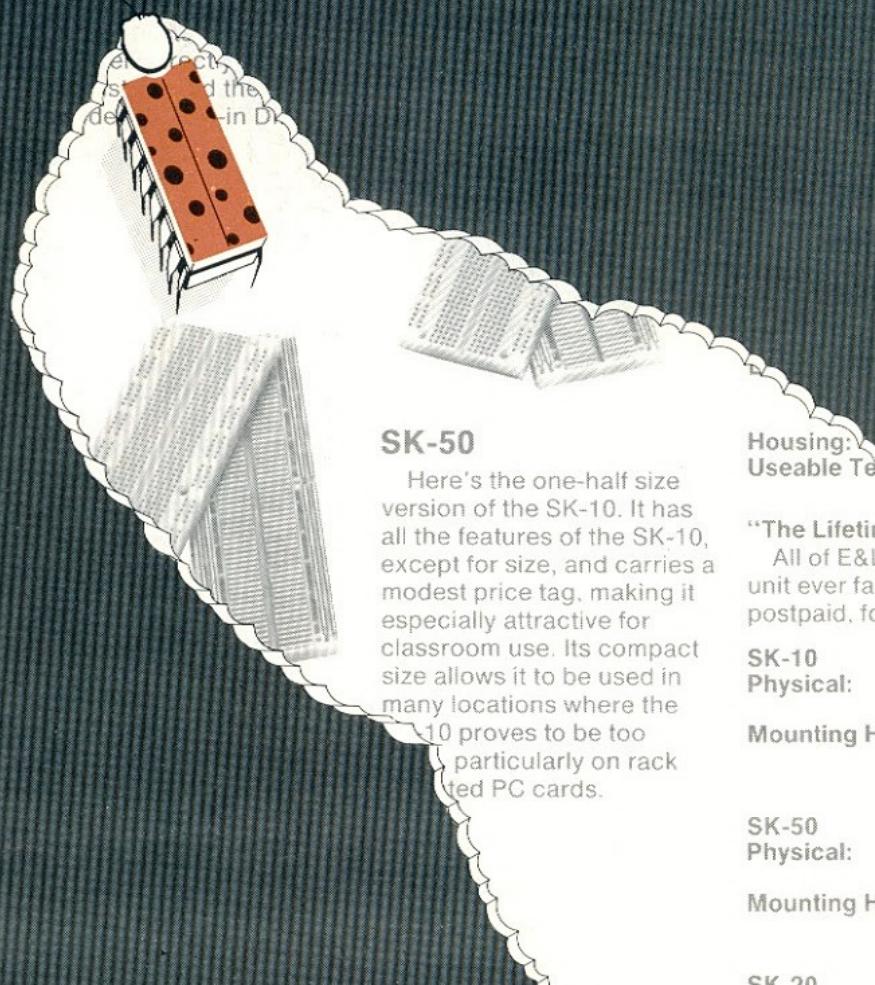


# THE COMPLETE BUGWORKS



## SK-50

Here's the one-half size version of the SK-10. It has all the features of the SK-10, except for size, and carries a modest price tag, making it especially attractive for classroom use. Its compact size allows it to be used in many locations where the SK-10 proves to be too large, particularly on rack mounted PC cards.

Housing:  
Useable Te

"The Lifelin  
All of E&L  
unit ever fa  
postpaid, fo

SK-10  
Physical:

Mounting H

SK-50  
Physical:

Mounting H

E & L INSTRUMENTS, INC.

61 First Street, Derby, Conn. 06418

# Solderless

If you are involved in any aspect of circuit design, experimental construction of electronics or are merely interested in learning about analog or digital techniques, then you should take a good look at the full line of E&L products that are featured in this brochure. They represent the least expensive, quickest and most direct route to mastering the world of electronics.



From simple solderless breadboards to complete design stations, E&L has the products, the instruments and the educational material that will enable you to design and build your own system.

After browsing through the next 22 pages of products, check the back cover for all ordering information including OEM, Educational and Industrial discounts.

## SK SERIES.

### SOCKETS FOR CIRCUIT DESIGN ... SIMPLE BUT VERSATILE.

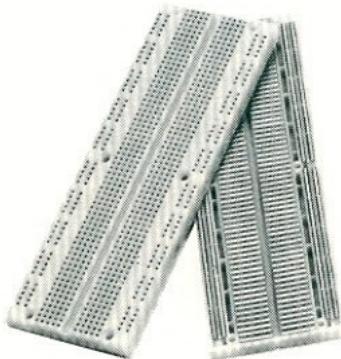
Start your circuit designing with E&L's SK series. These solderless breadboards enable you to insert all your electronic components directly into a spring matrix, without adapters, for instant circuit construction. All components of 20 to 26 gage insert directly. From  $\frac{1}{2}$  watt resistors and the smallest diodes to plug-in DIP

packages from 8 to 40 pins. Spread the leads when TO-5 package is desired. All interconnects are made with solid 22 gage wire, stripped  $\frac{1}{4}$ " (6.35 mm) on each end, eliminating the need for special jumper sets. Combine the solderless sockets with E&L's sophisticated instruments and you have great design systems.



### SK-50

Here's the one-half size version of the SK-10. It has all the features of the SK-10, except for size, and carries a modest price tag, making it especially attractive for classroom use. Its compact size allows it to be used in many locations where the SK-10 proves to be too large, particularly on rack mounted PC cards.



### SK-10

The SK-10's unique matrix configuration is embedded in a high temperature plastic molding. It gives you 64 pairs of 5 common spring contacts for principle circuit construction and a series of common buss strips (8) of 25 connections each.



### SK-20

The SK-20 is a miniature breadboarding socket that is an excellent replacement for standard DIP sockets in custom breadboarding, particularly in the interfacing

version. The SK-20 is perfect for permanent installation where the 5 common contact points are of prime importance for fan-in/fan-out.

## SK SERIES SPECIFICATIONS

**Contacts:** Nickel Silver

**Typical Insertion Life:**

Based on 22 gage components, a minimum of 10,000 insertions.

**Average Contact Resistance:**

5 milliohms

**Lead Size Accommodations:**

20 to 26 gage ( $\frac{1}{2}$  watt resistor to small diodes)

**Housing:** Acetal Co-polymer

**Useable Temperature Limit:**

105°C

### "The Lifetime Guarantee"

All of E&L's SK sockets now carry a lifetime guarantee. If a unit ever fails to meet your requirements, return it to E&L, postpaid, for a free replacement. No questions asked.

### SK-10

**Physical:** .33" H (8.4 mm) x 2.2" W (5.6 cm) x 6.5" L (16.5 cm)

**Mounting Holes:** (Designed for #4 flat head screws) 1.46" (3.71 cm) across width x 3.08" (7.82 cm) across center line to each end.

### SK-50

**Physical:** .33" H (8.4 mm) x 2.2" W (5.6 cm) x 3.4" L (8.6 cm)

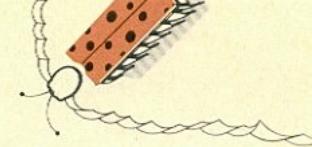
**Mounting Holes:** (Designed for #4 flat head screws) 1.4 (3.71 cm) across width x 3.08" (7.82 cm) across center line to each end.

### SK-20

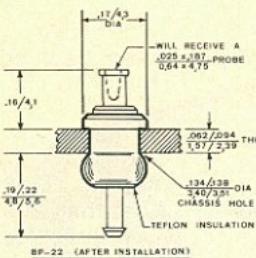
**Physical:** .33" H (8.4 mm) x 1" W (2.54 cm) x 1.75" L (4.45 cm)

**Mounting Holes:** 1.56" (3.96 cm) center to center

# Breadboarding



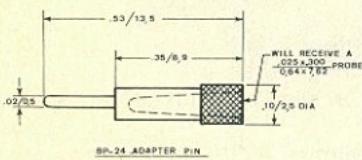
## BP SERIES



### QUALITY BREADBOARDING JACKS AND PINS

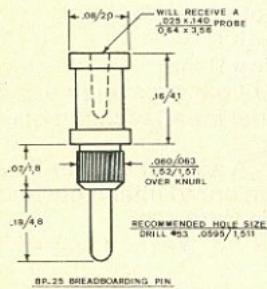
#### BP-22

The BP-22's are Teflon® insulated breadboarding jacks for use in metal panels of  $\frac{1}{16}$ " (1.57 mm) to  $\frac{3}{32}$ " (2.36 mm) thickness. Solderless interconnections are made with 22 gage solid wire. The BP-22 mounts in a .136" (3.45 mm) hole without soldering.



#### BP-24

A reusable adapter pin that allows up to 16 gage wires to be inserted in the BP-22, 25 or any of the SK-10/SK-20 Sockets. Large electrolytics can thus be breadboarded as simply as a DIP IC.

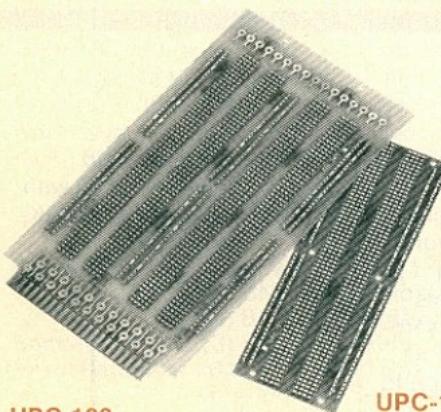


#### BP-25

A breadboarding pin where spacing on .100" (2.54 mm) centers is desired. .0595" (1.50 mm) hole size. A protruding metal tip that will engage the opening in the top of another pin allows "stacking."

## UPC-101, UPC-102

### SPECIAL PURPOSE PRINTED CIRCUIT BOARDS



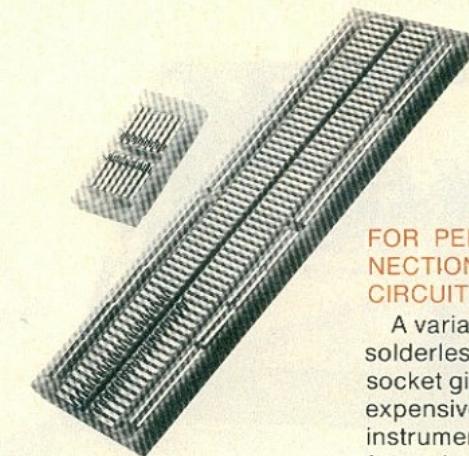
#### UPC-102

The 102 circuit board features dual SK-10 circuit patterns and adds a card edge connector for plug-in use. .156" (3.96 mm) centers; 22 connections.

#### UPC-101

The 101 is an exact duplication of the SK-10 circuit pattern. A drilled hole pattern and circuit pattern identical to the SK-10 allows the designer to go directly from his breadboard to final soldered unit without laying out the circuit again.

## THE INTERFACE SOCKET



FOR PERMANENT CONNECTION TO PRINTED CIRCUIT BOARDS

A variation on the original solderless breadboarding socket gives you another inexpensive way to construct instrument/computer interfaces. In addition to the normal 5 parallel contacts on top, a tab is punched out at the bottom of the contact pin. Interfacing is made simple by quick and permanent connection of the contact pin to the printed circuit board.

## SPECIFICATIONS

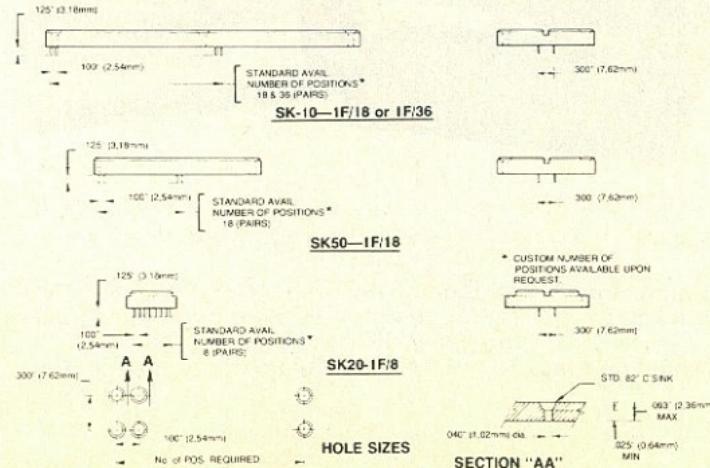
**SK-10-1F18** — 18 pairs of rear solder tabbed connectors/46 pairs of standard connectors.

**SK-10-1F36** — 36 pairs of rear solder tabbed connectors/28 pairs of standard connectors.

**SK-20-IF8** — 8 pairs of rear solder tabbed connectors.

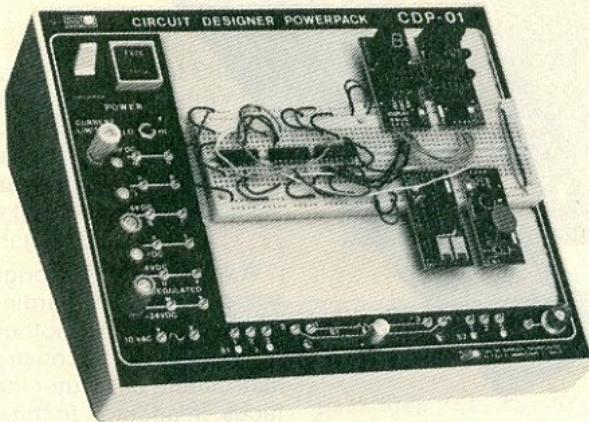
**SK-50-IF18** — 18 pairs of rear solder tabbed connectors/15 pairs of standard connectors.

## MOUNTING DETAILS



# Universal

E&L has designed a series of compact, inexpensive, reliable and rugged units to meet the needs of small labs, educational institutions and hobbyists. These units are available either in kit or assembled form.

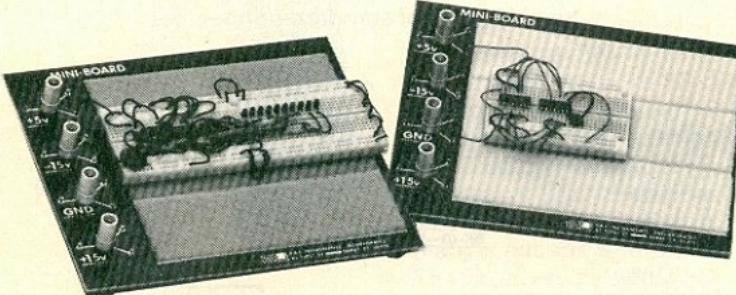


## CDP-01

### THE ALL-PURPOSE GENERAL DESIGNER

Here is all you need for a wide variety of circuit work. From CMOS Logic, TTL, Linear IC's to simple R/C design. A central work area covered by Velcro® Loop Material gives you complete freedom in attaching different units to the instrument. Terminals are labeled for easy identification.

tion and the unique dual current limiting concept saves precious IC's from burn-out. The power supplies have the capacity (.75A and .25A) to do any reasonably sized job that fits on the working surface. Each CDP-01 comes with a hard backed SK-10 Socket. Available in kit (CDP-01K) or assembled (CDP-01A) form at either 115V or 230V.



### SPECIFICATIONS

- Base:**  $\frac{1}{16}$ " (1.57 mm) G-10-Approx. 7" (17.8 cm) x 8" (20.3 cm)  
**Connectors:** (4) Binding Posts, (12) Breadboarding Pins  
**Sockets:** (1) SK-10 with Velcro® Hook Material Backing (SK-50 with the MB-101)  
**Mounting Area:** 6" (15.2 cm) sq. Velcro Loop Material

### SPECIFICATIONS

#### POWER SUPPLIES SUPPLY A

Voltage (DC)	5V	+15/-15V
Type	Trimmer adjustable	fixed, tracking
Tolerance (volts)	N/A	14.15/15.75
Output Current		
Low Setting	100 ma	50 ma
High Setting	750 ma	250 ma
Current Limiting	Yes	Yes
Noise and Ripple	Less than 10MV	Less than 20MV
Overload Indicator	LED Indicator	LED Indicator

In addition to the above supplies, the CDP-01 provides +24/-24V dc (unregulated) fused internally at  $\frac{1}{4}$  amp. Also available on the front panel are two connections to one of the low voltage secondary windings — nominally 10V ac. The primary fuse will blow in the event of a short.

#### CONTROLS:

- (1)—Off/On Switch (with integral light)
- (1)—Low/High current limiting switch.
- (1)—Uncommitted linear 10K slide pot with center tap (detent)
- (2)—Uncommitted slide switches — SPDT ( $\frac{1}{2}$  amp @ 125 V dc)

**Connectors:** (25) BP-22 — Insulated solderless breadboarding pins.

(1) SK-10 with permanent backing.

(1) BNC Connector

(6) 5 Way Binding Posts

**Miscellaneous:** Center portions of panel covered with Velcro® Loop Material for attachment of external components.

(3) Fuses — (2)  $\frac{1}{4}$ A and (1)  $\frac{3}{4}$ A Slo-Blo. (For additional Velcro to attach custom components, use V-04.)

3.5" H (8.9 cm) x 7.6" W (19.3 cm) x 9" L (22.9 cm)

Sloped Approx. — 17°

Weight — 5 lbs. (2.27 Kg)

#### Physical:

### MB-100

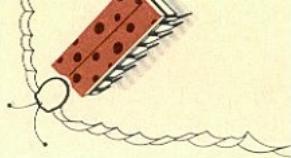
#### MINIMUM COST BREADBOARDING PACKAGES

MB-100 is an exceptionally flexible circuit design aid. A simple mounting board with binding posts and solderless breadboarding pins and a detachable SK-10 socket. In addition to the socket, you can mount any kind of electronic components, relays, meters, transformers, etc., with Velcro®. E&L supplies a hard backing for the rear of the socket.

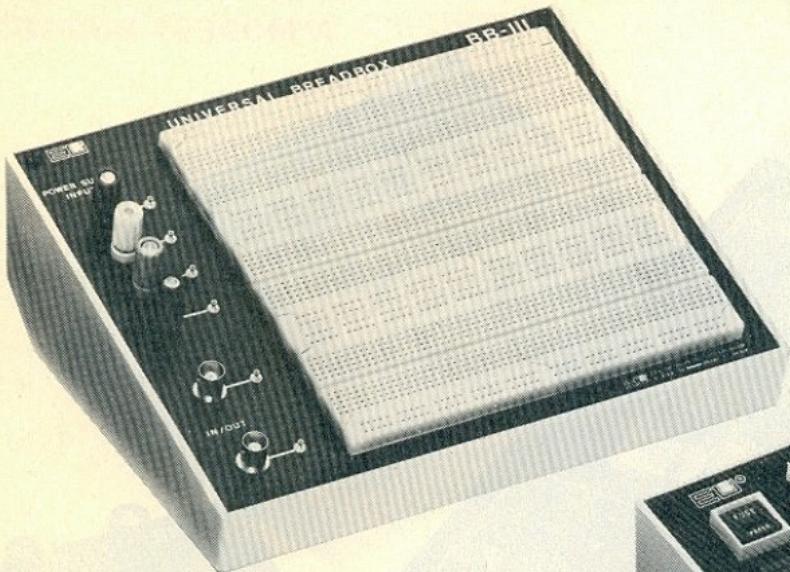
### MB-101

The same base and capabilities as the 100 with an SK-50 replacing the SK-10.

# Designers



## BREADBOX III



FOR ANALOG OR DIGITAL WORK, THE MOST BREADBOARDING CAPABILITY FOR THE LEAST MONEY.

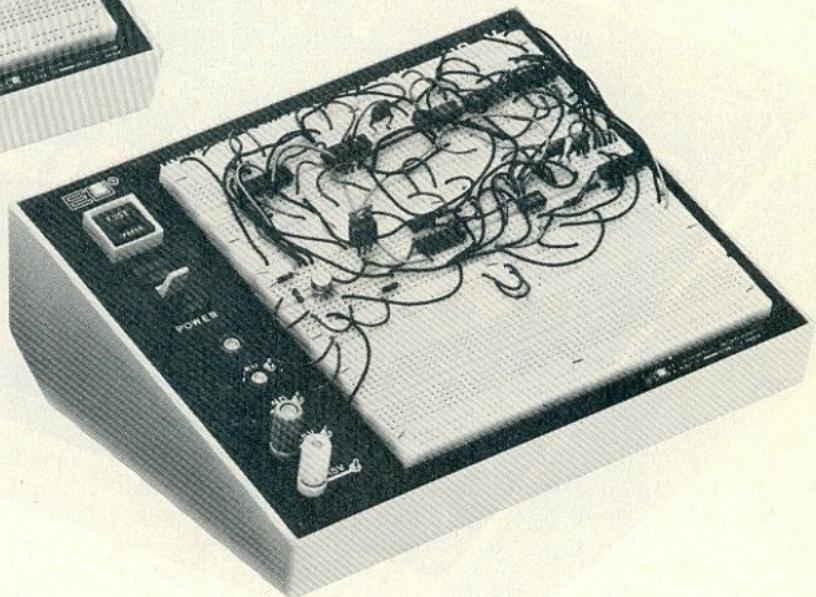
The Breadbox III is the most economical approach to either digital or analog work. Simply plug in your own components on 3 SK-10

sockets and you're ready to build your own circuits. With 4 binding posts for external power and BNC's for scope probe connections and other instrumentation as well. The Breadbox III may be ordered as Option 1 with the sockets detachable and held by Velcro®.

### SPECIFICATIONS

Connectors:	(4) 5 Way Binding Posts (2) BNC Connectors (6) BP-22 Solderless Breadboarding Pins
Sockets:	(3) SK-10 Sockets
Miscellaneous:	Molded Plastic Box Painted and Screened Metal Panel
Physical:	3.5" H (8,9 cm) x 7.6" W. (19,3 cm) x 9" L (22,9 cm) Sloped Approx. 17° Weight — 3 lbs. (1.12 kg.)

## BREADBOX IV UNIVERSAL POWERED BREADBOX



A LOW PRICED, COMPLETELY SELF POWERED DESIGNER.

Two husky power supplies, +5V and + / -15V, plus a breadboarding area of 3 SK-10 sockets large enough to handle almost any design. That's the Breadbox IV. For both digital

and analog designs, the Breadbox IV is the most reasonably priced instrument in the field. Available in kit (BB-IVK) or assembled (BB-IVA) form at either 115V or 230V.

### SPECIFICATIONS

Power Supplies:	+5V @ $\frac{3}{4}$ AMP $\pm 15V @ \frac{1}{4}$ AMP
Line & Load Regulation:	Less than 5%
Noise & Ripple:	Less than 5 mv on +5V Less than 10 mv on $\pm 15V$
Connectors:	4-five way binding posts 4-BP-22 Solderless Breadboarding Pins 3-SK-10 Sockets
Miscellaneous:	Molded, high-impact, plastic case. Painted and screened metal panel. Internally lighted, on-off switch. Fused @ $\frac{3}{4}$ AMP
Physical:	3.5" H (9 cm) x 7.6" W (19,3 cm) x 9" L (22,9 cm) Sloped Approx. — 17° Weight — 7 lbs. (3,18 kg.)

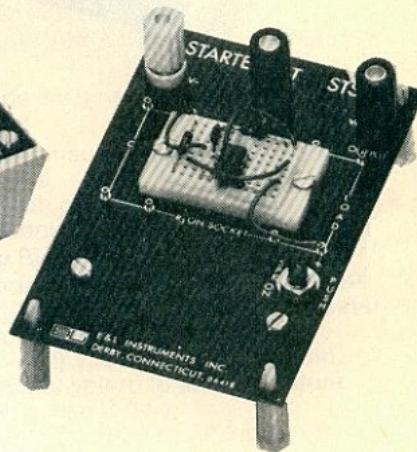
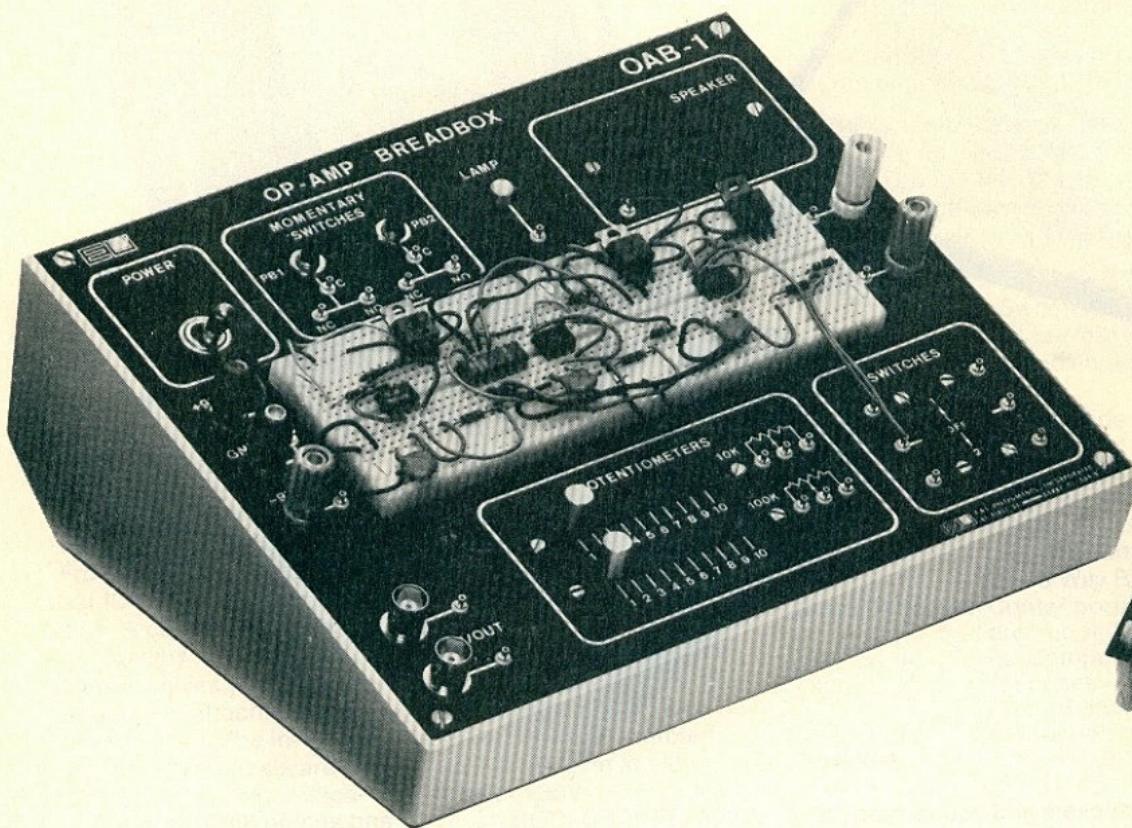
# Linear/Analog

OAB-1

THE COMPLETE, PORTABLE AND  
INEXPENSIVE, OP-AMP BREADBOX

STS-01

A STARTER KIT FOR  
A MODEST BUDGET



An instrument package for linear design work. For testing op-amps or actual circuit design, the battery powered OAB-1 gives you the SK-10 breadboard and BP-22 jacks

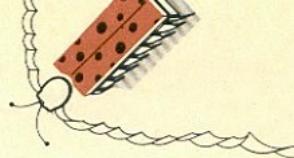
for complete solderless design. Available either in kit (OAB-1K) or assembled (OAB-1A) form. The OM-1 manual works well with the OAB-1.

## SPECIFICATIONS

- Power Supply:** (2) 9 volt cells (not supplied)  
**Controls:** (2) SPST Pushbuttons  
(2) 3-position slide switches  
(2) Slide Pots — 10K and 100K  
**Connectors:** (1) SK-10 Breadboarding Socket  
(5) 5-way binding posts  
(30) BP-22 Solderless Breadboarding Pins  
(2) BNC Connectors  
**Miscellaneous:** LED indicator light  
Incandescent Lamp (load)  
Miniature speaker  
**Physical:** 3.5" H. (8.9 cm) x 7.6" W. (19.3 cm) x 9" L.  
(22.9 cm)  
Sloped Approx. 17°  
Weight — 5 lbs. (2.27 kg.)

Here's a kit fit for even the most modest budgets. An SK-20 Socket combined with speaker, breadboarding pins, battery clips, mounting spacers and a test switch. The result is a simple but flexible means of building and testing op-amp circuits. Use the learning manual OM-1 for a comprehensive introduction to op-amp work.

# Designers



**OA-2**

**THE COMPREHENSIVE APPROACH TO  
DESIGNING OP-AMP CIRCUITRY**



Fixed +5V and +/−15V power supplies with large current capacity, a sensitive null detector and a full function generator with external frequency adjustment are all the tools you need for linear work and interfacing to TTL

## SPECIFICATIONS

Power Supplies:	Supply A	Supply B
Type	± 15V	+ 5V
Volt. tol.	Fixed, tracking	Fixed, regulator
Output current	14.25/15.75	4.7/5.3
Current limiting	200 ma. each supply	500 ma.
Noise/Ripple	Yes	Yes
	Less than 20 mv	Less than 10 mv

### Function Generator:

Waveforms — Sine, square and triangle.  
Frequency — Internal 500Hz or externally adjustable from 1Hz to 100KHz  
Distortion — < 3% all waveforms  
Amplitude — Better than 5V peak to peak — all waveforms

### Null Indicator:

2 LED's  
Input amplitude w/o overload — 15V maximum  
Sensitivity — detects less than 10/100 mv difference (switchable)  
Indicator — low, null, high (both off at null)

### Controls:

Off/On switch (Integral Light)  
Null sensitivity switch  
Internal/External frequency selector on function generator  
(2) uncommitted SPDT slide switches  
(2) Slide Pots — 10K and 100K

### Connectors:

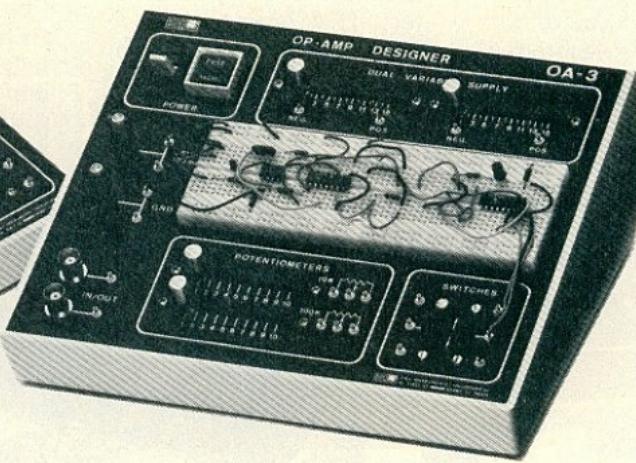
(1) SK-10 Solderless breadboarding socket  
(4) 5-way binding posts  
(29) BP-22 Solderless Breadboarding Pins

### Physical:

3.5" H (8.9 cm) x 7.6" W (19.3 cm) x 9" L (22.9 cm)  
Sloped approx. — 17°  
Weight — 7 lbs. (3.18 kg)

**OA-3**

**TWO FLOATING POWER SUPPLIES  
FOR OPEN-ENDED DESIGNING**



Logic. The circuit is assembled on the SK-10 and externally connected by BP-22 breadboarding pins. Available in kit (OA-3K) or assembled (OA-3A) form at either 115V or 230V.

The OA-3 features fully floating variable power supplies that form an exceptionally flexible unit. The highly regulated power supplies make the OA-3 most practical for unusual voltage requirements. The variable power and the fixed 5V supply open up the full range of

linear circuit work. The OM-1, OA-2M and the BRS-1, 2 educational materials are perfect for class or home study of linear circuits. Available in kit (OA-3K) or assembled (OA-3A) form at either 115V or 230V.

## SPECIFICATIONS

Power Supplies:	Supplies A&B	Supply-C
Type:	0 to plus 15 VDC	5 VDC
	0 to minus 15 VDC	
Front Panel		Trimmer
Adjustable		Adjustable
Volt. Tol:	± 10% of Scale (or 1 volt)	—
Output Current: (Max)	50 ma	100 ma
Noise/Ripple:	Less than 20 mv	Less than 10 mv

### Controls —

- (1) Off/On switch (Integral light)
- (2) Uncommitted SPDT Slide Switches
- (2) Slide Pots — 10K and 100K
- (2) Slide Pots For Variable Supplies

### Connectors —

- (1) SK-10 Solderless Breadboarding Socket
- (2) 5 Way Binding Posts
- (22) BP-22 Solderless Breadboarding Pins
- (2) BNC Connectors

### Physical —

3.5" H (8.9 cm) x 7.6" W (19.3 cm) x 9" L (22.9 cm)  
Sloped Approx — 17°  
Weight — 7 lbs. (3.18 kg)

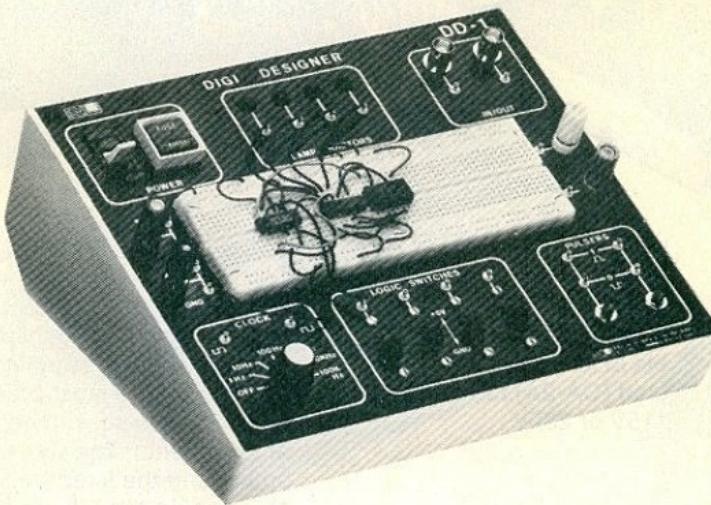
# Analog / Digital

## DD-1

### THE ORIGINAL DIGI-DESIGNER

The least expensive entry into digital circuits, the most dynamic area of circuit design. The DD-1 comes complete with a stable internal power supply, pulsers, status switches, I/O connectors, a 6 frequency clock, 4 LED indicators and the SK-10. This complete package

meets all of your requirements. At this price the DD-1 is a must for every student, technician or engineer doing digital circuit design. Available in kit (DD-1K) or assembled (DD-1A) form; at either 115V or 230V.



DC-2, an IC package with the appropriate integrated circuits (IC-1) and DD-1 form the DC-3 package.

"Digital Electronics and

Laboratory Computer Experiments," published by Plenum Press is an excellent reference tool for DD-1 self-instruction.

### SPECIFICATIONS

#### Power Supply:

##### Output:

5 volt DC (user adjustable from 4.0 to 7.0V)  
400 ma (5% regulation)

##### Clock:

Six Frequencies: nominal outputs, 1, 10, 100, 1K, 10K and 100KHz.

Outputs: normal and inverted

Amplitude: nominally 5v peak to peak

##### Switches:

(2) debounced pushbuttons (logic 0/ logic 1)  
(4) SPDT Slide Switches to apply ground or 5 volts to circuit

##### Logic Lamps: (4 LED type)

ON—greater than 2.5V

OFF—less than .5V

Input Impedance—22K  $\Omega$

##### Connectors:

(1) SK-10 Socket  
(4) 5-way binding posts  
(22) BP-22 Solderless Breadboarding Pins  
(2) BNC Conductors

##### Physical:

3.5" H (8.9cm)  $\times$  7.6" W (19.3cm)  $\times$  9" L (22.9 cm)

Sloped Approx.—17°

Weight—5 lbs. (2.27 Kg)

## CD-1 CMOS/TTL DESIGNER A NEW GENERATION OF DIGITAL DESIGNING

The new CMOS designer, CD-1, is the most advanced trainer available. It has a fully variable output voltage that allows the user to work with CMOS logic directly as if it were normal TTL circuitry. TTL circuit work is possible by setting the mode selector to TTL position. In

fact, with the CD-1 there are virtually no restrictions on designs. Associated educational materials are available for use in formal teaching situations.

Available in kit (CD-1K) or assembled (CD-1A) form at either 115V or 230V.

The CMOS-M and the associated IC's (CMK-1) plus the CD-1K form the CMC-3 package.

### SPECIFICATIONS

#### D.C. Power Supplies:

**Fixed:** +5 Volt +/- 5%  
2% load regulation  
1 Amp, short circuit protected

**Variable:** +3 to +15 Volt

Adjustable from front panel slide switch 100 ma for external use

**Clock:** 6 frequencies — nominal outputs 1, 10, 100, 1K, 10K, 100KHz  
**Complementary Outputs:** TTL/CMOS Compatible

##### Switches:

1 — TTL/CMOS Selector switch: places entire unit in either mode  
2 — debounced pushbuttons with complementary outputs  
4 — logic level slide switches

##### 4 Logic Lamps:

TTL/CMOS compatible logic indicators (L.E.D. type)

##### Connectors:

(1) SK-10 breadboarding socket (will accept up to 8-14 pin DIP IC's)  
(2) uncommitted BNC connectors, case grounded to panel  
(2) five-way binding posts  
(22) BP-22 Solderless Breadboarding Pins

##### Physical:

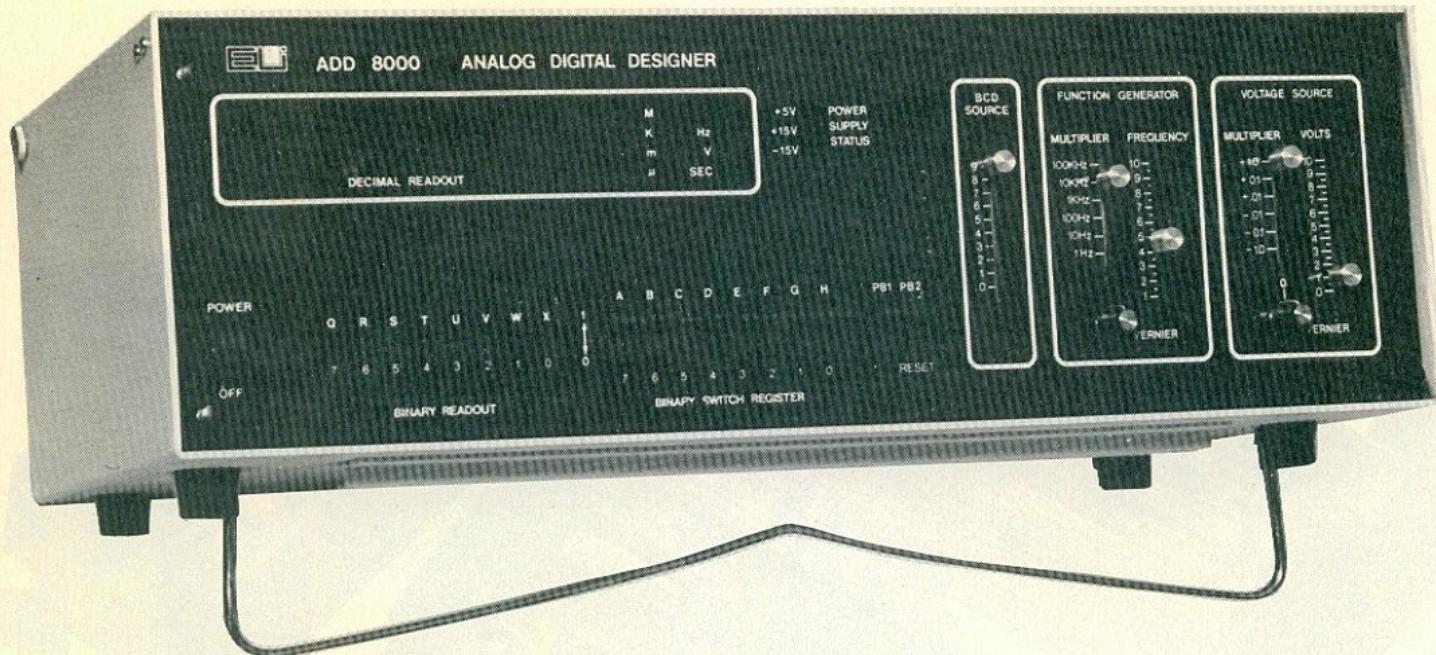
3.5" H (8.9cm)  $\times$  7.6" W (19.3cm)  $\times$  9" L (22.9cm)

5 pounds (2.27 Kg)

Sloped Approx.—17°

# Designers

ADD-8000



## MALMSTADT AND ENKE'S DESIGN FOR THE CLASS-ROOM

The Premiere Breadboarding System. The ADD-8000 is designed with unparalleled flexibility to form a unique aggregation capable of use as a digital voltmeter, a frequency counter and an analytical instrument.

Dr. Howard Malmstadt and Dr. Chris Enke have designed a mainframe complete with every basic function capable of sophisticated unitized circuitry: voltages, waveform generator, 7 segment displays and LED indicators, BCD source and all the necessary switches.

V/F, A/D conversions, counter/timer and analog

switches are only the beginning.

The ADD-8000 is totally flexible and expandable. It is supported by an experimental workbook, the ADDbook One, and can be used in conjunction with Electronic Measurements for Scientists. Published by W. A. Benjamin, Co., available at your local bookstores.

In addition, Drs. Malmstadt and Enke have designed a complete set of adapter boards and plug-ins, that can easily be installed in older models, such as the EU801A or EU801C, updating them to today's technology.

See separate brochure No. 803-0148.

## ADD-8000 SPECIFICATIONS

Entire System includes:

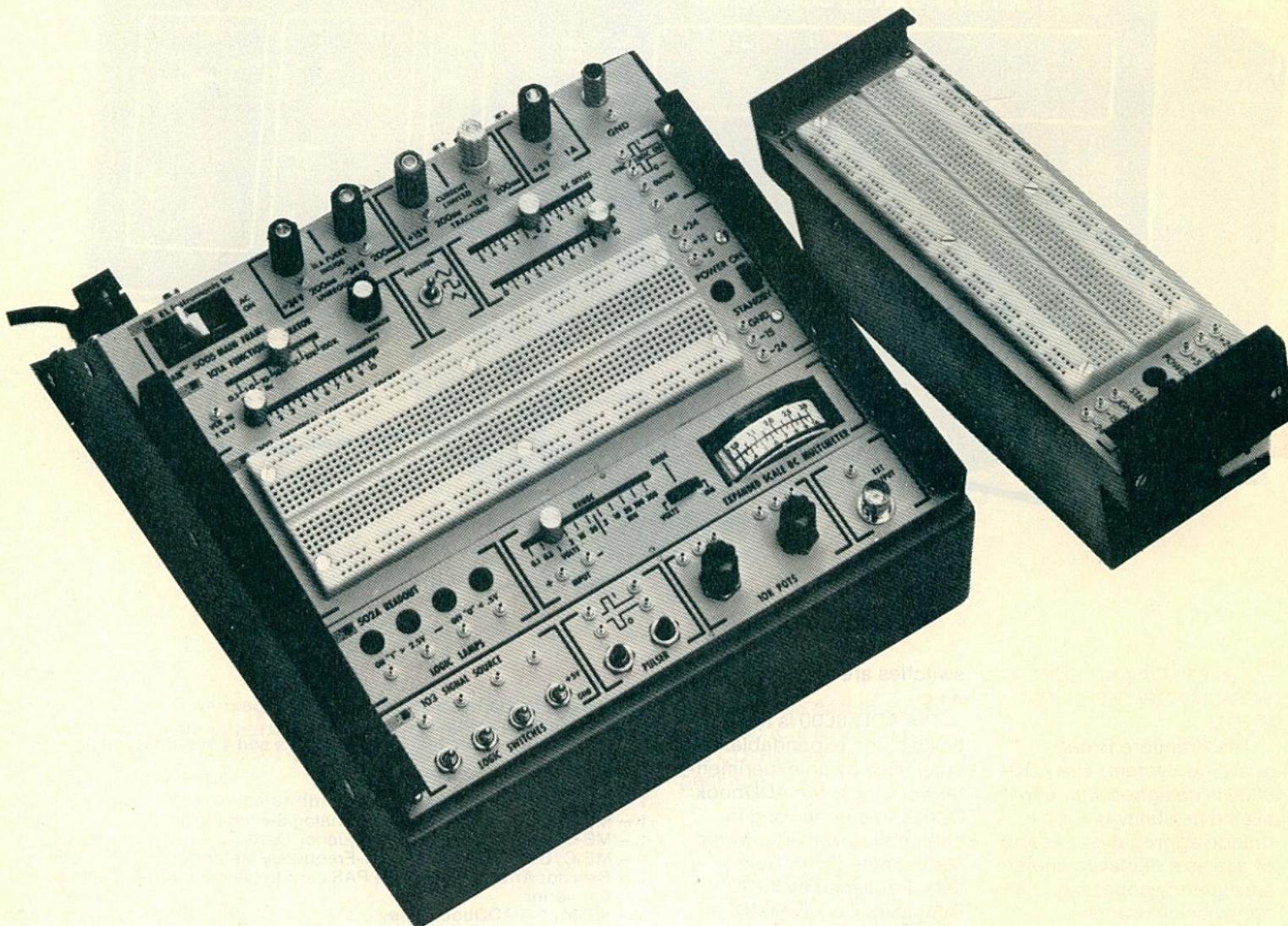
- 1 — ADD-8000 Mainframe
- 1 — ME-T/ADD — Terminal Block (2 BNC's and 4 five-way binding posts)
- 1 — ME-C/QOA — Quad Op-Amp Card
- 1 — ME-C/BBD — Breadboarding Card
- 1 — ME-C/PAS — Programmable Analog Switch Card
- 1 — ME-C/DVM — Voltage-to-Frequency Card
- 1 — ME-C/CTF — Counter-Timer-Frequency Meter Card
- 1 — Resistor Array — allows the PAS card to become a D/A Converter
- 1 — ME-M/1 — ADDbook One
- 1 — ME-J/RO — Readout Jumper Set
- 1 — ME-J/CW — Pre-cut wire package

## MAINFRAME DESCRIPTION

- Function Generator — sine, square and triangle
- Precise adjustable voltage reference source
- BCD encoded source
- Two 4-digit decimal readouts
- LED Status Indicators
- Binary Switch Register
- LED Binary Readout
- Regulated, Current-Limiting Power Supply — 5V @ 3A and ±15V @ 250 ma
- 21 Slot Card Bin
- Velcro® surfaces to attach 2 uncommitted SK-10's
- SK-50 Interface socket — to patch front panel functions

# Analog / Digital

**ADAM**



## THE MODULAR BREADBOARDING SYSTEM

Custom design your own instrumentation/breadboard package. Take your basic ADAM, use the 5005 powered mainframe and a wide range of individual plug-in modules to meet your own requirement for a specific job or

custom circuitry.

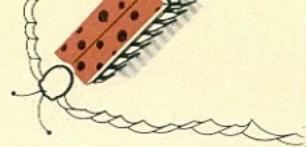
The basic 5005 Mainframe contains all power supplies necessary to operate the separate modules plus power for the circuit being designed on the panel-mounted SK-10 universal component socket.

The basic ADAM System includes:

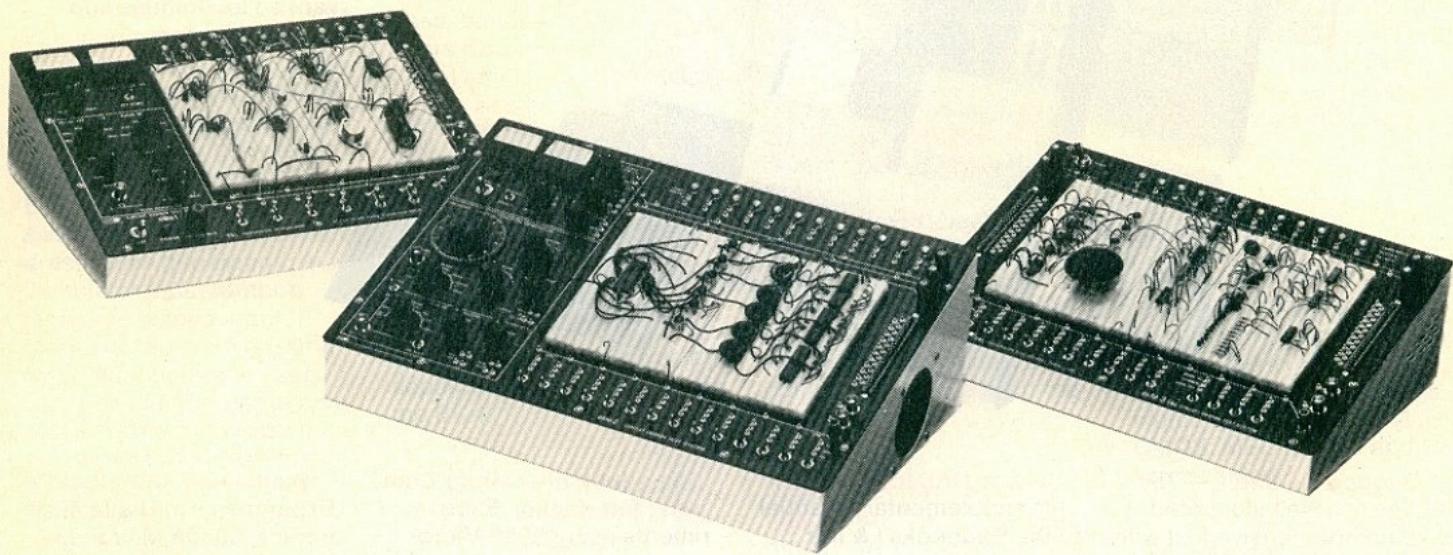
- 5005 Mainframe and power supplies
- 103 Signal Source Module
- 101 Function/Pulse Generator
- 302 Universal Component Socket Module (2)
- 502 Readout and DC Multimeter Module

Individual circuits may be saved and you can continue using the balance of the instrument. Plus, you can expand the entire system simply by adding a blank mainframe (5000) and drawing power from the main unit. See separate brochure 803-0122.

# Design Systems



## ELITE SERIES



### ELITE 1

#### A COST EFFECTIVE, FLEXIBLE, LARGE SCALE DESIGNER

ELITE 1 is a fully operational breadboarding system, compatible with CMOS logic work. A fully metered (current/voltage) variable stable supply (from 2-10V @ 2 amps), ideal for CMOS or TTL, is complemented by a wide range pulse generator (1Hz to 1MHz) with variable pulse width and amplitude. ELITE 1 also has 4 SK-10's Led status monitors, switches and I/O connections.

### ELITE 2

#### THE TOP OF THE LINE

All the ELITE 2 needs is an oscilloscope and you have a complete development system. Intermix analog and digital, discrete and integrated logic and work with all of the logic families. ELITE 2 has the capabilities to accomplish almost anything in electronics. Three floating, regulated meter supplies, a full function/pulse generator (1Hz-1MHz), buffered logic lamps (+/- input), a complete array of switches, and I/O connectors and 4 SK-10 sockets. ELITE 2 is the top of the line in circuit design.

### ELITE 3

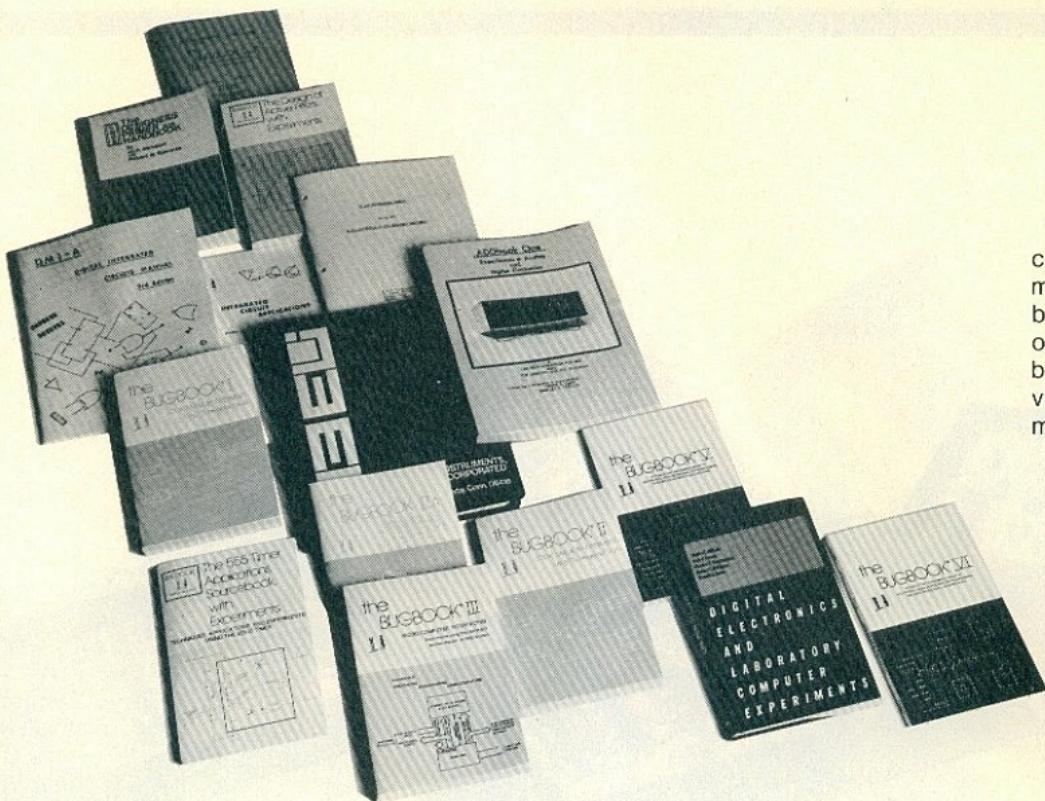
#### THE PACKAGED DESIGNER FOR TTL WORK

Save time, save money. ELITE 3 is all you need for your TTL applications. It carries a large power supply (2.amps @ 5V), ample switches (that can be ordered as pulsers or bounce free), and I/O connectors that make it a natural for designing a custom interface on a cost-effective basis.

A new option allows the 5 SK-10 sockets to be mounted on a  $\frac{1}{8}$ " (3.18mm) thick piece of plexiglass, permitting removal of the whole socket area. Please indicate your preference.

See separate brochure No. 803-0103.

# Educational



**Bugbooks I and II** — 750 pages of a well-illustrated and comprehensive text with integral experiments to carry the user from basic digital electronics, such as gates and codes (digital), to sophisticated circuits employing random access memories, sequencers, 4 decade counters and dot matrix displays. Thanks to the unique structure of each Bugbook, users can pick and choose appropriate experiments and questions and proceed at their own pace and depth of interest. Each book is soft bound.

**Bugbook IIA** — Interfacing and Scientific Data Communications. A supplement to Bugbooks I & II covering more advance topics in Digital Electronics; in particular, transmission of data with asynchronous techniques using the ASC II code; how to use RS 232/20ma current loops in combinations with the universal asynchronous receiver/transmitter. Soft bound.

**IS — Instructor's Manual** This supplementary manual to the Bugbooks I & II is necessary for instructor use in the classroom and laboratory or for individual use in home-study situations. The Manual provides supplemental information including answers to the questions at the end of each experiment, suggestions for further reading, a discussion of the philosophy of the authors in their approach to digital electronics, and organizational suggestions for a lecture/laboratory course. This material is a must for individuals who are taking the course on a self-teaching basis; the answers to the experimental questions provide important feedback concerning the extent to which the material has been learned.

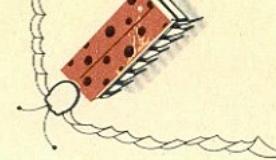
**Bugbook III — Micro Computer Interfacing.** Experiments using 8080 Microprocessor system. Soft bound, 597 pages. This is unique text written in a self teaching style with experiments that thoroughly explain how to use, interface and program microcomputers. It focuses on a microprocessor system that uses the 8080 microprocessor and describes both in a general and specific manner. How to interface, how to program, how to work with the I/O busses, working with timing loops and more. The Bugbook III has been used successfully by individuals who are just experimenters or all the way through direct integration into formal classroom studies in universities. The book contains over 60 experiments, over 200 definitions.

E&L offers a group of carefully selected texts, manuals, and reference books that relate to the area of circuit design concepts, basic digital electronics, advanced techniques and microcomputers.

**Bugbook V.** Introductory Experiments in Digital Electronics, 8080A Microcomputer Programming, and 8080A Microcomputer Interfacing. 493 pages.

The Bugbook V is the first book in an integrated approach to self-instructed basic digital electronics, breadboarding, and 8080A microcomputer interfacing/programming. Detailed laboratory experiments cover the 7440-series of TTL integrated-circuit chips, including the concepts of signal gating; AND, OR, NAND, and NOR gates, truth tables, decoders, demultiplexers, counters, flip-flops, latches, monostable multivibrators, and the 555 timer. The accompanying text provides background information on these subjects. Answers to all tests and laboratory experiment questions are provided in the text.

# Materials



**Bugbook VI.** Introductory Experiments in Digital Electronics, 8080A Microcomputer Programming, and 8080A Microcomputer Interfacing. 490 pages, May, 1977.

The second book in an integrated approach to basic digital electronics, breadboarding, and 8080A microcomputer interfacing/programming. Also written for self-instruction, Bugbook VI integrates the digital concepts discussed in Bugbook V into a treatment of 8080A microcomputer interfacing and programming. Detailed laboratory experiments in Bugbook VI cover device select pulse and memory address pulse generation; accumulator input/output; memory mapped input/output; three-state bussing; the 8080A instruction set; advanced input/output concepts and experiments; interrupt servicing; and the design of a modest 8080A-based microcomputer. Answers to all tests and laboratory experiment questions are provided in the text.

**BRS-1** — The first of the Bugbook Applications Lines is the 555 Timer Applications Sourcebook. E&L proudly introduces this new addition to the Bugbook Series, the Bugbook Reference Series. The BRS-1 is a laboratory workbook and reference textbook that provides theory and applications of the versatile 555 timer chip. The organization and electrical characteristics of the 555 are discussed and then followed by applications, including monostable multivibrators, astable square wave generators, regulated power supplies, measurement circuits, switching regulators, games, telephone, music and automotive circuits, circuits for the ham, photographer and CB buff. Like the original Bugbooks, the BRS-

1 is self-instructional and has sixteen experiments included. The parts to do all the experiments come as a separate package, known as the BK-1.

**BRS-2** — The second of the Bugbook Reference Series is a user-oriented text/workbook covering the best design of the various types of low-pass, high-pass, bandpass and notch filters built around operational amplifiers. 26 experiments, design graphs, tables and numerous illustrations make BRS-2 an excellent guide for the experimenter and hobbyist. An inexpensive 4-function calculator can be used to solve all equations and calculations. The parts to do all of the experiments come as a separate package, known as the BK-2.

**BRS-3** — The third addition to the Bugbook Reference Series describes D-Bug. Use the BRS-3 to debug assembly language programs for any 8080 microcomputer system. D-BUG may reside in either 1,024 words of EPROM or R/W memory and can be used to examine and modify the contents of memory, punch and read paper tapes (audio cassettes) and single step through an assembly language program using the breakpoint feature. Two complete source listings are included, and examples are used throughout the book to demonstrate valid D-BUG commands and operations.

**ADDbook One** — The ADDbook directly integrates the ADD-8000 and the Electronic Measurements for Scientists to form a truly comprehensive teaching system for Analog and Digital techniques. A large format (8½" x 11") book of 400 pages. It gives experimental implementation of the ideas brought out in the Electronic Measurements for Scientists, in up to the minute hardware designs.

**Designers Primer and Handbook CMOS-M** — Our recent publication in the CMOS circuitry area has been updated. New IC's have been covered, additional reference material added and redesigned. We also are offering CMK-1, a kit containing the necessary components to do all of the experiments.

**Digital Electronics and Laboratory Computer Experiments** by Plenum Press, New York and London. This new guidebook is designed to teach the basic principles of digital electronics and microcomputer applications in the laboratory.

By the proven use of graded experiments, the student is instructed in the application of computer technology to scientific data collection and analysis problems in the laboratory. All seventeen experiments have been thoroughly tested and found to be error free, making this book a reliable manual for both laboratory courses and self-instruction.

The DD-1 Digi-Designer has been used to work one-to-one with each of the experiments.

## Digital Fundamental

**DC-2** — An experimental approach to understanding digital electronics. The DC-2 is supplied in a lab binder format, with ample area for diagramming and circuit design. This volume covers items from simple switching devices to the complex 74181 Arithmetic-Logic Chip. The text ties directly into the DD-1 Designer and can be easily integrated into formal courses as a lab book. All the IC's necessary to do all of the experiments in the DC-2 are available in the kit IC-1.

## DM-1A — Digital Configuration Manual

This soft cover text lists almost 6000 IC's with their general type called out and referenced to one of 700 different pin outs. All types, including TTL, ECL, DTL, CMOS, MECL, MOS and LSI, are included.

## OP-AMP Experiment Manual OM-1

— The OP-AMP Experimenter's Manual. This book is a useful tool for understanding how Op-Amps work. The softbound volume contains 12 chapters on various experiments for learning linear integrated circuits. It is designed to work with the Op-Amp designers; the Op-Amp Breadbox, or Starter Kit.

## Integrated Circuit Applications and Experiments OA-2M

— A compilation of almost 200 experiments mainly covering linear circuitry with added information on complementary digital circuitry. The OA-2M covers an up-to-date spectrum of applications of IC's that range from simple circuits through complex waveform generators. Designed to be used with the OA-2 or the OA-3.

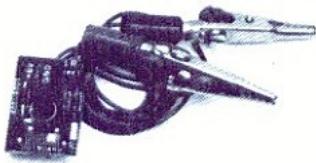
# Innovator

## Innovator Series

With this inexpensive, easy to use teaching system, students are involved on their very first day with the exciting world of digital electronics. Text/workbooks are integrated with the hardware. A separate teacher's manual gives the instructor valuable lesson information.

## BASIC OUTBOARDS

The "Basic Outboards" make up the initial system. They contain the fundamental modules needed to carry out the associated experiments in Bugbooks I & II. They are used to control and monitor what's going on in the breadboarded digital circuit under design/study.



### LR-1 POWER OUTBOARD

Used when operating the SK-10/Outboard System from a 6 volt battery. It guarantees that power cannot be applied backwards; it also gives the user a positive indication of power on. It comes complete with 2 insulated Alligator clips for attaching to a battery.

#### Specifications

Polarity reversal protected  
Indicator Light — LED  
Lead lengths — 18"  
(45, 7cm) terminated in  
Alligator clips.



### LR-2 LOGIC SWITCH OUTBOARD

Allows user to set either logic state 1 or 0 at output terminals.

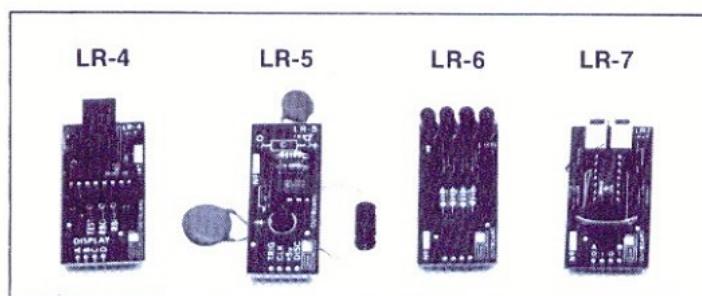
#### Specifications

4 logic switches — spdt —  
rated 1/2 Amp @ 125V  
4 "pull up" resistors  
connected to Vcc

insight into the problems a student will encounter, supplemental course work and answers to the text questions. Each idea presented by the authors, Rony and Larsen, is immediately reinforced with an experiment. The low cost of the materials makes it possible for each student to have his own

work station and to learn by doing. The experimental unit is small and portable, allowing the possibility for lab homework and extra experimentation by the ambitious student. The component parts used to demonstrate various aspects of digital circuitry are plug-in outboards. These outboards plug into

one of the SK series on the outer edge leaving the center portion open to build the particular circuit under study. The student actually uses IC's, resistors, transistors, LED's, etc. The system approaches the student first with the individual outboards as tools leaving later lessons open to theory.



### LR-4 SEVEN SEGMENT DISPLAY WITH DECODER/DRIVER

Gives a numeric readout (0 to 9) based on Binary Code Decimal (BCD) Input. Used in counting circuits, 0/1 indication, etc.

#### SPECIFICATIONS

**Input:** BCD, TTL input (5 volts nominal)

**Indicator:** LED, 7 segment display

**Current (max.):** 140 ma.

**Miscellaneous:** (4) BP25's — solderless interconnecting jacks for independent connections to Lamp Test, Blanking Output, Blanking Input and Decimal Point. Display and Associated IC are mounted in IC sockets allowing replacement without soldering.

### LR-5 CLOCK OUTBOARD

An outboard that can be used as a standard TTL "clock" that is adjustable via external capacitors inserted across the "C" terminals or as a timer through external components that can be constructed on the SK-10

when the Outboard is installed. The Outboard contains its own indicator for showing the output condition (e.g. — when clocked at a specific frequency, the light blinks on/off at that frequency).

#### Specifications

**Clock:**

**Capacitors supplied:**

**Miscellaneous:**

Frequency adjustable from .1 to 20K Hz. for a capacitance range of 5pf to 100  $\mu$ f.

.03, .33 and 1.0  $\mu$ f.

Indicator Light — LED: 20 ma. (max.)

### LR-6 LED LAMP MONITOR OUTBOARD

This outboard gives the user an indication of the logic levels at various points in the circuit under observation. Because the input is used to drive a transistor, a high input resistance results so the circuit is not "loaded" down by the indicator.

#### Specifications

**4 Logic Lights — LED Indicators**

**On:**

logic state 1 (greater than 2.5 volts)

**Off:**

logic state 0 (less than .5 volts)

**Input Impedance:**

4,700 ohms

**Current:**

80 ma. (max.)

### LR-7 DUAL PULSER OUTBOARD

Two miniature spring loaded switches are electronically "debounced" — that is, change state from 0 to 1 or 1 to 0, without any spurious signals when actuated.

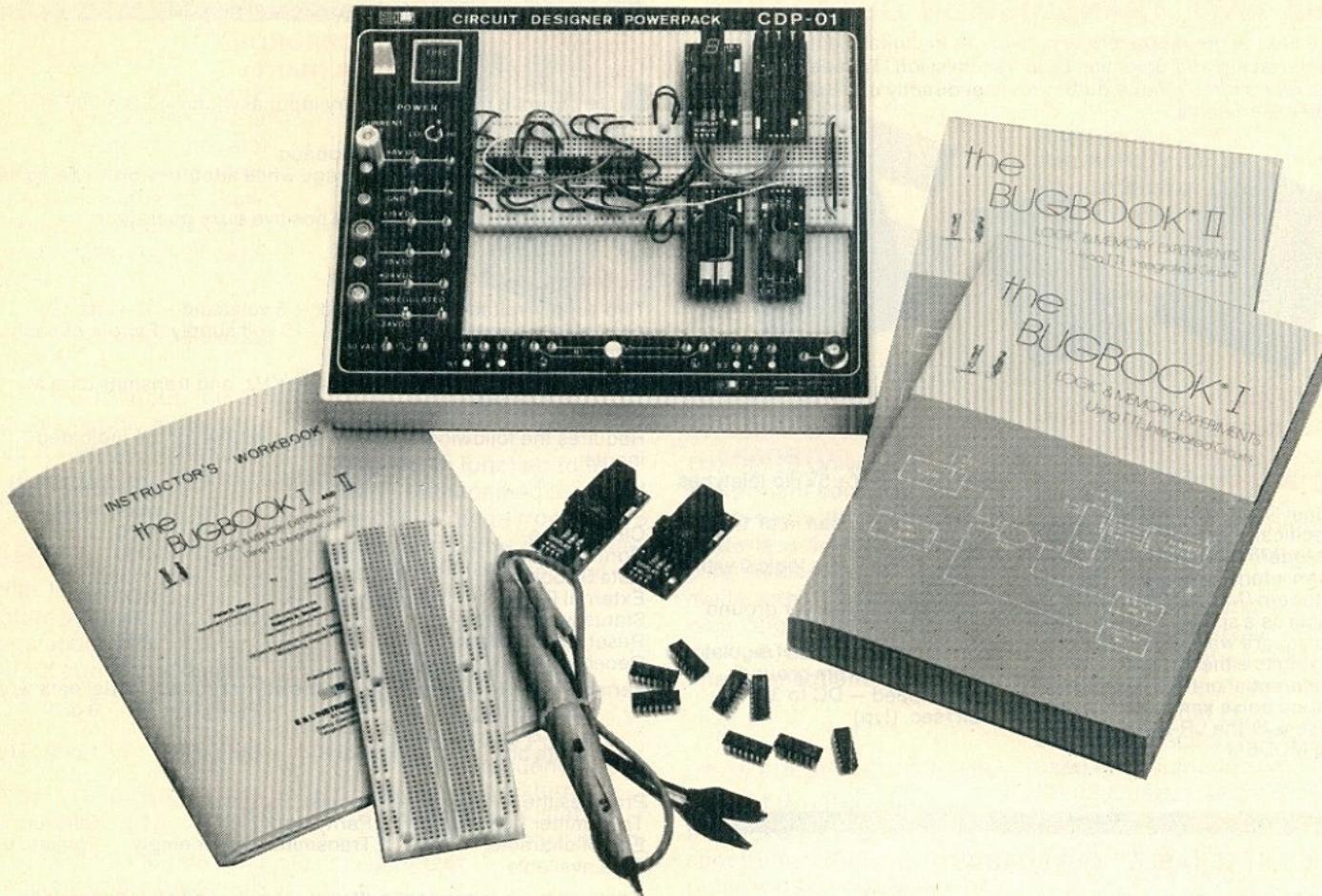
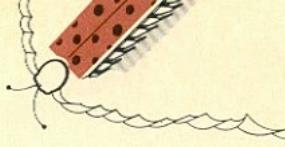
#### Specifications

2 miniature spring-loaded momentary contact switches. Outputs: 2 each switch: one normally "zero," one normally "one." Outputs reverse on switching.

**Current:**

20 ma. (max.)

# Series



## Innovator Systems

E&L has put together a number of specific combinations of the outboards and associated items for ease of specification and use by teachers and individual users.

**IS-2** — Basic outboards, IC's, wire, SK-10, Bugbooks I & II, a comprehensive assemblage for the beginner. As the student progresses, additional IC's and a power supply may be added to cover all topics and in-depth analysis of particular phases of interest. Available in Kit (IS-2K) or Assembled (IS-2A).

**IS-5** — All of the above (IS-2) plus an additional LR-4, IS-EC1 electronics component package, CDP-01 power supply, LT-2 (Logic Probe) instructor's manual and label set BGB-1. Available in Kit (IS-5K) or Assembled (IS-5A).

## INSTRUCTOR'S PACK IS-IP-1

To adequately handle most contingencies in a classroom situation, including the need for demonstration experiments, extra work assignments, special projects, and replacement Outboards and wire, E&L recommends that each instructor equip himself with the following items:

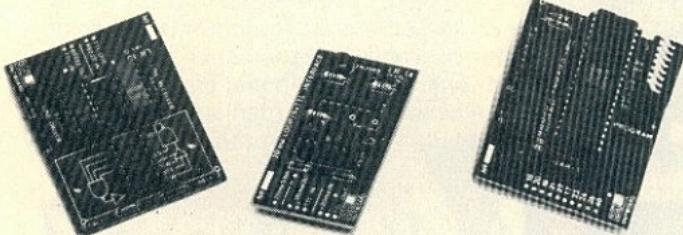
Contains Accessory Packages 1, 2 and 3 (see separate listing) Plus All of the Following:

1. Four extra SK-10 sockets
  2. One CDP-01, assembled
  3. Two "Bugbook I and Bugbook II."
  4. Two Instructor's Manuals
  5. Two BGB-1 Bugback packages.
  6. Additional Outboards. Two each of the following:
    - a. LR-1A Power Outboard
    - b. LR-2A Logic Switch Outboard
    - c. LR-4A Seven-segment LED Display Outboard
    - d. LR-5A Clock Outboard
    - e. LR-6A LED Lamp Monitor Outboard
    - f. LR-7A Dual Pulser OutboardOne each of the following:
    - g. LR-10A Programmable Counter/Timer Outboard
    - h. LR-11A Universal Outboard
  7. Zero-insertion-force sockets
    - a. Two 24-pin IC sockets
    - b. Two 40-pin IC sockets
  8. No. 22 gage solid wire cut to length with  $\frac{1}{4}$ " (6.4mm) stripped ends.  
Six (6) colors of each of the following lengths:
    - a. Ten (10) lengths of  $1\frac{3}{4}$ " (4.5cm)
    - b. Ten (10) lengths of  $3\frac{1}{2}$ " (7.6cm)
    - c. Four (4) lengths of 6" (15.2cm)
- Additional Software
- a. TTL Databook by Texas Instruments
  - b. TTL Cookbook (Lancaster) by H. Sams

# Innovator

## THE DATA TRANSMISSION OUTBOARDS

One area of great concern to individuals in digital electronics today is interfacing and Scientific Data transmission. To meet this need E&L offers three unique outboards that directly use Bugbook IIA for their experiments.



### LR-13 LINE DRIVER/RECEIVER – RS232 INTERFACE OUTBOARD.

A dual line driver/receiver specifically intended for a UART to Modern Interface

- Can interface any TTL to Modern/MODEM to TTL
- Acts as a schmitt trigger, sine to square wave converter
- Exhibits either a high differential or high common mode noise immunity
- Use with the LR-21 to interface to MODEM

### LR-14 TTL/20 MA CURRENT LOOP INTERFACE OUTBOARD.

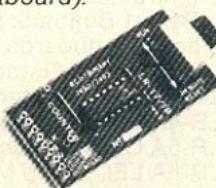
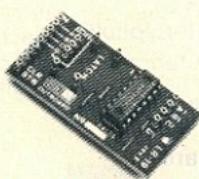
Interface TTL (+5V) to teletypes and CRT's.

- +5V TTL I/O; fan in of 1; fan out of 10
- logic 1 with 3 ma; logic 0 with 15ma.
- optically isolated for ground loop elimination
- on board regulation (regulator not isolated from ground)
- data speed – DC to 30 K bit/sec. (typ)

## THE "STACKABLE" OUTBOARDS\*

E&L's Stackable Outboards include a number of circuits that are configured in such a manner that they may be inserted directly into the SK-10, or they may be vertically assembled onto each other to perform a complete function in a number of ways. There are a

number of these combinations that have been evolved, for example:  
*To obtain a complete counting circuit, assemble on the LR-17 (BCD Decode Counter) the LR-19 (LATCH) and finally, the LR-4 (7 segment Readout/Decoder Outboard).*



### LR-19 LATCH OUTBOARD

The LR-19 incorporates a positive edge triggered latch which can be used as a 4-bit memory with complementary outputs, Q and Q. STROBE and CLEAR inputs are provided.

### LR-17/18 BCD DECADE COUNTER/4 BIT BINARY COUNTER

These Outboards differ only in the substitution of a 4-bit binary counter IC chip (LR-18) for a BCD decode counter IC chip, (LR-17). A DPDT switch permits either a free running counter or a counter that can be reset to 0 from a remote input. The decade counter can also be remotely reset to 9.

### LR-21 UNIVERSAL ASYNCHRONOUS RECEIVER/TRANSMITTER (UART)

LR-21 covers 8 bit parallel binary input asynchronous serial output and visa-versa.

- It operates at speeds to 30 kilobaud.
- Double buffered allowing storage while another word is being sent or received.
- Has 3 state outputs permitting positive buss operation.

### SPECIFICATIONS

Two supply voltages are required, +5 volts and -12 volts. It is possible to replace the latter by a -15 volt supply. Fanout at each output: one TTL load.

Will accept clock frequencies to 480 KHz, and transmits data at rates of up to 30K baud.

Requires the following minimum pulse widths for the indicated inputs:

Input	Minimum pulse width, nsec.
Clock Pulse	1000
Control Strobe	300
Data Strobe	190
External Reset	500
Status word enable	500
Reset data available	250
Received data enable	500

Permits the following options for the asynchronous serial data work:

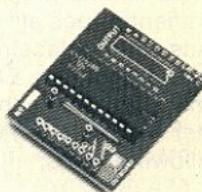
Start bit      1      Parity bits      0 or 1

Data bits      5, 6, 7 or 8      Stop bits      1 or 2

Provides the following flag signals:

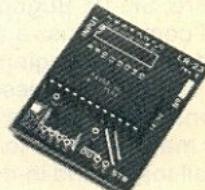
Transmitter buffer empty	Parity error	Overrun
End of character	Transmitter buffer empty	Framing error
Data available		

Contains an independent buffered receiver and an independent buffered transmitter that can be clocked independently. However, the control bits apply to both receiver and transmitter simultaneously, so both the transmitted and received words must have the same number of data bits, parity bits, and stop bits.



### LR-22 DECODER OUTBOARD

This 4-line to 16-line decoder Outboard can be stacked into the LR-18 binary counter to produce a 16-state sequencer. Its main use is as a microprocessor output decoder.



### LR-23 MULTIPLEXER OUTBOARD

The LR-23 is a 16-line to 1-line multiplexer that can select information appearing at any one of sixteen different input channels and provide it in inverted form at a single output. It is very useful for multiplexing data into a microprocessor input port.

# Series

## SUPPLEMENTAL OUTBOARDS

In keeping with the concept of flexibility and expansion of the basic Innovator Series, the following items are now available to complement the original Outboards®, Bugbooks®, and CDP-01.

### LR-16 VARIABLE POWER SUPPLY

With 15 VDC input, this small variable supply adjusts the output voltage continuously from approximately 3 to 14 volts DC.

#### SPECIFICATIONS

(With 15 volts in)  
Output voltage: 3 to 14 volts  
Regulation: -1%  
Output current: 100 ma.  
(max.)

### LR-25 TTL BREADBOARDING OUTBOARD

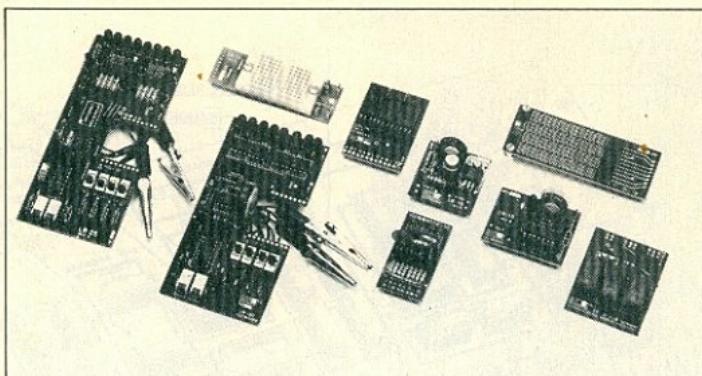
The LR-25 combines the functions of the basic outboards on a single DC board. All the basic controls and monitor elements needed for digital work are contained in a very hard supplement suitable for even advanced design work. The HEX decimal display is not supplied with the base unit but is available as an option.

#### SPECIFICATIONS

(8) LED type indicators  
(4) Logic Switches  
(2) Bounce-Free Pulser  
(1) Variable Clock (frequency selected by external capacitor)

### LR-110 KLUGE CARD OUTBOARD

This board complements the LR-11. It represents a simple way of building permanent circuits that are routinely used as part of a design.



### LR-30 CMOS BREADBOARDING STATION

Identical in function to the LR-25 but modified to operate over a range from 3 to 15 volts. This unit is not available with the HEX decimal optional display.

#### SPECIFICATIONS

Input voltage 3-15 volts  
(8) LED indicators  
(4) Logic Switches  
(2) Bounce-Free Pulser  
(1) Variable frequency clock selected by external capacitor; adjustable through outboard potentiometer.

### LR-27/28 THREE DIGIT LATCHES

Three character HEX-decimal displays. The 27 and 28 are identical except for independent displays with common strobe on the 28.

### LR-10 PROGRAMMABLE TIME/COUNTER

A counter/timer that allows the user to program various combinations of time delays and frequency generation.

#### SPECIFICATIONS

##### Programmable Timer/Counter

XR2240/2340  
Timer Length microseconds to days: accurate to .5%  
TTL Outputs

##### Maximum "toggle" rate

1.5 meg. hz.  
Current: 10 ma. (max.)

8-BP25's — solderless interconnecting pins for connections in parallel to 16 pin IC socket and header for programming.

NOTE: One unused 16 pin header is supplied for user's designed projects; one 16 pin header is supplied with components for experimental use.

### LR-31 FUNCTION GENERATOR OUTBOARD

The LR-31 Function Generator Outboard can generate a square wave and either a sine wave or a triangle wave. Frequencies of 0.01 Hz to 1 MHz are possible, depending on the value of the user selected capacitor. With a single capacitor the dynamic frequency range is greater than 1000:1.

### LR-32 4 DECADE COUNTER OUTBOARD

The LR-32 Decade Counter Outboard is a complete 4 decade counter including 4 decade counters, latches, display drivers, display multiplexing circuitry and 4, 7-segment LED displays. The carry output of the LR-32 4 Decade Counter Outboard is available so that LR-32's can be easily cascaded. When used in conjunction with the LR-33 Quartz Crystal Outboard, frequency counters, period meters and event counters can be easily constructed.

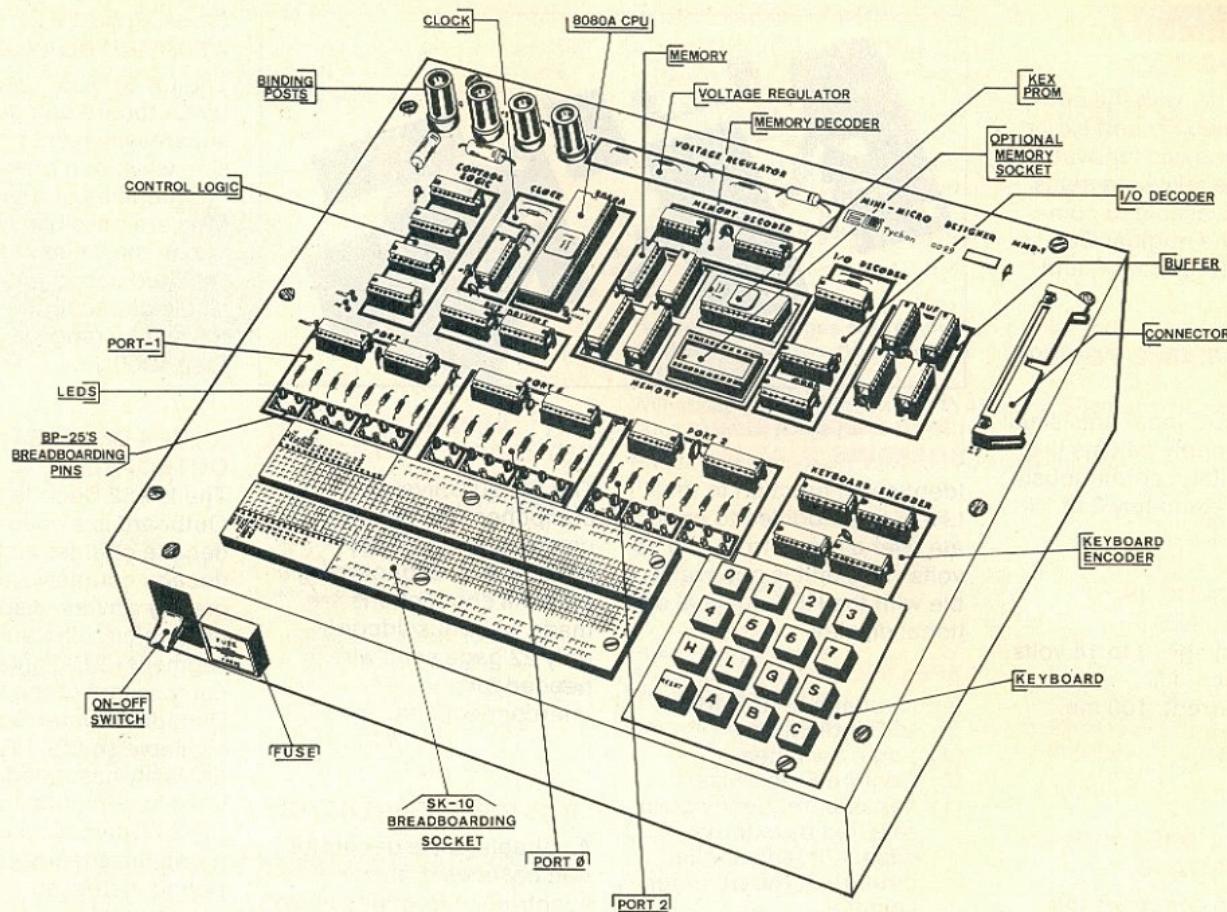
### LR-33 QUARTZ CRYSTAL OUTBOARD

The LR-33 Quartz Crystal Outboard uses a state-of-the-art MOS-LSI technology to provide stable, programmable frequency source. With the on-board thumb-wheel switch or jumpers on the bread-boarding socket, you can select an output frequency of from 1 MHz to 0.01 Hz, by factors of ten.

### LR-34 UNIVERSAL TRANSISTOR OUTBOARD

The LR-34 Universal Transistor Outboard enables you to easily breadboard TO-3 and TO-220 power transistors, SCR's, triacs and solid state voltage regulators. With transistor sockets provided on the outboard, it is very easy to switch between either a TO-3 or TO-220 device.

# Microprocessor



CONTROLS, SOCKETS, CONNECTORS, AND CIRCUIT FUNCTIONS

FIGURE - 1

## MMD-1

**MMD-1** 8080A Based Computer for training and hardware development. The Mini-Micro Designer is a low cost, expandable system totally supported by The Bugbook educational materials. The Bugbooks are the ideal introduction to computers for the beginner as well as those with considerable technical background and experience. The texts, which double as laboratory manuals, start with digital coding and microcomputer programming and advance the student to the practical aspects of programming and interfacing. The MMD-1 features direct keyboard entry of data and instructions in easily understood octal code.

The MMD-1 is the only microcomputer system now

on the market that permits the user to design his own interface in 10 to 20 minutes and implement the design with ordinary hook up wire and standard readily available 7400 series IC's. No special assembly tools are needed.

All in all, the student can carry out over 60 experiments in the Bugbook texts as well as many other circuit designs without the need for soldering or the construction of simple circuit functions. Available either in kit (MMD-1k) or assembled (MMD-1A) form at either 115V or 230V operation.

See separate brochure # 803-0144.

## SPECIFICATIONS

**Central Processor**  
8080A or equivalent

**Memory**

Read/Write, Random Access (RAM); 512 words by 8 bits furnished on main MMD-1 circuit board.  
Expandable up to a total of 65,536 words. (Additional power required over 2500 words.)  
Programmable Read Only (PROM) programmed to permit keyboard entry of data in octal code; keyboard executive program (KEX) 256 words by 8 bits.  
(Open socket on board permits an additional 256 words.)

**Display**

Light-emitting diode lamps (LEDs); three groups of eight individually latched and addressable under software control.  
LEDs display low address, high address and memory contents.

**Data Entry**

Keyboard: 16-switch with keys organized in octal code 0 to 7, Hi address (H), Lo address (L), go (G), reset (RESET), examine/deposit (S) and three optional keys (A, B, and C).

**Interface Socket**

E & L SK-10/IF 18. Direct interface connection includes  $\bar{D}_0$  -  $\bar{D}_7$ ;  $\bar{A}_0$  -  $\bar{A}_7$ ;  $\bar{T}_in$ ,  $\bar{T}_out$ ,  $\bar{MEMR}$ ,  $\bar{INT}$ ,  $\bar{INTE}$ ,  $\bar{WAIT}$ ,  $\bar{READY}$ ,  $\bar{TACK}$ .  
Open area on socket will take up to five 16-pin ICs and discrete components with 20 to 26 AWG wire leads.

**Ribbon Cable Connector**

Dual, 20-pin wired the same as the SK-10 interface socket with A8 thru A15 added.

**Internal Power Supply**

Line Voltage - 115V or 230V ac, fused

**Outputs**

+ 5V dc @ 1.5A  
+ 12V dc @ 150mA  
- 12V dc @ 150mA

**Microprocessor Chip Set**

1	8224	Clock Generator and Driver
4	8111-2	1024-bit (by 4) static MOS RAM
2	8216	4-bit parallel bidirectional bus drivers.
1	1702	2048-bit (256 by 8) programmable read only memory (PROM) (Factory programmed as KEX PROM)

**Dimensions**

12" (30.5cm) by 10" (25.4cm) by 3½" (8.9cm)

**Weight**

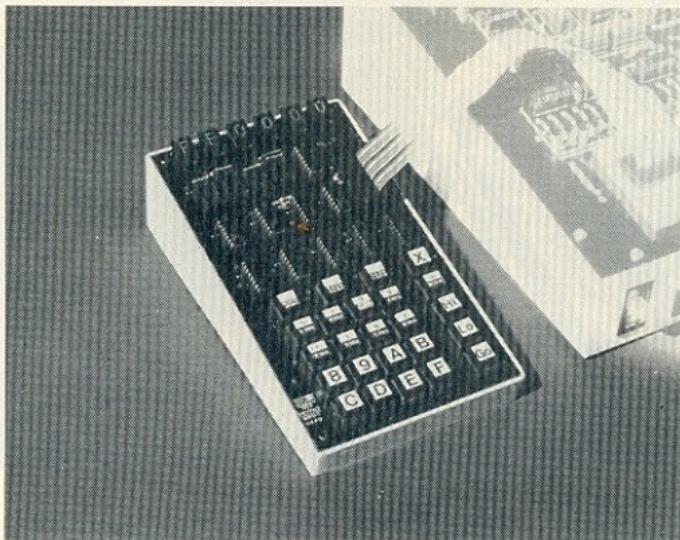
6.3 pounds (2.86kg.)



# microprocessor

EUROPEAN DATA

## HEX KEYPAD



The Hex Keypad has been developed as a general purpose, microcomputer, data entry/display device for persons who find it convenient to work with Hex-decimal Coding. The keyboard section generates four bit Hex code corresponding to the legends on the keys. The keys are priority encoded such that if two or more keys are struck simultaneously the value of the highest order will be output. This feature prevents the generation of false codes and simplifies the processing of data from the Keypad. The Keypad can also be jumper

selected for device codes 0 thru 7.

The Keypad is used in conjunction with E&L's Mini-Micro Designer (MMD-1) to permit direct Hex programming of the computer or as a separate I/O device. To convert the MMD-1 for direct hexadecimal programming simply replace the existing KEX prom, in position "O" with the Hex L/D prom provided and interconnect the two units with the cable provided.

## MMD-HEX-1 (without displays)

### SPECIFICATIONS

**Data Entry:** The keyboard section has a 16 key Hex Encoded Keypad plus 8 encoded function keys, priority encoded.

**Interfacing:** Interconnect capable via a 28 pin DIP double ended ribbon cable. One end goes to the committed portion of the SK-10 on the MMD-1 and the other end goes to the 28 pin DIP socket on the keypad. The following signals are utilized:

GND	Breadboarding pins provided for external use.
+5V	
IN	
OUT	

AO thru A7

DO thru D7

**Power Requirements:**

Approx. 1/4 AMP

**Device Selection:** The keypad is jumper selectable for device codes 0 thru 7. Factory wiring is for use with the HEX L/D PROM. Keyboard — Device Code 001

**Physical:** Dimensions — 7 3/4" (19.7cm) L x 4 3/8" (11.4cm) W x 3" (7.6cm) D. Weight — Approx. 1 lb.

## MMD-HEX-2 (with Displays)

### SPECIFICATIONS

**Displays:** Three pairs of Hexadecimal Latched Displays, provided for. One pair is supplied standard while the additional two pairs are optional.

**Data Entry:** The keyboard section has a 16 key Hex Encoded Keypad plus 8 encoded function keys, priority encoded.

**Interfacing:** Interconnect capable via a 28 pin DIP double ended ribbon cable. One end goes to the committed portion of the SK-10 on the MMD-1 and the other end goes to the 28 pin DIP socket on the Keypad. The following signals are utilized:

GND	Breadboarding pins provided for external use.
+5V	
IN	
OUT	

AO thru A7

DO thru D7

**Power Requirements:**

Approx. 1 AMP (fully loaded with all displays)

**Device Selection:** The keypad and each pair of Hex Displays is jumper selectable, for device codes 0 thru 7, via headers. Factory wiring is for use with the Hex L/D Prom.

Keyboard — Device Code 001

Data — Device Code 002

Lo Address — Device Code 000

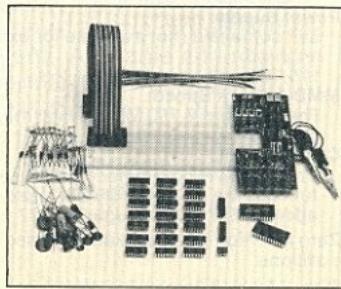
Hi Address — Device Code 001

**Physical:** Dimensions — 7 3/4" (19.7cm) L x 4 3/8" (11.4cm) W x 3" (7.6cm) D. Weight — Approx. 1 lb.

**Accessories:** Accessory #1 — Two (2) Hexadecimal (T.I. #311)

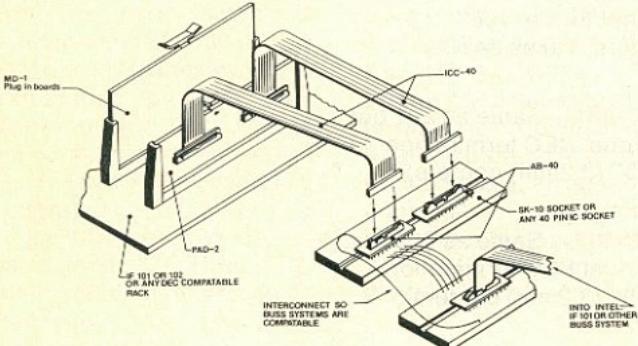
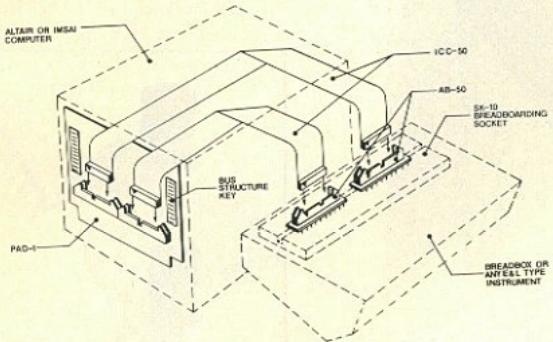
## MMD-1/SS

The Student Station is a package built around the LR-25. This package will give the user the material to do most of the experiments in Bugbooks V and VI. It includes an extra SK-10 socket, IC's, 28 pin dual interconnecting Cable, wire and miscellaneous components.



# Accessories

## COMPATIBLE ACCESSORIES



### ALTAIR®/IMSAI® COMPATIBLE

**PAD-1** — New breadboarding aid for the Altair®/Imsai® owner; plugs directly in the Altair®/Imsai® buss. Use with optional cable and dual-in-line adapter, listed below, with your PAD-1 to plug your Altair®/Imsai® unit into an SK-10 Breadboarding Socket, Breadbox, or other E&L Breadboarding instruments.

**AB-50** — A plug/socket combination to adapt 50 wire strip cable to 50 pin dual-in-line plug. Use with PAD-1 to plug into the SK-10 Socket.

**SC-50** — 50 wire strip cable with female, strain-relieved connector on each end. Comes standard at 18" (45.7cm) long. Plugs directly into the AB-50.

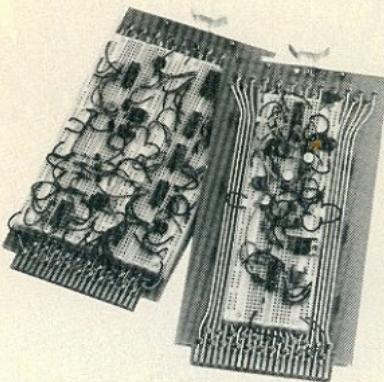
### MD-1/DEC® COMPATIBLE

**PAD-2** — For MD-1 and DEC® buss system owners. This board is similar to the PAD-1 but configured to plug into the MD-1 Interface Board or any other system using a dual DEC connector.

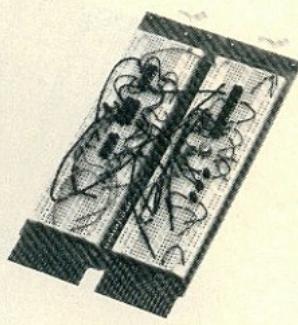
**AB-40** — A plug/socket combination to adapt 40 wire strip cable to 40 pin dual-in-line plug. Use with PAD-2 to plug into the SK-10 Socket.

**ICC-40** — 40 wire strip cable with female, strain-relieved connector on each end. Comes standard at 18" (45.7cm) long. Plugs directly into the AB-40.

## PL1, PL2



## DEC 2



The Plug In Socket Boards are used to construct semi-permanent wired circuits in a totally solderless manner. They can be plugged into card edge connectors (such as those on the Adam or Elite) that are part of larger breadboarding systems, or can be used in card racks as part of "finished" systems.

The PL 1 and PL 2 offer standard SK-10 sockets all of which are available for construction of circuitry; external connections to the edge connector are made by "jumping" to the appropriate interconnecting jack with 22 gage wire.

The DEC 2 uses the interfacing version of the SK-10, which hard wire a portion of the socket directly to edge connectors eliminating the need for jumpers. The DEC 2 uses standard DEC spacing on the edge connector and is particularly useful as a supplemental card in the MD-1 Microprocessor.

### SPECIFICATIONS

Printed Circuit Boards:  
1/16" (1.57mm) G10  
Size: 4.5" (114.33mm)w x 9.5" (25.44cm)L.

Edge Connectors: Gold Plated

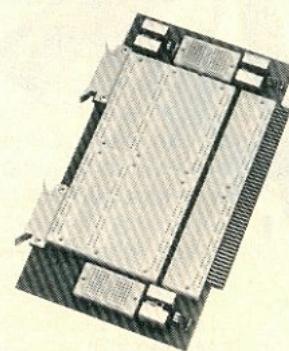
Card Pullers: Molded Plastic

- (2) SK-10-1F 18 Sockets
- (72) Contact Card Edge Connector: 125" (3.18mm) spacing

## S-100 BREADBOARDING CARD

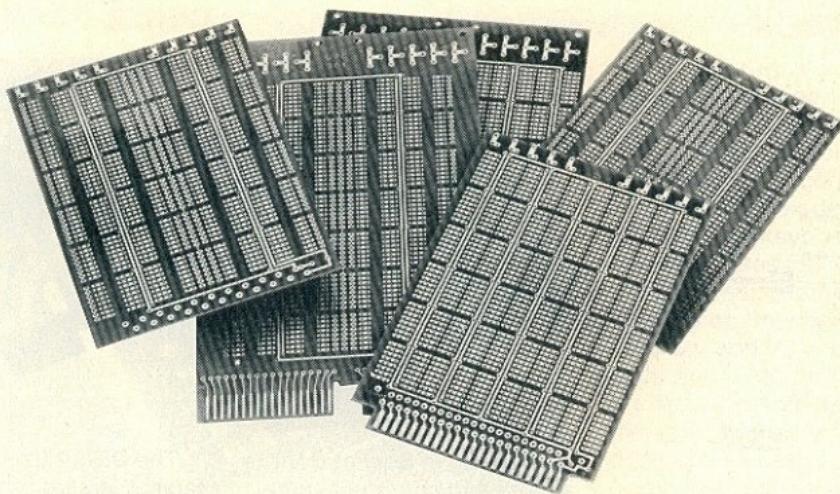
The S-100 will buss and fit into Altair or Imsai units to build semi-permanent interfaces and circuits.

Hardwired interface sockets contact the edge connector of the plug-in card giving the user access to every signal generated by the microcomputer, including those presently unassigned. The Data and Address buss structures are segregated for easy identification and external connection can be made through the AB40 or AB50.

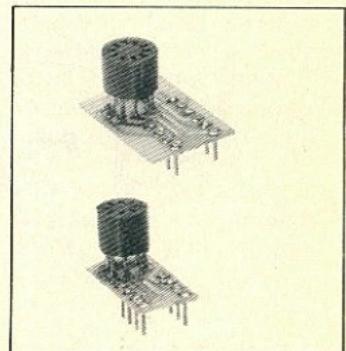


Standard 10" x 5" card size, with 100 gold plated fingers. Breadboarding area committed to S-100 buss.

# Universal



**AB-8 & AB-10** — Two reusable adapter boards that allow the instant use of 8 or 10 pin To-5 devices in any DIP socket or SK breadboarding socket.



You will find E&L an excellent source for standard printed circuit boards for those instances where permanently soldered circuits are required. All items are made from  $\frac{1}{16}$ " (1.57mm) G10 with 2 ounces of copper. All edge connectors have a heavy-wear gold plate. Hole size is .040" (1.01mm) (drilled, not punched).

**UPC-201** — An intermix board for high density packaging of IC's and discrete components; a single sided board..156 card edge spacing -22 contacts.

**UPC-202** — Identical to the 201 except no card edge connection.

**UPC-203** — A dual sided board meant for high density packing of 14/16 pin DIP

IC's. Has cut-away back plane. Double 22 card edge connector on .156" (3.9mm) centers. Takes 24 IC's.

**UPC-301** — Same as 201 but has dual DEC termination (.125" (3.2mm) centers).

**UPC-303** — Same as 203 but has dual DEC termination (.125" (3.2mm) centers).

## LOGIC PROBES

We offer two inexpensive probes for TTL logic work. Both feature LED readouts.



### LT-2

A dual state logic probe with great features at a great price! Two LED's indicate logic states. A switchable "pulse stretch mode" lets you see pulses as narrow as  $50\ \mu$  secs. With a cost this low you cannot afford not to have one handy.

### LT-3

A truly incredible combination "pulser/probe" in one compact package at a price that makes it available to anyone doing digital design, trouble-shooting or circuit analysis. The unit injects a pulse when switched to "pulse" mode. When in the "detect" position, it will detect short pulses and normal "high" states using the two LED's as readouts — thus, the user can both inject pulses to change logic states and measure the states with the same instrument.

### SPECIFICATIONS

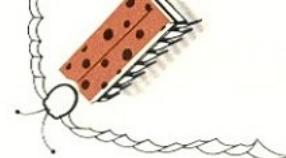
#### LT-2

Operating Voltage:	5V ± 10%
Full "on" Current:	80 ma
Frequency Response:	DC-12MHz
Input Impedance at DC:	600K ohm
Min. Pulse Width Detection:	50 nsecs.
Storage Feature:	Yes
Indicating Levels:	(Switchable) Red LED "on" at greater than 2.4V Green "on" at less than .7V Both off on open circuit
Weight (Shipping):	1/2 lb.
Size:	6.65"(16.9cm) × .6"(15.2mm) (supplied with 2 probe tips)

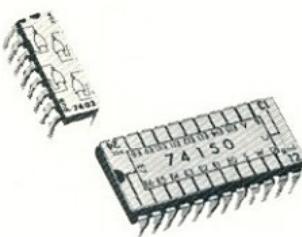
#### LT-3

Operating voltage:	5V ± 10%
Full "on" Current:	100ma.
Input Impedance:	30K ohm min. in parallel with 50 pf.
Pulse Duration:	200
Min. Det. Width:	No
Storage Feature:	Red LED on at greater than 1.5V
Indicating Levels:	Green lights with pulse of 200 ns. or more
Output Impedance:	100 ohms max.
Output Pulse Width:	approximately 1 millisecond.
Output Pulse Amplitude:	4.0V min. (P-P open circuit)
Weight (Shipping):	1/2 lb.
Size:	6.65"(16.9cm) × .6"(15.2mm)

# Design Aids



In the various books E&L publishes, components are required to do the referenced experiments. These have been gathered together in packages for your convenience. They are:



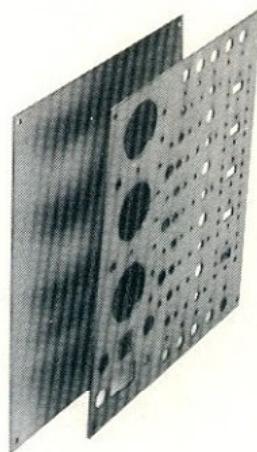
**BGB-1** — This concept for the identification of DIP integrated circuit chips consists of approximately 500 individual self-adhesive labels with printed "pin-outs" that show the logic function and pin numbers for the commonly used 7400-series TTL integrated circuit chips. These labels stick to the backs of the ICs. They eliminate the need to constantly refer to manufacturer's specifications for individual pin functions.

**BK-1** — Components necessary to do *all* the experiments in the BRS-1 Workbook

**BK-2** — Components necessary to do *all* the experiments in the BRS-2 Workbook.

**CMK-1** — Components necessary to do *all* the experiments in the CMOS-M Workbook.

**SJ-160** — E&L has prepackaged 160 different lengths of pre-stripped 22 gage wire to make your circuit work that much easier.



**UMP-01** — Inevitably when you need to design a custom instrument, you have to make a special panel. E&L has come up with a prepunched panel to alleviate this problem. It has a wide variety of holes in popular sizes, arranged for convenient mounting of the components. (Approximately  $7\frac{3}{4}'' \times 9\frac{1}{4}''$  (19,7cm x 23,5cm).)

**UMP-02** — An unpunched panel ( $7\frac{3}{4}'' \times 9\frac{1}{4}''$  (19,7cm x 23,5cm))

**H-06** — The high impact molded case used to mount the UMP-01. Same case as used on the DD-1.

For those instruments that require additional Velcro®, E&L offers the following packages:

**V-01** — 1 pc. SK-10 permanent backing with 6 mounting screws.

1 pc. 2" (5cm) x 6" (15cm) of self-adhesive Loop material.

2 pcs.  $\frac{1}{2}''$  (1,3cm) x 2" (5cm) of self-adhesive Hook material.

**V-02** — 1 pc. 2" (5cm) x 6" (15cm) of self-adhesive Loop material.

**VO-3** — 2 pcs.  $\frac{1}{2}''$  (1,3cm) x 2" (5cm) of self-adhesive Hook material.

1 pc. SK-10 permanent backing with 6 mounting screws.

**VO-4** — 6 pcs.  $\frac{1}{2}''$  (1,3cm) x 2" (5cm) of self-adhesive Hook material.



## AP-1, AP-2 and AP-3

E&L packages a number of special items together for those who wish the convenience of satisfying all their needs at one time since they may be difficult to obtain locally.

**IS-AP-2 Components — Electrical** — IS-AP-2 is an electrical component package containing 93 resistors, 32 capacitors and 8 LED's.

## IS-AP-1 TOOLS AND SOCKETS

1. 5" chain nose pliers.
2. Screwdriver (4" blade  $\frac{1}{8}$ " lip width), or equivalent.
3. Wire stripper/cutter.
4. Two, different color, 100 ft. rolls of No. 22 gauge, insulated wire
5. Two 14-pin IC sockets
6. Two 16-pin IC sockets
7. Two 24-pin IC sockets

**IS-AP-3** — A package containing 104 IC's in the 74 series.

**EC-1** is a package containing 26 IC's, 16 resistors and 64 pieces of pre-cut wire, the components necessary to do most of the experiments in the Bugbooks I and II. (Note; IC's to do all the experiments, see AP-3.)

**IC-1** — IC's necessary to do the experiments in the DC-2 manual.

# ORDERING INFORMATION, TERMS AND CONDITIONS

- All specifications are subject to change without notice.
- All material is F.O.B., Derby.
- All items may be ordered either 115V or 230V; 50/60 Hz at the same price. If you require 90V or 240V operation, it has to be done on a special order and requires special time and subject to a surcharge. (Check with the factory.)
- E&L guarantees its kits for 90 days after purchase for parts only; the guarantee is one year for parts and labor on assembled units. See the SK breadboarding page of this brochure for our unique "lifetime" guarantee on all sockets.
- All items featured in this brochure are carried by your area master distributor. In addition, you will find many local computer stores, electronics distributors and university book stores carry a major cross-section of the popular units. If you cannot find a local store carrying E&L products, contact your area master distributor who will direct you to a nearby one or who will process your order directly in the case of OEM, Education or Industrial clients. Please direct your purchase orders to the master distributors of local stores, NOT the factory.
- There are several items and terms used in this brochure that are subject to trademark acknowledgement. They are: Teflon® by The Dupont Co., Velcro® by the American Velcro Corporation, Aktair® by MITS, Imsai® by IMS Associates, Inc., and DEC® by the Digital Equipment Corporation.

## DOMESTIC REPRESENTATIVES

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ELECTRONIC MARKETING CO.  
1092 Johnson Road  
Woodbridge, CT 06525  
(203) 397-1461

**07001-07999/08800-11999**  
SHORTESS-RAWSON & ASSOC.  
155 U.S. Route 22  
Springfield, NJ 07081  
(201) 467-8585

**12000-14905**  
NACO ELECTRONICS CORP.  
P.O. Box 276  
N. Syracuse, NY 13212  
(315) 699-2651

**08000-08799/16800-19980**  
SHORTESS-RAWSON & ASSOC.  
P.O. Box 193  
Sauderton, PA 18964  
(215) 723-8733

**20001-29945**  
NINE ASSOCIATES, INC.  
Dandridge House  
10680 Main Street  
Fairfax, VA 22030  
(703) 273-1803

**30001-39776**  
NINE ASSOCIATES, INC.  
The 5750 Building  
Suite 219  
5750 Major Blvd.  
Orlando, FL 32805  
(305) 351-1841

**40003-47997/15001-16799**  
RIXAN ASSOCIATES  
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Dayton, OH 45414  
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(513) 278-4216

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**60001-61999/62300-62399**  
**62500-62999**  
MARTEC ASSOCIATES  
2351 E. Oakton Street  
Arlington Heights, IL 60005  
(312) 956-8090

**55001-58856**  
COMPUTER DEPOT, INC.  
1716 Midwest Plaza Bldg.  
Minneapolis, MN 55402  
(612) 338-6714

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**62400-62499/63001-69299**  
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Overland Parks, KS 66207  
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(214) 328-5484

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**80002-83499/84001-84780**  
BILL NEWMAN & COMPANY  
711 Vallejo, Suite 207

Denver, CO 80204  
(303) 534-1356

**85001-86515/89001-89114**  
**90001-93555**  
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Palos Verdes Penn., CA 90274  
(213) 377-0975

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Mountain View, CA 94040  
(415) 961-2828

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**97001-99950**  
JON JOLLY, INC.  
5416 California Ave. S.W.  
Seattle, WA 98136  
(206) 938-4166

## CANADA

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Electronics Limited  
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Edmonton, Alberta  
T5M 1V9  
telephone: 403-455-4122  
telex: 037-2372

**F110**  
John Fortin Company Limited  
\*main office\*  
660 King Edward Street  
Winnipeg, Manitoba  
telephone: 204-774-6286  
telex: 07-587500

**F121**  
R-A-E Industrial Electronics Limited  
1629 Main Street  
Vancouver, British Columbia  
telephone: 604-687-2621  
telex: 045-4550



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