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TR-05-94
Mobile Computer Workstation Technology Developments and Industry Product Reviews

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TECHNICAL REPORT

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NOTE: Further information about this report can be obtained by calling the CPRC information number (613) 998-6342

SUMMARY

The company of Fraser, Popovski & Associates Inc. was contracted to develop a common set of requirements for public safety agencies, in combination with a thorough industry review of current and emerging technologies. In order to accomplish this task, a survey of a large segment of the police and security community was conducted. The ensuing Standard(TR-03-94) is intended to define the elements and performance of the equipment in order to facilitate compatibility and standardization without limiting the design approach of individual suppliers.

This Standard defines the requirements for a mobile workstation from a hardware perspective. The requirements for application software, wireless communication and connectivity through radio systems are considered to a limited extend.

This Standard defines a mobile workstation device as an MS-DOS compatible computer, for installation in a vehicle, with a primary function of being a mobile data communications device. Even though the main function of the workstation is to serve as an integral part of the vehicle's radio communications system, it must be removable as well as capable for use as a personal computer.

In addition to this Technical Report are three others resulting from the contract work:

- Common Requirements for a Police Specific Enhanced Mobile Workstation(TR-04-94)

- Technology Developments and Industry Product Reviews for a Police Specific Enhanced Mobile Workstation(TR-05-94)

- Future Trends and Technology Developments for Police Mobile Workstations(TR-06-94)

The Canadian Police Research Centre would like to thank Mr. Robert Fraser, Mr. George Popovski, and Mr. David Burns of Fraser, Popovski & Associates Inc., the Committee members, Ms. Francine Boucher of the Royal Canadian Mounted Police, Mr. Peter Ungar of Peel Regional Police, and Constable Graydon Patterson of Ottawa Police, and finally, all those police and security agencies that participated in this very worthwhile project.

SOMMAIRE

Une entente a été conclue avec la compagnie Fraser, Popovski & Associates Inc. en vue de l'élaboration d'une série commune d'exigences pour les organismes de sécurité publique, en plus d'un examen approfondi des technologies actuelles et naissantes offertes par l'industrie. Afin de réaliser ce projet, on a fait un sondage auprès d'une grande partie de la communaute policière et des organismes charges de la sécurité. La norme qui suit(TR-03-94) vise à définir les elements et les caracteristiques du materiel afin de faciliter la compatibilité et la normalisation sans imposer de limites aux conceptions des fournisseurs individuels.

La présente norme definit les exigences d'un poste de travail mobile du point de vue du materiel. On y traite dans une certaine mesure des exigences reliées aux logiciels d'application, à la communication sans fil et à la connectivité par des liaisons radioelectriques.

La norme définit un poste de travail mobile comme étant un ordinateur compatible avec le MS-DOS pouvant Qtre installé dans un véhicule et servant avant tout de dispositif mobile pour la transmission des don&es. Même si la premiere fonction du poste de travail est de servir de partie intégrante du système de radiocommunications du véhicule il doit être amovible et utilisable comme ordinateur personnel.

A cause des travaux de ce contrat trois autres rapports en résulte en plus du Rapport technique:

- Exigences communes reliées à un poste de travail mobile amélioré destine à la police(TR-04-94)

- Mises au point et examens des produits de l'industrie pour un poste de travail amélioré destine à la police(TR-0594)

- Tendances futures et développements technologigues pour des postes de travail mobile destines à la police(TR-06-94)

Le Centre canadien de recherches policières aimerait remercier MM. Robert Fraser, George Popovski et David Burns de la compagnie Fraser, Popvoski & Associates Inc., les membres du comité, Mme Francine Boucher de la GRC, M. Peter Ungar du Service de police regional de Peel et l'agent Graydon Patterson de la Police d'Ottawa et, finalement, tous les services de police et de sécurit0 publique qui ont participé à ce projet interessant.

REPORT ON TECHNOLOGY DEVELOPMENTS AND INDUSTRY PRODUCT REVIEWS FOR A POLICE SPECIFIC ENHANCED MOBILE WORKSTATION

November 8th, 1993

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2. EXECUTIVE OVERVIEW

2.1. Purpose

The purpose of this survey is to research the present availability and future trends for development of mobile workstation devices suitable for use by Police and other Public safety agencies. More specifically the focus of the survey is on MS-DOS compatible ruggedized mobile computers suitable for use mounted within a police vehicle or as a stand-alone portable platform.

2.2. Objective

The objective of this study is to examine the performance and features of the mobile workstation devices currently available on the market and to determine if the common requirements of various Police agencies in Canada can be met by off-the-shelf standard products. A specific effort is made to determine the degree of suitability for a commercial grade laptop PC to serve as a mobile data computer.

All relevant environmental, functional, ergonomic and physical factors have been considered. The information presented in this review together with the common requirements, identified in the survey of the Police community in Canada, will be used to produce a standard for a Police mobile workstation. The standard will reflect the common requirements of the users and will consider the available technologies to meet this requirement.

2.3. Scope

The main focus of this review is on the ruggedized MS-DOS compatible mobile computers, designed specifically for use in the demanding mobile environment, for real time messaging and computer network access, as well as for stand-alone general application in and outside the vehicle. In order to gain an appreciation of current technology developments leveraged by economies of scale, a reprint of a review of 39 commercial MS-DOS compatible PC notebook computers, published in the August, 1993 issue of PC Magazine is included in Annex “A”.

Furthermore, the environmental specifications of several popular commercial notebooks with reputations for durability are included. This information, not normally published or in advertising literature, was collected by direct contacts with engineering and marketing specialists from the respective manufacturers

2.4. Methodology

Information presented, regarding special ruggedized mobile workstations was obtained mainly by personal contact with engineering specialists, and marketing and sales executives from a variety of manufacturers. Most of the presented information concerns product currently available on the market. Only the engineers from IBM were authorized to discuss future product offerings. All participants freely discussed general issues regarding the trends in technology development and their views of the market needs for a universal mobile workstation.

The material regarding features of commercial PC notebooks was obtained by research of current literature. The collection of data related to the performance of commercial notebooks under extreme environmental conditions was more difficult. Only a small number of manufacturers were cooperative, the rest either disregarded our request for information or stated that addressing applications other than these for general business computing is outside of their marketing focus.

A summary of the environmental specifications for the PC notebooks from several important manufacturers is given in Table 3.

3. INTRODUCTION

Over the past years the dedicated mobile data terminal has been the predominant device used for vehicular communications by law enforcement and other public safety agencies. The terminals, comprising of a display screen, a keyboard, and limited memory and computer power, have been traditionally developed under the principals of a "closed architecture", with proprietary circuits and closely guarded patents.

Furthermore, special, often single-sourced software, is required to support the functionality of the terminal. This design approach offers very limited hardware expansion capability and makes software upgrades difficult and costly.

On the other hand, mobile data terminals are rugged devices designed to the demanding industry and government standards for communications equipment intended for use in vehicular environments. They are supplied with ergonomically designed mounts allowing convenient operation and easy installation, and often come with all the necessary interface devices for integration with the radio communication system.

The rapid advances of computer technology, the establishment of the "open architecture" as the basic principal for hardware and software design, and the universality of the MS-DOS operating system and the Microsoft Windows graphical user interface are enabling applications, not even imaginable for mobile implementation only several years ago. The traditional configured mobile data terminal is poorly suited for this dynamic environment.

New applications require computer power and data storage capacity far outpacing the capabilities of a terminal device. The mobile data terminal is being replaced by the mobile workstation. Furthermore, the emerging wider concept of the "mobile office" requires the workstation to be removable from the vehicular installation and be used as an autonomous portable device.

For the purpose of this review, the mobile workstation is defined as a MS-DOS compatible computer, installed in a vehicle, with a primary function of being a mobile data communications device. Even though the main function of the workstation is to serve as an integral part of the vehicle's radio communications system , it could be removable for use as a stand-along portable computer. This last requirement calls for a device very similar in form and functionality to the increasingly popular portable laptop (notebook) computers.

On the other hand, most portable computers available on the market today are commercial devices intended for office use and are not designed to withstand long and indiscriminate exposure to the harsh automotive environment. Nevertheless, the wide availability of product, the dazzling array of features, available options, increasing processor power, and relatively low cost make the modern commercial laptop an attractive alternative to the more costly and somewhat feature-limited ruggedized mobile computer.

The implementation of commercial portable computers as mobile workstations has to be approached with extreme caution. It should be undertaken only after complete understanding of the limitations of the commercial product and the completion of a study addressing the relationship between the basic issues considered during the design of the system, including functionality, suitability to the environment (both physical and operational) and the cost of implementation and exploitation.

The focus of this study is primarily on the ruggedized, specialized mobile workstation. In addition the main functional elements (display, keyboard, mass memory storage devices, etc.) of modern portable computers are examined with an emphasis on performance under adverse environmental conditions. The environmental specification limits of several popular commercial notebooks are also discussed.

These specifications, seldom published in the marketing literature were obtained by direct communications with the respective manufacturers. A comprehensive review of 39 popular commercial notebook computers, published in PC Magazine from August 1993, is presented in Annex “A”.

4. THE MOBILE ENVIRONMENT

The prime objective of an effective system design is to achieve balance between cost, performance and functionality, while meeting the requirements for the highest possible reliability under the extremes of the intended physical environment. It is often mentioned in technical literature that next to space the mobile environment presents the biggest challenge for the designers of electronic equipment. In the summer, surfaces inside of the automobile's passenger compartment, exposed directly to the sun radiation can easily reach temperatures exceeding +80° C. In the winter -30°C is a temperature not considered extreme for many Canadian cities. In addition, the repeated exposure to vibration with wide frequency range and shock with considerable force, is not an unusual condition.

For over 40 years the mobile radio communication industry in North America has accepted the extremes of the environmental parameters recommended in the various EIA specifications as a measure of performance. All equipment designed for use by the Police and other Public Safety agencies meet and most often exceed these specifications. In our opinion there are no compelling reasons for a ruggedized mobile workstation, which is an integral part of the communications system, not to be expected to survive without damage a prolonged storage, or even remain fully operational, while subjected to the following EIA environmental limits:

- Temperature: -30°C to +60°C
- Shock: 20G with 11 millisecond duration
- Vibration: 1.5G

All of the ruggedized workstations reviewed in this document meet or exceed the above requirements for storage, and two, the Mobitron PCMOBILE and the Motorola 9100-386 Mobile Workstation are specified to be operational at the same extreme conditions. None of the commercial PC notebooks, for which we were able to obtain data, meet the same requirements.

For practical applications, the time required for the workstation to become fully operational at normal operating conditions (room temperature) after prolonged exposure to extreme temperatures, is even more important than the actual limits at which operation is guaranteed. Unfortunately this information is not readily available and has to be obtained by tests performed in each individual case before a final decision is made to implement a given product.

5. REQUIREMENTS OF POLICE AGENCIES

Based on the analysis of over forty responses to our survey of the common requirements for mobile data workstation in the Police Public Safety community and extensive interviews with marketing specialist from some of the manufacturers (IBM, Motorola, Ericsson, ElectroCom) which have good understanding of the Public Safety market, we can draw the following conclusions

1) a ruggedized computer platform is required

2) minimum permitted storage temperature shall not bc higher than -25° (-40" is preferable)

3) less than 5 min. warm-up period before reaching full functionality after prolonged cold storage, is required by majority of the users

4) main application is in-vehicle, portability is desirable

5) according to the police survey, detachable keyboard is not required, in contrast, the manufacturers opinion is that detachable keyboard could be very convenient for typing long documents

6) swivel mount is very important

7) in the opinion of the manufacturers the MS-DOC/Windows operating system should be resident in ROM

8) only special rugged hard disk drives are acceptable (the manufacturers have information about persistent problems with commercial grade hard disk drives during trials conducted by police departments in the U.S.A.

9) Floppy disk drives are not reliable for mobile (in-vehicle) operation (manufacturers opinion)

10) some type of removable mass data storage device (RAM cards) is required

11) colour screen is preferable

12) adjustable screen angle is required

13) some form of pointing device (built-in track ball, etc.) is required.

14) touch screen is desirable

15) full travel keys with tactile response are required

16) spill proof keyboard is very important

17) illuminated keyboard is desirable

18) operating shock and vibration resistance according to the manufacturers shall be according to EIA KS 204 and KS 374-A (shock 20G)

19) vehicular docking station or single docking connector for quick disconnect is required if the workstation will be frequently removed from the mobile installation (opinion of the manufacturers)

20) minimum of two RS232 serial ports required

6. WORKSTATION SUB-SYSTEMS AND COMPONENTS

6.1. Microprocessors

The majority of the reviewed ruggedized mobile computers are powered by a member of the 180386 microprocessor family, specified for operation in the "Extended Commercial Temperature" range of -40°C to +70°C. Some are based on the older S-Volt technology other use the newer 3.3-Volt "L" versions. The more powerful 180486 is either not available or offered as an option at additional cost. The 486 CPUs are faster, providing approximately twice the processing power when compared with a 386 running at the same clock speed, but have higher power drain which is a disadvantage when the unit is to be used out of the vehicle powered by the built in battery. However the newer 3.3-Volt technology, advanced power management techniques and the use of Nickel-Metal Hydrate batteries can considerable prolog the time the computer can operate on a single battery charge.

The commercial PC notebooks described in Annex "A" are predominantly powered by 486 type microprocessors. The use of 3.3-Volt technology coupled with advanced power saving technics is the general trend of the Industry.

Most of the commercial units usually employ processors, and other supporting solid-state devices, specified for operation in the 0°C to +70°C range. This seldom presents a practical problem because the modern solid-state devices normally continue to function properly at temperatures considerably lower than the specified temperature limits for other, non-ruggedized, system components, namely displays, mechanical drives and keyboards.

6.2. Displays

Two of the reviewed rugged mobile computers, the ElectroCom MDC-890 and the Motorola 9100-386 use monochromatic CRT VGA compatible displays. ElectroCom reviled that an optional SVGA colour CRT display will be available as an option early in 1994. It should be noted that both ElectroCom and Motorola workstations are intended for use as a vehicular device only. All other ruggedized notebook type portable workstations have monochromatic transflexive LCD (Liquid Crystal Display) screen with built-in back light, thermostaticlly controlled heater, and extended storage temperature range.(-40°C to +70°C). The heater is required in order to improve the display performance at low temperatures.

All of the commercial notebook portable computers described in Annex "A" have VGA or SVGA displays based on some variation of the LCD technology. Some are monochromatic other are colour. The newer Active-Matrix colour screens employ LCD panels with a driver transistor associated with each individual pixel, to provide the brightest and sharpest image possible today. 'I'he penalty is increased power consumption (up to 30%) and increased cost. However, the latest dual scan technology makes the less expensive passive-matrix displays more acceptable.

The standard LCD displays, without built-in heaters, have relatively high minimum operating temperature (-5°C approx.) limit. With the decrease of temperature beyond this limit the response of the display becomes progressively slower and at some low temperature (depending on technology and construction) the display becomes totally inoperative but will recover to full functionality after warm up. If exposed to temperatures below the absolute minimum allowable limit the display will suffer permanent damage. The temperatures at which the LCD screen becomes permanently damaged are not usually specified by the workstation manufacturer. It is safe to assume that any prolonged exposure of the display to temperature below the minimum specified storage temperature could potentially result in damage. It is very important that this is taken in consideration before a commercial product is introduced to the mobile environment.

6.3. PCMCIA Card Slots

Three different versions of PCMCIA (PC Memory Card International Association) expansion slots have reached the status of universal industry standards. All use the same style 68 pin, connector and have identical width and depth but have different height in order to accommodate devices with different thickness. Type I slots are intended for RAM, Flash Memory, Static Memory (SRAM) EPROM etc. Type II are typically used for modems and LAN adapters and large solid-state (RAM) drives. The type III slots are primarily for rotating mechanical mass storage devices (hard disk drives), memory enhancements and radio communication devices. PCMCIA capabilities are important because they provide the only currently available standard facility for functional expansion of a portable computer.

Of the ruggedized workstations reviewed in this document only one does not have PCMCIA expansion slots. Only 16 of the 39 commercial portable computers have PCMCIA expansion capabilities.

6.4. Mass Data Storage Devices

The preferred mass data storage devices for the mobile environment are the all solid-state Flash RAM, battery backed SRAM and RAM card devices with no moving parts which typically fail under low temperature extremes and high levels of mechanical shock and vibration.

Flash RAM is ideally suited for storage of program code and fixed read only data. It is totally non-volatile and does not require any electrical power for retention of data. The Flash RAM is re-programmable "in place" without removal from the equipment.

Flash RAM PCMCIA devices are available with capacity up to 40 MB, but modules with size above 2-3 MB are expensive.

Interchangeable 1 to 40 MB RAM PCMCIA compatible cards are currently available on the market. Larger capacity devices (up to 80 MB) are scheduled for commercial introduction in 1994. RAM cards are a convenient removable storage media and are excellent hard drive substitution.

Battery backed SRAM (Static RAM) PCMCIA compatible modules have recently appeared on the market. 'I'he SRAM is very fast, with typically less than 100 nanoseconds access time and are available with capacity of up to several mega bytes.

Some of the reviewed ruggedized workstations can be configured with mechanical hard and floppy disk drives as an option but these configurations have significantly reduced operating temperature range. ElectroCom offers a thermostatically controlled 128 MB hard drive which is automatically switched off (made not available for data storage or retrieval) at temperatures below -5°C. IBM is considering to offer as an option a ruggedized hard drive with built-in automatic heater for improvement of the low temperature performance.

The commercial portable computers equipped with PCMCIA slots can use all of the above described solid -state data storage options.

6.5. Keyboards

All of the reviewed ruggedized workstations are equipped with keyboards protected from dust and liquid spills. The keys have tactile response and are fully operational in sub-zero temperatures. The keyboards are backlit with manual or automatic light intensity control. All workstations but one (the Motorola 9100-386) have detachable keyboards for laptop use.

Non of the commercial portable computers have detachable keyboards and illumination of the keys.

6.6. Batteries

Nickel Cadmium (Ni-Cd) batteries are the predominant internal power source for most of the ruggedized and commercial portable workstations. They are relatively inexpensive and have satisfactory power to weight ratios. They also possess the familiar property to develop "memory" and lose effective capacity if not allowed to fully discharge between charges.

The newer technology Nickel Metal Hydrate batteries are used on some workstations.

Nickel Metal Hydrate batteries have 30% better power to weight ratio than the Ni-Cd, and do not develop memory but are considerably higher (up to two times) in price. Ni-MH batteries self discharge at faster rate than nickel cadmium batteries. Typically, they lose approximately 25% of their charged capacity in five days compared to 10% for the Ni-Cd.

In addition the operating temperature for Ni-MH batteries is -10°C to +60° compared to -30°C to +60°C for Ni-Cd.

7. RUGGEDIZED WORKSTATIONS

7.1. General Overview

The number of manufacturers offering truly ruggedized MS-DOS compatible mobile workstations is very small. To a certain extent, this reflects market conditions where demand for rugged mobile computers is at present very small. Historically, the majority of police agencies have used dedicated mobile data terminals for real time messaging and computer access. The trend for replacement of these terminals with more flexible mobile data computers is in its infancy. Although many agencies in Canada and the U.S.A. have done some preliminary investigative work, or have plans to do so, very few have implemented mobile workstations for support of their operations.

The manufacturers of mobile data terminals are responding to this trend by adding to their product line powerful MS-DOS mobile computers, packaged like the traditional mobile terminal. Equipped with emulation programs these platforms provide full back compatibility with the older technology while offering expanded functionality and full compatibility with the MS-DOS operating system. Two manufacturers, ElectroCom and Motorola offer mobile workstations falling in this category. On the other hand, most leading manufacturers of commercial business portable computers are waiting for the product requirements and the market size to become better defined before making decision to participate.

Three suppliers: Bell Mobility, IBM and Mobitron have chosen to offer a mobile computer in a package similar in style to the commercial laptop (notebook) computer, thus addressing the requirement for a removable workstation capable to operate as a stand-along device outside of the vehicular installation. Of the three IBM is the most powerful and flexible platform offering options of active matrix colour displays, heated hard drive and a 486 processor. All three offer quick disconnect docking facilities and have environmental specifications suitable for mobile application.

7.2. Equipment Description

7.2.1. Bell Mobility UMC 3000

The Bell Mobility UMC 3000 is a ruggedizcd mobile computer based on the Intel 20 MHz 80386SX processor. By construction the unit resembles a conventional laptop computer. The latest information sheet for the unit

lists only external DC as an available power source option. It is not clear if an internal battery is available.

The UMC 3000 comes with 2MB system RAM (expandable to 8MB), a 2.4MB solid-state disk using flash memory is standard, while a 10MB solid-state drive is available as an option. An IDE hard drive interface is part of the mother board. Both drives have access times of lms. A 3.5" and 5.25" floppy diskette drive controller is also part of the mother board and is accessible via RS 232 or the parallel port. PCMCIA expansion ports are not provided.

The unit is equipped with a 10.5" diagonal (267 mm) B&W, backlit LCD display with adjustable tilt angle, capable of displaying 16 shades of gray. The brightness and contrast are adjustable by means of manual controls. A glass plate fitted in front of the screen provides impact and glare protection. The VGA™ controller provides 640x480 lines resolution in graphic mode and 25x80 lines in text mode. An external VGA™ monitor is also supported.

The UMC3000's 92-Key keyboard (including ten programmable special status keys) is backlit for night operation, sealed against dust and liquid, and is fully IBM-AT™ compatible. A manual backlight intensity control is provided. The keyboard has QWERTY layout with key spacing of 19 mm, travel of 3 mm and key size approximately 13x13 mm. One special function key, to double the status keys, and one emergency key, protected against accidental use, are also provided. The special keys, when activated, change colour under software control. The 80 standard keys have bilingual markings. Support for an auxiliary external keyboard is included on the mother board with access via RS232 or the parallel port. No pointing device is standard. Mouse or pen interface is provided via RS232.

UMC3000 has a complete set of I/O ports, including one parallel Centronix port, one serial standard set (DB 25) KS 232 port, one RS 232 sub-set (DB9) port, one external VGA™ port, and one two pin standard PC audio sound port. All I/O ports and the vehicular DC power input port are incorporated in to a single quick connect-disconnect system.

The electrical power is supplied to UMC3000 via the integrated docking connector. The power requirements are DC input of 9 to 18 Volts and nominal current 2A. As mentioned earlier, there is no provision for internal battery.

The UMC 3000's rugged aluminum enclosure measures 86 mm H, 303 mm W and 235 mm D. A built-in retractable handle conveniently doubles as a handrest.

With 5.3 kg. total weight, this unit is heavy compared to the average laptop computer. Even though the weight has no particular significance from a transportation point of view, (as indicated before the UMC3000 is intended primarily for vehicular applications) it has to be considered from installation and safety perspectives.

The environmental specifications of UMC3000 are quite adequate. The operating temperature range of -20°C to +60°C comes short of the EIA limit for temperature performance of mobile radio equipment, but in practice is quite acceptable even for the most demanding conditions. The storage temperature extremes are -40°C to +70°C. The maximum allowable shock (both operating and during storage) is 20G, a number twice better than the average specified for the majority of commercial grade notebook and laptop computers. The maximum operating and storage vibration resistance limit is specified as 1.5G max. (50% greater than the spec. for the better commercial units).

The UMC3000 comes equipped with password access protection, installed MS DOS operating system, file transfer program and diagnostic software.

The solid mechanical construction, good environmental specifications, the flash drives and large 10.5” screen are the strong points of this unit. On the negative side, in our opinion, is the absence of a PCMCIA slot.

7.2.2. ElectroCom MDC-890 Mobile Data Computer

The MDC-890 is the latest addition to the ElectroCom data terminals product offering. It combines all the capabilities of the popular MDC-870 / 880 mobile data terminals with features offered by modern MS DOS based computer technologies integrated into a compact versatile mobile data device. The MDC-890 is a 100% PC/AT compatible computer with a built-in terminal emulation program which creates an operational environment identical to MDC-880 and is compatible with MDC-870. The terminal emulation program provides access to Ericsson GE EDACS trunking , and to many conventional digital data communications networks.

The MDC-890 is packaged like a traditional mobile data terminal. It is not a portable computer. It is a mobile data computer in a mobile terminal package intended for vehicular applications only. This product, in our

opinion will be of interest to organizations presently using the older MDC-870 or MDC-880 and are contemplating to upgrade the existing system with minimum training and without possible confusion during the changeover period.

The MDC-890 is of modular construction. Several primary level modules, including an integrated single board computer based on an Intel 80386DX, 20 MHz microprocessor that can plug into a standard PC ISA bus. A 33MHz 80386DX and a 25MHz 486SLC processors are available options.

The MDC-890 is offered with 1 MB of RAM as standard with 2 MB and 4 MB of memory expansion as an option. In addition a 384 KB flash RAM disk drive, expandable to 1 MB is included. Flash RAM, a form of non volatile, easily re-programmable RAM, is ideally suited for storage of program code and fixed data tables. No electrical power is required in order to retain the data stored in the Flash RAM . The Flash RAM disk is configured as a logical drive A: which contains the operating system and the PCMDT terminal emulation program.

The standard configuration of MDC-890 also includes 128 KB of battery backed static random access memory (SRAM) with access time of 70 nanoseconds, configured as B: Drive. When the external power is off, the data stored in the SRAM module is protected by an extremely long life lithium battery. The battery has shelf life of 10 years and will safe guard against data loss for several years without external power source connected. The SRAM drive also provides faster performance, low power consumption and high reliability in the mobile environment where mechanical disk storage systems do not perform well under extreme temperature and may fail when subjected to vibrations.

The primary mass storage system of MDC-890 is a Read/Write PCMCIA RAM card module. The module stores and reads data on interchangeable external RAM cards available with data storage capacity from 1 MB to 32 MB. Optional MDC-890 configurations can include the available ruggedized temperature compensated 128 MB hard disk drive with shock and vibration tolerance suitable for use in mobile environments. To preserve data integrity and to avoid the possibility of permanent damage, the hard drive is automatically inhibited from operating below -5°C. An external 1.44 MB 3.5” floppy drive is also available.

The MDC-890’s standard display is a 7” (diagonal) monochromatic VGA CRT with maximum resolution of 750 horizontal lines. The light emitting CRT provides, a sharp bright image in a wide variety of light conditions and offers 40” of horizontal viewing angle.. A Polaroid@ Twist Sun filter

laminated to an acrylic implosion shield, protects the screen from mechanical damage and reduces the effects of glare and reflections from external light sources. Manual controls for contrast and brightness are provided.

The standard MDC-890 features a fully IBM compatible VGA controller. The standard resolution in text mode is 80 columns by 25 lines. When running the PCMDT terminal emulation program, the easier to read, 40 columns by 25 lines format is automatically selected. In graphics mode the resolution is the standard VGA 640 by 480 pixels. An optional SVGA video adapter and a colour CRT display will be available in the near future.

The MDC-890 is equipped with a Extended Laptop PC compatible keyboard. The keyboard has 4 dedicated cursor control keys and 12 special function keys. 'I'he keys have positive tactile response to -40°C and are protected against dust penetration and accidental liquids spills. The keyboard swivels and is adjustable over a wide range of angles. In addition it is easily detachable for laptop use. Furthermore the keyboard is mounted in a such fashion as to allow one-handed operation.

All MDC-890 controls are located on the front panel, which is angled for easy access. The panel has manually adjustable illumination. A special emergency key, protected from accidental activation, and several status LED indicators are also located on the front panel. The status indicators remain operational even when the SRT screen is blanked.

The MDC-890 standard set of I/O ports consist of4 serial RS-232 ports, one standard Centronix parallel port, interface for one external floppy disc drive and one auxiliary keyboard port. All I/O connectors are recessed for protection from accidental mechanical damage and are electrically shielded to reduce spurious emission and noise.

The MDC-890 operates on external DC power of 8 to 19 Volts (13.8 V nominal) with current drain for the standard configuration of 2.5 Amps. An uninteruptable power supply (UPS) containing a rechargeable battery is standard. The UPS allows the work station to function in case of external power failure. It also assures undisturbed operation in presence of automotive power transients and during the vehicle starting . The built-in battery is automatically recharged by an internal charging circuit.

The case of M DC-890 has dimensions of 368 mm I-I, 330 mm L and 31 mm W. It is constructed Of molded Cross linked Polyethylene. This material has high impact resistance and is inert to erosion from chemicals common to the mobile environment. The corners and the edges of the case are rounded to reduce mobile operator exposure to accidental cuts and

bruises. A mount for permanent vehicular installation of the workstation is standard. Optional custom mounts are available for accommodation of special requirements , including the requirement for clearance for full deployment of dual airbags. The MDC-890 enclosure meets the UL combustion standards.

The MDC-890 is specially designed for reliable operation in the demanding vehicular operating conditions. The operating temperature range for units with standard configuration is -20°C to +60°C. The operating temperature range for the optional hard drive is -5° to +60°. The workstation remains operational below -5°C, but the hard drive operation will be inhibited by a special thermal control circuit to protect it fro damage.

The storage temperature range is -40°C to +70°C. The maximum permitted relative humidity is 95% non condensing.

The maximum permitted vibration exposure (during storage and operation) meets the limits specified by the EIA RS-374A Standard. The maximum shock (during storage and operation) is specified as 20G , measured per EIA RS-204B.

The MDC-890 meets the requirements for EM1 emission of FCC part 15 and has electrostatic discharge immunity (ESD) up to 20,000 Volts.

The MDC-890 comes with the MS-DOS operating system (the current revision at time of shipping) and the PCMDT terminal emulation program installed on the Flash RAM A:Drive. Terminal emulation programs for IBM 3270 and DEC VT-100 terminals are available as an option.

The MDC-890 is a rugged mobile data computer designed for public safety use. It provides durability , MS-DOS compatibility and an interface familiar to the users of the popular ElectroCom mobile data terminals. The standard configuration of the unit does not include devices with moving mechanical part which could fail if subjected to environmental extremes. The modular construction and the open architecture ISA internal bus allows for easy and inexpensive upgrade of the MDC-890 by using industry standard components from many different vendors. On the negative side, the 7” screen is too small for word-processing and some other popular DOS applications.

7.2.3. IBM Rugged Public Safety Mobile Workstation

From all contacted computer manufacturers, IBM was the only one to reveal details about a future product not yet introduced on the market. From the completeness of the information and the confidence with which it was presented we draw the conclusion that the product is in the final design stage and will be on the market in the very near future.

The workstation, a replacement for the recently discontinued ruggedized IBM laptop PC, has been designed with the participation of the System Integration Department of IBM Canada and is intended to meet the requirements for mobile computing in the public safety and the transportation markets.

The portable computer will be packaged as a traditional notebook PC. It will be based on the Intel 486 processor family with several possible processor upgrade options.

4 MB system RAM with zero wait state will be standard with optional expansion (possibly to 12 MB). 64 KB cache memory will be included. Also included will be 2 (two) Type II PCMCIA expansion ports. A rugged 80-100 MB hard drive and 10, 20 and 40 MB solid-state drives will be available.

The standard B&W LCD display will have adjustable contrast and back light intensity. An integrated film heater will be used to improve low temperature performance. VGA™ will be standard. Active matrix colour display, SVGA and touch screen will be available options.

The keyboard will have a minimum 84 keys plus a number of special function keys and a special emergency key. A spill and dust proof membrane type keyboard will be standard. Tactile keyboard will be offered as an option.

A quick connect-disconnect plug-in system for connection to a vehicular docking station will be incorporated in the design. Detailed information about the docking station is not available at this time.

A full compliment of I/O ports consisting of one parallel port, one serial RS232 port on the workstation (four additional RS 232 ports will be available on the docking station), one external floppy diskette drive port and a SCSI hard drive interface will be a standard offering.

The environmental target specifications of the IBM ruggedized workstation reflects a commitment of meeting and exceeding the

Industrial and Government standards for electronic equipment in mobile applications.

The target operating temperature range is -30°C to +50°C. Integrated heaters incorporated in the screen and the mechanical hard disk drive will be used for proper cold temperature operation.

The unit shall be able to survive storage temperatures from -40°C to+85°C for an indefinite period of time.

The permissible non condensing operating humidity ranger will be 10% to 95%.

The water resistance will be according to MIL STD 810E, Method 506.2, Procedure 2.

The target for vibration resistance during operation is MIL STD 810E, method 514.4. 'I'he minimum acceptable performance will be according to RS374-A. It is not clear if the vibration resistance specification targets will be applicable to workstations equipped with mechanical hard disk drives.

The shock resistance target specifications for both operational and non operational (storage) modes is 100G for 11 ms half sine cycle. The minimum acceptable limit is 75G for 11 ms half sine.

The workstation is expected to be available in 1994. The target list price for a machine with basic configuration (4 MB RAM, VGA™ and no hard drive) is reported to be approximately $4,500 US.

The advantages of the ruggedized IBM workstation will be numerous: modern configuration, variety of mass storage options, availability of SVGA and some of the most robust environmental specifications in the Industry. The only reservation we have is that the target for list price is very aggressive and it will be very difficult to achieve.

7.2.4. Mobitron Inc. PCMOBILE™ Mobile Computer

The PCMOBILE is a sister machine to the Bell Mobility UMC 3000. Both units were designed by the predecessor of Mobitron Inc.- Lectogram Corporation. Mobitron have modernized the design, and have added several options not available on the UMC3000.

PCMOBILE is a ruggedized mobile/ lap top computer based on Intel 20 MHz extended temperature range (-40°C to +85°C) 80386SL processor. It

includes an internal Nickel-Metal-I Iydrate rechargeable battery which provides of up to 4 hours of operation on a single charge.

The PCMOBILE™ comes with 2 MB system RAM (expandable to 8MB) a 5 MB solid-state disk, using flash memory is standard with a 20 MB solid state drive available as an option. Both drives have access time of lms. An IDE hard drive interface is part of the mother board. A 3.5" and 5.25" floppy diskette drive controller is also part of the mother board and is accessible via KS 232 or the parallel port. A rugged 120 MB internal hard disk drive is available as an option. It should be noted that the hard drive can not operate over the full operating temperature range of the workstation and has limited vibration and shock resistance. Two Type 2 PCMCIA expansion ports are available as an option. One PCMCIA Type 3 slot is also available.

The unit is equipped with a 10.5" diagonal (267 mm) B&W, backlit LCD display with adjustable tilt angle, capable of displaying 16 shades of gray. The brightness and contrast arc adjustable by means of manual controls. A glass plate fitted in front of the screen provides impact and glare protection. The VGA™ controller provides 640x480 lines resolution in graphic mode and 25x80 lines in text mode. An external VGA™ monitor is also supported. An integrated film heating element is incorporated in the display for improving operation at low temperatures. The element can bring the temperature of the screen to with in operational limits from storage at -40°C in approximately 5 minutes.

The PC mobile's 9'2-Key (including ten programmable special status keys) keyboard backlit for night operation and sealed against dust and liquid is fully IBM-AT™ compatible. A manual backlight intensity control is provided. The keyboard has a QWERTY layout with key spacing of 19 mm, travel of 3 mm and key size approximately 13x13 mm. One special function key, to double the status keys, and one emergency key protected against accidental use, are also provided. The special keys, when activated, change colour under software control. The 80 standard keys have bilingual marking. Support for an auxiliary external keyboard is included on the mother board with access via the RS 232 or parallel port. The keyboard is detachable for ease of use. Removing the keyboard exposes a touch pad area. The touch pad can be used for implementing of a pointing device functions. Additional 16 function keys can also be implemented.. Pen interface is provided via RS 232.

PCMOBILE has a complete set of I/O ports, including one parallel Centronix port, two serial RS 232 ports, one SCSI hard disk drive interface port, one mouse port, an alternate keyboard port and one two pin standard

PC audio sound port. All I/O ports are incorporated in to a single quick connect-disconnect docking connector.

External electrical power is supplied to PCMOBILE via the integrated docking connector. The power requirements are DC input of 9 to 18 Volts and nominal current 2A.

An internal rechargeable Ni-M-Hi battery and a rapid charger (1.5 h) with built-in overcharge protection are also provided.

The PCMOBILE's rugged magnesium enclosure measures 86 mm H, 303 mm W and 235 mm D. A built-in retractable handle conveniently doubles as a handrest.

The weight of the unit with out options is 3.6 kg (8 lbs)

The environmental specifications of PCMOBILE are very respectable. The operating temperature range of -30" to +60° equals the EIA limit temperature performance of mobile radio equipment The storage temperature extremes are -40" C to +70 C°. The maximum allowable shock is 25 G, performance more than twice better than the published specifications for the majority of commercial grade notebook and laptop computers. The maximum operating and storage vibration resistance meets the limits of EIA RS 374-A. The RFI and EM1 protection is compliant with FCC class B regulations.

The PCMOBILE comes equipped with password access protection, installed MS DOS operating system, file transfer program and diagnostic software.

The solid mechanical construction, good environmental specifications, the variety of mass storage options, the PCMCIA ports and the large 10.5" screen are the strong point of this unit. PCMOBILE should definitely be considered when selecting a rugged workstation for demanding public safety applications.

7.2.5. Motorola 9100-386 Mobile Workstation

Like the ElectroCom MDC-890 the Motorola 9100-386 Workstation combines all the capabilities of a data terminal with the features offered by the modern MS DOS based computer technology into a versatile mobile data computer. As a part of the 9100 product line of the Motorola Mobile Data Division of Richmond B.C, the workstation is designed specifically

for real time computer access and messaging in real time in a mobile environment.

The 9100-386 Workstation is 100 percent PC/AT compatible computer with a built-in terminal emulation program which creates an operational environment identical to all other terminals from 9100 product line. In addition the 9100-386 supports the MS-DOS/Microsoft Windows operating system. New features designed in the workstation are protocol upgradeability and removable storage. The Workstation also supports Motorola's Mobile Data Frequency Agility or Automatic Channel Selection (ACS) protocols, which are similar to roaming in a cellular system. According to the Company this feature "can dramatically reduce total system cost by more effective utilization of the available RF communications channels".

The 9100-386 is packaged like a traditional mobile data terminal. It is not a portable computer. It is a mobile data computer in a mobile terminal package intended for vehicular applications only and is not suited for use outside of the automobile. This product will be of particular interest to organizations presently using the older Motorola-MD1 terminals and are planing to up-grade the existing systems and are looking for smooth transition with minimum disruption of service during the change over period.

The 9100-386 is based on an Intel 80386DX, 2 MHz microprocessor. At this time no other processor option is available.

The Workstation is offered with 4 MB of RAM as standard with memory expansion options available for up to maximum of 12 MB. In addition, 4 MB ROM storage is provided for the resident MS-DOS/Windows operating system.

No mass storage device is offered as a standard feature. Two PCMCIA Type II card slots are provided for expansion. The slots can accommodate a variety of solid-state data storage devices available on the market as well as modems and other peripheral devices. No PCMCIA Type III card slot or any other hard disk drive interface is provided. A floppy disk drive is not available. It is obvious that Motorola support the philosophy that the presently available rotating mechanical data storage devices are poorly suited to the mobile environment.

The 9100-386's standard display is a 5" (diagonal) orange monochromatic VGA CRT (in our opinion rather small). The display supports VGA graphics with 640 x 480 lines resolution and 64 levels of gray scale. The CRT provides , sharp bright image in a wide variety of light conditions

offers wide viewing angle. Manual controls for contrast and brightness arc provided. SVGA and colour display options are not available at this time.

l'he 9100-386 is equipped with a Extended Laptop PC compatible keyboard with 4 dedicated cursor control keys. An auxiliary keyboard, containing 12 DOS function keys plus two special function keys, is located beside the display. Both keyboards are illuminated. The keys have positive tactile response and are protected against dust penetration and accidental liquids spills.

The standard set of I/O ports consist of 3 serial RS-232 ports (1 DB-25 male and 2 DB-9, female connectors) and one standard Centronix parallel port.

The 9100-386 operates on external DC power of 9.5 to 16 Volts (13.8 V nominal). Internal battery is not provided.

The case has dimensions of 290 mm H, 254 mm D and 311 mm W. It is constructed of black molded ABS thermoplastic.

The 9100-386 Workstation specially designed for reliable operation in the demanding vehicular environment. The operating temperature range is -30°C to +60°C.

The storage temperature range is -40°C to +85°C. The maximum permitted relative humidity is 9.5% non condensing. The maximum permitted shock and vibration exposure (during storage and operation) meets the limits specified by the EIA KS-374A Standard.

The Motorola 9100-386 is a rugged mobile data computer designed for public safety use. It provides durability, MS-DOS compatibility and an interface familiar to the users of the older Motorola / MDI mobile data terminals. The unit does not include devices with moving mechanical parts which could fail if subjected to environmental extremes. On the down side, one possible drawback of this otherwise well designed product could be the small 5" screen which is not very suitable for general DOS applications. The list price of the 9100-386 is $6700 US.

Table 1, Ruggedized Comparison

	BELL	IBM	MOBITRON	MOTOROLA	ELECTRO-
MANUFACTURER	MOBILITY				COM
Model	**UMC3000**	**TBA**	**PCMOBILE**	**9100-386**	**MDC-890**
Processor type/speed [MHZ]	386SX/20	486SL/DX	386SL/20	386SL/20	386DX/25 *
System memory [MB]					
Standard	2MB	4MB	2MB	4MB	1MB
Expandable to	8MB	16MB	4MB	12MB	4MB
Cache memory	N/A	64KB	64KB	N/A	N/A
Mass storage devices					
Rugged mechanical hard drive [MB]	N/A	100	120 (o)	No	128MB opt.
Solid-state "disk drive" [MB] (optional)	2.4 (10)	(10, 20, 40)	5 (20)	4 Flash ROM	384KB (1-32)
3.5" diskette drive/controller	Controller	Controller	Drive	No	Controller
5.25" diskette drive/controller	Controller	No	No	No	No
PCMCIA interface					
Type 2	No	2	1	2	1
Type 3	No	No	1	No	No
Keyboard					
Type	IBM AT	IBM AT	IBM AT	QWERTY	IBM AT
F (fixed) / D (detachable)	F	F (?)	D	F	D
Number of character/control keys	80	84	88	64	88
Numeric keypad	Integrated	Integrated	Integrated	No	No
Special cursor keys	No	4	No		4
Function keys	10	12	7	12	12
Spill proof	Yes	Yes	Yes	Yes	Yes
Special emergency keys	1	1	1	1	1
Other special keys	1	No	1	1	?
Illumination with controlled intensity	Yes	Yes	Yes	Yes	Yes
Touch pad	N/A	Touch screen	Yes	No	No
Pointing device: M (mouse) P (pen)	No	M	No	No	No
Video					
Screen type	LCD B&W	10.5" LCD	10.5 LCD B&W	5" CRT	7" CRT
Maximum resolution	640x480	640X480	640x480	640X480	640X480
Text mode lines	25x80	25x80	25x80	25x80	25x80
Colours / gray shades - maximum	16	32	32	64	64
Display Illumination	Backlit	Backlit	Backlit	N/R	N/R
Intensity control	Manual	Manual	Auto	Yes	Yes
Video display controller	VGA	VGA (SVGA)	VGA	VGA	VGA
Built-in anti-glare protection plate	Yes	Yes	Yes	No	Yes
Built-in heating element	No	Yes	No	N/R	N/R
Standard interface					
Parallel ports	1	1	1	1	1
RS-232 serial ports	2	4	2	3	4
SCSI ports	No	1	1	No	No
Mouse port	No	No	1	No	No
Alternate keyboard port	No	No	1	No	No
External video port	VGA	No	No	No	No
External audio port	1	No	1	No	No
Other special ports	Floppy disk	Floppy disk	No	No	No
Integrated docking connector	Yes	Yes	Yes	N/R	N/R

Continued on next page....

	BELL	IBM	MOBITRON	MOTOROLA	ELECTRO-
MANUFACTURER	MOBILITY				COM
Model	UMC3000	TBA	PCMOBILE	9100-386	MDC-890
Security					
Password protection	Yes	?	No	No	No
Encryption device	Optional	?			
Security lock	Optional	Yes	No	No	No
External power sources					
Vehicular power port	9 -18V, 2A	9-16V	9 - 16V	9 - 16V	8 - 19V
AC adapter	No	Yes	Yes	No	No
Auxiliary DC power	N/A	?	24V DC	N/A	Yes
Internal power source	N/A			N/A	
Battery type		Ni-Cad	Ni-M-Hydrate		Ni-Cad
Full function operation per charge		2.6 hours	4 hours		?
Battery saver mode		Yes	Yes		?
Battery charger		Fast charge	Yes		Built-in
Automatic switch to internal power		Yes	Yes		Yes
Battery status indicator		?	Yes		?
Docking station (optional)					
Vehicular	N/A	Yes	N/A	N/R	N/R
Office	N/A	Yes	N/A	N/A	N/R
Physical characteristics					
Enclosure	Aluminium	?	Magnesium	ABS plastic	Plastic
Dimensions [H mm, W mm, Dmm]	86, 305, 235	76, 305, 230	81, 294, 271	209, 311, 254	?
Weight [KG/lbs]	5.3 / 11.7	4 / 8.9	3.62 / 8	3.2 / 7	?
Built-in retractable handle	Yes	?	Yes	No	No
Environmental Characteristics					
Operating temperature range	-20C to +60C	-30C to +50C	-30C to +60C	-30C to +60C	-20C to +60C
Storage temperature range	-40C to +70C	-40C to + 85C	-40C to +85C	-40C to +85C	-40C to +70C
Humidity [c=condensing.]	5% to 95%	10% to 95%	0%to100% c	5% to 90%	5% to 95%
Altitude [meters] - operating	?	0 to 10,000	?	?	?
Shock resistance (operating)	20G max.	100G	25G max.	?	EIA RS-374A
Vibration resistance (operating)	1.5G max.	MIL 810E	EIA RS-374A	EIA RS-374A	EIA RS-374A
RFI&EMI protection	FCC class B	FCC class B	FCC class B	?	?

"?" Indicates that the information was not available at the time of writing

* Note: 33 MHz 386DX or 25 Mxz 486 SLC processors available as an option

8. PC MAGAZINE CHARTS OF COMMERCIAL NOTEBOOKS

SUMMARY OF FEATURES
PORTABLE PCs

N/A* - Not applicable: The product does not have this feature.
N/A** - Not applicable: The product could not perform this test.

Listed in alphabetical order by company
y = YES n = NO

	AST PowerExec EL Color	AST PowerExec 3/25SL Color	AST PowerExec 4/25SL Color Plus	Aurum GoldNote DX2-50	Blue Star 486DX2/66
List price (tested configuration) $US	$2799	$3499	$4499	$2395	$3495
Processor type and speed	Intel 386SL/25	Intel 386SL/25	Intel 486SL/25	Intel 486DX2/50	Intel 486DX2/66
Hard disk capacity	120MB	160MB	200MB	127MB	210MB
Dealers/Direct-distribution channel	y n	y n	y n	y y	y y
Dimensions (HWD, in inches)	2 x 11.5 x 8.5	2 x 11.5 x 8.5	2 x 11.5 x 8.5	2 x 11.3 x 11	2.3 x 11.5 x 8.5
System weight/travel weight (pounds)	6.4, 7.7	6.8, 8.1	7, 8.3	6.8, 8.2	5.9, 8.3
Display area and diagonal (inches)	5.8 x 7.5 x 9.5	5.8 x 7.5 x 9.5	5.8 x 7.5 x 9.5	5.8 x 7.5 x 9.5	5.8 x 9.3 x 9.5
Keys: total, function, cursor	82, 12, 8	82, 12, 8	82, 12, 8	81, 10, 4	85, 12, 8
Type of pointing device installed	Snap-on	Snap-on	Snap-on	None	Built-in
Motherboard manufacturer	AST	AST	AST	FI	Create Systems
Chip set manufacturer	Intel	Intel	Intel	Symphony	ACC
BIOS version (or date)	AST 2.03	AST 2.10	AST 2.10	AMI (7/7/91)	AMI 4.31
Setup in ROM/Password in ROM	y y	y y	y y	y y	y y
Installable RAM	2MB-20MB	4MB-20MB	4MB-32MB	4MB-16MB	4MB-16MB
User-installable	y	y	y	n	y
External processor RAM cache	None	64K	None	None	8K
Available hard disk sizes	60MB-200MB	80MB-200MB	80MB-200MB	80MB-210MB	80MB-210MB
I/O and Expansion					
Parallel, serial, mouse, expansion ports	1, 1, 1, 1	1, 1, 1, 1	1, 1, 1, 1	1, 2, 0, 1	1, 1, 0, 1
High-speed parallel/serial support	y n	y n	y n	n n	n n
Ports for port replicator/expansion chassis	y y	y y	y y	n y	n y
PCMCIA slots	One Type II	Two Type II	Two Type II	None	None
Internal modem installed	None	None	None	None	9,600-bps fax
Screen manufacturer	Sanyo	Sanyo	Hitachi	Hitachi	Sharp
Video chip set manufacturer	WD	WD	WD	Cirrus	Cirrus
Simultaneous external display	y	y	y	n	y
Maximum internal resolution	640 x 480	640 x 480	640 x 480	640 x 480	640 x 480
Maximum internal gray shades or colors	256 colors	256 colors	256 colors	32 gray shades	64 gray shades
Maximum external resolution	800 x 600	800 x 600	800 x 600	800 x 600	800 x 600
Maximum external colors	16	16	16	256	256
Illuminated screen/Active matrix	y n	y n	n y	y n	y n
AC adapter size (inches)	1.5 x 4.8 x 2.8	1.5 x 4.8 x 2.8	1.5 x 4.8 x 2.8	1.5 x 5.5 x 2.5	2.3 x 6.5 x 3
Rated battery life (hours)	3.5	5	5.5	1.8	3
ZDigit Rundown, Battery Rundown (hr:min)	4:03, 1:30	4:48, 1:35	6:17, 2:14	1:47, 1:34	2:48, 1:55
Charge time while on, off (hours)	4, 2	4, 2	1.5, 1	N/A, 4	6, 2.8
Battery weight, amp/hour rating	1.4 lbs, 1.7Ah	1.5 lbs, 2.2Ah	1.6 lbs, 2.2Ah	1.1 lbs, 2.8Ah	1.2 lbs, 5Ah
Display/hard disk power-down	y y	y y	y y	y y	y y
CPU/peripherals power-down	n n	n n	n n	n n	n n
Standby/Hibernation	y y	y y	y y	n n	y n
DOS version, Microsoft Windows version	5.0, 3.1	5.0, 3.1	5.0, 3.1	5.0, 3.1	6.0, 3.1
Warranty	1 year	1 year	1 year	1 year	1 year

SUMMARY OF FEATURES PORTABLE PCs Listed in alphabetical order by company y = YES n = NO	ACC - ACC Micro Electronics Inc., AES - Area Electronics Systems Inc., C&T - Chips & Technologies Inc., DTI - Display Technologies Inc.,				
	CAF AquaLITE II	Compaq Contura 4/25	Compaq Contura 4/25C	PC Magazine Editor's Choice Compaq Contura 4/25CX	Compaq LTE Lite 25E
List price (tested configuration) $US	$2399	$2499 (estimated)	$3249 (estimated)	$3899 (estimated)	$3249 (estimated)
Processor type and speed	AMD Am386SXL/2!	Intel 486SL/25	Intel 486SL/25	Intel 486SL/25	Intel 386SL/25
Hard disk capacity	123MB	120MB	120MB	115MB	84MB
Dealers/Direct-distribution channel	y n	y n	y n	y n	y y
Dimensions (HWD, in inches)	1.8 x 8.5 x 11	2 x 11 x 8.5	2 x 11 x 8.5	2 x 11 x 8.5	2 x 11 x 8.5
System weight/travel weight (pounds)	5.5, 6.9	6.3, 7.4	6.5, 7.7	6.9, 8	6.5, 7.3
Display area and diagonal (inches)	6 x 7.8 x 9.5	5.8 x 7.8 x 9.5	5.8 x 7.5 x 9.5	5.3 x 6.8 x 8.5	5.7 x 7.6 x 9.5
Keys: total, function, cursor	86, 10, 4	80, 10, 8	80, 10, 8	80, 10, 8	80, 10, 8
Type of pointing device installed	None	None	None	Clip-on	Built-in
Motherboard manufacturer	CAF	Compaq	Compaq	Compaq	Compaq
Chip set manufacturer	VLSI	Intel	Intel	Intel	Compaq
BIOS version (or date)	Phoenix (4/19/90	Compaq (2/8/93)	Compaq (2/8/93)	Compaq (2/8/93)	Compaq (9/23/92
Setup in ROM/Password in ROM	y y	y y	y y	y y	y y
Installable RAM	4MB-8MB	4MB-20MB	4MB-20MB	4MB-20MB	4MB-20MB
User-installable	y	y	y	y	y
External processor RAM cache	None	None	None	None	64K
Available hard disk sizes	80MB-200MB	120MB-209MB	120MB-209MB	120MB-209MB	80MB-120MB
I/O and Expansion					
Parallel, serial, mouse, expansion ports	1, 2, 1, 0	1, 1, 1, 0	1, 1, 1, 1	1, 1, 1, 0	1, 1, 1, 0
High-speed parallel/serial support	y n	y y	y y	y y	y y
Ports for port replicator/expansion chassis	n n	n n	n n	n n	n y
PCMCIA slots	None	None	None	None	None
Internal modem installed	2,400-/9,600-bps	9,600-bps fax	9,600-bps fax	9,600-bps fax	14,400-/9,600-bps
Screen manufacturer	Sharp	Sharp	Sharp	Sharp	Compaq
Video chip set manufacturer	Cirrus	Compaq	Compaq	Compaq	Compaq
Simultaneous external display	y	y	y	y	y
Maximum internal resolution	640 x 480	800 x 600	640 x 480	640 x 480	640 x 480
Maximum internal gray shades or colors	64 gray shades	64 gray shades	256 colors	256 colors	32 gray shades
Maximum external resolution	800 x 600	640 x 480	640 x 480	640 x 480	800 x 600
Maximum external colors	16	16	256	256	16
Illuminated screen/Active matrix	y n	y n	y n	y y	y y
AC adapter size (inches)	1.5 x 5.5 x 2.8	1.8 x 5.3 x 3.3	1.8 x 5.3 x 3.3	1.8 x 5.3 x 3.3	1.4 x 5.3 x 3.3
Rated battery life (hours)	2	3.5	3	3	4
ZDigit Rundown, Battery Rundown (hr:min)	3:02, 2:34	3:42, 2:28	3:32, 1:47	3:01, 1:36	3:32, 2:57
Charge time while on, off (hours)	2, 2	1.5, 1	1.5, 1	1.5, 1	2, 1
Battery weight, amp/hour rating	1.1 lbs, 1.7Ah	1.1 lbs, 1.7Ah	1.1 lbs, 2.2Ah	1.3 lbs, 2.2Ah	1.3 lbs, 2.2Ah
Display/hard disk power-down	y y	y y	y y	y y	y y
CPU/peripherals power-down	n n	n n	n n	n n	y y
Standby/Hibernation	y y	y y	y y	y y	y y
DOS version, Microsoft Windows version	5.0, 3.1	5.0, 3.1	5.0, 3.1	5.0, 3.1	5.0, 3.1
Warranty	1 year	3 years	3 years	3 years	3 years

SUMMARY OF FEATURES PORTABLE PCs	FI - First International Computer Corp., TI - Texas Instruments, VSLI - VLSI Technology Inc., WD - Western Digital.				
Listed in alphabetical order by company y = YES n = NO	Compaq LTE Lite 4/25C	CompuAdd Express 425Color	CompuAdd Express 425ColorPlus	CompuAdd Express 425XL	Compudyne 4DX2/66 Active TFT Color Slimnote
List price (tested configuration) $US	$4099 (estimated)	$2595	$3895	$1895	$4499
Processor type and speed	Intel 486SL/25	Cyrix Cx486SLC/25	Cyrix Cx486SLC/25	Cyrix Cx486SLC/25	Intel 486DX2/66
Hard disk capacity	120MB	128MB	208MB	128MB	213MB
Dealers/Direct-distribution channel	n y	n y	n y	n y	y y
Dimensions (HWD, in inches)	2 x 11 x 8.5	2 x 11.5 x 8.5	2 x 11.5 x 8.5	2 x 11.5 x 8.5	2 x 11 x 8.5
System weight/travel weight (pounds)	6.6, 7.8	6.5, 7.8	6.6, 7.8	6.2, 7.6	6.7, 8.2
Display area and diagonal (inches)	5.1 x 6.4 x 8.4	5.1 x 6.8 x 8.5	5.3 x 6.8 x 8.5	5.8 x 7.5 x 9.5	5.3 x 7 x 8.5
Keys: total, function, cursor	80, 10, 8	84, 12, 8	84, 12, 8	84, 12, 8	84, 10, 8
Type of pointing device installed	Built-in	Built-in	Built-in	Built-in	Built-in
Motherboard manufacturer	Compaq	Veridata	Veridata	Veridata	Twinhead
Chip set manufacturer	Compaq	Headland	Headland	Headland	ACC
BIOS version (or date)	Compaq (9/23/92	Award 4.20	Award 4.20	Award 4.20	Phoenix 1.02
Setup in ROM/Password in ROM	y y	y n	y n	y n	y y
Installable RAM	4MB-20MB	8MB-20MB	8MB-20MB	4MB-20MB	4MB-20MB
User-installable	y	y	y	y	m
External processor RAM cache	None	None	None	None	None
Available hard disk sizes	120MB-210MB	128MB	208MB	128MB	213MB-340MB
I/O and Expansion					
Parallel, serial, mouse, expansion ports	1, 1, 1, 1	1, 1, 0, 0	1, 1, 0, 0	1, 1, 0, 0	1, 1, 1, 1
High-speed parallel/serial support	y y	n n	n n	n n	n n
Ports for port replicator/expansion chassis	n y	n n	n n	n n	n y
PCMCIA slots	None	None	None	None	None
Internal modem installed	None	9,600-bps fax	9,600-bps fax	9,600-bps fax	None
Screen manufacturer	Compaq	Sanyo	Sharp	Sharp	Sharp
Video chip set manufacturer	Compaq	Cirrus	Cirrus	Cirrus	Cirrus
Simultaneous external display	y	y	y	y	m
Maximum internal resolution	640 x 480	640 x 480	640 x 480	640 x 480	640 x 480
Maximum internal gray shades or colors	16 colors	256 colors	256 colors	64 gray shades	256 colors
Maximum external resolution	800 x 600	800 x 600	800 x 600	800 x 600	1,024 x 768
Maximum external colors	16	16	16	16	16
Illuminated screen/Active matrix	y y	y n	y y	y n	y y
AC adapter size (inches)	1.4 x 5.3 x 3.3	1.8 x 6 x 3	1.8 x 6 x 3	1.8 x 6 x 3	1.5 x 6 x 2.8
Rated battery life (hours)	2.5	2	2	3	2.5
ZDigit Rundown, Battery Rundown (hr:min)	4:12, 1:52	1:47, 1:35	2:20, 1:32	3:35, 2:30	N/A**, 1:58
Charge time while on, off (hours)	2, 1	3.5, 3.3	3.5, 3.3	3.5, 3.3	4, 2
Battery weight, amp/hour rating	1.3 lbs, 2.2Ah	1.1 lbs, 2Ah	1.1 lbs, 2Ah	1.1 lbs, 2Ah	1.5 lbs, 2.3Ah
Display/hard disk power-down	y y	y y	y y	y y	y y
CPU/peripherals power-down	y y	y y	y y	y y	y n
Standby/Hibernation	y y	y n	y n	y n	y n
DOS version, Microsoft Windows version	5.0, 3.1	6.0, 3.1	6.0, 3.1	6.0, 3.1	6.0, 3.1
Warranty	3 years	1 year	1 year	1 year	1 year

SUMMARY OF FEATURES
PORTABLE PCs

Listed in alphabetical order by company
y = YES n = NO

	Compudyne 4DX2/66 Monochrome Slimnote	Compudyne 4SL/25 Subnote	Dell NL25	Dell NL25C	Dell 325N
List price (tested configuration) $US	$2999	$2138	$1949	$2449	$2798
Processor type and speed	Intel 486DX2/66	Intel 486SL/25	Intel 386SL/25	Intel 386SL/25	Intel 386SL/25
Hard disk capacity	213MB	80MB	115MB	115MB	208MB
Dealers/Direct-distribution channel	y y	y y	y y	y y	y y
Dimensions (HWD, in inches)	1.5 x 11 x 8.5	1.5 x 10 x 7.3	2 x 11 x 8.5	2 x 11 x 8.5	2 x 11 x 8.5
System weight/travel weight (pounds)	6.2, 7.8	3, 5.4	6.4, 8	6.7, 7.9	6.5, 7.6
Display area and diagonal (inches)	5.8 x 7.5 x 9.5	4.5 x 6 x 7.5	5.8 x 7.5 x 9.5	5 x 7.3 x 9	5.8 x 7.5 x 9.5
Keys: total, function, cursor	84, 10, 8	80, 10, 4	85, 12, 4	85, 12, 4	85, 12, 4
Type of pointing device installed	Built-in	Built-in	Clip-on	Clip-on	Clip-on
Motherboard manufacturer	Twinhead	Twinhead	Dell	Dell	Dell
Chip set manufacturer	ACC	ACC	Intel	Intel	Intel
BIOS version (or date)	Phoenix 1.02	Phoenix 1.03	Phoenix (2/8/93)	Phoenix (2/24/93	Phoenix (10/30/92
Setup in ROM/Password in ROM	y y	y y	y n	y y	y y
Installable RAM	4MB-20MB	4MB-20MB	4MB-8MB	2MB-8MB	4MB-12MB
User-installable	y	y	y	y	y
External processor RAM cache	None	None	64K	64K	64K
Available hard disk sizes	213MB-340MB	80MB-120MB	80MB-120MB	80MB-200MB	80MB-120MB
I/O and Expansion					
Parallel, serial, mouse, expansion ports	1, 1, 1, 1	1, 1, 1, 0	1, 1, 1, 0	1, 1, 1, 0	1, 1, 1, 0
High-speed parallel/serial support	n n	y n	n n	n n	y n
Ports for port replicator/expansion chassis	n y	n n	n n	n n	n n
PCMCIA slots	None	One Type II	None	None	None
Internal modem installed	None	2,400-/9,600-bps	14,400-/9,600-bps	9,600-bps fax	9,600-bps fax
Screen manufacturer	Sharp	Sharp	Sharp	Sharp	Sharp
Video chip set manufacturer	Cirrus	Cirrus	Cirrus	Cirrus	WD
Simultaneous external display	y	y	n	y	n
Maximum internal resolution	640 x 480	640 x 480	640 x 480	640 x 480	640 x 480
Maximum internal gray shades or colors	64 gray shades	64 gray shades	32 gray shades	16 colors	64 gray shades
Maximum external resolution	1,024 x 768	640 x 480	800 x 600	800 x 600	800 x 600
Maximum external colors	16	16	16	16	16
Illuminated screen/Active matrix	y n	y n	y n	y n	y n
AC adapter size (inches)	1.8 x 6.5 x 3	1.3 x 4 x 2.5	1.8 x 2.8 x 6	1.8 x 2.8 x 6	1.5 x 2.3 x 4.5
Rated battery life (hours)	2.5	4.5	2.5	2.5	4
ZDigit Rundown, Battery Rundown (hr:min)	N/A**, 2:48	N/A**, 3:07	3:16, 2:43	3:01, 2:19	7:00, 3:53
Charge time while on, off (hours)	4, 2	4, 2	10, 2	10, 2	12, 3.5
Battery weight, amp/hour rating	1.3 lbs, 2.3Ah	0.9 lbs, 2.3Ah	1.3 lbs, 1.7Ah	1.4 lbs, 1.7Ah	1.6 lbs, 2.2Ah
Display/hard disk power-down	y y	y y	y y	y y	y y
CPU/peripherals power-down	y n	y y	y y	y y	y y
Standby/Hibernation	y n	y y	y y	y y	y y
DOS version, Microsoft Windows version	6.0, 3.1	6.0, 3.1	5.0, 3.1	5.0, 3.1	5.0, 3.1
Warranty	1 year	1 year	1 year	1 year	1 year

SUMMARY OF FEATURES
PORTABLE PCs

Listed in alphabetical order by company
y = YES n = NO

	Dell 325NC	Dell 325SLi	Digital DECpc 325SL	Digital DECpc 325SLC	Digital DECpc 425SL
List price (tested configuration) $US	$3298	$2264	$2099	$2899	$2499
Processor type and speed	Intel 386SL/25	Intel 386SL/25	Intel 386SL/25	Intel 386SL/25	Intel 486SL/25
Hard disk capacity	208MB	213MB	84MB	84MB	120MB
Dealers/Direct-distribution channel	y y	y y	y y	y y	y y
Dimensions (HWD, in inches)	2 x 11 x 8.5	1.3 x 11 x 7.8	2 x 11.5 x 8.3	2 x 11.5 x 8.3	2 x 11.5 x 8.5
System weight/travel weight (pounds)	7.3, 8.3	3.7, 4.8	6.9, 7.6	6.9, 8.2	6.3, 7.4
Display area and diagonal (inches)	5.5 x 7.3 x 9	5.8 x 7.8 x 9.5	5.8 x 7.5 x 9.5	5.8 x 7.5 x 9.5	5.8 x 7.5 x 9.5
Keys: total, function, cursor	85, 12, 4	85, 12, 4	82, 12, 8	82, 12, 8	82, 12, 8
Type of pointing device installed	Clip-on	Clip-on	Snap-on	Snap-on	Snap-on
Motherboard manufacturer	Dell	Dell	AST	AST	AST
Chip set manufacturer	Intel	Intel	Intel	Intel	Intel
BIOS version (or date)	hoenix (10/30/92	Phoenix (2/2/93)	AST 1.01	DEC 1.01	AST 2.03
Setup in ROM/Password in ROM	y y	y y	y y	y y	y y
Installable RAM	4MB-12MB	2MB-10MB	4MB-20MB	4MB-20MB	4MB-32MB
User-installable	y	y	y	y	y
External processor RAM cache	64K	16K	64K	64K	8K
Available hard disk sizes	80MB-120MB	60MB-200MB	80MB-200MB	80MB-200MB	80MB-200MB
I/O and Expansion					
Parallel, serial, mouse, expansion ports	1, 1, 1, 0	1, 1, 0, 0	1, 1, 1, 1	1, 1, 1, 1	2, 1, 1, 1
High-speed parallel/serial support	y n	y n	y n	y n	n n
Ports for port replicator/expansion chassis	n n	n n	y y	y y	y y
PCMCIA slots	None	One Type II	Two Type II	Two Type II	Two Type II
Internal modem installed	9,600-bps fax	2,400-/9,600-bps	None	None	None
Screen manufacturer	Sharp	Sharp	AST	AST	AST
Video chip set manufacturer	WD	Cirrus	WD	WD	WD
Simultaneous external display	n	y	y	y	y
Maximum internal resolution	640 x 480	640 x 480	640 x 480	640 x 480	640 x 480
Maximum internal gray shades or colors	16 colors	64 gray shades	64 gray shades	256 colors	64 gray shades
Maximum external resolution	800 x 600	800 x 600	800 x 600	800 x 600	800 x 600
Maximum external colors	16	16	16	16	16
Illuminated screen/Active matrix	y n	n n	y n	y n	y n
AC adapter size (inches)	1.5 x 2.3 x 4.5	1.5 x 2.3 x 4.5	1.5 x 4.5 x 2.8	1.5 x 4.5 x 2.8	1.5 x 4.8 x 2.8
Rated battery life (hours)	4	3.5	6.5	6	6
ZDigit Rundown, Battery Rundown (hr:min)	5:31, 2:52	N/A**, 2:55	8:33, 3:41	5:02, 2:20	9:34, 4:03
Charge time while on, off (hours)	12, 3.5	12, 1.8	1.5, 1	1.5, 1	1.5, 1
Battery weight, amp/hour rating	1.6 lbs, 2.2Ah	0.7 lbs, 2.2Ah	1.5 lbs, 2.2Ah	1.5 lbs, 2.2Ah	1.5 lbs, 2.2Ah
Display/hard disk power-down	y y	y y	y y	y y	y y
CPU/peripherals power-down	y y	y y	y y	y y	y y
Standby/Hibernation	y y	y y	y y	y y	y y
DOS version, Microsoft Windows version	5.0, 3.1	5.0, 3.1	5.0, 3.1	5.0, 3.1	5.0, 3.1
Warranty	1 year	1 year	1 year	1 year	1 year

SUMMARY OF FEATURES
PORTABLE PCs

Listed in alphabetical order by company y = YES n = NO	Epson ActionNote 4SLC/25	Ergo PowerBrick 486	PC Magazine Editor's Choice Gateway Nomad 425SXL	PC Magazine Editor's Choice Gateway Nomad 450DXL	GRiD Convertible
List price (tested configuration) $US	$1649	$1995	$1995	$2995	$4790
Processor type and speed	Cyrix Cx486SLC/25	Intel 486DX/33	Intel 486SX/25	Intel 486DX2/50	Intel 386SL/25
Hard disk capacity	131MB	120MB	128MB	208MB	125MB
Dealers/Direct-distribution channel	y y	n y	n y	n y	y y
Dimensions (HWD, in inches)	1.8 x 11 x 8.8	1.8 x 11.3 x 8.8	1.8 x 11 x 8.5	1.8 x 11 x 8.5	1.5 x 11.5 x 9.3
System weight/travel weight (pounds)	5.5, 7.1	5.3, 8.4	5.7, 6.9	5.6, 6.9	5.7, 7.2
Display area and diagonal (inches)	5.8 x 7.5 x 9.5	5.8 x 7.5 x 9.5	6 x 8 x 9.8	6 x 8 x 9.8	6 x 7.8 x 9.5
Keys: total, function, cursor	84, 12, 8	84, 10, 4	79, 10, 4	79, 10, 4	79, 12, 4
Type of pointing device installed	Clip-on	Built-in	Free-standing	Clip-on	Built-in
Motherboard manufacturer	Epson	AES	TI	TI	GRiD
Chip set manufacturer	ACC	WD	TI	TI	Intel
BIOS version (or date)	AMI (5/5/91)	Award (12/12/91)	Phoenix 1.03	Phoenix 1.04	Phoenix (9/18/92)
Setup in ROM/Password in ROM	y y	y	y y	y y	n y
Installable RAM	4MB-8MB	4MB-20MB	4MB-20MB	8MB-20MB	2MB-8MB
User-installable	y	y	y	y	y
External processor RAM cache	None	None	None	None	64K
Available hard disk sizes	80MB-131MB	120MB-350MB	128MB-208MB	128MB-208MB	125MB
I/O and Expansion					
Parallel, serial, mouse, expansion ports	1, 2, 1, 0	1, 1, 1, 0	1, 1, 1, 1	1, 1, 1, 1	1, 1, 1, 0
High-speed parallel/serial support	n y	n n	n n	y y	y y
Ports for port replicator/expansion chassis	n n	n n	n n	n n	n n
PCMCIA slots	None	None	None	None	One Type II
Internal modem installed	2,400-/9,600-bps	2,400-/9,600-bps	9,600-bps fax	None	1,400-/9,600-bps
Screen manufacturer	Hitachi	Toshiba	Sharp	Sharp	Sharp
Video chip set manufacturer	Cirrus	Cirrus	Cirrus	Cirrus	Cirrus
Simultaneous external display	y	y	y	y	y
Maximum internal resolution	640 x 480	640 x 480	640 x 480	640 x 480	640 x 480
Maximum internal gray shades or colors	32 gray shades	64 gray shades	64 gray shades	64 gray shades	64 gray shades
Maximum external resolution	800 x 600	1,024 x 768	300 x 600 interlace	1,024 x 768 interlac	640 x 480
Maximum external colors	16	16	16	16	256
Illuminated screen/Active matrix	y n	y n	y n	y n	y n
AC adapter size (inches)	1.8 x 6.3 x 3	1.8 x 6.3 x 3	1.5 x 2.3 x 6	1.5 x 2.3 x 6	1.5 x 2.8 x 6
Rated battery life (hours)	2	1.8	6.5	6.5	3
ZDigit Rundown, Battery Rundown (hr:min)	2:02, 1:45	2:24, 1:56	6:46, 2:58	5:32, 2:16	2:01, 1:37
Charge time while on, off (hours)	3.5, 3.5	4, 2	2.8, 2.8	2.8, 2.8	1.5, 1.5
Battery weight, amp/hour rating	0.8 lbs, 1.7Ah	1.4 lbs, 2.1Ah	1.3 lbs, 5.7Ah	1.2 lbs, 5.7Ah	0.77 lbs, 2Ah
Display/hard disk power-down	y y	y y	y y	y y	y y
CPU/peripherals power-down	n n	y n	y y	y y	y y
Standby/Hibernation	y y	y n	y n	y n	y n
DOS version, Microsoft Windows version	6.0, 3.1	6.0, 3.1	5.0, 3.1	5.0, 3.1	5.0, Pen Windows
Warranty	1 year	1 year	1 year	1 year	1 year

SUMMARY OF FEATURES
PORTABLE PCs

Listed in alphabetical order by company
y = YES n = NO

	HyperBook 2300DLC/40	HyperBook 2300DX2/50	Hyundai Courier	Hyundai Courier Spectra	PC Magazine Editor's Choice IBM ThinkPad 720C
List price (tested configuration) $US	$3695	$4195	$1199	$2499	$4695
Processor type and speed	Cyrix Cx486DLC/4C	Intel 486DX2/50	AMD Am386SXL/2!	Cyrix Cx486SLC/25	IBM 486SLC2
Hard disk capacity	213MB	213MB	85MB	120MB	160MB
Dealers/Direct-distribution channel	y n	y n	y y	n y	y y
Dimensions (HWD, in inches)	2.4 x 11 x 8.8	2.4 x 11 x 8.8	1.8 x 11 x 8.5	2.3 x 11 x 8.8	2 x 11.8 x 8.3
System weight/travel weight (pounds)	6.9, 8.3	6.9, 8.3	5.7, 6.9	5.7, 7.4	7.4, 8.9
Display area and diagonal (inches)	5.3 x 7.2 x 8.9	5.3 x 7.2 x 8.9	5.8 x 7.8 x 9.5	5 x 6.8 x 8.5	6.5 x 8.5 x 10.5
Keys: total, function, cursor	84, 10, 8	84, 10, 8	84, 10, 4	86, 12, 8	84, 12, 4
Type of pointing device installed	None	None	Built-in	Built-in	Built-in
Motherboard manufacturer	SunRace	SunRace	Hyundai	IBM/Lexmark	IBM
Chip set manufacturer	Symphony	Symphony	WD	WD	IBM
BIOS version (or date)	AMI (3/9/93)	AMI (3/9/93)	Phoenix 1.01	Phoenix 1.01	IBM (1/29/93)
Setup in ROM/Password in ROM	y y	y y	y n	y n	n y
Installable RAM	4MB-20MB	4MB-20MB	2MB-8MB	4MB-16MB	4MB-16MB
User-installable	y	y	y	n	y
External processor RAM cache	128K	256K	None	None	None
Available hard disk sizes	130MB-210MB	130MB-340MB	60MB-120MB	120MB-170MB	160MB-240MB
I/O and Expansion					
Parallel, serial, mouse, expansion ports	1, 2, 1, 0	1, 2, 1, 0	1, 1, 1, 1	1, 1, 1, 1	1, 1, 1, 1
High-speed parallel/serial support	n n	n n	n n	n n	y n
Ports for port replicator/expansion chassis	n n	n n	n n	n n	n y
PCMCIA slots	None	None	One Type II	None	Two Type II
Internal modem installed	2,400-/9,600-bps	2,400-/9,600-bps	None	2,400-/9,600-bps	None
Screen manufacturer	Hitachi	Hitachi	Sanyo	Sanyo	DTI
Video chip set manufacturer	Cirrus	Cirrus	C&T	WD	IBM
Simultaneous external display	n	n	y	n	y
Maximum internal resolution	640 x 480	640 x 480	640 x 480	640 x 480	640 x 480
Maximum internal gray shades or colors	64 gray shades	64 gray shades	64 gray shades	16 colors	256 colors
Maximum external resolution	800 x 600	800 x 600	640 x 480	800 x 600	640 x 480
Maximum external colors	256	256	16	16	256
Illuminated screen/Active matrix	y n	y n	y n	y n	y y
AC adapter size (inches)	2 x 5.9 x 2.9	2 x 5.9 x 2.9	1.5 x 2.3 x 5.5	1.8 x 5.8 x 3	1.5 x 2.8 x 5.5
Rated battery life (hours)	1.5	1.5	2	2	2.6
ZDigit Rundown, Battery Rundown (hr:min)	1:47, 1:36	N/A**, 1:46	2:02, 1:55	1:59, 1:23	4:03, 1:59
Charge time while on, off (hours)	7, 1.1	7, 1.1	3, 1	3, 1	1.5, 1.4
Battery weight, amp/hour rating	1.3 lbs, 2.8Ah	1.3 lbs, 2.8Ah	1 lbs, 1.7Ah	0.7 lbs, 1.4Ah	1.5 lbs, 2.9Ah
Display/hard disk power-down	y y	y y	y y	y y	y y
CPU/peripherals power-down	y n	y n	y y	y y	y y
Standby/Hibernation	y n	y n	y n	y n	y n
DOS version, Microsoft Windows version	6.0, None	6.0, None	5.0, 3.1	5.0, 3.1	5.02, None
Warranty	15 months	15 months	18 months	18 months	3 years

SUMMARY OF FEATURES
PORTABLE PCs

Listed in alphabetical order by company
y = YES n = NO

	Jetta Jetbook 486DX/33	Micro Electronics WinBook 486SLC/E/33	Micro Express NP943 Notebook PC	Mitsuba Ninja 486SX/25	NEC UltraLite Versa 25C
List price (tested configuration) $US	$2345	$1799	$1899	$1895	$4269
Processor type and speed	Intel 486DX/33	Cyrix Cx486SLC	Intel 486DX/33	Intel 486SX/25	Intel 486SL/25
Hard disk capacity	213MB	128MB	123MB	123MB	120MB
Dealers/Direct-distribution channel	y n	n y	n y	y n	y n
Dimensions (HWD, in inches)	2 x 11 x 9	1.8 x 11.3 x 8.8	2 x 12 x 9.5	2 x 11 x 8.5	2.1 x 11.7 x 9.3
System weight/travel weight (pounds)	6.6, 8	5.5, 7	7.2, 8.4	6.9, 7.9	6.9, 8.6
Display area and diagonal (inches)	5.8 x 7.5 x 9.5	5.8 x 7.8 x 9.5	5.8 x 7.8 x 9.5	5.8 x 7.5 x 9.5	5.8 x 7.8 x 9.5
Keys: total, function, cursor	86, 12, 8	84, 10, 4	84, 10, 8	70, 12, 4	83, 12, 4
Type of pointing device installed	None	Built-in	Free-standing	None	Clip-on
Motherboard manufacturer	Jetta	Jetta	Micro Express	Mitsuba	NEC
Chip set manufacturer	C&T	Motorola	ACC	ACC	Intel
BIOS version (or date)	AMI (11/10/92)	AMI (12/12/91)	AMI (10/5/92)	Award 4.20	Phoenix (4/19/90)
Setup in ROM/Password in ROM	y y	y y	y y	y n	y y
Installable RAM	4MB-16MB	4MB-8MB	4MB-16MB	4MB-20MB	4MB-20MB
User-installable	y	n	y	n	y
External processor RAM cache	8K	None	None	None	None
Available hard disk sizes	86MB-213MB	128MB-250MB	80MB-200MB	120MB-210MB	120MB-240MB
I/O and Expansion					
Parallel, serial, mouse, expansion ports	1, 1, 1, 1	1, 1, 1, 1	1, 1, 0, 1	1, 1, 1, 0	1, 1, 1, 1
High-speed parallel/serial support	n y	n n	n y	n n	y n
Ports for port replicator/expansion chassis	n y	n y	n n	n n	n y
PCMCIA slots	None	One Type II	None	None	Two Type II or
Internal modem installed	2,400-/9,600-bps	2,400-/9,600-bps	2,400-/9,600-bps	None	None
Screen manufacturer	Hitachi	Hitachi	Sanyo	Sharp	NEC
Video chip set manufacturer	Cirrus	Cirrus	Cirrus	Cirrus	C&T
Simultaneous external display	y	y	n	y	y
Maximum internal resolution	640 x 480	640 x 480	640 x 480	640 x 480	640 x 480
Maximum internal gray shades or colors	64 gray shades	64 gray shades	64 gray shades	64 gray shades	256 colors
Maximum external resolution	800 x 600	800 x 600	640 x 480	800 x 600	1,024 x 768
Maximum external colors	16	256	256	16	16
Illuminated screen/Active matrix	y n	y n	y y	y n	y y
AC adapter size (inches)	1.8 x 2.5 x 6	1.5 x 2.8 x 5.8	2 x 5.3 x 2.8	1.5 x 4.5 x 3	2 x 3 x 7
Rated battery life (hours)	3.5	3.5	2.5	3	2.3
ZDigit Rundown, Battery Rundown (hr:min)	2:33, 2:18	3:47, 3:28	4:18, 3:27	2:48, 2:04	3:32, 2:00
Charge time while on, off (hours)	2, 2	2, 1.5	3, 2	3, 2	2.8, 1.4
Battery weight, amp/hour rating	1.7 lbs, 2.8Ah	0.9 lbs, 2.2Ah	1.9 lbs, 1.4Ah	1 lbs, 2.2Ah	1.1 lbs, 3.4Ah
Display/hard disk power-down	y y	y y	y y	y y	y y
CPU/peripherals power-down	y n	y y	n y	y y	y y
Standby/Hibernation	y n	y n	y n	y y	y y
DOS version, Microsoft Windows version	5.0, None	6.0, 3.1	6.0, 3.1	5.0, None	6.0, 3.1
Warranty	1 year	1 year	15 months	1 year	3 years

SUMMARY OF FEATURES
PORTABLE PCs

Listed in alphabetical order by company
y = YES n = NO

	Packard Bell 486DX/25 Notebook	PC Brand Active Color LeaderBook Pro	Poly NB325V	Poly NB425C	Samsung NoteMaster 486SLC Model S3800
List price (tested configuration) $US	$1999	$3994	$1480	$2380	$2678
Processor type and speed	Intel 486DX/25	Intel 486DX/33	Intel 386SL/25	Cyrix Cx486SLC/25	Cyrix Cx486SLC/25
Hard disk capacity	123MB	121MB	84MB	84MB	121MB
Dealers/Direct-distribution channel	y n	n y	y y	y y	n y
Dimensions (HWD, in inches)	1.3 x 11 x 8.5	2 x 11.3 x 9	2 x 11.7 x 8.6	1.8 x 11 x 8.5	2 x 11 x 8.5
System weight/travel weight (pounds)	5.1, 8	6.9, 8.6	6.8, 7.9	6, 7.2	6.4, 7.8
Display area and diagonal (inches)	5.8 x 7.5 x 9.5	5.3 x 6.8 x 8.5	5.8 x 7.6 x 9.5	5.1 x 6.9 x 8.5	5.8 x 7.5 x 9.5
Keys: total, function, cursor	80, 12, 4	84, 10, 8	85, 12, 4	82, 12, 4	80, 12, 4
Type of pointing device installed	Free-standing	None	Snap-on	Built-in	None
Motherboard manufacturer	Packard Bell	PC Brand	Vinsotec	Compaq	Samsung
Chip set manufacturer	ACC	ACC	Intel	VLSI	Motorola
BIOS version (or date)	Award Q3H	AMI (12/12/91)	Phoenix 3.02	Phoenix 3.01	Phoenix 1.01A
Setup in ROM/Password in ROM	y y	y y	y y	y y	y n
Installable RAM	4MB-20MB	4MB-20MB	2MB-20MB	4MB-8MB	2MB-8MB
User-installable	y	y	y	y	y
External processor RAM cache	None	None	64K	None	None
Available hard disk sizes	123MB	80MB-200MB	130MB-200MB	130MB-200MB	80MB-121MB
I/O and Expansion					
Parallel, serial, mouse, expansion ports	1, 1, 1, 1	1, 1, 0, 0	1, 1, 1, 1	1, 1, 0, 1	1, 1, 1, 0
High-speed parallel/serial support	n n	n n	n n	n n	n n
Ports for port replicator/expansion chassis	n n	n n	n n	n n	n n
PCMCIA slots	None	None	None	None	None
Internal modem installed	2,400-/9,600-bps	2,400-/9,600-bps	None	2,400-/9,600-bps	None
Screen manufacturer	Packard Bell	Sharp	Sanyo	Sanyo	Sharp
Video chip set manufacturer	Cirrus	Cirrus	Epson	Cirrus	Cirrus
Simultaneous external display	y	y	y	n	m
Maximum internal resolution	640 x 480	640 x 480	640 x 480	800 x 600	640 x 480
Maximum internal gray shades or colors	64 gray shades	256 colors	32 gray shades	16 colors	64 gray shades
Maximum external resolution	800 x 600	1,024 x 768	800 x 600	800 x 600	640 x 480
Maximum external colors	16	16	16	16	16
Illuminated screen/Active matrix	y n	y y	y n	y n	y n
AC adapter size (inches)	1.5 x 5.8 x 3	1.8 x 6 x 3	1.6 x 5.1 x 2.3	1.5 x 5.5 x 2.8	1.8 x 4.8 x 3.3
Rated battery life (hours)	2.5	3	6	3.5	2.5
ZDigit Rundown, Battery Rundown (hr:min)	3:03, 2:39	N/A**, 1:24	2:01, 1:32	2:32, 1:44	3:12, 2:27
Charge time while on, off (hours)	1.5, 1.5	2, 2	4.5, 1.5	3, 2	5, 3
Battery weight, amp/hour rating	1.4 lbs, 2.3Ah	1.4 lbs, 2.8Ah	0.8 lbs, 5.0Ah	1.3 lbs, 5Ah	1.2 lbs, 2.4Ah
Display/hard disk power-down	y y	y y	y y	y y	y y
CPU/peripherals power-down	y y	y y	y y	y y	y y
Standby/Hibernation	y y	y y	y n	y n	y n
DOS version, Microsoft Windows version	5.0, 3.1	5.0, 3.1	5.0, 3.1	5.0, 3.1	5.0, None
Warranty	1 year	1 year	15 months	1 year	1 year

SUMMARY OF FEATURES
PORTABLE PCs

Listed in alphabetical order by company y = YES n = NO	Santron 486 Jetbook	Tenex 486SLC/25	Tenex 486DX/33 Chroma	TI TravelMate WinSLC 25	PC Magazine Editor's Choice TI TravelMate 4000 WinDX/25
List price (tested configuration) $US	$2120	$1850	$3100	$1899	$2799
Processor type and speed	Intel 486DX/33	Cyrix Cx486SLC/25	Intel 486DX/33	TI 486SLC/25	Intel 486DX/25
Hard disk capacity	86MB	120MB	213MB	64MB	128MB
Dealers/Direct-distribution channel	n y	y y	y y	y n	y n
Dimensions (HWD, in inches)	2 x 11 x 9	2.2 x 12 x 9.4	2.2 x 12 x 9.5	1.8 x 11 x 8.5	1.8 x 11 x 8.5
System weight/travel weight (pounds)	6.6, 8	7.5, 9	7.7, 9	5.6, 6.8	5.6, 6.9
Display area and diagonal (inches)	5.8 x 7.5 x 9.5	5.8 x 7.6 x 9.5	5.2 x 6.9 x 8.5	6 x 8 x 9.8	6 x 8 x 9.8
Keys: total, function, cursor	86, 12, 4	84, 12, 8	84, 12, 8	79, 10, 4	79, 10, 4
Type of pointing device installed	Built-in	Clip-on	Clip-on	Clip-on	Clip-on
Motherboard manufacturer	Jetta	Notestar	Notestar	TI	TI
Chip set manufacturer	C&T	C&T	C&T	TI	TI
BIOS version (or date)	AMI 4.00	AMI (6/13/90)	AMI (7/7/91)	Phoenix 1.02	Phoenix 1.02
Setup in ROM/Password in ROM	y y	y n	y y	y y	y n
Installable RAM	4MB-16MB	2MB-8MB	4MB-16MB	4MB-6MB	8MB-20MB
User-installable	y	n	y	y	y
External processor RAM cache	32K	None	None	None	None
Available hard disk sizes	85MB-210MB	80MB-210MB	80MB-210MB	64MB-80MB	128MB-200MB
I/O and Expansion					
Parallel, serial, mouse, expansion ports	1, 1, 1, 1	1, 1, 0, 1	1, 1, 0, 1	1, 1, 1, 1	1, 1, 1, 1
High-speed parallel/serial support	n n	n n	n n	n n	n n
Ports for port replicator/expansion chassis	n n	n y	n n	y y	y y
PCMCIA slots	None	None	None	None	None
Internal modem installed	2,400-/9,600-bps	2,400-/9,600-bps	2,400-/9,600-bps	None	None
Screen manufacturer	Hitachi	Sharp	Sharp	Sharp	Sharp
Video chip set manufacturer	Cirrus	C&T	Cirrus	Cirrus	Cirrus
Simultaneous external display	y	y	y	y	y
Maximum internal resolution	640 x 480	640 x 480	640 x 480	640 x 480	640 x 480
Maximum internal gray shades or colors	64 gray shades	64 gray shades	16 colors	64 gray shades	64 gray shades
Maximum external resolution	800 x 600	640 x 480	800 x 600	640 x 480	1,024 x 768
Maximum external colors	16	16	16	256	16
Illuminated screen/Active matrix	y n	y n	y n	y n	y n
AC adapter size (inches)	1.8 x 5.8 x 3.5	1.6 x 6 x 2.5	1.9 x 5.3 x 5.3	1.5 x 2.3 x 6	1.5 x 2.3 x 6
Rated battery life (hours)	2.5	3	3	4	4
ZDigit Rundown, Battery Rundown (hr:min)	2:50, 2:23	3:17, 2:59	2:47, 2:02	4:01, 3:43	4:00, 1:47
Charge time while on, off (hours)	2, 2	5, 3	5, 1	3, 3	3, 3
Battery weight, amp/hour rating	1.4 lbs, 1.9Ah	1.9 lbs, 1.4Ah	2.9 lbs, 1.4Ah	1.3 lbs, 5.7Ah	1.3 lbs, 5.7Ah
Display/hard disk power-down	y y	y y	y y	y y	y y
CPU/peripherals power-down	y n	y y	y y	y y	y y
Standby/Hibernation	y y	y n	y n	y n	y n
DOS version, Microsoft Windows version	5.0, 3.1	6.0, 3.1	5.0, 3.1	6.0, 3.1	6.0, 3.1
Warranty	1 year	1 year	1 year	1 year	1 year

SUMMARY OF FEATURES
PORTABLE PCs

Listed in alphabetical order by company y = YES n = NO	PC Magazine Editor's Choice TI TravelMate 4000 WinDX2/40 Color	PC Magazine Editor's Choice TI TravelMate 4000 WinDX2/50	PC Magazine Editor's Choice TI TravelMate 4000 WinSX/25	PC Magazine Editor's Choice TI TravelMate 4000 WinSX/25 Color	Toshiba Satellite T1850C
List price (tested configuration) $US	$4199	$3499	$2199	$2999	$1850 (estimated)
Processor type and speed	TI DX2/40	Intel 486DX2/50	Intel 486SX/25	Intel 486SX/25	Intel 386SX/25
Hard disk capacity	208MB	208MB	128MB	128MB	80MB
Dealers/Direct-distribution channel	y n	y n	y n	y n	y n
Dimensions (HWD, in inches)	1.9 x 11 x 8.5	1.8 x 11 x 8.5	1.8 x 11 x 8.5	2.3 x 11 x 8.5	2.3 x 11.8 x 8.5
System weight/travel weight (pounds)	6.2, 7.5	4.4, 6.9	5.6, 6.9	6.1, 7.4	7.2, 8.4
Display area and diagonal (inches)	5.8 x 7.7 x 9.4	6 x 8 x 9.8	6 x 8 x 9.8	5.8 x 7.7 x 9.5	5.8 x 7.5 x 9.5
Keys: total, function, cursor	79, 10, 4	79, 10, 4	79, 10, 4	79, 10, 4	82, 12, 8
Type of pointing device installed	Clip-on	Clip-on	Clip-on	Clip-on	Clip-on
Motherboard manufacturer	TI	TI	TI	TI	Toshiba
Chip set manufacturer	TI	TI	TI	TI	Toshiba
BIOS version (or date)	Phoenix 1.02	Phoenix 1.02	Phoenix 1.02	Phoenix 1.02	Toshiba (7/17/92)
Setup in ROM/Password in ROM	y y	y y	y y	y y	y y
Installable RAM	8MB-20MB	8MB-20MB	8MB-20MB	8MB-20MB	4MB-12MB
User-installable	y	y	y	y	y
External processor RAM cache	None	None	None	None	None
Available hard disk sizes	208MB	208MB	128MB	128MB	80MB-120MB
I/O and Expansion					
Parallel, serial, mouse, expansion ports	1, 1, 1, 1	1, 1, 1, 1	1, 1, 1, 1	1, 1, 1, 1	1, 1, 1, 1
High-speed parallel/serial support	n n	n n	n n	n n	n n
Ports for port replicator/expansion chassis	y y	y y	y y	y y	n n
PCMCIA slots	None	None	None	None	None
Internal modem installed	None	None	None	None	2,400-bps data
Screen manufacturer	Sanyo	Sharp	Sharp	Sanyo	Toshiba
Video chip set manufacturer	Cirrus	Cirrus	Cirrus	Cirrus	Toshiba
Simultaneous external display	y	y	y	y	n
Maximum internal resolution	640 x 480	640 x 480	640 x 480	640 x 480	640 x 480
Maximum internal gray shades or colors	256 colors	64 gray shades	64 gray shades	256 colors	256 colors
Maximum external resolution	1,024 x 768	800 x 600	1,024 x 768	1,024 x 768	640 x 480
Maximum external colors	16	256	16	16	256
Illuminated screen/Active matrix	y n	y n	y n	y n	y n
AC adapter size (inches)	1.6 x 6 x 2.3	1.5 x 6 x 2.3	1.5 x 2.3 x 6	1.6 x 6 x 2.3	1.5 x 5.8 x 2.8
Rated battery life (hours)	3.5	4.5	4	3.5	2
ZDigit Rundown, Battery Rundown (hr:min)	4:12, 2:15	5:21, 3:05	7:02, 4:18	3:44, 2:16	3:47, 2:03
Charge time while on, off (hours)	3, 3	3, 3	3, 3	3, 3	2, 1.3
Battery weight, amp/hour rating	1.3 lbs, 5.7Ah	1.3 lbs, 5.7Ah	1.3 lbs, 5.7Ah	1.3 lbs, 5.7Ah	1.6 lbs, 2.8Ah
Display/hard disk power-down	y y	y y	y y	y y	y y
CPU/peripherals power-down	y y	y y	y y	y y	y n
Standby/Hibernation	y n	y n	y y	y y	n n
DOS version, Microsoft Windows version	6.0, 3.1	6.0, 3.1	6.0, 3.1	6.0, 3.1	5.0, 3.1
Warranty	1 year	1 year	1 year	1 year	1 year

SUMMARY OF FEATURES
PORTABLE PCs

Listed in alphabetical order by company
y = YES n = NO

	Toshiba T4400C	Toshiba T4500	Toshiba T4500C	Twinhead Slimnote 4DX/33T	Twinhead Slimnote 4DX2/66T
List price (tested configuration) $US	$4858	$3004	$3799	$3899	$4499
Processor type and speed	Intel 486DX/25	Intel 486SX/20	Intel 486SX/20	Intel 486DX/33	Intel 486DX2/66
Hard disk capacity	213MB	86MB	120MB	203MB	203MB
Dealers/Direct-distribution channel	y n	y n	y n	y y	y y
Dimensions (HWD, in inches)	2.3 x 11.8 x 8.4	1.8 x 11.5 x 8.3	2 x 11.5 x 8.5	2 x 11 x 8.5	2 x 11 x 8.5
System weight/travel weight (pounds)	8, 9.9	6.3, 7.5	7, 8.2	6.7, 8.2	6.8, 8.3
Display area and diagonal (inches)	5.7 x 7.6 x 9.5	5.8 x 7.5 x 9.5	5 x 6.8 x 8.5	5.3 x 6.9 x 8.5	5.3 x 6.9 x 8.5
Keys: total, function, cursor	82, 12, 8	82, 12, 8	82, 12, 8	84, 10, 8	84, 10, 8
Type of pointing device installed	None	Snap-on	Snap-on	Built-in	Built-in
Motherboard manufacturer	Toshiba	Toshiba	Toshiba	Twinhead	Twinhead
Chip set manufacturer	Toshiba	Toshiba	Toshiba	ACC/Twinhead	ACC/Twinhead
BIOS version (or date)	Toshiba (10/7/92)	Toshiba 1.10	Toshiba 1.10	Phoenix (2/15/93)	Phoenix (3/15/93)
Setup in ROM/Password in ROM	y y	y y	y y	y y	y y
Installable RAM	4MB-20MB	4MB-20MB	4MB-20MB	4MB-20MB	4MB-20MB
User-installable	y	y	y	y	y
External processor RAM cache	None	None	None	None	None
Available hard disk sizes	80MB-120MB	120MB-200MB	120MB-200MB	130MB-203MB	203MB
I/O and Expansion					
Parallel, serial, mouse, expansion ports	1, 1, 1, 1	1, 1, 1, 1	1, 1, 1, 1	1, 1, 1, 1	1, 1, 1, 1
High-speed parallel/serial support	n n	n n	n n	y n	n n
Ports for port replicator/expansion chassis	n y	n y	n n	n y	n y
PCMCIA slots	None	One Type II	One Type II	None	None
Internal modem installed	14,400-bps fax	2,400-/9,600-bps	2,400-/9,600-bps	2,400-/9,600-bps	14,400-/9,600-bps
Screen manufacturer	DTI	Info not available	Info not available	Sharp	Sharp
Video chip set manufacturer	Toshiba	WD	WD	Cirrus	Cirrus
Simultaneous external display	y	y	y	y	y
Maximum internal resolution	640 x 480	640 x 480	640 x 480	640 x 480	640 x 480
Maximum internal gray shades or colors	256 colors	64 gray shades	256 colors	256 colors	256 colors
Maximum external resolution	640 x 480	1,024 x 768	1,024 x 768	1,024 x 768	1,024 x 768
Maximum external colors	256	16	16	16	16
Illuminated screen/Active matrix	y y	y n	y y	y y	y y
AC adapter size (inches)	1.8 x 6.3 x 3	1.3 x 5.8 x 3	1.3 x 3 x 6	1.5 x 6 x 2.8	1.5 x 6 x 2.8
Rated battery life (hours)	3	3	2.5	2.5	2.5
ZDigit Rundown, Battery Rundown (hr:min)	4:36, 2:22	6:17, 3:58	4:19, 1:50	1:54, 1:36	2:30, 2:03
Charge time while on, off (hours)	1.5, 1.5	4, 2	4, 2	4, 2	4, 2
Battery weight, amp/hour rating	2.4 lbs, 2.4Ah	1.4 lbs, 2.4Ah	1.5 lbs, 3.3 Ah	1.5 lbs, 2.3Ah	1.5 lbs, 1.7Ah
Display/hard disk power-down	y y	y y	y y	y y	y y
CPU/peripherals power-down	y y	y y	y n	y n	y n
Standby/Hibernation	y y	y n	y y	y n	y n
DOS version, Microsoft Windows version	5.0, 3.1	5.0, 3.1	5.0, 3.1	5.0, 3.1	5.0, 3.1
Warranty	1 year	1 year	1 year	1 year	1 year

SUMMARY OF FEATURES
PORTABLE PCs

Listed in alphabetical order by company
y = YES n = NO

	Twinhead Slimnote 4SX/33M	ZDS Z-Lite 320L	ZDS Z-Note 425Ln Model 120	ZDS Z-Note 425Lnc Model 200	ZDS Z-Note 425Lnp Model 120
List price (tested configuration) $US	$1849	$1999	$2878	$4278	$3278
Processor type and speed	Intel 486SX/33	Intel 386SL/20	Intel 486SL/25	Intel 486SL/25	Intel 486SL/25
Hard disk capacity	130MB	61MB	121MB	200MB	121MB
Dealers/Direct-distribution channel	y y	y y	y y	y y	y y
Dimensions (HWD, in inches)	1.5 x 11 x 8.5	1.3 x 10 x 7.5	2.3 x 11.5 x 8.5	2.3 x 11.5 x 8.5	2.3 x 11.5 x 8.5
System weight/travel weight (pounds)	6.1, 7.8	4, 5.1	5.8, 7.3	6.6, 8.1	6.5, 8
Display area and diagonal (inches)	5.8 x 7.5 x 9.5	5.3 x 6.8 x 8.5	5.8 x 7.8 x 9.5	5.3 x 6.8 x 8.5	5.8 x 7.8 x 9.5
Keys: total, function, cursor	84, 10, 8	83, 12, 8	82, 12, 8	82, 12, 8	82, 12, 8
Type of pointing device installed	Built-in	Snap-on	Clip-on	Clip-on	Clip-on
Motherboard manufacturer	Twinhead	ZDS	ZDS	ZDS	ZDS
Chip set manufacturer	ACC/Twinhead	Intel	Intel	Intel	Intel
BIOS version (or date)	Phoenix (2/15/93)	ZDS (3/26/93)	ZDS 4.01	ZDS 4.01	ZDS 4.01
Setup in ROM/Password in ROM	y y	y y	y y	y y	y y
Installable RAM	4MB-20MB	2MB-10MB	4MB-28MB	4MB-28MB	4MB-28MB
User-installable	y	y	y	y	y
External processor RAM cache	None	None	None	None	None
Available hard disk sizes	130MB-200MB	61MB	120MB-200MB	200MB	120MB-200MB
I/O and Expansion					
Parallel, serial, mouse, expansion ports	1, 1, 1, 1	1, 1, 1, 0	1, 1, 0, 1	1, 1, 0, 1	1, 1, 0, 1
High-speed parallel/serial support	n n	y n	n y	n y	n y
Ports for port replicator/expansion chassis	n y	n n	y n	y n	y n
PCMCIA slots	None	Two Type I,	None	None	None
Internal modem installed	2,400-/9,600-bps	None	None	None	None
Screen manufacturer	Sharp	Info not available	Info not available	Info not available	Info not available
Video chip set manufacturer	Cirrus	Cirrus	C&T	C&T	C&T
Simultaneous external display	y	y	y	y	y
Maximum internal resolution	640 x 480	640 x 480	640 x 480	640 x 480	640 x 480
Maximum internal gray shades or colors	64 gray shades	64 gray shades	64 gray shades	256 colors	256 colors
Maximum external resolution	800 x 600	640 x 480	1,024 x 768	1,024 x 768	1,024 x 768
Maximum external colors	16	256	16	16	16
Illuminated screen/Active matrix	y n	y n	y n	y y	y n
AC adapter size (inches)	1.8 x 6.5 x 3	1.5 x 5.3 x 2.5	1.6 x 6 x 2.8	1.6 x 6 x 2.8	1.6 x 6 x 2.8
Rated battery life (hours)	2.5	3	4.3	2.5	4.3
ZDigit Rundown, Battery Rundown (hr:min)	3:05, 2:03	4:02, 3:31	8:33, 4:23	4:17, 2:39	5:01, 2:37
Charge time while on, off (hours)	1.5, 1.5	10, 2.5	8, 2.3	8, 2.3	8, 2.3
Battery weight, amp/hour rating	1.3 lbs, 1.7Ah	0.9 lbs, 2.3Ah	1.2 lbs, 2.3Ah	1.3 lbs, 2.2Ah	1.3 lbs, 2.3Ah
Display/hard disk power-down	n y	y y	y y	y y	y y
CPU/peripherals power-down	y y	y n	n n	n n	n n
Standby/Hibernation	y n	y y	y y	y y	y y
DOS version, Microsoft Windows version	5.0, 3.1	5.0, 3.1	6.0, 3.1	6.0, 3.1	6.0, 3.1
Warranty	1 year	1 year	1 year	1 year	1 year

SUMMARY OF FEATURES
PORTABLE PCs

Listed in alphabetical order by company
y = YES n = NO

	ZDS Z-Sport 420S	ZDS Z-Sport 425S	Zeos Contenda
List price (tested configuration) $US	$1798	$2098	$1894
Processor type and speed	Intel 487SX/20	Intel 487SX/25	Intel 386SL/25
Hard disk capacity	85MB	121MB	80MB
Dealers/Direct-distribution channel	y y	y y	n y
Dimensions (HWD, in inches)	2 x 11 x 8.5	2 x 11 x 8.5	1.8 x 9.7 x 6.1
System weight/travel weight (pounds)	6, 7.8	6, 7.7	4.1, 5.1
Display area and diagonal (inches)	5.8 x 7.8 x 9.5	5.8 x 7.8 x 9.5	4.5 x 6 x 7.5
Keys: total, function, cursor	87, 12, 8	87, 12, 8	80, 12, 4
Type of pointing device installed	None	None	Built-in
Motherboard manufacturer	ZDS	ZDS	Zeos
Chip set manufacturer	Intel	Intel	Intel
BIOS version (or date)	Phoenix (4/19/90)	Phoenix 1.01	Phoenix (2/23/93)
Setup in ROM/Password in ROM	y y	y y	y y
Installable RAM	4MB-12MB	4MB-12MB	2MB-10MB
User-installable	y	y	n
External processor RAM cache	None	None	None
Available hard disk sizes	85MB	120MB	80MB
I/O and Expansion			
Parallel, serial, mouse, expansion ports	1, 1, 0, 1	1, 1, 0, 1	1, 1, 0, 1
High-speed parallel/serial support	y n	y n	y n
Ports for port replicator/expansion chassis	n y	n y	n n
PCMCIA slots	None	None	None
Internal modem installed	None	None	2,400-/9,600-bps
Screen manufacturer	Info not available	Info not available	Sharp
Video chip set manufacturer	Cirrus	Cirrus	Cirrus
Simultaneous external display	y	y	y
Maximum internal resolution	640 x 480	640 x 480	640 x 480
Maximum internal gray shades or colors	64 gray shades	64 gray shades	64 gray shades
Maximum external resolution	640 x 480	640 x 480	800 x 600
Maximum external colors	256	256	16
Illuminated screen/Active matrix	y n	y n	n n
AC adapter size (inches)	2 x 7 x 3	2 x 7 x 3	1.5 x 3 x 4.5
Rated battery life (hours)	2	2	3.5
ZDigit Rundown, Battery Rundown (hr:min)	4:02, 2:49	N/A**, 2:49	2:52, 2:38
Charge time while on, off (hours)	3.5, 1.5	3.5, 1.5	5, 1.3
Battery weight, amp/hour rating	1 lbs, 2.2Ah	1 lbs, 2.2Ah	1 lbs, 2.2Ah
Display/hard disk power-down	y y	y y	y y
CPU/peripherals power-down	y n	y n	y y
Standby/Hibernation	n y	n y	y n
DOS version, Microsoft Windows version	5.0, None	5.0, None	6.0, 3.1
Warranty	1 year	1 year	1 year

9. SUMMARY AND CONCLUSIONS

The analyzes of the results from our investigation demonstrate that the requirements for an universal mobile data workstation, with the capability to fully support various applications beyond real time messaging and database access, and yet survive harsh vehicular environments, are very specific. The commercial portable PC notebooks are powerful and rich with features, but are optimized for their target market - general business and office computing. They are intended to be use in the controlled environmental conditions of the home or office and will not provide reliable service when exposed to the extremes of the mobile environment.

In addition, many police specific operational and ergonomic requirements can not be met without by the commercial grade portable computing platforms without significant custom modifications. A comparison, referenced to the specific requirements for a police mobile workstation, between features for of-the-shelf specialized rugged computers and the commercial grade PC notebooks is given in Table 2. It is evident that many of the necessary and desirable mobile workstation features are not available on the commercial product.

Table 2, Comparison of Ruggedized vs. Commercial Portable PC's

FEATURE	RUGGEDIZED	COMMERCIAL
-40°C to +60° temperature, storage	yes	no (-20°C to +60°C)
-20°C to +60°C temperature, operating	yes	no (+5°C to +60°C)
shock, operating 20 G (EIA 374 A)	yes	no (10 G)
adjustable screen angle	yes	yes
detachable keyboard	yes	no
spill proof keyboard	yes	yes (only few)
illuminated keyboard	yes	no
emergency key	yes	yes (custom software)
illuminated screen	yes	yes
removable hard drive (PCMCIA III)	yes	yes (on some)
rugged temp. comp. hard drive	yes	no
RAM card (PCMCIA I, II)	yes	yes (on some)
vehicular mount	yes	no
swivel mount	yes	N/A
pass word security	yes	yes
MS-DOS/Windows in ROM	yes	no
two or more RS-232 serial ports	yes	no (except two)
docking connector or station	yes	no
2 or more RS232 ports	yes	no (except two)

Table 3, Summary of Environmental Specifications for Popular Notebook Computers

MODEL	GRiD 1680	GRiD CONVERTABLE	AST BRAVO
OPERATING			
Temperature	+5C to +35C	+5C to +35C	+10C TO +60C
Humidity (non condensig)	10% to 90%	10% to 90%	20% to 90%
Shock	?	10G	?
Vibration (5-200-5 Hz)	?	1G	?
Altitude [meters]	0 to 3000	0 to 3000	0 to 3000
Electrostatic Discharge [kV]		15	
Storage & Transportation			
Temperature	-20C to +60C	-20C to +60C	-20C to +60C
Humidity (non condensig)	5% to 90%	5% to 90%	5% to 95%
Shock	?	80G	?
Vibration (5-200-5 Hz)	?	4G	?
Altitude [meters]	12000	12000	12000
MANUFACTURER	**COMPAQ**	**TOSHIBA**	**TOSHIBA**
MODEL	**LTE Lite Notebook**	**T 1900**	**T 4500 / T6600C**
OPERATING			
Temperatrure	+10C to +40C (Note 1)	+5C to +35C (Note 4)	+5C to +35C
Humidity (non condensig)	10% to 90%	20% to 80%	20% to 80%
Shock	10G (Note 2)	10G	10G
Vibration	0.25G (Note 3)	0.5G	0.5G
Altitude [meters]	0 to 3000	-60 to 3000	-60 to 3000
Storage & Transportation			
Temperature	-20C to +60C (Note 4)	-20C to +65C (Note 4)	-20C to +65C (Note 4)
Humidity (non condensig)	5% to 98%	10% to 90%	10% to 90%
Shock	'60G (Note 2)	'60G	'60G
Vibration (5-200-5 Hz)	1G (Note 3)	1G	1G
Altitude [meters]	0 to 12,000	0 to 12,000	0 to 12,000

Note 1: Thermal gradient of 10C/Hr. max.
Note 2: 11 mS, half sine
Note 3: 5 to 500 Hz, 1/2 octave per minute sweep
Note 4: Thermal gradient of 20C/Hr. max.
"?" Indicate that the information was not available at the time of writing

An examination of Table 3, summarizing the guaranteed minimum environmental specifications for several popular notebook computers, further supports the conclusion that the commercial computers are not intended by design for use as mobile workstation platforms. This is not to say that compromising solutions are not possible for some limited application. It is our opinion that business grade PC notebooks can be used as mobile workstation computer platforms under the following conditions:

⇨ Tests are performed in order to determine the degree of ruggedness of the product.

- ⇨ The notebook is removed from the vehicle when possible exposure to temperature outside of the specified, or measured, limits are expected (the most possible component to sustain damage at extreme temperature is the LCD screen).

- ⇨ Only solid-state mass data storage devices, or mechanically rugged removable hard drives are used and operated at temperature above +5°.

- ⇨ In order to avoid possible exposure to potentially damaging shock and vibration, the built-in hard disk drives should be used only when the vehicle is parked and only at a temperature of above +5°C.

In addition, the implementation of commercial PC notebooks as police mobile workstations will require custom mounting, special arrangements for docking and auxiliary illumination of the keyboard.

Taking in consideration all the limitations of the business grade portable computers and the demands of the mobile operating environment, our recommendation is that the use of commercial PC notebooks is restricted only to limited and well researched applications.

The of-the-shelf ruggedized mobile computers are the recommended choice for wide spread general application.

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11. ANNEX "A"

The following articles have been selected from PC magazine to provide the reader with an overview of the standard commercial notebooks available today. The final article is one year old and has been included in order to evaluate the progression of features and technologies.

ANNEX "A" TABLE OF CONTENTS

PC Magazine August 1993 v12 n14 p125(63)

The portable puzzle. (Hardware Review) (overview of 39 evaluations of portable computers)

(includes related articles on brief overview, Editors' Choices, highlights, benchmark tests, suitability to task ratings, price/performance index, battery life vs. portability, third-party add-ons, PCMCIA, summary of features) (Evaluation)

Author
Howard, Bill

Absrtact
Sixty-four notebook and subnotebook computers are reviewed. Major trends in the portable-computer industry include lighter weight, color active-matrix screens, built-in pointing devices and PCMCIA slots. Systems arc lighter today than ever before while offering better battery life, and major vendors such as Compaq and Toshiba have introduced 'value lines' that attempt to leverage name recognition. Sixteen of the tested systems include PCMCIA slots, but these are not necessarily plug-and-play. Compaq's Contura 4/25CX, Gateway 2000 Inc's Nomad 425SXL and 450DXL. IBM's ThinkPad 720C and Texas Instruments' TravelMate 4000 series are rated Editors' Choices.

Full Text
With such an embarrassment of notebook riches to choose from, confusion reigns. PC Magazine fits the pieces together to help you make sense of the picture.

What does it take to get a break in the laptop business today'? That's the question on the lips of the vast majority of portable computer vendors. With such a stunning variety of products a consumer can choose from, the short answer is to do everything right, from design and engineering all the way through to service and support.

This big question is paramount among the vendors who are typically labeled as "others" on charts depicting market share. These are companies selling speedy, capable 6- and 7-pound notebook computers with 386- and 486-level CPUs/ And while many have what would have seemed like bargain-basement prices a year ago, they still include color displays, PCMCIA slots, and built-in pointing devices. Yet, as a group these firms are actually losing market share to the top ten vendors who now control about three-quarters of the portable PC market. These 50 to 100 "others" must fight for the remaining quarter.

That's one of two notable ironies in the notebook business today. The other: Despite rapid advances in teclmology and packaging, the next notebook you buy may weigh more, cost the same, and have worse battery life than the notebook you're carrying around today. That's because of the increased demand for color systems, which are generally heavier, more expensive, and have shorter battery lives than their monochrome brethren

In this issue of PC Magazine we sort through the gamut of issues concerning portable PCs, from our reviews of 64 notebooks and four subnotebooks to companion stories on portable multimedia machines, the Apple PowerBook, battery technology, and the first generation of PCMCIA products. You'll also find reviews of six battery-powered portable printers and a look at wireless communications technology. And we've included a foldout guide that covers the basic information you need for staying in touch on the road.

NOTEBOOK DIRECTIONS

In an industry so competitive that a company is only as good as its present products, movement is quick. Some of the more important trends indicate where the notebook market is heading:

The 486 reigns. Of the 68 systems we reviewed, 51 have some flavor of 486 CPU from Cyrix, IBM, Intel, or Texas Instruments. Megahertz for megahertz, the 486 provides twice the processing oomph of a 386 CPU. Unless $1,000 is your price ceiling, there's no compelling reason to buy a 386-based portable today.

Color beckons. No longer must you turn to costly active-matris LCD panels for a decent color display. The new dual-scan (or double-scan) technology, makes less expensive passive-matrix color displays acceptable.

Weight is down, battery life up. The average road weight of the systems reviewed has dropped 4 ounces to 7.5 pounds since the last time we looked at portables. Average battery life of tested systems rose slightly to about 2 hours 25 minutes. The average price of a system has leveled off to $2,850, after many months of sharp declines.

Built-in pointing devices are a must. As Microsoft Windows becomes de riguer on the road, users are shunning separate trackballs or mice. The dividing line between acceptable and klunky` is the snap-on cordless trackball.

Value lines take off. Attempting to cash in on brand-name recognition. Compaq and Toshiba have launched their value lines-Contura and Satellite, respectively. Budget systems generally offer slightly lower performance and fewer features.

PCMCIA proliferates but is lacking. While intended to be plug-and-play, the PCMCIA accessory slot is anything but. PCMICA slots are on 16 of the systems we tested, and there's been a flurry of products: modems, network adapters, hard disks, and flash memory.

REVIEW CRITERIA

For inclusion in this issue, we sought all products that had been released or significantly upgraded since our last roundup (March 30, 1993). Systems had to be shipping as of early April and have a travel weight (system, battery, power adapter, and cord) of no more than 9 pounds. We sought systems with at least a 386 CPU, a hard disk with at least a 60MB capacity, and DOS and Windows preloaded.

Testing took place in April and May and prices are current as of early June. Unitsthat were sent too late to be tested are described in a two-page addendum.

Our search criteria netted us 68 systems from 32 vendors. These systems are based on 20 different types of CPUs manufactured by AMD, Cyrix, IBM, Intel, and Texas Instruments. The processors range from a 20MHz 386 all the way through the 486DX2/66. Fifteen of the 68 systems used non-Intel CPUs Note that some of the 486-labeled systems are hybrids. It is important to remember that the Cyrix 486SLC/25, Cyrix 486SLC/33, and clock-doubled IBM 486SLC2/50 all have 16-bit memory paths, as do 386SX-class CPUs, but not the more capable 486s.

The two most popular CPUs among the tested machines belong to Intel's power-saving SL family--the 386SL/25 and the 486SL/25--found in 13 and !! systems, respectively. Later this summer you can expect a 33-MHz 486SL, the last chip to carry the SL name. which will deliver about 25 percent more processing power than its 25-MHz cousin. Intel will continue to migrate the functional attributes of the SL into its desktop chip lines. This not only means that power-managed desktop systems are ahead, but that manufacturers will not have to stock DX- and SL-type CPUs of the same clock speed.

Because of the variety of CPU types and speeds, performance levels varied widely. On PC Magazine Labs' benchmark tests, the fastest processor score surpassed the slowest by a ratio of 6 to 1. This hierarchy of performance shows that careful engineering counts for at least as much as the speed of the CPU. In terms of raw CPU power, 486DX2/50 portables actually outperformed 486DX2/66 systems. The TI TravelMate 4000 WinDX2/50, the similar Gateway Nomad 450DXL, and the HyperBook 2300DX2/50 averaged 12,287 processor operations per second and finished first, second, and third in the processor test. The next four finishers were 486DX2/66-based units that averaged 11,173 processor operations per second. The top seven units were able to process data twice as fast as the average notebook.

The progression of processing power since our last portables review- is shown by the performance midpoint in this review, which is held by the 11 486SL/25 notebooks that averaged 5,578 processor operations per second. This is almost twice as fast as the previous generation of 386SL/25s which averaged roughly 3,000 operations per second.

In addition, our tests show a 5-to-1 ratio between the fastest and slowest video subsystems. The five best video performers under Windows, in descending order, were the IBM ThinkPad 720C, the NEC UltraLite Versa 25C (the first laptop with a video local bus), the PC Brand Active Color LeaderBook Pro, the Toshiba T4400C. and the HyperBook 2300DX2/50. In all, 18 systems performed at or above the 3-megapixel-per-second level: the ThinkPad 720C surpassed the 5-megapixel-per-second mark.

For the first time in a portable PC roundup, we used the PC Labs' Windows Applications test suite, which approximates the demands of a multitasking environment by timing a computer's performance on four popular Windows programs. The best score was turned in by the Twinhead Slimnote 4DX2/66T.

For many users, the most important measure of a portable's worth IS battery life. We performed both our worst-case Battery Rundown test (with all power-conservation features disabled) and the ZDigit test, which alternately exercises the system, puts it in standby mode, and then triggers its power-conserving sleep mode before starting the cycle again.

In terms of Battery Rundown test scores, three monochrome 486 systems topped 4 hours: the ZDs Z-Note 425Ln Model 120, at 4 hours 23 minutes; the TI TravelMate 4000 WinSX/25, at 4 hours 18 minutes; and the DECpc 425SL, at 4 hours 3 minutes. The best battery time for a color portable belongs to the Dell 325NC, which uses a 386 processor and a passive-matrix color screen to last just under 3 hours. The bottom line is that it's not unreasonable to expect a monochrome PC to run for at least 2.5 hours and a color system to last in the neighborhood of 2 hours.

We expect battery performance to improve by 1994 as nickel hydride cells and other innovations take hold (for more information. see the sidebar "Power to the Portables"). Another approach to battery life is to use an advanced core logic chip set that can vary the system clock speed to suit the required level of computing. One such chip set is Evergreen, from PicoPower Technology (408-954-8880): which makes its debut on the CompuAdd 425TX system.

WHO'S WHO. AND WHY

Three companies that have stressed innovation in their products are Apple, Compaq, and Toshiba, and each claims about 15 percent of the notebook market, based on a survey from the end of 1992. AST, Dell, Sharp, Tandy/GRiD and Texas Instruments each command 5 to 7 percent of the market. Just behind them are NEC and Zenith Data Systems (ZDS), two late-1980s high fliers that recently stumbled, and IBM which is only now emerging from a decade-long string of klunkers. The Apple PowerBook thrived last year primarily because its innovate design fulfilled the market's pent-up demand for a decent Macintosh portable. Nevertheless, the unit suffers from inferior battery life and a high price tag.

A comparison of two pairs of manufacturers shows where this market has been and where it is heading. Toshiba, which hasn't stumbled in the eight years since the breakthrough T1100 system came out, has been the most consistent player. The Toshiba T4500C has an unrivaled keyboard, a PCMCIA slot, and a high-quality 8.5-inch color screen, but lacks an integrated trackball, making do with a snap-on QuickPort version of the Microsoft Ballpoint. By contrast, the Compaq LTE Lite 4/25C has a faster 25-MHz CPU, a roughly equivalent size, a lighter weight. a dedicated modem slot for a 14,400-bps data/fax modem, and a trackball incorporated into the case.

Dell Computer Corp. and NEC Technologies bear scrutiny for opposite reasons. After a dry spell, NEC once again has

a highly competitive product in the NEC UltraLite Versa 25C, a 486SL/25 system with a removable 9.5-inch active-matrix color display that can be turned to face a group for presentations. Conversely, Dell's dry spell is here and now; its aging products don't include any 486 systems and probably won't until 1994.

What Dell has done well IS boost its value-oriented NL line of notebooks. The trend toward giving the buyer an inexpensive alternative is also seen at Compaq (Contura), IBM (PS/Note), Toshiba (Satellite), and ZDS (%-Sport). For some companies, value-line computers represent half their sales volume.

In comparison to their higher-priced siblings, the value-line notebooks often rely on components that are one level removed from being state-of-the-art, have cases that are a bit thicker and heavier, and employ CPU's and video subsystems that aren't as fast. The exception appears to be the Compaq Contura 4/25CX, which nips at the heels of the company's more expensive LTE Lite 4/25C.

But don't dismiss the lesser-known brands. There are some good values lurking out there. Read our reviews and test analyses carefully before you proceed, and choose a company you feel will be around for several years to come.

FEATURES THAT SELL

While high performance is always desirable, you may find certain features that are more desirable than raw power. The most significant newcomer is the dual-scan screen technology and the sophisticated electronics behind it. This innovation divides a screen into top and bottom halves and refreshes each independently at twice the traditional speed. The result: crisper color and less smearing or ghosting for only a marginally higher cost. Of all reviewed notebooks, only the Contura 4/25C uses this technology. The image quality produced by dual-scan tcclmology falls midway between the quality of passive-matrix and active-matrix panels. The only downside is that there can be a visible line dividing the scanning sections--tolerable in text mode but annoying for graphics.

An increasing number of notebook systems feature built-in trackballs. None is ever as good as a real mouse, but most traveling users can tolerate the best portable pointing devices for short amounts of time. Our favorites remain the large trackball at the front of the Apple PowerBook and IBM's TrackPoint II, which looks like a pencil eraser jutting up between the G and H keys. IBM reportedly is preparing to license the technology, in part to keep other vendors from adopting copycat devices. We hope TrackPoint 11 holds up under long-tenn use. Its use of strain-gauge technology is fairly sophisticated, but the only problem we've had so far has been that the rubber nub has the tendency to fall off.

Micro Electronics deserves a kudo for coming closest to knocking off the look and feel of the PowerBooks trackball on its WinBook 486SLC/E/33. Another approach comes from Appoint (X00448-1 184), which sells Gullivcr. a handheld mouse that is about one-third the size of a Microsoft mouse and can be flipped over and used as a tiny trackball.

Many vendors impressed us with the inclusion of removable hard disks that let you lock away sensitive data without having to buy a bigger safe. By the same token, removable floppy disk drives can reduce the total weight of a portable by three-quarters of a pound or can make room for a second battery. Most of the major vendors offer docking stations with drive bays and expansion slots, or cheaper port replicators that allow for quick cable connections in the office, or both.

The office of today relies on wires, but that may change due to a PCMCIA-based system that establishes a wireless local area network. Made by Proxim (415-960-1630), the product is called RangeLAN/PCMCIA and can be purchased as separate cards or bundled with a desktop base station from AST Research. The system uses spread spectrum radio frequency transmitters to make contact through Windows for Workgroups in the AST version: other variations support NetWare or Microsoft LAN Manager. While Proxim claims its product works for distances of 300 to 500 feet indoors and up to 800 feet in the open. our anecdotal tests showed that it worked reliably up to about 100 feet in our office, which is criss-crossed with interfering wires and steel girders. Don't expect the data throughput of a wired network connection because the RangeLAN system can pump data only at the rate of 242 kilobits per second (Kbps).

A whole industry has arisen around specialty notebook accessories. For example, if your notebook's hard disk is rapidly tilling up, consider an upgrade that could take you as high as 340MB for many popular Compaq or Toshiba notebooks. Laptop Solutions of Houston, Texas (713-7X9-0878) will install a new hard disk overnight and even transfer your files onto the new disk. But at $1,500, this extra headroom is not cheap.

On the other hand, an external hard disk with removable media might do the trick if it were light and battery-operated. SyDOS of Boca Raton, Florida (800-437-9367) sells a 1.5-pound unit called the Pro*Note that holds 42MB and interfaces via the notebook's parallel port. This product gets power from nickel cadmium cells that last for about 2 hours of real-world use. While data transfer is slower than with an internal drive or through an expansion port, the Pro*Note is useful for making backups or for storing very large data sets.

Among the systems we tested, several had a special bent. The NEC Versa and the GRid Convertible can double as pen computers. By contrast, the Canon NoteJet 486 (see the sidebar "Canon NoteJet 486: Hybrid Office") creates a new paradigm by combining a Cyrix SLC/25-based notebook computer with an ink jet printer in a 7.7-pound package.

We also encountered four subnotebooks, each weighing less than 4 pounds: the Compudyne 4SL/25 Subnote, Dell 325SLi, ZDS Z-Lite 320L, and Zeos Contenda. In our opinion, none offers enough of the power and practicality of a full-featured product to compete. Adequate for simple

tasks such as collecting electronic messages on the road, subnotebooks are likely to disappoint when it comes to writing a memo or going over a spreadsheet.

The most talked-about subnotebook started shipping after our deadline: The Hewlett-Packard OmniBook 300, a sub-$2,000, instant-on system with several Windows applications in ROM and a pennanently attached pull-out mouse; it can use an infrared connection to transfer files to desktop PCs and printers. The system can be thought of as a docking station for a variety of functional PCMCIA cards, including memory (hard disk or flash memory), applications, or network or modem card. HP took two big gambles with this PC: eliminating the screen's backlight to extend battery life, and using a 386-class CPU to contain costs.

At the other size extreme are suitcase computers that have multimedia pretensions (see the sidebar "Multimedia on the Go"). The recently announced Toshiba T6600C is the newest and most capable, with a built-in sound system and speakers, two ISA slots, and room for a 5.25-inch CD-ROM drive and a digital video interactive adapter. Weight 17 pounds; cost: $7,500 to $9.500, depending on user-spccilied options.

SORTING IT OUT

With such an embarrassment of riches to choose from: we offer a few suggestions. Steer toward a 486:class color system. Get a large hard disk on the order of at least 120MB. Try several built-in pointing devices and select the one you like best. If high-speed communication is important to you right now, you may be safer with a notebook that has an internal modem slot. We have included in this roundup a compilation of those portable-PC features we like and those we abhor.

Perhaps most importantly, look at our service and support ratings for the largest vendors It is interesting to note that Compaq, Dell; IBM, Toshiba, and Zeos received scores significantly above the average on all three measures, and stand out as vendors of choice. A few vendors now cover repairs for three years, not just one. Others will replace a faulty system overnight.

In most cases, the 68 system reviews that follow arc arranged alphabetically by vendor. In addition, three systems shipped too late for inclusion--a subnotebook from Twinhead Corp., a 486SLC-powered PS/Note from IBM, and a dual-scan passive color notebook from PC Brand Multiple versions of essentially a single design are grouped together. Each review includes a Suitability to Task rating in four areas: road warrior, DOS applications, Windows applications, and desktop replacement.

A frequent traveler, for instance, may cherish extremely light weight and a great modem so much as to sacrifice computing power. More power-minded users might value a high-quality screen so much that weight or battery life are immaterial to them. We all know there is no single ideal configuration for all the possible uses you can find for a laptop.

Related Article

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* Compaq Contura 4/25CX

* Gateway Nomad 425SXL

* Gateway Nomad 450DXL

* IBM ThinkPad 720C

* T1 TravelMate 4000 series

In judging this wide palette of both old and new, of stripped-down and feature-rich portable PCs, we returned to the basics of portability: size, weight, battery life, performance, and screen quality. Those that stood out from this highly qualified pack of 68 portables seamlessly combined these elements to create roadworthy PCs. The best will satisfy you and should continue to keep up as mobile computing becomes more demanding.

A STEP AHEAD

'The T1 TravelMate 4000 family members we reviewed and the nearly identical Gateway Nomads--the 425SXL and 450DXL--pack power into small, lightweight packages. These two product lines include notebooks for virtually every budget and computing style. The units do still lack PCMCIA slots and active-matrix color screens, but both features are on the way.

Close on the heels of the very successful IBM ThinkPad 700C, the IBM ThinkPad 720C is lighter and more utilitarian. yet retains the 10.4-inch active-matrix color screen--today's best notebook display. Weighing nearly 9 pounds, the 720C can be a lot to lug around, though.

The Compaq Contura 4/25CX is the first value-line portable that doesn't scrimp on features or performance. It either beat or kept up with its Compaq LTE Lite 4/25C cousin on our benchmark tests. The 4/25CX is a lower-priced alternative with similar performance levels, but it lacks expansion port capabilities.

NOT FAR BEHIND

Several systems were impressive, but disappointed us in one way or another. they rated Honorable Mention.

A newcomer, the Micro Electronics WinBook 486SLC/E/33, unpressed us by pairing a very usable built-in trackball with a low price tag. It lacks an optional color screen, however.

The NEC UltraLite Versa 486/SL combines excellent benchmark test results--a ranking among the top three in its CPU class for processor, memory, and video scores--with an appealing design. Its unique reversible screen is balanced by the lack of a built-in trackball and its huge power adapter.

The Compaq LTE Lite 25E remains the only active-matrix monochrome portable. and easily has the most readable monochrome screen, but it really should have a 486 CPU. (The Compaq LTE Lite 4/25E, powered by a 48681,125 chip, shipped too late for this review.)

A pair of identical twins--the AST PowerExec 4/25Sl Color Plus and the DECpc 425SL-led the pack in putting together an amalgam of features, performance, and battery life. Add to that a front-mounted clip-on trackball and you have 8-pound marvels.

One system of note is the Toshiba T4500C, whose combination of lightness, long battery life, and excellent screen virtually established the power notebook segment. Today, the T4500C has been left behind by its competitors, but its shortcomings are addressed in the new T4600C.

Related Article

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Power without the Pounds

The trend to portable computers is the latest step toward making computing truly a part of our lives. In this, our third annual summertime portable computer issue, we look at the tremendous strides being made in notebook computers, peripherals, and software. We also explore the potential of related new technologies.

Just a few years ago, it seemed that portable computers would always lag behind their desktop counterparts in power, speed, and expandability. But look at the 68 remarkable systems we review in "The Portable Puzzle." They range from inexpensive monochrome systems to full-featured comptuers with great color, lots of memory, and hundreds of megabytes of hard disk storage. And of course this breed will be even more powerful in the future as witness the 10 new mahcines previewed in the sidebar "Up Next. "

Soon we expect to see even smaller, lighter, more portable machines, some with keyboards and some with alternative user interfaces. Call them personal digital assistants, personal communicators, or personal information processors--they promise to become part of our everyday lives. Many of us will want to have them connected to wireless networks for immediate contact with the information we have in our offices. Wireless communications is still in its infancy, but it offers enormous promise. We take a look at this fascinating technology in "Connecting over the Airwaves." Computing has gone from the glass room to the desktop and now to the briefcase and the laptop. It may soon be a constant companion.

Related Article

Portable PCs

CI IOICES, CHOICES. From 4-pound subnotebooks to 20-pound suitcase multimedia machines, the portable PC arena has exploded with choice. We tested 68 new or significantly improved units and took a look at several others.

THE AVERAGE PORTABLE PC today is powered by a 486 processor, has a monochrome screen, weighs 7.5 pounds, has a battery life of about 2 hours 25 minutes, and costs $2,863.

PCMCIA SLOTS were present on 16 of our test systems, but their rapid acceptance by portable makers appears to be outpacing the number of avdilable and compatible PCMCIA devices.

COLOR PORTABLES are making tremendous inroads due primarily to the increasing sophistication of passive-matrix color displays. The best passive-matrix units use a dual scanning technique to improve color depth and sharpness and reduce shadowing.

VALUE-LINE NOTEBOOKS such as the Compaq Contura series and the Toshiba Satellite T1850C are giving smaller vendors a run for the money.

QUALITY ENGINEERING SHOWED in two 486DX2/50 systems--the nearly identical TI TravelMate 4000 WinDX2/50 and Gateway Nomad 450DXL--that beat more powerful DX2/66 systems in raw computing performance.

THREE LASTED FOUR HOURS or more on battery tests. The ZDS Z-Note 425Ln Model 120, the TI TravelMate 4000 WinSX/25, and Digital's DECpc 425SL achieved the best compromise between power and battery weight. The best battery time for a color unit belongs to the Dell 325NC, which uses a 386 processor and a passive-matrix color screen to last just under 3 hours.

BUILT-IN POINTING DEVICES vary in comfort and ease of use from the Apple PowerBook's large, front-mounted device to many smaller and less useful ones. IBM's TrackPoint II and Micro Electronics' small, front-mounted trackball were the best.

THE APPLE POWERBOOK line continues to amaze with superior ergonomics: the downside is higher cost, sluggish performance, and short battery life.

HP's OMNIBOOK 300 may be the first acceptable subnotebook. Based on a relatively weak 386 CPU and utilizing a nonbacklit screen, it has its shortcomings.

PORTABLES WITH CD-ROM may seem more like an oxymoron than an engineering trend, but there are several luggable systems out there that are perfect for high-quality graphics or presentations.

INTEL's POWER-SAVING SL CPU family provided the most popular processors in this review: they were used in more than a third of the systems we tested.

IBM'S THINKPAD 720C continues where the 700C left off. It is not only lighter and more utilitarian but still uses

the same 10.4-inch color display--easily the best in the business today.

Related Article

Benchmark Tests: Portable PCs

What the Numbers Mean

Of the 68 portable systems we review here, 20 processors are represented, with CPUs ranging from mid-level 386 chips to high-end 486s. While the best systems were able to approach the performance of average desktop personal computers, having the fastest chip wasn't always the ticket to the computing fast lane.

PROCESSOR AND MEMORY

Rapidly advancing processor technology and the proliferation of chips are seen in the diversity of CPUs found in this review. The computer industry's newest portable systems rely on various versions of486 processors. Although in this issue we introduce our first batch of 486DX2/66-based notebooks, we find that the fastest processor does not always produce the best system. For example, the TI TravelMate 4000 WinDX2/50 continues to be the top gun of the portable world, outperforming several DX2/66-based systems. The 4000 WinDX2/50 performed 12,568 processor operations per second and handled 8,467 kilobytes per second (KBps) on our memory tests. This is 13 percent better in terms of the processor score and 10 percent better in terms of the memory score than the average 486DX2/66 achieved in this roundup. The TI TravelMate 4000 WinDX2/40 also stood out, sporting Intel's new 486DX2/40 CPU. It scored 10,070 processor operations per second and 6,746 KBps on the memory tests, making it one of the top ten processor and memory performers we reviewed.

Intel's 25-MHz 486SL CPU appears to be the fastest-growing processor class for portables. The use of this chip rose from a handful in our last portables roundup to 11 in this article, second only to the number of notebooks using the 386SL CPA. The NEC UltraLite Versa 25C led the 486SLs, with a processor score of 6,165 operations per second.

At the other performance extreme are the lower-order 486 processor types, including the seven systems based on the Cyrix 486SLC/25 CPU. The Hyundai Courier Spectra ranked first in its processor category and ranked 44th overall. The Epson ActionNote 4SLC/25 produced the slowest processor score among the Cyris-based machines: which is attributable to the Epson's poor memory subsystem. The only 486SLC/E-33 in this roundup is the Micro Electronics WinBook 486SLC/E/33. Of all tested systems it ranked 41 st in processor testing, at 4,480 operations per second, and 17th in memory, at 4,740 kilobytes per second.

HyperData Technology Corp.'s Hyperbook 2300 DLC/40 uses the Cyrix 486DLC/40 CPU and is one of the fea systems with a fairly large external memory cache. It scored tenth on processor and memory tests, due in part to its 128K of external cache.

Leading the pack among 386SL/25 units was the Compaq LTE Lite 25E, performing 3,186 processor operations per second. At the bottom of this CPU group is the AST PowerExec EL Color, performing 2,409 processor operations per second, and the Zeos Contenda subnotebook, performing 2,759 processor operations per second. These units suffered a performance penalty because both lacked esternal processor caches. By contrast, the systems powered by the 386SX/25 CPU did slightly better. The Toshiba Satellite T1850C, a 386SX/25-based unit performed 2,692 processor operations per second and 3,432K per second on the memory tests.

The CAF AquaLITE II and the Hyundai Courier were the only two systems using the AMD386SXL/25 CPU. The average processor performance of these two non-L2 cache systems was slightly better than that of the two non-L2 cache Intel 386SL/25 units (the AST PowerExec EL Color and the Zeos Contenda). The ZDS Z-Sport 4253 and the Mitsuba Ninja 486SX/25 tracked below average in memory performance, ranking fifth and sixth among the 486SX/25-based units.

DOS VIDEO

Two systems were able to rise above the pack in terms of DOS video operations, each breaking the 4-million-operation-per-second barrier for notebooks. The DECpc 425SL, which emplovs Western Digital's WD90C26 chip set, yielded 4.17 million operations per second, and the IBM ThinkPad 720C, using proprietary electronics, handled 4.06 million operations per second. The NEC UltraLite Versa 25C is unique in featuring a local-bus video implementation but was slightly behind the pack, at 3.89 million video operations per second.

Once again. the top video perfonners were the active-matrix color units, an indication that screen technology remains the limiting factor in video performance. Out of the 12 active color units, 6 were in the top 10.

DOS DISK

Toshiba's MK-2224FC hard disk led the pack in a variety of implementations. The Twinhead Slimnote DX2/66T, with its 128K of on-board hardware cache, led the group, scoring 35.56K per second (KBps). This was followed closely by the Blue Star 486DX2/66, the HyperBook 2300DX2/50, and the Compudyne 4DX2/66 Monochrome Slimnote, all of which scored well over 30 KBps On the other side of the spectrum, the ZDS Z-Lite 320L, using a 60MB Seagate 908A drive, scored only 14.13 KBps.

DOSMARK

The DOSmark score combines all of the DOS scores and heavily weights each system's disk performance. Here again, Toshiba's MK-2224FC hard disk excelled, particularly in the Compudyne 4DX2/66 Active TFT Color Slimnote, which had a DOSmark score of over 35.

GRAPHICS WINMARK

Nine out of the top ten Graphics Wmmark performers were based on the Intel 486 designs. The exception, the IBM ThinkPad 720C, uses an SLC/2 CPU and a proprietary IBM video chip set; it ranked first, with a Graphics Wimnark score of over 5 megapixels per second. The NEC Versa was the only system in this roundup to use local-bus technology, utilizing a Chips & Technologies 65530 chip set, the Versa came in second, with a Graphics Wimnark score **of** nearly 4.5 megapixels per second.

DISK WINMARK

For this portion of the testing, we configured each system with a fixed 1MB of SmartDrive cache to represent a Windows setup for a system with 4MB of system RAM With the exception of the Blue Star 486DX2/66, GRiD Convertible, and Samsung NoteMaster 486SLC Model S3800 (at 8MB) and the ZDS

Z-Lite 320L (at 6MB), all other systems were tested with 4MB of system RAM. The units with 6MB and above could not be depopulated in order to keep within the 4MB filter. All of the top Disk Winmark performers were on the higher end of the 486 processor scale. The **Tenex** 486DX/33 Chroma--which ranked third, with a Disk Winmark score of 35.99 KBps--is the only unit among the top ten that does not use clock-doubling technology.

WINDOWS APPLICATIONS

For this issue, we ran the Windows Applications suite for the first time on portable PCs. This test suite uses four popular Windows programs running serially. We found that the overall results mirrored processor type and disk performance, as reflected in a nearly fourfold difference between the best and the worst systems. The top live performers were the Twinhead Slinmote 4DX2/66T the Blue Star 486DX2/66, HyperData Technology Corp.'s HyperBook 2300DX2/50, the Compudyne 4DX2/66 Active TFT Color Slimnote, and the Compudyne 4DX2/66 Monochrome Slinmote.

How We Tested

We used PC Magazine Labs' Hardware Benchmark Tests, Release 7.0 1, to predict processor, memory, video, and disk performance using DOS applications. Each of the four scores we report is the weighted harmonic mean of the results from several tests. These results are summarized in a composite score called the DOSmark that estimates system performance. We also used the Windows Benchmark Tests (Winbench), Release 3.11, to obtain the Graphics Winmark and Disk Winmark scores, and used the Windows Applications tests to simulate a multitasking environment.

The processor score is a measure of the CPU's performance and its interaction with cache and mam memory. It uses small and medium-size instruction mixes, along with either the floating-point calculation test or the coprocessor test (depending on the availability Of a math coprocessor).

The memory score is compiled from 8-, 16-, and 32-bit extended-memory read and write tests, as well as 8- and 1 G-bit conventional-memory read and write tests.

The disk score measures throughput using standard DOS INT 21h tile I/O calls. The tests measure the speed of file reading and writing both sequentially and randomly, for a range of file sizes from 256K to 32MB. The tests are performed without software disk caches installed.

The video score is based on direct-to-screen text-write and graphics-write tests.

The DOSmark score is a composite rating derived from the processor, memory, video, and disk scores. It indicates a PC's ability to run DOS applications.

The Graphics Winmark score is based on 12 Windows graphics and text functions that are derived from extensive profiling of popular Windows applications. This score is measured in megapixels per second (a megapixel is 1,048,576 pixels).

The Disk Wimnark score rellccts disk operations in the Windows enviromnent. Systems are configured with up to 2MB of SmartDrive software cache.

In the Windows Applications suite, portions of four programs--Ami Pro, CorelDRAW, Microsoft Excel, and Superbase--are run via a macro and are timed. Because the results are given in seconds, lower scores represent better performance.

Related Article

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Suitability to Task: Portable PCs

Road warrior rates how complete a traveling companion each system is. Excellent units combine small size, light weight, long battery life, large hard disk capacity, and good communications options.

DOS applications measures a system's ability to run DOS software quickly. Excellent systems have at least a 25-MHz 386 CPU, an 80MB hard disk, a 9-inch display, and a DOSmark score in the top 25 percent of the group.

Windows applications measures CPU speed and high-volume data storage. Top units have system RAM expandable to at least 8MB, an optional 120MB hard disk available, a built-in pointing device, and Microsoft Windows-compatible power management capabilities. In addition, the best units received Graphics Wimnark, Disk Winmark and Windows Applications test scores in the top 25 percent of the roundup.

An excellent desktop replacement offers suitable internal expansion or a docking station option, has a hard disk of at least 120MB and a good keyboard, and supports an external SVGA monitor.

SERVICE AND RELIABILITY

In our 1993 Service and Reliability Survey, we sent questionnaires to 17,000 random subscribers; about half of them responded. We publish results only for those vendors for which we received an adequate number of responses. For more information, please see our July 1993 issue. Vendors are rated above average, average, or below average in three areas:

Reliability scores indicate to what degree PC owners felt the systems they purchased met their overall expectations for consistent operation.

Repair service scores are culled from those users who contacted the manufacturers to have their PCs repaired. The scores reflect users' satisfaction with the service they were given.

Technical support scores are a measure of how well the vendors' telephone support services met the respondents expectations.

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Price/Performance Index: Portable PCs

The era of the high-performance notebook has arrived. Of the 6X notebook systems we reviewed for this roundup, 2X had color displays and 5 1, an overwhelming majority, used a 486-class CPU from Advanced Micro Devices. Cyrix, Intel, or IBM. With the current generation of notebooks, you give up relatively little in terms of computing power when you take your desktop applications on the road.

Color units still carry higher price tags, but two passive-matrix display systems managed to land in the best price/performance sector. These color-on-the-cheap systems were the Ergo PowerBrick 486 and the AS? PowerExec EL Color.

Digital Equipment Corp.'s DECpc 325SL and 425Sl had the best price/performance scores, thanks to a robust mix of features and excellent Battery Rundown test results. Among the next ones were the Gateway Nomad 425SXL and Nomad 450DXL, as well as the nearly identical TI TravelMate 4000 WinSX/25 and WinDX2/50. Also in the price/performance sweet spot was the Jetta Jetbook 486DX/33.

At $3,249 and about average on our performance scale was the Compaq Contura 4/25C, which is our value leader. Its dual-scan passive-matrix color screen leads other color units in its price range in image quality, and it has both the performance and battery life of systems that cost hundreds more. Among the active-matrix color displays, the top performers were the AST PowerExec 4/25SL Color Plus, the Twinhead Slimnote 4DX2/66T, the IBM ThinkPad 720C, and the ZDS Note 425Lnc Model 200.

The systems that had trouble keeping up with the pack fall into the lower-left-hand comer of the chart, most notably the GRiD Convertible. Low-priced machines with relatively poor scores for performance and features include individual units from Hyundai, Polywell, and Tenex.

THE DATA POINTS

In determining performance scores, we consider benchmark test results (42 percent), RAM and hard disk capacities (X.5 percent), size and weight (22 percent), ZDigit Rundown time (11 percent), and features (16.5 percent).

The features category gives credit for larger display size, external VGA support, built-in pointing devices. PCMCIA slots, internal modems, user-installable nonproprietary RAM and expansion units, high-speed serial and parallel ports, port replicators, external keyboards. power-management features (including advanced power management support), battery hot swap, and separate cursor and PgDn, PgUp, Home, and End keys. The composite performance score is plotted on the x-axis versus the selling price of the tested configuration on the y-axis.

You can find more data in PC MagNet's Software Library Editorial Forum as 14BANG.WK1.

Related Article

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Battery Life vs. Portability

Eight out of the 6X systems we tested were able to combine a travel weight of under 7.5 pounds and a battery that lasted for 3 hours or more. They stand out as road warriors of distinction.

For notebooks, long battery life and light weight are a traveler's ideals. Of the 6X systems reviewed, only 3 combined a travel weight of under 7.5 pounds with battery life of 4 hours or more. Another 5 fell in the 3- to 4-hour range. but none had color displays. (Note that our system weight includes battery weight, while the travel weight adds the AC adapter and power cord but not the external floppy disk drive that may come with a subnotebook system.)

The ZDS %-Note 425Ln Model 120, the TI TravelMate 4000 WinSXR5, and the DECpc 425SL had the longest Battery Rundown times among sub-7.5-pound units. For true lightweights, battery life is often sacrificed. Yet the featherweight Dell 325Sli, at 4.X pounds, ran for 2 hours 55 minutes.

Color systems still weigh more and use more power than monochrome. The TI TravelMate 4000 WinSX/25 Color and WinDX2/40 Color weigh about 7.5 pounds each and had Battery Rundown times of about 2 hours 15 minutes. Compaq's Contura 4/25C and LTE Lite 4/25C arc a little heavier, with battery life of about ! hour 50 minutes each. The Poly NB425C--at 7.2 pounds, the lightest passive-matrix color system--has a battery life of 1 hour 44 minutes. In the same category, the AST PowerExec EL Color and Hyundai Courier Spectra have even shorter battery lives but remain relatively light for color units.

Active-matrix color adds to the weight. The AST PowerExec 4/25SL Color Plus, IBM ThinkPad 720C, NEC UltraLite Versa 25C, and ZDS Z-Note 425Lnc all provide roughly 2 to 3 hours of battery life and weigh 8 to 9 pounds.

Related Article

Beyond Benchmark Tests

Some Delightful and Some Dubious Portable Features and Products

Here's a quick showing of a few things we liked and didn't like about the laptops reviewed in this issue. In addition to our usual comparison of portable features, this time we also ran across some third-party add-on products that were too good to pass up. If these products are any indication at all, the truly portable office is already here.

AC Adapter Brick AC adapters have been accepted as bulky add-ons since the dawn of the portable age. But since Toshiba came out with its tiny two-prong adapter last year (left), power bricks the size of the one shipped with the NEC UltraLite Versa 25C really have no excuse.

Overall Weight The bigger your notebook, the more difficult a time you'll have packing; the heavier the notebook, the more you'll sweat jogging through airports. Any of the Texas Instruments' TravelMte 4000 series notebooks weigh 6.2 pounds, while the Tenex 486DX/33 Chroma comes in at an arm-straining 9.1 pounds.

Axonix CableMate

Axonix defines its $199 CableMate as a "docking bar" for users to connect many peripherals in **one** step. The CableMate attaches to the expansion port of your Compaq LTE or Toshiba notebook. 800-866-9797.

External Hard Disk

Another of the neat third-party peripherals we saw- this time around was the SyDOS Pro*Note external hard disk. With a 42MB capacity, the unit configures through your parallel port and weighs 1.5 pounds. 800-437-9367.

Screen Width

If a wide, readable screen is important to you, whether in color or monochrome, check out something like the IBM ThinkPad 720C's 10.4-inch display and try to avoid smaller screens like Zeos Contenda's 7.5-inch screen.

Internal Trackball

Two more heroes quested for the perfect-internal-trackball grail this roundup. IBM has come very close with its keyboard-situated TrackPoint II, while CompuAdd Express provides the usual slippery rodent with side-mounted buttons--but on the left-hand side of the system's case. It's not a critical weakness, but it's surely an annoyance to any right-handed users.

Portable Scanner

Nisca's Niscan Portable Grayscale Scanner is the first portable full-page scanner we've seen. Capable of 400 dpi with 256 shades of gray, the Niscan is almost fully Twain-compatible and is about the size of a carton ot cigarettes. 800-245-7226.

TI Battery Charger

Tired of juggling your productivity with your portable battery life'? Texas Instruments' battery charger/discharger allows **you** to work with one battery while charging up a new one. It even allows a full discharge to condition your battery and avoid problems like battery "memory." At only $149, it's certainly cheaper in the long run to invest in the charger than it is to keep buying expensive nickel cadmium batteries every time one dies on you.

Proxim RangeLAN

Proxim Corp.'s $595 RangeLAN/PCMCIA is another add-on winner A wireless LAN for notebook computers with a Type IL PCMCIA slot, this system can access networks 300 to 500 feet away indoors. 415-960 1630.

Screens

You may pay less for passive-matrix color than for active-matrix, but that's **no** reason to stop comparison shopping there. Beware of differences among passive screens, like the beautiful dual-scan passive-matrix Compaq Contura screen (left) and the problematic AST PowerExec EL (the same screen found on the DECpc 325SLC). Though the Compaq uses a more advanced technology than the AS?', its price is comparable.

Related Article

PCMCIA: Almost Here

The year 1992 was supposed to be the year PCMCIA card technology hit the big time. Now it's the middle of 1993 and we're still waiting. We set a late-May deadline for receiving shipping PCMCIA products, which netted us just 24 products; five more barely missed the cutoff date. The majority of devices we saw were modems, Ethernet network adapters, and dynamic RAM (DRAM) or flash memory cards. We also received three mini-hard disks, a marvelous PCMCIA-based radio LAN, and a SCSI adapter. After plugging these into the PCMCIA-capable notebooks reviewed in this roundup (including the Toshiba 1'4500 and T4500C, the Dell 325SLi, the Compudyne 4SL/25Subnote, the AST PowerExec series, the DECpc series, the GRid Convertible, the Hyundai Courier, the IBM ThinkPad 720C, the Micro Electronics WinBook 486SLC/E/33, the NEC UltraLite Versa 25C, and the ZDS Z-Lite 320L), WC were still disappointed.

Plug-and-play is PCMCIA's most ambitious goal and its biggest shortcoming. Though you can purchase any of the cards listed here, you must still make do with interim drivers for your specific system We found memory cards slightly easier to configure than modems or Ethernet cards, which had about the same level of difficulty. During our examination period, Award Software finished its universal PCMCIA BIOS module. This one-size-tits-all program reduced the configuration time significantly. Once vendors implement this new BIOS or similar products from Phoenix and SvstemSoft, hardware plug-and-play compatibility will be achieved.

The advent of the SunDisk-type flash memory card has been touted as the death of hard disks, but flash products remain very expensive. Those we saw were faster than the mini-hard disk entries and the PCMCWATA standard makes them as easy to use as "D" But at about $400 for 4MB of flash storage, hard disks will stick around for quite some time.

Some of the most exciting news was from products we did not receive. We missed three static RAM (SRAM) memory cards from Epson America: the 512K ($169.99), the IMB ($249), and the 4MB ($389). Socket Communications managed to deliver two network adapters, but narrowly missed entering not only a $325 serial port adapter card but also a Global Positioning System. Socket sees a market for the $795 Socket Mobile GPS card, which was adapted from the military for civilian use: accessing a $12 billion U.S. Department of Defense satellite system for all-weather position and velocity information and even usmg the government's ultra-precise atomic clocks. Look for it and other interesting variations at Fall Comdex.

Related Article

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Summary of Features: Portables

List price (tested configuration)

Not all portables are available in comparable configurations. We report the price of each system as tested.

Dealers/Direct distribution channel

Various machines are sold directly through mail order, through dealers, or, increasingly, through company-owned stores and superstores.

System weight/travel weight

The system weight includes the weight of the battery. The travel weight adds that of the AC adapter brick and power cord (but not the external floppy disk drives used in tine systems).

Keys: total, function, cursor

The table describes each portable's keyboard: the total number of keys, the number of function keys and the number of cursor keys. If you have only four cursor keys and you need to access PgUp, PgDn, Home, or End, you hold a function key and tap an arrow key.

Type of pomting device installed

A device can be free-standing (a normal serial or PS/2-style mouse), built-in (built into the unit's case), clip-on (a device that clips onto a unit's case and via a cable), and snap-on (similar to a clip-on, but needs no cable).

The BIOS version (or date) can affect the system's performance on our benchmark tests.

PCMCIA slots accept removable I/O devices roughly the size of a credit card. Currently, add-in components that tit this form factor include expansion memory, nonvolatile SRAM for storage, and modems. There are currently three versions of the PCMCIA standard: Type 1 Type II, and Type III.

Internal modem installed indicates the type of modem bundled with the vendor's computer.

Ports for port replicator/expansion chassis

Some machines have expansion ports that let the system bus connect to a port replicator (which re-creates the I/O ports and can easily be removed from the system without disconnecting all your peripherals) or an expansion chassis (which is an external floppy disk drive or full-fledged docking station with additional ports and space for expansion cards).

The chip set and video memory determine the maximum external resolution and number of simultaneous colors the external monitor can display at that resolution. Decreasing the resolution setting usually increases the maximum external colors.

Illuminated screen/Active matrix

An illuminated screen is either backlit, edgelit, or sidelit. Active-matrix displays are brighter, provide richer colors or shades of gray, and are easier to view at an angle than passive-matrix screens are.

This table includes each system's rated battery life as reported by the vendor, PC Labs also tests the battery life and reports the results in the benchmark test section. The ZDigit Rrmdown time shows battery life with power-saving features enabled, and the Battery Rundown time provides a worst-case scenario for battery life No power-conservation features were active. We also indicate the battery charge time with the unit on and off, as reported by the vendor.

The battery weight; amp/hour rating shows the battery's weighht as well as how long that battery is rated to deliver a steady current of one ampere.

The systems in this review all include power-conservation features, such as automatic display dimming or blanking, automatic hard disk power-down, slowing or halting the CPU, and peripherals power-down for removing power to

the I/O ports (modem, parallel, and serial ports) when the machine is not in use. More advanced power-management features include standby mode (in which a system preserves its current state in memory, ususally via a secondary battery) and hibernation (in which the system's state is written to the hard disk).

Warranty

All systems included in this roundup came with a one-year parts-and-labor warranty or better.

Each system has an FCC Class B identification number, which means it has sufficiently low radio-frequency emissions to be used in the home. To verify any system's status, you may dial up the Public Access Lmk, the FCC's own bulletin board service, at 30 1-725-1 072.

Type
hardware review
evaluation

Company
AST Research Inc.
Digital Equipment Corp.
Aurum Computer Corp.
Blue Star Marketing Inc.
CAF Technology Inc.
Compaq Computer Corp.
CompuAdd Express
CompuDyne Corp.
Dell Computer Corp.
Epson America Inc.
Ergo Computing Inc.
Gateway 2000 Inc.
Texas Instruments Inc.
GRiD Systems Corp.
HyperData Technology Corp.
Hyundai Electronics America
International Business Machines Corp.
Jetta lntemational Inc.
Santron Computer Inc.
Micro Electronics
Micro Express Inc.
Microsphere Inc. Tenex Computer Express Inc.
Mitsuba Corp.
NEC Technologies Inc.
Packard Bell Electronics Inc.
PC Brand Inc.
Polywell Computers Inc.
Samsung Electronics America Inc.
Toshiba America lnformation Systems Inc.
Twinhead Corp.
Zenith Datasystcms Inc.
ZEOS International Ltd.

Product
Gateway 2000 Nomad 450DXL
AST Research PowerExec EL Color
AST Research PowerExec 3/25SL
AST Research PowerExec 4/25SL Color
DEC DECpc 325SL
DEC DECpc 325SLC
DEC DECpc 425SL
Aurum Computer GoldNote DX2-50
Blue Star Marketing 486DX2/66
CAF Teclmology AquaLite-II
Compaq LTE Lite/25E
Compaq Contura 4/25
Compaq Contura 4/25c
Compaq Contura 4/25CX
Compaq LTE Lite 4/25c
CompuAdd Express 425XL
CompuAdd Express 425Color
CompuAdd Express 425ColorPlus
Compudyne 4SL/25 Subnote
Dell Computer Dell 325N
Dell Computer Dell 325NC
Dell Computer Dell 325SLi
Dell Computer Dell NL25
Dell Computer Dell NL25C
Epson ActionNote 4SLC/25
Ergo Computing PowerBrick 486
Gateway 2000 Nomad 425SXL
Texas lnstruments TravelMate WinSLC 25
Texas Instruments TravelMate 4000 WinSX/25
'Texas Instruments TravelMate 4000 WinSX/25 Color
Texas Instruments TravelMate 4000 WinDX2/40 Color
Texas Instruments TravelMate 4000 WinDX2/50
GRid Systems GRiD Convertible
HyperData Technology HyperBook 23000DLC/40
HyperData Technology HyperBook 23000DX2/50
Hyundai Electronics America Courier
Hyundai Electronics America Courier Spectra
IBM ThinkPad 720C
Jetta International Jetbook 486DX/33
Santron Computers 486 Jetbook
Micro Electronics WinBook 486SLC/E/33
Micro Express NP943
Tenex Computer Express 486DX/33 Chroma
Mitsuba Ninja 486SX/25
NEC Technologies UltraLite Versa 25c
Packard Bell 486DX/25 Notebook
PC Brand Active Color LeaderBook Pro
Polywell Computers Poly NB425C
Polywell Computers Poly NB325V
Samsung Electronics NoteMaster 486SLC S3800
Tenex Computer Express 486SLC/25
Toshiba Satellite T1850C
Toshiba T4400C
Toshiba '1'4500
Toshiba T4500C
Compudynr 4DX2/66 Monochrome Slimnote
Compudyne 4DX2/66 Active TFT Color Slimnote
Twinhead Slimnote 4SX/33M
Twinhead Slimnote 4DX/33T
Twinhead Slimnote 4DX2/66T
Zenith Data Systems Z-Note 425Ln
Zenith Data Systems Z-Note 425Lnp
Zenith Data Systems Z-Note 425Lnc
Zenith Data Systems Z-Lite 320L
Zenith Data Systems Z-Sport 420S
Zenith Data Systems Z-Sport 4258
Zeros International Zeos Contenda

PC Magazine August 1993 v12 n14 p148(3)

AST PowerExec EL Color; AST PowerExec 3/25SL; AST PowerExec 4/25SL Color; DECpc 325SL; DECpc 325SLC; DECpc 425SL.

(AST Research Inc., Digital Equipment Corp.) (Hardware Review) (one of 39 evaluations of notebook and subnotebook computers in 'The Portable Puzzle') (Evaluation)

Author
Rist, Oliver

Absrtact

AST Research Inc's PowerExec line of notebooks is also sold by DEC under DEC's DECpc brand name and offers average quality and above-average vendor service. The AST PowerExec 4/25 SL Color Plus costs $4,499 equipped with a 9.5-inch TFT color screen and uses a 3.3-volt Intel 80486SL microprocessor. The DEC 425SL is similar but has a monochrome screen: it sells for $2,499. Both can support 200Mbyte hard disk drives, flash BIOS and two PCMCIA Type II slots. Other models in the PowerExec and DECpc lines are built around 386-class processors and are largely identical; the $2,799 PowerExec EL Color offers a passive-matrix color screen with disappointing quality, while the $2,099 DECpc 325SL is a low-end monochrome system. Performance is average for 80386-based computers.

Full Text

AST PowerExec 3/25SL;

AST PowerExec 4/25SL Color Plus; Digital Equipment Corp.DECpc 325SL; DECpc 325SLC: DECpc 425SL AST PowerExec EL Color AST PowerExec 3/25SL Color AST PowerExec 4/25SL Color Plus AST Research Inc. 162 15 Alton Pkwy., Irvine, CA 92619-7005: 800-876-4278, 714-727-4141; fax, 714-727-9355 List price: EL Color, $2,799 3/25SL Color, $3,499; 4/25SL Color Plus, $4,499.

Tested configuration: 4MB 70-ns RAM (3/25SL Color came with 64KB of extsrnal cache); 120MB Toshiba MK2124FC IDE hard disk with 32K cache (EL), 160MB Quantum GRS160AT IDE hard disk with 32K cache (3/25SL), 200MB Seagate ST9235AG IDE hard disk with 64K buffer (4/25SL); 1.44MB floppy disk drive; DOS 5.0: Microsoft Windows 3.1: SmartPoint trackball.

Options: SmartPoint trackball, $69: PowerStation docking station, $449; EasyProt, $139; extra nickel cadmium battery, $1 19; 14,400-/9,600-bps PCMCIA data/fax modem, $599; PCMCIA Ethernet LAN adapter models 10BT and 10B2 $329 and $349, respectively.

In short: With this iteration, AST has hit the big time in the notebook computer market with its PowerExec line. These powerful and light-weight systems have all the options you're looking for: active-matrix color, PCMCIA, internal clip-on pointing device. advanced power management, and upgradable hard disks and processors.

DECpc 325SL DECpc 325SLC DECpc 425SL Digital Equipment Corp., 50 Nagog Park, Acton, MA 01720: 800-722-9332; fax, 800-524-5624 List price: 325SL, $2,099: 325SLC, $2,899; 425SL, $2,499.

Tested configuration: 4MB 80-ns RAM with 64K of external cache (325SL, 325SLC), 4MB 70-ns RAM with 8K of external cache (425SL); 84MB Toshiba MK-2024FC IDE hard disk with 32K buffer (325SL, 325SLC), 120MB Seagate IDE hard disk with 5 12K buffer (425SL): 1.44MB floppy disk drive: DOS 5.0: Microsoft Windows 3.1; snap= on trackball.

Options: 200MB hard disk upgrade, $400: 8MB RAM upgrade, $900: 12MB RAM upgrade, $1,800; docking station, $379; port replicator, $89; extra nickel hydride battery, $169: external 2,400-/9,600-bps data/fax modem, $300: Xircom Ethernet adapter, $405: math coprocessor, $229: external keyboard, $79; numeric keypad, $79: battery charger, $49: extra AC adapter, $79.

In short: The DECpcs offer almost all the winning options contained in the PowerExec line and at times offer several tweaks. In this roundup, DEC exhibited only passive-matrix color and it's of the same dismal quality as AST's On the other hand, DEC's battery scores were outstanding.

Competition in the laptop arena just keeps getting fiercer as evidenced by the deluge of new notebooks from AST Research. These machines are also sold by Digital Equipment Corp., which has in some cases tweaked them a little. Though the 386 members of this family exhibited generally average performance coupled with monochrome or below-average passive-matrix color screens, all had competitive pricing and feature sets.

By contrast, the AST PowerExec 4/25SL Color Plus with its brilliant active-matrix color screen, managed to stand out as an excellent buy in today's notebook market. You don't have to go to AST's high end to obtain TFT color, however. All of the PowerExecs are fully user-upgradable in tenns of their processors, memory, hard disks, and screens.

AST COLOR PLUS AND DECpc 425SL

Powered by Intel's 3.3-volt 486SL 25-MHz silicon, the $4,499 AST Color Plus stands out with a 9.5-inch TFT screen capable of 256 colors at 640-by480 resolution. The $2,499 DECpc 425SL model offers the same processing power, but with a monochrome screen.

Both machines are capable of supporting up to a 200MB hard disk, flash BIOS, and two PCMCIA Type II slots. Though both systems have the same case size, the AST Color Plus's active-matrix screen bulks the unit's weight up to exactly 7 pounds, while the DEC remains at only 6.3 pounds. Both machines can hold up to 32MB of system memory. The DEC system comes standard with a front-mounted trackball, although this is an option on the Color Plus. You can get a $99 drive bay adapter from AST for

shuttling data between the Color Plus's hard disk and that of a desktop.

Performance was adequate for both machines on our benchmark tests, with the AST unit edging out the DEC offering on everything but the video test suite. Here the combination of monochrome LCD and a 486-level processor pushed the DEC into first place overall. The DECpc 425SL really shone in terms of battery life. The DEC unit came in at a whopping 4 hours 3 minutes on the Battery Rundown test (many systems couldn't manage that on the ZDigit Rundown test!) and an incredible 9 hours 34 minutes on the ZDigit test with power-management features enabled. The AST Color Plus was no slouch, however, with a respectable 2 hours 14 minutes on the Battery Rundown test and 6 hours 17 minutes with all power-saving features enabled. In an emergency you can run both machines with 12 AA batteries.

ALL THE OTHERS

The rest of the machines in this portable PC group are largely identical. All based around 386-class processors and featuring design options similar to their 486 counterparts, the $3,499 AS?' PowerExec 3/25SL Color, $2,799 AST PowerExec EL Color, and $2,899 DECpc 325SLC also sport disappointing passive-matrix color screens--only the $2,099 DECpc 325SL remains a monochrome system.

These machines displayed color that was disappointing compared not only with active-matrix color but with the color of a number of other passive-matrix machines as well. The AST EL Color and the DECpc 325SLC exhibited the worst characteristics: excessive bands of gray along almost an inch of border, obvious ghosting, and uneven lighting during Windows' BitBlting operations. The AST 3/25SL Color's screen seemed slightly better but was still uncompetitive.

Performance was competitive for 386-class products in a market moving largely toward the 486. The two DECpc 386-based units and the AST 3/25SL Color performed closely on almost all tests: processor and memory scores were average and video was exceptionally fast, while disk scores under both DOS and Windows fell below par. The AST EL Color, on the other hand, fell significantly behind its siblings and stayed there on every test, placing near last of all tested units in some tests.

Battery rundown times were surprising for the most part, especially for the DEC products. Even though some of the niftier power-management features of the AST units are not to be found on the DECs, the DECpc 325SLC still managed to last 2 hours 20 minutes on the regular battery test and 5 hours 2 minutes on the ZDigit test. The monochrome DECpc 325SL blew the DECpc 325SLC away, lasting 3 hours 4 l minutes with power-management features disabled and a wondrous 8 hours 33 minutes on the ZDigit test. The more colorful ASTs, on the other hand, couldn't keep up, with the AST 3/25SL Color coming in at 1 hour 35 minutes on the Battery Rundown test and 4 hours 48 minutes in power-management mode. As usual, the AST EL Color lagged slightly behind its sibling, staying alive for 1 hour 30 minutes on the straight rundown test and 4 hours 3 minutes on the ZDigit test.

Type
hardware review
evaluation

Company
Digital Equipment Corp.
AST Research Inc.

Product
AST Research PowerExec EL Color
AST Research PowerExec 3/25SL
AST Research PowerExec 4/25SL Color
DEC DECpc 325SL
DEC DECpc 325SLC
DEC DECpc 425SL

PC Magazine August 1993 v12 n14 p158(1)

Aurum GoldNote DX2-50. (Aurum Computer Corp.)

(Hardware Review) (one of 39 evaluations of notebook and subnotebook computers in 'The Portable Puzzle') (Evaluation)

Author
Bornstein, Robin B.

Absrtact
Aurum Computer Corp's $2,395 Aurum GoldNote DX2-50 has a very fast processor and removable hard disk but suffers from short battery life. It has few power-conservation features, and the cursor keys are half-sized vertically and are difficult to use. Benchmark test scores vary from below average to excellent. The battery lasts only one hour and 34 minutes without power conservation and only 17 more minutes with power conservation enabled. Aumm will replace or repair a faulty unit within 48 hours, The GoldNote is a good system for those whose primary need is processing power.

Full Text
Aurum GoldNote DX2-50

Aurum Computer Corp., 5 Pond Park Rd., Hingham, MA 02043: 800-552-8786, 617-749-5092: fax, 617-749-5 188 List price: $2,395.

Tested configuration: 4MB 70-ns RAM, 127MB Quantum GO 120AT IDE hard disk with 32K buffer, 1.44MB floppy disk drive: DOS 5.0, Microsoft Windows 3. 1., mouse.

Options: 210MB hard disk upgrade, $150; 12MB RAM upgrade, $900: hard disk docking bay, $195, docking station, $395: extra nickel cadmium battery, $95; 2,400-/9,600-bps data/fax modem, $113; Pocket LAN Ethernet adapter, $325; external 1.2MB floppy disk drive, $265:

external keyboard, $35: numeric keypad, $99: hand scanner, $205; portable printer, $360.

In short: The Aurum GoldNote DX2-50. while delivering fairly solid performance, is hampered by a dark LCD panel, almost nonexistent power-conservation features, and an extremely short battery life.

Aurum Computer Corp.'s $2,395 Aurum GoldNote DX2-50 is a powerful portable with a removable hard disk. Unfortunately, it has very few power-conservation features and a short battery life. Its benchmark test scores spanned the range from below average to excellent.

The GoldNotes LCD panel displays up to 32 shades of gray at VGA resolution. It is extremely dark, with difficult-to-use control wheels. The GoldNote can display to the screen or an external monitor, but not simultaneously.

The cursor keys are arranged in an inverted-l. layout but are difficult to use because they are half-size vertically. With the Fn key, they perform double duty as Home, End, PgUp. and PgDn.

The GoldNote lasted only l hour 34 minutes without power conservation and only 17 more minutes when we enabled its power-conservation features (limited to user-adjustable display and hard disk power-downs).

Its test performance was mixed: Processor, memory; Disk Wimnark, and Windows Applications scores were in the top quarter of the roundup, disk and Graphics Wimnark scores were average, and a DOS video score was in the cellar.

The company will replace or repair a faulty unit within 4X hours--a great help while you're on the road. If you need processor power more than battery power, the GoldNote may be a welcome traveling companion.

PC Magazine August 1993 v12 n14 p158(1)

Blue Star 486DX2/66.

(Blue Star Marketing Inc.) (Hardware Review) (one of 39 evaluations of notebook and subnotebook computers in The Portable Puzzle') (Evaluation)

Author
Bonomo, Michael

Absrtact
Blue Star Marketing Inc's $3,495 Blue Star 486DX2/66 offers one of the fastest microprocessors available but fails to take full advantage of its power: its benchmark scores are lower than those of better-designed systems with less capable CPUs. The 9.5-inch diagonal monochrome display is large but uses passive-matrix technology that makes it difficult to view from an angle. The Blue Star is sturdily built and weighs 8.3 pounds with all accessories. Battery life is 1 hour 55 minutes with power-conservation disabled and 2 hours 4X minutes with power conservation enabled.

Full Text
Blue Star 486DX2/66

Blue Star Marketing Inc., 2312 Cantral Ave. N.E.. Minneapolis: MN: X00-950-8884, 612-78X-5000: fax, 6 12-78X-3442 List price: $3,495.

Tested configuration: XMB 70-ns RAM with XKB of external cache. 210MB Toshiba 2224 IDE hard disk with 128K cache, 1.44MB floppy disk drive, 9,600-bps data/fax modem; DOS 6.0. Microsoft Windows 3.1, built-in trackball.

Options: Docking station, $599; extra nickel cadmium battery, $99; 2,400-/9,600-bps data/fax modem, $189; 12-volt adapter, $99; Motorola cellular phone adapter, $295.

In short: If you are in need of a power portable, the Blue Star's 486DX2/66 processor is certainly a good start. The system, however, turned in only mixed benchmark test performance, despite its high-powered processor, and its trackball was inconvenienly positioned on the front of the unit.

The theory that a great notebook starts with a great chip is the philosophical basis for the Blue Star 486DX2/66 notebook. Unfortunately, the $3,495 portable PC could have used this high flying CPU to better advantage. It was surpassed in both the CPU and memory benchmark tests by better-designed systems with the less capable DX2/50 processor, though it regained the lead in the Windows Application suite.

The system we tested had XMB of system memory (upgradable to as much as 16MB) and a 2 1 OMB hard disk.

A major drawback to this machine is the 9.5-inch diagonal monochrome display. Though it is sizable and good for a passive matrix, it is as hard to view from an angle as any passive matrix and has overly sensitive contrast and brightness knobs. Another problem is the trackball that is inconveniently located on the front vertical side of the machine and is rather uncomfortable to use.

On the positive side, the Blue Star's keyboard is comfortable and well laid out. It has 85 keys, 12 somewhat small function keys, and 4 cursor keys.

Encased in no-scratch plastic, the Blue Star notebook is solidly built and has a travel weight of X.3 pounds. On the battery tests: the Blue Star was able to operate for 1 hour 55 minutes on the Battery Rundown test and for 2 hours 4X minutes on the ZDigit Rundown test. Blue Star is working with Motorola and US West Cellular on a mobile office workstation that would include a cellular connection and an internal fax modem.

PC Magazine August 1993 v12 n14 p160(1)

CAF Aqualite ll.

(CAF Technology Inc. (Hardware Review) (one of 39 evaluations of notebook and subnotebook computers in The Portable Puzzle') (Evaluation)

Author
Plain, Stephen W.

Absrtact
CAF Teclmology's AquaLITE II costs only $2,399 with 8Mbytes of RAM and a 120Mbyte hard disk and is sturdily constructed but suffers from a somewhat awkward keyboard. There is no built-in pointing device, but the Sharp monochrome VGA display is crisp and battery life is two hours without power conservation and three hours in a test simulating normal usage. Performance is comparable to other 25-MHz 80386SL-based systems. The AquaLITE II has all basic features, but offers little to distinguish itself from competing products other than the low price.

Full Text
CAF AquaLITE II

CAF Technology Inc., 1315 Johnson Drive, City of Industry, CA

91745;

336-9369, 818-369-3690; fax, 800-329-2537 List price: $2,399.

Tested configuration: 8MB 70-ns RAM, 123MB Toshiba Mk-2124 IDE hard disk with 32K buffer, 1.44MB floppy disk drive, 2,400-/9,600-bps data/fax modem.

Options: 2MB upgrade, $234: 4MB upgrade, $403: mouse, $20; extra battery, $79: 2,400-/9,600-bps data/fax modem, $188; numeric keypad, $66: 12-volt battery adapter with converter, $131; DOS 5.0, $50: Microsoft Windows 3.1. $65.

In short: Basic, and priced that way, the CAF AquaLITE II performs adequately, but its keyboard is a bit disappointing, and the unit lacks an integrated pointing device. On the plus side, the portable's monochrome VGA display was bright and offered crisp images, and battery life was adequate.

One of two portables in this roundup using the AMD Am386SXL/25 processor, the CAF AquaLITE II is a reasonably priced notebook stressing the basics of computing on the road. The list price is $1,777 for a 4MB system with an 80MB hard disk. Our tested configuration--with a 120MB hard disk and 8MB of RAM--is $2,399.

The AquaLITE II is based on a traditional notebook design; it weighs 5.5 pounds, and its case is solidly built. The keyboard does not seem so solid: Each key is flimsy to the touch, handling as if balanced on the tip of a pin. The keyboard also does not allow access to system options through the existing Fn key, as most other units do. Power management and system configuration can be accessed only through an external setup program. The system also lacks the built-in pointing device that is now almost standard for units in its class.

Although the AquaLITE II's rated battery life is only 2 hours, our ZDigit Rundown test with power conservation produced a respectable ?-hour time. The unit's other test results were generally comparable with those of most 386SL/25 units we tested.

The CAF AquaLITE II uses a Sharp monochrome VGA display which gives a very crisp image. While the unit covers most of the basics, there's scant reason to choose it aside from its price.

Type
hardware review
evaluation

PC Magazine August 1993 v12 n14 p160(1)

Compaq LTE Lite 25E.

(Compaq Computer Corp.) (Hardware Review) (one of 39 evaluations ofnotebook and subnotebook computers in 'The Portable Puzzle') (Evaluation)

Author
Rist, Oliver

Absrtact
Compaq's $3,249 LTE Lite 25E notebook computer charges a premium price for an monochrome active-matrix display and offers flash-upgradable BIOS, upgradable processor and hard disk, an extra battery, fast and trickle charging and a screen-mounted trackball. Performance is better than average for 80386-class products. Battery life is 2 hours 57 minutes with power conservation disabled and 3 hours 32 mindes in tests simulating normal use. The keyboard is somewhat stiff The LTE Lite 25E is targeted at those who purchase it as a desktop replacement.

Full Text
Compaq LTE Lite 25E

Compaq Computer Corp., P.O. Box 692000, Houston, TX 77269-2000: 800-345-l 5 18, 713-370-0670 List price: $3,249 (estimated selling price).

Tested configuration: 4MB 70-ns RAM with 64K external cache, 84MB Conner Henshu IDE hard disk with 32K buffer, 1.44MB floppy disk drive, 14,400-/9,600-bps data/fax modem, DOS 5.0, Microsoft Windows 3.1., Compaq EasyPoint

Options: Compaq mouse, $39; 14,400-/9,600-bps data/fax modem, $399; enhanced keyboard, $89: numeric keypad, $79: battery charger, $89: extra AC adapter, $129: 12-volt battery adapter, $89; SCSI-2 controller, $139: Compaq 1024, QVision and SVGA monitors, $2,499; briefcase, $119; carrying case, $59.

In short: Basically, a high-end portable targeted at a niche market, the LTE 25E is meant for those who want a 386-

based portable as their primary machine and desire an active-matrix monochrome display.

Based on a 25-MHz 386 processor, the $3,249 Lite LTE LITE 25E is something of an experiment seeing whether buyers will pay for a monochrome active-matrix display.

Aside from screen technology, the Lite 25E has the same features as the rest of the Lite line from Compaq Computer Corp.: flash-upgradable BIOS, upgradable processor and hard disk, an extra battery, fast and trickle charging, and, of course, the screen-mounted trackball. As with other Lite line products, its keyboard's stiff resistance and slightly short key travel may not meet with some users' approval.

Performance was respectable for a 386-class product. The Lite 25E's 25-MHz 386 processor was on the low end of this roundup's processor spectrum and scored generally in the lower quarter of all machines reviewed. In its own CPU group, however, it placed first on the processor test and fourth or fifth on all the other hardware benchmark tests. Its Windows performance was sixth among its CPU peers and fifty-third among all machines reviewed. The Lite 25E managed 2 hours 57 minutes on PC Labs' Battery Rundown test and 3 hours 32 minutes on the ZDigit Rundown test with power-saving features enabled.

Compaq ships this machine with a three-year parts-and-labor warranty that also includes on-site service.

PC Magazine August 1993 v12 **n14 p163(1)**

Compaq LTE Lite 4/25C.

(Compaq Computer Corp.) (Hardware Review) (one of 39 evaluations of notebook and subnotebook computers in 'The Portable Puzzle') (Evaluation)

Author
Rist, Oliver

Absrtact
Compaq's $4,099 LTE Lite 4/25C is targeted at those planning to use a notebook computer as a desktop replacement and offers many high-end features. It uses a 25-MHz 80486SL microprocessor and offers flash-upgradable BIOS, fast battery charging, sophisticated power-conservation features and above-average performance. Battery life is one hour and 52 minutes with power conservation disabled; tests simulating normal use show a battery life of 4 hours and 12 minutes. The LTE Lite's only drawback is its stiff keyboard feel; the placement of the Home, PgUp, PgDn and End keys is also non-standard.

Full Text
Compaq LTE Lite 4/25C

Compaq Computer Corp., P.O. Box 692000, Houston; TX 77269-2000; 800-345-l 5 18, 713-370-0670 List price: **$4,099.**

Tested configuration: 4MB 70-ns RAM, Conner Henshu 16-ms 12OMB hard disk with 32K buffer, 1.44MB floppy disk drive, DOS 5.0, Microsoft Windows 3.1, built-in trackball.

Options: Compaq mouse, $39; 14,400-bps cellular data/fax modem, $649: 9,600-bps data/fax modem, $399: enhanced keyboard, $89: numeric keypad, $79: battery charger, $89; extra AC adapter, $129; 12-volt battery adapter, $89; SCSI-2 Controller, $139: Compaq 1024, QVision, and SVGA monitors, $2,499: briefcase, $119: carrying case, $59.

In short: The Lite LTE 4/25C is cheaper than many other active-matrix color offerings yet it supports just about every feature you could want. The lack of a PCMCIA slot and a stiff keyboard were the only downsides.

The $4,099 Compaq LTE Lite 4/25C is for those interested in using a notebook as a desktop replacement. That's why the Lite series, not the $700-cheaper Compaq Contura 4/25CX can connect to the $579 Desktop Expansion Base from Compaq Computer Corp. or its QuickConnect port replicator.

The Lite 4/25C uses a 25-MHz 486SL CPU and TFT color screen and includes flash-upgradable BIOS, fast battery charging (about an hour), trickle charging to prevent battery overload, and a screen-mounted trackball. Superior battery and power-conservation features include a standby button, three preset levels of conservation, and one user-configurable conservation level.

The Lite 4/25C casts only one shadow, extending to both LTE systems. The keyboard is stiff and doesn't have enough travel or response to satisfy everyone. Still, Compaq does not place either the Home, PgUp, PgDn, or End key to the right of the Backspace key as others (including Toshiba America Information Systems) do, alwavs causing chaos for those not used to such key placement

The Lite 4/25C managed average or above-average scores compared with the whole roundup. With 486-class products, though: it encountered stiff competition: mainly the DX2/40, DX2/50, and DX2/66-MHz 486s now becoming popular. The 4/25C placed below-average on everything except disk scores, where it managed fifth place under DOS and third place under Windows. On PC Labs' Battery Rundown test, the Lite 4/25C scored 1 hour 52 minutes. On the ZDigit Rundown test, the Lite 4/25C scored a surprising 4 hours 12 minutes.

Compaq ships this product with a three-year parts-and-labor warranty including on-site service.

PC Magazine August 1993 v12 n14 p163(2)

Compaq Contura 4/25; Compaq Contura 4/25C; Compaq Contura 4/25CX.

(Compaq Computer Corp.) (Hardware Review) (one of 39 evaluations of notebook and subnotebook computers in The Portable Puzzle') (Evaluation)

Author
Rist, Oliver

Absrtact
Compaq's Contura 4/25 Contura 4/25C, and Contura 4/25CX represent the company's 'value line' of lower-priced systems offering performance very competitive with that of the higher-end LTE Lite series. The 4/25CX sells for $3,400 and has an active-matrix color screen, screen-mounted trackball, large hard disk and sophisticated power management. It weighs 6.9 pounds and has a well-designed keyboard. The 4/25CX is rated an Editors' Choice. The 4/25C and 4/25 are processor-upgraded versions of older Conturas with passive-matrix color and monochrome screens respectively. Battery life is somewhat less than that of the LTE Lite units; the 4/25 runs for 3 hours 42 minutes with power conservation enabled, while the 4/25CX lasts for 3 hours 1 minute.

Full **Text**
Compaq Contura 4/25;

Compaq Contura 4/25C; Compaq Contura 4/25CX Compaq Contura 4/25 Compaq Contura 4/25C Compaq Contura 4/25CX Compaq Computer Corp., P.O. Box 692000, Houston, TX 77269-2000; 800-345- 15 18, 713-370-0670 List price: 4/25 $2,499; 4/25C, $3,249; 4/25CX, $3,X99 (estimated selling prices).

Tested configuration: 4MB 80-ns RAM, 120MB Conner Model CP2121 IDE hard disk with 32K cache, 1.44MB floppy disk drive, 9,600-bps data/fax modem, DOS 5.0, Microsoft Windows 3.1, mouse.

Options: 4MB RAM upgrade, $259; 8MB RAM upgrade, $519; 16MB RAM upgrade, $1,51 9; Compaq mouse, $39: Compaq trackball, $89; extra battery, $29: 14,400-bps cellular data/fax modem, $649; 9,600-bps data/fax modem, $399: numeric keypad, $79: battery charger/discharger, $89: extra AC adapter, $89: 12-volt adapter, $109: external slipcase, $19: carrying case, $59: briefcase, $119.

In short: This generation of Conturas from Compaq Computer Corp. have lifted themselves out of the value-line category by offering just about every high-tech feature you could possibly desire. All of these features come at a great price, too. All that's really missing from this line of portable machines is desktop expandability and PCMCIA slots.

In our last peek at notebooks (PC Magazine, March 30, 1993), the Contura value line from Compaq Computer Corp. managed a solid though not outstanding impression. That initial showmg was improved on so much this time that the high-end LTE Lite line may be in jeopardy.

CONTURA 4/25CX

The Compaq Contura 4/25CX tries to be all things to all people. At a basic configuration price just below $3,400, it will be almost $700 less than the Compaq LTB Lite 4/25C.

Unfortunately for the Lite 4/25C, there is little difference between the two machines' feature sets. Both feature active-matrix color, the well-known screen-mounted internal trackball, similar-sized hard disks, and the same power management features. They're almost the same size and weight, too. The Lite 4/25C's only advantages arc slightly faster hard disk performance, the ability to attach to a desktop expansion unit, and battery life of about an hour longer (with power-saving features enabled).

The rest of the Contura mirrors its siblings. The same solid, charcoal-gray case surrounds the 6.9-pound unit, and there is the same excellent, "clicky" keyboard. Its screen-mounted trackball is a departure from other Conturas that use a clip-on Trackman clone, but you can still attach the latter device if the internal one is not to your liking. Though documentation is excellent, the Lite line does have one more advantage over the Contura: You don't have to remove the keyboard to upgrade memory.

CONTURA 4/25C AND 4/25

The other two units are processor-upgraded versions of older Contura products. The Compaq Contura 4/25C and the Compaq Contura 4/25 sell for $3,249 and 2,499. respectively, and mirror the 4/25CX *in* all respects save for the active-matrix screen with its internal trackball. The 4/25C boasts high-quality dual-scan passive-matrix color, while the 4/25 has monochrome.

Performance on PC Labs' benchmark tests were largely identical for all three Conturas, except, of course, those on video. Processor and disk scores were average, while memory numbers were noticeably fast.

On PC Labs' battery tests, however, numbers varied widely. Both the 4/25CX and the 4/25C had low Battery Rundown test scores (1 hour 36 minutes and 1 hour 47 minutes, respectively) but managed semi-competitive ZDigit Rundown test scores of 3 hours 1 minute and 3 hours 32 minutes, respectively. The monochrome

4/25 came in at 2 hours 2X minutes on the Battery Rundown test but only 3 hours 42 minutes on the ZDigit Rundown test. By contrast, both active-matrix LTE Lite units lasted over 4 hours on the ZDigit Rundown test.

Compaq Computer Corp. provides its standard three-year. parts-and-labor warranty with the Contura line, and that includes one year of free on-site service.

PC Magazine August 1993 v12 n14 p164(3)

CompuAdd Express 425XL; CompuAdd Express 425Color; CompuAdd Express 425ColorPlus.

(CompuAdd Express) (Hardware Review) (one of 39 evaluations of notebook and subnotebook computers in 'The Portable Puzzle') (Evaluation)

Author
Cline, Camille N.

_____---_----------

Absrtact

CompuAdd Express' 425XL, 425Color and 425ColorPlus notebook computers use monochrome: passive-matrix color and active-matrix color screens respectively and offer superior display quality at low prices. The $3,895 425ColorPlus has a very well-designed active-matrix display that is easy to read at any angle: the $2,595 425Color uses a passive-matrix version that is less bright but nevertheless vibrant. Each can display 256 colors at 640-by-480-pixel resolution. The $1,895 425XL has a 9.5-inch diagonal Sharp monochrome screen and provides 64 gray shades. Processor performance is below average because the units use a relatively slow Cvrix CPU, but video benchmark scores are good. Battery life is somewhat marginal, ranging from 1.5 hours for the color units to 2.5 hours for the monochrome system. Tests with power-conservation enabled show that the 425Color lasts only one hour and 47 minutes while the 425XL lasts 3 hours and 35 minutes.

Full Text

CompuAdd Express 425Color;

CompuAdd Express 425ColorPlus CompuAdd Express 425XL CompuAdd Express 425Color CompuAdd Express 425ColorPlus CompuAdd Express, 12301 Teclmology Blvd. Austin, TX 78727; 800-925-3000, 5 12-219-I 800: fax. 5 12-2 19-2890 List price: 425XL, $1,895; 425color $2,595; 425ColorPlus, $3,895.

Tested configuration: 4MB 80-ns RAM (425XL), 8MB 80-ns RAM (425Color and 425-ColorPlus 128MB Seagate ST9144A IDE hard disk (425XL and 425Color), 208MB Seagate ST9235A SCSI-II hard disk (425 ColorPlus), 1.44MB floppy disk drive, BitFax fax modem software, 9,600-bps data/fax modem, DOS 5.0, Microsoft Windows 3.1; built-in trackball, LotusWorks 3.0 integrated application software, Close-up 4.0 customer/terminal program.

Options: 4MB upgrade, $150 (425XL); 16MB upgrade, $600; extra nickel cadmium battery, $69: Xircom LAN adapter, $330; battery charger, $49: extra AC adapter, $49: keyboard adapter, $6.

In short: The CompuAdd Express family of portable computers reviewed here are distinguished by their attractively low price tags, high-quality displays, and the company's useful on-line remote-diagnostics service. The performance of these machines was disappointing, however.

CompuAdd Express offers a mixed bag with its latest trio of active color, passive color, and monochrome systems. Despite travel weights just shy of 8 pounds, left-handed trackballs, marginal Battery Rundown times, and slow Cyrix 486SLC/25 processors, the CompuAdd Express 425ColorPlus, 425Color, and 425XL sport top-technology displays and aggressive prices at $3,895, $2,595, and $1,895, respectively.

The most distinguishing feature among the three was the display The 425ColorPlus and 425Color notebooks have beautiful 8.5-inch diagonal active- and passive-matrix displays, respectively. Easily readable at any angle, the 425ColorPlus Sharp display supports 256 bright, clear colors at 640-by-480 resolution.

Less distinct but still vibrant is the Sanyo screen of the 425Color. Although it is not easy to read from all angles, this passive-matrix display is easier on the eyes than many others of its kind (including the DECpc 325SLC). With a 9.5-inch diagonal Sharp screen, the 425XL has a crisply contrasted screen and provides 64 shades of gray at 640-by-480 resolution. Even with solid DOS-based video scores, two of the three systems, the 425Color and 425XL, still garnered the worst DOSmark scores in the 486SLC/25 category. In fact, the 425ColorPlus with its Cirrus Logic chipset had the highest DOS-based video score of all and performed adequately in the 486SLC/25 category Each system has either knobs or sliding dimmers to the right of the screen for brightness and contrast control and can display simultaneously with a full-sized monitor.

Memory scores were low both within the 486SLC/25 group and outside it, perhaps due to the lack of caches. Upgrading memory is as easy as unscrewing a clearly marked back panel, snapping m a module, closing it up, and letting Setup reconfigure the system. The system detects the change in memory but you have to verify the change. The color laptops have 8MB of RAM (expandable to 20MB) standard, and the monochrome unit, only 4MB (expandable to 8MB or 20MB)

The almost indistinguishable brown matte exteriors of the three laptops conceal nickel cadmium batteries--the 425XL lasted 2.5 hours on the Battery Rundown test, while the others turned off about an hour earlier. The trio also contain 9,600-bps data/fax modems.

While the 425Color and 425XL units had 128MB hard disks, the 425ColorPlus contains a 208MB hard disk--ranked 26th overall among all systems tested--and a SCSI-II interface. This makes the CompuAdd Express 425ColorPlus a rarity in the portable PCs World--a notebook that can be connected to a CD-ROM or tape backup.

Each CompuAdd system had limited power management features. Power-down was only adjustable on the hard disk--l to 15 minutes or disabled. Screen power-down was limited to either "enable" or "disable." ZDigit scores ranged from a typical 3 hours 35 minutes (425XL) to a deficient 1 hour 47 minutes (425Color). All lacked PCMCIA slots but came with free carrying cases.

The CompuAdd Express 425ColorPlus, 425Color, and 425XL have extremely helpful Remote Rescue on-line teclmical support, toll-free support, Monday to Friday, from 9 a.m. to 9 p.m. Eastern time, and a one-year limited warranty covering replacement or repair.

PC **Magazine August 1993 v12** n14 p170(2)

Compudyne 4SL/25 Subnote.

(Compudyne) (Hardware Review) (one of 39 evaluations of notebook and subnotebook computers in 'The Portable Puzzle') (Evaluation)

Author
Bonomo, Michael

Absrtact
Compudyne's $2,138 4SL/25 Subnote offers a low price and weighs only 5.4 pounds with its optional external floppy drive. The machine uses a 25-MHz 8048681 microprocessor, but performance is disappointing and the screen is a small 7.5-inch passive-matrix monochrome unit that is difficult to read from an angle. The keyboard layout is cramped, but battery life is a strong 2 hours and 4X minutes with power-conservation disabled and 3 hours 7 minutes with power-conservation enabled. The Subnote is nevertheless not an especially good value in a small system.

Full Text
Compudyne 4SL/25 Subnote

Compudyne, 15167 Business Ave., Dallas, TX 75244: 800-862-3099, 214-702-0055; fax, 214-888-5743 List price: $2,138.

Tested configuration: 4MB 70-ns RAM, 80MB Toshiba MK1422FC IDE hard disk with 32K buffer, external 1.44MB floppy disk drive, 2,400-/9,600-bps data/fax modem, DOS 6.0, Microsoft Windows 3.1, built-in trackball, Lotus Organizer 1 .O software.

Options: Extra 80MB hard disk, $389; 4MB RAM upgrade, $279; extra nickel hydride battery, $129; external 1.44MB floppy drive, $119; extra fast charge adapter, $89: extra compact AC adapter, $59.

In short: Compudyne is keeping the price of this easy-to-carry subnotebook down while offering some mnovative ideas. Unfortunately, the Compudyne 4SL/25 Subnote lacks processing power. its keyboard is cramped: and its small, 7.5-inch passive-matrix display is sometimes difficult to view.

Despite the somewhat reduced expectations of subnotebook buyers, the Compudyne 4SL/25 Subnote still ends up as a bit of a disappointment.

Priced at $2,138, and powered by Intel's 25-MHz 486SL chip, the 4SL/25 Subnote was out-perfonned by all of the other reviewed machines in its processor class.

The 7.5-inch passive-matrix monochrome screen is small and difficult to read from an angle Contrast and brightness controls are embedded in the function keys and can be awkward to use. Like other subnotebooks in this test, the 4SL/25 Subnote uses an external floppy disk drive.

On PC Labs' performance tests, the unit finished in last place in all categories for its CPU group, except for the DOS and Windows disk tests, where it only managed to notch 10th place of the 11 486SL/25 machines tested.

The Subnote has a cramped keyboard layout and small function keys as well, At just over three pounds--and a road weight of 5.4 pounds including the floppy drive--it is a light, easy-to-carry subnotebook. Another plus is battery life: The Subnote lasted 2 hours 4X minutes on our Battery Rundown test and 3 hours 7 minutes on our ZDigit test with its power-conservation features enabled.

At $2,138, the Subnote is certainly inexpensive for a 486SL-based subnotebook, but the unit's light weight and decent battery life don't do enough to compensate for the machine's poor overall performance.

PC Magazine August 1993 v12 n14 p175(1)

Dell 325SLi.

(Dell Computer Corp.) (Hardware Review) (one of 39 evaluations of notebook and subnotebook computers in 'The Portable Puzzle') (Evaluation)

Author
Yagyazarian, Anush

Absrtact
Dell Computer Corp's $2,264 325SLi subnotebook computer weighs only 3.7 pounds without the optional external floppy drive and 5.6 pounds with all accessories for traveling, but the screen is a monochrome reflective display with no backlighting. The system does include a PCMCIA Type 11 slot and a keyboard with good key travel. Users can fold the display back past 180 degrees to use an external VGA monitor, but there is no built-in trackball. Performance is below average overall but above average for 386-class machmes. Dell offers a one-year warranty with on-site service.

Full Test
Dell 325SLi

Dell Computer Corp., 9505 Arboretum Blvd., Austin, TX 78759; 800-289-3355, 512-338-4400: fax, 512-343-3643 List price: $2,264.

Tested configuration: 6MB 80-ns RAM with 16K of external cache, 2 13MB Toshiba MK-2224FC IDE hard disk with 128K cache, 2,400-/9,600-bps data/fax modem, DOS 5.0, Microsoft Windows 3.1, Microsoft Ballpoint Mouse.

Options: 2MB RAM upgrade, $100; 4MB RAM upgrade, $200: 8MB RAM upgrade, $400; extra nickel hydride battery, $99; math coprocessor, $149; battery charger, $149

In short: Light and packaged for the road, the Dell 325SLi Subnotebook boasts good battery life and performance. Among tested portables with Intel 386SL/25 CPUs, its PC Labs' memory, disk, and DOSmark scores were in first

place. The lack of a backlit screen mars image quality, however.

The Dell 325SLi subnotebook isn't for everyone. With a system weight of3.7 pounds, it is very light; with its floppy disk and travel-ready, it weighs only 5.6 pounds. And its $2,264 price is not bad for a 3X631,/25 subnotebook.

Unfortunately, the downside is its screen. The SLi has a monochrome reflective display, which may save on weight and increase battery life but which doesn't help image quality. In some lighting conditions, at an angle and after extended viewing, it is more difficult to distinguish objects on the screen. Dell's heavier but comparably priced 386-based N and NL lines both offer backlit passive-matrix screens in monochrome and color.

On the other hand, the SLi comes with a PCMCIA Type II slot and has a Battery Rundown test time of 2 hours 55 minutes. Its keyboard has 12 half-size function keys, with separate Home, End, PgUp, and PgDn keys. Its cursor keys are arranged in the popular inverted-T layout, and key travel was good. The screen folds back past 180 degrees, allowing for simultaneous display with an external VGA monitor. But there's no built-in trackball.

Across our suite of performance tests, the Dell 325SLi came in with average to below-average marks. Within its CPU group, however, the portable's memory, disk, and DOSmark scores were in first-place.

Dell offers a one-year warranty with the SLi which includes first-year on-site service.

PC Magazine August 1993 v12 **n14 p175(2)**

Dell 325N; Dell 325NC. (

Dell Computer Corp.) (Hardware Review) (one of 39 evaluations of notebook and subnotebook computers in 'The Portable Puzzle') (Evaluation)

Author
Canter, Sheryl

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Absrtact
Dell Computer Corp's $3,298 325NC and $2,798 325N notebook computers are high-end units with passive-matrix color and monochrome screens respectively. Both use the aging 386 microprocessor and suffer from below-average overall performance; battery life is an astounding 7 hours on the monochrome unit and 5 hours 31 minutes on the color unit with power conservation enabled. The keyboards are mushy, and the display quality is only adequate. A Microsoft BallPoint Mouse is supplied to compensate for the lack of a built-in pointing device.

Full Text
Dell **325N**

Dell 325NC Dell Computer Corp., 9505 Arboretum Blvd., Austin, TX 78759; 800-289-3355. 512-338-4400; fax, 512-343-3643 List price: 325N, $2,798: 325N, $3,298.

Tested configuration: 208MB Seagate ST9235A IDE hard disk with 64K buffer, 4MB 70-ns RAM with 64K external cache, Microsoft BallPoint mouse, 9,600-bps data/fax modem. 1.44MB floppy disk drive, DOS 5.0, Microsoft Windows 3.1.

Options: 2MB RAM upgrade, $100: 4MB RAM upgrade, $200. 8MB RAM upgrade, $400; extra battery, $169; math coprocessor, $149: battery charger, 5269; carrying case, $39.

In short: The lack of a 486 processor in what Dell sells as its high-end line Of notebooks is a disappointment, although superior battery times and quality construction are positives. The 325NC has a resonably good passive-matrix color display, though it doesn't approach the richness of active-matrix color screens, and the 325N offered a passable monochrome display. The ability to change the screen font is a nice touch. Note that Dell recently announced that it had ended production of the 325N. Also, the 208MB hard drive sent for testing is no longer being offered.

The Dell 325NC ($3,298) and Dell 325N ($2,798) are the Dell Computer Corp.'s high-end notebook offerings reviewed for this roundup, although both are powered by aging 386 chips. Shortly after this review was completed, the company announced that it had ended production of the 325N. Availability of this model depends on the company's existing stock. Also, Dell said that it would no longer offer the 208MB hard disk used in testing these notebooks.

Unfortunate- ly, these machines' incredible battery scores don't do enough to outweigh their mushy keyboards, so-so displays, and high price tags. Hotkeys let you enhance the video contrast, display the battery charge, and perform a number of other functions.

Power-saving features include four processor speeds, and the units can be configured to scale down automatically.

There's no built-in pointmg device, but a Microsoft BallPoint Mouse is supplied. You can attach the mouse to either side of the keyboard, although, if placed on the right, the mouse can block access to the floppy disk drive.

The keyboard is a bit mushy, though adequate. Certain keys can be used to simulate a mouse, but this option is not easy to use.

The cursor keys are positioned in an inverted-T layout on the lower right-hand side of the keyboard.

The 325NC has a passive-matrix color display. Edge-lighting improves evenness and contrast, but the screen is still not as clear and bright as active-matrix color.

The screen quality of the monochrome 325N is adequate. Contrast could be better, but the ability to switch the system font aids greatly in readability. Both machines delivered some of the best Battery Rundown and ZDigit Rundown scores of all systems we tested. The 325N lasted 3 hours 53 minutes on the Battery Rundown test, while the 325NC stopped one hour short of that time. With power-

saving features in gear, the monochrome unit ran for an astounding 7 hours. The 325NC turned in an equally impressive score of 5 hours 3 1 minutes.

Both models support flash BIOS, and new BIOS versions can be downloaded from CompuServe (GO DELL) or Dell's own BBS as they become available. Dell's technical support is available 24 hours a day.

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Dell NL25; Dell NL25C.

(Dell Computer Corp.) (Hardware Review) (one of 39 evaluations of notebook and subnotebook computers in 'The Portable Puzzle') (Evaluation)

Author
Canter, Sheryl

Absrtact
Dell Computer Corp's $1,949 NL25 and $2,449 NL25C notebook computers are low-end units based on 80386-class microprocessors that offer only a few essential features. The NL25C has a passive-matrix color screen that suffers from poor color quality and ghosting. Dell supplies a Microsoft Ballpoint pointing device that can be mounted on either side of the system: it interferes with the floppy drive if mounted on the right. Keyboard quality is mushy but adequate. The flash BIOS is uppradable. Battery life is average at 3 hours and 16 minutes for the NL25 and 3 hours 1 minute for the NL25C with power-conservation enabled.

Full Text
Dell NL25

Dell NL25C Dell Computer Corp., 9505 Arboretum Blvd., Austin, TX 78759; 800-2X9-3355, 512-33X-4400; fax, 512-343-3643 List price: NL25, $1,949: NL25C, $2,449.

Tested configuration: 115MB Seagate ST9144A IDE hard disk with 64K buffer, 4MB 80-ns RAM with 64K external cache, Microsoft Ballpoint Mouse, 14,400-/9,600-bps data/fax modem (NL25), 9,600-bps data/fax modem (NL25C), 1.44MB floppy disk drive, DOS 5.0, Microsoft Windows 3.1.

Options: 2MB RAM upgrade, $100; 4MB RAM upgrade, $200; 6MB RAM upgrade, $300; extra battery, $99; math coprocessor, $149: battery charger cradle, $29.

In short: Inexpensive and rugged, the NL25 has reasonably good battery times and good performance for a 3X6 system. The passive-matrix color screen of the NL25C does not measure up to others in this review, but its level of performance and battery times do.

The Dell NL25 ($1,949) and Dell NL25C ($2,449), from Dell Computer Corp., are the company's budget-line notebooks. These units are basically average-priced 386-based machines with only the bare essentials.

Many of the options that are featured in Dell's mainstream line of notebook computers--the 325N and the 325NC--are missing from these two offerings. There is no reverse-video mode available; the monochrome NL25 system is set permanently to black text on a white background.

You also cannot cycle through different text fonts; only one system font is provided. And finally, only two levels of processor speed are supported, rather than the four offered by the 325N.

The NL25C has a backlit passive-matrix color display, the image quality of which has some noticeable drawbacks. The colors tend to be both faded and uneven, and you can also see shadow images around the graphics boxes in Microsoft Wmdows.

The display screens on both the NL25 and the NL25C fold all the way back, making the machines easy to use with an external monitor.

For both of the Dell lines, the supplied pointing device is a Microsoft Ballpoint serial mouse, which--if mounted on the right side--interferes with access to the floppy disk drive. A simulated mouse is embedded in the keyboard, but it is awkward to use--for emergencies only.

The keyboard is the same as that used in the 325N: somewhat mushy, but adequate. A setup option lets you add or remove an audible keyboard click.

Unlike their higher-priced counterparts, the NL25 and NL25C turned in average battery scores. On the ZDigit Rundown test with power saving enabled, these units showed their use of rudimentary power management. The NL25 ran out of juice after 3 hours 16 minutes while the NL25C came in at 3 hours 1 minute. On the Battery Rundown test, the NL25 averaged 2 hours 43 minutes and the NL25C averaged 2 hours 19 minutes.

As with the 325N, the flash BIOS is upgradable. (New versions are available on CompuServe or from Dell's BBS).

Technical support is available 24 hours a day and is backed with a guaranteed waiting time of no more than 5 minutes. If you have to wait any longer than that, Dell will send you $25.

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Epson ActionNote 4SLC/25.

(Epson America Inc.) (Hardware Review) (one of 39 evaluations of notebook and subnotebook computers in 'The Portable Puzzle') (Evaluation)

Author
Kunkemueller, Catherine

Absrtact
Epson America's $1,649 ActionNote 4SLC/25 is an inexpensive unit based on a Cyrix CX486SLC 25-MHz

CPU that comes with an mternal fax/data modem and good power-management features. It is designed for ease of use when traveling rather than for raw processing performance: benchmark performance is below average. The ActionNote has a battery life of only one hour and 45 minutes with power-conservation disabled and 2 hours 2 minutes with power management enabled. The system is sturdy and well-engineered; it is a good choice for those on a tight budget and is very light in weight.

Full Text
Epson ActionNote 4SLC/25

Epson America Inc., 20770 Madrona Ave., Torrance, CA 90503; 800-922-89 11, 3 1 o-782-0770: fax. 3 1 O-782-5225 List price: $1,649 (estimated street price).

Tested configuration: 131MB Area1 A120 IDE hard disk with 32K cache, 4MB 70-11s RAM, Logitech trackball, 2,400-/9,600-bps data/fax modem, 1.44MB tloppy disk drive, DOS 5.0, Microsoft Windows 3.1.

Options: 6MB RAM upgrade, $399: extra nickel cadmium battery, $79; 2,400-/9,600-bps data/fax modem with BitCom and WinFax Lite software, $219: external keyboard, $69; 12-volt battery adapter, $129.

In short: While lacking PCMCIA slots and powered by a less-than-awe-inspiring Cyrix CX486SLC/25 processor, the Epson ActionNote 4SLC/25 nevorthess provides a well-engineered product for a good price. Battery life wasn't stunning, but the unit's keyboard and its lightness may make it a good notebook option for tight budgets.

If low cost is more important than sheer performance or a color display, consider the monochrome $1,649 Epson ActionNote 4SLC/25. Based on a Cyrix CX486SLC/25 chip, the ActionNote comes with an internal data/fax modem and decent power-management features.

This unit lacks some of the expansion abilities of other notebooks, but adding up to 6MB of RAM is easy. The Hitachi screen tilts back to only about 120 degrees, which may limit use with an external monitor.

The ActionNote travel weight is 7.1 pounds. The firm X4-key keyboard (85 with the space bar) has ten separate function keys and separate Home, End, PgUp, and PgDn keys.

Raw performance is not the ActionNote's strength. On our benchmark tests, the ActionNote performed consistently in the lower half of this roundup, save for an above-average disk score and an average video score. Even among its CPU peers, the ActionNote performed slightly below average.

On the Battery Rundown test; the ActionNote 4SLC/25 lasted just 1 hour 45 minutes, and 2 hours 2 minutes on the ZDigit Rundown test. The portable's power-management functions let you enable separate timeout counters for the display, hard disk, and system.

The ActionNote carries a l-year warranty, which includes on-site service.

PC Magazine August 1993 v12 n14 p178(2)

Ergo PowerBrick 486.

(Ergo Computing Inc.) (Hardware Review) (one of 39 evaluations of notebook and subnotebook computers in 'The Portable Puzzle') (Evaluation)

Author
Brown, Bruce

Absrtact
Ergo Computing Inc's $1,995 PowerBrick 486 uses a 33-MHz 80486 CPU and includes a built-in trackball, but battery life is only 1 hour 56 minutes with power-conservation disabled and 2 hours 24 minutes with power-conservation enabled. The trackball is positioned in the center of the Ergo's wrist rest and moves freely. CPU performance is average: graphics performance is above average, and the screen is easy to read under all lighting conditions. The Ergo's best features are its ergonomic wrist rest and convenient pointing device; it is otherwise undistinguished in its field.

Full Text
Ergo powerBrick 486

Ergo Computing Inc., One Intercontinental Way, Peabody, MA 01960: X00-633-1925, 508-535-7510; fax, 508-535-7512 List price: $1,995.

Tested configuration: 4MB 70-ns RAM, 120MB Quantum IDE hard disk with 64K cache, 1.44MB floppy disk drive, 2,400-/9,600-bps data/fax modem, DOS 6.0, Microsoft Windows 3.1, mouse, Magic Cursor.

Options: 200MB hard disk upgrade, $200; 350MB hard disk upgrade, $700: 4MB RAM upgrade, $195; 16MB RAM upgrade, $1,495; upgrade to 486DX2/66, $300; 2,400-/9,600-bps data/fax modem, $149.

In short: While the unit puts an emphasis on user comfort, with its integrated trackball situated in the middle of the wrist rest; the $1.995 Ergo PowerBrick is otherwise a typical albeit low-cost 486DX 33-MHz monochrome notebook. Its battery, with a lower amperage rating than most, lagged on our Battery Rundown test.

The Ergo PowerBrick 486, from Ergo Computing, is a value-oriented notebook with relatively low weight and a built-in trackball. At $1,995 with 4MB of RAM and a 120MB hard disk, the PowerBrick is a low-priced 486DX/33 notebook.

The PowerBrick weighs 6.7 pounds with its nickel cadmium battery. Most notebook batteries have a higher amperage rating, a factor limiting the PowerBrick's Battery Rundown test result to 1 hour 56 minutes and its ZDigit Rundown score to 2 hours 24 minutes.

The Ergo's trackball, placed in the center of its wrist rest, moves freely and lets you shift easily from typing to cursor movement. The built-in flat wrist rest can forestall hand pain despite long hours of typing. The keyboard is arranged nicely, with an inverted-T cursor-key layout, and it has a responsive keystroke feel.

The PowerBrick scored around the middle of its CPU class in performance tests. The system's Cirrus Logic video chip set and Toshiba 9.5-inch-diagonal, monochrome LCD panel scored second on the Graphics Winmark test among 33-MHz 486DX systems, ninth overall, so a demanding Microsoft Windows user might factor that in. The screen was easy to read under all lighting conditions.

The wrist rest and trackball arc the best features of the otherwise typical 486DX/33 PowerBrick

PC Magazine August 1993 v12 n14 p182(3)

Gateway 2000; Texas Instruments. (Gateway Nomad 425SXL, Gateway Nomad 450DXL, Tl TravelMate WinSLC 25, Tl TravelMate 4000 WinSX/25 TI TravelMate 4000 WinSX/25 Color, TI TravekMate 4000 WinDX/25, TI TravelMate 4000 WinDX2/40 Color, TI TravelMate 4000 WinDX2/50)

(Hardware Keview) (one of 39 evaluations of notebook and subnotebook computers in 'The Portable Puzzle') (Evaluation)

Author
Rist, Oliver

Absrtact
Gateway 2000 Inc's Nomad 425SXL and Nomad 450DXL arc slightly enhanced versions of notebook computers made by Texas Instruments Inc (TI) and are reviewed along with six models in TI's TravelMate line. All the systems except the TravelMate WinSLC 25 hold up to 20Mbytes of system RAM and 208Mbyte hard drives and have well-laid-out keyboards, monochrome versions weigh 5.6 pounds, while color versions weigh 6.2 pounds. The $4,199 TravelMate 4000 WinDX2/40 Color and $2,999 TravelMate WinSX/25 Color both have passive-matrix color screens that provide adequate but unspectacular color quality. Processors range from a Cyrix 486SCL/25 to an Intel 80486DX2/50. Power-conservation features are competitive. The TravelMate WinDX2/50 is similar to the Gateway Nomad 450DXL, but the TI's battery lasts 3 hours without power management while the Gateway managed only 2 hours and 16 minutes; the difference disappears when power-management features are activated. The TravelMate 400 WinSX/25 is similar to the Gateway Nomad 425SXL. The higher-end systems from both vendors are rated Editors' Choices.

Full Text
Gateway Nomad 425SXL

Gateway Nomad 450DXL Gateway 2000, 610 Gateway Drive N. Sioux City, SD 57049: 800-846-2000, 605-232-2000; fax, 605-232-2023 List price: 425SXL, $1,995: 450DXL, $2,995.

Tested configuration: 4MB 60-ns RAM, 128MB Seagate ST9144A IDE hard disk with a 64K buffer (425SXL), 208MB Seagate ST9235AG IDE hard disk with 64K buffer (450DXL), 1.44MB floppy disk drive, 9,600-bps data/fax modem (425SXL).

Options: 8MB RAM upgrade, $200: 20MB RAM upgrade, $1,700; extra battery, $65; 9,600-bps data/fax modem, $415; 2,400-/4,800-bps data/send-only fax modem, $85; extra AC adapter, $65; carrying case, $50.

In short: The Gateway Nomad 425SXL and Nomad 450DXL compete well in this roundup with their combination of low price and excellent battery life. A special system chip set helps to prolong battery life and keep the units' heat levels low, something that other manufacturers have not been succesful at. The Nomad 450DXL offers lots of raw processing power with its 486DX2/50 CPU, while the battery in the 486SX/25-based Nomad 425SXL logged a ZDigit Rundown test time of 6 hours 46 minutes, plenty of time for the average traveler.

TI TravelMate WinSLC 25 Tl TravelMate 4000 WinSX/25 Tl TravelMate 4000 WinDX/25 Texas Instruments, P.O. Box 202230. Austin, TX 78720-2230: 800-527-3500, 817-771-5856: fax, 817-774-6660 List price: WinSLC 25, $1,899: WinSX/25 $2,199: WinDX/25, $2,799.

Tested configuration: 2MB 70-ns RAM (WinSLC 25), 4MB 60-ns RAM (WinSX/25 and WinDX/25); 64MB Seagate ST9077A IDE hard disk with 32K buffer (WinSLC 25), 128MB Seagate ST9144A IDE hard disk with 64K buffer (WinSX/25 and WinDX/25; 1.44MB floppy disk drive, DOS 5.0, Microsoft Wmdows 3.1, TravelPoint.

Options: 2MB or 4MB RAM upgrade, $279; 16MB RAM upgrade. $1,999; expansion station with three 16-bit expansion slots and three 3.5-inch drive bays, $929; extra nickel cadmium battery, $89: 14,400-/9,600-bps data/fax modem, $599: Ethernet module with 10BaseT and thick coax connectors, $469: Token-Ring adapter 4/16, $899: numeric keypad, $59; battery charger, $149: SCSI adapter. $369; I/o adapter, $199.

In short: These worthy and capable members of the Texas Instruments notebook family compete on much the same platfonns as their many siblings from other makers: light weight, great battery life, and nice prices. But beware: Though the TravelMate WinSLC 25 has a great price tag, it's based on the company's own low-cost 486 clone processor and didn't keep up with other 486-class CPUs on PC Labs' performance tests.

Tl TravelMate 4000 WinSX/25 Color Tl TravelMate 4000 WinDX2/40 Color TI TravelMate 4000 WinDX2/50 Texas Instruments, P.O. Box 202230, Austin, TX 78720-2230; 800-527-3500, 8 17-771-5856; fax, 8 17-774-6660 List price:

WinSX/25 Color, $2,999; WinDX2/40 Color, $4,199; WinDX2/50, $3,499.

Tested configuration: 4MB 80-ns RAM, 8MB 60-ns RAM, 128MB Seagate ST9144A IDE hard disk with 64K buffer (WinSXR5 Color), 208MB Seagate ST9235AG IDE hard disk with 64K buffer (WinDX2/40 Color and WinDX2/50); 1.44MB floppy disk drive, DOS 5.0, Microsoft Windows 3.1, Microsoft mouse.

Options: 2MB or 4MB RAM upgrade, $279: 16MB RAM upgrade, $1,999; expansion station, $929: extra nickel cadmium battery, $89: 14,400-/9,600-bps data/fax modem, $599; Ethernet module with 10BaseT and thick coax connectors, $469; Token-Ring adapter 4/16, $899; numeric keypad, $79; battery charger, $149

In short: Featuring light weight, great battery life, and very competitive performance, two of these Texas Instruments gangsters pack color. The third boasts a muscle-bound DX2/50 processor that managed tine performance scores with relatively little heat buildup.

Talk about a street gang. Dressed in charcoal gray plastic instead of black leather, Texas Instruments' new road warriors and their slightly tweaked Gateway 2000 blood brothers make a formidable band of portable PCs.

The entire gang shares numerous features: up to 20MB of system memory (except for the `TI TravelMate WinSLC 25. which can onlv take 6MB of RAM), up to a 208MB hard disk drive, a nicely laid out keyboard with a disappointingly "mushy" feedback, and either a Microsoft BallPoint mouse (with a cordless QuickPort or a Thumbelina-type serial mouse. Monochrome versions weigh about 5.6 pounds, while color versions weigh about 6.2 pounds.

TI OEMs its system to Gateway 2000; the Nomads generally come with a larger software bundle to differentiate them.

GANG COLORS

The only two color-capable members of this group both hail from the TI camp: the $4,199 TI TravelMate 4000 WinDX2/40 Color and the $2,999 TI TravelMate WinSXR5 Color. Both have passive-matrix screens which provide passable color, but certainly nothing that compares with active matrix. However, TI has an active-matrix TFI version of the DX2/50 waiting in the wings. Unfortunately for Texas Instruments, you can find today some portables equipped with active-matrix screens for under $3,500; so TI has to come up with something more in order to attract buyers.

These portable PCs also have processing power--all the way from the Cyrix 486SLC/25 to the Intel 486DX2/50. TI touts the accompaniment of its own system chip set with its clock-doubled units, which allows the CPU to fall to 0MHz in real time when not in use. Not only does this have the desired effect of controlling CPU heat levels, it also provides competitive power conservation. The TravelMate 4000 WinDX2/40 Color clocked in at 2 hours 15 minutes on PC Labs' Battery Rundown test and 4 hours 12 minutes on the ZDigit Rundown test with power-saving features enabled.

The TI TravelMate WinSX/25 Color managed 2 hours 16 minutes on the Battery Rundown test and 3 hours 44 minutes on the ZDigit Rundown test. On PC Labs' benchmark tests, both machines did well for their processor class The WinSX/25 came in third or fourth (compared with all other SX/25-MHz systems) on all tests except memory and Graphics Winmark where it placed second. The DX2/40 didn't have any other systems directly in its processor class, but compared with all the systems in this roundup it scored excellently, successfully reaching the upper echelon on all tests save for video, where it ranked forty-fifth.

TRAVELMATE WINDX2/50 AND GATEWAY NOMAD 450DXL

These systems provide the muscle for the 'H/Gateway gang. They are distinguished by monochrome screens and Intel DX2/ 50-MHz processors.

Oddly enough, though the two systems are identically configured, their battery test scores differed widely. The Tl WinDX2/50 came in at about 3 hours on the Battery Rundown test, while the Gateway Nomad 450DXL managed 2 hours 16 minutes. The difference nearly disappeared on the ZDigit Rundown test with power management features activated, where the TI WinDX2/50 lasted 5 hours 21 minutes, while the Nomad 450DXL came in at 5 hours 32 minutes.

Scores for these portables on the PC Labs benchmark test suite weren't divergent at all, both systems scoring at the top of their processor class in every test. On both the processor and memory tests, these machines turned in the two best scores of all systems in this roundup, surpassing even the more powerful DX2/66-equipped portables we tested.

TI TRAVELMATE 4000 WINSX/25 AND GATEWAY NOMAD 425SXL

The $2,199 monochrome TI TravelMate WinSX/25 and the $1,995 Gateway Nomad 425SXL are again identical machines with different labels.

Battery scores were excellent for both machines: the WinSX/25 came in at 4 hours 18 minutes on the Battery Rundown test and 7 hours 2 minutes on the ZDigit Rundown test, while the Nomad 425SXL clocked in at just under 3 hours on the Battery Rundown test and 6 hours 46 minutes on the ZDigit Rundown test. Benchmark test results for the WinSX/25 and the Nomad 425SXL were nearly identical, with both machines scoring high marks among other 486SX/25MHz systems and average scores when compared with all other notebooks in this roundup. Only the Nomad's video score fell slightly below the average, at forty-ninth place overall.

TI TRAVELMATE WINDX/25

This system represents the Intel 486DX/25-based product, but it is otherwise identical in all respects to the rest of the gang.

With a price of $2,799, this system managed competitive battery times at 1 hour 47 minutes on the Battery Rundown test and 4 hours on the ZDigit Rundown test. Its PC Labs' benchmark test results, measured against all other laptops, were respectable as well, with video having the lowest score--thirtieth out of all systems in this roundup.

TI TRAVELMATE WINSLC 25

This last $1,899 gang member is powered by TI's version of the Cyrix 486SLC chip, and it is by far the lowest-priced system in the group. Of course, with a monochrome display, 6MB of RAM maximum, and a 60MB hard disk, a high price is uncalled for.

Battery times for the TravelMate WinSLC 25 were excellent: 3 hours 43 minutes on the Battery Rundown test and 4 hours 1 minute on the ZDigit Rundown test. The unit's benchmark test scores could only be compared against those of all the other laptops that we reviewed in this roundup (as opposed against those of a similar processor class), and these were consistently in the lowest quartile.

PC Magazine August 1993 v12 **n14 p186(1)**

GRiD Convertible. (GRID Systems Corp.) (Hardware Review)

(one of 39 evaluations of notebook and subnotebook computers in 'The Portable Puzzle') (Evaluation)

Author
Plain, Stephen W.

Absrtact
GRiD Systems Corp's GRiD Convertible combines a standard notebook computer with a pen-based system by using a screen that folds flat to cover the keyboard. The Convertible comes with a Type II PCMCIA slot, but the external floppy disk drive uses the parallel port. The keyboard is comfortable to use. Processor, memory and video benchmark scores are average for the 80386SL 25-MHz processor class. Windows performance is better than some competing systems. Battery life is 2 hours with power conservation enabled and ⌇ hour 37 minutes with power conservation disabled. The price of $4,790 is reasonable for a system with the Grid's unique features.

Full Text
GRiD Convertible

GRiD Systems Corp., 7 Village Circle, Westlake, TX 76262; 800-934-4743, 817-491-5200; fax, 817-491-5982 List price: $4,790.

Tested configuration: 8MB 80-ns RAM with 64K external cache, 123MB Toshiba MK-424FC IDE hard disk with 32K buffer, 14,400-/9600-bps data/fax modem, DOS 5.0, Microsoft Windows for Pen Computing, pen.

Options: 2MB RAM upgrade, $225; 6MB RAM upgrade, $595: extra nickel cadmium battery, $99: extended battery, $149: extra AC adapter, $129: 12-volt battery adapter, $129.

In short: The Convertible turned in decent benchmark test results, but it disappointed m terms of battery life.

As pen technology creeps toward maturity, the 386SL/25-based GRiD Convertible, from GRiD Systems Corp., offers the benelits of pen computing without putting you through keyboard withdrawal or sticker shock.

The Convertible, whose screen folds flat to cover the keyboard, comes with a Type II PCMCIA slot. The external floppy disk drive uses the parallel port, which means you can't print and read a floppy disk at the same time. The keyboard is comfortable and provides easy access to a wide range of power-conservation features. The screen cannot be flipped over to close in the traditional manner but is covered with glass. The screen locks into a fixed position--no adjustments can be made for lighting.

The Convertible turned in scores on our processor, memory, and video test routines consistent with its CPU class, but its hard disk turned in some of the slowest times of any 386SL/25 we tested. Despite this, the Convertible outperfonned its processor classmates on our Windows Applications tests. Battery life was just over 2 hours with power conservation on, 1 hour 37 minutes with those features off.

Overall, the unique Convertible offers users excellent technology at a reasonable price.

PC Magazine August 1993 v12 n14 p189(1)

HyperBook 23000DLC/40; HyperBook 23000DX2/50.

(HyperData Technology Corp.) (Hardware Review) (one of 39 evaluations of notebook and subnotebook computers in 'The Portable Puzzle') (Evaluation)

Author
Hicks, Adam A.

Absrtact
HyperData Technology Corp's HyperBook 23000DLC/40 and HyperBook 23000DX2/50 notebook computers both offer solid features and excellent performance. The $3,695 23000DLC/40 is built around a 40-MHz Cyrix processor, whilke the $4,195 23000DX2/50 has a 50-MHz Intel 80486DX2. Both systems have slightly shorter-than-average battery life with power conservation disabled: the DLC/40 lasts one hour and 47 minutes and the DX2/50 lasts one hour and 43 minutes. Each has an external VGA monitor port, bidirectional parallel port, dedicated scanner port and SCSI port for superior expandability, but neither

includes a built-in pointing device or PCMCIA slot. Overall performance is excellent escept in the area of video, where it is only average. The screens suffer from ghosting, and the batteries are bulky.

Full Text
HyperBook 2300DLC/40

HyperBook 2300DX2/50 HyperData Technology Corp., 809 S. Lemon Ave., Walnut, CA 91789: 800-786-7223, 909-468-2955; fax, 909-468-2961 List price: HyperBook 2300DLC/40 $3,695: HyperBook 2300DX2/50,

$4,195.

Tested configuration: 8MB 70-ns RAM with 128K external cache (2300DCL/40) or 256K external cache (2300DX2/50); 213MB Toshiba MK-2224FC IDE hard disk with 128K cache, 1.44MB floppy disk drive, 2,400/9,600-bps data/fax modem, DOS 5.0.

Options: 4MB RAM upgrade, $300; 16MB RAM upgrade, $1,000; 486DX2/66 CPU upgrade, $200 (2300DX2/50); extra nickel cadmium battery $50; extra AC adapter, $95: Logitech 3-in-1 mouse, $35; PS/2 mouse, $35.

In short: These fairly large notebooks from HyperData Technology (formerly SunRace Technologies) have quite a few attractive features and very respectable performance scores, but are not much to recommend because of their lack of flexibility and the promised improvements in the upcoming 3000 series. Nice touches, such as a bidirectional parallel port, a dedicated scanner port, and a SCSI port may make these units especially attractive to some users.

The HyperBook 2300 series is the latest generation of notebook computers from HyperData Technology (formerly SunRace Technologies). While neither of the machines is the sleekest or most flexible, they both have solid features and displayed consistently excellent performance.

The $3,695 HyperBook 2300DLC/40 and the more powerful $4,195 HyperBook 2300DX2/50 are both solidly built, and they weigh about 8.3 pounds each This excessive weight is a result of including two large nickel cadmium batteries (which function as a unit) as well as a sizable AC adapter with each unit. For their bulk, however, the batteries performed well.

Both machines scored slightly below average on the Battery Rundown test, with the 2300DLC/40 coming in at 1 hour 47 minutes and the 2300DX2/50 coming in at 1 hour 43 minutes.

Both of the units' keyboards are of standard layout, which requires the use of a function key to access an embedded numeric keypad and the F11 and F 12 keys. Both of the screens looked fairly clear and sharp from most angles, but they did have troublesome ghosting. Both the contrast and the brightness ranges can be adjusted by using the sliding switches located in the upper right-hand comer of the keyboard.

In addition, each machine has an external VGA monitor port, a bidirectional parallel port, a dedicated scanner port, and the interesting addition of a SCSI port, making this a potential power system away from the office. Neither machine included a PCMCIA slot or a built-m pointing device.

Overall performance of the 2300DLC/40 and the 2300DX2/50 was strong in all areas except video. The 2300DLC/40--the only machine in this roundup with a Cyrix CX486DLC/40 chip--remained in the top ten on all test suites, save on the Graphics Wimnark and DOS video routines, where it was only an average performer.

The 2300DX2/50 ran exceptionally well, landing in the top ten or better overall performers on all benchmark tests escept the DOS video routines, where it ranked second in its processor class but 25th overall.

For the price, HyperData could have put more thought into design and presentation in order to complement the large disks and fast CPUs of these machines.

PC Magazine August 1993 v12 **n14 p189(2)**

Hyundai Courier.

(Hyundai Electronics America) (Hardware Review) (one of 39 evaluations of notebook and subnotebook computers in 'The Portable Puzzle') (Evaluation)

Author
Canter, Sheryl
_-_-__---------_____---------

Absrtact
Hyundai Electronics America's $1,199 Courier is one of the least expensive notebook computers available but suffers from poor performance It has few extra features, and the keyboard is cramped and poorly laid out. Display quality deteriorates quickly at a slight angle, and battery life is relatively short: the batteries run down in 1 hour 55 minutes with power conservation disabled, and enabling power conservation extends it by only seven minutes. The Courier 1s difficult to recommended despite its low price.

Full Text
I lyundai Courier

Hyundai Electronics America, 1955 Lundy Ave., San Jose, CA 95131; 800-933-3445, 408-473-9200; fax, 408-894-9751 List price: $1,199.

Tested configuration: 4MB 70-ns RAM, 85MB Conner CP2088 IDE hard disk with 32K cache, 1.44MB floppy disk drive, DOS 5.0, Microsoft Windows 3.1.

Options; 120MB hard disk upgrade, $461; 2MB RAM upgrade, $149: 6MB RAM upgrade, $449; extra battery pack, $149: numeric keypad, $65: 12-volt battery adapter, $65.

In short: The Hyundai Courier is certainly inexpensive enough when compared to its competition, but, unforttmately, you get what you pay for-minimal features and marginal quality. While it does offer a useful PCMCIA slot, the unit's cramped and poorly configured keyboard, inconveniently located trackball, and low-quality monochrome display make it hard to recommend.

With a price of $1, 199, the monochrome Hyundai Courier is the least expensive notebook in this issue's roundup. But you get what you pay for: The Courier scored near the bottom on all of our performance tests, and, with the exception of a PCMCIA slot, the unit contains few extras.

The Courier's keyboard is both cramped and poorly laid out, and the feel of its keys is clackety and unsubstantial. The cursor keys are laid out in an inverted-T configuration, but they are embedded among other keys and they are also unusually narrow. The Courier's display quality quickly deteriorates at even a slight angle. In graphics mode, there is also some troublesome shadowing.

A trackball is built into the machine directly above the keyboard to the right--an inconvenient placement. The two mouse buttons that are used to control it are vertically aligned to the left of it. This layout is awkward, since you must reach across the keyboard with your left hand.

The Courier's nickel cadmium battery: while weighing less than a pound, was rather short on life span On the Battery Rundown test, it clocked in at 1 hour 55 minutes: on the ZDigit Rundown test, it lasted 2 hours 2 minutes.

Despite its low price, this machine is hard to recommend because of its uncomfortable keyboard, low-quality display, and poor performance.

PC Magazine August 1993 v12 n14 p190(1)

Hyundai Courier Spectra.

(Hyundai Electronics America) (Hardware Review) (one of 39 evaluations of notebook and subnotebook computers in 'The Portable Puzzle') (Evaluation)

Author
Canter, Sheryl

Absrtact
Hyundai Electronics America's $2,499 Courier Spectra is a passive-matrix color notebook computer based on Cyrix Corp's CX486SLC/25 microprocessor that provides basic functionality for a low price. Its screen suffers from poor contrast, and the system font is very small. Hatter-y life is only one hour and 23 minutes with power conservation disabled and just under two hours in a test simulating normal use. The keyboard offers good resistance and has both full-sized keys and a good layout. Hyundai builds a trackball into the lower right-hand comer with mouse buttons at the lower left. The Spectra has few extras but is a serviceable and inexpensive product.

Full Text

Hyundai Courier Spectra

Hyundai Electronics America, 1955 Lundy Ave., San Jose; CA 95 13 1: 800-933-3445, 408-473-9200; fax, 408-894-975 1 List price: $2,499.

Tested configuration: 4MB 80-ns RAM, 120MB Area1 15-ms IDE hard disk with 32K buffer, 1.44MB floppy disk drive, 2,400-bps/9,600-bps send/receive fax modem , DOS 5.0, Microsoft Windows 3.1, built-in trackball.

Options: 8MB RAM upgrade, $499; 16MB RAM upgrade, $ 1,999; extra battery, $69; battery charger and AC adapter, $139. 12-volt adapter, $65.

In short: Aside from its tiny screen and poor battery life,` the Hyundai Courier Spectra is a good choice as a budget color notebook. Its keyboard is well laid out and easy to use.

The Hyundai Courier Spectra, a passive-matrix color notebook based on the Cyrix CX486SLC/25 chip, provides basic functionality for the relatively low price of $2,499. Hyundai also sells a monochrome notebook called the Hyundai Courier, but this is a completely different machine.

The first thing you will notice about the Courier Spectra is the small size of its system font, Even given the small screen size (8.5 inches diagonally), the font is smaller than it has to be. If you have trouble reading small type, this is not the notebook for you. The unit's poor screen contrast compounds the readability problem. In text mode, the background is silvery rather than black, and the characters are dull gray no matter how you adjust the contrast settings. The display is better in graphics mode, but the color is still a bit washed out.

This unit also ran into difficulty in battery testing. On the Battery Rundown test, the Courier Spectra came in dead last at 1 hour 23 minutes, Its ZDigit Rundown score of just under 2 hours was not much better, barely placing it above the bottom 10 percent.

On a positive note, the keyboard gives good resistance and has full-size keys that are well laid out, making the unit comfortable to use. A trackball is built into the lower-right-hand comer of the keyboard, with mouse buttons on the lower left. This arrangement is very easy to use.

Though it has few extras, the Courier Spectra is a very serviceable, low-priced color notebook. If you are not doing a lot of work in text mode, it is a good choice for a budget unit.

PC Magazine August 1993 v12 n14 p190(2)

IBM ThinkPad 720C.

(IBM Personal Computer Co.) (Hardware Review) (one of 39 evaluations of notebook and subnotebook computers in 'The Portable Puzzle') (Evaluation)

Author
Canter, Sheryl

Absrtact
IBM Personal Computer Co's $4,695 ThinkPad 720C notebook computer offers superior performance at a premium price. It weighs 8.9 pounds with all accessories for traveling and uses a 50-MHz CPU; extras include a PCMCIA slot and a unique pointing device called the TrackPoint II located between the G and H keys. The active-matrix color screen provides superb display quality, and keyboard quality is exceptional as well. Users can type comfortably and expand the system readily as well. Battery life is a solid two hours with power conservation disabled. The ThinkPad is rated an Editors' Choice.

Full Text
IBM ThinkPad 720C

IBM Personal Computer Co., Rte. 100. Somers, NY 10589: 800-772-2227: fax, 80042611329 List price: 54,695.

Tested configuration: 4MB 80-ns RAM, IBM 160MB Direct Bus Access hard disk with 128K buffer, 2.88MB floppy disk drive, DOS 5.0.

Options: 2MB RAM upgrade, $245; 4MB RAM upgrade, $475; 8MB RAM upgrade, $945: 14,400-bps PCMCIA data/fax modem, $595: expansion cartridge with AC adapter, $445; quick charger, $195: AC adapter, $15: 12-volt adapter, $165; keyboard/mouse connector, $40: external numeric keypad, $85.

In short: The IBM ThinkPad 720C is a superbly engineered active-matrix machine with all the features you could want in a notebook. Its weight and price may be hefty, but its solid keyboard and adequate battery life may make it worth saving up for.

IBM hit a home run with the ThinkPad 700C, and Big Blue has done it again with the IBM ThinkPad 720C. Since the system is priced at $4,695, you may find a cheaper notebook, but you probably won't find a better one overall. The 8.9-pound (travel weight) 720C uses a faster chip (50 MHz) than the 700C, has a longer battery life, and adds a PCMCIA slot.

The 10.5-inch active-matrix thin-film transistor (TFT) color screen is, in a word, stunning When the machine runs in text mode, the screen background is a dark, solid black, providing excellent contrast. When the machine runs in graphics mode, the colors are both sharp and even.

The ThinkPad 720C uses a unique pointing device called the TrackPoint II, which looks like a pencil eraser. It is located between the G and H keys. Pressing on the TrackPoint 11 moves the mouse cursor around--heavier pressure increases cursor speed. The two mouse buttons are both conveniently located below the Spacebar.

The keyboard is also exceptional, The spring-loaded keys give satisfying resistance when typing. The cursor keys are arranged in an inverted-T layout and are positioned in the lower-right comer of the keyboard.

The IBM ThinkPad 720C is a superbly engineered machine that scored above the average on all our benchmark tests and turned in a solid 2-hour Battery Rundown test time. If you can afford it, this is the notebook to buy.

PC Magazine August 1993 v12 n14 p208(2)

Jetta Jetbook 486DX/33;

Santron 486 Jetbook. (Jetta International Inc., Santron Computers Inc.) (Hardware Review) (one of 39 evaluations of notebook and subnotebook computers in 'The Portable Puzzle') (Evaluation)

Author
Brown, Bruce

Absrtact
Jetta International Inc's $2,345 Jetbook 486DX/33 and Santron Computers' $2,120 486 Jetbook use the same basic case and 33-MHz 80486DX CPU; both use a tlitachi 9.5-inch passive-matrix LCD screen with 64 gray scales that fades significantly when viewed from an angle. Each has a two-inch wrist-rest area in front of the keyboard, but the rest slopes toward the front and is not as comfortable to use as similar keyboards from a few other vendors. The Jetbook 486DX/33 includes a 213Mbyte 12-millisecond Toshiba hard disk with a 12Kbyte cache that provides significantly higher-than-average scores on disk benchmarks; the Santron's 202Mbyte drive is much slower. The Santron adds a small trackball Just behind the keyboard positioned slightly right of center. The trackball buttons are flush with the surface of the case and require significant conscious effort to push. Both machines log average scores on battery-rundown tests; the Santron's battery lasts 2 hours and 23 minutes with power conservation disabled, while the Jetta's lasts 2 hours and 18 minutes. Simulating real-world use conditions results in very little performance gain.

Full **Text**
Jetta Jetbook 486DX/33

Jetta International Inc., 51 Stouts Lane, #3, Monmouth Junction, NJ 08852: 908-329-965 1; fax, 908-329-0105 List price: $2,345.

Tested configuration: 4MB 70-ns RAM with 8K external cache, 2 13MB Toshiba MK-2224 FCV IDE hard disk with 128K cache, 1.44MB floppy disk drive, 2,400/9,600-bps data/fax modem, DOS 5.0, Thumbelina trackball.

Options: 4MB upgrade, $295: internal trackball, $98: docking station, $465; extra battery, $135; internal 2,400-19,600-bps data/fax modem, $195.

In short: With no stand-out features, the Jetbook 486DX/33 is still a reasonable buy. It lacks the built-in trackball of the similar Santron 486 Jetbook but makes up for it with better disk and video performance.

Santron **486** Jetbook Santron Computers Inc., 1185 Chess Drive, Suite I, Foster City, CA 94406; X00-938-7888: fax, 415-571-6079 List price: $2,120.

Tested configuration: 4MB 70-ns RAM. Toshiba 86MB 17-ms MK-2024FC IDE hard disk with 32K cache, DOS 5.0. Microsoft Windows 3.1, 2,400-/9,600-bps data/fax modem.

Options: 4MB RAM upgrade, $225; 2,400-/9,600-bps data/fax modem, $12 5.

In short: Almost identical to the competent but ordinary Jetta Jetbook 486DX/33, the Santron 486 Jetbook comes with a smaller hard disk but also with an integral trackball.

Jetta International manufactures three of the notebooks reviewed in this issue, two of which use the same basic case and CPU (Jetta's own $2,345 Jetbook 486DX/33 and Santron Computers' $2,120 486 Jetbook), and a third machine with a different, innovative design (the Micro Electronics WinBook 486, which is reviewed separately). The Jetbooks are competent machines with no particularly outstanding features or problems.

The Jetta and Santron notebooks both have a gray case with a 2-inch wrist-rest area in front of the keyboard, so your wrists don't have to hang in the air while you type. This ergonomic feature is a good idea, but both machines slope toward the front, making thetn less comfortable to use than the Micro Electronics WinBook and the Ergo PowerBrick both of which sport relatively flat wrist-rest areas.

Both systems use a 64 gray-scale Hitachi 9.5-inch diagonal monochrome passive-matrix LCD screen, which, like most screens of this type, produces noticeable fading when viewed from the side. Also, the display does not fold back flat enough to fit under the front of an external monitor, a drawback if you intend to use an external monitor often.

The Jetbook 486DX/33 justifies a higher cost than the Santron system by including a 2 13MB 12-ms Toshiba hard disk with its own 128K cache. This disk helped the Jetbook 486DX/33 attain significantly higher-than-averageDOS and Winmark disk performance scores (which were also much better than the Santron's disk scores).

The Jetta also had a higher Graphics Winmark score than the Santron, even though both systems have the same Cirrus Logic video chip set, the same CPU, and 4MB of RAM.

The Santron 486 Jetbook comes with an added bonus: a small trackball has been placed just behind the keyboard and positioned slightly right of center, making it a little bit more comfortable to use than most for right-handed people.

The trackball positions the cursor fairly well, though you have to lift a hand to use it, but the buttons are flush with the case's surface and require more of a conscious effort to push than most. The Santron system comes with an 86MB 17-ms Toshiba hard disk with a 32K cache.

The Santron and Jetta, both of which logged average Battery Rundown test times (2 hours 23 minutes and 2 hours 18 minutes, respectively) and below-average ZDigit Rundown test times (2 hours 50 minutes and 2 hours 33 minutes, respectively) are both relatively low-priced for 33-MHz 486DX notebooks, but otherwise have no truly compelling features.

PC Magazine August 1993 v12 n14 p209(1)

Micro Electronics WinBook 486SLC/E/33.

(Micro Electronics) (Hardware Review) (one of 39 evaluations of notebook and subnotebook computers in 'The Portable Puzzle') (Evaluation)

Author
Brown, Bruce

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Absrtact
Micro Electronics' $1,799 WinBook 486SLCE/33 notebook computer is an unusually good value for its price: it is based on a 33-MHz Cyrix Cx486SLC/3 microprocessor that offers average performance and excellent battery life. The built-in trackball is located in the center of a flat wrist rest in front of the keyboard and is easy to use. Battery life is an exceptional 3 hours 28 minutes with power conservation disabled and 3 hours 47 minutes in a test simulating real-world use. The 9.5-inch monochrome screen suffers from ghosting, but the WinBook is a good value overall.

Full Text
Micro Electronics WinBook 486SLC/E/33

Micro Electronics, 1160 Steelwood Rd., Columbus, OH 432 12: 800-468-2162; fax, 800-448-0308 List price: $1,799.

Tested configuration: 4MB 70-ns RAM; 128MB Maxtor 25128-A IDE hard disk with 32K buffer 1.44MB floppy disk drive; 9,600-bps send/receive and fax/2,400-bps data modem: DOS 6.0: Microsoft Windows 3.1; trackball; PCMCIA, Version 2.0 slot.

Options: 8MB RAM upgrade, $250; docking station, $399: nickel hydride battery pack, $79.95; math coprocessor, $99: battery charger, $19.95; 12-volt adapter, $99.95.

In short: The WinBook 486SLC/E/3 has a screen that is ghostier than usual, and adjusting the contrast and brightness didn't completely resolve the problem. But in all other respects this Cyrix Cx486SLC/e-based notebook includes a plethora of features for its price.

Scoring high in overall value and design, the $1,799 Micro Electronics WinBook 486SLC/E/33 gives you a lot for your money, including an outstanding integral trackball. The only system in this review that is based on the 33-MHz Cyrix Cx486SLC/e microprocessor chip, the WinBook unit balances an average overall performance rating with excellent battery life.

The WinBook's trackball sits in the middle of an expansive, flat wrist rest that is located in front of the keyboard. This design makes it easy to use the trackball while you are typing. This machine scores high marks for ergonomics, design, and functionality.

Value is also among the WinBook's greatest attractions. The standard system configuration includes 4MB of RAM and a 128MB hard disk, in addition to an internal data/fax modem.

On our battery tests, the WinBook performed exceptionally well, clocking in at 3 hours 28 minutes on the Battery Rundown test and 3 hours 47 minutes on the ZDigit Rundown test.

One shortcoming, however, of the WinBook is its 9.5-inch monochrome screen, which had the tendency to ghost images; adjusting the contrast and brightness controls never completely resolved the problem.

The Micro Electronics WinBook 486SLC/E/33 offers you a lot for your money, including possible relief for hands and wrists that are tired from typing.

PC Magazine August 1993 v12 **n14 p211(2)**

Micro Express NP943 Notebook PC; Tenex 486DX/33 Chroma.

(Micro Express, Tenex Computer Express) (Hardware Review) (one of 39 evaluations of notebook and subnotebook computers in 'The Portable Puzzle') (Evaluation)

Author
Stilwell, Brad

Absrtact
Micro Express' $1,899 NP943 Notebook PC and Tencx Computer Express' $3,100 486DX/33 Chroma use 33-MHz 80486DX microprocessors but otherwise suffer from aging design. Each comes with 4Mbytes of RAM and a 120Mbyte hard drive: the Tenex includes a passive-matrix color display, but both screens suffer from ghosting. The keyboards are generously sized, but neither machine has a built-in pointing device. The Chroma has a disk cache and delivers superior performance on disk benchmarks, but both units suffer from poor video performance. Battery life on the Micro Express is excellent at 3 hours 27 minutes with power conservation disabled and 4 hours 18 minutes with power management enabled.

Full Text
Micro Express NP943 Notebook PC

Micro Express, 1801 Carnegie Ave., Santa Ana, CA 92705: 800-989-9900, 714-852-1400; fax, 714-852-1225 List price: $1,899.

Tested configuration: 4MB 70-ns RAM, 123MB Toshiba 3224 IDE hard disk with 64K buffer, 1.44MB floppy disk drive, 2,400-/9,600-bps data/fax modem, DOS 5.0, Microsoft Windows 3.1. serial mouse

Options: 4MB RAM upgrade, $200: portable trackball, $99: 2,400-/9,600-bps data/fax modem, $169; extra nickel cadmmm battery, $65; Ethernet adapter, $199.

In short: The Micro Express NP943 Notebook PC offers an adequate 486DX/33 CPU, but lacks a pointing device. Although this machine has few features to recommend it, its battery life, at 3 hours 27 minutes on PC Lab's Battery Rundown test and 4 hours 18 minutes on the ZDigit Rundown test, was the longest among 486DX-based notebooks in this review.

Tenex 486DX/33 Chroma Tenex Computer Express, 56800 Magnetic Dr., Mishawaka, IN 46545: 800-776-6781, 219-272-1234: fax, 219-259-0300 List price: $3,100.

Tested configuration: 4MB 70-ns RAM, 213MB Toshiba MK2224FC IDE hard disk with 128K cache, 1.44MB floppy disk drive, 2,400-/9,600-bps data/fax modem, DOS 6.0, Microsoft Windows 3.1, Logitech trackball, Bitcom, Bitfax.

Options: 4MB RAM upgrade, $199: 8MB RAM upgrade, $399: extra nickel cadmium battery, $69.99; Ethernet module, $249.99: SCSI interface, $99.99.

In short: The Tenex 486DX/33 notebook, with a hazy passive-matrix color display that produces distracting ghosting: fell short in both battery life and video performance. The unit lacks a pointing device but sports a generously sized keyboard and produced top-rank scores on PC Labs' DOS and Microsoft Windows Applications tests.

The only place in which the two new notebooks from Micro Express and Tenex Computer Express have kept pace with the most recent advances in portable-PC technology is in their CPUs: Both systems are old designs with powerful 486DX/33 processors dropped into them.

Both of the machines come standard with 4MB of RAM and a 120MB hard disk drive, in addition to a 1.44MB 3.5-inch internal floppy disk drive. Each unit hasone serial port and one parallel port, as well as ports for an additional keyboard, a VGA monitor, and an external floppy disk drive. RAM is ugradable to 16MB for either unit. The Tenex 486DX/33 Chroma is available with a 213MB hard disk, while Micro Express's NP943 Notebook PC is available with a 200MB hard disk.

Among the eight 486DX/33 machines that we reviewed, the NP943 had the longest battery life by far. Micro Express's unit clocked in at 3 hours 27 minutes on our Battery Rundown test and 4 hours 18 minutes on the ZDigit Rundown test with its power-management feature enabled: the Tenex's times were 2 hours 2 minutes on the Battery Rundown test and 2 hours 47 minutes on the ZDigit Rundown test.

After removing one of the two batteries on these machines, users can add optional modules, including fax modems and Ethernet adapters. With just one battery available, however, the user may have to rely on AC power to take advantage of such components.

A speedy 128K cache on the Chroma's 2 13MB Toshiba hard disk allowed this system to deliver top-rank performance on both our DOS and Microsoft Windows Applications tests. Both units, however, also ranked among the worst in DOS video performance.

The Tenex system differs from Micro Express' notebook in that it offers a passive-matrix color display. Both screens, however, have ghosting problems that can be very distracting to the user, and Tcnex's Sharp screen often appears hazy because of its uneven backlighting.

While each of these machines sports a generously sized keyboard that includes all of the standard cursor and function keys, both lack built-in pointing devices, a factor that may be a serious drawback for those who use Microsoft Windows extensively.

PC Magazine August 1993 v12 **n14** p214(1)

Mitsuba Ninja 486SX/25.

(Mitsuba Corp.) (Hardware Review) (one of 39 evaluations of notebook and subnotebook computers in 'The Portable Puzzle') (Evaluation)

Author
Cline, Camille N.

Absrtact
Mitsuba Corp's $1,895 Ninja 486SX/25 uses a 25-MHz 80486SX microprocessor that provides somewhat erratic performance, but it is compact and has excellent ergonomic features including a superb display. Windows and CPU benchmark scores are below-average, and battery life is mediocre at 2 hours 4 minutes with power-conservation disabled and 2 hours 48 minutes in a test simulating normal use. The 70-key keyboard has good kev travel and is comfortable to use, but there is no built-in trackball. Standard system memory is 4Mbytes and can be upgraded to 8Mbytes or 20Mbytes a 120Mbyte hard disk is standard. The 9.5-inch monochrome Sharp display is large and clear.

Full Text
Mitsuba Ninja 486SX/25

Mitsuba Corp., 1925 Wright Ave., La Verne, CA 91750: 800-648-7822, 909-392-2000; fax, 909-392-2021 List price: $1,895.

Tested configuration: 4MB 70-11s RAM, 123MB Toshiba MK-2124FC IDE hard disk with 32K cache, 1.44MB floppy disk drive, DOS 5.0, Microsoft Windows 3.1, mouse.

Options: 210MB hard disk upgrade, $280: 4MB RAM upgrade, $200, extra nickel hydride battery, $110; 2,400-19,600-bps data/fax modem, $180; Ethernet adapter, $150: 12-volt batten, adapter, $79: external keyboard, $36; external numeric keypad, $45.

In short: Thin and light, the Mitsuba Ninja 486SX/25 comes with a high-quality screen and mixed performance results. The unit had the lowest processor, memory, and DOS and Windows disk test scores for its CPU group, and its battery times on the ZDigit and Battery Rundown tests were below average.

Performance scores for the Mitsuba Ninja 486SX/25 were erratic, almost reaching both extremes among units in its processor class, which includes such systems as the Gateway Nomad 425SXL. But the Ninja's compactness, exceptional display, and comfortable keyboard layout elevate it above the average laptop. And at a price of $1,895, the bone-colored Mitsuba Ninja is easy on the budget.

The Ninja garnered below-average scores in its group on our Windows Applications tests and processor tests, and turned m mediocre times for ZDigit (2 hours 48 minutes) and Battery Rundown (2 hours 4 minutes). System memory is upgradable to 8MB or 20MB. The Ninja's memory module slots are located beneath a removable cover on the bottom of the unit, but can only be upgraded by the company. This portable arrived with 4MB of RAM and a 120MB hard disk.

Though it has an 8-pound travel weight, its 2-inch thickness makes it easier to handle than many systems that are lighter. Its monochrome 9.5-inch (diagonal) Sharp display is generous in size and clarity.

The keyboard has only 70 keys, but travel and distance between them can accommodate any user. Although it's small, the Ninja's keyboard features large Enter, Shift, and Backspace keys. However, it lacks a built-in trackball.

The Ninja carries a one-year warranty.

PC Magazine August 1993 v12 n14 p214(2)

NEC UltraLite Versa 25C.

(NEC Technologies Inc.) (Hardware Review) (one of 39 evaluations of notebook and subnotebook computers in 'The Portable Puzzle') (Evaluation)

Author
Yegayazarian, Anush

Absrtact
NEC Technologies Inc's UltraLite Versa 25C is a state-of-the-art, premium-priced 80486SL-based notebook computer that offers local-bus video, a vibrant active-matrix color screen and upgradability. The $4,269 system has a removable hard disk, two Type II PCMCIA slots and a floppy disk drive that can be removed to make room for a second battery. The screen folds back 180 degrees to allow simultaneous external display; CPU, memory, hard disk and screen can all be upgraded. Battery life is respectable for an active-matrix color notebook: 2 hours with power-conservation disabled and 3 hours 32 minutes with power-conservation enabled. One minor drawback is the lack of a built-in pomting device: NEC uses a clip-on trackball. The Versa's performance is above average on video benchmarks, and it comes with a three-year warranty.

Full Text
NEC UltraLite Versa 25C

NEC Technologies Inc. , 14 14 Massachusetts Ave., Boxborough, MA 01719: 800-388-8888, 508-264-8000: fax, X00-327-8329 List price: $4,269.

Tested configuration: 4MB 80-ns RAM, 120MB Seagate ST9144A IDE hard disk with a 64K buffer, 1.44MB floppy disk drive, DOS 6.0, Microsoft Windows 3.1, Microsoft trackball.

Options: 180MB hard disk, $1,099; 4MB RAM upgrade, $349; 8MB RAM upgrade, $699; docking station, $699: extra nickel hydride battery, $199: 14,400-bps data/fax PCMCIA modem, $699; extra AC adapter, $99.

In short: Designed with upgradability in mind, and utilizing the latest technology, the NEC UltraLite Versa 25C can really grow with you.

The 486SL-based NEC UltraLite Versa 25C is a state-of-the-art machine, complete with local-bus video. Its active-matrix color screen is clear and vibrant, and the unit is upgradable. Its hard disk is removable, its floppy disk drive can be removed to make room for a second battery, and it has two Type 11 PCMCIA slots. It does come with a $4,269 price tag, however. And the unit lacks a built-in pointing device; it uses a clip-on one.

Upgradability is the key to this machine: CPU, memory, hard disk, and screen are all upgradable. The CPU upgrade is the only upgrade that needs to be made at the factory.

The screen folds back 180 degrees and offers simultaneous external display. The unit's local-bus video system scored very well on our DOS and Microsoft Windows video tests, placing it third under DOS and second under Windows.

For an active-matrix color notebook: it also has good battery life: it turned in a Battery Rundoun test score of 2 hours and a ZDigit score (with power-conservation features enabled) of 3 hours 32 minutes. The Versa offers a variety of power-management features, ranging from LCD timeouts to a suspend mode that uses about 4 percent of the power that normal mode uses. An LED pane1 lets you know how much power management is being used and displays the amount of power left in the battery (or batteries).

NEC offers a 3-year warranty with the UltraLite Versa.

PC Magazine August 1993 v12 **n14 p216(1)**

Packard Bell 486DX/25 Notebook.

(Packard Bell Electronics Inc.) (Hardware Review) (one of 39 evaluations of notebook and subnotebook computers in 'The Portable Puzzle') (Evaluation)

Author
Cline, Camille N.

Absrtact

Packard Bell Electronics' $1,999 486DX/25 Notebook suffers from relatively poor benchmark scores for its processor class but is otherwise an adequate machine with a low price. It comes with several pre-installed applications and offers reasonable battery life, but there is no built-in trackball. The floppy disk drive is located far enough back to allow room for attaching a clip-on trackball; the 80-key keyboard has an inverted-T cursor pad. Memory can be upgraded from 4Mbytes to 8Mbytes or 20Mbytes: the proprietary screen folds back 180 degrees for ease of use with an office desktop or external monitor. The system weighs 8 pounds with all accessories needed for travel.

Full **Text**
Packard Bell 486DX/25 Notebook

Packard Bell Electronics Inc., 9425 Canoga Ave., Chatsworth, CA 91311; X18-886-9988 List price: $1,999.

Tested configuration: 4MB 70-ns RAM, 123MB Toshiba MK2124FC IDE hard disk with 32K cache, 1.44MB floppy disk drive, 2,400-/9,600-bps data/send-only fax modem, DOS 5.0, Microsoft Windows 3.1, Lotus 1-2-3, Lotus SmartPics, Lotus Write, mouse.

Options: None.

In short: Providing a combination of excellent battery time and adequate performance, the Packard Bell 486DX/25 Notebook is a serviceable portable. While it does lack a built-in trackball, the positioning of the floppy disk drive near the rear of the unit allows ample room for a portable trackball to be attached on either side.

Even though this season's machine from Packard Bell Electronics did not fare well in benchmark tests against the other 486DX/25 system in this roundup--the TI TravelMate WinDX/25--it performed more than adequately against the rest of the systems reviewed. Its several preinstalled Lotus applications and reasonable battery scores also propel it above the similarly designed Mitsuba Ninja 486SX/25, making this $1,999 monochrome notebook the slightly more attractive of the two.

Unlike many of the other units herein, however, the machine does not have a built-in trackball. However, the internal floppy disk drive is located toward the back of the machine, so there is space to attach a portable trackball. The system's 80-key keyboard features an inverted-T cursor pad (not separate from the Home, End, PgUp, and PgDn keys). The machine has an 8-pound travel weight.

The Packard Bell 486DX/25 is bone-colored with darker beige keys, a color combination that achieves a less utilitarian look than that of many black and matte gray units. Although you might have some difficulty detecting where the SIMMs are enclosed, you can upgrade the unit's standard 4MB to XMB or 20MB. And the proprietary screen lies flat for easier use with an external monitor on an office desktop.

Packard Bell offers a one-year limited warranty, a 24-hour toll-free teclmical support line, a BBS, and a messaging service.

PC Magazine August 1993 v12 n14 p216(2)

PC Brand Active Color LeaderBook Pro.

(PC Brand Inc.) (Hardware Review) (one of 39 evaluations of notebook and subnotebook computers in 'The Portable Puzzle') (Evaluation)

Author
Bonomo, Michael

Absrtact
PC Brand Inc's $3,994 33-MHz 80486DX-based Active Color LeaderBook Pro portable computer suffers from disappointing performance but does have a bright active-matrix color screen. The display is clear and easy to view from any angle; the built-in trackball is comfortable to use, but the 84-key keyboard feels cramped. Battery life is 1 hour and 24 minutes with power-conservation disabled. The system's best benchmark scores arc its Windows graphics score and its DOS video score; processor and memory performance are mediocre. PC Brand offers one year of free repair or replacement service with 48-hour turnaround.

Full Text
PC Brand Active Color LeaderBook Pro

PC Brand Inc., 405 Science Dr., Moorpark, CA 9302 1; 800-722-7263, 805-378-7848; fax, 805-378-7801 List price: $3,994.

Tested configuration: 4MB 70-ns RAM, 12 1MB Conner CP-2124 IDE hard disk with 32K buffer, 1.44MB floppy disk drive, 2,400-/9,600-bps data/fax modem, DOS 5.0. Microsoft Windows 3.1. built-in trackball.

Options: 200MB hard disk upgrade, $400; 4MB RAM upgrade, $300; 16MB RAM upgrade, $1,500; extra nickel cadmium battery, $69: 2,400-/9,600-bps data/fax modem with BitFax software, $199; battery charger, $89: extra AC adapter, $89; 12-volt battery adapter, $99.

In short: The PC Brand unit offers quality features and a good service policy but an ultimately disappointing performance.

Powered by a 486DX/33 processor, the $3,994 PC Brand Active Color LeaderBook Pro turned in disappointing to mediocre performance scores overall. The LeaderBook is a midpriced active-matrix color system that comes with 4MB of RAM and hard disk configurations of 80MB 120MB, and 200MB

The active-matrix screen is this laptop's best feature. It is clear and easy to view from an angle. Another good feature is the trackball, which is placed below the keyboard and is comfortable to use. The 84-key keyboard; however, feels cramped.

The system can be powered-down through an easy-to-use suspend mode. Automatic power-down can be set for 5, 10, or 15 minutes for the screen and from 0 to 15 minutes for the hard disk and system. However, on our Battery Rundown test, the PC Brand machine's display did not go off and thus the unit logged a short 1 hour and 24 minutes.

The system's stand-out benchmark test scores were its Graphics Wimnark score--which was nearly the best--and its DOS video score. If PC Brand had given the same attention to detail for the processor and memory design as it did for the video, this would have been a much more rounded notebook.

The company offers a free, 48-hour turnaround repair or replacement service for the first year.

PC Magazine August 1993 v12 n14 p221(2)

Poly NB425C.

(Polywell Computers Inc.) (Hardware Review) (one of 39 evaluations of notebook and subnotebook computers in 'The Portable Puzzle') (Evaluation)

Author
Schwarz, Mark

Absrtact
Polywell Computers Inc's Poly NB425C portable computer sells for $2,380 and includes a Sanyo passive-matrix color screen, built-in trackball and side-mounted floppy disk drive but has no PCMCIA slot or upgrade path for its relatively sluggish Cyrix Cx486SLC CPU. The machine is ruggedly designed, but its performance is not outstanding. The display appears blotchy, and battery life is only 1 hour 44 minutes with power-conservation features disabled. Enabling power conservation extends battery life to 2 hours 32 minutes. The keyboard suffers from a sluggish and soft feel. The Poly has no truly distinguishing features and is essentially a set of compromises that do not add up to a superior value.

Full Text
Poly NB425C

Polywell Computers Inc., 61-C Airport Blvd., San Francisco, CA 94080; 800-999-1278, 415-583-7222; fax, 415-583-I 947 List price: $2,380.

Tested configuration: 4MB 70-ns RAM with OKB of external cache, 84MB Toshiba MK-2024FC IDE hard disk with 32K buffer 1.44MB floppy disk drive, 2,400-/9,600-bps data/fax modem, DOS 5.0; Microsoft Windows 3.1; trackball.

Options: Internal 9,600/2,400 fax modem, $170: additional battery, $40; docking station, $500; 486SLC/33, $100; 8MB upgrade, $188.

In short: Not a standout performer, the Poly NB425C suffers from poor battery life and a subpar screen.

The Poly NB425C notebook computer combines a 7.2-pound travel weight with a Sanyo passive-matrix color screen, a built-in trackball, and a side-mounted IDE floppy

disk drive. But the Poly machine, which sells for $2,380, does not have a PCMCIA slot, nor is its Cyrix Cx486SLC CPU user-upgradable.

The Poly proved extremely durable during testing Beyond ruggedness, however, the system was not a standout performer among the machines we tested. The Poly's CPU test results were average. In addition to this, the machine's display appeared somewhat blotchy, and it was also difficult to read when viewed from au angle.

Also, on PC Labs' battery tests. the Poly's Battery Rundown test time of 1 hour 44 minutes placed it m the lower quarter of this roundup; on the ZDigit Rundown test, with system power-saving features enabled, the Poly lasted for 2 hours 32 minutes.

The keyboard was not a favorite among the reviewers, who thought that the overall feel was sluggish and soft. The right-handers among them said that the built-in trackball had a surprisingly good feel. But a left-hander in the group was disappointed that the external ports were on the left side of the machine, leaving no place for the user to attach an input device.

Unfortunately, with the Poly NB425C, you get many compromises, but nothing that really sets this machine apart. Given the Toshiba 1800C's superior keyboard and the Dell `NL25C's simultaneous display capability the Poly NB425C appears to lack any special features that overshadow its design compromises.

PC Magazine August 1993 v12 **n14 p224(1)**

Poly NB325V.

(Polywell Computers Inc.) (Hardware Review) (one of 39 evaluations of notebook and subnotebook computers in 'The Portable Puzzle') (Evaluation)

Author
Plain, Stephen W.

Absrtact
Polywell Computers Inc's $1,480 Poly NB325V notebook computer is very low-priced and exceptionally flexible. It uses a 25-MHz 80386SL microprocessor, and the hard disk and screen can be upgraded. The trackball is a removable module that plugs into either side of the unit: a two-line status panel displays icons representing information about configuration and battery status. Battery life is relatively poor at 1 hour 32 minutes with power-conservation features disabled and 2 hours 1 minute in a test simulating uonnal use. The system is bulky, weighing almost 8 pounds with its battery and AC adapter. Scores are average on most benchmarks and consistently above average on Microsoft Windows application tests and disk-intensive operations.

Full Text
Poly NB325V

Polywell Computers Inc., 61-C Airport Blvd., San Francisco, CA 94080: 800-999-1278, 415-583-7222: fax, 415-583-1974 List price: $1,480.

Tested configuration: 4MB 70-ns RAM with 64K external cache, 84MB Toshiba MK2024FC IDE hard disk with 32K buffer, 1.44MB floppy disk drive, DOS 5.0, Microsoft Windows 3.1, built-in removable trackball.

Options: 8MB upgrade, $225; upgrade to Cyrix 486SLC/33 CPU, $180: extra battery, $60: 2,400-/9,600-bps data/fax modem, $170.

In short: Formerly sold by Librex Computer Systems, Polywell Computers' Poly NB325V is not a cookie-cutter design standing out in terms of functionality and features.

If the Poly NB325V from Polywell Computers seems familiar, it's because you have seen it before--in the form of a Librex Computer Systems notebook. Polywell now sells this unconventional unit since Librex backed out of the U.S. market. This 386SL/25-based portable offers exceptional flexibility and average performance for a low price of $1,480.

The NB325V offers a comfortable degree of upgradability upgradable features include hard disk and screen. You can replace the floppy disk drive with an additional battery, and the trackball is actually a removable module that can be plugged into the right or left side of the unit or hidden altogether in favor of another pointing device. A two-line LCD status panel clearly displays icons representing information about the unit's current configuration and battery status.

Although most of the NB325V's benchmark test scores were average when compared with the scores of other 386SL/25 machines, the unit turned in consistently above-average results on our Windows Applications tests and disk-intensive operations. On our Battery Rundown test, it scored relatively low: 1 hour 32 minutes. With power-saving features enabled on our ZDigit Rundown test, it lasted 2 hours 1 minute.

The tradeoff for the modularity is its bulk, the system's travel weight, with battery and AC adapter included, is almost 8 pounds. If you can put up with the weight, however, the NB325V gives you your money's worth in flexibility, as well as a growth path for storage and display devices.

PC Magazine August 1993 v12 n14 p224(2)

Samsung NoteMaster 486SLC Model S3800.

(Samsung Electronics America Inc.) (Hardware Review) (one of 39 evaluations of notebook and subnotebook computers in 'The Portable Puzzle') (Evaluation)

Author
Rist, Oliver

Absrtact
Samsung Electronics America Inc's $2,678 NoteMaster 486SLC Model S3800 uses a Cyrix 486SLC 25-MHz microprocessor and a monochrome screen; its benchmark

scores are disappointing: with only average processor and memory performance and below-average video and disk performance. Battery life is slightly better than average: 2 hours 27 minutes with power conservation disabled and 3 hours 12 minutes with power conservation enabled. The NoteMaster is overpriced for the level of overall quality it offers and is undistinguished when compared with competing systems.

Full Text
Samsung NoteMaster 486SLC Model S3800

Samsung Electronics America Inc., 105 Challenger Rd., Ridgefield Park, NJ 07660: 800-446-0262, 201-229-4000: fax, 201-229-4059 List price: $2,678.

Tested configuration: 4MB 70-ns RAM, 12 1 MB Conner CP 2124 IDE hard disk with 32K cache, 1.44MB floppy disk drive, DOS 5.0, Microsoft Windows 3.1.

Options: 2MB RAM upgrade, $299; 4MB RAM upgrade, $599; 6MB RAM upgrade, $899; 2,400-/9,600-bps data/fax modem, $399.

In short: With its not-quite-486-level Cyrix 486SLC/25 CPU, the Samsung NoteMaster seems overpriced for what it offers. The unit turned in midrange scores on many PC Labs benchmark tests.

Based on the Cyrix 486SLC/25 processor and featuring a 121MB hard disk, the monochrome Samsung NoteMaster 486SLC Model S3800 is a $2,678 portable PC that doesn't stand out from the pack.

The NoteMaster charcoal-gray case feels solid, with sturdy hinges and seams. The keyboard is well-sized and comfortable, but the keys lack adequate travel and our test unit randomly skipped keys during long typing sessions.

The unit offers a software mouse substitute that uses cursor keys and left-hand Ctrl and Alt keys. Its power-management features include Doze, Standby, and Suspend/Resume.

The NoteMaster turned in disappointing scores on PC Magazine Labs' benchmark tests. Processor and memory performance was average compared with other Cyrix-based products but below average compared with all reviewed machines. Video performance was well below average in both cases, while disk performance was below average for the entire test group but average when compared with the other Cyrix 486SLC/25-based machines. Battery times were slightly better than average at 2 hours 27 minutes on the Battery Rundown test and 3 hours 12 minutes on the ZDigit test.

The NoteMaster would make an acceptable low-cost notebook--if it only had the price tag to match.

PC Magazine August 1993 v12 n14 p226(1)

Tenex 486SLC/25.

(Tenex Computer Express) (Hardware Review) (one of 39 evaluations of notebook and subnotebook computers in 'The Portable Puzzle') (Evaluation)

Author
Cline, Camille N.
_____------____----------

Absrtact
The $1,850 Tenex Computer Express 486SLC/25 notebook computer is heavy at 8.9 pounds and suffers from below-average overall performance, although its disk and DOS scores are good and its battery life is better than average. The batteries reside below the display and are easily detachable; pressing the release button on the right causes a battery pack to pop out of its dock. The monochrome display is disappointingly blotchy and difficult to read at an angle. Rated battery life is 3 hours, and tests show that the battery runs **down** slightly sooner with power conservation disabled and slightly later in a simulation of real-world use.

Full Text
Tenex 486SLC/25

Tenex Computer Express, 56800 Magnetic Dr., Mishawaka, IN 46545: 800-776-6781, 219-272-1234; fax, 219-259-0300 List price: $1,850.

Tested configuration: 4MB 70-ns RAM, 120MB Maxtor hard disk with 8K of cache, 1.44MB floppy disk drive, 2,400-/9,600-bps data/fax modem, DOS 6.0, Microsoft Windows 3.1, BitCom, BitFax, Porta-Point.

Options: 4MB RAM upgrade, $230; 6MB RAM upgrade, $300; extra nickel cadmium battery, $70; Ethernet module, $250: SCSI interface, $100.

In short: Good battery life and nice touches, such as easy-to-use pop-out battery packs, help the Tenex 486SLC/25 distinguish itself, despite its mostly below-average benchmark test performance and its disappointing monochrome display. The 8.9-pound unit also misses the mark in terms of portability. The only performance bright spot for the Tenex unit was on PC Magazine Labs' DOS disk tests.

Although it has nifty pop-out batteries, the 8.9-pound Tenex 486SLC/25 system is **heavy** and produced below-average performance overall. The exceptions were high disk and DOSmark scores and good battery life.

The most impressive feature is the easily detachable set of batteries that reside below the display. Pushing the release button on the right causes a battery pack to pop out of its dock, exposing the external disk slot (with two phone jacks). Removing the left battery pack reveals the expansion bus.

With a travel weight hovering around 9 pounds--heavy for a monochrome system--and a 12- by 9-inch format, the unit misses the mark in terms of portability. However, the keyboard is more comfortable than many others seen here.

The Tenex's 9.5-inch monochrome display also disappoints by tending to be on the blotchy side, and it is qdifficult to read if not viewed head-on.

The company is on target in rating this system's battery life at 3 hours; Battery Rundown and ZDigit Rundown times were slightly below and slightly above that level, respectively. Except for video performance scores, the unit consistently ranked first or close to first among Cyrix 486SLC/25 systems in all other benchmark tests.

Tenex includes a prepaid UPS airbill with every unit to cover shipment for repairs during the first year. There is also a 30-day satisfaction guarantee and toll-free technical support.

PC Magazine August 1993 v12 **n14** p228(1)

Toshiba Satellite T1850C.

(Toshiba America Information Systems Inc.) (Hardware Review) (one of 39 evaluations of notebook and subnotebook computers in 'The Portable Puzzle') (Evaluation)

Author
Brown, Bruce

Absrtact
Toshiba America Information Systems Inc's $1,800 Satellite T1850C is a low-end passive-matrix color unit with a 25-MHz 80386SX CPU. The display is difficult to read at an angle, and battery life is a moderate 2 hours and 3 minutes with power conservation disabled. Enabling power conservation extends battery life to 3 hours and 47 minutes. The machine weighs 8.4 pounds with its battery and AC adapter. The keyboard is well-designed, with well-laid-out, responsive keys. The Satellite T1850C is a good value for those who do not need 80486-class processing power and are satisfied with passive-matrix color.

Full Text
Toshiba Satellite T1850C

Toshiba America Information Systems Inc., 9740 Irvine Blvd.,

Irvine,

CA 92718; 800-334-3445, 714-583-3000 List price: $1,800-$1,900 (estimated street price).

Tested configuration: 4MB 70-ns RAM, 85MB Conner CP2084 IDE hard disk with 32K butler, 1.44MB floppy disk drive, 2,400-bps data modem, DOS 5.0, Microsoft Windows 3.1, Logitech TrackMan.

Options: 2MB RAM upgrade, $195: 4MB upgrade, $309: 8MB upgrade, $559: extra battery, $89; 2,400-/9,600-bps data/fax modem, $259; numeric keypad, $59; battery charger, $269: 12-volt battery adapter, $149; keyboard adapter, $169: Kensington security lock, $55.

In short: With an estimated street price of under $1,900, the Toshiba Satellite T1850C gives you typical Toshiba notebook quality that combines a 386SX/25 CPU, good battery life, and a passive-matrix color screen in a small package.

Toshiba is most well-known for notebooks with gorgeous active-matrix color screens, but it also offers passive-matrix color for those who don't want to pay the higher cost. The Satellite T1850C has no suggested list price, but with its 25-MHz 386SX CPU, it can be expected to sell through dealers for about $1,850 with 4MB RAM and an 80MB hard disk drive.

The display looks best when viewed straight on. From the sides, you'll see the colors and images quickly fade.

The battery lasted a moderate 2 hours 3 minutes on the Battery Rundown test and 3 hours 47 minutes on the ZDigit Rundown test. The case is about the same size as the T4400C's (2.25 by 11.75 by 8.5 inches), but it weighs less: 7.2 pounds with nickel cadmium battery and 8.4 pounds with battery and AC adapter, versus the T4400C's 8 pounds with battery and 9.8 pounds equipped for the road. The keyboard is responsive and has well-arranged keys. The case's design is better than the T4400C's including a sliding back port cover, a sliding modem line cover, and better-attached, fold-down access covers than found on the T1850C's predecessor, the discontinued T1800.

If you want passve color and can live without a 486 CPU, the T1850C's under-$2,000 price tag lets you buy a Toshiba-quality notebook with a color screen for at least $1,000 less than an active-matrix color system

PC Magazine August 1993 v12 n14 p228(2)

Toshiba T4400C.

(Toshiba America Information Systems Inc.) (Hardware Review) (one of 39 evaluations of notebook and subnotebook computers in 'The Portable Puzzle') (Evaluation)

Author
Brown, Bruce

Absrtact
Toshiba America Information Systems Inc's $4,858 T4400C is an incremental upgrade from the earlier T4400SXC but remains a good value because it has a large display and fast 25-MHz 80486DX CPU. The screen is a high-quality 9.5-inch active-matrix color unit that displays deep, bright colors and remains clear when viewed at very wide angles. The keyboard has a verv good feel with full-size keys and a good layout. Battery life is a surprisingly good 2 hours 22 minutes with power conservation disabled and 4 hours 26 minutes with power-saving features enabled. The system is heavy; it weighs 8 pounds with its battery and 9.8 pounds with the AC adapter added. There is also no built-in

pointing device. The T4400C is slightly outdated in the area of user conveniences, but its performance is very good.

Full Text
Toshiba `T4400C

Toshiba America Information Systems Inc., 9740 Irvine Blvd., Irvine CA 92718; 800-334-3445, 714-583-3000 List price: $4,858.

Tested configuration: 4MB 65-ns RAM, 213MB Toshiba 12-ms MK-2224FC IDE hard disk with 128K cache, 1.44MB floppy disk drive, 14,400-bps data/fax modem, DOS 5.0.

Options: 4MB RAM upgrade, $309: 8MB RAM upgrade, $559; 16MB RAM upgrade, $2,549; docking station, $849; extra battery, $279; 14,400-bps data/fax modem, $475; 17-key numeric keypad, $59: battery charger, $279: universal AC adapter, $165; 12-volt adapter, $125: keyboard adapter, $169; 150-pin SCSI adapter, $245.

In short: The active-matrix color Toshiba T4400C shows the age of its design with its loose port covers and its weight, but it is still a good performer with a particularly good battery life.

The $4,858 Toshiba T4400C is an incremental upgrade from its Editors' Choice-winning predecessor, the T4400SXC (December 22, 1992). The T4400C's case doesn't have all of the user convenience and information features found in the T4500 series, but this slightly older model is still a good buy because of its larger display and faster system operation.

The T4400C's strength is a 9.5-inch diagonal active-matrix screen: deep, bright colors and a display still clear when viewed at very wide angles. The keyboard is standard high Toshiba quality: very good feel with full-size keys, inverted-T cursor keys, and separate Home, End, PgUp, and PgDn keys.

The T4400C's battery life is surprisingly good for such a large screen: the nickel cadmium unit kept the system running for 2 hours 22 minutes on the Battery Rundown test, and 4 hours 36 minutes on the ZDigit Rundown test with power-saving features enabled.

This system isn't light: with battery it weighs just under 8 pounds. Add the AC adapter and the weight increases to 9.8 pounds, making it the heaviest system we tested. There is no built-in pointing device, and the system lacks the QuickPort connector found on the T4500 series.

The T4400C has a larger screen and faster 25-MHz 486DX CPU than the T4500C. If all these make up for slightly outmoded user conveniences and heavier weight, this is the unit to buy.

PC Magazine August 1993 v12 n14 p232(1)

Toshiba T4500; Toshiba T4500C.

(Toshiba America Information Systems Inc.) (Hardware Review) (one of 39 evaluations of notebook and subnotebook computers in The Portable Puzzle') (Evaluation)

Author
Brown, Bruce

Absrtact
Toshiba America Information Systems Inc's $3,004 monochrome T4500 and $3,779 active-matrix color T4500C notebook computers both use 3.3-volt versions of the 20-MHz Intel 80486SX CPU and include several state-of-the-art features. Each has an LCD status screen that indicates system activity and battery status, a QuickPort attachment port for installing a Microsoft Ballpoint Mouse, a PCMCIA Type II slot and a battery quick-change feature. The T4500C is slightly smaller than the T4400C and weighs 7 pounds with the battery the T4500 weighs Just over 6 pounds. The T45--C's display is an 8.5-inch active-matrix color screen with bright, deep colors: battery life is 2 hours with power conservation disabled and 4 hours 19 minutes with power conservation enabled. The 1'4400 has a battery life of 4 hours with power-saving features turned Off and 6 hours 17 minutes in a test simulating normal use. Benchmark performance is not as good as that of the T4400 due to the slower CPU, but both systems are highly recommended for those who find a 20-MHz 486SX adequate.

Full Text
Toshiba T4500C

Toshiba America Information Systems Inc., 9740 Irvine Blvd., Irvine CA 92718: 800-334-3445, 714-583-3000 List price: T4500, $3,004; T4500C, $3,779.

Tested configuration. 4MB 70-ns RAM, 86MB Toshiba MK-1422FC IDE hard disk with 32K cache (T4500), 120MB Toshiba MK-2 124FC IDE hard disk with 8K buffer (T4500C), 1.44MB tloppy disk drive, 2,400-/9,600-bps data/fax modem, DOS 5.0, Microsoft Windows 3.1, Microsoft Ballpoint Mouse with QuickPort.

Options: 4MB RAM upgrade, $399; 8MB RAM upgrade, $679; 16MB RAM upgrade, $2,549; Desk Station IV docking station, $849: extra battery, $149: extra nickel hydride battery, $299: 2,400-/9,600-bps data/fax PCMCIA Type II modem, $339: 14,400-/9,600-bps data/fax Type II PCMCIA modem, $499: battery charger, $279; 12-volt adapter, $149.

In short: The above-average monochrome Toshiba T4500 is a good example of current notebook technology, featuring good battery life. If raw CPU power isn't your highest priority, the active-matrix color Toshiba T4500C also has good power-management, one of the brightest screens available, and user-convenience features.

The $3,004 monochrome Toshiba T4500 and the $3,779 active-matrix color Toshiba T4500C, both 3.3-volt systems, are based on a low-power-consumption version of the Intel 20-MHz 486SX CPU. The two systems share several modem features found on the Toshiba T4400C.

The list of both portables' features includes an LCD status screen that indicates system activity and battery life, a QuickPort attachment port on the right side that allows you to attach the standard Microsoft Ballpoint Mouse with ease, a PCMCIA Type II slot, and battery quick charge that lets you recharge in 2 hours (system off) or 4 hours (system on). The QuickPOrt is a time saver that does away with hard-to-reach cable plugs. If, however, you prefer an integrated trackball, or if you would rather use a mouse with your left hand, QuickPOrt does not offer any help.

The T4500C is slightly smaller than the T4400C in all dimensions and weighs about a pound less--with its battery. the T4500C comes in around 7 pounds. The monochrome T4500 weighs just over 6 pounds with its battery pack included.

In addition to having different display systems, the machines have different base hard drives (80MB in the T4500 and 120MB in the T4500C and utilize different battery technologies, The T4500 uses a monochrome 9.5-inch diagonal backlit display, which looks crisper than most similar screens; function keys used to adjust contrast and brightness quickly cleared up some minimal screen ghosting. The T4500's nickel cadmium battery kept the system going for almost 4 hours on the Battery Rundown test and 6 hours 17 minutes on the ZDigit Rundown test.

The 8.5-inch diagonal active-matrix color screen on the T4500C is quite bright and has very deep colors. The nickel hydride battery powered the T4500C for almost 2 hours on the Rundown test and 4 hours 19 minutes on the ZDigit test.

The T4500 and T4500C are both highly recommended if you can get by with less than the highest-level CPU performance. Each machine features excellent examples of its respective screen technology, and both machines' convenience features reflect concern for users.

PC Magazine August 1993 v12 **n14 p234(3)**

Compudyne 4DX2/66 Monochrome Slimnote; CCompydyne 4DX2/66 Active TFT Color Slimnote; Twinhead Slimnote 4SX/33M; Twinhead Slimnote 4DX/33T; Twinhead Slimnote 4DX2/66T.

(Compudyne, Twinhead Corp.) (Hardware Review) (one of 39 evaluations of notebook and subnotebook computers in 'The Portable Puzzle') (Evaluation)

Author
Fersko-Weiss, Henry
__-_---_----_____~~~~~~~

Absrtact
Twinhead Corp's Slimnote 4SX/33M, 4DX/33T and 4DX2/66T portable computers are also sold by Compudyne under the Compudyne name: a total of five units are reviewed. The Twinhead Slimnote 4DX2/66T and Slimnote 4DX/33T and Compudyne 4DX2/66 Active TFT Color Slimnote have active-matrix color screens; the Compudyne 4DX2/66 Monochrome Slimnote and Twinhead Slimnote 4SX/33M have monochrome screens. All live systems offer consistently good performance and have the highest CPU benchmark scores of all systems tested the higher-end machines use a very fast 66-MHz 80486SX2 microprocessor. The Slimnote machines scored only slightly better than average on DOS video tests but well above average on Microsoft Windows graphics tests. THe Sharp TFT screen used in the color models offers superb quality, but the monochrome units suffer from image echo and uneven brightness. Both the monochrome and color systems come in well-designed cases. Battery life ranges from one hour and 36 minutes for the Compudyne Color to 3 hours and 5 minutes for the monochrome Twinhead with power conservation disabled.

Full **Text**
Compudyne 4DX2/66 Active TFT Color Slimnote:

Twinhead Slimnote 4SX/33M; Twinhead Slimnote 4DX/33T; Twinhead Slimnote 4DX2/66T Compudyne 4DX2/66 Monochrome Slimnote Compudyne 4DX2/66 Active TFT Color Slimnote Compudyne, 15167 Business Ave., Dallas, TX 75244: 800-862-3099, 214-702-0055: fax, 2 14-888-5743 List price: Monochrome Slimnote, $2,999: Color Slimnote. $4,499

Tested configuration: 4MB 70-ns RAM, 213MB Toshiba MK2224FC IDE hard disk with 128K cache, 1.44MB floppy disk drive, DOS 6.0, Microsoft Windows 3.1, Lotus Orgaziner 1.0, built-in trackball.

Options: 4MB RAM upgrade, $229; 16MB RAM upgrade, $1,700; extra nickel hydride battery, $139: 2,400-/9,600-bps data/fax modem, $199; external 1.44MB floppy disk drive, $149; external numeric keypad, $69.

In short: Thin, lightweight, and powerful, the Compudyne 4DX2/66 Monochrome Slimnote and its color cousin both had respectable battery times for a power portable.

Twinhead Slimnote 4SX/33M Twinhead Slimnotew 4DX/33T Twinhead Slimnote 4DX2/66T Twinhead Corp., 1537 Centre Pointe Dr., Milpitas, CA 95035; 800-995 8946, 408-945-0808: fax, 408-945-1080 List price: Slimnote 4SX/33M, $1,849; Slimnote 4DX/33T, $3,899: Slimnote 4DX2/66T, $4,499.

Tested configuration: 4MB 70-ns RAM, 130MB Toshiba MK-2124FC hard disk with a 32KB buffer (4SX/33M), Toshiba MK2224FC IDE hard disk with 128K cache (4DX/33T, 4DX2/66T), 1.44MB floppy disk drive, 2,400-/9,600-bps data/fax modem (4SX/33M, 4DX/33T), 14,400-/9,600-bps data/fax modem (4DX2/66T)< DOS 5.0, Microsoft Windows 3.1, built-in trackball.

Options: 4MB RAM upgrade, $250: 16MB RAM upgrade, $1,399: mouse, $69: expansion box, $399; extra nickel cadmium battery, $80; extra nickel hydride battery, $125; 14,400-/9,600-bps data/fax modem, $350.

In short: The Slimnote 4SX/33M offered some bright spots but was inconsistent. The Slimnote DX/33T and 4DX2/66T offered small, light, but powerful packages.

Fast, thin, and well designed. That describes the Slimnote computers from Twinhead, but don't be confused by the company name on the case. Twinhead manufactures the Slimnote line under its own name and also allows Compudyne to sell identical units.

In this review we look at five units in all: the Twinhead Slimnote 4DX2/66T (active color screen), Compudyne 4DX2/66 Active TFT Color Slimnote, Compudyne 4DX2/66 Monochrome Slimnote, Twinhead Slimnote 4DX/33T (active color screen), and Twinhead Slinmote 4SX/33M (monochrome).

The Slimnote units perform consistently well across all processor classes. They have the same motherboard and differ in terms of CPU type, battery type, formatted hard disk size, case colors--dark gray for the Twinhead and off-white for the Compudynes-- and screen type.

These units also accounted for three of the four DX2/66 computers in the roundup, so comparison within the CPU group is meaningless. The three DX2/66 models had the highest DOSmark scores of all tested machines. In addition, their Microsott Windows Applications test results put them solidly in the top 15 percent, and their overall applications scores were top-notch as well.

The three systems placed near the very top on both the processor and memory tests. They had the second-best DOS and Windows hard disk scores, thanks to the Toshiba MK-2224FC hard disk with a 128K cache and an average access time of 12 milliseconds.

The video test scores were more mixed. On the DOS video tests, the three scored only slightly better than average. But on the Windows graphics tests, they placed in the top 15 percent.

The Twinhead 4SX/33M, the only SX/33 in this roundup, performed well in some areas, but had a more inconsistent set of scores overall. It features the Cirrus Logic GD6410 video chip set rather than the GD6420 used in all the other models. The GD6410 supports 256K of VRAM rather than 512K.

The Twinhead 4SX/33M Slimnote also has a smaller, slower hard disk: the Toshiba 130MB MK2124FC, with an average access time of 17 ms. So, while this machine came in just behind the Twinhead 4DX/33T on the processor, memory and Windows Application tests, its DOS disk and video scores were average to below average for the entire test group; its DOSmark score was just above average. Its Windows test scores kept it in the top third of all tested machines.

The Sharp TFT screen used on the color models produces excellent text and graphics. Characters have sharp edges and a crisp look: color is true and evenly saturated. Screen brightness can be adjusted so you will not see an echo or any other distortion, The Sharp screen compares quite well with a VGA desktop color monitor.

The Sharp monochrome screen on one of the Twinheads and on one Compudyne is another story. The screen produces a fair amount of image echo, though the characters and images look well defined. Also, the brightness is quite uneven. The lower third of the screen and the sides get overly bright, making images look washed out

The units' two different cases--a slightly thicker version for the active TFT models--are well designed. You'll find the on/off switch and a trackball conveniently located just above the keyboard. Near the trackball is a suspend switch and a panel of eight LED indicator lights for the keyboard and system. The 84-key keyboard has standard spacing and a good, responsive feel.

A 1.44MB floppy disk drive is on the right side toward the front. At the back you'll find an expansion slot, external keyboard and monitor connectors (simultaneous use of a CRT is supported), and the I/O ports. A batter easily slips in and out of a compartment underneath the unit.

The two battery types used--nickel cadmium for the two monochrome units; nickel hydride for the color models--had varied ZDigit Rundown scores, ranging from 1 hour 36 minutes for the Compudyne Color (the shortest time of all systems in this roundup) to 3 hours 5 minutes for the monochrome Twinhead 4DX/33T, which placed it in the top third. Battery Rundown times also ran the gamut from the Twinhead 4DX/33T which was in the bottom 15 percent overall, to the Compudyne Monochrome, which lasted 2 hours 48 minutes.

You can easily install a fax/modem and additional memory in a compartment above the keyboard on the left,

You can upgrade to 20MB of RAM with a 16MB SIMM ($1,400 for the Twinhead, $1,600 for the Compudyne). In the DX2/66 models you'll find several features to lower the heat: a temperature-controlled fan, a heat sink, and an Intelligent Power Management chip that slows down the processor when the data bus is idle.

Each of the Twinhead and Compudyne models would make an excellent traveling companion. Choosing between them is a matter of price and service.

The Twinhae 4DX2/66T has the advantage with a very fast 14,400-/9,600-bps data/fax modem included in its price. One nice feature Compudyne offers is a one-day replacement service for an extra $99 per year.

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ZDS Z-Note 425Ln Model 120; ZDS z-Note 425Lnp Model 120; ZDS Z-Note 425LNc Model 200.

(Zenith Datasystems Inc.) (Hardware Review) (one of 39 evaluations of notebook and subnotebook computers in 'The Portable Puzzle') (Evaluation)

Author
Chen, Steve

Absrtact
Zenith Data Systems (ZDS) offers built-in Ethernet connections, good displays, above-average performance and reasonable performance on its Z-Note 425Ln, Z-Note 425Lnp and Z-Note 425Lnc notebook computers. Each uses the 25-MHz Intel 80486SL chip and comes with 4Mbytes of RAM expandable to 28Mbytes. The 92,878 425Ln is equipped with a monochrome display; the mid-priced $3,278 425Lnp as a passive-matrix color LCD with good screen quality, while the $4,278 Z-Note 425Lnc Model 200 has an 8.4-inch active-matrix color display. The active-matrix screen is not as bright as competing units. ZDS provides 12 1Mbyte hard disks in the 425Ln and 425Lnp and a 200Mbyte drive in the Lnc. All three models support high resolutions with external monitors. Overall benchmark performance is above average. The battery in the monochrome system lasts 4 hours 23 minutes with power-saving features disabled and an impressive 8 hours 33 minutes with power-saving features enabled. Each of the color units has a battery-rundown time of 2 hours 30 minutes: the Lnc lasts 4 hours 17 minutes aith power-saving turned on, while the Lnp lasts just over 5 hours.

Full Text
ZDS Z-Note 425Lnp Model 120:

ZDS Z-Note 425Lnc Model 200 ZDS Z-Note 425Ln Model 120 ZDS Z-Note 425Lnp Model 120 ZDS Z-Note 425Lnc Model 200 Zenith Data Systems, 2 150 East Lake Cook Rd., Buffalo Grove, IL 60089; 800-553-033 1, 708-808-5000; fax,

800-808-4434

List price: 425Ln, $2,878: 425Lnp, $3,278: 425Lnp, $4,278

Tested configuration: 4MB 70-ns RAM, 121MB Conner CP2124 IDE hard disk with 32K buffer (425Ln and 425Lnp), 200MB Seagate IDE hard disk with 64K buffer (425Lnc), 1.44MB floppy disk drive, DOS 6.0, Microsoft Windows 3.1, Microsoft Windows for Workgroups, Logitech Trackman.

Options: 4MB RAM upgrade, $279: XMB RAM upgrade, $519; port replicator, $79: extra nickel hydride battery, $149; Ethernet LAN adapter (thin, twisted cable, or 10BaseT), $89; numeric keypad, $69: battery charger, $59: worldwide power adapter, $109.

In short: These three Z-Note portables are solid performers that are network-ready and reasonably priced, setting them apart from the competition. The machines turned in above-average scores on most benchmark tests and received impressive Battery Rundown test scores. While the Z-Notes have spacious keyboards and full-size function keys, they lack integrated pointing devices and have nonupgradable CPUs

All three of these Z-Notes from Zenith Data Systems (ZDS) have built-in Ethernet connections, good displays, reasonable prices, and above-average performance. The units are all based on the same 25-MHz Intel 486SL chip (microprocessors are not upgradable). The systems come with 4MB of RAM (expandable to 28MB) and have no external cache. The Z-Notes range in price from $2,878 to $4,278.

What sets them apart from one other is the type of display. The $2.878 ZDS Z-Note 425Ln Model 120 is equipped with a monochrome display. The slightly more expensive model, the $3,278 ZDS Z-Note 425Lnp Model 120, has an above-average passive-matrix color LCD and the $4,278 ZDS Z-Note 425Lnc Model 200 has an active-matrix color display.

With a measurement of 8.4 inches diagonally, the screen of the 425Lnc is a little smaller than some of the competition, but it does produce sharper and more brilliant color than the 425Lnp passive-matrix model. However, when compared with the competition, the 425Lnc's display lacks the brightness of similar active-matrix screens. The unit does come equipped with a 200MB hard disk instead of the 121MB units found in the 425Ln and 425Lnp.

The Z-Notes come standard with a spacious keyboard that does not give the user the typical cramped feeling associated with many other notebooks. Most function keys are full-size and clearly marked, and the keyboard's audible click can be turned off. These units, however, lack some of the full-travel feel found on other portables in this roundup.

All three models allow you to use the LCD and an external monitor (with up to 1,024-by-768 resolution) simultaneously, with 16 colors. Two text-display modes are available: The standard display leaves a blank space at the top and at the bottom of the screen, while the "stretch" mode fills the entire screen. These settings have no effect in Microsoft Windows, which uses the entire screen. In place of a built-in pointing device, the Z-Notes come bundled with a Logitech Trackman.

Rather than using LED status lights, a small rectangular LCD panel (about the size of a 5.25-inch disk label) gives the status such things as hard disk and floppy disk.

If you're looking for networking features, all three units are ready to go with built-in Ethernet-compatible ports and preinstalled client software. All that is required additionally is the $89 Media Adapter for either a thin, twisted-pair, or 1 0BaseT cable. While no external expansion box is available, ZDS does offer a $79 port replicator for speedy attachment and detachment.

Performance on PC Magazine Labs' suite of benchmark tests was above average for all three machines, although the 425Lnc ranks a bit higher than the other two models in most categories. Within its CPU group, the 425Lnc placed first on both the DOSmark and Disk Winmark test suites. This machine also performed exceedingly well overall on the video tests. The monochrome 425Ln has the best battery life of the three units--4 hours 23 minutes on the

Battery Rundown test and 8 hours 33 minutes on the ZDigit Rundown test with power-saving features enabled. Both of the color models also managed to turn in impressive ZDigit Rundown times: The active-matrix Lnc clocked in at 4 hours 17 minutes, while the passive-matrix Lnp lasted just over 5 hours. The straight Battery Rundown time for each of the color units was approximately 2 horns 30 minutes.

If you are in the market for a network-ready portable computer, you have a choice of three solid 486-based performers from ZDS. When choosing among the Z-Notes, your buying decision may depend largely on your display requirements.

PC Magazine August 1993 v12 n14 p263(2)

ZDS Z-Lite 320L.

(Zenith Data Systems) (Hardware Review) (one of 39 evaluations of notebook and subnotebook computers in 'The Portable Puzzle') (Evaluation)

Author
Chen, Steve

Absrtact
Zenith Data Systems' $1,999 Z-Lite 320L subnotebook computer uses a 20-MHz Intel 80386SL 1nicroprocessor and weighs less than 6 pounds. The system comes with a 61Mbyte hard drive and holds up to 10Mbytes of memory; the floppy disk drive is external. ZDS provides two PCMCIA Type II expansion slots for adding peripherals and a unique LitePoint two-button pointing device that easily attaches to the front of the keyboard. Users can run an external monitor simultaneously with the LCD but only at 640-by-480-pixel resolution: a cable and tile-transfer software are included. The keyboard has 83 compact keys and feels cramped.

Full Text
ZDS Z-Lite 320L

Zenith Data Systems, 2150 East Lake Cook Rd., Buffalo Grove, IL 60089; 800-553-0331, 708-808-5000; fax: 800-808-4434 List price: $1,999.

Tested configuration: 6MB 70-ns RAM, 61MB Seagate ST9080A IDE hard disk; 1.44MB external floppy drive, DOS 5.0, Microsoft Windows 3.1, LitePoint trackball.

Options: 2MB RAM upgrade, $149; 4MB RAM upgrade, $279; LitePoint trackball, $89: extra nickel hydride battery, $159; 14,400-/9,600-bps PCMCIA data/fax modem, $559: PCMCIA LAN adapter, $299: external floppy disk drive, $249; battery charger, $59: extra AC adapter, $109: worldwide power adapter, $109.

In short: The Z-Lite 320L is a small and lightweight subnotebook with a clear display, good battery life, and plenty of expansion options via two PCMCIA slots. But performance is lacking and the keyboard is cramped.

If you're looking for a small, lightweight subnotebook, the $1,999 ZDS Z-Lite 320L will easily fit the bill. It's powered by a 20-MHz Intel 386SL processor and equipped with a 6 1 MB hard drive. Memory can be expanded from 2MB to 10MB.

Like other units in this category, the floppy disk drive is external. What sets the Z-Lite apart are two PCMCIA Type 11 expansion slots.

In addition, the unique LitePoint two-button pointing device easily attaches to the front of the keyboard. It may be small, but the Z-Lite includes all the standard ports plus a PS/2 mouse port. It is missing a port replicator, however, like the one found in the Z-Note family.

The unit's external monitor port supports simultaneous display, but only at 640-by-480 resolution. File-transfer software and cable are included.

The Z-Lite weighs less than 6 pounds and is slightly larger than the Zeros Contenda to accommodate its larger 8.5-inch screen.

The 83-key compact keyboard does feel a bit cramped--even if you have small hands. The unit's Battery Rundown time of 3 hours 31 minutes is on the high side, as is its 4 hours 2 minutes on the ZDigit Rundown test, in which power-conservation features were enabled.

The Z-Lite 320L is a good unit with a clear display, but its slow 20-MHz 386SL processor makes it less than ideal for power users.

PC Magazine August 1993 v12 n14 p265(2)

ZDS Z-Sport 420S; ZDS Z-Sport 4258.

(Zenith Data Systems) (Hardware Review) (one of 39 evaluations of notebook and subnotebook computers in 'The Portable Puzzle') (Evaluation)

Author
Chen, Steve

Absrtact
Zenith Data Systems' $1,798 Z-Sport 420S and $2,098 Z-Sport 4258 are value-line notebook computers that offer good designs but have fewer features than other ZDS systems and are not as fast. The computers use 20- and 25-MHz Intel 487SX microprocessors, which are essentially versions of the 80486SX with external math coprocessors. The 420S comes with an 85Mbyte Conner hard disk; the 4258 offers a 121Mbyte hard disk. Standard memory is 4Mbytes expandable to 12Mbytes. Neither machine has the built-in Ethernet or built-in pointing devices found in the higher-end Z-Note series. There is a connector for an optional docking station instead of a port replicator; the keyboards have a standard layout but use small function keys and do not have the full-travel key feel of some other notebooks. Battery life is 2 hours 49 minutes with power conservation disabled and 4 hours with power conservation enabled. Benchmark performance is respectable but

somewhat worse than average overall: video performance is relatively poor, although disk performance is good.

Full Text
ZDS Z-Sport **420S**

ZDS Z-Sport **4253** Zenith Data Systems, 2150 East Lake Cook Rd., Buffalo Grove; IL 60089; 800-553-0331, 708-808-5000: fax, 800-808-4434 List price: 420S, $1,798; 4253, $2,098.

Tested configuration: 4MB 70-ns RAM, 85MB Conner CP2084 IDE hard disk with 32K cache (420S), 121MB Conner cp2124 IDE hard disk with 32K cache (425s), 1.44mb floppy disk drive, DOS 5.0, Microsoft Windows 3.1.

Options: 2MB RAM upgrade, $179; 4mb RAM upgrade, $279; mouse, $69; docking station, $599; 2,400-/9,600-bps data/fax modem, $1 Y 9.

In short: Each of these well-designed, low-cost units offers good value and reasonable performance. Unfortunately, the Z-Sports lack a built-in pointing device. Both of these Intel 487SX/25-based units held up admirably when compared with reviewed portables equipped with 486DX CPUs. The 9.5-inch LCD screen appears sharp but suffers from slight bleeding in both DOS and Windows. The nickel hydride battery pack used by both machines delivered a decent 2 hours and 49 minutes on PC Labs' Battery Rundown test.

If cost is a major factor in your notebook purchasing plans, take note that the Zenith Data Systems' ZDS Z-Sport 420S and ZDS Z-Sport 4258 machines offer low price tags, but with fewer features and lower performance ratings than other reviewed notebooks in the ZDS family. These value-line models offer a good compromise between cost, processing power, and features.

Both of these machines use 20-MHz and 25-MHz Intel 487SX microprocessors, which are pin-compatible with the more widely used 486SX chips, but include an external math coprocessor, which gives them overall performance similar to 486DX chips.

The $1,798 Z-Sport 420S includes an 85MB Conner hard disk and the $2,098 4258 offers a 121MB IDE hard disk. Both units include 4MB of RAM, which is expandable to 12MB.

Introduced before the 486-based Z-Note series of notebooks, both Z-Sport models offer a smaller 8.5- by 1 1-inch footprint. However, useful features such as built-in Ethernet connections and built-in pointing devices are missing in the basic Z-Sport models.

lnstead of a port replicator, a connector is provided for an optional docking station. The keyboard is fairly standard, except that several of the function keys arc slightly smaller than full-size. Moreover the Z-Sports lack the full-travel key feel of some other notebooks in this roundup.

A pop-up screen in either DOS or Windows displays battery level and battery-saving features, such as the shutdown times for the hard disk and the LCD panel.

The 9.5-inch LCD screen appears sharp, but has slight but noticeable bleeding in both DOS and Windows. Adjusting the contrast reduces this, but gray shades in Windows still appear a bit washed out.

In DOS mode, there are blank spaces at the top and bottom of the screen. With the Z-Sports, there's no text-stretch adjustment like the one available in Z-Note models.

Automatic power-management features come standard with the Z-Sports. The nickel hydride battery pack delivered 2 hours 49 minutes on our Battery Rundown test for both machines. On our ZDigit Rundown test, in which power-management features are enabled, the 420S's battery lasted for 4 hours, but the 4253 was not able to run this test.

Neither notebook's battery lasted as long as the monochrome Z-Note 425Ln Model 120, but both Z-Sports had endurance that was nevertheless respectable. While the units themselves are compact enough, their AC adapter bricks arc a little bit on the bulky side.

Both models produced respectable benchmark test scores in most categories when viewed alongside comparable 486DX-based portables. But both models showed weaknesses on our benchmark tests compared with all tested machines.

The units' video test scores were among the slowest of all the portable machines in this roundup. The 420S model turned in a better score in PC Magazine Labs' Disk and DOSmark performance tests than the 425S. On the other hand, the 425S produced a faster processor rating and a better Disk Wimnark score than the 420S.

Compared with the latest Z-Note models, the Z-Sports arc slightly out-of-date but still offer a good return for the price--as long as speed is not the feature on top of your notebook-purchasing wish list.

Just make sure you bring along your own pointing device.

PC Magazine August 1993 v12 n14 p266(2)

Zeos Contenda.

(Zeos International Ltd.) (Hardware Review) (one of 39 evaluations of notebook and subnotebook computers in 'The Portable Puzzle') (Evaluation)

Author
Cline. Camille N.

Absrtact
Zeos International Ltd's $1,894 Zeos Contenda subnotebook computer is slower than high-end notebook units and has a small, somewhat awkward keyboard, but it weighs only 5.1 pounds with the external floppy disk drive, battery and AC adapter. It uses a 25-MHz 80386SL microprocessor that

offers average performance for its class: disk performance is very good. The backlit screen is crisp and displays 64 shades of gray. Battery life is 2 hours and 38 minutes with all power-saving features disabled and 2 hours 52 minutes in a test simulating normal use. The keyboard has 68 regular and 12 half-sized function keys. Memory can be expanded from 4Mbytes to 1 0Mbytes only at the factory.

Full Text
Zeos Contenda

Zeos International Ltd., 1301 Industrial Blvd., Minneapolis, MN 55413: 800-554-7172, 612-633-4591; fax, 612-633-1325 List price: $1,894.

Tested configuration: 4MB 60-ns RAM, 80MB Toshiba MK1422FCV IDE hard disk with 32K buffer, 2,400-/9,600-bps data/fax modem, DOS 6.0: Microsoft Windows 3.1, Lotus Organizer, built-in trackball.

Options: 10MB RAM upgrade $561; extra battery $99: Xircom Ethernet adapter, $349; numeric keypad, $79: battery charger, $79: extra AC adapter, $69; 12-volt battery adapter, $49; Media Vision Audio Port, $169; color SVGA monitor, $399; FastLynx file transfer, $79; NYLON carrying case, $79; leather carrying case, $129.

In short;The Zeos Contenda, the smallest machine in this review, offered a nice display and performed well for a subnotebook with a 386SL/25 microprocessor. The unit's battery lasted almost 3 hours on PC Labs' ZDigit Rundown test.

In choosing the Zeos Contenda subnotebook, whatever you give up in keyboard perks and high-flying performance is more than made up for in this little unit's portability and affordability.

Even though the Contenda's keyboard layout lacks a separate inverted-T cursor pad and large key spacing, it still seems spacious for a unit of this size, and has room for a competent built-in trackball for right-handers.

As far as performance goes, the Zeos Contenda was about average compared with other subnotebooks in this roundup--the ZDS Z-Lite 320L, Dell 325SLi, and Compudyne 4SL/25 Subnote. The Contenda consistently placed second or third on most tests except for video, where it came in last. Surprisingly; the system's disk performance score was very close to that of the Compudyne Subnoter, which is a 486-based system.

On PC Magazine Labs' battery testing, the Contenda, clocked in at 2 hours 38 minutes on the Battery Rundown test and 2 hours 52 minutes on the ZDigit Rundown test with system power-manage ment features enabled, placing it in the same league with full-size units.

At $1,894, the monochrome Zeos Contenda is also one of the lowest-priced units in its 386SL/25 class, though its price tag is more in line with other subnotes.

With 68 regular and 12 half-sized function keys, the Contenda is just 6.1 inches across, making it the most diminutive notebook reviewed. The Shift, Enter, and Ctrl keys are the same size as the alpha keys, and the space bar is only about 1.5 inches long. The unit's total travel weight, including battery, AC adapter, and external tloppy disk drive, is just 5.1 pounds (4.1 pounds for the system without power adapter).

The unit we tested arrived at PC Labs with 4MB of system memory, although the Contenda may be upgraded to 10MB of RAM--but only by Zeos. Like the unit itself, the crisp, backlit screen, with its 64 shades of gray, is functional and quite good compared with those of other subnotebooks. Zeos offers toll-free technical support seven days a week, as well as a 30-day money-back guarantee and express parts replacement. On-site service is optional.

The Contenda's solid battery life and fair power management let you leave the 3- by 4.5-inch AC adapter behind for increased portability. And, for the price of this system, you'll be able to afford the trip.

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Portable computers: on the road.

(includes related articles on review highlights, the Editors' Choice winner and the benchmark test results) (Hardware Review) (overview of 44 evaluations of portable computers) (Evaluation)

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Absrtact
Sixty monochrome laptop computers using at least a 20-MHz 80386SX microprocessor are reviewed and compared. Interesting features in the review group include an active-matrix display and improved battery life on most systems. Most of the tested units are not suitable for use with Microsoft Windows because their slow, monochrome displays and awkward pointing devices are poorly-suited to graphical user interface work. The systems all weigh under 7 pounds with batteries or under 9 pounds with AC adapter. Compaq's LTE Lite/25E is selected the Editors' Choice because its active-matrix screen makes graphical applications usable in monochrome. Its modem options and battery life are also commendable, although the keyboard is not ideal. Dell Computer Corp's Dell System 325N and Toshiba America Information Systems' T3300SL receive honorable mentions.

Full Text

Slim, light, and powerful are the qualities that traveling executives cherish most in a portable computer. PC Magazine tests 67 of the latest portable systems ranging from Acer to Zenith.

In just four months, the portable PC market has almost completely turned its products over. As an indication of how quickly change occurs in this area, in August PC Magazine devoted a single issue to reviewing all the new notebook PCs--80 of them. In this story; we take a look at 64 color and monochrome systems released since then and re-review 3 machines from our last portable PCs roundup for comparison.

The laptop buyer is the ultimate bcneliciary of the rapid change, with greater performance, more features, and lower prices across the board. For instance, with the exception of eight machines, all systems are based on at least a 25-MHz 386 processor. Many systems now include built-in trackballs of varying quality, and an increasing number have 120MB hard disks available. Weight and size have decreased marginally, and battery life is improving, although we expect the biggest gans to come next year when systems built around the 3.3-volt 486SL processors become prevalent.

Video performance remains the stumbling block, with both speed and quality lagging far behind recent strides in desktop PCs.

ACTIVE-MATRIX MONOCHROME LCD

The hottest new machine is the Compaq LTE Lite/25E, which seeks to take the best of both worlds: the extended battery life of a monochrome system with the brilliant clarity of an active-matrix display. Its display quality is head and shoulders above that of every other noncolor system reviewed here or in any previous issue. The Lite/25E is one notebook that several people can gather around, and all can get a good view, regardless of viewing angle. An earlier generation of the display was used on Apple's PowerBook though the Compaq screen is sharper.

Once you've seen the Lite/25E's display, you're likely to decide that running Microsoft Windows on any other noncolor portable system is a compromise. We awarded the Lite/25E one of our Editors' Choice designations for this story. But before you sign on with Compaq, try the keyboard, which many PC Magazine testers found to be stiff

Other intriguing systems under review include the sub-% pound Dell System 320SLi, a subnotebook with an external floppy disk drive and no screen illumination; the GRiD Convertible, a notebook/tablet hybrid that combines a rudimentary stylus with a standard keyboard, and ZDS's Z-Note family, which comes with built-in Ethernet LAN connections and shells of popular network programs.

Equally intriguing is the impending demise of Librex at a time when lesser-known vendors have narrowed the quality and performance gap between the haves (such as Compaq, Toshiba, and ZDS) and the have-lesses. The Librex R386SL impressed us with consistent high quality and technical advances like its reversible, clip-on trackball for both left- and right-handers. Despite a huge image advertising campaign, Librex couldn't garner enough market share to satisfy its parent, multi-billion-dollar Nippon Steel, which will pull the plug by April. If there's a lesson from the Librex departure, it's that even though laptops are the fastest growing area of the PC business, there are still too many brands chasing a finite number of buyers.

WINDOWS NONPERFORMERS

The more we run Microsoft Windows on the road with notebook systems, the more disenchanted we become. Virtually all monochrome LCD screens have trouble resolving colors as clearly distinguishable shades of gray. Also, we have grown tired of bulky clip-on trackballs and the always available, however inconvenient, built-in mini-trackballs. Yes, you can run Windows, but it's not pretty, it's not convenient, and it's not very fast. Products such as the Compaq LTE Lite/25E and the color systems in this review represent what we believe will soon be the preferred display quality for Windows systems.

The most disappointing aspect of working with a notebook is the lackadaisical video performance under Windows. At a time when desktop systems commonly achieve a Graphics Wimnark score of 5 to 8 megapixels per second and the best machines go beyond 12, the 60 monochrome notebooks we reviewed averaged only about 1.7 megapixels per second. Video performance generally tracked processor type. All but 1 of the 22 machines with 486 chips from Intel and Cyrix produced a Graphics Winmark score of at least 2 megapixels per second, just ahead of the machines with Intel 386SX, SL, and AMD SXL chips, at less than 2. The fastest performer was the Intel 486SX/25-based TI TravelMate 4000 WinSX/25, with a Graphics Wimnark score of 2.9, followed by Jetta International's Jetta Jetbook 486DX/33 at 2.8.

BATTERY LIFE IMPROVING

We consider how long a system can operate on the road without needing an AC outlet to be of paramount importance. As a result, we test notebook battery life in two ways: with our Battery Rundown test, a worst-case scenario rundown with power conservation disabled, and our ZDigit Rundown test, during which power conservation is enabled and the system alternates between 2 minutes of enforced activity and 10 minutes of inactivity. Based on our informal threshold of a 3-hour battery life, ten systems met that standard on the worst-case rundown. Seven of those managed even better, achieving either 3.5 hours on the Battery Rundown test or 5 hours on the ZDigit test: the Dell System 320SLi the Dell System 325N, the Librex R386Sl (with its add-on battery installed), the Tl TravelMate 4000 WinSX/25, the Toshiba T3300SL, the Z-Note 320L, and the Z-Note 325L. At the other extreme, the GRiD Convertible only lasted 1 hour 39 minutes before needing a charge on our ZDigit test.

As always, our curiosity was aroused by those systems that were announced but didn't ship in time for testing, particularly portables based on Intel's 486SL chip.

Designed to run at either 3.3 or 5 volts, the 486SL, unlike the 486SX seen on nine systems reviewed here, includes a built-in math coprocessor. Intel says the 486SL has twice as much power (exclusive of the math unit) as the 386SL and will produce 25- and 33-MHz versions, positioning it as a truly high-end notebook chip. The first 486SL systems are expected to ship by late fall, led by the 25-MHz 6.5-pound Compaq active-matrix color LCD unit with a 209MB hard disk and a 14,400-bit-per-second data/fax cellular modem option.

Look for 160MB to 210MB 2.5-inch hard disks to be available in limited quantities by early 1993. Price? About $300 to $500 more than a 120MB hard disk. Taking a different tack, Identity Systems Technology has announced that in November they will offer a 500MB hard disk option using a bulkier--and heavier--3.5-inch drive. AST Research's new PowerExec 3/25SL features 60MB to 160MB hard disks that can be plugged into desktop PCs with a $99 drive bay adapter.

In an effort to shed weight and add versatility, some new notebooks will allow you to slide out the floppy disk drive and reduce travel weight by just under a pound, and/or to slide in a second battery in place of the floppy disk drive. On its new CF-1000, based on the 3.3-volt AMD 25-MHz SXLV processor, Panasonic claims up to 11 hours of stop-and-go use with both batteries installed.

Also by early 1993, users with laptops containing credit card-size PCMCIA slots may finally see some relief from low-speed modems. AT&T announced the shipment of a 14,400-bps PCMCIA data/fax modem that will be built by AT&T and sold by others. Other PCMCIA cards recently announced include wireless LAN cards from Proxim, which allow radio frequency communications with an effective range of several hundred feet at roughly floppy disk transfer speeds, and virtually indestructible flash memory cards from SunDisk

On the color front, IBM showed a ThinkPad 700c, the first fruits of its joint venture with Toshiba on active-matrix LCD screens. PC Magazine examined a near-production-level unit and found the 10.5-inch display to be nothing short of dazzling.

While in the past we've been skeptical of passive-matrix color technology's often muted appearance, which is reminiscent of an Impressionist painting, that appraisal was based primarily on economics. And, as the price premium of passive-color over monochrome falls to $500, we believe it may be time to take a second look.

So far, few vendors have chosen to follow the subnotebook path taken by Dell with its 320SLi Dell squeezed what would have been a 5.5-pound notebook PC down to 3.8 pounds by removing the floppy disk drive (it's an external plug-in) and removing the screen's backlighting. It's still an open question whether any display that relies on reflection will satisfy users.

REVIEW CRITERIA

To be included in this review, products had to be battery powered notebooks with least a 20-MHz 386SX. 386SL, or equivalent AMD or Cyrix processor; AMD and Cyrix processors powered 12 systems in our roundup. Monochrome systems had to weigh less than 7 pounds with batteries or have a road weight (including AC adapter) of less than 9 pounds. We tested only new systems that were shipping by early fall; prices are current as of late October. We re-reviewed two monochrome Editors' Choice systems, the Dell System 325N and the Toshiba T3300SL, for comparison.

In addition to the tested products, we learned of several notebook systems that were announced but not shipping as of our deadline, including the Aspen 486 Personal Notebook, the AST PowerExec 3/25SL, a new line of Innova notebooks from Canon, the pen-based NCR 3-30 Notepad, PC Brand's LeaderBook 486/SLC, the Zeos Freestyle SL, and IBM's monochrome pen-based ThinkPad

In addition, several systems submitted by vendors turned out to be less than meets the eye and were dropped from this review. Some were discontinued, including ACMA's 386DX/33 Blackship's BLK 386SXNB, Bona International's Bonaiide 3800 SXL/25 and 3900 SL/25, and PC Brand's 486/SLC Notebook. Others were judged to be prototype machines or encountered unresolvable problems during testing, including the Compudyne Slimnote 486DX2/50 and Spear Technology's NP206. Several vendors, including CompuAdd Express, Cumulus, and Swan, decided not to participate in this review.

SUITABILITY TO TASK

To help select the system that's right for you, we evaluate each system for its suitability for use in four areas: on-the-road computing and communications, DOS applications, Windows applications, and as a desktop replacement.

After our first Suitability to Task ratings (August 1992), some readers and vendors complained that we aimed too high by setting the top score at what we believe users expect from a good product. For instance, not many products have 9,600-bps or faster modems built-in, but we believe it's reasonable to expect this level of performance in portable computers. By early 1993, the market should catch up with our expectations.

IN THIS ISSUE

Reviews in this issue are arranged in two sections: 60 monochrome portable PCs and 7 color portable systems. Because of their similarity, the two color machines from ALR are reviewed with their monochrome relatives and have entries in the monochrome portables Summary of Features table and benchmark test pages. All systems sharing the same FCCB ID number are reviewed together (although tests were run separately on each system). In this issue, we encountered several machines of common manufacture: the fraternal twins include products from Advanced Logic Research, Altima Systems, Aspen Computer, Compudyne Products, Digital Equipment Corp., Ergo Computing, GRiD Systems Corp., Lightning Computers, Matrix Digital Products, Mitsuba Corp., and

Twinhead Corp. Within the categories, they're generally in alphabetical order by vendor name, from Acer America Corp. to Zenith Data Systems. Products from a single OEM are grouped together, as are products in the same line from a single vendor.

Monochrome Notebook PCs

COMPAQ'S LTE LITE/25E, with the world's first production active-matrix PC monochrome screen, was easily able to eclipse the displays of every other portable in the test. Not only can it realistically reproduce colors as shades of gray, its display can be viewed from a variety of angles, making it perfect for small group presentations.

BATTERY LIFE continues to improve. With power-conservation features enabled, 43 machines lasted for more than 3 hours on our ZDigit Rundown test. In contrast, the GRiD convertible could operate for only 1 hour 39 minutes *on* a charge.

THE GRiD CONVERTIBLE notebook incorporates a rudimentary stylus that can be used for pointing or drawing with a standard keyboard, but a current lack of applications software reduces its usefulness. Most intriguing is its ability to let users sketch with the pen in space above the screen.

BUILT-IN TRACKBALLS were generally disappointing. Included with many of the units tested, most were in awkward spots, required two hands to operate, and often were too inaccurate to be effective.

WINDOWS PERFORMANCE for most of these notebooks also was a letdown. The best portables were able to acheive a Graphics Winmark score one-third that of the average desktop unit. With the exception of the Compaq LTE Lite/25E none were able to mimic the colors in Windows as various shades of gray.

TODAY'S IDEAL NOTEBOOK is powered by at least a 25-MHz 386 processor, has a hard disk in the 80MB to 120MB range, and can operate for at least 3 hours without visiting an AC outlet for recharging.

ZENITH'S Z-NOTES came with built-in LAN Ethernet connections, the only portables to include this important device.

THE DELL 320SLi trades screen illumination and a built-in floppy disk drive for a lightweight (3.8 pounds), easily transportable package. It is a passable compromise for those who need to avoid the bulk of today's standard-size notebooks.

EDITORS' CHOICE

Compaq LTE Lite/25E

If you are as demanding as we were while testing these 60 monochrome portable computers, you would probably be happy with any of at least half of them. But the products of three vendors stand apart from the crowd: Compaq, Dell, and Toshiba. They continue to leapfrog the competition and to play leapfrog with each other's 25-MHz Intel 386SL-based notebook systems in terms of price, performance, and features. Among the monochrome systems reviewed twice before this year, those three vendors accounted for all five Editors' Chyoice selections. In this issue, it's Compaq's just-released LTE Lite/25E that receives an Editors' Choice award. The Dell System 325N and the Toshiba T3300SL, Editors' Choice selections in our August 1992 roundup of portables, merit honorable mention this time around.

Compaq's stunning active-matrix monochrome display makes the 6.5-pound Lite/25E a one-of-a-kind portable--at least for now. It's the only noncolor portable PC system with an active-matrix display and the only noncolor notebook system that adequately renders the colors in Microsoft Windows and graphics-intensive applications as clearly distinct shades of gray. We were impressed by the screen's consistently superior image quality, its high contrast ratio, and its ability to accurately display black and white. One staffer remarked that the display resembled a black-and-white television screen. We expect other portable PC makers to have similar products in the near future.

Compaq's communications option is equally state-of-the-art: an optional 14,400-bit-per-second (V.32bis data/9,600-bps send-fax modem with the ability to use standard and cellular telephones. Other features that give the Compaq the best combination of performance and features: a QuickConnect port replicator similar to ZDS's multiple levels of kevboard, screen, and drive security; and the ability to write the contents of memory to disk. Equally impressive was the Compaq's lightweight batteries, which lasted 2 hours 38 minutes on our Battery Rundown test and 4 hours 11 minutes on our ZDigit Rundown test (with conservation features enabled)--about 20 and 40 minutes above average, respectively.

Our only quahn, and this pertains to all Compaq LTE Lite systems, involves the keyboard: The feel is quite stiff and key travel is limited, both of which may not be to your liking, and the directional keys are a bit small. With a $2,999 list price that buys you 4MB of RAM and an 80MB hard disk: the 6.5-pound Lite/25E is a fair deal.

HONORABLE MENTION

Dell Computer Corps Dell System 325N and Toshiba America Information Systems' Toshiba T3300SL have each come down in price since winning Editors' Choice recognition in August. The Dell's price has dropped by about $400 and the Toshiba's more recently by about $1,000. But despite attractive price tags, neither have Compaq's display.

The Dell represents a highly affordable value at $2,249 for 60MB with an excellent battery life (3 hours 41 minutes and 5 hours 7 minutes on the Battery Rundown test and ZDigit Rundown test, respectively), and a 9,600-bps data and fax modem option. Keyboard feel is good, but the key width was reduced slightly to make the case 11 by 8.5 inches.

If you want the best keyboard among portables, look no further than Toshiba's T3300SL, list-priced at $2,798 with 4MB of RAM and a 120MB hard disk. Its battery life is great (it scored 3 hours 19 minutes on the Battery Rundown test and 5 hours 8 minutes on the ZDigit Rundown test), and the AC adapter is a model of space efficiency. Toshiba's Achilles' heei: its reliance on a PCMCIA slot for modem communications, a problem until 9,600- and 14,400-bps data modems become available early in 1993.

Suitability to Task: Monochrome Portables

Five of the monochrome systems we reviewed--the Tl TravelMate 4000 WinSX/25 and WinDX/25, Polywell's Poly NBC25, the Jetta Jetbook 486DX/33, and the Compudyne Slimnote 486SX/25-80--notably combined the light weight, long battery life, and high-speed communications devices required to be good traveling companions.

Most units fell short in several categories. Only the Compaq LTE Lite/25E with its revolutionary active-matris monochrome LCD screen, could accurately display the colors used in Microsoft Windows as realistic shades of gray. And only three of the monochrome notebooks--the Altima 433 80486DX, the Compudyne Slimnote 486SX/25-80, and the Twinhead Slimnote 486DX/33--were considered suitable for use as desktop replacements.

Road warrior/communications indicates how complete a traveling companion each portable is. A unit was rated as excellent if it combined in a small package light travel weight (no more than 7 pounds, including AC adapter and battery), long battery life (at least 3 hours with power-conservation features enabled), and good communication options (such as a 9,600-bps data/fax modem or a PCMCIA card).

DOS applications measures each system's ability to run DOS software quickly. To rate excellent in this category, a system must have at least a 25-MHz 386 processor, as well as an 80MB hard disk or larger, a display that measures at least 9 inches diagonally, and a DOSmark score in the top 25 percent on PC Magazine Labs' Hardware Benchmark Tests, Release 7.0.

Windows applications are extremely demanding, requiring a combination of processor speed and high-volume data storage. To be worthy of a top rating in this area, a unit should have system memory that can be expanded to at least 8MB, a 120MB hard disk available, Graphics Wimnark and Disk Winmark scores in the top 25 percent, a built-in pointing device, and power management that works under Windows. Image quality was also a criterion.

To be considered a suitable desktop replacement. a system has to be capable of internal expansion or have a docking station available, offer a 120MB hard disk or larger, and support Super VGA graphics on an external monitor. We also consider the portable's keyboard and whether an external keyboard can be plugged in.

Price/Performance Index: Monochrome Portables

Roughly one-quarter of the 60 monochrome portable PCs we tested for this issue--l6 of them--featured Intel 486 microprocessors, and as might be expected, those units dominated the high-performance area of our price/performance chart. The TI TravelMate 4000 WinDX/25 and WinSX/25 along with the Aspen Aquiline 433, were performance leaders and fell in the upper price range. The leading price/performers in the 486 class were the Lightning Thundemote 486DX/33 the Compudyne Slimnote 486SX/25-80 and the Primax Eagle 425SX.

Five systems used the Cyrix 486SLC/25 chip. The CompuAdd Express 485CXL-80 and Keydata's Keynote 486SLC scored respectably on price/performance; the other three Cyrix-based entries--the Tandy 3800 HD, the GRiD 1755 486SLC and the Wyse DecisionMate 486SLC--fell in the mid to low region of the 386SL/25 performance area, with closely clustered prices.

Leading 386-class price/performance entries include the Micro Express NP933--which was the only system to use the AMD386DX/33 chip--and the Compudyne Slimnotc 386SL/25-80

Four systems priced under $1,700 provided performance that was low but reasonable enough to be worth a close look: the Primax NightHawk 325SXL ($1,449), Keydata's Keynote 386SX-25 ($1,595), the Compaq Contura 3/20 ($1,608, discounted), and Polywell's Poly NB325'I ($1,695). The rest of the 386-based systems were generally clustered in the middle of the group's performance range, within a $1,000 spread between $1,700 and $2,700.

THE DATA POINTS

This chart plots each system's selling price (y-axis) versus its performance index (x-axis). We discounted systems available only through dealers by 15 percent.

The performance index reflects numerous features. DOSmark, Graphics Winmark and Disk Wimnark scores account for 35 percent of the rating; system memory and hard disk size, 16 percent, and the size, weight, and ZDigit Rundown test score (battery life), 11 percent each. The remaining 16 percent is based on display size, I/O ports, PCMCIA slots, internal modem, simultaneous external display capability, super VGA output, extra cursor keys, built-in pointing device, flash BIOS provision, ROM power-conservation features, 16550 UART support, enhanced parallel port, and hot-swap battery change capability. For details, see 22MBANG.WKI in the Software Library of PC MagNet's Editorial Forum.

Battery Life vs. Portability

Increasing attention to the traveling executive's wants and needs is evident in this group of 67 portable systems, most of which easily fit into an attache case and weigh just under 8 pounds with AC power adapter included. We subjected each of the systems to PC Magazine Labs' worst-case Battery Rundown test, which measures battery life without any power-conservation features. They also underwent our ZDigit Rundown test, which uses an automated test-bed

and specially designed control software to approximate notebook system operation under typical conditions when all power-management features are enabled.

On the Battery Rundown test this group of portables achieved an average operating life of 2 hours 21 minutes, and on the ZDigit test an average of 3 hours 31 minutes--more than an hour of additional life. A few machines--the Toshiba T3300SL, the American Mitac 3027F, the Ergo 486DX/33 NoteBrick II, and the Aspen Aquiline 433--had longer screen and hard disk time-outs, which put them at a marked disadvantage on the ZDigit test. The Zeos Color Notebook could not execute the ZDigit operations because of a power-management BIOS conflict, and the Dell System 320SLi has no ZDigit score because our test does not work with a nonilluminated screen.

Design features such as displav type, power management and I/O device control had a direct impact on battery life. Among the seven color systems--the ALR Ranger MC425s 120, the ALR Ranger MC425-420, the Compaq LTE Lite/25c, the Keydata Color Keynote 386SL-25, the Toshiba T4400SXC, the ZDS Z-Note 325SLc Model 120, and the Zeos Color Notebook--three used active-matrix displays, while the ALR, Keydata, and Zeos systems used passive-matrix screens. Yet the expected disparity between active- and passive-screen power consumption was not evident. While the average battery life for the color systems (just under 2 hours) was below the overall average (2 hours 21 minutes), there was no significant difference between the active-matrix and passive-matrix systems. The Toshiba T4400SXC, with an Intel 486SX processor (the only 486 color system) and a 2.3-pound battery (the heaviest of all), was a notable exception. With a Battery Rundown score of 2 hours 3 1 minutes and a ZDigit score of nearly 4 hours, this system delivered processing power, and above-average battery life.

The ALR Ranger M425-120 had the best ZDigit performance (7 hours 41 minutes), but the longest Battery Rundown time was achieved by two of the ZDS Z-Note systems. The Z-Note 320L was tops, at 4 hours 27 minutes (6:03 ZDigit score), and the Z-Note 325L was right behind, at 4 hours 21 minutes (5:36 ZDigit Both systems use the 3.3-volt Intel 386SL, with a 20-MHz clock rate for the Z-Note 320L and 25 MHz for the Z-Note 3251. Each uses a 1.1 -pound nickel hydride battery, which brings the travel weight up to 7.9 pounds. Lighter on the scale (at under 7 pounds) and packing 486 processor punch are two machines from Texas Instruments--the Tl TravelMate 4000 WinDXR5 and WinSX/25. These systems had battery lives within 20 minutes of one another (3 hours 28 minutes for the WinDX/25 and 3 hours 46 minutes for the WinSX/25); each uses a 25-MHz 486 chip and the same 1.3-pound nickel cadmium battery.

The Dell System 320SLi was the real feather- weight, at just under 5 pounds, with a life of 3 hours 8 minutes from a 0.7-pound battery--the best battery life per pound in the group. In the heavyweight class, the Ergo 486DX-33 NoteBrick II and Aspen Aquiline 433 tipped the scales at 10.2 pounds, with 2.2 pounds in the battery compartment. Breaking the rule of thumb that says"weight generally equals battery life," these systems had rundown times well under 2 hours. Both use 486DX/33 processors, offer large hard disks, and use NTC motherboards with an Award 3.03 BIOS and no ROM power-management features.

BENCI IMARK TESTS

What the Numbers Mean: Portables

Test results highlight the importance of the integrated power-management features and cache controller of Intel's 386SL/25 processor. Notebooks with the chip were able to stretch battery life with no compromise on performance.

DOS PROCESSOR AND MEMORY

Eleven different processor levels were represented across the 67 monochrome and color portables tested. CPU processing power ranged from the Librex T386SX (2,157.58 processor operations per second) and the Toshiba Satellite T1800 (2,070.15)--based on the Intel 386SX/20--to a number of 486DX/33 systems led by the Jetta Jetbook 486DX/33 (which scored 8,623.54).

The most popular processor was the Intel 386SL/25, thanks to its integrated power management features and built-in cache controller. Among the 26 systems that used it, the ZDS Z-Note 325L and Z-Note 325Lc Model 120 took top honors, at roughly 3,220 processor operations per second each. In addition, both ZDS systems use a 64K external processor cache and have the fastest memory scores in the group, showing the profound influence memory has on 386-class CPU performance.

Within the AMD Am386SXL/25 category, there was a wide disparity between the fast Austin 386/SXL-25 Notebook (2,810.01 operations per second) and the DTK Grafika 3N (2,376). Neither used an external cache, but the Austin had a noticeably faster memorv score due to more efficient DRAM design. All of the &ix 486SLC/25-based systems were outperformed by the lone AMD Am386DX/33-based Micro Express NP933.

DOS VIDEO

While 49 systems used Cirrus Logic video chip sets, the top-performing Toshiba T4400SXC (3,088.87 thousand video operations per second) relied on the Western Digital WD-90C30 chip set with 5 12K of video RAM. The Toshiba Satellite T1800 and the Compaq units performed exceptionally well and used proprietary video circuitry. The slowest unit was the Cyrix CX486SLC/20-based Tandy 3800 HD, at only 467.3 thousand operations per second.

DOS DISK

Generally, laptop disk performance is slow compared with desktop systems, because of less installed cache. The 486DX33-based Aspen Aquiline 433 delivered 38.08 kilobytes per second using a Seagate 3283A 245MB IDE drive with an average access time of 19 ms and 128K of on-board cache. The Ergo 486DX-33 NoteBrick II used a 16-ms 2 10MB Maxtor Cheyenne 7213AT drive with 64K cache, delivering a second-place score of 27.18. The AMD Am386SXL/25-based Identity system incorporated a

210MB 19-ms Conner Cougar drive with 256K on-board cache and placed third, with a score of 24.45. At the low end of the disk spectrum was the new Compaq Contura 3/20, a 386SL/20-based unit, scoring only 10.05 using a Compaq/Conner 19-ms 84MB drive with a 32K on-board buffer.

Although higher processor levels are not usually an overwhelming disk performance factor (compared with software and hardware disk caches or mechanically faster drives), they will improve disk scores somewhat. Also, the larger the drive capacity, the less far the heads have to move across the disk surface to perform random read/write operations on the 32MB test file (the largest we used). Reduced head-stroke distance usually means improved performance

DOSmark

DOSmark scores results depend heavily on disk and CPU speed, and to a lesser extent on memory and video performance. When we developed our Hardware Benchmark Tests, Release 7.0, our application profiles indicated that a large percentage of DOS performance problems are related to slow disk subsystems. Of the top 20 DOS disk performers, 17 were also in the top 20 DOSmark list. The DOSmark champion was the Aspen Aquiline 433, achieving a score of 30.96, thanks to a strong disk subsystem and 486DX/33 processor. Not surprisingly, the new Compaq Contura 3/20, a 386/20-based laptop, placed dead last, with a DOSmark score of 9.33. which correlates with its paltry disk score.

GRAPHICS WINMARK

None of the laptops were stellar performers in Winbench 3.1, since none incorporated graphics accelerators or local bus technology. We tested all systems at 640-by-480 resolution, with 16 colors where applicable. Texas Instruments delivered the best Graphics Winmark score--2.9 megapixels per second--in both the Tl TravelMate 4000 WinDX/25 and the WinSX/25, which use the Cirrus CL-GD6420 chip set. The slowest Graphics Winmark score--0.83--came from the 386SL/20-baseed Dell Dimension NL20, which also uses a Cirrus GD6 10 chip set.

DISK WINMARK

Since most of the laptops had 4MB of RAM, we set up a 1MB SmartDrive 4.0 cache to represent a typical Windows setup. With SmartDrive loaded, the speed of the CPU and memory subsystems affect overall disk subsystem performance. The Aspen and Ergo units again took top honors in the Disk Winmark category, for the same reasons as in the DOS disk context. 486-based systems generally achieved the best Disk Wimnark scores.

HOW WE TESTED

In preparing this issue, we used PC Magazine Labs' new Hardware Benchmark Tests, Release 7.0, to predict PC processor, memory, video subsystem, and disk performance using DOS applications. Each of the four scores we report is the weighted harmonic mean of the results from several tests, expressed in terms of throughput or operations per second. These results are summarized in a composte score called the DOSmark.

We also used the new Windows Benchmark Tests (Winbench), Release 3.1, to obtain the Graphics Winmark and Disk Wimnark scores, which predict the relative performance levels using popular Windows applications.

The processor score is a measure of the CPU's performance and its interaction with cache and main memory. It is derived from tests that use small and m&urn-size instruction mixes, along with either the floating-point calculation test or the coprocessor test (depending on the presence or absence of a math coprocessor). The score indicates how well a computer's CPU and cache subsystems would execute common DOS and Windows applications.

The memory score is compiled from 8-, 16-, and 32-bit extended-memory read and write tests, as well as 8- and 16-bit conventional-memory read and write tests. Taken together, these tests reflect the throughput of a computer's main memory.

'The disk score measures throughput using standard DOS INT 2 1 h file I/O calls, The tests measure the speed of file reading and writing both sequentially and randomly, for a range of tile sizes from 256K to 32MB. The tests are performed without software disk caches installed.

The video score is based on direct-to-screen text-write and graphics-write tests. Taken together, these tests reflect the video throughput for a standard EGA/VGA adapter running DOS applications.

The DOSmark score is a composite rating derived from the processor, memory, video, and disk test scores. The DOSmark indicates a computer system's ability to run DOS applications.

The Graphics Wimnark score is based on 12 Windows graphics and text functions derived from extensive profiling of popular Windows applications. It is measured in megapixels per second (a megapixel is 1,048,576 pixels).

The Disk Winmark score is based on testing techniques adapted from the DOS disk tests to reflect operations within the Windows environment. For this portion of the testing, the systems were configured with up to 2MB of SmartDrive cache.

Beyond Performance: A Gallery of Good and Not-So-Good Features

A notebook is a notebook is a notebook? Hardly. Besides performance, there are many features that differentiate these portable systems from one another.

The superiority of active-matrix color over passive-matrix color is obvious, but a similar ranking exists between monochrome screens, too. The superb active-matrix monochrome LCD panel on the new Compaq LTV Bite/25E (left) has better contrast and produces sharper images than the low-cost Compaq Contura 3/20 (right).

Many laptops use ribbon-pull batteries; should the plastic door break, the battery can easily fall out. The Librex T386SX has one of the easiest to use yet reliable batter) ports we encountered.

Nobody has invented a perfect track ball, but the Librex R386SL has come very close. Not only can it plug into either side of the case side to accommodate both right- and left-handed users, it can also be stowed when not in use.

Portable computing is all about stuffing as much power as possible into your briefcase. The thicker your notebook, the more difficult a time you'll have packing it and the reasoning goes the less likely you'll be to take it on the road. The ALR Ranger MC425s-120 (right) is about 2.3 inches thick, while the Dell System 320SLi (left) is only 1.3 inches thick--the thinnest in our test. A suitable mix balances performance and portability.

If you're interested in connecting to an external monitor you've probably found at one time or another that external VGA is inadequate. The two TI TravelMate portables can support an external resolution of 1,024-by-768.

The ability to fold your laptop underneath the monitor is a desirable one. The Chaplet 386 SL25 Notebook, for example, can fold its display flat, tucking under an external monitor.

Compaq's bulky $799 docking station (left) offers two internal expansion slots, two drive bays, and its own power supply, but it raises the laptop about 3 inches from the desk. Minimalist alternatives include the Ergo offering's $295 station (center), which plugs into the notebook's back and ZDS's $109 port replicator (right).

Sure, your laptop is small, but if your AC adapter is klunky, you're right back to square one. The new Toshiba Satellite T1800 offers not only a small AC brick but also two-prong power plug, which means you don't need to use a three-prong outlet or pack a three- to two-prong adapter in your already crowded briefcase.

Although active-matrix color offers the best clarity, this type of screen is usually disappointingly small (the Toshiba T4400SXC's 8.5-inch-diagonal display is an example). If color or monochrome active-matrix technology is not important to you, look for a nice, wide display like the one that comes with the GRiD 1660.

BATTERY LIFE vs. PORTABILITY	ZDigit cycle used for (minutes)" testing	ZDigit Rundown time m inutes) (hours:	Rank	Battery Rundown time minutes) (hours:	Rank	Battery weight (pounds)	Rank	Battery life per pound minutes) (hours:	Rank	System weight (pounds)	Rank	Travel weight with (pounds) adapter	Rank
AST PowerExec EL Color (386SL/25	3, 3, 10	04:03	21	01:30	66	1.4	44	01:07	63	6.4	32	7.7	28
AST PowerExec 3/25SL Color (386SL/25)	3, 3, 10"	04:48	14	01:35	61	1.5	51	01:03	65	6.8	48	8.1	47
AST PowerExec 4/25SL Color Plus (486SL/25)	3, 3, IO"	06:17	7	02:14	38	1.6	60	01:24	48	7	60	8.1	47
Aurum GoldNote DX2-50 (486DX2/50)	3, 3, IO	01:47	59	01:34	63	1.1	14	01:29	46	6.8	48	8.3	54
Blue Star 486DX2/66 (486DX2/66)	3, 3. IO	02:48	45	01:55	48	1.2	22	01:37	41	5.9	20	8.7	64
CAF AquaLITE II (Am386SXL/25)	3, 3, IO	03:02	40	02:34	26	1.1	14	02:20	16	5.5	8	6.9	6
Compaq Contura 4/25 (486SL/25)	3, 3, IO	03:42	30	02:28	28	1.1	14	02:13	19	6.3	29	7.4	19
Compaq Contura 4/25C (486SL/25	3, 3, 10	03:32	32	01:47	52	1.1	14	01:36	42	6.5	37	7.7	28
Compaq Contura 4/25CX (486SL/25)	3, 3, 10	03:01	41	01:36	58	1.3	26	01:16	60	6.9	52	8	40
Compaq LTE Lite 25E (386SL/25)	3, 3, 10	03:32	32	02:57	15	1.3	26	02:16	17	6.5	38	7.3	17
Compaq LTE Lite 4/25c	3, 3, 10	04:12	19	01:52	50	1.3	26	01:26	47	6.6	40	7.8	31
Com puAdd Express 425Color (Cx486SLC/25)	3, 3, 10	01:47	59	01:35	61	1.1	14	01:23	49	6.5	37	7.8	31
CompuAdd Express 425ColorPlus Cx486SLC/25)	3, 3, IO	02:20	52	01:32	64	1.1	14	01:21	54	6.6	40	8	40
CompuAdd Express 425XL (Cx486SLC/25)	3, 3, IO	03:35	31	02:30	27	1.1	14	02:11	20	6.2	26	7.6	25
Compudyne 4DX2/66 Active TFT Color Slimnote (4860	-	N/A		01:58	46	1.5	51	01:20	57	6.7	45	8.2	50
Compudyne 4DX2/66 Monochrome Slimnote (486DX2/	-	N/A		02:48	20	1.3	26	02:09	22	6.2	26	7.8	31
Compudyne 4SL/25 Subnote (486SL/25)		N/A		03:07	11	0.9	6	03:19	5	3	1	5.4	4
Dell NL25 (386SL/25)	3, 3, 10	03:16	36	02:43	21	1.3	26	02:02	29	6.4	32	8	40
Dell NL25C (386SL/25	3, 3, 10	03:01	41	02:19	33	1.4	44	01:43	40	6.7	45	7.9	37
Dell 325N (386SL/25)	3, 3, IO	07:00	5	03:53	5	1.6	60	02:27	13	6.5	35	7.6	25
Dell 325NC (386SL/25)	3, 3, 10	05:31	10	02:52	17	1.6	60	01:49	34	7.3	64	8.3	54
Dell 325SLi (386SL/25)		N/.A		02:55	16	0.7	1	04:14	1	3.7	2	4.8	1
Digital DECpc 325SL (386SL/25)	3, 3, 10"	08:33	2	03:41	7	1.5	51	02:27	13	6.9	52	7.6	25
Digital DECpc 325SLC (386SL/25)	3, 3, 10	05:02	12	02:20	32	1.5	51	01:33	44	6.9	52	8.2	50
Digital DECpc 425SL (486SL/25)	3, 3, 10**	09:34	1	04:03	3	1.5	51	02:42	11	6.3	29	7.4	19
Epson ActionNote 4SLC/25 (Cx486SLC/25)	5, 5, IO	02:02	53	01:45	55	0.8	3	02:11	20	5.5	8	7.1	14
Ergo PowerBrick 486 (486DX/33)	3, 3, 10	02:24	51	01:56	47	1.4	48	01:23	49	5.3	7	8.4	59
Gateway Nomad 425SXL (486SX/25)	2, 2, IO	06:46	6	02:58	14	1.3	26	02:15	18	5.7	15	6.9	6
Gateway Nomad 450DXL (486DX2/50)	2, 2, 10	05:32	9	02:16	35	1.2	22	01:53	33	5.6	11	6.9	6
GRiD Convertible (386SL/25)	3, 3, 10	02:01	55	01:37	57	0.8	3	02:06	24	5.7	15	7.2	15
HyperBook 2300DLC/40 (Cx486DLC/40)	3, 3, 10	01:47	59	01:36	58	1.3	26	01:12	62	6.9	52	8.3	54
HyperBook 2300DX2/50 (486DX2/50)		N/A		01:46	54	1.3	26	01:19	58	6.9	52	8.3	54
Hyundai Courier (Am386SXL/25)	3, 3, IO	02:02	53	01:55	48	1	9	02:00	30	5.7	15	6.9	6
Hyundai Courier Spectra (Cx486SLC/25)	3, 3, 10	01:59	57	01:23	68	0.7	1	01:57	31	5.7	15	7.4	19

BATTERY LIFE vs. PORTABILITY	ZDigit cycle used for (minutes)* testing	ZDigit Rundown time minutes) (hours:	Rank	Battery Rundown tim e minutes) (hours:	Rank	Battery weight (pounds)	Rank	Battery life per pound minutes) (hours:	Rank	System weight (pounds)	Rank	Travel weight with (pounds) adapter	Rank
IBM ThinkPad 720C (IBM 486SLC/2)	3, 3,10	04:03	21	01:59	45	1.5	51	01:21	54	7.4	65	8.9	65
Jetta Jetbook 486DX/33 (486DX/33)	3,3,10	02:33	48	02:18	34	1.7	64	01:21	54	6.6	40	8	45
Micro Electronics Winbook 486SLC/E/33 (Cx486SLC/E	3, 3, 10	03:47	27	03:28	9	0.9	6	03:46	3	5.5	8	7	13
Micro Express NP943 Notebook PC (486DX/33)	3,3, IO	04:18	17	03:27	10	1.9	65	01:48	36	7.2	62	8.4	59
Mitsuba Ninja 486SX/25 (486SX/25)	3, 3, IO	02:48	45	02:04	39	1	9	02:03	26	6.9	52	7.9	37
NEC UltraLite Versa 25C (486SL/25)	2,2,10	03:32	32	02:00	44	1.1	14	01:49	34	6.9	52	8.6	62
Packard Bell 486DX/25 Notebook (486DX/25)_	5,5,10	03:03	39	02:39	22	1.4	44	01:57	31	5.1	6	8	40
PC Brand Active Color LeaderBook Pro (486DX/33)		N/A		01:24	67	1.4	44	01 :oo	67	6.9	62	8.6	62
Poiy NB325V (386SL/25)	3, 3, IO	02:01	55	01:32	64	0.8	3	02:03	26	6.8	48	7.9	37
Poiy NB425C (Cx486SLC/25)	5,5, IO	02:32	49	01:44	56	1.3	26	01:22	52	6	21	7.2	15
Sam sung NoteMaster 486SLC Model S3800 (Cx486SLC	3, 3. 10	03:12	37	02:27	29	1.2	22	02:03	26	6.4	32	7.8	31
Santron 486 JetBook (486DX/33)	3,3, 10	02:50	44	02:23	30	1.4	44	01:46	38	6.6	44	8	40
Tenex 486SLC/25 Notebook (486SLC/25)	3, 3,10	03:17	35	02:59	13	1.9	65	01:35	43	7.5	66	9	66
Tenex 486DX/33 Chrom a (486DX/33)	3,3,10	02:47	47	02:02	43	2	67	01:02	66	7.7	67	9	66
Ti TravelMate WinSLC 25 (Ti 486SLC/25)	2,2,10	04:01	25	03:43	6	1.3	26	02:48	8	5.6	11	6.8	5
Ti TravelMate 4000 WinDX/25 (486DX/25)	2,2, IO	04:00	26	01:47	52	1.3	26	01:22	52	5.6	11	6.9	6
TI TravelMate 4000 WinDX2/40 Color (Ti 486DX2/40	3, 3, 10	04:12	19	02:15	37	1.3	26	01:45	39	6.2	26	7.6	23
Ti TravelMate 4000 WinDX2/50 (486DX2/50)	3,3, 10	05:21	11	03:05	12	1.3	26	02:21	15	4.4	5	6.9	6
Ti TravelMate 4000 WinSX/25 (486SX/25)	2,2,10	07:02	4	04:18	2	1.3	26	03:17	6	5.6	11	6.9	6
TI TravelMate 4000 WinSX/25 Color (486SX/25)	2,2,10	03:44	29	02:16	35	1.3	26	01:47	37	6.1	24	7.4	19
Toshiba Satellite T1850C (386SX/25)	3,3,10	03:47	27	02:03	40	1.6	60	01:18	59	7.2	62	8.4	59
Toshiba T4400C (486DX/25)	3,3,10	04:36	15	02:22	31	2.4	68	01 :oo	67	8	68	9.9	68
Toshiba T4500 (486SX/20)	3, 3,10	06:17	7	03:58	4	1.4	44	02:48	8	6.3	29	7.5	23
Toshiba T4500C (486SX/20)	3,3,10	04:19	16	01:50	51	1.5	51	01:13	61	7	60	8.2	50
Twinhead Slim note 4DX/33T (486DX/33)	2,2,10	01:54	58	01:36	58	1.5	51	01:05	64	6.7	45	8.2	50
Twinhead Slim note 4DX2/66T (486DX2/66)	3, 3, IO	02:30	50	02:03	40	1.5	51	01:23	49	6.8	48	8.3	54
Twinhead Slim note 4SX/33M (486SX/33	3,3,10	03:05	38	02:03	40	1.3	26	01:33	44	6.1	24	7.8	31
ZDS Z-Lite 320L (386SL/20)	3.3, 10	04:02	23	03:31	8	0.9	6	03:54	2	4	3	6.1	3
ZDS Z-Note 425Ln Model 120 (486SL/25)	3,3,10	08:33	2	04:23	1	1.2	22	03:32	4	5.8	19	7.3	17
ZDS Z-Note 425Lnc Model 200 (486SL/25)	3,3,10	04:17	18	02:39	22	1.3	26	02:07	23	6.6	40	8.1	47
ZDS Z-Note 425Lnp Model 120 (486SL/25)	3.3.10	05:01	13	02:37	25	1.3	26	02:06	24	6.6	37	8	40
ZDS Z-Sport 4205 (487SX/20)	3,3,10	04:02	23	02:49	18	1	9	02:47	10	6	21	7.8	31
ZDS Z-Sport 425S (487SX/25)		N/A		02:49	18	1	9	02:51	7	6	21	7.7	28
Zeos Contenda (386SL/25)	3, 3, 10	02:52	43	02:38	24	1	9	02:40	12	4.1	4	5.1	2

N/A - Not applicable: This product was not compatible with our ZDigit Rundown test.

. The typical ZDigit Rundown teting cycle consists of 3 m inustes in active mode, 3 minutes in standing mode, and 10 minutes In sleep mode; this cycle repeats until the battery is drained.

. * Because this unit was not fully com patible with our ZDigit Rundown test, we tested it manually.