



TOGETHER
for a sustainable future

OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.



TOGETHER
for a sustainable future

DISCLAIMER

This document has been produced without formal United Nations editing. The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations Industrial Development Organization (UNIDO) concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries, or its economic system or degree of development. Designations such as “developed”, “industrialized” and “developing” are intended for statistical convenience and do not necessarily express a judgment about the stage reached by a particular country or area in the development process. Mention of firm names or commercial products does not constitute an endorsement by UNIDO.

FAIR USE POLICY

Any part of this publication may be quoted and referenced for educational and research purposes without additional permission from UNIDO. However, those who make use of quoting and referencing this publication are requested to follow the Fair Use Policy of giving due credit to UNIDO.

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

NIFES

CONSULTING ENGINEERS

16568

UNIDO PROJECT DP/RER/83/003

**REGIONAL CO-OPERATION IN THE FIELD OF
INDUSTRIAL ENERGY CONSERVATION
ENERGY AUDITING, CZECHOSLOVAKIA**

FINAL REPORT

**PROVISION OF COMPUTERISED DATA COLLECTION AND PROCESSING
SYSTEM FOR ENERGY AUDITING ON A MOBILE DIAGNOSTIC UNIT**

7.

NATIONAL INDUSTRIAL FUEL EFFICIENCY SERVICE LIMITED

2 DARNLEY ROAD EDGBASTON BIRMINGHAM B16 8TF TEL: 021 454 4471

DATE SEPTEMBER 1987 REF MJS/SJMc/NAT202

SUMMARY

This project is to be part of the overall UNIDO programme to encourage and extend assistance to the developing countries for the development, expansion and modernisation of their industries. The objective is to strengthen the capability of the participating institutions in the Energy auditing sector by providing and demonstrating a computerised energy efficiency diagnostic unit.

An Energy Bus, equipped with portable measuring instruments to measure temperature, gas flow, pressure, humidity and gas analysis already existed at the Research Institute for Ceramics, Refractories and Non-Metallic Raw Materials in Pilsen. In order to analyse and present the data, a micro-computer and interface hardware with the necessary software was required.

This package, known as a computerised energy efficiency diagnostic unit, was procured by NIFES and delivered to the Research Institute under the UNIDO-Czechoslovakian joint programme. The hardware package originally proposed by NIFES had to be changed due to export restrictions. However, this did not alter or down rate the system for the functions intended. The revised hardware package is based on the IBM XTS FD computer and the biodata microlink computer interface.

The equipment was successfully demonstrated at the complex sectoral group meeting on Energy Auditing which was held between 4th and 15th May 1987 at the Research Institute in Pilsen. The counterpart staff were given detailed training on the operation of the hardware and software. The operators of the mobile diagnostic unit will, however, require further practice in the use of the system before using it without supervision. Adequate engineering and computing expertise exists in the Research Institute for Ceramics, Refractories and Non-Metallic Raw Materials to help them to use the system.

It is important that the measuring procedures, measured parameters, bases of calculating and data input and output from the computer are first agreed and specified before the system is extended. Differing views on these items were apparent during the course of the sectoral meeting. Indeed the system can be extended and developed to accommodate a greater number of measuring points. The next stage in this demonstration programme must be to work on expanding and developing the system.

The intention is to use this diagnostic unit as the basis of a standard system for conducting energy audits within the nine European countries participating in this project, i.e. Bulgaria, Cyprus, Czechoslovakia, Hungary, Malta, Poland, Portugal, Rumania and Yugoslavia.

	Page No.
INTRODUCTION	1
SECTION A : DELIVERY OF HARDWARE AND SOFTWARE	2 - 9
1.0 System Hardware	
2.0 System Software	
3.0 Costs	
SECTION B : DEMONSTRATION OF THE COMPUTERISED SYSTEM AND TRAINING OF THE COUNTERPART STAFF	10 - 15
1.0 System Demonstration	
2.0 Training of Counterpart Staff	
SECTION C : SYSTEM DEVELOPMENT	16 - 18
1.0 Procedures and Techniques	
2.0 Hardware	
3.0 Conclusions and Recommendations	
APPENDICES	
APPENDIX 1 - System Hardware Manufacturers Data Sheets	
APPENDIX 2 - System Software	

INTRODUCTION

This report details the work done by NIFES in the course of the project.

A description is given of the computer hardware and software programmes, a detailed cost breakdown of the equipment supplied. Details are given of the demonstration at the Research Centre in Pilsen, at the Chlumcany tile factory and at the NIFES presentation to the Ad Hoc meeting in Budapest between 21st and 25th September 1987.

The training given to the counterpart staff is explained, future training needs specified and touches on how the system can be developed to suit the needs of the auditing and diagnostic tasks required.

The report concludes by emphasising the procedures necessary for the successful operation and development of the unit.

SECTION A - DELIVERY OF HARDWARE AND SOFTWARE

1.0 SYSTEM HARDWARE

1.1 Specification of Hardware

In NIFES proposal dated December 1986, it was proposed that the data capture hardware to be supplied to UNIDO should consist of:

IBM AT Microcomputer with 80286.16 bit processor, 20 Mb fixed disk, 80287 maths co-processor, high resolution display and Hercules graphics card. Teamer Labmaster analogue/digital converter TM100 and Epson LX80 dot matrix printer.

This system was specified due to its large data handling capacity and speed of operation. In addition IBM have a worldwide network of agents which are available for the necessary back-up services for UNIDO.

It was not possible to obtain the Licence to export the Teamer Labmaster analogue to digital converter, originally specified, it was necessary to revise the proposals for the data capture system.

The following is a list of the equipment supplied.

Computer;

An IBM XTSPD Enhanced colour computer comprising 8088 8 bit processor, 20 Mb fixed disk, 360 kb flexible disk, enhanced keyboard, 8087 maths co-processor, serial/parallel adaptor, 640 kb memory.

Data Capture Interface;

A Biodata Microlink system comprising of a power supply computer interface and 12 slots for the location of hardware modules. A12-D Analogue to Digital converter and a 12 bit converter with a relative accuracy at $\pm 0.025\%$ with a conversion time of 25 microseconds.

The PGA12 Analogue Input Module accepts 16 channels of differential voltage with programmable zero offset and gain with fullscale ranges of 10 mV, 100 mV, 1 V and 10 V.

A Temperature input module (TC16) accepts 16 thermocouples of common types and the unit is complete with an isothermal box containing an encapsulated resistance temperature detector to provide a cold junction reference temperature.

A Type RTD8 Temperature input module monitors temperature from upto 16 resistance temperature detectors, these detectors can be installed in either 2, 3 or 4 wire configurations.

External connecting boxes were fabricated to facilitate the connection of analogue inputs and resistance temperature detectors to the Microlink modules.

Printer;

The Epson LX80 printer had been superseded by the LX86 printer at the time of purchase, this machine was therefore substituted.

Appendix 1 shows system hardware manufacturers data sheets.

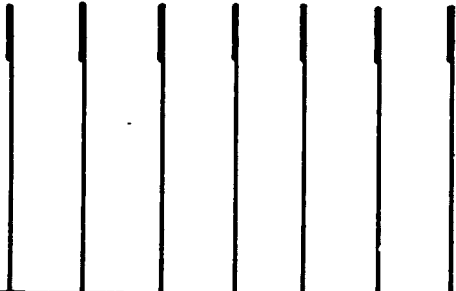
1.2 Hardware Configuration

The configuration of hardware is shown schematically on drawing nos. NAT202/1 and NAT202/2.

The Microlink analogue input module accepts only voltage signals, current signals from instruments must, therefore, be converted to voltage signals by measuring the voltage across high precision electrical resistors. This system is shown schematically on drawing NAT202/2.

KILN, BOILER, DRYER
(THERMAL PROCESSES.)

SENSORS :
THERMOCOUPLES.
MANOMETERS.
GAS ANALYSERS ETC.



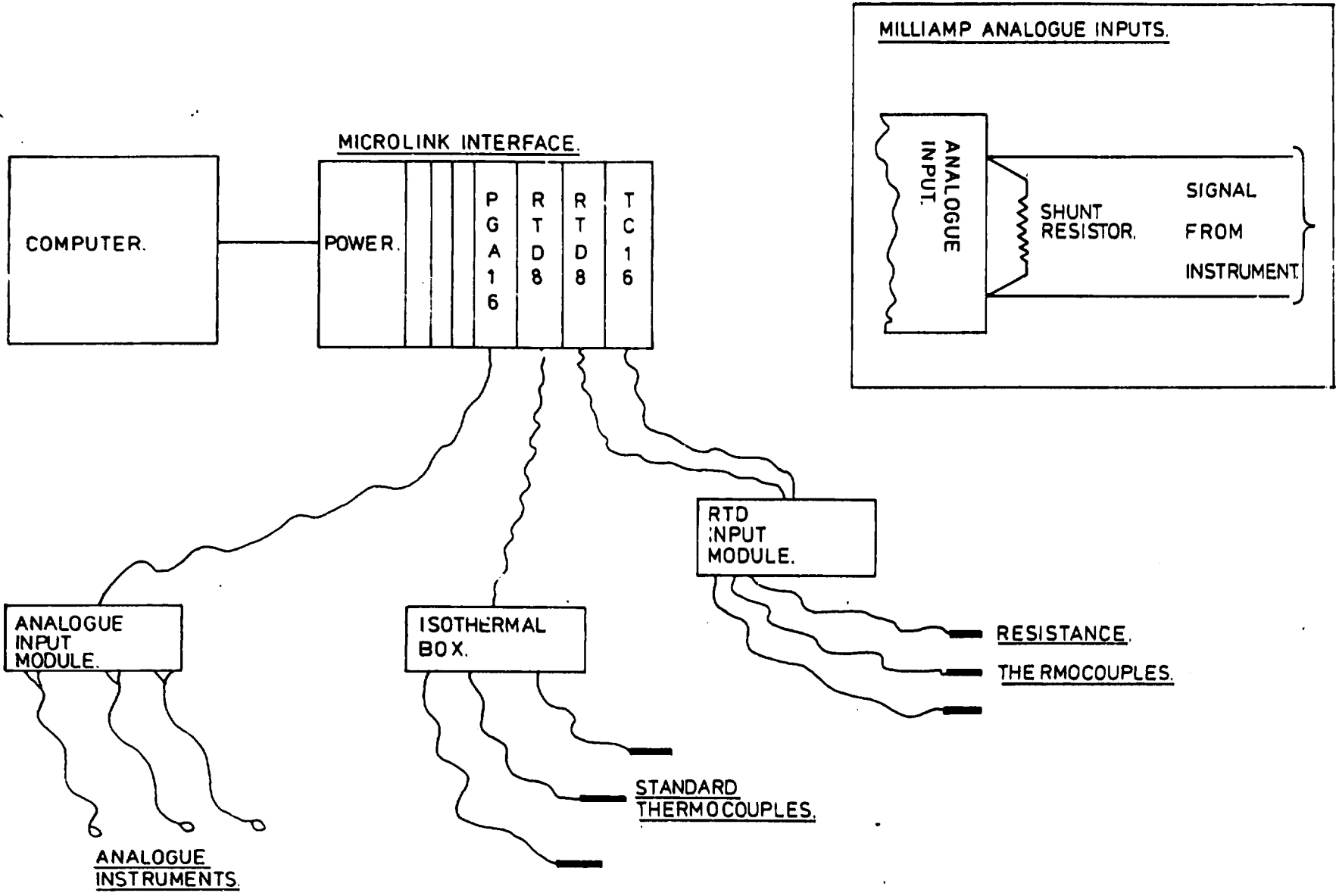
MICROLINK
INTERFACE.

IBM XTSD
COMPUTER
40 kb. ROM.
640 kb. RAM.
(FD) (HD)

FD = 5 1/4" 360kb FLOPPY DISK.
H.D. = 20Mb FIXED DISK.

EPSON
LX 86 NLO
PRINTER.

I.B.M. COLOUR
HIGH
RESOLUTION
MONITOR.



5

2.0 SYSTEM SOFTWARE

2.1 Commercial Application Software

The commercial application software packages purchased for UNIDO under this contract are as follows:

i) Microlink Entry Level Data Logging (ELDL) Package for IBM XT:

This package is used to drive the Microlink data logging system by the IBM computer through the IEEE interface and enables the following procedures to take place;

- o Create a procedure for data logging from thermocouples and/or analogue inputs.
- o Selection of logging parameters for example, the number and rate of logging cycles required.
- o Keyboard control of routine logging.
- o Storage of logged data on disk.
- o Registration of logged data to the printer or to the screen.
- o Runtime graphical illustration of up to 4 sets of logged data.
- o Post runtime review of logged data in the form of graphs or tabulated data on the screen or on the printer.

Configuration of logged data files for access from the following external application software;

Lotus 123
D base II or III
Data Interchange Format
Comma Separated Variable Format

ii) Lotus 123:

This package is an electronic worksheet on to which formulae, data and tables can be entered, facility is also included to enable data to be displayed and printed in various graphical forms. The worksheet can be configured as a simple database for flexible filing of figures and data files. Files can be imported from the Microlink ELDL package for data reduction and presentation.

iii) Herculese Graphics:

This package is provided for future implementation of high resolution graphical presentations.

Appendix 2 shows in more detail Lotus 123 software information.

2.2 NIFES Thermal Software

NIFES Thermal Software is written in BASICA for the IBM microcomputer and compatible machines and the following programs were produced:

SURFLOSS : Radiation and convection losses from hot surfaces.

FLUGASA : Flue gas losses.

HUMIDITY : Properties of air.

THERM : A Program containing the routines from SURFLOSS, FLUGASA and HUMIDITY, to be used for automatic data reduction from data logged in the Microlink ELDL package.

THERMINA : A Program for setting up models of thermal processes to enable the program THERM to operate.

3.0 COSTS

The cost of the hardware and software provided under the UNIDO project is detailed in Table 1.

Table 1 : UNIDO Project Hardware and Software Costs

Item	Quantity	Unit Cost £	Total £	Total \$
IBM XT SFD Microcomputer	1	1 000	1 700	2 764.2
Enhanced keyboard	1	144	144	234.1
AST card with Hercules, Enhanced Graphics Adapter and Serial/Parallel Adapter	1	445	445	723.6
Tecmar IEEE Controller	1	400	400	650.4
8087 Co-processor	1	150	150	243.9
Enhanced Colour Monitor	1	449	449	730.1
IEEE/IEEE Cable	1	30	30	48.8
Hercules Graph X software	1	45	45	73.2
DOS 3.2	1	50	50	81.3
Lotus 123	1	310	310	504.1
Epson LX86 Tractor Feed Printer	1	256	256	416.3
Printer Cable	1	25	25	40.7
Microlink MF-12	1	520	520	845.5
A12-D	1	245	245	398.4
FGA16	1	445	445	723.6
TC16	1	475	475	772.4
RTD8	2	375	750	1 219.5
Driver Routines	1	95	95	154.5
ELDL Software	1	695	695	1 130.1
Microlink Delivery		15	15	24.4
Components for connection boxes (excluding labour)		137	137	222.8
TOTAL	-	-	7 381.00	12 001.9
Air Freight to Czechoslovakia		289.41	289.41	470.6
GRAND TOTAL			7,670.41	12,472.5

Exchange Rate at 27 May 1987 \$1.626 = £1

The cost of the hardware and delivery quoted in NIFES original proposal were as follows:

Hardware	£8,217	\$11,832
Delivery	£ 347	\$ 500
Total	£8,564	\$12,332

Exchange rate at date of proposal \$1.44 = £1

The exchange rate of the US Dollar against Sterling has risen by 12.9% from \$1.44 to \$1.626 since the date of NIFES proposal. This means that although the cost of the delivered hardware was £839.59 cheaper than the original proposal, the cost in US Dollars has increased by \$140.5. The cost increase on the original package due to the fluctuation of the US Dollar would have been \$1,592.9

**SECTION B : DEMONSTRATION OF THE COMPUTERISED SYSTEM AND
TRAINING OF THE COUNTERPART PERSONNEL****1.0 SYSTEM DEMONSTRATION****1.1 NIFES Presentation to the Complex Sectoral Group Meeting on
Energy Auditing**

On the 6th May 1987 NIFES gave a presentation of the hardware and the data logging software to the Complex Sectoral Group Meeting on Energy Auditing.

The computer equipment including the Microlink Interface and the software were described in detail to the delegates and a demonstration was given of the data logging system. It was set up to graphically illustrate the effect of heating a thermocouple in a flame thereby simulating the firing cycle of a kiln. Figure 1 shows the printed results of such a simulation.

**1.2 UNIDO-Czechoslovakia Energy Audit Team Computer System
Demonstration**

The computerised system was demonstrated to the personnel from the UNIDO-Czechoslovakia Energy Audit Team, these Engineers will be responsible for using the system in the office and on site in the Mobile Diagnostic Unit.

The use and programming of the data logging system was first demonstrated in detail using a simulation in order to brief the team prior to the on-site demonstration of the system at Chlumcany where the firing curve of a tunnel kiln was to be monitored.

The NIFES software was also demonstrated in order that it could be used if necessary for the Chlumcany Energy Audit and the THERM Program was demonstrated, using model data, to simulate the convection and radiation loss, flue gas and moisture in air loss facilities of the program.

Temperature Test

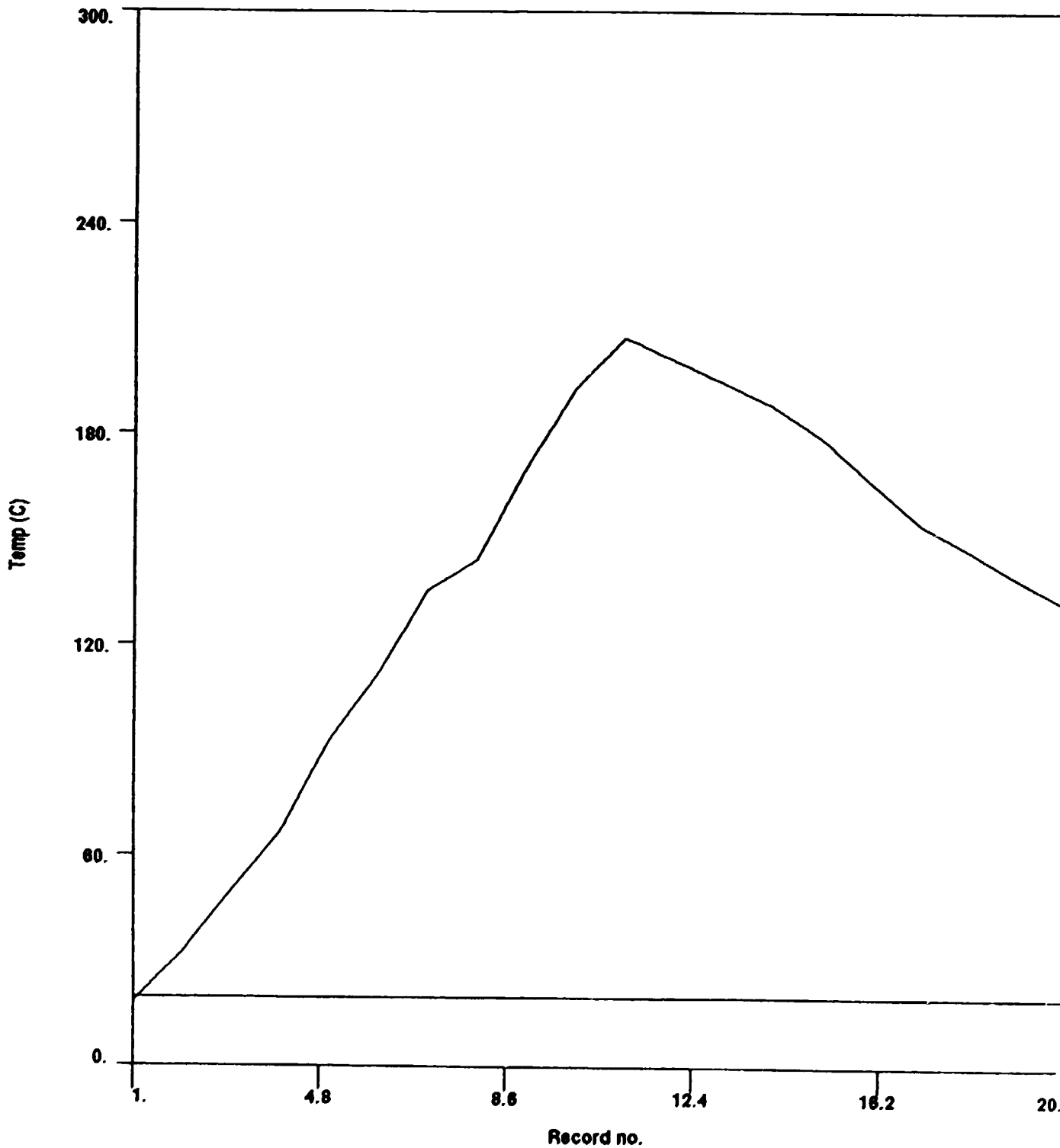


Figure 1 : Simulated Tunnel Kiln Firing Curve Demonstrated at the Sectoral Group Meeting.

1.3 Chlumcany Tunnel Kiln Test

The computer was installed in the Mobile Diagnostic Unit to monitor the firing curve of a tunnel kiln. Travelling thermocouples were installed on a kiln car at high and low level. The compensating cables from these thermocouples, the analogue outputs from a carbon dioxide analyser and anemometer were connected to the Microlink system for continuous monitoring.

The system initially failed to respond in the manner demonstrated in the office. This was, however, found to be due to the way in which the electrical power was installed in the vehicle through an isolating transformer. The use of the transformer was setting up differential voltages of sufficient value to affect the data logging input voltages. This was rectified by feeding the computer directly from the factory supply and ensuring an adequate earth continuity.

The firing curve recorded over a 3 hour period, is shown in Figure 2 and compared favourably with the zone temperatures indicated by the permanent temperature recording equipment.

The two spikes which occur on the two curves (See Fig. 2) are thought to be due to external voltages that were picked up on the thermocouple leads.

It was not possible to compute the carbon dioxide content in the kiln as the conversion characteristics of the instrument, i.e., of analogue volts and the carbon dioxide content of the gases had not been provided by the operators as requested.

From this initial trial the following lessons were learnt;

- o The power supply for the computer must be taken directly from the factory system.
- o Screened compensation cables and analogue feeders should be used as standard.
- o The earth continuity from instrumentation through to the computer interface and computer and thence to the factory earth system must be ensured.
- o Precautions must be taken to ensure that particles of dust do not enter the computer and affect the diskettes.
- o Smoking should not be permitted near the computer in order that smoke particles do not get drawn into the machine by the cooling fan.

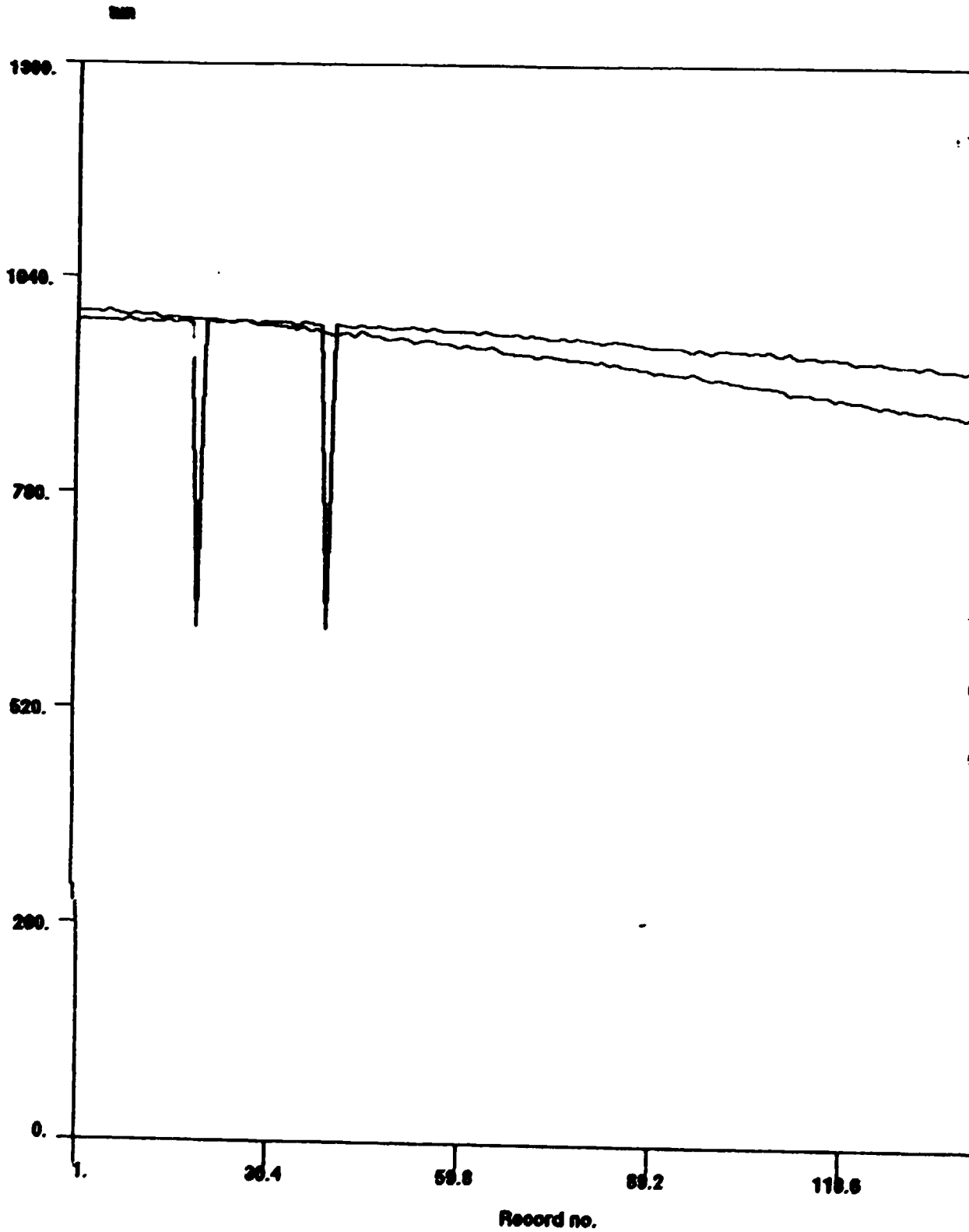


Figure 2 : Results of the Test to Ascertain the Firing curve of the Chlumcany Tunnel Kiln.

- o An adequately damped system must be provided for the computer and the monitor to prevent damage during transportation of the hardware to site. This is particularly crucial with regard to the hard and flexible disk drives.

The tests at Chlumcany can be seen to have adequately demonstrated the system.

2.0 Training of Counterpart Staff

2.1 Introduction

The training of counterpart staff took the form of "hands on" training at the computer keyboard. The draft operating manual was used during the course of the training sessions.

2.2 Operator Training

The training sessions were held with the energy audit team, a senior UNIDO-Czechoslovakia Joint Programme Consultant and a computer programmer from the Research Institute for Ceramics, Refractories and Non-Metallic Raw Materials.

It was immediately apparent that the personnel who are to use the system are not computer literate. Although this was not a major disadvantage, it did mean that the training had to commence at a much lower technical level. The demonstration program and games approach was used to introduce the participants in the use of the keyboard. The operators will need to practice using the computer to overcome their apprehension of the equipment before they can use it for engineering purposes.

The technical training was then given with detailed instruction and demonstration of the data logging hardware and software and the NIFES thermal software library. Subsequently the operators were given access to the equipment to gain experience in its use. Further experience with the system under the adequate control of the Institute's Engineering Staff and Computer Programmer will be required before personnel are permitted to use the equipment without supervision.

2.3 Computer System Updates

NIFES thermal software has been written in such a manner that it can be customised for use with any fuel and any instrument with an analogue output of the appropriate range. The following data has to be installed into the program before it can be run;

- o Fuel data and stoichiometric flue gas analysis for each fuel.

- o Conversion factors from recorded emf to engineering units for each instrument connected to the data logging system.

NIFES had previously programmed the fuel, data for Czechoslovakian natural gas and towns gas into the relevant programs. The manner in which this data and the instrument conversion data is programmed were demonstrated to the computer programmer for future reference.

SECTION C : SYSTEM DEVELOPMENT**1.0 Procedures and Techniques**

The Regional co-operation in the field of Industrial Energy Conservation energy auditing is aimed at producing a standard package of hardware and software.

The discussions held during the course of the demonstrations highlighted the differing views on such things as:

- o Measuring procedures and techniques.
- o Measured parameters.
- o Bases of calculations.
- o Specifications.
- o Data input and computed output.

It is evident therefore that before the system of standardised computer programs is extended, these views should be debated at length and a detailed specification produced for each measurement and calculation.

2.0 Hardware**2.1 Hardware Optimisation**

The computer hardware specification is based on an outline specification of the projected use of the mobile diagnostic unit, suggested in UNIDO's original terms of reference, however the demonstration of the system and the subsequent discussions indicate that slight changes to future systems for optimum use may be worthwhile. For example, the provision of more thermocouple modules and fewer resistance temperature detectors could be considered.

The optimisation of the hardware would be an integral part of any discussions on the standardisation of measuring and calculation techniques as discussed in Section C, 1.0 of this report.

2.2 Procurement of Consumable Goods

The choice of the IBM computer and the Epson printer was made partly upon the knowledge that both machines are generally available worldwide. This therefore reduces the problems associated with servicing and the provision of consumable goods.

From normal operation of the unit, the following consumable items will be required;

- o Printer ribbons
- o Diskettes
- o Printer paper
- o Cleaning materials.

It appears, however, that the procurement of such goods in Czechoslovakia may be difficult, therefore, the provision of a central agency for the procurement of consumable items should be considered in any extension to the project.

3.0 Conclusions and Recommendations

The hardware package originally proposed by NIFES had to be changed due to Export Restrictions, however, this did not alter or downgrade the functions necessary for the purpose intended of the system.

Although the revised package was £893.59 cheaper than the originally proposed package in the UK, the fluctuation of the US Dollar against Sterling resulted in a net increase of \$140.5 in the cost of the equipment.

The computerised data collection system was successfully demonstrated to the Sectoral Group Meeting and on a kiln in a ceramics factory. Lessons were learned from this short trial and the following procedures should be followed.

- o The power supply for the computer should be taken directly from the factory supply.
- o Screened signal cables should be used to connect sensors to the interface.
- o The earth continuity should be ensured between the sensor and the interface/computer.
- o Precautions must be taken to prevent the ingress of dust into the computer and Smoking should not be permitted near the computer.
- o Care must be taken during transportation of the computer to prevent damage to the disk drives and the monitor.
- o Consideration should be given to a central purchasing agency for consumable items which have to be imported.

The operators of the mobile diagnostic unit are not experienced in the use of computers to operate the system without supervision. However, the software is sufficiently "user friendly" and well documented to be used by experienced operators.

NIFES Thermal software can be used with a wide range of fuels and measuring instruments. The method of programming these factors into the system was demonstrated to the computer programmer from the Research Institute.

The system can be extended and developed to accommodate a greater number of measuring points and the software programmed to process and display the results.

The following is a list of calculations which should be included in the software programs;

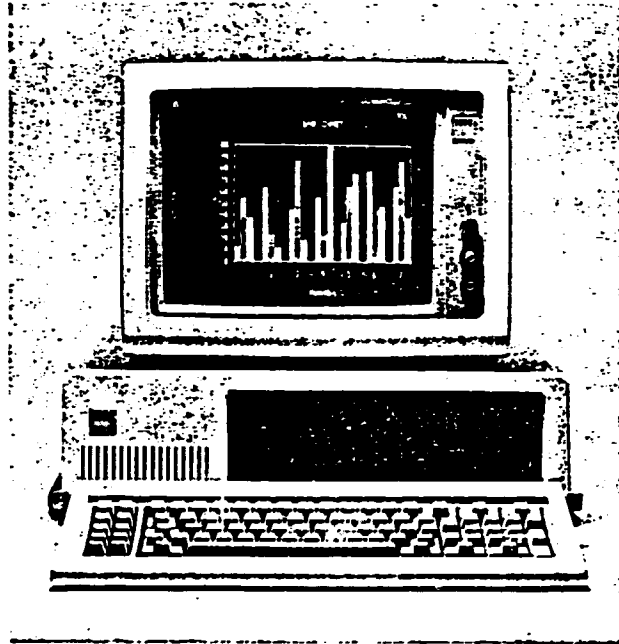
- Fuel analysis
- Flow measurement
- Pipework and plant insulation
- Building heat losses, heat gains and target consumptions
- Building insulation and condensation
- Heat losses from tanks and vessels
- Evaporative losses from water.
- Energy audit presentation
- Energy monitoring
- Grit and dust emissions from chimneys
- Combined heat and power
- Air compressor analysis
- Power factor analysis
- Motor part load analysis

The next stage in this programme must be to produce a standard specification of measuring and calculation procedures and commission the unit for conducting plant and factory audits.

This diagnostic unit will standardise, speed up and improve the quality of Energy Audit work.

APPENDIX 1

Systems Hardware Manufacturers Data Sheets



IBM Personal Computer

- The IBM Personal Computer can provide individual users with a personal system for their own applications.
- It can be used throughout the complete spectrum of business activity, from the one-person business to a large number of individuals in a multinational organisation.
- The system is designed for ease of use.
- There is a wide range of applications for many user groups, including:
 - Business professionals
 - Secretaries
 - Engineers and scientists
 - Academics
 - Retailers
 - Production managers.
- Some of the most commonly-used software packages cover:
 - Word processing
 - Spreadsheets
 - Data base managers
 - Data communications
 - Graphics.

- An IBM Personal Computer may operate as a standalone machine, giving the user fast access to data with the sort of computing power mainframes had 15 years ago. Alternatively, it can be used as an intelligent terminal.

IBM Personal Computer XT

- The IBM Personal Computer XT (illustrated above) has everything offered by the IBM Personal Computer, plus a range of standard and design features which offer wider facilities and make it suitable for handling large amounts of information.
- One of the most significant benefits it can offer is faster, more convenient access to programs and information files stored on the 10Mb fixed disk drive. This can be integrated within the system unit.
- The IBM Personal Computer XT can offer more storage, more memory, and more capacity for growth.



The IBM Personal Computer as an intelligent terminal

- If the IBM Personal Computer is used as an intelligent terminal, host applications can be run and data can be extracted from the company data base: the data can then be manipulated locally, in accordance with the user's particular business needs.
- As an intelligent terminal, the IBM Personal Computer offers many attractive features:
 - Open architecture, which maximises on its potential to match current and future needs
 - A wide range of software, with over 650 programs currently available in the UK
 - Communications flexibility to enable it to fit within existing data processing networks

Technical description of the IBM Personal Computer

- **System Unit (8130152):**
 - Based on an Intel 8088 microprocessor
 - 40 Kb of Read-Only Memory (ROM)
 - Memory access time: 250 nanoseconds (ns)
 - Cycle time: 410 ns
 - Five expansion slots
 - Parity generation and checking
 - 64 Kb of user memory
 - Upgradeable to 640 Kb
 - One double-sided diskette drive of 360 Kb
 - A second double-sided diskette drive can be added
 - An Expansion Unit can be added with one or two fixed disk drives and eight expansion slots.

Technical description of the IBM Personal Computer XT

- **System Unit (Both models: 6134272 or 6134223):**
 - Based on an Intel 8088 microprocessor
 - 40 Kb of ROM
 - Memory access time: 250 ns
 - Cycle time: 345 ns
 - Eight expansion slots
 - Parity generation and checking
 - 256 Kb of user memory
 - Upgradeable to 640 Kb.
- **System Unit (6134272):**
 - Two double-sided diskette drives of 360 Kb
 - An Expansion Unit can be attached, with one or two disk drives and eight expansion slots
- **System Unit (6134223):**
 - One double-sided diskette drive of 360 Kb
 - One 10 Mb fixed disk drive
 - Asynchronous Communications Adapter
 - An Expansion Unit can be attached, with a disk drive and eight expansion slots

IBM Personal Computer and IBM Personal Computer XT options

Some of the IBM Personal Computer options which are supported on the IBM Personal Computer and the IBM Personal Computer XT are:

- IBM Personal Computer Keyboard
- IBM Proprinter
- IBM Quietwriter
- IBM Wheelprinter
- IBM Colour Jetprinter
- IBM Parallel Printer Adapter
- IBM Monochrome Display
- IBM Colour Display
- IBM Enhanced Graphics Display
- IBM Professional Graphics Display
- IBM Asynchronous Communications Adapter
- IBM Binary Synchronous Communications Adapter
- IBM Synchronous Data Link Control (SDLC) Communications Adapter
- IBM 3278/79 Emulation Adapter
- IBM Games Adapter
- IBM Enhanced Display Station Emulation Adapter (for attachment to IBM System/34, IBM System/36, IBM System/38)
- IBM Display Station Emulation Adapter
- IBM Personal Computer Network
- IBM Personal Computer Cluster
- IBM Display Stand
- IBM Prototype Card
- IBM Videotex Communications
- IBM Maths Co-processor
- IBM Personal Computer XT/370 Option Kit (IBM Personal Computer XT option only).

Physical specifications

All models

Height	142 mm (6.0 in.)
Width	500 mm (20.0 in.)
Depth	410 mm (16.0 in.)
Temperature	System on: 15-32°C (60-90°F)
	System off: 10-43°C (50-110°F)
Humidity	System on: 8-80%
	System off: 20-80%

IBM Personal Computer System Unit (8130152)

Weight (with two diskette drives)	12.7 kg (28.0 lb)
Power supply	190-259 V ac, 50-60 Hz

IBM Personal Computer XT (6134272 or 6134223)

Weight	14.5 kg (32.0 lb)
Power supply	180-259 V ac, 50 or 60 Hz, 130 Watt

IBM United Kingdom Limited
PO Box 32
Alencon Link
Basingstoke
Hampshire RG21 1FJ
Telephone:
Basingstoke (0256) 56144

Registered in England, No. 21590
Registered Office: PO Box 32
North Harbour, Portsmouth
Hampshire PO6 1AU

IBM is the Registered Trademark of
International Business Machines
Corporation.

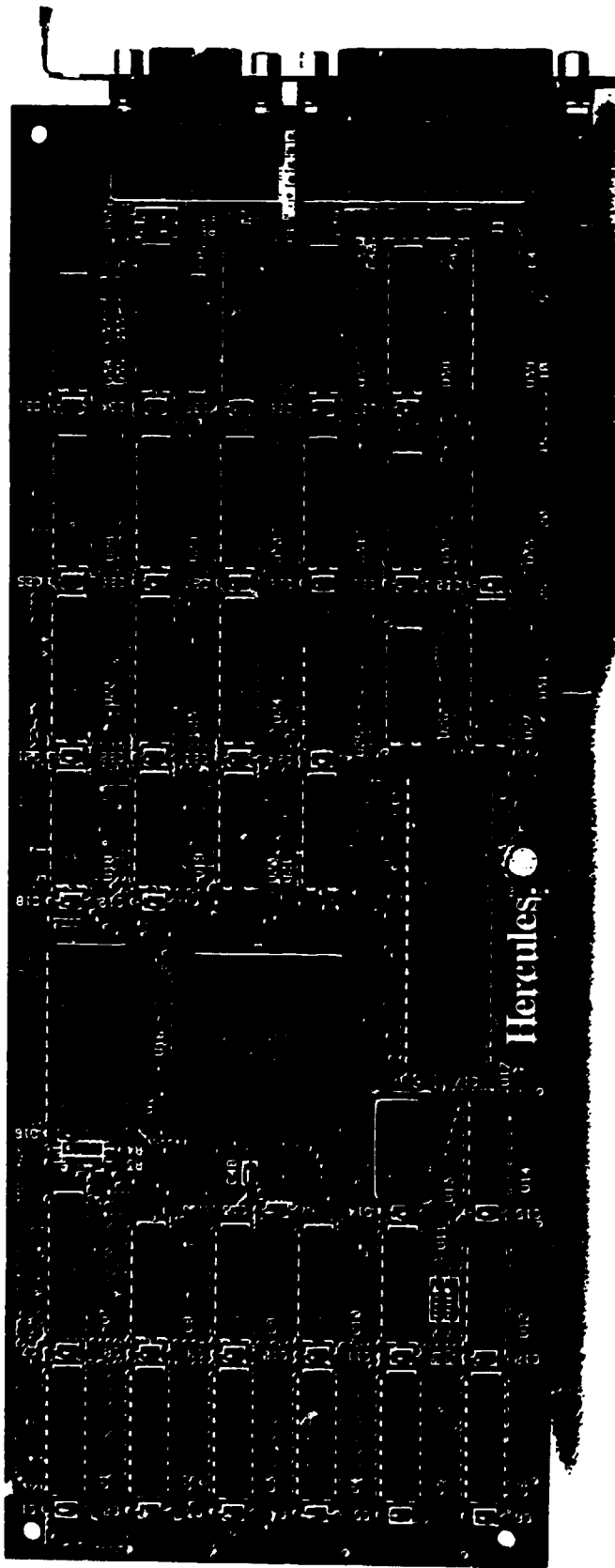
This publication is for general
guidance only. Please contact an IBM
Sales Representative, an IBM Retail
Centre, or an IBM Authorised Dealer
— IBM Personal Computer, for
further information.

All products referred to in this
publication are subject to availability.

Printed in England by
Richard Clay plc
Bungay, Suffolk



The Hercules Graphics Card Plus



The new Hercules[™] Graphics Card Plus dramatically improves the way software can be displayed on the screens of IBM[™] PCs and compatibles—without sacrificing speed, ease of use or compatibility with existing text and graphics software.

Ideal for all users of Microsoft[™] Word, Lotus[™] 1-2-3, Release 2, Symphony,[™] Manuscript[™] and Framework II[™]; for anyone who processes English, foreign language or scientific text; and for power users of all kinds.

Offers all of the same features—including high-resolution 720 x 348 graphics—and runs the same text and graphics software of the original industry-standard Hercules Graphics Card.

Combines the speed and ease-of-use of text mode with the flexibility of graphics mode into a new, third mode, called RamFont[™]—made possible by the unique new V112 microchip,* Hercules' next-generation video processor.

Revolutionizes text processing by replacing the 256-character limit of text mode with the capacity to handle up to 3072 characters or graphic elements. Microsoft Word, for example can now display italics, boldface, superscripts, small capitals and more—while scrolling nearly three times faster than before.

Enhances integrated software by mixing true text and graphics on the same screen. Lotus 1-2-3, Release 2 and Symphony can now display graphs in a convenient pop-up window, with spreadsheet remaining in the background.

Enhances spreadsheet performance by using smaller characters to display nearly twice as much information on one screen—with rapid scrolling.

Opens the door to a new generation of software. All major publishers are developing new packages or adapting existing programs to take advantage of the unique capabilities of RamFont. Applications include scientific and foreign language word processing, desktop publishing, and even recreational software.

*Patent applied for

Graphics Card

Features

- Replaces the IBM Monochrome Display/Printer Adapter
- Meets the specifications of the IBM Monochrome Display and many other popular TTL monochrome monitors
- 100% compatible with the original Hercules Graphics Card
- Has three modes of operation:
Text mode: Runs all text-mode software compatible with the IBM Monochrome Display Adapter
Graphics mode: Graphics resolution of 720 horizontal x 348 vertical. Runs the same software as the Hercules Graphics Card
RamFont™ mode: A new mode that combines the speed and ease-of-use of text mode with the versatility of graphics mode. Allows up to 3072 different software-defined characters to be displayed
- Includes the new Hercules LPT112: a parallel printer port on a chip which can be disabled if necessary
- Includes valuable software:
FontMan, a font editor for creating new character fonts for use in RamFont mode
A Screensave program, to extend the life of your monochrome monitor
A graphics-mode screen dump, for use with Epson and IBM graphics printers
- Text mode and 4K RamFont mode support the standard monochrome text attributes: blink, reverse video, underline, high-intensity, blank and normal
- 48K RamFont mode adds two new attributes: boldface and overstrike
- Two year warranty standard

Specifications

- Text mode resolution: 80 columns x 25 rows, using a 9 x 14 character matrix
- Graphics mode resolution: 720 horizontal x 348 vertical
- RamFont resolution: 80 or 90 columns x 21 to 87 rows, using a character matrix 8 or 9 bits wide x 4 to 16 bits high
- On board 64K dynamic RAM multi-formatted display memory
Text mode display memory format: 4K display buffer from B0000 to B0FFF
Graphics mode display memory format: two 32K graphics pages: page 0 from B0000 to B7FFF; page 1 from B8000 to BFFFF
RamFont mode display memory format: 16K display buffer from B0000 to B3FFF; up to 48K character-definition storage from B4000 to BFFFF
- RamFont storage capacity:
In 4K RamFont mode, one software-defined font of 256 characters
In 48K RamFont mode, 3072 different software-defined elements — equivalent to twelve standard 256-character sets
- Parallel printer port:
Address: 03BC-03BE
Logical device designation: LPT1
- Video signals (at standard TTL levels): +Intensity, +Video, +Horizontal sync, & -Vertical sync
- Sync frequencies: 50Hz vertical, 18.4kHz horizontal
- Current consumption: approximately 1.0 amps at 5 volts
- Worst case memory access time: 1 microsecond

Hercules™

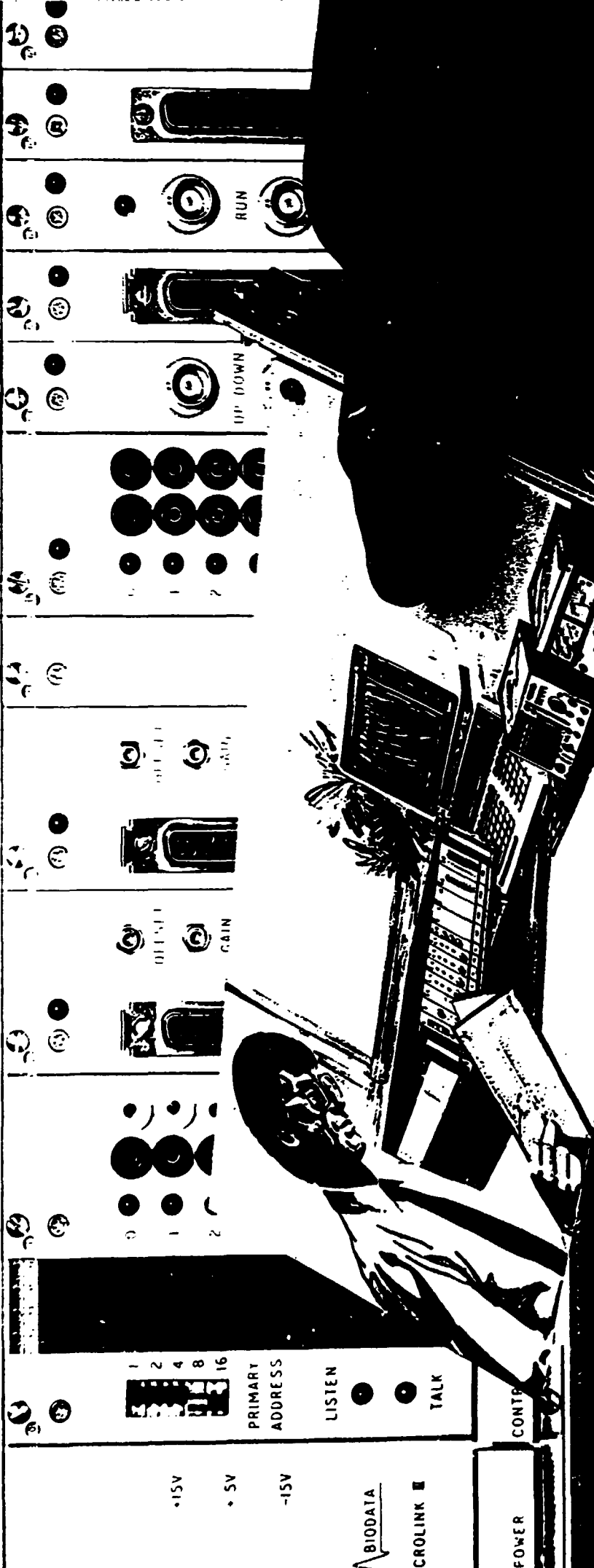
We're strong on graphics.

Hercules Computer Technology, 2550 Ninth Street, Berkeley, California 94710, Tel: (415) 540-6000.

Trademarks Owners: Lotus, Lotus Symphony Lotus, Microsoft, Microsoft, Framework II, Ashton-Tate, Hercules, RamFont, FontMan, Hercules.

MICROLINK

THE MOST FLEXIBLE COMPUTER INTERFACE



1 2 4 8 16
 PRIMARY ADDRESS

• 15V
 • 5V
 -15V

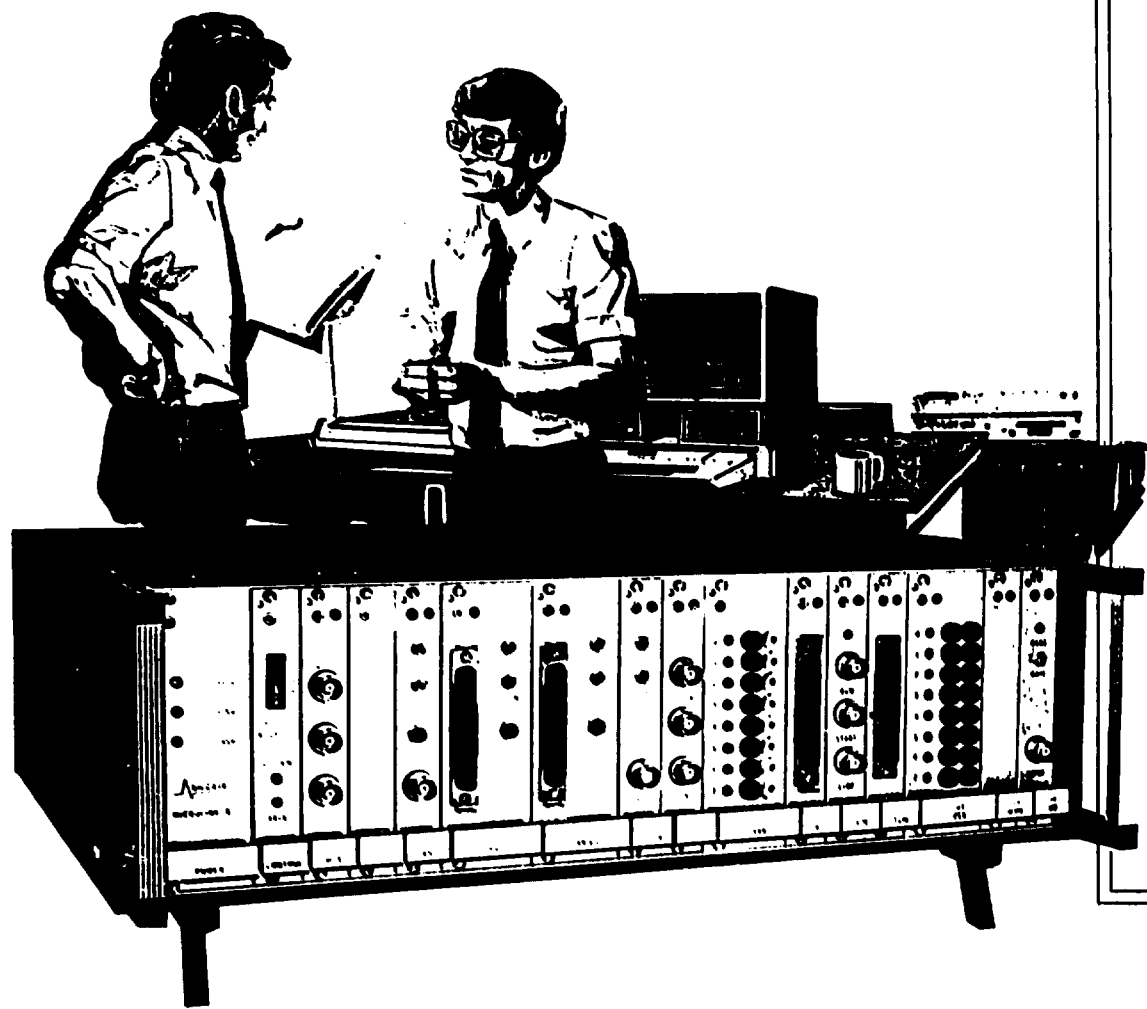
BIODATA
 SCROLINK

POWER

LISTEN
 TALK

CONTR





MICROLINK THE COMPLETE INTERFACING SOLUTION

MICROLINK is a modular hardware interface, specially designed for connecting laboratory instruments to microcomputers. It is a complete implementation of IEEE-488 which is the unique European and American standard for instrumentation interfaces – there is no other interfacing standard specifically intended for this purpose.

MICROLINK is flexible, versatile and offers superlative performance, backed by our unrivalled experience in the field of microcomputer interfacing. It offers the largest range of modules available, from which you may select any combination to plug directly into the mainframe. MICROLINK incorporates its own power supply and IEEE-488 control circuitry, and a single cable links it to your computer, while connections to instrumentation are made to the module front panels.

MICROLINK stands apart from fixed configuration interfaces or those of limited function. If high performance is your goal, MICROLINK is the answer – upto 256 analogue inputs, analogue to digital conversion at speeds of upto 60,000 samples per second and the ability to interface almost any instrument to your computer.

All this means that you can tailor an interface precisely to your initial requirements without paying for features that you don't want, and then add extra facilities when you need to. The choice of the IEEE-488 standard means that MICROLINK is compatible with most major microcomputers, and can be combined with upto 14 other instruments and peripherals to form integrated measurement or control systems.



MICROLINK FOR UNIVERSAL APPLICATION

MICROLINK's potential has been realized in environments as varied as North Sea oil production platforms, agricultural research stations, hospital neurological units and defence establishments. MICROLINK has solved interfacing problems in the following areas:

CHEMISTRY LABORATORY AUTOMATION

- Data collection from chromatographs and spectrophotometers
- Controlling mass spectrometers
- Interfacing electronic balances, colorimeters and temperature monitors
- Processing chart recorder data.

ENGINEERING

- Interfacing transducer outputs such as strain gauges, thermocouples and R.T.D.'s
- Generating control voltages
- Providing switching functions for valves and actuators
- Monitoring switch states.

ELECTRONICS AND PHYSICS

- Sampling multiple analogue voltage inputs
- Interfacing digital voltmeters and counters
- Controlling power supplies and generators
- Generating complex voltage waveforms
- Building ATE systems.

LIFE SCIENCES

- Sampling ECG, EEG and neural pulse data
- Event timing
- Controlling stimulus presentation.

These are just some of the uses of MICROLINK. To discuss your particular application, contact one of our sales engineers.



CONFIGURING THE MICROLINK THE MAINFRAME

MICROLINK's flexibility means that from the many available options you can select a configuration that precisely matches your needs. Here are a few hints to help you in your choice.

The mainframe containing the modules forms a single device on the IEEE-488 bus. Individual modules are simply accessed through use of a secondary address. Up to 15 devices can be connected on the IEEE-488 bus so that several MICROLINK's can be incorporated in an integrated measurement system. The devices on the bus can be up to 2m apart with a maximum bus length of 20m. If your equipment is further than this from the computer, you will require a bus extender.

The modules plug into the mainframe which handles communication with the IEEE-488 bus and incorporates a power supply. There are three sizes of free-standing mainframe providing space for 7, 12 or 18 single width modules - this is in addition to the power and control circuitry. These frames are the MF-7, MF-12 and MF-18, respectively. An MF-17 19" rack mounting version is also available. Modules are single, double or treble width.

To select a mainframe, first identify the modules you require and determine the number of single width spaces they will occupy; using the information provided overleaf and in the Technical Supplement. Then, choose a mainframe that will accommodate them, taking into account that you may wish to add further modules in the future.



TOTAL SOFTWARE SUPPORT FOR MICROLINK

MICROLINK fully implements the IEEE-488 standard to simplify communication between it and the computer – often only a couple of BASIC statements are necessary. Biodata support most computers that have IEEE-488 ports as standard or available as add-on cards.

To help you get your system up and running with minimum delay, each MICROLINK is supplied with a comprehensive user's manual, covering all aspects of its operation. Example programs, written in BASIC, are listed for each of the modules in the system. You can use these programs to familiarise yourself with MICROLINK, and then build on them to create your own measurement and control system.

The BASIC programs are listed in the dialect of BASIC appropriate to the computer used. Where necessary, we have supplemented the software supplied with particular computers' IEEE-488 interfaces, to ensure the fullest use of MICROLINK's facilities.

MICROLINK user manuals are available for a wide range of computers including Hewlett Packard, IBM, Apple, Apricot, Sirius, BBC, Commodore and DEC.

   **apple** **apricot**

sirius **BBC** **digital**  **commodore**

CONFIGURING THE MICROLINK THE MODULES

Analogue signals – single or multi-channel, single-ended or differential, analogue input modules are available. Multi-channel versions are appropriate where several analogue signals are of the same voltage range.

Input data are passed through either an 8- or 12-bit analogue to digital converter, one for each MICROLINK mainframe. For sampling at more than 20 or 30 times per second, you will need the high speed clock module, HSC, which controls the sampling rate and multiplexing of multiple analogue signals.

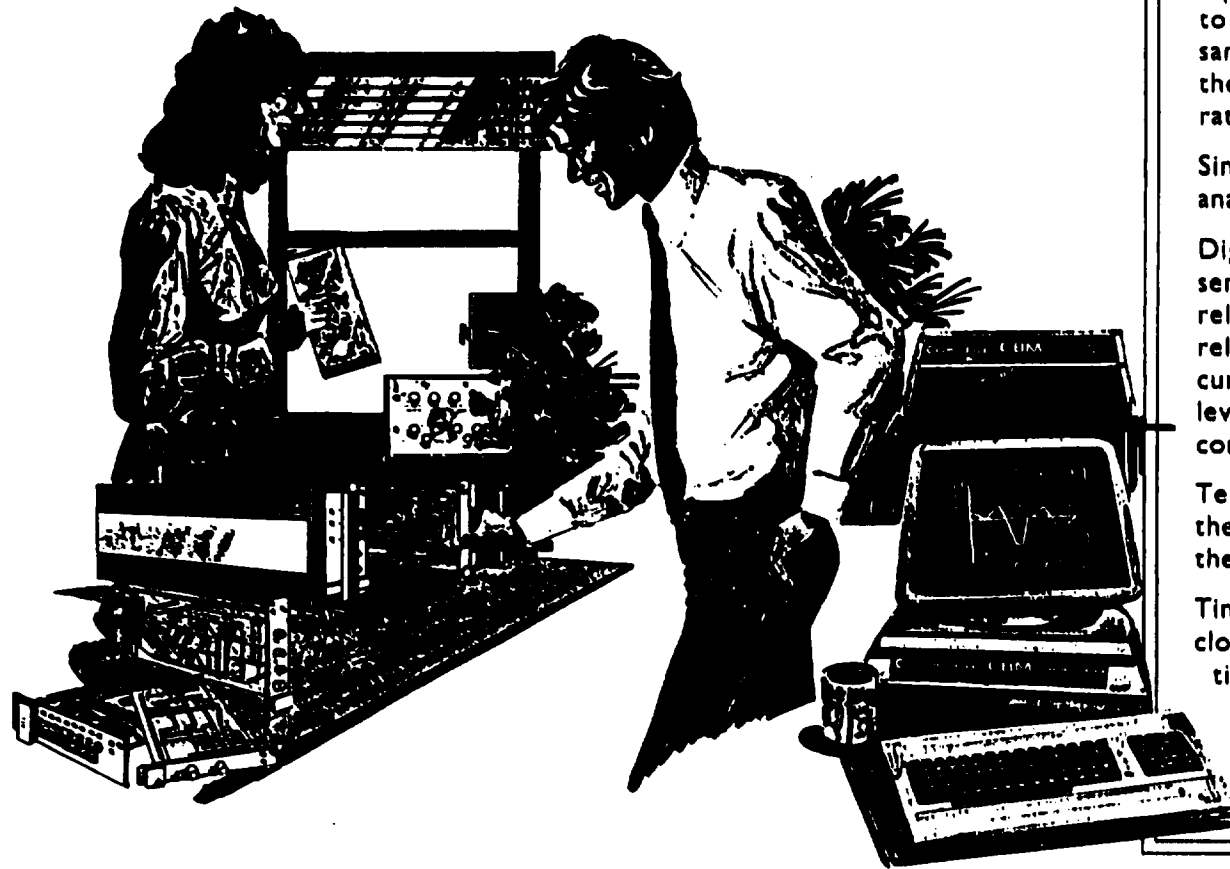
Single channel 8-bit and single and 4 channel 12-bit digital to analogue converters are available.

Digital signals – the contact closure module CC-8, is used to sense upto 8 TTL/CMOS inputs or switch states, while the reed relay module RR-8, provides 8 independently controllable relays. The HDR-4 gives 4 changeover relays suitable for heavier current loads. The BCD-8 module monitors the state of logic level signals on upto 8 lines, and the 8DO module enables the computer to generate logic signals.

Temperature inputs – 16 thermocouple inputs from most thermocouple types can be accepted by the TC-16 module, and the RTD-8 module supports 8 platinum resistance sensors.

Timing and counting – the HSC doubles as a precision real-time clock. The TIM, TAD and UDC provide inter-event/elapsed time measurement, time and date and event counting.

Special purpose functions – modules include those for RS-232 inputs, for stepper motor control and for physiological signals.



This is a guide to help you to select the modules needed for your application. Detailed specifications are provided in the Technical Supplement.

Modules are single, double, or treble width and occupy, respectively, 1, 2 or 3 spaces in the MICROLINK mainframe. All modules are single width except where otherwise indicated. Modules are removed by loosening two screws on the front of the module and sliding free. All modules are fully interchangeable and conform to a standard Eurocard and connector format.

SAMPLING ANALOGUE VOLTAGES SIGNAL CONDITIONING MODULES

- AN-1** A single-ended, single input, analogue voltage conditioning module.
- AN-1D** A differential input of the AN-1, with sample and hold facilities. The use of several AN-1Ds allows several channels to be simultaneously sampled.
- AN-16/32** This accepts either 16 differential analogue inputs or 32 single-ended analogue inputs. A p.c.b. switch selects either option.(double width)
- RMS-1** A single input module that converts the input signal to its equivalent r.m.s. amplitude.

If your signals are low level (< 10mV) or require to be kept floating free of earth you should use the differential input module AN-1D or the AN-16/32.

If you have less than four inputs, or if your signals have very different ranges, then use one or more single channel AN-1s or AN-1Ds.

If you have more than four inputs and your signals are of similar size, use the AN-16/32. Upto 256 single-ended, or 128 differential inputs can be accommodated in one MICROLINK mainframe, using multiples of the AN-16/32.

ANALOGUE TO DIGITAL CONVERTERS (ADCs)

- A-8D** 8-bit analogue to digital converter.
- A-12D** 12-bit analogue to digital converter.
- INT-16** 16 channel differential analogue inputs followed by a 4½ digit integrating analogue to digital converter.(double width)

8-bit conversion is appropriate for the sorts of signals that might previously have been monitored on an oscilloscope, chart recorder or meter. Where greater accuracy or resolution is required, use the 12-bit converter, for example when measuring temperatures where changes may be only a few percent of the measured value and good resolution is necessary. Only one converter of either type is required in any one MICROLINK mainframe regardless of the number of signal inputs. The INT-16 does not require separate analogue input modules.

DIGITAL TO ANALOGUE CONVERTERS (DACs)

- 8D-A** An 8-bit digital to analogue converter which converts numerical data in the computer to analogue voltages.
- 12D-A** A 12-bit version of the 8D-A.
- Q12D-A** A 4 channel version of the 12D-A. (double width)
- 8D-XY** Provides 2 channels of 8-bit D-A conversion for control of an analogue X/Y plotter.(treble width)

HIGH SPEED SAMPLING OF ANALOGUE DATA

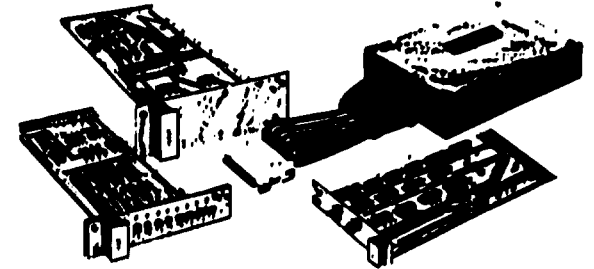
- HSC** Programmable high speed clock and multiplexer giving precision control over sampling rates. The HSC also allows external control of sampling.

Sampling rates of upto 20 or 30 samples per second are generally possible using a simple BASIC program.

For faster rates, or where precise timing is required, use the HSC module. The HSC module also controls multiplexing when more than one channel is sampled at high speed.

The rate at which data can be transferred is dependent upon the computer used. Maximum data transfer rates in K bytes/sec. are as follows: HP 85 - 20, HP 150 - 15, HP 9816 - 60, IBM PC - 10, Apple - 17, Sirius - 20, Amiga - 20, CRM 8022 - 10.

MICROLINK · THE MODULES



Data are transferred as 8-bit bytes. Thus, with 8-bit A to D conversion, one sample uses one byte, but with 12-bit, two bytes must be used so the overall sampling rate is halved. The speeds quoted are for single channel data transfer. To obtain the rate for one of N channels, divide by N.

DIGITAL INPUT, OUTPUT AND CONTROL

- BCD-8** Allows instruments with parallel binary coded decimal outputs to be interfaced to the computer - 8 digits can be accepted.
- 8DO** Allows the computer to send out 8 decades of parallel binary coded decimal data - can also be used to provide 32 TTL/CMOS compatible digital outputs. Tristate facilities are incorporated.
- RR-8** 8 reed relays set by a single stored data byte. (double width)
- CC-8** Accepts upto 8 digital inputs from TTL/CMOS devices or switch closures. (double width)
- HDR-4** 4 heavy duty changeover relays set by a single stored data byte.(treble width)
- TR-4** 4 transistor switches set by a single stored data byte.(double width)

MICROLINK · THE MODULES

DIGITAL INPUT, OUTPUT AND CONTROL

When choosing a module for switching applications, a critical factor is the power that has to be switched. You must consider the power drawn when the apparatus is switched on or off. The relay (RR-8 and HDR-4) specifications in the Technical Supplement are for steady state conditions e.g. a motor on startup will draw many times the steady state current. If the power switched by the relay exceeds specification then the contacts may be damaged. The transistor switches are useful in medium power applications where switching time is important e.g. for the control of solenoid operated camera shutters.

TEMPERATURE INPUTS

TC-16 Accepts upto 15 thermocouples and provides cold junction compensation on the sixteenth channel using a Pt resistance device at the thermocouple terminations.

RTD-8 8 channel resistance temperature detector input.

TIMING AND COUNTING

UDC A 6 decade counter that can be programmed to count up from zero or down from a preset count, to zero.

TIM A module that measures time in milliseconds between a start and stop signal. A signal can be sent either by the computer or can be generated externally.

- TAD** A clock/calendar module with battery backup. Provides separate registers for seconds, minutes, hours, days and months.
- HSC** The HSC module can be used to generate time intervals continuously from a few microseconds to 255 seconds.

SPECIAL PURPOSE MODULES

RS-232A microprocessor-based RS-232 input and output port, providing input and output data buffering and handling XON and XOFF protocol on output.

SMC Incorporates a stored program stepper motor controller which is programmed using high level commands sent as ASCII data.

IFM-8 Several modules have the capacity to set or pulse the Service Request (SRQ) line of the IEEE-488 bus, 'true'. If you have more than one module in the mainframe which can do this, the IFM-8 module will manage the SRQ interrupts, and ensure their correct servicing by the computer.

HR Measures beat to beat interval in milliseconds from an ECG signal (or pulse to pulse interval in a TTL/CMOS pulse train). An ECG R-wave detection circuit is switch selectable. Maximum interval 9.999 seconds.

NHI Accumulates post- and peri-stimulus time and interval histograms from neural pulse data.(double width)

DESIGNING YOUR OWN MODULES

A prototyping and technical manual provides information which allows you to develop customized modules. The manual provides details of backplane connections, timing diagrams and interface logic.

GUARANTEE

Biodata will repair or replace without charge, any instrument manufactured by themselves which fails in normal service within one year of purchase date. This excludes failure caused by misuse. An extended warranty is available on an annually renewable basis.

DISTRIBUTED BY:

Biodata

BIODATA LTD., 10 STOCKS STREET, MANCHESTER M8 8QG, U.K. TEL: 061-834 6688

MAINFRAME

The mainframe consists of a cabinet containing the IEEE-488 interface, power supply and empty slots into which the modules are plugged. A choice of 3 free-standing mainframes, designated MF-7, MF-12 and MF-18, is available to accommodate upto 7, 12 or 18 single width modules. An MF-17 19" rack mounting version is also available.

Interface	IEEE-488, primary address 0-30
Operating ambient	0-40°C
Front panel indicators and controls	+15V, +5V, -15V power supply indicators. Listen and Talk status indicators DIL address switch
Power supply	240V ± 10%, 50Hz 120V, 50Hz or 110V, 60Hz on request
Size MF-7	246mm x 420mm x 145mm
MF-12	338mm x 420mm x 145mm
MF-17	483mm x 420mm x 145mm
MF-18	460mm x 420mm x 145mm

MODULES

A listing of modules follows, while specifications are provided overleaf.

1. MODULES FOR ANALOGUE SIGNAL CONDITIONING AND ANALOGUE TO DIGITAL CONVERSION

AN-1	single analogue input
AN-1D	differential analogue input
AN-16/32	16 differential analogue inputs or 32 single-ended analogue inputs
RMS-1	r.m.s. to D.C. converter
A-8D	8-bit analogue to digital converter
A-12D	12-bit analogue to digital converter
IIT-16	16 channel integrating analogue to digital converter
HSC	high speed clock

2. MODULES FOR DIGITAL TO ANALOGUE CONVERSION

8D-A	8-bit digital to analogue converter
12D-A	12-bit digital to analogue converter
Q12D-A	4 channel 12-bit digital to analogue converter
8D-XY	2 channels of digital to analogue conversion for control of an X/Y plotter

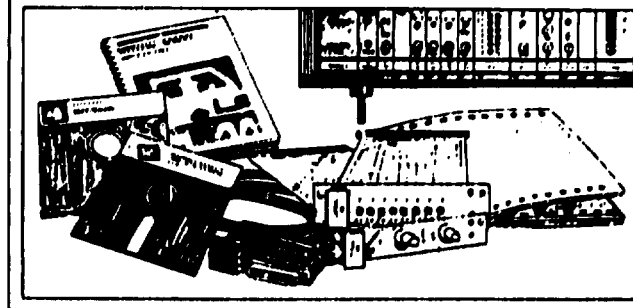
3. MODULES FOR DIGITAL INPUT, OUTPUT AND CONTROL

BCD-8	accepts BCD input upto 8 decades
RR-8	8 independent reed relays
HDR-4	4 heavy duty changeover relays
TR-4	4 transistor switches
8DO	provides TTL outputs on 32 lines
CC-8	8 digital inputs for monitoring contact closures

4. TEMPERATURE INPUTS

TC-16	16 thermocouple inputs
RTD-8	8 R.T.D. inputs

MICROLINK TECHNICAL SUPPLEMENT



5. TIMING AND COUNTING MODULES

UDC	up/down counter
TAD	time and date clock
TIM	millisecond timer

6. SPECIAL PURPOSE MODULES

RS-232	serial interface
SMC	stepper motor controller
HR	heart rate timer
IFM-8	interrupt flag and mask

COMPUTER HARDWARE

MICROLINK can be used with any computer that has an IEEE-488 port as standard or available as an add-on card. MICROLINK can be used with the following:

MICROS WITH BUILT-IN IEEE-488 INTERFACES

Commodore 4000 and 8000 Series
HP 86B
HP 87
HP 150
HP 9816, 9826, 9836
Sirius

MICROS WITH IEEE-488 FACILITIES PROVIDED BY ADD-ON BOARDS

Apple II
Apricot
BBC Micro
DEC Professional
DEC Rainbow
HP 85B
IBM PC

We can supply the add-on boards for the computers above, and full specification sheets are available on request.

N.B. If your computer is not listed here, please enquire as we are constantly expanding our coverage.

COMPUTER SOFTWARE

MICROLINK is supplied with software for most computers that have IEEE-488 facilities as standard or available as add-on cards.

Software is generally provided on disk and a comprehensive manual accompanies the disk. This manual incorporates a general section including an introduction to the facilities offered by the IEEE-488 bus and a description of the mainframes and the whole range of modules. A further section deals with the specific computer used with MICROLINK, providing example programs for each module, written in the dialect of BASIC appropriate to the computer.

With this depth of software support MICROLINK is not dedicated to any particular computer. If you wish to use MICROLINK with different computers, it is simply a matter of ordering the appropriate software packages.

APPLE II

Software medium: 5.25" disk

APRICOT

Software medium: 3.5" disk
Operating system: MS-DOS

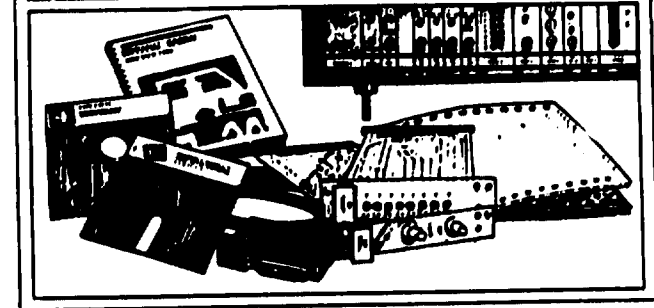
BBC MICRO

Software medium: 5.25" disk

COMMODORE 4000 AND 8000 SERIES

A software manual is provided with these computers. If an HSC high speed clock module is used, then a plug-in ROM is supplied for the computer to supplement the CBM BASIC, together with a cassette tape or disk providing examples of machine code usage.

MICROLINK TECHNICAL SUPPLEMENT



HP 85B

Software medium: Plug-in I/O ROM

HP 86B

A software manual is provided in HP BASIC

HP 87

Software medium: Plug-in I/O ROM

HP 150

Software medium: 3.5" disk
Operating system: MS-DOS

HP 9816, 9826, 9836

A software manual is provided in HP BASIC. If an HSC high speed clock is used, the disk BASIC EXTENSIONS 2.1 must be used.

IBM PC

Software medium: 5.25" disk
Operating system: PC-DOS

SIRIUS

Software medium: 5.25" disk
Operating system: MS-DOS

1. MODULES FOR ANALOGUE SIGNAL CONDITIONING AND ANALOGUE TO DIGITAL CONVERSION

The MICROLINK system is arranged so that one analogue to digital converter module can service a number of analogue signals. The signals themselves are input through analogue signal conditioning modules, which match the voltage range of the signal to the voltage input range of the analogue to digital converter.

ANALOGUE SIGNAL CONDITIONING

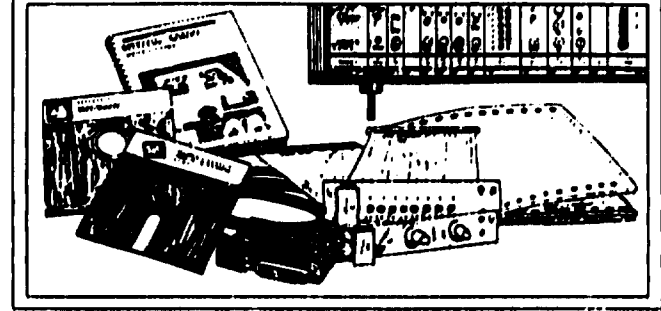
AN-1 An analogue input module with its own secondary address for software scanning of the analogue signals. A switch enables selection of 3 voltage ranges 10V, 1V and 0.1V. An additional GAIN trimmer allows setting of the full scale input range anywhere from 10mV to 10V. An OFFSET trimmer allows the D.C. offset voltage to be adjusted to meet different signal types.

Full Scale Ranges	100mV, 1V, 10V nominal
F.S. Gain Adjust	10% to 100% of nominal range
Offset Adjust	Allows removal of offset from -110% to +25% of full scale range (referred to 0V input for data 0 output)
Minimum F.S. Span	10mV
Maximum F.S. Span	10V
Input Impedance	100M Ω
Module Width	1

AN-1D A differential input version of the AN-1 that is appropriate for low level signals, signal generators that have high output impedance, or signals that require to be kept at high impedance from mains earth. The minimum full scale range is 1mV, maximum 10V. As well as accepting a single differential input, the AN-1D now has a sample and hold circuit, which is only brought into use when the unit is under HSC high speed clock control. The facility is enabled by setting the appropriate bit in the control byte. In a high speed scan, the sample and hold circuit is put into sample mode by the "return" signal occurring at the end of the scan. The circuit is switched to hold by the first sample of the next scan. The use of several AN-1D's now enables several channels to be simultaneously sampled. The limit on the number of channels sampled is set by the size of the mainframe.

Full Scale Ranges	10mV, 100mV, 1V, 10V nominal
F.S. Gain Adjust	10% to 100% of nominal range
Offset Adjust	Allows removal of offset from -110% to +25% of full scale range (referred to 0V input for data 0 output)
Maximum Input Voltage Range	$\pm 12V$
Frequency Response	To >10KHz except on 1mV range (1 KHz)
Input Noise	1.0 μV pk - pk (0.01 - 10Hz) 1.3 μV rms (D.C. - 10KHz)

MICROLINK TECHNICAL SUPPLEMENT



Differential Input Impedance	100M Ω
Common Mode Input Impedance	100M Ω
CMRR	90 - 110dB (low gain - high gain)
Input Voltage Stability	2 $\mu V/^{\circ}C$ (at gain = 100)
Input Socket	3 pin DIN
Sample and Hold aperture time	125 n sec
Module Width	1

AN-16/32 This accepts 16 differential analogue inputs or 32 single-ended analogue inputs. A p.c.b. switch selects use for 16 differential inputs or 32 single-ended inputs. The analogue signals are input through a 37-way D-connector, and are multiplexed to an AN-1 type signal circuit. The AN-16/32 has an internal multiplexer which allows individual channels to be selected from software, or multiple channels can be read in a multiplexed scan of 1 upto 32 channels. The AN-16/32 should be used when multiple analogue channels have to be digitised, provided the analogue signals are of similar full scale amplitude, because the gain and offset controls apply to all channels connected to an AN-16/32. One or more AN-16/32's can be used under the timing control of an HSC for high speed scanning of upto 256 single-ended analogue inputs, or 128 differential inputs.

Full Scale Ranges 100mV, 1V, 10V nominal
 F.S. Gain Adjust 10% to 100% of nominal range
 Offset Adjust Allows removal of offset from -110% to +25% of full scale range (referred to 0V input for data 0 output)

Amplifier
 Input Noise 1.0 μ V pk - pk (0.01 - 10Hz)
 Input Impedance 100M Ω
 CMRR 90 - 110dB (low gain - high gain)

Input Voltage
 Stability 2 μ V/ $^{\circ}$ C (at gain = 100)
 Multiplexer

Input Switch On - resistance 400 Ω typical

On-resistance v. temp $\pm 1.5\Omega/^{\circ}$ C

On-leakage-current 0.1nA typical (max 0.5)

Cross-talk between channels 75dB (at 500 KHz)
 Module Width 2

RMS-1 This converts analogue voltage signals to their RMS (root mean square) values.

Maximum Input Voltage Range $\pm 12V$ pk-pk
 RMS Voltage Ranges 0.01, 0.02, 0.05, 0.1, 0.2, 0.5, 1, 2, 5 V rms
 Input Impedance 10M Ω
 Bandwidth D.C. to 10KHz on 0.01 range rising to D.C. to 2MHz on 5V range

Time Constant of RMS Integration 250ms
 D.C. Offset at output, referred to input (A.C. coupled) 1mV
 Accuracy of Gain Settings better than 0.5%
 Module Width 1

ANALOGUE TO DIGITAL CONVERSION

A-8D This accepts data from an analogue signal conditioning module and converts it to a digital form for the IEEE-488 bus. The input module is connected to the A-8D by instructions from the computer, and one A-8D will accept signals from any number of analogue input modules.

Relative Accuracy $\pm 0.2\%$ (8-bits)
 Linearity $\pm 1/2$ least significant bit
 Sample and Hold - Acquisition Time < 5 μ sec.
 Aperture Time 125 n sec
 Conversion Time < 10 μ sec.
 Data Type single byte BINARY
 Module Width 1

A-12D A 12-bit analogue to digital converter giving greater resolution than the A-8D, which is suitable for both slow and rapid sampling.

Relative Accuracy $\pm 0.025\%$ (12-bits)
 Non-linearity Error < ± 1 least significant bit
 Sample and Hold - Acquisition Time < 10 μ sec
 Aperture Time 125 n sec
 Conversion Time 25 μ sec approx.
 Data Type switch selectable from:
 i) 3 ASCII characters + carriage return
 ii) 2 byte binary (8 most significant + 4 least significant bits)
 iii) 2 byte integer (4 most significant + 8 least significant bits)
 iv) 1 byte 8 most significant bits

Module Width 1

INT-16 This is a 16 channel integrating analogue to digital converter, with software-selectable voltage ranges. The INT-16 is particularly suitable for high resolution, low speed applications. Unlike the A-8D or A-12D, the INT-16 does not require separate analogue input modules.

Ranges $\pm 11V, \pm 2V, \pm 200mV$
 Resolution 10 μ V (4 $1/2$ digit)
 Accuracy $\pm 0.03\%$ reading + 2 digits
 Conversion Rate 2.5 readings per sec
 DVM Chip Intersil 7135 or equivalent
 Data Output returns 5 ASCII characters, reading latched, rejects 50 and 60Hz.

Integration Period
 Common Mode
 Voltage $\pm 13V$ maximum
 C.M.R.R. 90dB
 Module Width 2

HIGH SPEED CONTROL OF ANALOGUE TO DIGITAL CONVERSION

HSC The high speed clock permits the conversion of analogue data at fixed intervals. The HSC can multiplex analogue input channels from one or more analogue input modules, so that a separate multiplexer is not required. The clock is crystal-controlled and is programmed with 2 data bytes – the first selects the basic clock units in powers of 10 from 1 μ sec to 1 sec, and the second, the number of clock units to elapse between each sample. The limits on data transfer rate will probably depend on the type of microcomputer you are using e.g. with the HP 9816 the maximum data transfer rate from the MICROLINK is 60 Kbytes/sec, with IBM PC 10 Kbytes/sec and with Apricot 20 Kbytes/sec. On-board switches allow sampling to be controlled by an external clock signal, and enable a full multiplexed scan to be taken at each time interval. Sampling can be initiated by software or by an external signal.

Clock Units	1 μ s, 10 μ s, 100 μ s, 1ms, 10ms, 100ms, 1s
Programmable Interval	1 to 255 clock units
Stability	< 50 p.p.m. over 0-50°C
Data Type	HSC programming data – 2 BINARY coded bytes. The use of the HSC alters the output of the A-8D and A-12D to FAST BINARY type.
Module Width	1

2. MODULES FOR DIGITAL TO ANALOGUE CONVERSION

These modules enable numeric data to be converted to analogue voltages for the purposes of waveform generation, plotting results on chart recorders or providing analogue control of instruments. There are two modules which provide single analogue voltage outputs with either 8-bit or 12-bit resolution, and a 4 output module with 12-bit resolution. A further module is designed to allow plotting on an analogue X/Y plotter.

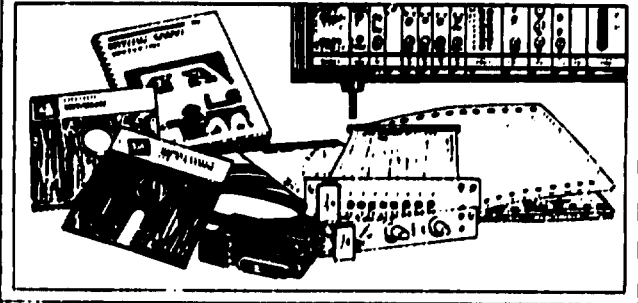
DIGITAL TO ANALOGUE CONVERTERS

8D-A An 8-bit resolution digital to analogue converter providing a single channel of analogue output. GAIN and OFFSET trimmers give control over full scale voltage output and D.C. output.

Accuracy	$\pm 0.2\%$
Linearity	$\pm 1/2$ least significant bit
Response Time	< 25 μ s for full scale step
Output Offset	From $\pm 10\%$ to $\pm 110\%$ of set output range (allows all +ve, all -ve and bipolar outputs)
Output Range	Adjustable to a maximum of $\pm 10V$
Data Type	BINARY
Module Width	1

12D-A A 12-bit resolution digital to analogue converter intended for the generation of accurate voltage outputs within a number of fixed full scale ranges. GAIN and OFFSET controls are available to fine trim the full scale output voltages to the correct value. Data is sent as 2 bytes, the first byte containing the most significant 4-bits, the second byte the least significant 8-bits (i.e. 16-bit integer format).

MICROLINK TECHNICAL SUPPLEMENT



Accuracy	$\pm 0.013\%$
Linearity	$\pm 1/2$ least significant bit
Full Scale Ranges	$\pm 10, \pm 5, \pm 2.5, 0-10, 0-5V$ (selectable)
Response Time	5 μ s for full scale step (to $\pm 0.01\%$ of full scale)
Maximum Output Current	$\pm 5mA$
Output Impedance	0.05 Ω
Data Type	BINARY
Module Width	1
Q12D-A	This provides 4 channels of 12-bit digital to analogue conversion.
Ranges	0-10V or $\pm 10V$ selected by p.c.b. switches
Power-up Condition	always 0V output
Connection	4 BNC sockets
Output Current	$\pm 10mA$ at 10V
Accuracy	$\pm 1LSB$
Module Width	2

X/Y PLOTTER CONTROL

8D-XY This provides 2, 8-bit resolution, digital to analogue converter channels for controlling the pen position of an analogue X/Y plotter. A reed-relay output can be used to operate the external pen-lift control available on many plotters. The module accepts data as pairs of bytes which are converted to simultaneous voltage changes on the X and Y channels. GAIN and OFFSET controls are included for each channel.

D-A specifications	as 8D-A
Relay	normally open contacts; 28V D.C., 250mA maximum
Connections	X, Y channels – BNC sockets Pen lift relay – 2 x 4mm sockets
Data Type	2 or 3 byte BINARY
Module Width	3

3. MODULES FOR DIGITAL INPUT, OUTPUT AND CONTROL

INTERFACING INSTRUMENTS WITH BCD OUTPUTS

BCD-8 This module offers upto 8 decades of BCD (Binary Coded Decimal) input. Many instruments with digital displays offer BCD outputs and these can be easily interfaced through a MICROLINK fitted with a BCD-8 module. The BCD-8 also has 3 control lines (2 inputs from the external instrument and 1 output from the computer) that can be used to provide a 'handshake' of the data and/or signal the computer that a reading should be taken. The latter is accomplished by sending an SRQ interrupt to the

computer. The BCD-8 module will always transmit 8 digits to the computer, the end of the data being signalled on the EOI line of the IEEE-488 bus as the last digit is transmitted. If fewer than 8 decades are required for your instruments, then the most significant decades can be wired to 0's or be used to transmit status information from the instrument.

Inputs	TTL/CMOS compatible biased to +5V through 4k7 resistor
Output Connection	TTL/CMOS compatible
Data Type	37-way D-type socket
Module Width	1

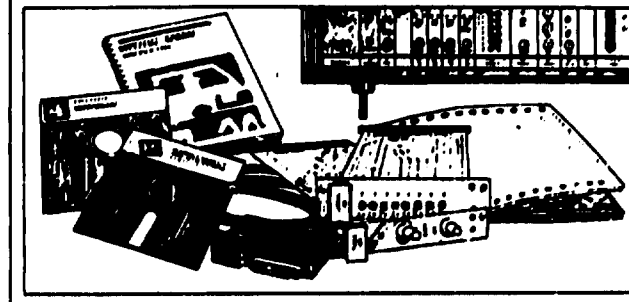
RELAY AND TRANSISTOR OUTPUTS FOR SWITCHING FUNCTIONS

RR-8 8 independent reed-relays in a single module. The state of each of the 8 relays is determined by the 8-bits of a single data byte. The state of each relay is indicated by a light emitting diode. The reed-relays are ideal for switching low voltage, low current signals at relatively high speeds. For mains voltage or higher currents see the HDR-4.

Relays	Normally open 28V D.C. 250mA max
Operate/Release Time	1msec (typical)
Connections	2 x 2mm sockets for each relay
Data Type	single byte BINARY
Module Width	2

HDR-4 4 heavy-duty changeover relays, capable of switching mains voltage. The state of each of the 4 relays is determined by the least

MICROLINK TECHNICAL SUPPLEMENT



significant 4 bits of a single data byte. Connections to the relays are made either through screw terminals on a 12-way strip, or by soldering to a 12-way 'fanning-strip'.

Relays	Changeover type; maximum ratings (resistive loads) <5A at 30V D.C. or 250V A.C.
Operate/Release Times	<16msec
Connections	Solder terminals or screw terminals
Data Type	single byte BINARY
Module Width	3

TR-4 The TR-4 module provides 4 solid state (transistor) switches which can be programmed by a single data byte. The state of each switch is determined by the least significant 4 bits of a single data byte. The state of each switch is indicated by a light emitting diode.

Switching characteristics < 1A, < 50V
 Connections 2 x 2mm sockets for each transistor
 Data Type single byte BINARY
 Module Width 2

MULTIPLE TTL DRIVER LINES

8DO This gives TTL compatible outputs on 32 lines, arranged as 8 groups of 4. Each of the 32 lines is individually controllable from the computer, but to make programming easier, 8 decades of BCD information are sent from the computer to set the 8 groups of 4 lines.

This now has tristate facilities added. The outputs can be placed in tristate mode either by external control or by software.

Outputs Will drive 2 standard TTL loads

Connection 37-way D-type socket
 Data Type ASCII (8 character message)
 Module Width 1

MONITORING THE STATE OF SWITCHES OR TTL LOGIC LEVELS

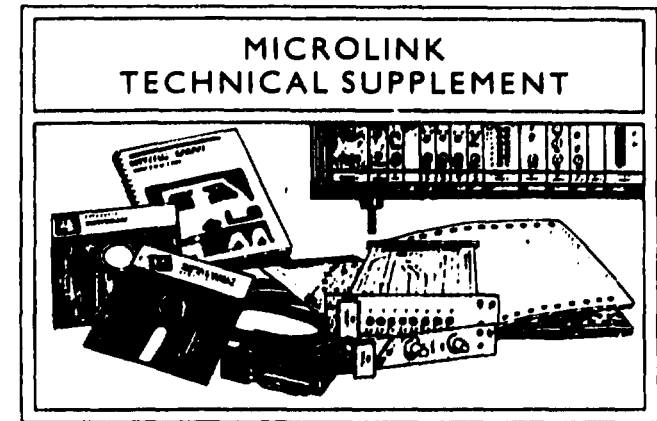
CC-8 8 digital inputs that can be used to monitor the state of switches (contact closures) or TTL logic levels. The states of the 8 inputs are transferred to the computer as the 8 bits of a single data byte. The information transferred is the instantaneous state (i.e. the module does not de-bounce switch closures). The state of each input is indicated by a light emitting diode.

Inputs TTL/CMOS compatible, biased to +5V through 4k7 resistor
 Connections 2 x 2mm sockets for each input
 Data Type single byte BINARY
 Module Width 2

4. TEMPERATURE INPUTS

TC-16 The TC-16 module provides the elements for monitoring thermocouple voltages. Upto 16 thermocouples can be monitored. The TC-16 comprises an isothermal box, which contains a copper block heat sink onto which the thermocouple leads are terminated using screw connections. Also included in the isothermal box is an encapsulated RTD mounted on the copper block, which can be monitored as one of the 16 input channels, to provide a cold junction reference temperature. The isothermal box is connected via ribbon cable to the TC-16 module within the MICROLINK mainframe. This module contains an FET multiplexer and a high accuracy instrumentation amplifier. The output voltage from the module can be converted by one of the MICROLINK analogue to digital converter modules, A-12D or A-8D.

The module features the capability of selecting any one of the 16 inputs by sending a single data byte from the computer. The gain of the amplifier is selectable from x100, x200, x500 and x1000, by the same data byte. (The output of the amplifier conforms to the full scale input range of the A-D converters which is



0-10.24V.) An offset is applied so that temperatures less than ambient can be monitored. When the gain is set to x100, normal thermocouple voltages can be handled, in the range -25.6 to +76.8mV. The higher gains permit better resolution of temperatures close to ambient. The module also provides the precision voltage source necessary for energising the resistance bridge to monitor the RTD resistance. The manual provided with the TC-16 contains formulae for calculating temperature from voltage for common thermocouple types, and corresponding formulae for calculating equivalent cold junction offset voltage from measured RTD bridge voltage.

Multiplexer
 Input switch on resistance 400Ω typical max 580Ω
 on resistance v. temp. + 1.5Ω/°C
 on resistance match 35Ω
 on leakage current 0.1nA typical max 0.5nA
 cross-talk between channels (at 500kHz) 75db

Amplifier
 Input offset current 10nA typical
 Input offset current v. temperature $\pm 0.5\text{nA}/^\circ\text{C}$
 Input offset voltage v. temperature $< 0.85\mu\text{V}/^\circ\text{C}$
 Input offset voltage v. time 1.2 μV /month typical
 Input noise
 0.01 - 10Hz 0.8 μV p-p
 10Hz 18nV/ $\sqrt{\text{Hz}}$
 100Hz 15nV/ $\sqrt{\text{Hz}}$
 Bandwidth D.C. - 10kHz normally limited to 500Hz
 Input impedance to ground 1M Ω
 CMRR (1k Ω source imbalance) 110dB
 Max CM voltage $\pm 10\text{V}$
 RTD
 Platinum resistance sensor conforms to BS1904
 Bridge resistances 100 $\Omega \pm 0.1\%$ 3 ppm/ $^\circ\text{C}$
 Bridge voltage 1V
 Module Width 1
RTD-8 This will monitor temperature from upto 8 resistance temperature detectors. 2, 3 or 4 wire configurations can be used. The RTD-8 has 2 resistance ranges which are software-selected, with the resolution determined by the analogue to digital converter being used. The nominal accuracy of the RTD-8 is ± 0.1 ohm, and higher accuracy can be obtained by auto-calibration techniques.
 Module Width 1

5. TIMING AND COUNTING MODULES

UDC This is a 6 decade up/down counter module. The count direction can be controlled either by software or by an external input. The count input will accept TTL pulses or switch closures and can be inhibited by an external "GATE" input. The counter contents can be preset from software and the counter can be read at any time. When the counter is counting down, an SRQ interrupt signal is generated on the IEEE-488 bus when the count reaches zero.

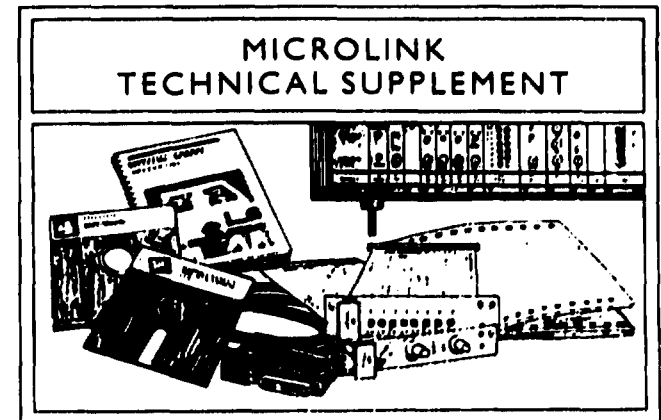
Maximum Count 999999
 Inputs Count TTL/CMOS biased to 5V
 Up/Down via 4k7 resistor
 Gate

Data Type 6 digit ASCII, single byte
 BINARY programming information

Module Width 1

TAD The TAD module provides the MICROLINK with a clock/calendar. The module has a battery back-up so that the clock continues to run while power to the MICROLINK is switched off. The clock is presettable from the computer and the following information is available to be sent to the computer: Seconds (0-60), minutes (0-60), hours (0-24), days (1-28, 30, 31), days of week (1-7), months (1-12). The clock can handle transitions through leap years. Accuracy is ensured through crystal control.

Module Width 1



TIM This timer module can be started either by a switch closure or by the computer, and can be stopped similarly. When addressed, the module will transmit the time in milliseconds between the start and stop signals. The TIM module can also generate an SRQ interrupt on the IEEE-488 bus, when it receives a start or stop command. A RUN output socket changes from normally high (+5V) to low (0V) while the timer is running and can be used to synchronise external equipment to the START and STOP of the timer. Data is transferred as a 5 digit number, and the EOI line of the IEEE-488 bus is set during the transfer of the fifth digit.

Input TTL/CMOS compatible biased to +5V through 4k7 resistor
 Maximum Time 99999 ms
 Data Type 5 digit ASCII to computer, single byte BINARY control from computer
 Module Width 1

6. SPECIAL PURPOSE MODULES

RS-232 This serial data interface module provides a means of interfacing one or more peripherals that normally communicate on an RS-232C/V24 serial link. Using this module, the associated computer can access multiple V.D.U.'s, tape drives, tape readers, printers and other peripherals giving each RS-232C port its own address.

Baud Rates 50-9,600 in 13 standard rates
Data Format transparent to computer, accepts BINARY data 0-255 range, 7/8 data bits, 1/2 stop bits selectable
Connection Female socket, configured as DCE (modem)
Buffer Size ~700 bytes, input and output
Handshakes Hardware: DSR, DTR and CTS all implemented
 Software: X-ON, X-OFF available

Module Width 1

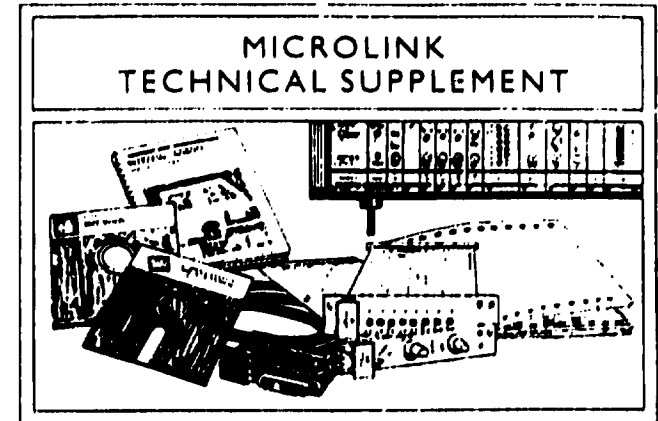
SMC This module incorporates a CY-500 stored program stepper motor controller. The SMC accepts high level language commands sent as data over the IEEE-488 bus for convenient control of directional position and acceleration of any 4-phase stepper motor. The SMC is supplied with the CY-500 programming manual which has full details of the commands used.

Features include a stored program capability ramp-up/slew/ramp-down mode: 22 instruction set: do-while command and wait-until command. The SMC operation is easily set up from BASIC. All inputs and outputs are TTL-compatible.

Module Width 1

HR This module accepts as input either an amplified ECG signal or TTL/CMOS level pulses. The module times, in milliseconds, the pulse to pulse interval (R-R interval for the ECG). The module can send an SRQ interrupt at each pulse received (each R-wave detected). When addressed the last measured interval is transferred as a 4 digit number. The R-wave detector is an amplitude level detector that operates on an ECG signal of either polarity. A GAIN control provides amplitude level adjustment. A BEAT light-emitting diode is illuminated at each pulse or detected R-wave.

Input (logic pulse) TTL/CMOS compatible biased to +5V through 4k7 resistor
(ECG) Variable amplitude, can operate on R-wave amplitudes of 100mV to 5V
Maximum Interval 9999 ms
Data Type 4 digit ASCII
Module Width 1



IFM-8 The IFM-8 interrupt, flag and mask module is used when more than one module in the MICROLINK can generate SRQ interrupts. The IFM-8 can manage SRQ interrupts from upto 8 sources within the MICROLINK mainframe. The IFM-8 receives the service request from a module, then compares the source of this request with a mask register set by software to see whether this source is allowed to cause an SRQ. If so, an SRQ true signal is put on the IEEE-488 bus and is held until the computer responds to it. The source of the request can be determined by reading the interrupt register of the IFM-8, whose bit pattern determines which sources are currently requesting service. The IFM-8 requires a minor modification to the backplane connections of modules used with it.

Module Width 1

Biodata



LX86 FX SERIES

From the pristine original ... derives (and all too easily, it seems) the imperfect copy.

A problem — inherent in now outmoded technology — which is avoided entirely with our LX and FX printers.

Eliminating the fuss and mess of less advanced methods, these sophisticated machines perform every day-to-day printing task (in the office, school or at home) with flair and precision.

Effortlessly, at the press of a button, these printers produce perfect copy. And reproduce it — time and time again. All to the same exacting standards.

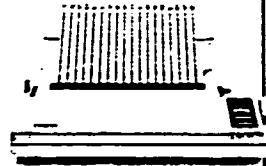
They'll take multiple stationery in their stride too, as and when required.

And happily, paper management is no longer a challenge to manual dexterity. Now, Epson make it simple.

There's no mess either. Every letter, report, spreadsheet is printed flawlessly.

No make-do cover ups with correcting fluid. And no carbon. (No smudges. No smears).

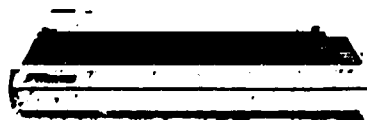
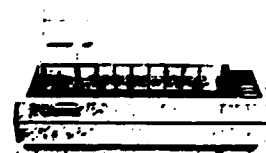
Just perfect copy. Every time.



Yet there's more than just clean, easy printing! For all printers in the FX and LX Series offer a host of built-in, powerful features ...

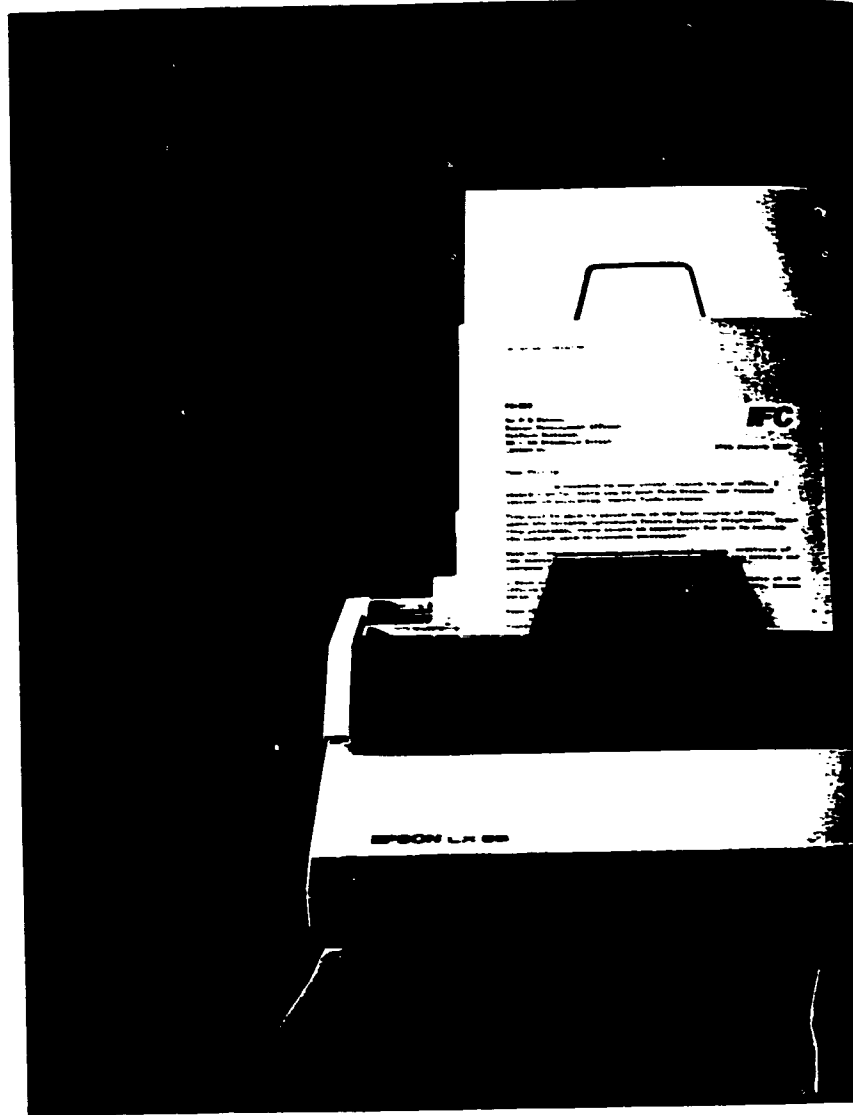
Such as fast draft print in a variety of typestyles. And bold, quality fonts — perfect for all important correspondence. With a full selection of attractive typestyles for much greater freedom of expression! These versatile printers even offer you the opportunity to create special symbols and logos — adding a personal touch to any business document.

And, of course, all printers require only the minimum of maintenance — ensuring every task is carried out efficiently. And always with style!



Easy, clean, trouble-free printing is a priority when you're choosing a printer for the classroom, study or small business. Epson's LX-86 offers you just that — plus a few extra benefits!

Such as a range of typesyles, fonts and printing options, so you can quickly and easily create perfectly finished letters, reports and documents. And a range of paper-handling options for easy paper feeding. With quick-change ribbons and simple installation.



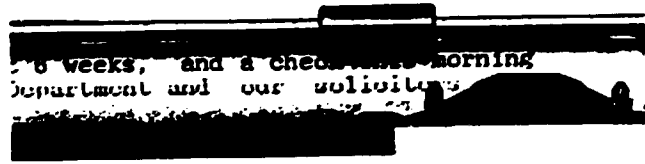
Specifically designed to give you reliable printing performance to a continuously high standard, the LX-86 dot-matrix printer

additional range of useful features. All at a price which represents unprecedented value for money.

are a draft printing speed around 120 cps; a built in Roman font for correspondence print; Pica and Elite character spacing for all drafting work; graphics capabilities; built in buffer; a standard parallel interface and a full repertoire of useful and attractive typesyles.

To create a superior correspondence quality image, two specially written typefaces are combined. The last line pictured here shows the first pass before the printhead makes its second pass.

much of your time with more...
 ch constructive and potential...
 anies.



combines selectable draft, correspondence and graphics print together with printing accuracy, speed and an

Stylish features.
 Just some of the features which have established the LX-86 as one of the best-selling printers

Flexible too ...

For example, if you're printing a report you'll find the LX-86 quickly produces high-definition charts and diagrams in combination with text in typesyles of your choosing — including sub and super-script.

P
R
I
N
T
E
R
S
A
B
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
S
T
U
V
W
X
Y
Z
0
1
2
3
4
5
6
7
8
9
@

\$
%
&
'
(
)
*
+
,
-
.
:
;
=

P
R
I
N
T
E
R
S
A
B
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
S
T
U
V
W
X
Y
Z
0
1
2
3
4
5
6
7
8
9
@

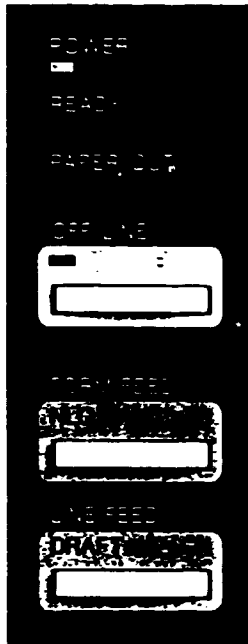
\$
%
&
'
(
)
*
+
,
-
.
:
;
=

P
R
I
N
T
E
R
S
A
B
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
S
T
U
V
W
X
Y
Z
0
1
2
3
4
5
6
7
8
9
@

\$
%
&
'
(
)
*
+
,
-
.
:
;
=



The LX-86, featuring the optional automatic cut-sheet feeder, easily taking as many as 75 sheets of paper at a time.



Features such as the control panel conveniently located at the front of the LX-86 make this printer so easy to use.

Moreover, a friction feed makes sure every individual sheet of paper feeds through smoothly and easily, ready for printing. If you need to feed cut sheets at speed, there's an inexpensive optional cut-sheet feeder. For continuous stationery, an optional tractor feeder enables the LX-86 to handle anything from pre-printed forms to self-adhesive labels just 3 inches wide.

With built-in reliability.

Finally, we know you'll be looking for reliability. And as a measure of our reliability — backed by our assurance you'll benefit from easy, troublefree printing — the LX-86 boasts a printhead life of one hundred million characters. At least.

And to help you make the most of these features, the LX-86 carries out a range of word processing functions — including highlighting and underline.

enlarged and condensed, emphasised, double-strike and italics.

	Normal
DRAFT	Condensed
	Double-width
PICA	Double-width
	Double-width condensed
	Normal
DRAFT	Condensed
	Double-width
ELITE	Normal
	Double-width
ROMAN	Normal
	Double-width
HEB	Normal
	Double-width

You can add international characters. And use the buffer to design six of your own. You can create special mathematical and chemical formulae. Or create logos and unique symbols to give your correspondence a personal touch.

FONTS AND TYPESTYLES

PITCH Number of characters per inch	EMPHASISED Single pass — horizontal press head displacement	DOUBLE STRIKE Second pass — vertical paper displacement	ITALIC	UNDERLINE	SUB-SUPERSCRIPT Half-height characters
10	•	•	•	•	•
12	•	•	•	•	•
14	•	•	•	•	•
16	•	•	•	•	•
18	•	•	•	•	•
20	•	•	•	•	•
24	•	•	•	•	•
30	•	•	•	•	•
36	•	•	•	•	•

... And so very easy to use.

Print styles are quickly selected from a finger-touch control panel — conveniently placed at the front of the printer. And the ribbon changed by simply releasing the used ribbon cartridge and snapping a new one cleanly into place.



Easy-fit, low cost optional tractor feed.

LX-86

FEATURES

IBM character set

Correspondence quality text built in to 32 cps

Print speeds to 120 cps

Integral 1K buffer

Push-button controls

Easy installation

From **£275** net

OPTIONS

Tractor unit

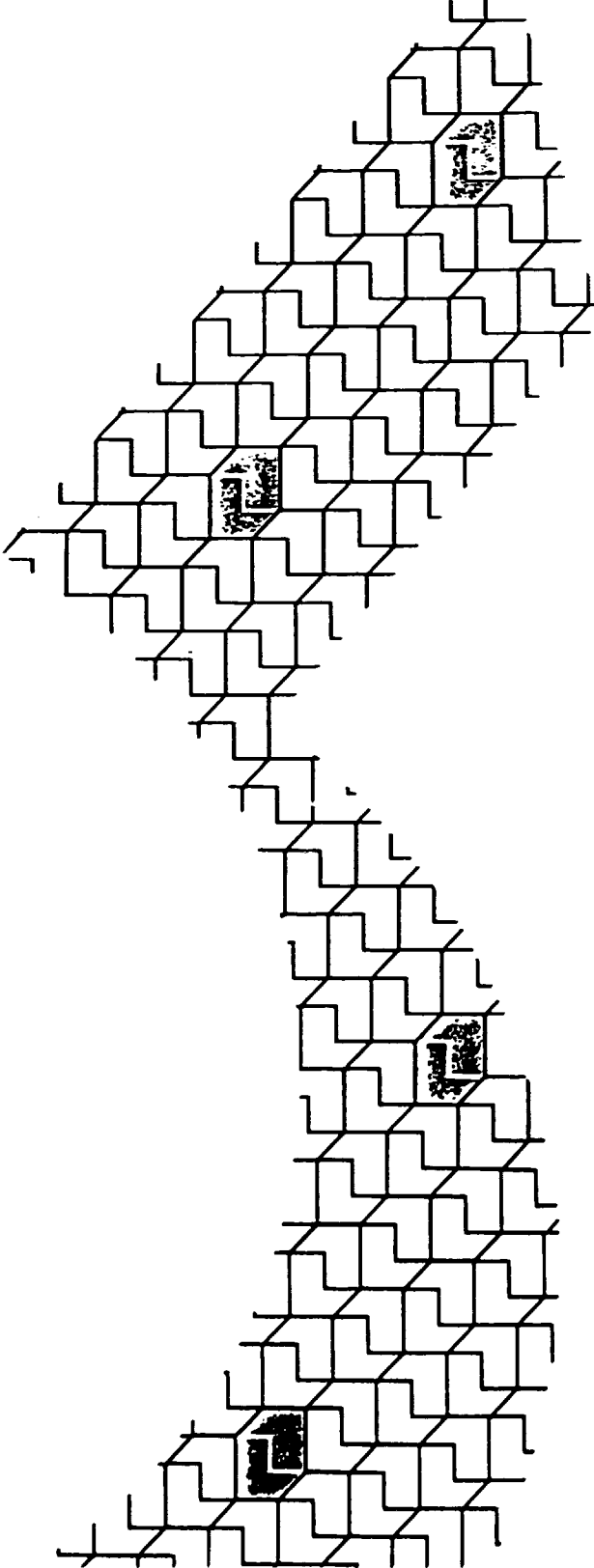
Cut sheet feeder (single bin)

Roll paper holder

APPENDIX 2
System Software

123™

4 4 | 4 4 | 4 7 | 4 4 | 4 7



4 1

7

LOTUS: DEPEND ON IT

In a modern business you are called on to perform miracles on a daily basis. Time is at a premium and the pressure is intense. The challenge may be exhilarating but it places enormous demands on individuals. You're expected to have the organization, rational talent of a civil servant, the financial dexterity of a Rothschild, the creativity of a Leonardo and the memory of an elephant.

Your raw material is information - facts and figures about the company, the market, the competition, all the factors that affect your business. Accurate information presented lucidly and at the right time can be the difference between success and failure.

Years ago there might have been an army of clerks to back you up. Now the chances are that your main resource is a computer. How will you get the best out of it?

The answer lies in the programs you use, and by opening this brochure you've taken the vital first step towards finding that answer. Lotus Software products are acknowledged to be the best in the field. 1-2-3 is the established industry standard in spreadsheet software and more people use Lotus Software than any other software in the world, because they know our programs get right down to business, performing miracles so regularly that you can take them for granted, like for example Paul Berry of the Scandinavian Bank -

In addition to using 1-2-3 for financial analysis and our management information system, I've also found it valuable for the annual salary review, something I didn't envisage using it for. We've even developed a credit analysis system based on 1-2-3 which we've sold to other banks. I believe 1-2-3 is the best business software package on the market - it saves me time because it's so quick to use. Whenever I've had queries relating to Lotus products I've found the Lotus Hot Line very useful.

The satisfaction of knowing you're on top of the job is incalculable. With Lotus Software you can depend on it.

THREE INTO ONE

The next time you're asked to pull together information, make projections, and present your results in the form of graphs, count the number of steps you take and the stages you go through. Look at the time it takes, and assess the reliability of the results. You could have been using Lotus 1-2-3.

In one program, on one floppy disk, 1-2-3 gives you financial analysis of unmatched versatility. Its major element is:

- The Spreadsheet - an electronic work-sheet on which to tabulate and process figures, identifying trends and making projections.

This is backed up by:

- Graphics - to translate figures into meaningful charts and graphs, quickly and easily.
- Data Handling - electronic filing that makes sure your data is always where you want it.



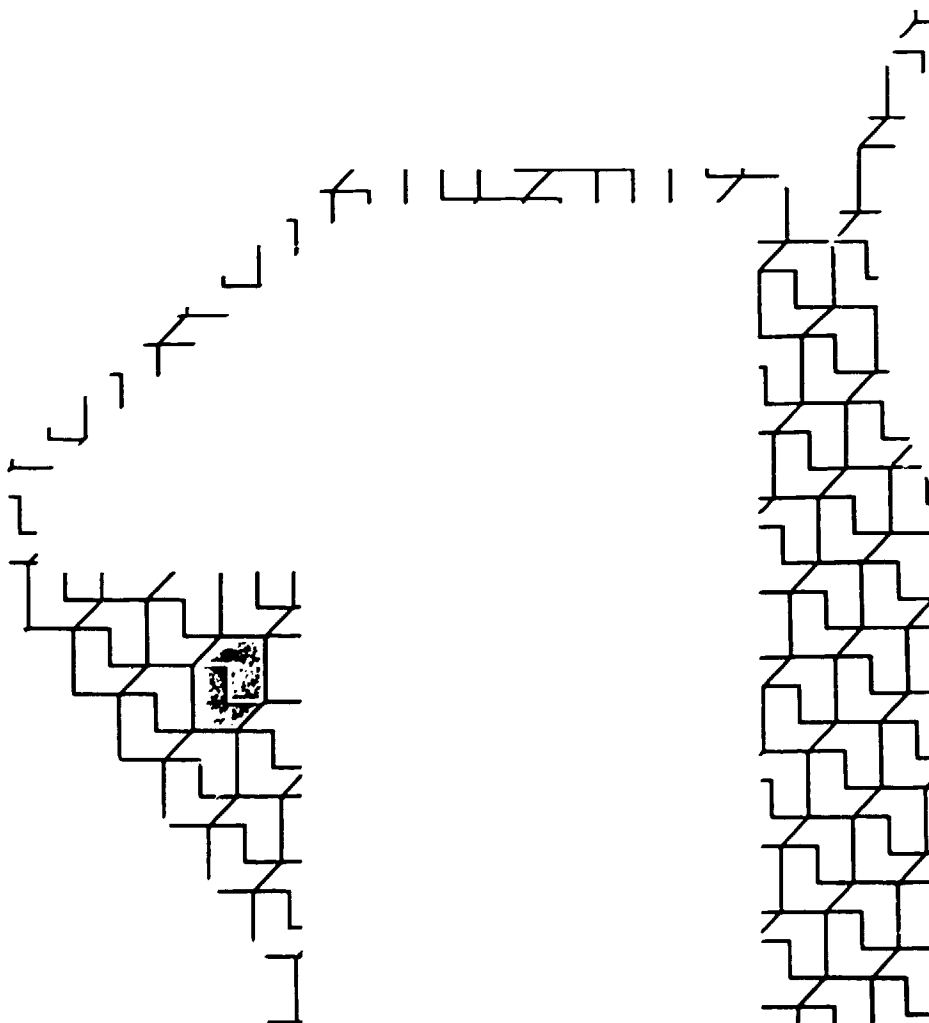
FIRST AND STILL FOREMOST

Lotus 1-2-3 took these three units of financial management and welded them into a single program, establishing the industry standard in "integrated spreadsheet" software: a standard that others still try and fail to match. For 1-2-3 has been the number one best seller in worldwide business software charts for over two years, a record that no other business software package can lay claim to.

1-2-3 is already proven in thousands of businesses large and small, and in hundreds of different industries. Millions of users have found that 1-2-3 is:

- fast
- easy to use, with simple procedures and a minimum of jargon
- flexible to suit experts and newcomers to computing equally, like for example Peter Gamon of American Express Europe Ltd -

"We use 1-2-3's spreadsheet for budgeting, and especially for monitoring such items as salesman's expenses and vehicle records. After using other software we standardized on 1-2-3 because of its integrated graphics function and the short cuts that the package helps you make. The advantages of 1-2-3 are its speed, flexibility and the sensible size of the spreadsheet, which the Lotus Hot Line has been helpful when we've needed assistance."





EASY TO USE

1-2-3 really is as easy as 123

ONE DISK

1-2-3's main functions are on *one* disk, with one set of commands, in plain English. You don't have to change disks or learn complex codes to go from spreadsheets to data handling to graphing.

TUTORIAL

Even if you've never used a computer before, you can be using the basics of 1-2-3 in just a few hours.

With 1-2-3 you only have to learn commands once for all three functions.

A special Tutorial disk guides you through the process, step-by-step. It takes you from "Getting Started" to specific lessons on "Handling a Database," "Graphing" and more.

Since everything is displayed in English, right on the screen, it's easy for first-time users or experts to understand.

Each lesson guides you through the process of building 1-2-3 applications, checks entries and explains how 1-2-3 works. The Tutorial keeps you on track and directs you to the correct answer.

What's more, you learn at your own pace and you can choose specific lessons to guide you along the way.

HELP!

Forget a command, or confused about what to do next? Just press one key to call for HELP. In less than a second, simple instructions will get you back on track. More than 200 sets of instructions can be called up on the screen, to handle virtually any conceivable problem.

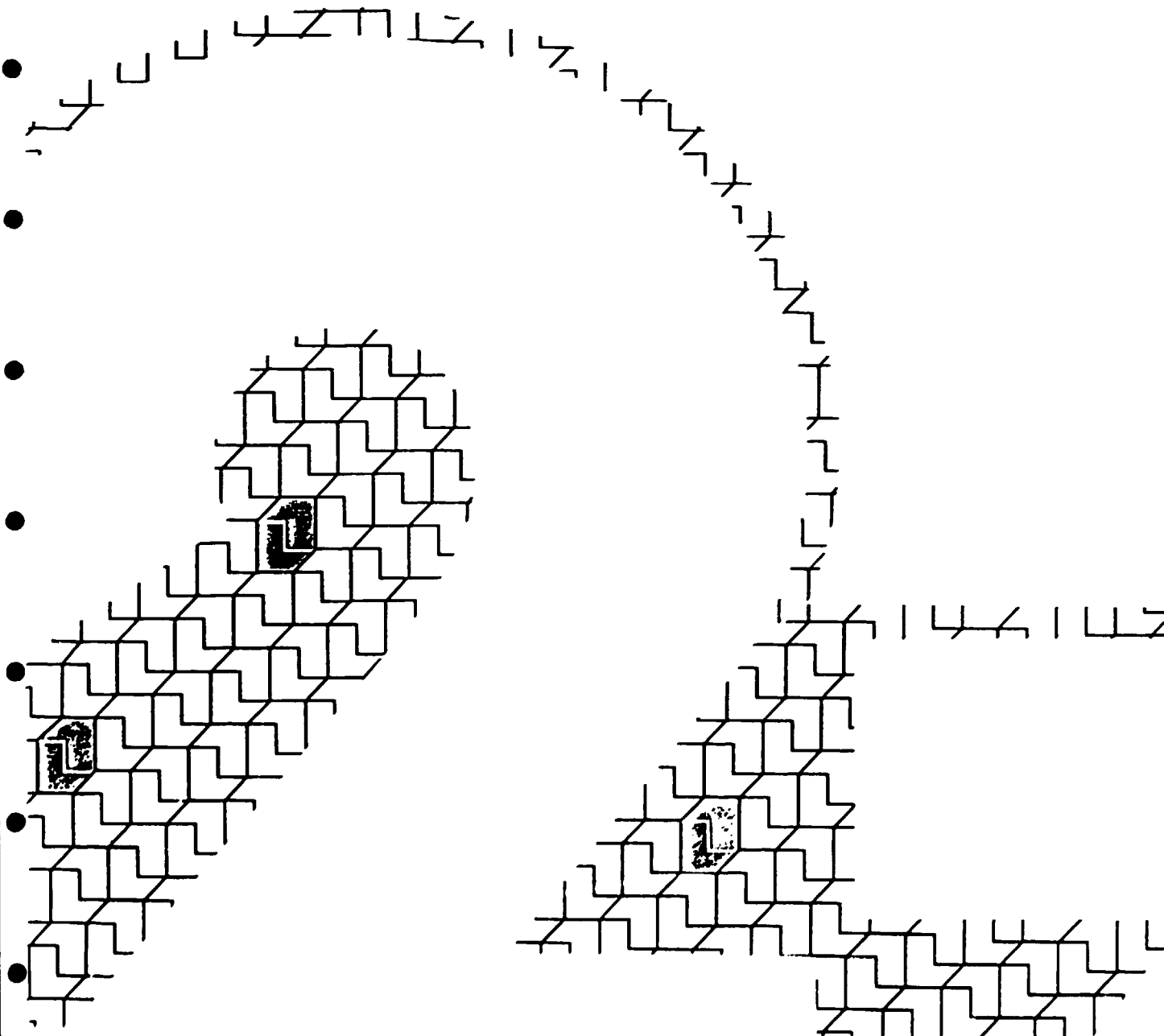
Plus, all screens are cross-indexed with our clearly-written User's Manual. So help is always as close as your keyboard.

MACROS

User-defined keys called Macros save time and make work easier. A Macro is a sequence of commands triggered by a single command. It's a convenient way to save keystrokes when typing the same sequence over and over, and it can be used to create custom applications and worksheets that can easily be utilized by people with no computer expertise.

TEMPLATE

1-2-3 is fully customized to take advantage of the personal computer's power. In fact, 1-2-3 comes with a convenient template that "labels" the computer's function keys and simplifies the execution of frequently-used commands.





SPREADSHEET – A HEAD FOR FIGURES

1-2-3 turns your computer's memory into a large work area called a "Spreadsheet".

"Spreadsheet" is a humble and rather dull name for one of the most powerful business tools of the day. But picture a huge continuous sheet of paper 256 columns wide and 2048 rows deep, and imagine looking through a "window" onto a small section of it. The window is your computer's monitor screen and you can move it to show any section that you wish to see.

TODAY AND TOMORROW

The 1-2-3 spreadsheet offers limitless possibilities for the processing of figures. Taking data currently available to you, like monthly sales, inventory levels, profit & loss accounts, budgets, etc., 1-2-3 performs virtually every financial and statistical function that you're ever likely to need, however complex. Internal rate of return, Present, net present and future values, Variance and standard deviations, Absolute date values to project appreciation, depreciation and inflation, True or false scenarios. In all there are 41 functions at your disposal to solve complex numerical problems in less than a second, problems that could take hours with a pen and calculator.

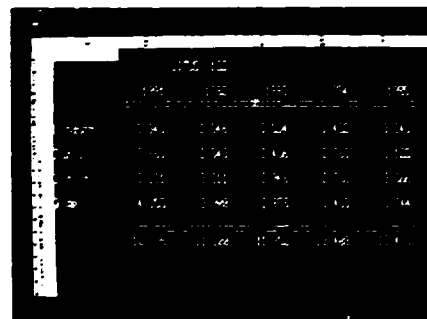
"WHAT IF"

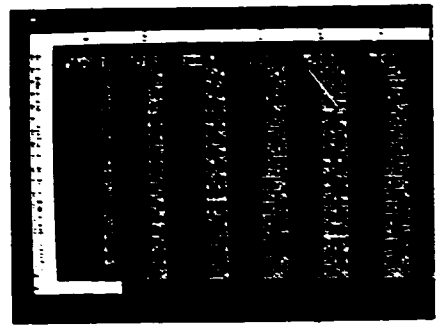
But it is as a window of the future that 1-2-3 comes into its own. Where will you stand if the exchange rate falls, or interest rates rise? What if your customers negotiate extended periods of credit? At a single keystroke the 1-2-3 spreadsheet will recalculate all the relevant equations to show you in seconds what the precise effect of altered circumstances will be.

There's no financial wizardry involved – it is simply using the computer for the kind of job it does best. But without a 1-2-3 spreadsheet, such calculations would take several hours.

To enable you to work with these numbers quickly, easily and flexibly 1-2-3 has 66 command functions to enable you to produce the right spreadsheet to solve your business problems. Alter the width of the individual columns; display your numbers as currency, dates, percentages, etc; align your entries to the left, centre or right of your columns; move or copy any entry; insert or delete columns or rows.

Whatever you throw at it 1-2-3 will adapt to your requirements, which means when changes come you'll be ready for them.





DATABASE – 'FLEXIBLE FILING'

Picture a filing cabinet bulging with 2,047 manila folders, each of which contains 256 A4 sheets of information. Consider the time it would take to extract from the cabinet the information contained on, say, the seventh sheet of every folder – and then to re-file the entire system on the basis of a new criteria, for example part number instead of company name.

1-2-3's information handling system is a filing cabinet along those lines, but its files are held on a floppy disk and its filing clerk is a series of electronic impulses.

It responds immediately to a request for information. It knows where to go, how to retrieve the information you want according to up to 32 different sort criteria and it will even let you use files from other software. When you've finished, it will return the information to the file, maintaining its own index. 1-2-3's database ensures that your most important asset, information, is better managed and more accessible than ever before.

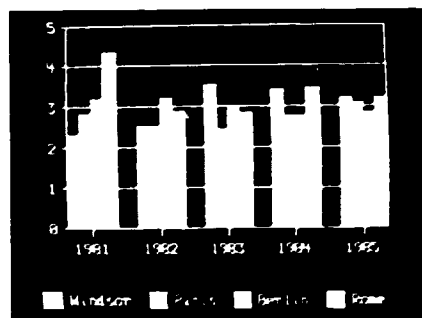
GRAPHICS – SAY IT WITH PICTURES

Most people think in pictures, not numbers, so it often makes sense to transform rows and columns of figures into a graph or chart – this improves the standard of your presentation, makes trends more readily identifiable, makes results more easily absorbed, and allows you to visualise 'what if' changes. 1-2-3's graphics are the professional tool for professionals, giving you the options of

- Colour – to bring out critical features
- Six types of graph – bar chart, stacked bar chart, scatter graph, x-y graph, line graph, and pie chart
- Eight different typefaces – to add style and character

As with 1-2-3 as a whole, the keyword is simplicity in transforming a list of figures 1-2-3 takes care of the axes, scale, heading and legends in any format you wish to specify. When you're testing hypotheses using the spreadsheet it takes only one keystroke to produce a revised graph – and because 1-2-3 is fully integrated there is no need to exit from one program, insert a new disk, transfer data, enter another program, or any of the thousand and one other procedures that single-task programs impose on you.

This aspect of 1-2-3 is the most rewarding visually: it adds clarity to the work done elsewhere in the program and it gives a professional gloss to everything you produce.



SUPPORT/AFTER SALES

By choosing 1-2-3 from Lotus you have the support of the world's biggest computer software company behind you. Only Lotus offers you the following comprehensive after sales support:

TRAINING

Whilst 1-2-3 is easy to use there is no substitute for effective and comprehensive training. Lotus offers you introductory and Advanced Courses designed and developed by experts at Lotus, to ensure that you get the most out of 1-2-3. This training is available through Lotus Authorized Training Centres which offer a complete training environment with course material, hardware and expert tuition all under one roof. The training staff have all been trained by Lotus personnel and have passed a rigorous examination of their competence, resources and suitability. The training itself is direct and practical and will show you how to use 1-2-3 to meet your personal needs. In addition when you have completed the course you will receive a copy of the training program to keep, so the course need not finish when you leave the classroom.

HOT LINE

If you have a question about 1-2-3, then simply pick up the phone and ring WINDSOR (0753) 840441, any time of the day, any day of the week. A dedicated customer support team is ready to answer your call and give you technical help and advice.

ONE YEAR GUARANTEE

Inevitably accidents happen. If your disk is damaged we'll replace it free of charge at any time in the first twelve months. Beyond this period it will cost you a nominal fee to replace a damaged disk.

LOTUS ASSURANCE PLAN

The Lotus Assurance Plan is your guarantee that you will be kept informed of new developments from Lotus, so that you will always know about the latest Lotus products available on the Market.

LOTUS CLUB

The Lotus User Club will introduce you to the community of Lotus users. All members will receive the new Lotus magazine on 6 months free trial, which will keep you abreast of the latest industry developments and news from Lotus.

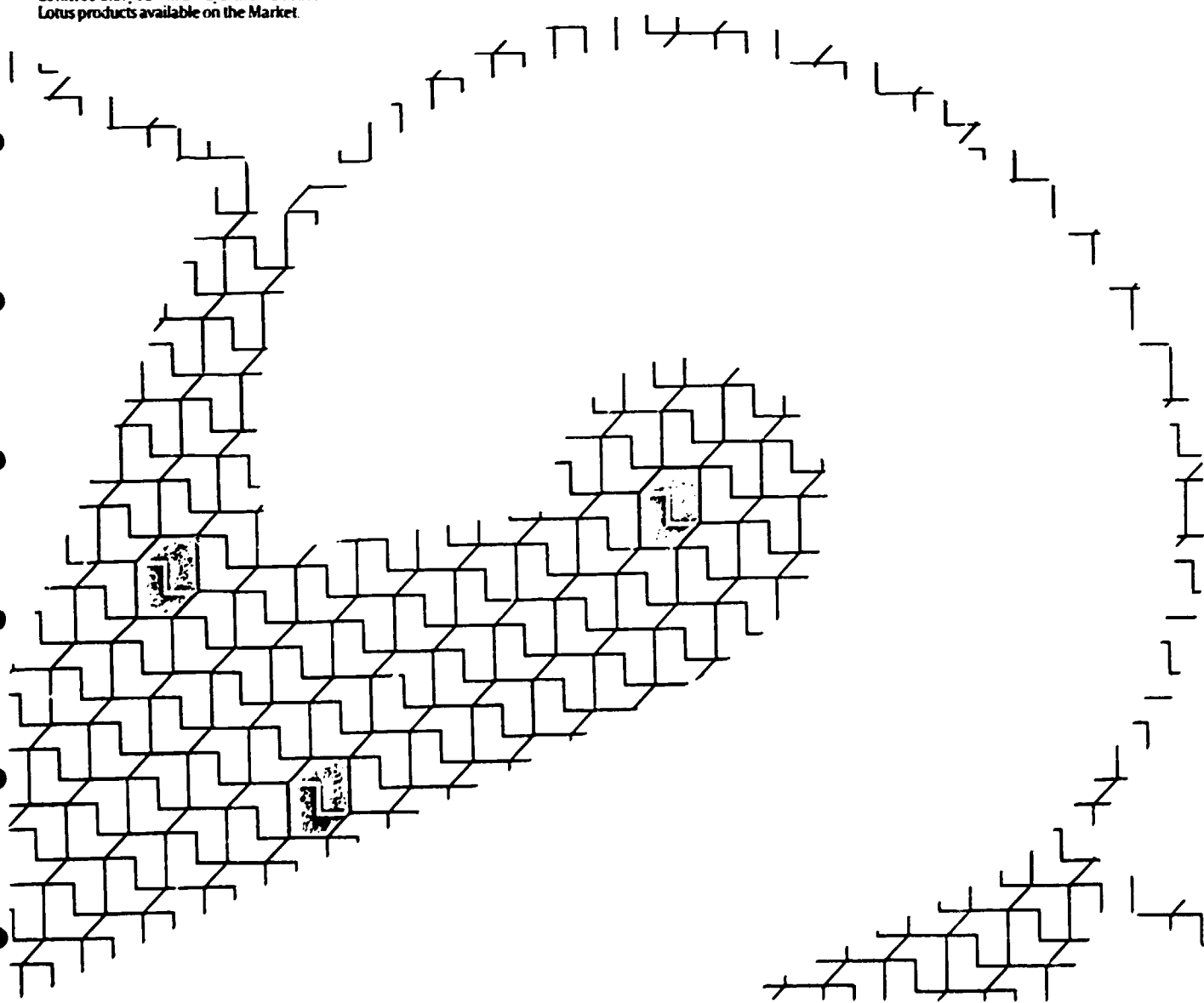
BOOKS

There are already many books available from independent authors on 1-2-3, but later in the year look out for special books on 1-2-3 from Lotus itself, after all nobody knows 1-2-3 like Lotus.

COMPREHENSIVE PRODUCT RANGE

If you want additional features to 1-2-3 then Lotus "Symphony" is an all-in-one solution for planning, organising, analyzing and communicating information and ideas, combining all the benefits of 1-2-3 with word processing and communications facilities. It's also a system that can expand and grow to meet your changing needs, so you'll never be left behind with Symphony.

Alternatively, you may prefer the "ease-of-use" features of the Apple Macintosh, in which case Lotus "Jazz" offers you a powerful integrated business program (covering spreadsheet, graphics, database, wordprocessing and communications) all on one disk that really is so easy to use.



1-2-3 FEATURES

SPREADSHEET

- 2048 rows x 256 columns
- **FUNCTIONS**
 - Date and Time: TODAY, DATE, MONTH, DAY, YEAR
 - Financial: NPV, FV, PV, IRR, PMT
 - Statistical: COUNT, SUM, AVG, MIN, MAX, STD, VAR
 - Mathematical: +, -, *, /, ABS, ACOS, ASIN, ATAN, ATAN2, COS, EXP, INT, LN, LOG, MOD
 - Logical: FALSE, TRUE, IF, ISNA, ISERR, AND, OR, NOT
 - =, =, =, =
 - Special: NA, ERR, CHOOSE, HLOOKUP, VLOOKUP
- Individual cell formats
- Individual column widths: 1-72 characters
- Protected cells
- Move or copy any cell range
- Insert or delete columns or rows
- "Moving-cursor" menus
- Expanding cell pointer
- Percentage and scientific number formats
- Label formatting - left, centre, right, labels can extend over cell boundaries
- Extract and consolidate any part of the spreadsheet
- Windows
- Titles
- Printout control - formatted headers and footers, borders, margins, printer setup, page length (20-100), automatic page numbering and date insertion, single or continuous feed, print to file and print format

DATABASE

- Up to 2047 records and up to 256 fields
- Computed fields, converted fields, display-only fields
- Data entry validation, including look-up tables
- Data entry prompts - user-definable
- Query - allows wild-card parameters and compound search criteria, up to 32 fields
- "What-if?" tables - one or two variables
- Multiple databases - in a single worksheet, any number of entry, query and report forms per database
- Variety of date formats
- Fast sorting - any field, up to 2 sort levels, max ascending and descending sorts
- Database statistical functions

GRAPHICS

- 6 Types pie charts, XY graphs, water, line, bar and stacked bar charts
- Create fast graphs for "What-if?" analysis
- Manual and automatic scaling
- Control of origins, titles, legends, scale dimensions and formats, colors, background and fill patterns, print density, page size, graph size and orientation, and type-faces
- Presentation quality on a variety of printers and plotters in colour or black-and-white

AND THERE'S MORE

- Over 200 on-line HELP screens - cross-referenced to the reference manual
- Tutorials - interactive training
- Keyboard Macros
 - Store any sequence of commands
 - Simple programming - prompted input, user-defined menus, if-then-go-to, call and return, debugging
 - Automatic macro execution

- Full use of function keys
- Menu-driven commands
- Limited text processing
- Complete Documentation
- Lotus Service and Support

THE FOLLOWING PERSONAL COMPUTERS WILL RUN WITH LOTUS 1-2-3

- Apricot PC and XI
- Burroughs B-25
- Bytec Hyperion
- Compaq Deskpro
- Compaq Portable and Compaq Plus
- Convergent Technologies NGEN Workstation
- Data General/One
- DEC Rainbow 100+
- Ericsson PC
- Grid Compass
- Hewlett Packard 110 Portable
- Hewlett Packard 150

- IBM PC/AT
 - IBM PC, XT, Portable
 - IBM 3270-PC
 - ITT XTRA
 - Olivetti M21
 - Sperry PC
 - Televideo Tele-PC
 - Texas Instruments Professional
 - Wang Professional
 - Zenith Z-100
- and all Lotus certified IBM compatible computers

Using in general:

- MS DOS Version 1.1 or later versions
 - Minimum 192K RAM
 - Additional RAM can be used
 - One double-sided, disk-drive, double-density optional
 - Second floppy or hard disk optional
 - Supports a variety of monitors and peripherals
- Specific requirements will vary from computer to computer. For further details and for the exact configuration on non-IBM equipment please consult our Technical Support Hot Line on 0753 840441.

TM Symphony, Jazz, 123 and Lotus are trademarks of Lotus Development Corp.

[®] IBM and PC are registered trademarks of International Business Machines.

TM XT and AT are trademarks of International Business Machines.

TM COMPAQ and COMPAQ DESKPRO are trademarks of COMPAQ Computer Corp.

TM Texas Instruments Professional Computer is a trademark of Texas Instruments.

TM Z-100 is a trademark of Zenith Data Systems.

TM Hyperion is a trademark of the Dynamic Division of BYTE Corp.

TM Rainbow 100 is a trademark of Digital Equipment Corp.

TM Wang Professional Computer is a trademark of Wang Laboratories Inc.

TM Grid Compass Computer is a trademark of GRID Systems Corp.

TM Hewlett-Packard 150 and 110 are trademarks of the Hewlett-Packard Company.

TM XT and Apricot are registered trademarks of ACT (Advanced Technology).

[®] Apple is a trademark of Apple Computer Inc.

TM Macintosh is a trademark licensed to Apple Computer Inc.

TM Data General One is a trademark of Data General Corp.

TM Sperry is a trademark of The Sperry Corp.

TM Televideo is a trademark of Televideo Business Computers.

TM Convergent Technologies is a trademark of Convergent Technologies.

TM Ericsson is a trademark of Ericsson Information Systems Ltd.

TM Olivetti is a trademark of Olivetti.

TM ITT XTRA is a trademark of ITT.