT terminal like the Tektronix CT8500.

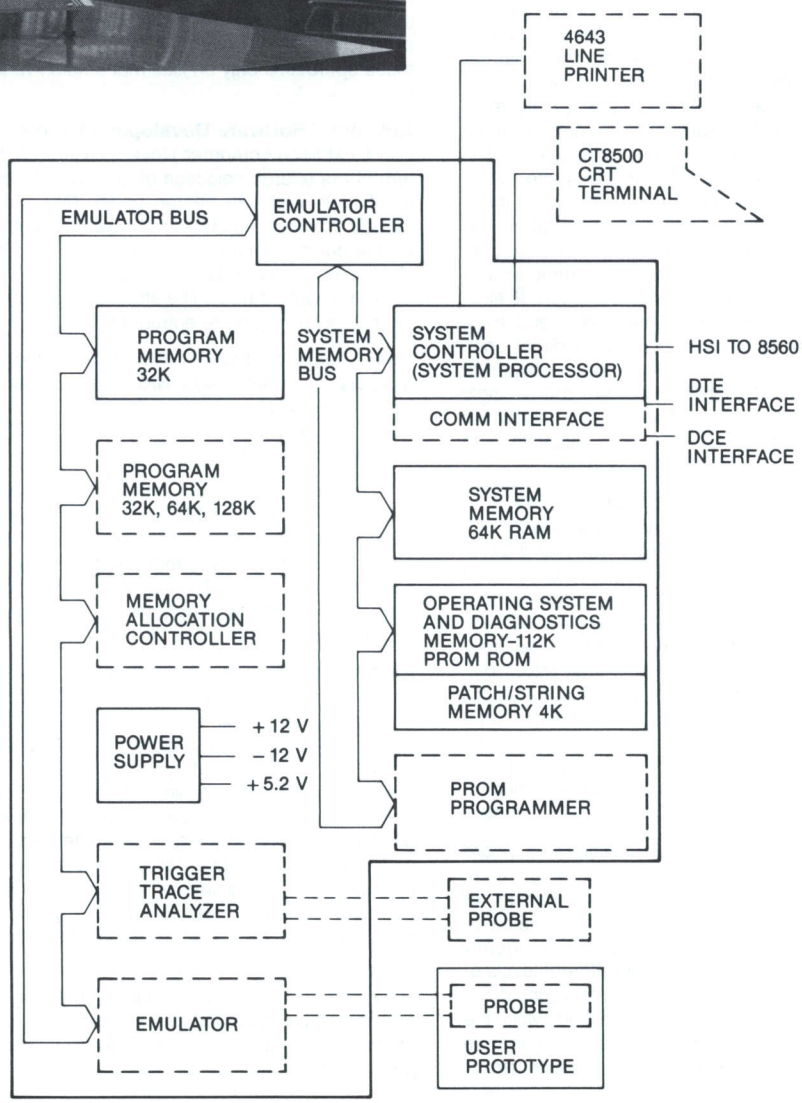
Block Diagram

As shown in Figure 1, a block diagram of the 8540, the complete operating system and system diagnostics are contained in 112 kilobyte PROM/ROM memory. The operating system is loaded from PROM and executed in the 64 kilobyte system memory. User symbol table information is also stored in system memory.

Part of the 8540 memory system also contains a non-volatile EEPROM buffer to store command strings and operating system update information. Complex and repeated command sequences can be permanently stored and then recalled by employing one user-definable string name. The EEPROM is also used to store update information for operating system maintenance.

The 8540 includes 32 kilobytes of static program memory for use by the emulator processor. The static program memory can be expanded to 256 kilobytes and with the optional Memory Allocation Controller, segments of this memory can be mapped anywhere in the emulator processor's address range.

Figure 1. 8540 Block Diagram
Note: Dashed lines indicate optional equipment.



8540/8560 SYSTEM CONFIGURATIONS

Local Interface Configuration

The 8540 Integration Unit connects to the 8560 Multi-User Software Development Unit via a high speed serial interface (Figure 2). Interconnecting cable lengths of up to 2,000 feet can be accommodated without performance degradation. A specialized interface protocol is used between the 8540 and the 8560 to eliminate any errors that might occur in the transmission process.

Operating Modes

The Tektronix CT8500 CRT Terminal (or a user supplied RS-232 terminal) is the user's interface with the 8540/8560 system. 8540/8560 commands that are entered from the terminal are routed first to the 8560. The 8560 processes each command line and routes 8540 commands to the appropriate 8540. This allows commands to be intermixed on a single line and also gives the user the ability to control any 8540 (or several 8540s) in the system. (The 8540 can be configured to operate through a separate 8560 port with no terminal attached.) A local mode is also available so a user can communicate directly with the 8540.

8540 (With Option 01 Communications Interface) Host Computer Configuration

The 8540 Integration Unit is interfaced to a host computer via an RS-232 serial port on an Option 01 Communications Interface. Data bytes are ASCII encoded and transmitted asynchronously at speeds up to 9600 baud between the 8540 and the host computer. For location interface configurations (up to 50 feet), the 8540 can be hardwired directly to the host computer using a standard RS-232 cable (Figure 3a). For remote configurations (more than 50 feet) the 8540 interfaces to the host computer via a data set arrangement (Figure 3b). Data sets can connect over moderate distances using dedicated lines or virtually unlimited distances with conventional phone lines.

The 8540 can communicate with a host computer in several modes including:

Local Mode — In this mode the terminal communicates directly with the 8540 operating system to control the emulation and debugging process.

Terminal Transparent Mode — In this mode the terminal communicates with a host computer using standard protocol; keyboard data is transmitted to the host and host data is displayed on the terminal's display screen.

Formatted Upload/Download — In this mode, microprocessor object code is transferred between the host computer and the 8540 program (emulation) memory. Binary data is encoded into Extended TEKHEX format and transmitted in message blocks. Checksum information is also included in the message blocks to allow detection of communication errors.

Details of TEKHEX encoding and protocol are included in the 8540 System Users Manual.

Emulation Support

When a program is ready for testing, the object module is downloaded from the host computer (or 8560) into 8540 emulator memory. When a symbol table is included with the object module, it is also downloaded and stored in a separate portion of system memory. Program symbols can then be used to reference memory locations instead of the absolute addresses.

The object code is now executed by the emulator processor under control of the 8540 debugging system. Trace displays to the screen (or line printer) show all pertinent information including instruction mnemonics, processor status and any program symbols. The user can set breakpoints to stop in critical sections or use the trace display to show selected instructions or address ranges.

Three progressive emulation modes are available in the 8540. In the first (Mode 0) the 8540 supplies all memory, clock, and interface signals to the emulator processor. No prototype hardware is required. In the second (Mode 1) the clock and interface signals are provided by the prototype hardware. The emulator processor connects to the prototype microprocessor socket via the prototype control probe. The program under test still resides in the 8540 but as debugging progresses, it can be gradually transferred (mapped) over to the prototype's memory. In the third (Mode 2) all of the program is transferred to prototype memory. The 8540 still maintains control of program execution through the debugging system. For more specific emulator support information, refer to the appropriate data sheet for each (supported) emulator.

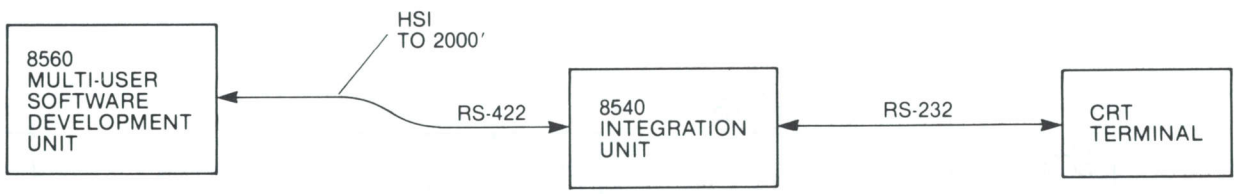


Figure 2. HSI Configuration

Diagnostics

The 8540 has a complete diagnostic subsystem. On each power-up cycle, diagnostic firmware checks the basic 8540 operation before leaving the operating system. In addition, a complete diagnostic system is available for an extensive system verification (including all options) and to perform board level fault isolation for quick on-site repair.

Trigger Trace Analyzer

The Trigger Trace Analyzer (TTA), optional equipment for the 8540, is a powerful debugging tool. It monitors program flow in realtime and allows sophisticated control and analysis of the emulator processor. The TTA stores program information in a high-speed 255-event buffer. Each event contains 62-bits of information including: up to 24-bits of address and 16-bits of data; up to 14-bits of processor information, and 8-bits of external probe information. TTA information is displayed on the terminal in processor specific mnemonics along with all pertinent register and flag information.

PROM Programmer

The PROM Programmer, optional equipment for the 8540 is a general purpose controller unit with plug-adaptor modules. Each module supports a group of similar programmable devices. Functions include: Read, Write, and Compare.

CHARACTERISTICS

Operating System (Software) — DOS/50 derivative (contained in 8 k PROM/ROM's) i.e., 88 k bytes, command interpreter and kernel 24 k bytes diagnostics; 4 k bytes patch and command storage (EEPROM).

Card Slot Usage

Standard Boards
System controller
Emulator controller
System memory (64 k RAM)
Program memory (32 k RAM)
System memory (240 k PROM/ROM capacity)

Empty Board Slots —
System side: 1 slot
Program side: 11 slots

I/O Ports — J100 (8560 Interface); J101 (remote DTE male); J102 (remote DCE female); J103 (Line Printer, Aux); J104 (Terminal).

I/O Port Data Rates — J100 (HSI) = 153.6 k baud.
J101, J102, J103, J104 = 110/ext CLK, 150, 300, 600, 1200, 2400, 4800, 9600 baud.

Reliability

MTBF — 6700 hour (calculated).
MTTR Board — 0.5 hour.
MTTR Component — 1.5 hour.

Standard Compliance — UL 1244; CSA Bulletin 556B; IEC 1348.

ENVIRONMENTAL CHARACTERISTICS

Temperature Ranges

Operating — 0°C to +50°C (+32°F to +122°F).
Storage — +55°C to +75°C (+67°F to +167°F).

Altitude Range

Operating — Sea level to 4500 m (15,000 ft).
Storage — Sea level to 15 000 m (50,000 ft).
Humidity — 0 to 90% noncondensing (0°C to +50°C).

AC POWER

Nominal Operating Voltage — 115 V ac and 230 V ac at 60 Hz.
Power Requirements — 700 W maximum.
Line Voltage Ranges — 90 to 132 V ac and 180 to 250 V ac.
Line Frequency Range — 48 to 66 Hz.

PHYSICAL CHARACTERISTICS

	Cabinet	
Dimensions	**mm**	**in**
Width	430	17
Height	280	11
Depth	585	23
Weight	**kg**	**lb**
Net	26	57.5
Shipping*	35	77.5

Cabinet Color — Three tone; ivory/gray, smoke tan, earth brown.

** Standard configuration only, no options.*

RS-232 Communications Interface

Option 01 — Interface signals are routed to and from the 8540 system controller board via rear panel connectors J101 (male) and J102 (female). Table 1 lists the J101/J102 pin numbers and corresponding signal names and descriptions. Baud rate on transmitted data and received data is selectable from 110 to 9600 baud. All signals are RS-232C compatible.

Table 1
Interface Signal (Option 01, Communications Interface)

Signal Name	Circuit	J101 DTE	J102 DCE	Pin
GND	AA	Protective ground	Protective ground	1
Tx	BA	Out	In	2*1
Rx	BB	In	Out	3*1
RTS	CA	Out*2	In*3	4
CTS	CB	In*4	Out*5	5
DSR	CC	In*6	Out	6
GNC	AB	Signal ground	Signal ground	7
DCD	CF	In*7	Out	8
DTR	CD	Out	In*8	20

**1 Selectable, 110 to 9600 baud.*
**2 DTE 1, DTE 2 modes; goes high when data to send.*
**3 DCE mode; must be high before 8540 accepts data.*
**4 DTE 1 mode; must be high before 8540 sends data.*
**5 DCE mode; goes low when 8540 sends data.*
**6 DTE 2 mode; must be high before 8540 sends data.*
**7 DTE 1,DTE 2 mode; must be high before 8540 accepts data.*
**8 DCE mode; must be high before 8540 sends data.*

Order 8540 Integration Unit **$11,000**

OPTIONAL ACCESSORIES

Flex Disks (box of 10). Order 119-1182-01 ..... **$175**
RS-232 Connecting Cable (15 ft).
Order 012-0757-00 ..... **$140**
HSI Connecting Cable (8 ft/2.4 m).
Order 012-1009-00 ..... **$55**
HSI Connecting Cable (20 ft/6.1 m).
Order 012-1008-00 ..... **$90**
HSI Connecting Cable (50 ft/15.2 m).
Order 012-1007-00 ..... **$125**
HSI Connecting Cable (250 ft/76.2 m).
Order 012-1010-00 ..... **$395**

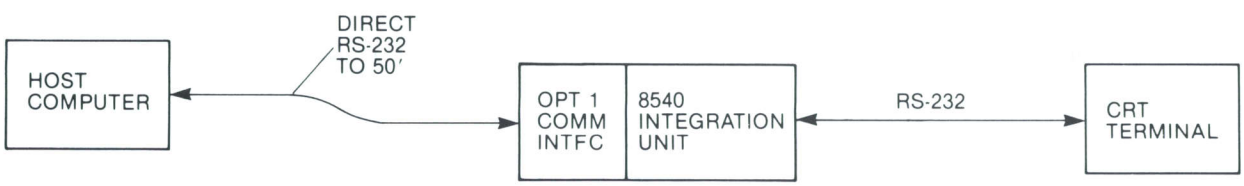


Figure 3a. Direct RS-232 Configuration

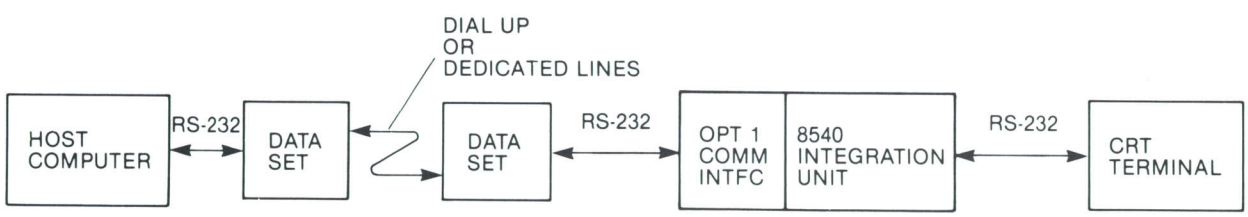
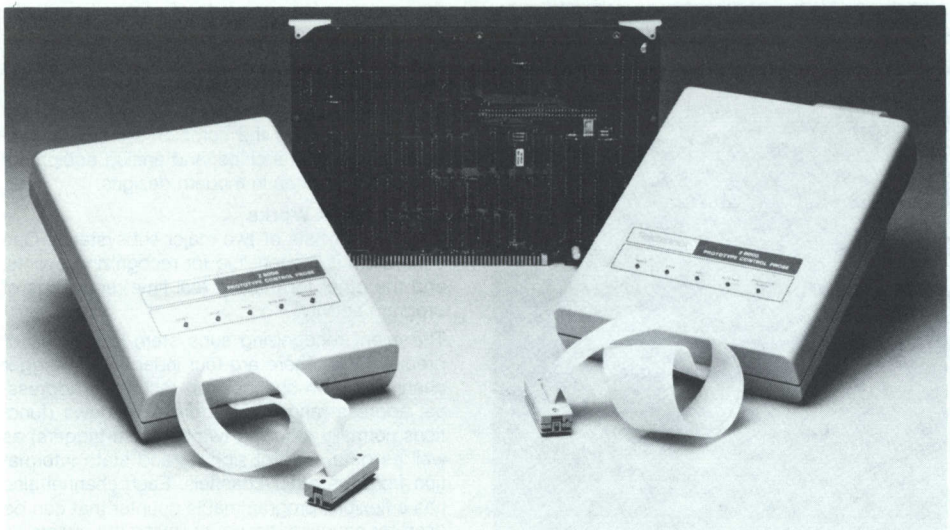


Figure 3b. Data Set Configuration



Emulator Processor and Prototype Control Probe Support Packages
The 8500 Microcomputer Development Lab family supports a wide variety of different microprocessors and microcomputers.

Emulators
Emulator packages may be ordered as systems options. These options provide capabilities necessary to fully emulate the target microprocessor in a user's prototype system.

The emulator processor, which resides on a plug-in circuit module along with controlling logic circuitry, enables the user to execute and debug the program on a microprocessor identical to the one which will be used in the prototype, while giving him access up to 256 kilobytes of Microprocessor Lab program memory.

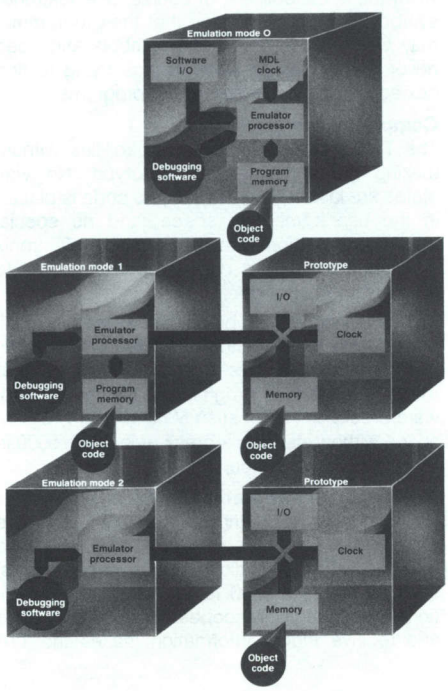
Software execution is performed under control of DOS-50 in the 8550 system, and under control of TNIX in the 8560 system. During software development, DOS-50 allows the creation of a tree-like file structure with subdirectories to whatever nesting level a project requires. When converting source code to object code, it provides complete supervision of assembly or compilation procedures. During hardware/software integration, DOS-50 handles prototype execution monitoring and debugging operations. It also takes care of general I/O, intersystem communications and PROM programming.

TNIX, the operating system used in the 8560 system uses timesharing to apportion system resources among up to eight work stations plus system utilities. A hierarchial-type filing system is used that groups files and directories logically. Each file carries a date/time attribute to help confirm that the proper version is being accessed. A security system allows password protection, multiple-user file access, and work copies according to current project needs.

Probes
The prototype control probe connects the emulator processor card to the prototype microprocessor, and allows a designer to transfer program control in three stages from the 8550 or 8560/8540 Microcomputer Development Lab to the prototype.

All emulation operations are controlled by the powerful Microprocessor Lab system software. The user is able to monitor program execution, set software breakpoints, examine and change memory and register contents. Debug trace information is displayed in a format unique to the microprocessor, with instruction fetches disassembled into mnemonics for easy interpretation.

Three Emulation Modes
Once an object code file has been created, the program may be exercised in system Mode 0. During execution, program steps can be traced, hardware breakpoints can be set, and memory can be examined and changed as required. Should an error be discovered, that portion of the program can be corrected at the source level using the text editor. Object code can then be reassembled and re-executed. This procedure continues until the developmental software program is complete and can be executed without errors.



After the developmental software has been debugged, it may be exercised on the prototype circuitry (Mode 1). During partial emulation, control may be released in stages to the prototype. Developmental software is sequenced using the emulator memory space and the prototype I/O and clock. The memory mapping feature allows code to be gradually mapped over to the prototype's memory in blocks. Throughout partial emulation, the program designer has access to prototype circuitry. This access enables the examination and changing of memory and register contents, hardware tracing, and setting of breakpoints.

In full emulation, Mode 2, the developmental software program is run on the prototype, but program execution is still under the complete control of the 8550 Microcomputer Development Lab or 8540 system. All I/O and timing functions are directed by the prototype and all memory has been mapped over to it. The Prototype Control Probe is connected and still emulating the prototype microprocessor. Although the prototype is effectively free-standing, the designer may still direct program activity from the console terminal.

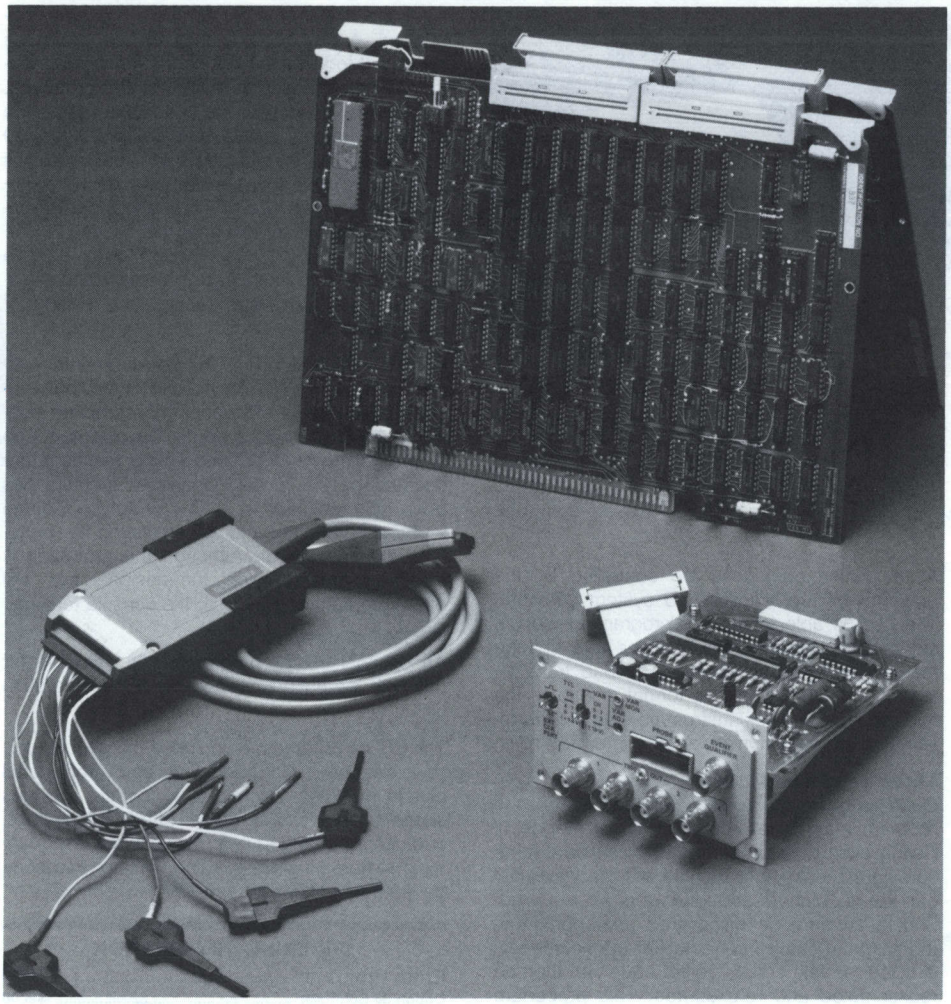
PROM Programmer
An optional PROM programmer is available for use with the 8550 MDL and the 8540 Integration Unit.

The PROM programmer includes the general purpose controller board and a series of front panel plug-in modules. Each plug-in module provides support for a similar group of PROM devices, and can be changed in a few seconds. Programming features include reading, writing, and comparing (for verification) a PROM.

ORDERING INFORMATION

Prom Program **$2000**
Option 30 Controller **$2000**

PROM MODULE	DEVICE	MANUFACTURER
Option 31	TMS 2508	TI
	2758	Intel
	2758 51865	Intel
	TMS 2516	Intel
	2816	Intel
	TMS 2532	TI
	2732	Intel
	2732A	Intel
	MCM 68764	Motorola
	MCM 68766L35	Motorola
Option 32	8755A	Intel
	8748	Intel
	8749	Intel
	8741A	Intel
Option 33	2764	Intel
	27128	Intel
	2817	Intel
	TMS 2564	TI
Option 35	8751A	Intel



TRIGGER TRACE ANALYZER

The TTA

The Trigger Trace Analyzer, or TTA, is the fundamental debug and integration tool in the 8500 family. This two-board package works with emulators inside the 8550 or 8540 mainframe to provide the user with unprecedented control over software execution. The TTA is a universal tool, supporting most of the 8-bit and 16-bit emulators in the 8500 family.

Interactive Control of Software Execution

The TTA opens a kit of powerful tools for the user. Conventional breakpoint and trace functions are just the beginning. The programmer can trap read, write, or execute accesses to any part of memory, break when a subprogram has been called in a particular sequence, and track register contents while uninvolved instructions execute at full speed.

The bus cycle recording capabilities of the TTA permit tracing of instructions while the microprocessor runs at full speed. Trace qualification hardware gives the user the power to specify what cycles should be recorded, so an entire program execution can be recorded, for instance, as a list of call instructions.

In addition, the TTA's performance analysis capabilities can identify code "hot spots", recognize unused sections of code, measure the time necessary to traverse a routine, or even dynamically monitor the growth of a list or a stack.

All of these capabilities, of course, use Tektronix' symbolic debug system, so that the programmer may work with source code symbols and need never grope through linker listings trying to find hex addresses or misplaced subprograms.

Complete Transparency

The TTA provides all these capabilities without making demands on the prototype. No wait states are inserted by the TTA, no code is placed in the user's memory space, and no special hardware provisions are required. Like Tektronix emulators, the TTA is completely transparent to the customer's design.

When working with 16-bit chips that feature multiple address spaces, the TTA distinguishes between the spaces. This means, for instance, that the Motorola 68000 programmer can set a hardware breakpoint at location 5000 in User Program space without causing a break at location 5000 in System Program space.

A Network of Integration Tools

By using its four trigger outputs and nine pattern/qualifier inputs, the TTA can work in a network with other digital measurement tools, such as the DAS 9100 family, and with conventional or digital oscilloscopes. This ability to send and receive trigger information makes the TTA the center of a network of integration tools, permitting microprocessor, peripheral, and outside analog measurements from a variety of instruments to be correlated.

Only this level of integration support makes it practical to debug the complex systems of processors, peripheral chips, and analog equipment that occur so often in modern designs.

How the TTA Works

The TTA consists of two major subsystems. One subsystem is responsible for recognizing events, and the other for making real time recordings of program activity.

The event recognizing subsystem is a group of precise tools. There are four independent trigger channels. Each channel can recognize addresses, address ranges, or address windows (functions normally requiring two separate triggers) as well as data, control signals, and state information from the other channels. Each channel also has a flexible, programmable counter that can be used for counting, timing, or linking the events as they are detected. The channels may be linked in and, or, or sequence configurations to meet nearly any triggering need.

Real time recording is provided by a 255 word by 62 channel high-speed recording buffer. The record may be frozen by an event channel, so that a sequence of instructions can be recorded at full prototype speed, and then held for examination after the prototype has reached a safe stopping place. In addition, the buffer can be set to record only on command from one of the event channels, permitting a long prototype run to be condensed to a trace of the crucial events.

Working together, the tools in the TTA provide debug and integration capabilities never available in one system before the introduction of the 8500 family.

TEKTRONIX EMULATION SYSTEMS

What is Tektronix Emulation, Exactly?

Not surprisingly, every manufacturer tries to define emulation in terms of the capabilities and limitations of their own product. Unfortunately, this has led to some rather distorted views of what emulation is, and what it is for.

Tektronix has a simple, comprehensive view of emulation. Emulation is the technique of controlling the microprocessors in a device so that software execution may be observed and controlled. Emulation is accomplished by placing each microprocessor in a probe assembly, where it can be controlled by the development system without compromising the chip timing characteristics.

A Tektronix, we believe that emulation should be real time, transparent, and full-function. Real time means that the device under control runs at its intended clock speed with no wait states inserted by the development system. Transparent means that the device under control runs exactly the same way with the emulator as with the microprocessor itself. No added circuits, no "monitor" software, no compromises in chip timing at critical pins. Full-function means that all the features of the microprocessor, including interrupts, multiprocessing features, co-processing, and address space separation, are supported by the emulator.

Tektronix Emulators
Tektronix offers emulators for most major 8-bit microprocessors and microcomputers. We set the standard for 16-bit emulation of the 8086, 8088, 68000, Z8001, Z8002, and 9900.

Each Tektronix emulator can execute code from program memory in the development system. Each provides hardware breakpoints, single-step, and trace capabilities. Each emulator can perform Service Cals (SVC's) which make the hardware resources and software tools of the development system available to user programs.

With these facilities Tektronix emulators provide a complete enviroment for software debug inside the development system. When the time comes to test software operation in the device under development, Tektronix Prototype Control Probes extend the capabilities of emulators into the device.

Prototype Control Probes
The Prototype Control Probe is the connection between a Tektronix emulator and the device under test. The probe replaces the user's microprocessor, extending all the emulator's debug capabilities to the device under test.

Via these probes, Tektronix emulators can execute code from the device under test, examine or change the device's memory contents, set breakpoints, trace program execution, and map portions of development system memory into the device's address space. Further, Tektronix 16-bit probes permit Service Calls to be performed from the device under test. This feature permits development system resources to substitute for parts of a prototype system that are not available for testing. As an example, the winchester disk in the 8560 can be accessed from a prototype to simulate a prototype mass storage system still under development.

The Systems
The Tektronix 8500 family provides microprocessor emulation in three formats for the three different kinds of design teams. In the 8550, emulators share a cabinet with software development facilities. This provides the most cost-effective packaging for teams in which several users do not need to work simultaneously.

In the multi-user 8560 environment, where several members of the team must be able to use the development system at once, emulation is provided in a separate cabinet, the 8540. This permits Tektronix emulators to be operated from any station in the system without tying up software development facilities.

For design teams that use mainframe computers for software development, the 8540 connects directly to the host computer to provide Tektronix emulation as a natural augmentation of the existing computer facilities.

Emulation Accessories
Several accessories expand the emulation capabilities of the 8550 and 8540 systems. Additional program memory is available in 32, 64, or 128 kilobyte increments to accommodate large software modules. For two of the 16-bit emulators, the 68000 and Z8000, a separate memory controller permits the program memory to replace blocks of prototype memory over the chips' entire address ranges, in any of the chips' address spaces. This mapping feature makes it unnecessary to reassemble or relink code to fit it into a particular address range during debug.

Two logic analyzers, an economical Real time Prototype Analyzer for 8-bit microprocessors and the unprecedented Trigger Trace Analyzer for most 8 and 16-bit processors, extend the debug features of the 8500 family to meet the challenges of the most formidable software projects.

The System Solution
A wide variety of emulators, mainframes to fit the needs of design teams, memory and analysis options together with the 8500 family emulation products, form a system that is cost effective for an individual project and flexible enough not to be outgrown.

Table 2. TTA Command Set

Command	Description
acq	Acquire Data: Controls data storage in the high-speed trace buffer; allows event four parameters to act as a storage qualifier when specified.
ad	Address Comparator: Programs address portion of each channel's word recognizer.
bre	Breakpoint Control: Halts TTA data acquisition when a specified channel's trigger output goes active; includes option to let prototype continue executing code.
bus	Bus/Control Signals Comparator: Programs control bus portion of each channel's word recognizer; specific control signal mnemonics supplied with each emulator package.
cons	Detect Consecutive Cycles: Specifies sequence in which trigger channel events must come true to cause a data acquistion trigger; selects type of bus cycle to be used.
cou	Counter Programming: Determines counter value that will cause active counter output; includes increment/decrement select, counting source select, and reset function.
ctr	Counter Output Feedback: Programs counter output feedback portion of each channel's word recognizer.
data	Data Comparator: Programs data portion of each channel's word recognizer.
disp	Display Acquisition Memory: Displays acquired bus activity in disassembled mnemonics native to the emulator processor in use.
eve	Event Comparators: Single command allowing all of a channel's word recognizer values to be programmed at once.
pro	External Probe Input Compartor: Programs probe input portion of each channel's word recognizer (8 bits).
qua	External Qualifier Comparator: Programs external qualifier portion of each channel's word recognizer (single bit received via BNC input).
tclr	Clear an entire trigger channel (event, counter and breakpoint).
ts	Trigger Status Display: Shows all trigger information current programmed on each of the four trigger channels including breakpoint status.

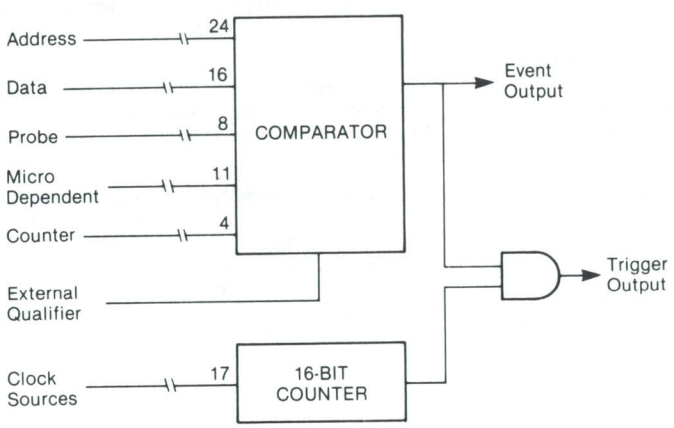


Figure 1. TTA Channel Configuration

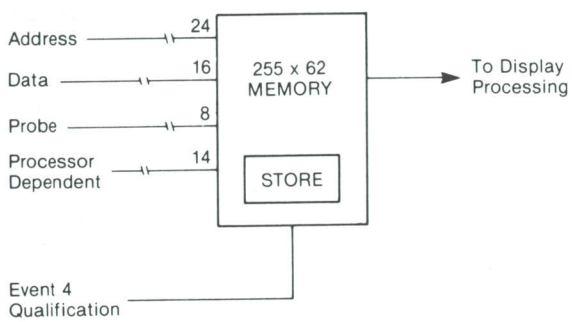
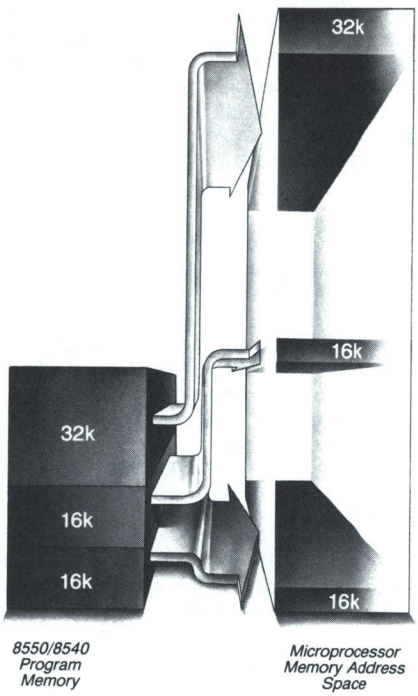


Figure 2. TTA Acquisition Control

The Memory Allocation Controller

The Memory Allocation Controller is an option to be used with the 68000 and Z8000 support packages. It allows full support of these processors' address ranges, as well as support of the six address spaces of the Z8000 and the four address spaces of the 68000. Memory is allocated in 4 k blocks over the entire address range, and can also be allocated as existent and nonexistent, in which case any read or write to nondefined memory will be flagged as an error condition.

The 8086 emulator supports the full 1 megabyte address range without this option.



Memory Allocation allows program memory to be assigned to different logical addresses within the microprocessor address range.

SOFTWARE TOOLS

Tektronix offers a variety of software tools for the microprocessor design development cycle, including:

— A Language Development System, LANDS, on the 8560, which provides an integrated set of tools from code entry through debugging.

— Editors for Data Entry: A screen (CRT)-oriented editor, in addition to the standard line-oriented editor.

— High-level-language compilers, Pascal and MDL/μ specifically designed for microprocessor applications.

— Assemblers support for a wide range of microprocessors to translate assembly language programs into relocatable object modules.

— A powerful linker to merge the object modules and a library generator to create and maintain object module libraries are standard with the operating system.

LANDS

The Tektronix Pascal Language Development System, optional software for the 8560, provides an integrated set of language development tools. The Language-Directed Editor (LDE), the Pascal Compiler with an Integration Control System (ICS), and Pascal Debug (PDB) are tools that support your design effort, from code entry through debugging.

Language-Directed Editor

The Language-Directed Editor (LDE) for Pascal, eases editing of programs written in the Pascal language. The LDE combines text manipulation functions of a general purpose editor with the syntax-checking function of a compiler.

LDE is tailored to the syntactic structure of the Pascal language, allowing more productive editing of Pascal programs than a general purpose editor. The Parse command checks the syntactic validity of the text entered, saving you repeated compiler passes for syntax checking.

The LDE provides an auto-indentation at the time of text entry by remembering the level of indentation of the previous line. Language-Directed Editing provides a generic key to facilitate entering Pascal's reserved words. When the generic key is entered during the typing of a Pascal reserved word, the LDE completes the text entry of that word, reducing spelling errors and typing effort. For example, if you type "PROC" or "PR" and then enter the generic key, the work "Procedure" is entered into the text.

As a screen-oriented process, LDE displays a screenful of text in your file, allowing you to view the text surrounding the point of editing that is indicated by the cursor. The terminal screen serves as a window into the file where you can insert or modify text. The text is automatically scrolled up or down through the display window as the cursor is moved with the cursor movement keys. New text can be entered at the position of the cursor by simply typing in characters. LDE commands, implemented by programmed keys on the keyboard are available to modify or delete text.

LANDS Pacal Compiler

Pascal, high-level programming language, is receiving much attention in the electronics industry. Features, such as program structure, strong data typing, and readability, greatly enhance programmer efficiency, and thereby reduce software development and maintenance costs.

The Tektronix Pascal Compiler implements the proposed ISO Standard Pascal, with microprocessor application extensions. A true compiler rather than a P-code interpreter, the Pascal Compiler generates object code for the targeted chip directly. Each program statement is translated to machine code only once instead of every time the statement is executed, resulting in faster and often more compact code. LANDS Pascal on the 8560 is currently targeted for the 8086/8088 and Z8001/Z8002 chips.

Standard Pascal Feature

Pascal is a block-structured language that allows the program to be divided into subprograms called procedures and functions. This block structure encourages programmers to logically plan and construct programs, so debugging time is greatly reduced.

Pascal's control structures correspond closely with flowchart elements and make algorithm coding very natural. All control structures have a single entrance and exit, so program modifications are unlikely to introduce errors into the program.

Pascal allows programmers to use many flexible forms of data representations and to define data types that accurately express their particular problems. Tektronix Pascal allows all standard data types: integer, real, character, Boolean, enumerated, set, array, record, file, and pointer.

Pascal programs are easy to read, and thus to maintain. Pascal allows extra spaces, tabs, and carriage returns almost anywhere, so indented spaces can be added to make the program more readable. Variable, procedure, and function names can be meaningful and easily understood because they are not restricted in length.

Tektronix Pascal Extensions

Extensions have been added to the standard Pascal to assist in microprocessor applications.

Separate Compilations

The Tektronix Pascal Compilers support separate compilations. The main program module's first word is the keyword Program. Submodules to be separately compiled begin with the keyword Module.

Global variables, procedures, and functions can be referenced between separately compiled Modules and the main Program via Public and Extern attributes.

Linkage with Assembly Language Modules

Speed-critical or timing-critical applications may require some program segments to be written in assembly language. Because the code generated by the Pascal Compiler is compatible with the Tektronix-Linker, assembly code can be linked to Pascal code.

Interrupt Handling
Tektronix Pascal allows full use of the microprocessor interrupts. You can specify the procedure to be executed for an interrupt routine with the Interrupt attribute in the procedure heading.

Input/Output
Tektronix Pascal allows full use of the Chip I/O. The Port and Origin attributes can be used to locate a variable at a given I/O port or memory location.

Nondecimal Integers
In many microcomputer applications, programmers want to use nondecimal integers. The Pascal Compiler supports binary, octal, and hexadecimal integers for input and output.

Bit Manipulation
To allow bit manipulation and masking, Boolean operators can be used with integers in the Tektronix Pascal.

Compiler Directives
Tektronix Pascal recognizes a set of compiler directives to format the listings, include external files, and generate a pseudo-assembly language listing of the object code produced by the compiler.

Integration Control System
Included with the LANDS Pascal is a software program, known as the Integration Control System (ICS), that simplifies the integration of your Pascal program to your particular hardware configuration. With Pascal, there is no direct way to specify implementation-specific requirements such as interrupt vectors, restart routines, or memory configuration. The ICS allows the programmer to specify such configurations and create the necessary assembly language routines and linker commands automatically.

ICS allows the user to configure the program to run on his prototype after the source program is compiled and checked. Changes in the hardware configuration do not require recompiling the source programs.

Pascal Debug
The Tektronix Pascal Debug is a real-time symbolic debugging tool for programs that are written in Pascal. Pascal Debug (PDB) allows the programmer to use Pascal language constructs to examine and modify the program during execution.

With PDB, the programmer can debug his program without a detailed knowledge about the compiler-generated code, thus, extending the efficiency of coding in a high-level-language to the debugging cycle.

Pascal Debug, which runs on the 8560 Multi-User Software Development Unit, controls the program as it executes at full speed on the targeted emulator in the 8540 Integration Unit. Usable in any emulation mode, PDB generates 8540 commands to run the emulator. Any 8540 error messages returned are examined and, in some cases, repaired allowing the debugging session to proceed.

Displaying/Modifying Variables
PDB provides the programmer with a high-level-language interface to display and modify variables.

Variable modification commands in PDB are used to examine and change the values of variables. PDB allows the programmer to refer to the variables using the same symbolic names declared in the original source code.

PDB recognizes the same types of expressions as the Pascal compiler. General expressions are accepted as arguments for PDB commands.

Controlling Program Execution
PDB allows the programmer to control the execution of the program flow with breakpoints, single-steps of Pascal statements, returns to calling procedures, and program resets.

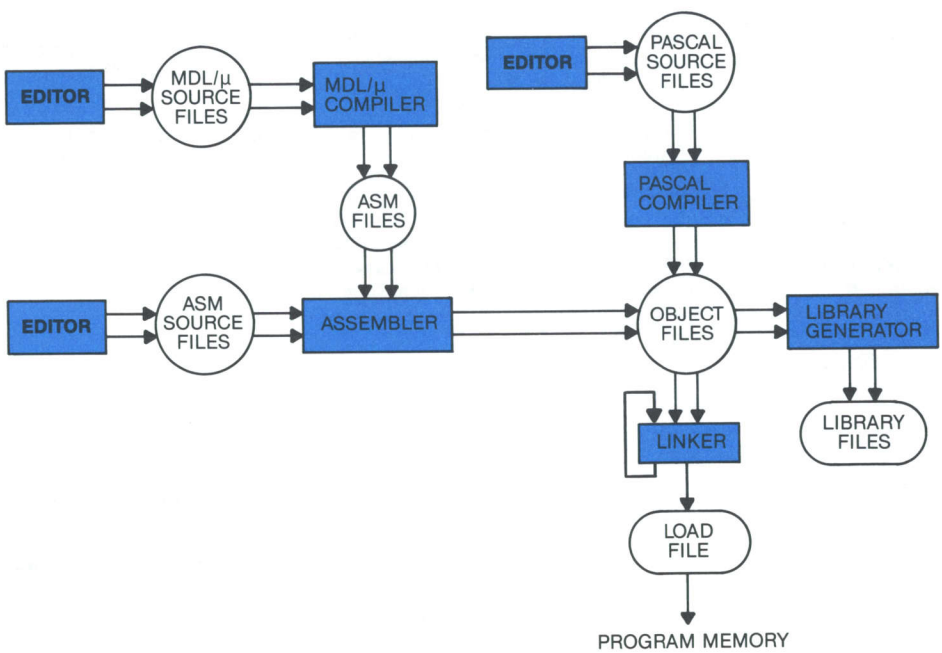
Recording and Displaying Debug Information
PDB has several commands to record and display important debugging information, including the trace command to trace previous calls; TB (traceback) command to interpret the activation record list, in reverse order, the procedures called, displaying a traceback to the main program; and a Log command that records all PDB input and output to a file, so it can be reviewed and analyzed later.

EDITORS

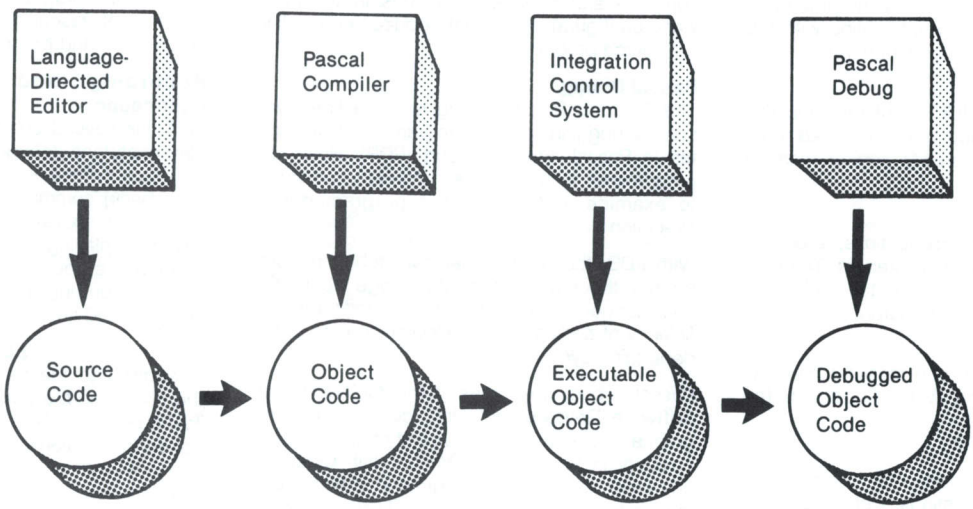
In addition to the Language-Directed Editor on the 8560 and the standard line-oriented editors, Tektronix offers ACE, an Advanced CRT-Oriented Editor. Optional software to both the 8550 and 8560, ACE eases program creation and editing tasks.

With the ACE Editor, programmers may conveniently view and edit the program text. A window, the CRT, shows the text surrounding the ACE Editor's pointer. The text can be edited either as a sequence of lines or a stream of characters.

Screen Oriented Editing
ACE divides the display screen of the CRT into two areas: a monitor area to display messages, and a window area to display text that is being edited. The window constantly shows the text surrounding the cursor, a visible pointer in the window area of the screen. The cursor is moved by the user to the specific character within the text where editing will occur. Text displayed in the window can be moved both horizontally and vertically to bring different parts of the file into view. After an edit command has been processed, the window will display the change(s) made to the text.



LANGUAGE DEVELOPMENT SYSTEM (LANDS)



Pascal Language Development System (LANDS) — Together, the Language-Directed Editor, Pascal Compiler, Integration Control System and Pascal Debug provide the most efficient and productive environment for high-level language programming in microprocessor design.

Character and Line Manipulation

It is often desired to edit text at one place as a sequence of lines and at another place as a stream of characters. ACE is versatile, permitting both character and line manipulation. Character manipulation features allow the user to find, or find and replace, multiple occurrences of a character string, to insert or delete characters. Other character manipulation capabilities such as overtyping, copying from one position to another, and changing alphabetic character case can also be accomplished. Line manipulation features include insert and delete lines, move lines, split one line into two, and combine two lines into one. The operator can, at any time, use line-oriented commands.

During execution of ACE, the user may define, view and invoke macros. The use of macros allows the user to define a sequence of ACE commands that may be called many times during an editing session.

Terminal Selection

The advanced CRT-oriented Editor is configured to operate with the Tektronix CT8500 Terminal. For optimum performance and software support under the license agreement, Tektronix recommends the CT8500. ACE, however, may be configured to operate with alternate CRT terminals. Depending on the terminal functions, some degradation may occur. While ACE is designed to work with terminals of varying characteristics, Tektronix does not warrant or support ACE with terminals other than the CT8500.

The advanced CRT-oriented Editor requires 64 kilobytes of program memory for correct operation. At no time does the size of the workspace affect the size of the file that can be edited.

COMPILERS

Pascal Compilers

In addition to the LANDS Pascal on the 8560, Tektronix offers Pascal compilers for the 8086/8088 and 8080/8085 microprocessors on the 8550 Microcomputer Development Lab.

Both Pascals implement the proposed ISO Standard Pascal and are developed for microprocessors designed with the TEK Pascal extensions. The 8086/8088 Pascal includes the Integration Control System.

MDL/μ Compilers

An expanded form of ANSI Minimal Basic, the MDL/μ Compiler is a high-level language designed specifically for microprocessor-based product development. A system option available with the 8550 MDL, MDL/μ supports software development of the 8080A, the 8085A and the 8080A subset of the Z80 microprocessors. A second system option supports software development of the 6800, 6802, and 6808 microprocessors.

Like Minimal Basic, MDL/μ is easy to learn and use. Offering additional advantages such as increased flexibility in variable name and string definition, direct access to I/O ports and absolute memory addresses, MDL/μ also provides enhanced function, statement and operator capabilities.

The MDL/μ compiler produces executable, not interpreted assembly language code. Each program statement is compiled into machine code only once, instead of every time the statement is executed. Thus, fewer operations result in faster and often more compact code for final program execution.

MDL/μ makes possible a module-oriented approach to software development. The programmer may create user-defined libraries of assembly language code or may use routines from the MDL/μ support routine library. These callable routines are stored on flexible disks in object code and are brought into the main program at link time. All support routines except those relating to I/O activities are serially re-entrant; that is they use no temporary values other than those in the registers and on the stack. Register contents are saved when an interrupt occurs and restored when the interrupt is completed.

An additional feature of the MDL/μ compiler is that two statements, Uses and Provides, allow variables, functions and procedures to be shared by different modules of the main program.

Tektronix offers service training classes on Microprocessor Development Labs. For further training information, contact your local Sales/Service Office or request a copy of the Tektronix Service Training Schedule on the return card in the center of this catalog.

Assemblers Support

Tektronix Assemblers support software development for a wide range of microprocessors, thus allowing you the flexibility to choose the microprocessor best suited to your particular application. Each assembler also maintains identical operational characteristics for each microprocessor supported, greatly facilitating your ability to move from one microprocessor to another.

The assembler, which recognizes the instruction set, registers addressing modes, and full address space of the specific microprocessor, then translates assembly language statements into machine instructions (object code) for that microprocessor. However, the programmer may use the same assembler directives and advanced programming features, such as time-saving macros and language extensions, with every assembler.

Powerful macro capability enables the progammer to write a segment of source code only once, and call it up for in-line code expansion as often as required. Additionally, parameters can be passed to the macro, allowing a different sequence of code for each invocation.

Conditional assembly directives allow a sequence of source code statements to produce object code that varies according to conditions. For example, a statement or statements inside an IF block will be assembled if the operand expression with the IF directive is true. This feature serves to reinforce the macro capability, allowing the designer to customize the final program.

Other language extensions allow operand expressions to contain bit and string manipulations as well as standard arithmetic operations. Data constants may be entered as binary, octal, decimal, hexadecimal, or ASCII characters.

8550 Assembler Support: 8080A, 8085A, Z80, 6800, 6801, 6802, 9900, 9989, 3870, 3972, F8, 1802, 8048 Family, 8051, 6500/1, 6809, 8086, 8088, 68000, Z8001, and Z8002.

8560 Assembler Support: 8080A, 8085A, Z80, 6800, 6801, 6802, 1802, 8048 Family, 8051, 6809, 9900, 9989, 8086, 8088, 68000, Z8001, and Z8002.

Linker

The Linker merges one or more object modules into a load file that is suitable to load into the development system's program memory. The load file contains executable program instructions and data. The Linker assigns exclusive address ranges that each program section will occupy.

Any of the following attributes may be defined at link time: relocation type of a section, exact or approximate location of a section, global symbol values, and address of the first instruction to be executed. The programmer may specify simple linking operations with a single command line. Special or complex operations can be specified with a series of Linker commands from a command file.

The user can list the location of all global symbols and sections, section length, unresolved references, undefined symbols, and the transfer address.

Library Generator

The Library Generator is used to create and maintain object module libraries. Subroutines commonly used by one or more object modules may be stored in a library file. These subroutines are developed and assembled separately and the resulting object modules stored together in the library.

The Library Generator allows you to insert, delete, or replace object modules in the library. Any object module contained in a library can be individually accessed by the Linker. At link time, the Linker will insert in the load file the object module of any routine that your source program calls. The user can list defined and undefined global symbols in each module of the library.

CT8500 TERMINAL

The CT8500 Terminal is an optional peripheral recommended for use with the Tektronix 8540, 8550 and 8560.

The CT8500 can display a full 25 lines at 80 characters per line on its 12 inch diagonal display screen. A complete set of upper- and lower-case ASCII characters is provided. The green-on-black display with adjustable brightness level is easy to read and can reduce eye fatigue in extended use.

The detachable keyboard for the CT8500 Terminal is arranged in an office typewriter configuration to aid new user familiarity. Eight programmable function keys can be user-defined. Up to a 64-character command or character string can be generated with a single key stroke. The two page memory of the CT8500 allows buffering and scrolling of up to 4000 characters. Visual field attributes of blink, reduce, inverse, underline, and blank, as well as seven combinations of these attributes can be obtained. Alternative modes of operation allow the terminal to be used for local editing or to be controlled by a host computer using the many available remote commands. Other terminal operating modes are described in the following paragraphs.

Tektronix software tools include various Editors (Language-Directed and CRT-oriented), Pascal and MDL/μ Compilers, a variety of Assemblers, a Pascal Debug, and a Linker to merge object modules.

TERMINAL OPERATING MODES

Local
Off-line data entry with full editing capability. Block mode transmission by page or line.

Remote Power Up
Full duplex character-by-character transmission. Local Functions active include: full editing capability, two page download memory with paging and scrolling.

Remote-Host Control
Full duplex character-by-character transmission. Remote Power Up local functions are disabled. Keys transmit a two-byte code sequence to the host.

Monitor
Displays all transmitted characters, including control characters.

Test
Provides verification of the display unit capabilities.

Learn
Allows the terminal to learn the user definition of the eight programmable function keys.

CHARACTERISTICS

Display Paramaters
Alphanumeric Mode Format: 25 lines at 80 characters/line.
Memory: Two pages (50 lines x 80 characters per line = 4000 characters).
CRT Size: 12 inch (304 mm) diagonal.
CRT Type: Non-glare (P31 Phosphor).
Refresh Rate: 50 or 60 Hz, switch selectable.
Visual Attributes: Blink; Reduce; Blank; Inverse; Underline; Blink and Underline; Blink and Reduce; Blink and Inverse; Reduce and Underline; Blink, Reduce and Underline; Inverse and Reduce; Blink, Inverse and Reduce.

Keyboard Characteristics
Detached 79 key with auto repeat. Separate cursor positioning, programmable tab, backspace, eight programmable function keys, edit capability.

COMMUNICATIONS

Interface — EIA Standard RS-232C; full duplex; parity enable/disable.
Selectable Baud Rates — 110, 150, 300, 600, 1200, 2400, 4800, 9600 externally switched.
Cable — 3 m (10 ft).

ENVIRONMENTAL CHARACTERISTICS

Operating Temperature Range — +10°C to +40°C (+50° to +104°F).
Storage Temperature Range — −55°C to +75°C (−67° to +167°F).
Operating Altitude Range — Sea level to 3000 m (10,000 ft).
Storage Altitude Range — Sea level to 12 000 m (40,000 ft).
Operating Humidity — To 90% relative noncondensing.

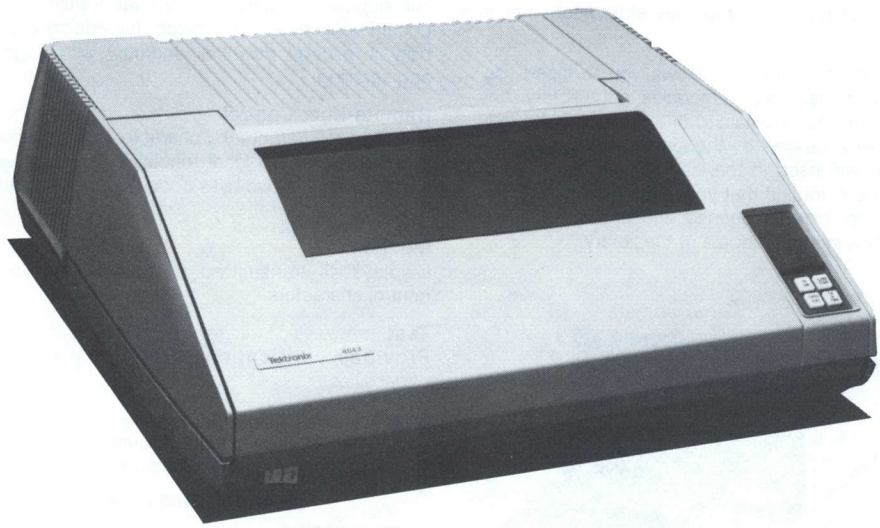
AC POWER

Input Voltage Selection — 115 or 230 V ac switch selectable at 50 or 60 Hz.
Power Consumption — 65 W maximum.

PHYSICAL CHARACTERISTICS

	Cabinet		Keyboard	
Dimensions	**mm**	**in**	**mm**	**in**
Width	456	18.0	456	18.0
Height	318	12.5	76	3.0
Depth	508	20.0	222	8.7
Weight	**kg**	**lb**		
Net	19.2	42.5		

Order CT8500 CRT Terminal **$2,700**



4643 Printer

The Tektronix 4643 Printer provides fast, high-quality, impact printing that is suitable for most data processing applications. With high reliability built in, the 4643 is a convenient and economical choice requiring no preventive maintenance and infrequent servicing.

The 4643 is a fast and highly reliable serial printer for use with the 8500 Series development systems. The 4643 can be connected to either the 8540, 8550 or 8560 to provide high quality hard copy at a modest cost. The 4643 connects via an RS-232 interface, so no special interface cards or mainframe options are required for operation.

Long, reliable service can be expected from the 14-wire matrix head component. The 4643 backs up the printing of each character with more head wires to assure an expected (head) life of more than 300 million characters with no maintenance except normal cleaning. This figure normally means at least two full years of continuous work from a single matrix head. The fabric ribbons continuous loop cassette is usable for at least 5 million characters. Both the matrix head and ribbon cassette are quickly operator-replaceable, eliminating the need for a service call.

High quality matrix printing is ensured by the unique 14-wire printing head. the 7 x 7 format print font permits easy reading and the operator can specify condensed, expanded or standard characters. In the condensed (character) face the 4643 prints out a 132-character line format on an 8 1/2 x 11 in sheet.

Because the 4643 uses impact printing, six very legible copies (including five NCR or carbon copies) can be made to save time and avoid the expense of photo copies.

You can generate output simply with the easy-to-use 4643 Printer. The few operator controls needed are conveniently clustered at the front of the machine.

No attendance is necessary when the 4643 is running because the paper supply sensor automatically lets the machine print to the end of the last form. With either front, back or bottom loading ports, loading the machine is also an easy task. The operator may quickly position the pa per to be loaded with the help of built-in horizontal and vertical alignment guides.

Compatibility

The printer of choice for high technology systems, the standard Tektronix 4643 is RS-232 compatible and can be interfaced with most standard RS-232 data processing instruments and systems. Option 01 provides a parallel interface. The 4643 is compatible with the following Tektronix products: 4010 and 4110 Series Terminals, 4020 Series Terminals, and 4050 Series Desktop Graphic Computing Systems; the 8001, 8002A, 8540, 8550 and 8560 Microprocesosr Labs; the S-3250, S-3270 and S-3280 Semiconductor Test Systems; the 7612D and 7912AD Programmable Digitizers.

Fast But Not Expensive

The 4643 Printer uses bi-directional logic technology to print 340 characters/second. With a full 132 character line, speeds of 125 lines/minute are nominal. Even faster throughput rates are used for printing graphs and tables. The 4643 Printer rivals the speed of many line printers but is available for the modest price of a matrix printer.

Practical for Many Applications

This versatile printer can be used, for example, as a fast way to record the stages-in-process of software program development. It can also provide the hard copy needed to analyze research and development data. Because the 4643 output is of report quality, you need only to push a button to generate reports on your research, programming or statistics directly from your data base. For added convenience, you will find the 4643 very useful in time consuming tasks such as label generation, previewing text and correcting the format of manuals or letters prior to typesetting.

Virtually no maintenance means an even greater savings, and less downtime for repairs as well. A diagnostic display and self-testing routine virtually eliminate the need for preventive maintenance calls. On the infrequent occasion that something goes wrong, you will find out directly from the machine.

Both the matrix head and ribbon cassette are quickly operator-replaceable, eliminating the need for a service call.

CHARACTERISTICS

Printing Speed — 340 characters/second.

Character Density
Condensed — 219 characters/line.
Standard — 132 characters/line.
Expanded — 72 characters/line.

Throughput Rate
132 Columns Wide — 125 lines/minute.
72 Columns Wide — 200 lines/minute.
40 Columns Wide — 300 lines/minute.

Paper Slew Rate — 254 mm/s minimum (10 in/s minimum).

Character Set — 128 (96 ASCII plus 32 commonly used international characters).

Vertical (Line) Spacing — 2.4 lines/cm.

Horizontal (Standared Character) Spacing — 3.9 characters/cm (10 or 5 characters/in).

Printing Matrix — 7 x 7 half-dot matrix.

Paper
Type — Continuous fan fold, edge perforated.
Width — 76.2 mm to 406.4 mm (3 to 16 in) at 0.7 mm (0.028 in) maximum thickness.

Ribbon
Type — Fabric, continuous loop, cassette.
Life — Five million characters nominal life.

AC POWER

Line Voltage Ranges — 90 to 140 V ac or 187 to 275 V ac.

Line Frequency Range — 50 to 60 Hz.

Power Consumption — 250 W operating; 125 W in stand-by.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	676	26.6
Height	203	8.0
Depth	592	23.3
Weight	**kg**	**lb**
Net	27.1	60.0

INCLUDED ACCESSORIES

Ribbon Cassette (118-1314-00); RS-232 Interface.

ORDERING INFORMATION

4643 Printer (2400 Baud Standard) **$4,200**
Option 01 — Parallel Interface ..... **NC**
Option 02 — Specify Baud Rate 110, 150, 300, 600, 1200, 4800, 9600 ..... **NC**
Option 03 — 8500 Series Interface Compatibility ..... **NC**

OPTIONAL ACCESSORIES

Pedestal Order 118-1335-00 ..... **$195**

PROM Programmer

An optional PROM programmer is available for use with the 8550 MDL and the 8540 Integration Unit.

The PROM programmer includes the general purpose controller board and a series of front panel plug-in modules. Each plug-in module provides support for a similar group of PROM devices, and can be changed in a few seconds. Programming features include reading, writing, and comparing (for verification) a PROM.

Chips Currently Supported Include:

Intel	Motorola	Texas Instruments
2716	MCM68764	TMS2508
2732/32A		TMS2516
2758/2758S1865		TMS2532
2816		
8741A		
8748		
8749		
8755A		

8540/8560 ACCESSORIES

Flex Disks (box of 10) Order 119-1182-01 ..... **$175**
RS-232 Connecting Cable (15 ft)
Order 012-0757-00 ..... **$140**
HSI Connecting Cable 2.4 m (8 ft)
Order 012-1009-00 ..... **$55**
HSI Connecting Cable 6.1 m (20 ft)
Order 012-1008-00 ..... **$90**
HSI Connecting Cable 15.2 m (50 ft)
Order 012-1007-00 ..... **$125**
HSI Connecting Cable 76.2 m (250 ft)
Order 012-1010-00 ..... **$395**

Microcomputer Development Lab Workshops and Seminars

Tektronix offers Microcomputer Development Lab Workshops and Seminars in a number of locations throughout the year. The workshops and seminars are intensive and are designed to meet the demanding challenges of the growing microcomputer development market.

The Development System in the Design Process Workshop

The Development System in the Design Process Workshop follows the microcomputer-based design process for initial software development through hardware/software integration and PROM programming. The workshop stresses the overall operation of the 8550 development system, the DOS-50 operating system, and how the 8550 supports the design process. Topics covered include volume structures, program design, editing, assembling, linking, library generation, program debugging, I/O simulation with service calls, PROM programming, and intersystem communications.

This highly intensive four and one-half day workshop is intended for the user who has performed at least one microprocessor-based software design at the assembly level with one or more microprocessors. Throughout the workshop the attendee gets extensive hands-on experience, for a total understanding of development system concepts.

Software Design and Debugging Workshop

The Software Design and Debugging Workshop emphasizes the basics of 8-bit microprocessor software design. The workshop also covers the use of development systems for editing, assembling, debugging, hardware/software integration, and PROM programming.

This intensive four and one-half day workshop provides an educational experience for the person who has limited microprocessor-based software design experience and wants to learn about software design and the use of the development system in microcomputer designs. The workshop includes detailed hands-on lab time to complete the learning experience.

Productivity and the Design Team Environment Workshop

This workshop follows the progression of the software design process, using the team-oriented approach. The design process is first examined from the standpoint of problems encountered in the traditional single-user design environment. The "productivity environment" is then examined as a means of solving the traditional design problems. Students are divided into design teams and are given specialized tasks to simulate the multiuser environment. The productivity tools supported by the 8560's TNIX operating system are demonstrated.

Guidelines for Microprocessor Selection Seminar

The Guidelines for Microprocessor Selection Seminar is a one-day seminar designed to clarify how to evaluate and select the microprocessor best suited for a given application. Several 8- and 16-bit microprocessors are examined and compared based on pertinent selection criteria. By the end of the seminar, the attendee will know the factors to consider when selecting a microprocessor, as well as how to select the microprocessor that best suits his application.

The seminar is designed for the person who has an introductory knowledge of computer hardware and software architecture.

Maximizing Microprocessor Software Design Productivity Seminar

This one-day seminar presents methods for organizing and managing a software design team to achieve maximum productivity. Targeted at software project leaders and managers, the seminar presents information about the methods used at Tektronix.

Content is designed for persons involved in software development, principally at the project leader and manager level. Other software team members will gain an understanding of the current trends in design processes.

For detailed information on Tektronix Microcomputer Development Workshops and Seminars, contact your local Tektronix Sales Engineer.