THE INTERNATIONAL JOURNAL FOR RECREATIONAL ELECTRONICS

September 1991

$3.00 US
CANADA $4.00

Elektor Electronics USA

Peak Indicator for Loudspeakers

ZAP51—An 8751 Programmer

Build the Opticalock

Fiber Optics Pt. 1

Central Car Locking Control

Understanding the EDIF Standard

Elektor Electronics USA

CONTENTS

September 1991
Volume 1
Number 11

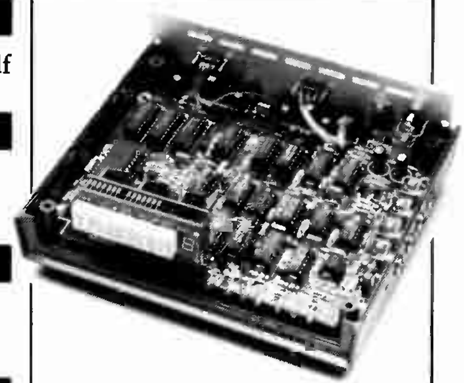
In next month's issue

- Electronic hygrometer
- AC detector
- Function generator [1]
- 50 MHz 8-bit DAC
- A review of coding theory
- Four-terminal networks
- Audio spectrum shift techniques

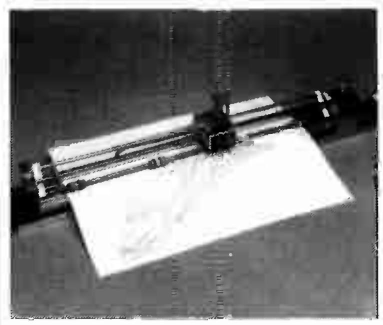
Front cover
Maps and charts on a constantly changing video wall—at 25 m (80 ft) the largest in Europe—give up-to-the-minute pictures of how Britain's telephone networks are performing, highlighting potential trouble spots. BT's Worldwide Network Management Centre at Oswestry receives every six hours data equivalent to the contents of the *Encyclopædia Britannica*. BT says that its digital network is more comprehensive in comparative terms than that of any major operator. The centre currently monitors all the organization's processor-controlled System X exchanges—57 in the trunk network and 373 local units. It also monitors the company's three digital international exchanges and 1500 routes linking its UK network to 199 countries.

ELEKTOR ELECTRONICS USA (US ISSN 1051-5690) is published monthly except August at $28 per year, $50 for two years by Audio Amateur Publications, Inc., 305 Union St, Peterborough NH 03458 USA. Second class postage paid at Peterborough NH and an additional mailing office.

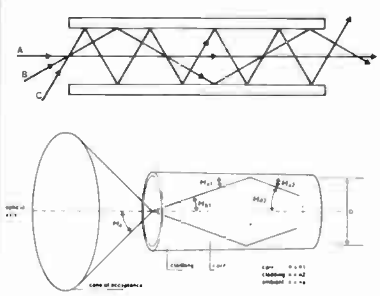
POSTMASTER: Send address changes to **Elektor Electronics USA**, Caller Box 876, Peterborough NH 03458-0876. Return Postage Guaranteed.



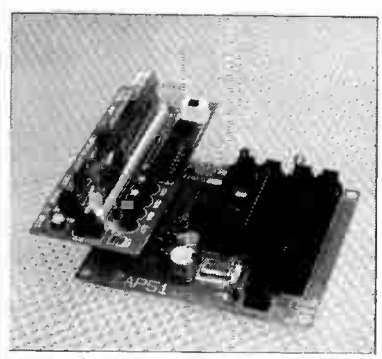
Timecode interface for slide control p.18



Plotter driver – p. 53



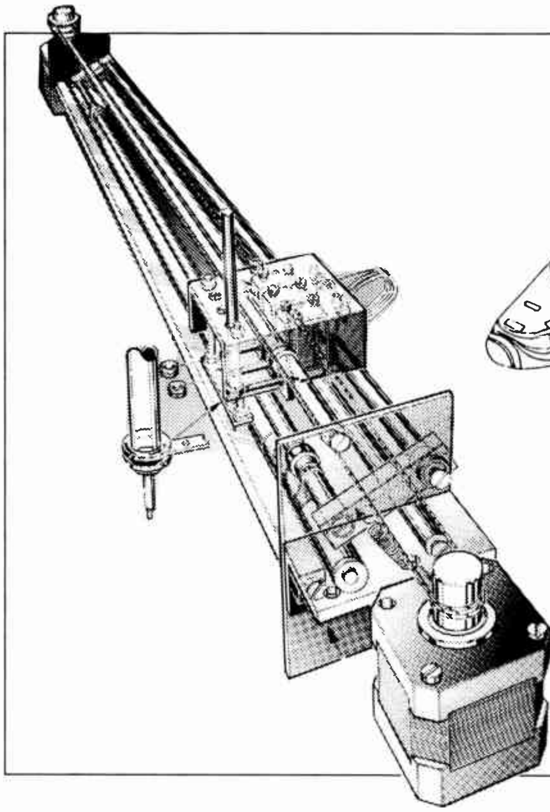
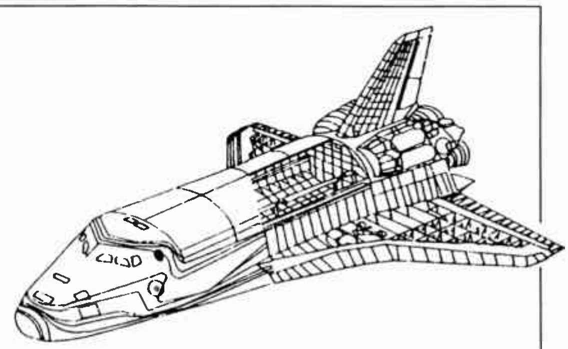
Fiber optics Part 1 – p. 24



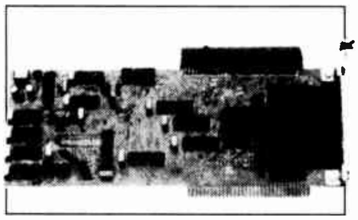
ZAP51: an 87C51 programmer – p. 39

MEEK IT
ELECTRONICS
THE HAGUE HOLLAND

OLD COLONY SOUND LAB

EUROPE'S HOTTEST KITS NOW AVAILABLE IN NORTH AMERICA!



IBM PC SERVICE CARD

This card was developed for assistance in the field of service, development and test. The card is used as a bus-extension to reach the measurement points very easy. It is also possible to change cards without having a "hanging computer".

Ready Assembled Module

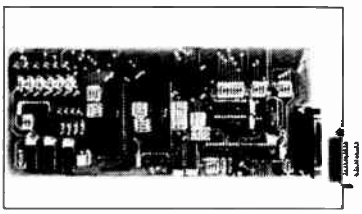
$145

PLOTTER MARK-II

completely reworked version: see Elektor Electronics March 1990.

* Max. width 50 cm.
* All mechanical parts supplied ready-drilled, filed and tapped, so get going at once.
* Complete kit, including 2 stepper motors, 3 pen lift solenoids, HPGL software on disk (IBM), stepper motor control board

100.100 **$275**

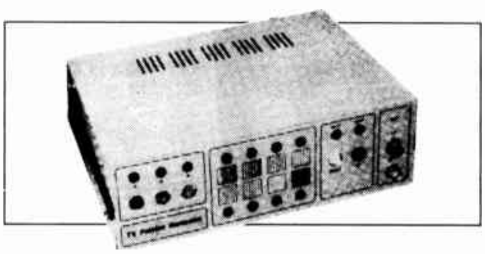


IC TESTER FOR IBM-PC-XT/AT

With the ELV IC tester logic function tests can be carried out on nearly all CMOS and TTL standard components, accommodated in DIL packages up to 20 pin. The tester is designed as an insertion card for IBM-PC-XT/AT and compatibles. A small ZIF test socket PCB is connected via a flat band cable. Over 500 standerd components can be tested using the accompanying comprehensive test software. Complete Kit including Textool sokket, connectors, sockets, Flat band cable, PCB, Software.

Ready Assembled Module

$200



COLOUR TEST PATTERN GENERATOR

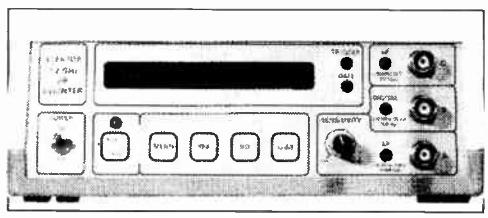
A PAL-compatible colour video source that supplies a number of test patterns for aligning television sets.

A test pattern generator is virtually indispensable for troubleshooting in television sets because it supplies a video signal that is known to be stable, and thus easily displayed and synchronized on an oscilloscope.

Inc. case and front 100.111 **$175**

ELEKTOR P.C. i/o card

· 220.007 **$175**



MICROPROCESSOR-CONTROLLED FREQUENCY METER

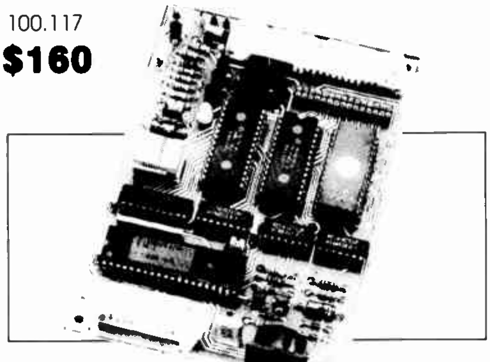
A professional grade multi-purpose frequency meter, designed by Elektor Electronics, that can be build by many at affordable cost. Described in Elektor Electronics December 1984, January & February 1985. U665B-based prescaler.

- Frequency meter: 0.01 Hz to 1.2 Ghz.
- Pulse duration meter: 0.1 to 100 s.
- Pulse counter: 0 to 10^9 pulses
- Period meter: 10 ns to 100 ns
- Sensitivity: Input A: 10 mV $_{rms}$ (Z_{in} = 2 MΩ);
- Input B: TTL or CMOS compatible (Z_{in} = 25 kΩ);
- Input C: prescaler input: 10 mV $_{rms}$ (Z_{in} = 50 Ω).
- Auto-ranging and completely menu-driven.
- 6 or 7 digit accuracy.

Kit includes power supply, prescaler and enclosure.....100.112 **$300**

BASIC COMPUTER
With Intel 8052AH-BASIC

100.117
$160

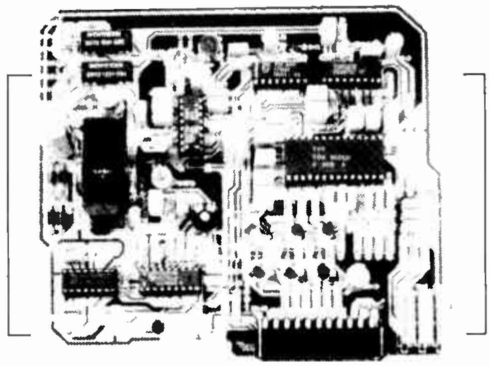


ANALOG MODULE
eps 880162 100.113 **$80**

DIGITAL MODULE
eps 880163 100.114 **$55**

ADRESSDECODER
eps 880159 100.115 **$45**

S-VHS/CVBS-TO-RGB CONVERTER



Following last month's introduction into the main characteristics of the Super-VHS system, we close off the article with details of a practical converter circuit that allows an S-VHS-VRC or camcorder to be connected to the RGB inputs of a colour TV or monitor. The circuit presented here forms a state-of-the-art approach to all-analogue picture standard conversion, and is based on the latest in IC technology available for this purpose.

220.039 **$150**

MEEK IT ELECTRONICS

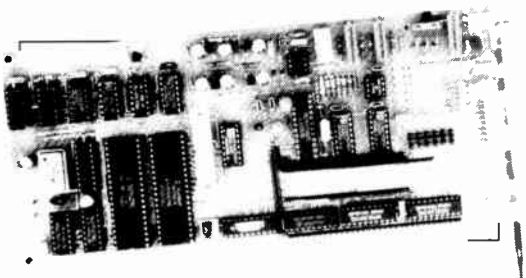
THE HAGUE HOLLAND

AVAILABLE FROM:

OLD COLONY SOUND LAB

PO Box 243, Dept E91
Peterborough, NH 03458 USA
24-Hour Lines:
Tel. (603) 924-6371 FAX (603) 924-9467

- Check, money order, MC/VISA accepted.
- Please allow 6-8 weeks for delivery.
- **SHIPPING:** Airmail shipping to USA included in price. Others: Please inquire.
- **CUSTOMS:** USA residents may be required to pay 5-10% customs duty. Others may vary.

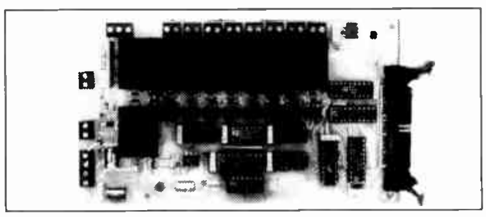


MULTIFUNCTION MEASUREMENT CARDS FOR PCs

The high-performance insertion card described in this article allows your IBM PC-XT, PC-AT or 100 % compatible to measure direct voltage at 12-bit accuracy, as well as frequency and a host of other parameters related to pulse-shaped signals. The accuracy and versatility afforded by the card are of a level associated with much more expensive, industrially rated products. The menu-driven control software developed for this exciting project allows you to keep tabs on up to eight voltages quasi-simultaneously, while up to eight remaining inputs can be used for time-related measurements including frequency, duty factor and pulse duration, not forgetting the event counter. Connected to the sensors and timing devices of your choice, this card turns a PC into a powerful central controller in a complex measurement and control system.

220.040 **$225**

MICROPROCESSOR-CONTROLLED TELEPHONE EXCHANGE



The telephone exchange presented here allows up to eight pulse-dialling telephone sets to be connected, and has an option for connecting calls to or from an external (trunk) telephone line. The unit is controlled by the popular 8052-based BASIC computer we introduced a few years ago.

220.057 **$190**

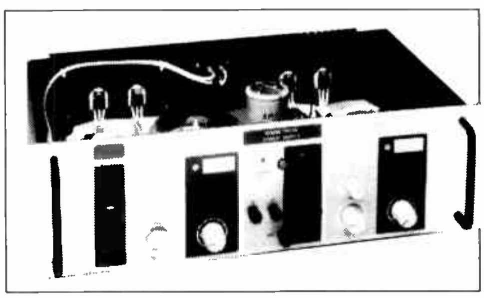
MAIN FEATURES

- 8 internal lines
- 1 external line
- memory for 10 numbers
- internal through connections
- versatile computer control
- automatic hold for external line
- simple-to-extend
- can be interfaced to a PC
- selective external call acceptance
- shortcut dial codes for external number
- works with pulse-dialling telephone sets
- one optinal relay for extra switching function

SPECIAL PARTS SERVICE

We are the no. 1 suppliers of hard-to-find components for Elektor Electronics projects.Always contact us first if you see an unfamiliar component. Items include analogue & digital ICs (HCT, SMD), precision resistors (1%, 0,1%), capacitors (MKT/styroflex), inductors (Neosid, Toko), transducers, enclosures (Telet, OKW) and quartz crystals.

FOR FURTHER INFORMATION, PLEASE SEND A BUSINESS-SIZE SASE TO OLD COLONY SOUND LAB (ADDRESS ABOVE), ATTN: MEEK IT.



400-WATT LABORATORY POWER SUPPLY

Here is an all-purpose d.c. power supply for symmetrical as well as asymmetrical use, and capable of supplying high output currents and voltages. An all-analogue design based on discrete parts only, this 400-watt PSU deserves a prominent place on your work bench.

ex. case 220.036 **$525**

MAIN SPECIFICATIONS

- **Mode: Single**
  - one adjustable power supply with current an voltage controls
  - Output: 0 - 40 V at 0 - 5 A
- **Mode: independent**
  - two identical, electrically separated, power supplies.
  - Outputs: 2 x 0 - 40 V at 2 x 0 - 5 A
- **Mode: Tracking**
  - two indentical, series connected, power supplies.
  - Outputs: ± 0 - ± 40 V at 0 - 5 A; 0 - 80 V at 0 - 5 A
  - Voltage and current of *slave* follow *master*.
- **Mode: parallel**
  - two identical, parallel connected, power supplies.
  - Outputs: 0.6 - 39.4 V at 0 -10 A
- **Maximum output voltage:** 0 - 40 V (at full load); 48 V (no load)
- **Maximum output current::** 5 A
- **Ripple:** 10 mV (no load); 50 mV (at full load)
- **Voltage difference in tracking mode:** 50 mV

WorldRadioHistory

REBUILDING OUR AVOCATION IS MORE DO-IT-YOURSELF

If you are an American in the nineties and you wish to get into building electronic gear for yourself, you face a number of serious obstacles which do not afflict the ham, potter, woodworker, fly tier, model railroader, boat builder, computer assembler, or people practicing a host of other avocations. A general scorn of anyone who presumes to build anything electronic has grown up in the US over the last 30 years for a number of reasons. First, the publications which served the hands-on electronics community have lusted after the higher ad revenues promised by the consumer goods manufacturers. Some, dreaming of such rewards, have committed suicide, as the old *Popular Electronics* managed to do 20 years ago when it announced it would no longer publish do-it-yourself articles.

Gernsback, one of the oldest supporters of electronic construction for the amateur, has stuck to its mandate faithfully, and resurrected the defunct *PE* title as a nice entry-level monthly for people new to the pleasure of building.

Although we are seeing a genuine renaissance of hands-on accomplishment in other disciplines: gardening, cooking, house building, model railroading, woodworking and the like, helped especially by the electronic media, the electronics construction effort continues to decline. The kits have virtually disappeared. Heath Co., born in the aftermath and on the surplus parts disgorged after World War II, abandoned kits as their primary mode, lured by the lower costs of assembled goods and frightened by Oriental competition.

But the deeper cause of this change is the altered business style. Businesses used to be institutions, proud of longevity, their image based on experience and self respect. The business schools have changed all that. Today businesses are as evanescent as May flies, appearing, rising meteorically, highly profitable one quarter, levereraged out of existence two quarters later. The young managers are out to get theirs in the shortest time possible, maximizing profits to look good, ink a golden parachute contract for themselves, and bail out just before the whole thing topples or is taken over.

The classic case of this in audio electronics was Dynaco. A fine old company whose owner sold it to a plastics company for a reputed $11 million. Four years later, the plastics toy maker not having any idea whatever about running the company, sold it for $400,000 to a company who gutted the Dynaco inventory, executed a nice tax writeoff and went Chapter 11 soon after. The best audio kit company we have ever seen was simply a victim of profit takers.

The proof about the need for a Dynaco is that the founder reinvented the company very successfully a few years later, gave it his own name (and remarkably little capital) and has now sold it again to a conglomerate which, at least this time, knows something about running an audio company. But not much about kits.

How we have come, generally, to regard the hands-on person who likes to build electronic gear as some kind of silly, incompetent nerd is a sad commentary on our capitalist society.

Isn't this a worldwide trend, you ask? Not really. Germany, for example, with a population of 75 million, supports three publications dedicated entirely to electronic construction, each with circulations in excess of 100,000. Kit companies abound, and parts houses equipped with everything from screws to test gear are located in any town larger than 20,000.

This magazine is dedicated to the proposition that one of the most basic characteristics of the human being is his or her ability to make things: *homo faber*. Serving the needs of those who respond to this deep drive with regard to electronics has lost out to the larger rewards a country of this size offers to those vending electronic parts, kits, and the like.

This means that if you, as a person who has responded to our offer to publish *Elektor Electronics USA*, want to build projects, you will need to recognize that we have a problem and take some extra action and some different methods to succeed.

First, be vocal with suppliers about your needs. Business people who hear your request for parts often enough may have it dawn on them that there is a market again in the US for small quantity parts orders, both from you and from the development labs where small prototype runs are being made. Yours and their needs are similar. The regular suppliers of most electronics hardware suffer, because of this country's size, from elephantiasis and the passivity that arises from being overfed.

Second, please start recognizing that the fax and the credit card have turned the electronics supply market into a global one. Fortunately for Americans, most of the world speaks our language even if we too seldom speak theirs. We are, with the other 13 publishers of this magazine, making an effort to attract world class parts suppliers to our ad pages. Your response to them, and to those appearing in these pages is vital if you really want a supply infrastructure for your interest.

The relationship between an active avocation group and its suppliers meets in publications. Talk to suppliers about your needs. Dialog with advertisers in these pages. Ask for what you need. Share your thoughts with us. We will certainly pass along your requests to those who can supply them. Elsewhere in this issue you will find vendors listed who can respond to your needs for parts. Our service department makes circuit cards, software, panel overlays, and firmware available for most of the projects we publish. Some of you write me every month asking where these may be found, making it clear that many of you are not bothering to read the ads and the information already provided. You'll never make a good hobby of electronics without carefully reading ads and collecting every catalog you can find.

In short, if you wish to play in the electronics game, you can't remain passive, wait for someone to hand you a prepackaged kit, or expect it will be easy to get the merchandise you need. We must become a market here, and we won't build it without some special effort.

I am pleased to welcome, beginning with our next issue, Donald Kennedy as Advertising Representative for *Elektor* in North America. He comes to us with over 30 years experience in electronics, having served clients of such magazines as *Electronic Design News*, among others. We will do our best to find the suppliers you need. You will do yourself, and us, a favor by responding actively to those who seek your custom. Deciding to advertise here is going against the collective "wisdom" prevalent in the US for the last generation. We hope you will help us turn it around. It's long past time.—E.T.D.

Published by Audio Amateur Publications, Inc.

Editor/publisher: Edward T. Dell, Jr.
Editorial Offices:
305 Union St., P.O. Box 876
Peterborough, NH 03458-0876 USA

Telephone: 603-924-9464 *(National)*
or +1 (603) 924-9464 *(International)*
FAX: (603) 924-9467 *(National)*
or +1 (603) 924-9467 *(International)*
Advertising: Donald B. Kennedy
Telephone: (617) 383-9059
FAX: (603) 924-9467
Subscriptions: Katharine Gadwah
Elektor Electronics USA
Post Office Box 876,
Peterborough, New Hampsire 03458
Subscriptions to *Elektor Electronics USA* are available **ONLY** in the fifty United States, Canada, Puerto Rico, the Virgin Islands and those Pacific territories administered by the United States of America.

European Offices:
Elektuur BV
Postbus 75
6190 AB BEEK
The Netherlands
Telephone: 011 31 4638 9444
Telex: 56617 (elekt nl)
FAX: 011 31 4637 0161
Managing Director: M.M.J. Landman

Overseas Editions:
FRANCE
Elektor sarl
Les Trois Tilleuls
B.P. 59; 59850 NIEPPE
Editors: D.R.S. Meyer
G.C.P. Raedersdorf
GERMANY
Elektor Verlag GmbH
Susterfeld Strasse 25
5100 AACHEN
Editor: E.J.A. Krempelsauer
GREECE
Elektor EPE
Kariskaki 14
16673 Voula—Athena
Editor: E. Xanthoulis

HUNGARY
Elektor Elektronikai folyoirat
1015 Budapest
Batthyany U. 13.
Editor: Lakatos Andras
INDIA
Elektor Electronics PVT Ltd
Chhotani Building
52C, Proctor Road, Grant Road (E)
BOMBAY 400 007
Editor: Surendra Iyer
ISRAEL
Elektorcal
P O Box 41096
TEL AVIV 61410
Publisher: M. Avraham
NETHERLANDS
Elektuur BV
Peter Treckpoelstraat 2-4
6191 VK BEEK
Editor: P.E.L. Kersemakers
PAKISTAN
Electro-shop
35 Naseem Plaza
Lasbella Chawk
KARACHI 5
Editor: Zain Ahmed

PORTUGAL
Ferreira & Bento Lda.
R.D. Estef-83-ni, 32-1°
1000 LISBOA
Editor: Jeremias Sequeira
SPAIN
Resistor Electronica Aplicada
Calle Maudes 15 Entio C.
28003 MADRID
Editor: Agustin Gonzales Buelta
SWEDEN
Electronic Press AB
Box 5505
14105 HUDDINGE
Editor: Bill Cedrum
UNITED KINGDOM
Down House
Broomhill Road
LONDON SW18 4JQ
England UK
Editor/Publisher: Len Seymour

Printed in the United States of America.

ISSN: 1051-5690

ELECTRONICS SCENE

SBC FOR EMBEDDED CONTROL SYSTEMS

Systronix has introduced an 80C188-based single board computer that uses the MS2184 multifunction 80188-family peripheral ASIC. The 2184-SBC can be used for any general-purpose embedded control application. The device includes two programmable serial ports, parallel printer port, character or dot-matrix LCD interface, keypad interface, audio speaker, and more. The MS2184 handles all peripheral timing, and a prototyping area provides room for additional application-specific circuitry. The MS2184 ASIC is also available separately for use in custom embedded control designs.

You can write code on any MS-DOS PC and verify it using a PC-based debugger. Once the code is solid, you can use a variety of standard linker/locators to move it to an EPROM for use in any of the three EPROM sockets on the 2184-SBC.

The optional 2184-EXER EPROM provides examples of code for all low-level I/O drivers, interrupt and DMA handlers, startup code, LCD menus, keypad handler, and more. Written in Microsoft C and Assembler, the 2184-EXER includes extensively documented source code.

The 2184-SBC sells for $395 and the 2184-EXER for $195 (or $100 when ordered with the 2184-SBC). The MS2184 ASIC is available separately for $10.80 (in quantities of 5,000). For more information, contact Bruce Boyes, Systronix, Inc., 754 E. Roosevelt Ave., PO Box 526398, Salt Lake City, UT 84152-6398, (801) 487-7412, FAX (801) 487-3130.

PROFESSIONAL 4X1 VIDEO ROUTING SWITCHER

Image Labs has introduced the RS-4100, a 4x1 Y/C or composite routing switcher, designed for the customer in the transition stage between an all-composite operation and a Y/C operation. The unit lets you select the type of input you will be feeding to each input individually. It does not do standards conversion. With broadcast specifications, the unit is priced at $440. See your local dealer or call (914) 737-4420 for more information.

SPECTRUM ANALYZER MEASURES TO 1GHz

B&K PRECISION has announced the Model 2610, an AC, DC, or battery-powered unit featuring a 1GHz frequency range, 70dB dynamic range, and other features. A selectable 1MHz fixed bandwidth setting locks the 3dB bandwidth at 1,000kHz regardless of scan width setting. This is ideal for observing video/TV/CATV signals.

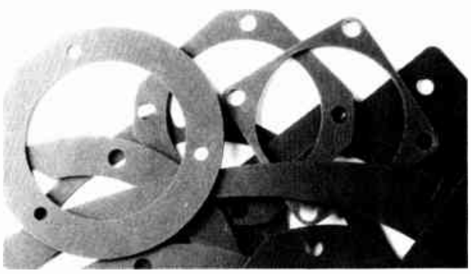
The switch selectable input impedance matches either the 50Ω loads of two-way applications or the 75Ω applications of CATV/MATV. The Model 2610 comes with an internal battery and charger, AC line cord, DC source connector, 75Ω input cable, BNC-to-F adapter, CRT hood, adjustment tool, spare fuses, and instruction manual. A top-mounted pouch holds accessories and power cords. To maintain accuracy in the field, the unit can be calibrated anywhere.

The Model 2610 sells for $2,995. For more information, contact your local distributor or B&K PRECISION, 6470 W. Cortland St., Chicago, IL 60635, (312) 889-1448, FAX (312) 794-9740.

NORSOREX GASKETS

Polydax has introduced a new line of Norsorex gaskets. A super-damped material, Norsorex was initially developed as surround material and is used on Polydax's high-end loudspeaker components. Placed between the loudspeaker basket and cabinet, these gaskets help eliminate vibrations and resonances. Available in a variety of custom sizes, the gaskets have been designed to fit all Polydax standard drivers.

A test kit is available to show the difference between Norsorex gaskets and the most common gasket material. For more information, contact Polydax Speaker Corp., 10 Upton Dr., Wilmington, MA 01887, (508) 658-0700.



16-CHANNEL PROGRAMMABLE "MX" PORTABLES

Midland LMR has introduced an "MX" series of two-way FM portable radios programmable for up to 16 channels. The output power of the VHF and UHF models is 5W, switchable to 2W. VHF models (70-145MX) cover 138–174MHz in three frequency ranges; UHF models (70-245MX) cover 406–512MHz in four frequency ranges.

The portables have programmable tone-coded squelch (CTCSS) as a standard feature and incorporate a new circuit design that improves CTCSS performance and minimizes noise and voice blocking. The CTCSS is programmable by channel, independently, transmit and receive. Programmable transmitter time-out timing is also standard. The portables meet or exceed MIL STD 810 C/D for shock and vibration.

The radios are available with a front keypad and DTMF encode/decode options (with or without ANI). Other options include voice scrambling, external weatherproof speaker/microphone with clip, and choice of interchangeable batteries and chargers.

For more information, contact Midland LMR, Marketing Department, 1690 N. Topping, Kansas City, MO 64120, (800) 643-5263, ext. 1690.

3M ELECTRONICS VACUUM

Mouser Electronics offers a lightweight, compact portable vacuum cleaner for cleaning toner from copying machines and laser printers, as well as for general cleanup tasks.

A 10 micron toner dirt filter (included) protects the motor, and the 1hp/5A motor with sealed ball bearings is continuous duty rated. This electronic vacuum is self-contained and static safe. The high impact plastic case stores attachments and power cord.

For more information or a free catalog, contact Mouser Electronics, 2401 Hwy. 287 North, Mansfield, TX 76063, (800) 992-9943, FAX (817) 483-0931.

MRX MULTI-ROOM RECEIVER COMPATIBLE WITH EIA CEBUS

Audioaccess has launched their six-zone receiver, the MRX. Among its features are compatibility with the twisted-pair wiring format defined by the EIA CEBUS standard, a special stereo AM/FM tuner section, and the fact that the MRX is the first multi-zone, multi-source receiver to come equipped with six 40W/channel amplifiers and six separate zone controllers, providing six zones with independent control of source and volume level without affecting any other zone.

Audioaccess has also announced a lineup of custom installation accessory products that simplify the installation of entire home entertainment systems. The Source Equipment Interface ($500) module is an infrared interface module that lets Audioaccess control systems integrate with most other brands of source equipment without hard-wiring.

The SRM/2 ($200), an updated version of the company's Speaker Relay Module, provides independent on/off control of speakers in rooms within the same zone. Another module, the Special Interface Module ($300) helps integrate Audioaccess' control systems with any computer-controlled equipment.

For more information, contact Richard Frank, Frank Marketing Associates, 8 Mohave Rd., Medfield, MA 02052, (508) 359-5977, FAX (508) 359-5343.

GRAPHICAL USER INTERFACE ENHANCEMENTS

American Small Business Computers has announced DesignCAD 2D Version 5.0, a low-cost, full-featured computer-aided design (CAD) program that runs under MS-DOS. The program allows you to perform architectural, engineering, and mechanical drafting; business graphics; electrical and civil engineering design; office layout; space design; desktop publishing; technical illustration; and printed circuit board design. Drop-down menus and pop-up context-sensitive help screens make it easier to use.

DesignCAD 2D requires an IBM or compatible computer with 640K RAM and a hard drive and can take advantage of a math coprocessor. Version 5.0 includes new disks, a digitizer menu, a quick reference card, and updated manuals. DesignCAD's programmable language, BasicCAD, a subset of Microsoft Quick Basic, lets you write and run your own BASIC programs.

The program sells for $349 including BasicCAD. Current users can update for $50. For more information or free demo disks and literature, contact American Small Business Computers, Inc., One American Way, Pryor, OK 74361, (918) 825-4844, FAX (918) 825-6359, BBS (918) 825-4878.

ELECTRONICS SCENE

MINIATURE FOUR-CALL PAGING ENCODER

Communications Specialists has announced a four-call paging encoder in the POCSAG (also known as RPC-1) format, established as the UN paging format for worldwide use. The PE-4 was designed for those using only a small number of addresses. It will fit inside a variety of radios from hand-helds to base stations. The seven-digit POCSAG format allows more than 10 million codes to be encoded, and the device can be programmed to send calls containing tone only or those with a numeric message of up to 10 digits. The PE-4 will be factory programmed at no charge, or may be field programmed with an optional 16-button keypad. All programming is retained in a nonvolatile EEPROM.

The PE-4 is priced at $99.95. For more information, contact Communications Specialists, Inc., 426 W. Taft Ave., Orange, CA 92665-4296, (800) 854-0547 or (714) 998-3021, FAX (714) 974-3420.

CEDIA's SECOND ANNUAL TRADE EXPO

The **Custom Electronic Design & Installation Association** (CEDIA) has announced its second annual Business Management and Trade Expo will be held on October 8-13 at San Francisco's Fairmont Hotel. You can make hotel reservations by calling (800) 621-5002 and asking for the CEDIA desk.

For more information, contact CEDIA, 10400 Roberts Rd., Palos Hills, IL 60465, (800) CEDIA30, FAX (708) 598-4888.

PC BOARD DIAGNOSTIC SYSTEM OFFERS TROUBLESHOOTING

An in-circuit and out-of-circuit PC board diagnostic system designed to troubleshoot complex boards rapidly is available from **PRO-LINE by B&K**. The PRO-LINE Model PL 5000 PC Board Diagnostic System is ideal for benchtop production testing, depot repair and testing, SROs, and independent or third-party service organizations.

All test routines and voltage thresholds are user defined for compatibility with a wide variety of semiconductor technologies and component types. In addition to testing of TTL, CMOS, and ECL devices, the PL 5000 system tests analog devices.

The system uses an 80286-based IBM compatible with 1MB standard system memory (expandable to 4MB) and two expansion slots. The package includes one 40MB hard disk and a 1.2MB 5¼" floppy drive, a 13" monochrome EGA amber monitor, and an 84-key AT-style keyboard. EGA color is optional.

The base unit sells for $14,950. For more information, contact PRO-LINE by B&K, Maxtec International Corp., 6470 W. Cortland St., Chicago, IL 60635, (312) 889-1448.

CDMA CELLULAR PHONES JOINT VENTURE

Alpine Electronics, its parent **Alps Electric Co.**, and **QUALCOMM** have agreed to form a jointly owned company to design, develop, manufacture, and sell code division multiple access (CDMA) digital cellular telephone systems. The company will be headquartered in San Diego.

Capital investments will be made by Alpine, the Alps Electric Group, and QUALCOMM. Alpine Electronics of America will perform certain marketing activities for the alliance. The Alps Group, including Alpine Electronics Manufacturing of America, will support worldwide production.

This little circuit, designed and marketed as a kit by ELV, provides a visual warning when the maximum drive power to a loudspeaker is approached. The sensitivity of the circuit can be set to power levels between 1 W and 300 W. Connected in parallel with the loudspeaker terminals, the peak indicator is simple to build, and does not require a separate power supply.

THE power applied to a loudspeaker drive unit is disproportional to the volume, which is a subjective quantity. In practice, this means that doubling the volume requires more than double the drive power. It is for this, and other, reasons that the maximum permissible power applied to a loudspeaker is difficult to determine subjectively, i.e., by listening. Unfortunately, this has caused the destruction of many an expensive loudspeaker drive unit, although we must hasten to add that many drive unit manufacturers and suppliers state peak power ratings that are, to put it mildly, on the high side.

Adjusted to a sensible indication level, the present peak indicator gives you ease of mind as far as the protection of your costly loudspeakers is concerned. First, however, consider the difference between the following power specifications of a loudspeaker: continuous power, music power, peak power and pulse power. In general, the indication level of the peak power monitor should be based on the continuous power rating of the loudspeaker — but only if you have reason to believe that this value makes sense, in other words, that it is not grossly exaggerated by the manufacturer. In some cases, this means that you have to set an indication level as low as 50% of the continuous power rating stated by the manufacturer.

Such a 'conservative' setting of the peak power indication may cause the LED on the unit to light briefly at times, that is, when the corresponding volume is at all desired. When the volume is increased further, the LED starts to flash shorter and at a lower rate. This is an indication that the maximum safe power level has been reached, and that the volume should be reduced to prevent damage to the loudspeaker (and, even more importantly, your ears).

The circuit

Two flexible wires are used to connect the input of the peak indication circuit in parallel with the loudspeaker terminals. This results in the loudspeaker drive voltage being applied to PCB terminals ST1 and ST2. The polarity of the drive signal is irrelevant, since the input signal is rectified by D1-D2 (see Fig. 1), and assumed to be symmetrical.

The input voltage (supplied by the amplifier) also serves to power the circuit. This is achieved by rectifying and smoothing the input signal with the aid of diode D2 and smoothing capacitor C2. Resistor R4 serves to increase the internal resistance of the circuit, and so prevents waveform distortion of the input signal.

The input voltage is also applied to a potential divider, R1-R2, via diode D1. The signal at junction R1-R2 is fed to the base of transistor T1 via a series resistor, R3, and a

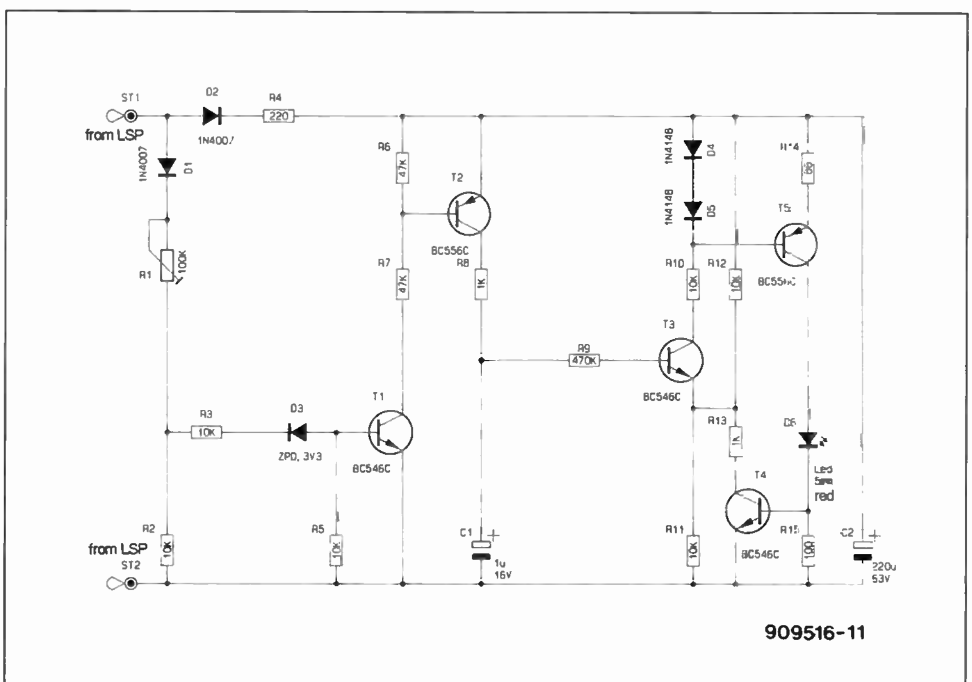


Fig. 1. Circuit diagram of the peak indicator. Note that the circuit is powered by the drive signal supplied by the amplifier.

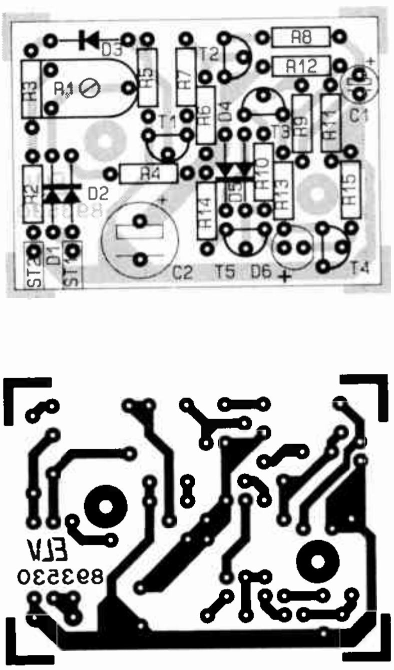


Fig. 2. The printed-circuit board for the peak indicator is small and single-sided.

COMPONENTS LIST

Content of kit supplied by ELV

Resistors:
1 68Ω R14
1 100Ω R15
1 220Ω R4
2 1kΩ R8;R13
6 10kΩ R2;R3;R5;R10; R11;R12
2 47kΩ R6;R7
1 470kΩ R9
1 100kΩ preset H R1

Capacitors:
1 2μF2 63V C1
1 220μF 63V C2

Semiconductors:
2 BC556 T2;T5
3 BC546 T1;T3;T4
1 3V3 0.4W zener diode D3
2 1N4007 D1;D2
2 1N4148 D4;D5
1 red LED D6

Miscellaneous:
2 PCB soldering pin
1 printed-circuit board

A complete kit of parts for the peak indicator is available fron the designers' exclusive worldwide distributors:

ELV France
B.P. 40
F-57480 Sierck-Les-Bains
FRANCE

Telephone: +33 82837213
Fax: +33 82838180

zener diode, D3. The diode serves to set up a well-defined switching threshold. Resistors R5 and R3 are dimensioned such that T1 is kept off in the absence of an input signal.

When the voltage at junction R1-R2 exceeds 4.5 V, T1 starts to conduct. Consequently, T2 is driven via R7, which causes capacitor C1 to be charged via R8. As soon as the charge voltage exceeds about half the supply voltage (measured across C2), transistor T3 starts to drive a constant current source, D4-D5-T5-R14, which in turn sends a current of about 10 mA through the indicator LED, D6. This lights to signal the overload condition.

At the same time, the constant current causes T4 to start conducting, so that the potential at the emitter of T3 drops to a fraction of the previously established half supply voltage. This creates an amount of hysteresis sufficient to cause the indicator to light for about half a second, even when the overload condition at the input was pulse-like. When no further overload levels are detected, C1 is no longer charged, and starts to discharge via R9, the base-emitter junction of T3, and R11-R13-T4, until the voltage drops below the switching threshold of T3. When that happens, transistors T3, T4 and T5 are switched off, and the LED, D6, goes out.

Preset R1 allows the sensitivity of the circuit to be set between 1 W and 300 W. The corresponding input voltage levels are summarized in Table 1.

Table 1. Circuit actuation levels

U_{LSP} (V)	Power (W)		
	4 Ω	8 Ω	16 Ω
5.7	4	2	1
6.3	5	2.5	1.25
8.9	10	5	2.5
11.0	15	7.5	3.75
12.6	20	10	5
15.5	30	15	7.5
17.9	40	20	10
20.0	50	25	12.5
25.3	80	40	20
28.3	100	50	25
34.6	150	75	37.5
40.0	200	100	50
44.7	250	125	62.5
49.0	300	150	75

Construction

All components are accommodated on the small printed circuit board shown in Fig. 2 (size: approx. 35×48 mm, or 0.14×0.19 inch). Start the construction by fitting and soldering the low-profile parts shown on the component overlay. Then follow the taller components. Take care to fit the polarized components (the diodes, electrolytic capacitors, transistors and the LED) the right way around. The cathode (negative connection) of the LED is the terminal with the tab near the underside of the plastic body. Fortunately, the LED will not normally be damaged when fitted the wrong way around, at least, so long as the reverse voltage is not excessive.

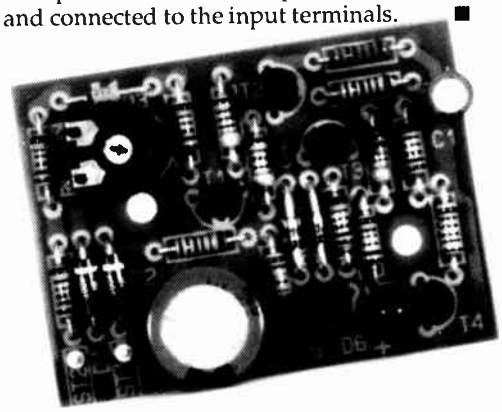
Adjustment

Run a thorough visual check on the completed printed circuit board before carrying out the first electrical tests. These require a stabilized, adjustable d.c. power supply. Depending on the supply voltage, the circuit draws a few milliamps when the LED is out, or 10 mA or so when the LED is on. In any case, the current requirement is never higher than 20 mA.

Determine the power at which you want the indication to be actuated, and take the required switching threshold from Table 1. For instance, when a level of 100 W is required for a loudspeaker with an impedance of 4 Ω, the threshold works out at 28.3 V. Similarly, for 10 W into 16 Ω, the switching threshold is 17.9 V.

Set the desired threshold voltage on the stabilized PSU, and connect the positive output to ST1 of the peak indicator, and the negative output to ST2. Set preset R1 to its maximum value, i.e., turn it fully clockwise. The LED must remain off at this point. Next, carefully turn R1 anti-clockwise until D6 lights. Leave R1 at this setting. Reduce the test voltage. The LED should remain on for a while as a result of the relatively large hysteresis. When it goes out, increase the test voltage again. Keep an eye on the applied voltage. The LED should light at the previously set voltage level. If not, carefully redo the adjustment of R1.

Since the LED is supplied from a constant current source, it will light at a virtually constant intensity irrespective of the actually measured loudspeaker voltage. After the adjustment, the circuit may be fitted at a suitable position in the loudspeaker enclosure, and connected to the input terminals. ■



CENTRAL LOCKING CONTROL

by Dip. Eng. S. Zipp

Most new cars are now provided with a central locking system, either as standard (most) or as an optional extra, sometimes combined with an anti-theft system. If you are one of the unfortunate many who can not (yet) afford a new car, but would like the many benefits of a central locking system, the project described in this article may well be for you.

NOT all variants of a particular model of car are fitted with central locking. It is possible to have such variants modified at a late date, but that is invariably more expensive than buying a relevant kit from a car accessory dealer. In many countries, there are two DIY kits of parts available: one for the front doors only, and the other for all four doors. We don't know of a kit that also caters for the boot or, in case of a hatchback, the fifth door.

The two-door kit contains two master modules that must be coupled to the opening mechanism in each door. Each module contains an electric motor that via suitable gearing raises or lowers a lock shaft by about 50 mm. The lock shafts must be mechanically coupled to the existing doorlock mechanism. When the modules are fitted to both front doors, simultaneous locking or unlocking of both doors can be done from either doorlock.

The four-door kit contains two master modules and two slave modules. All four doors can be locked and unlocked from either front door, but neither of the rear door locks can control the other doors.

The main difference between a master module and a slave module is that the former has an additional electrical change-over contact that ascertains the position of the key in the lock.

The kits also contain a small PCB, on which the electronic control circuits are housed. These circuits interpret the position of the switch contacts and control the power required by the motors. They can not be modified for the control of say, four or five masters, and, in some cases, are not infallible.

In view of the limitations of the electronics part of these kits, it was felt that a far more sophisticated circuit would not come amiss. Moreover, the proposed circuit also offers the possibility of being operated by an infra-red remote control.

Circuit description

The circuit—see Fig. 1—is fairly straightforward and uses only a handful of components. It is suitable for the control of up to four master modules and two slave modules.

When the lock on a master-controlled door is operated, the ensuing signal from the relevant change-over contacts in the master module is applied to one of the inputs of quadruple Schmitt trigger IC_1 via an *RC*-type low-pass filter. This manifests itself as a voltage jump at one of the outputs of the Schmitt trigger, and this is registered at inputs A0–A3 and B0–B3 of comparator IC_2. Because of the *RC*-type low-pass filters at inputs B0–B3, the signal at these inputs is delayed slightly. Consequently, the level at the A=B output of the comparator changes from high to low and this triggers monostable IC_3, which is a non-retriggerable type 4538.

During the mono time, which is determined by time-constant R_{13}-C_9, the output of the monostable is high, so that transistor T_1 is switched on and relay Re_3 is energized. As long as this condition pertains, and only for so long, the battery supply line to the motors of all modules is completed via the rest contacts of relays Re_1 and Re_2.

It follows that the mono time must be long enough to allow the motors operating the lock shaft, thereby locking or unlocking all the doors. On the other hand, the mono time must not be too long, since the motors in their stop position draw maximum current and overheat quickly. The proposed time of 220 ms has proved ideal in use with a number of different kits. If, nevertheless, problems are experienced, the time can be made longer by increasing the value of R_{13} and/or C_9, and made shorter by reducing the value of these components.

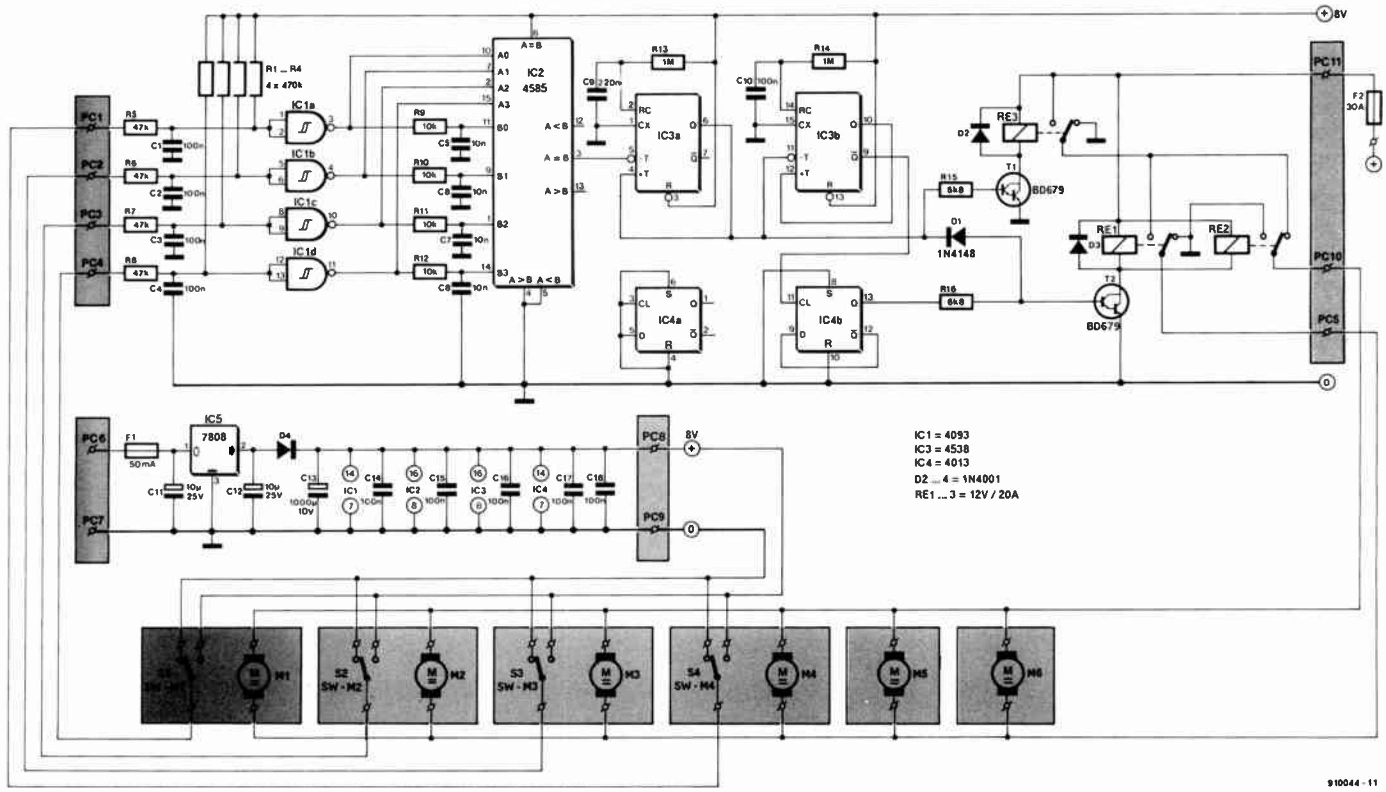
The direction of rotation of the motors depends on the position of the contacts of Re_2 and Re_3. The change-over contacts of these relays are arranged as reversing switches. Since the motors have to change direction every time a key is turned, their latest direction is stored in D-bistable (US: flip-flop) IC_{4b}, which functions as a binary scaler (US: scale-of-two counter). When the Q-output of this stage is high and the monostable is active (AND-gated via D_1), transistor T_2 toggles and relays Re_1 and Re_2 are energized.

When the Q-output of IC_{4b} is low, relays RE_1 and Re_2 are quiescent and the polarity of the voltage across the motors is reversed.

The status of IC_{4b} changes at every leading edge at the $\overline{Q}$-output of IC_{3b}. This has the advantage that the next direction of rotation of the motors is determined only when the motors have reached their end-stop.

The power supply of a circuit that is used

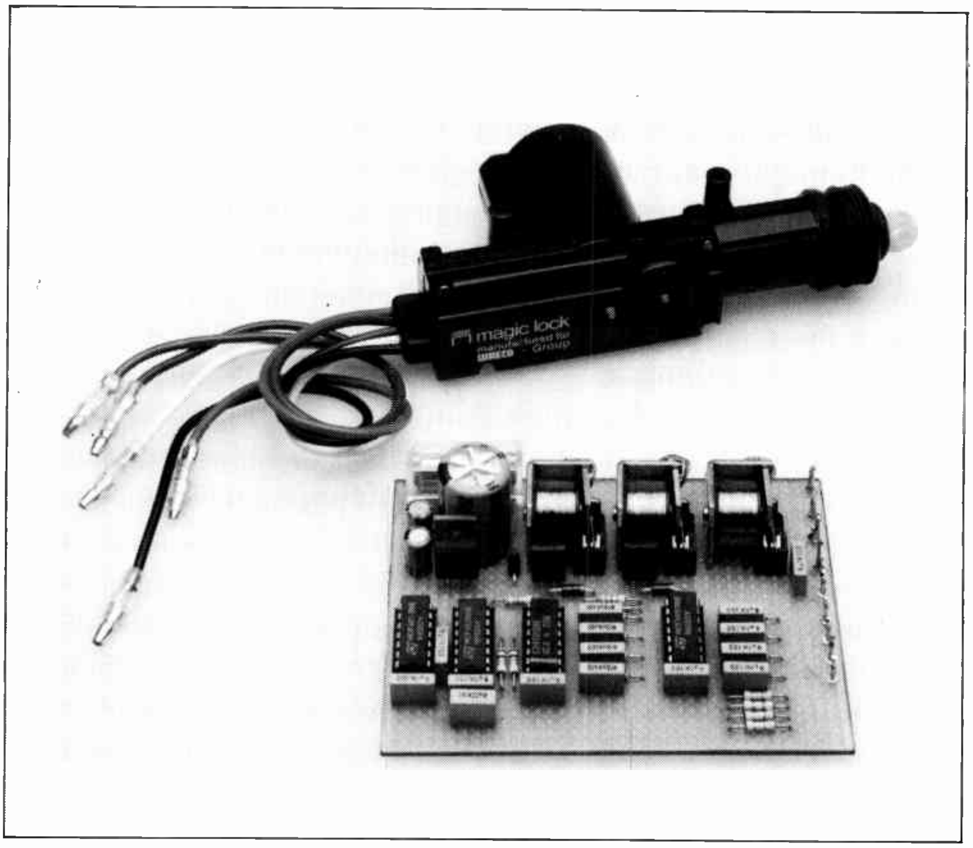
1



in a car must be designed to overcome the problems that can occur in a car's electrical system. The present circuit requires 8 V and this is derived from the car battery via an 8–V regulator, IC_5, followed by a 1000 µF capacitor, C_{13}, to earth. Diode D_4 prevents the capacitor being discharged via the regulator when the engine is started. The capacitor ensures that the circuit remains operational for at least 10 seconds after the battery voltage fails.

If remote control is wanted, one of the four masters must be forgone and the ensuing free input at the Schmitt trigger used as the remote control input. Suitable remote control transmitters and receiver units can be obtained from most car accessory dealers.

2



Construction

The circuit is best built on a suitable piece of prototyping board (veroboard) —see Fig. 2. Decoupling capacitors C_{14}–C_{18} *must* be located as close as possible to the relevant pins of IC_1–IC_3 to make certain that any noise on the supply lines does not enter these CMOS devices.

The relays can be of the type used for flashing indicators, which are fairly small, yet have contacts that are rated at 20 A.

Connections between the board and the modules and the battery are best made with the aid of standard car-type connectors.

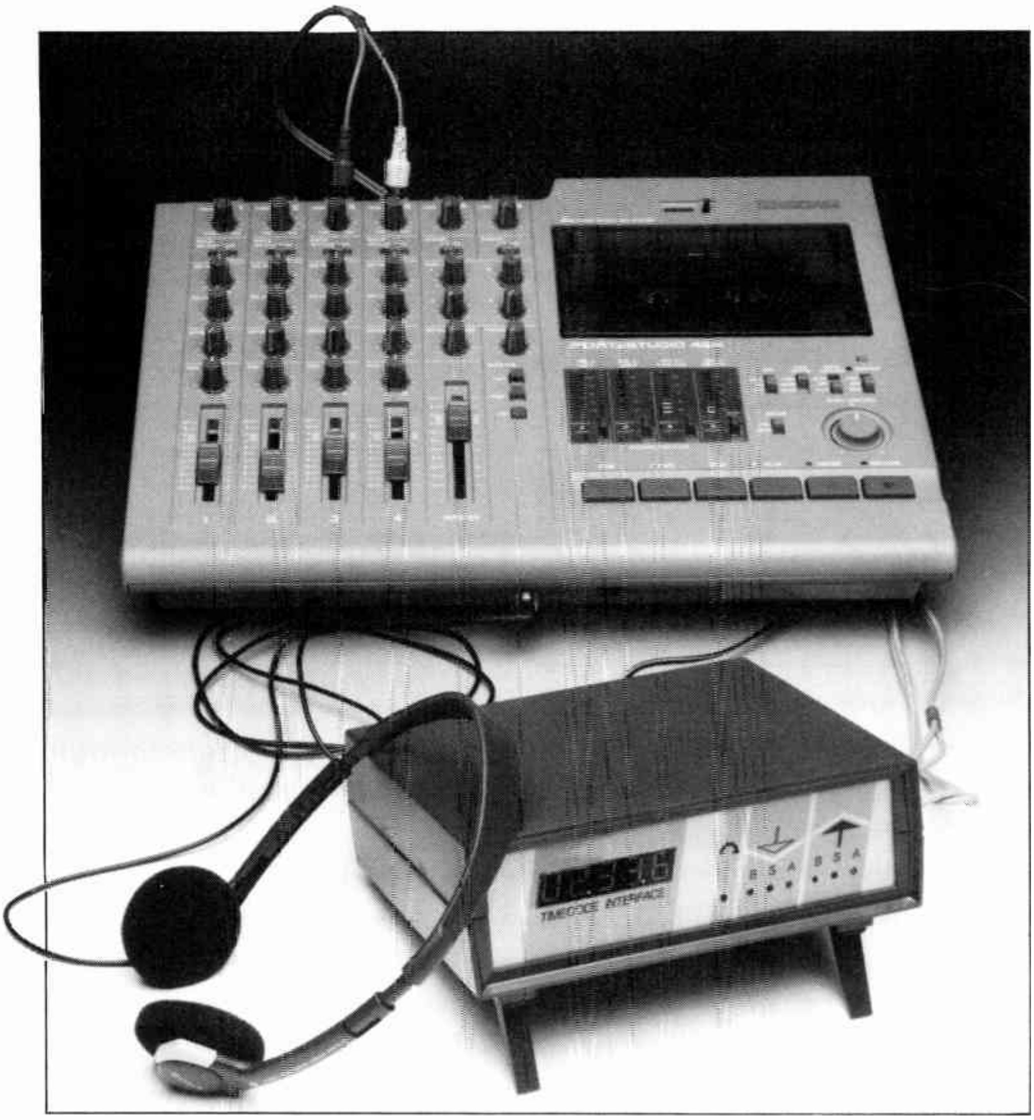
The board may be housed in a simple ABS or other man-made fibre enclosure.

Full fitting instructions are enclosed with the DIY central locking kits. The main additional work involves preparing and laying the cables to the various locations. You should set aside about 2–2$^1/_2$ hours per door. ■

TIMECODE INTERFACE FOR SLIDE CONTROL

PART 2: CONSTRUCTION

As discussed last month, the timecode interface is an ingenious piece of electronics capable of putting time codes on a magnetic tape at 0.1-second intervals. Here, this system is used to control slide projectors. This month we finish the article with details on the construction and practical use of the unit.



by A. Rigby

Continued from the July/August 1991 issue

If you felt a little put off by the complexity of the timing diagrams shown last month, rest assured that you need not understand these in detail to be able to build and use the timecode interface. The purpose of including the timing diagrams in last month's instalment was to set out the operation of the circuit in sufficient detail whilst avoiding a very long circuit description.

Fortunately, the construction and practical use of the timecode interface are not as complex as the actual circuit. The unit is controlled by a program supplied on disk through our Readers Services (order code 1611). The program enables you to run a test on the timecode interface with the aid of the Universal I/O Interface for PCs. Also on the disk are a number of source files, written in Turbo Pascal, that contain all the routines necessary for the practical use of the timecode interface.

Construction

The layout of the front panel designed for the timecode interface is shown in Fig. 7. The self-adhesive foil that gives the front panel a professional look is available ready-made through our Readers Services.

Motherboard

The double-sided, through-plated printed circuit board (Fig. 8) is cut to separate it from the three support pieces at the side of the arrow.

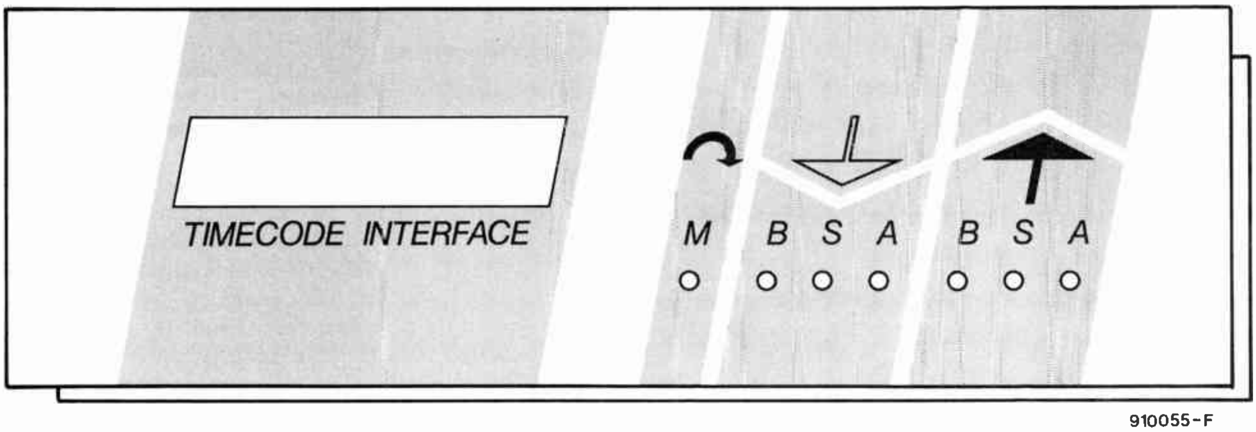


Fig. 7. The front panel foil designed for the timecode interface gives the unit an attractive, professional finish (shown at true size).

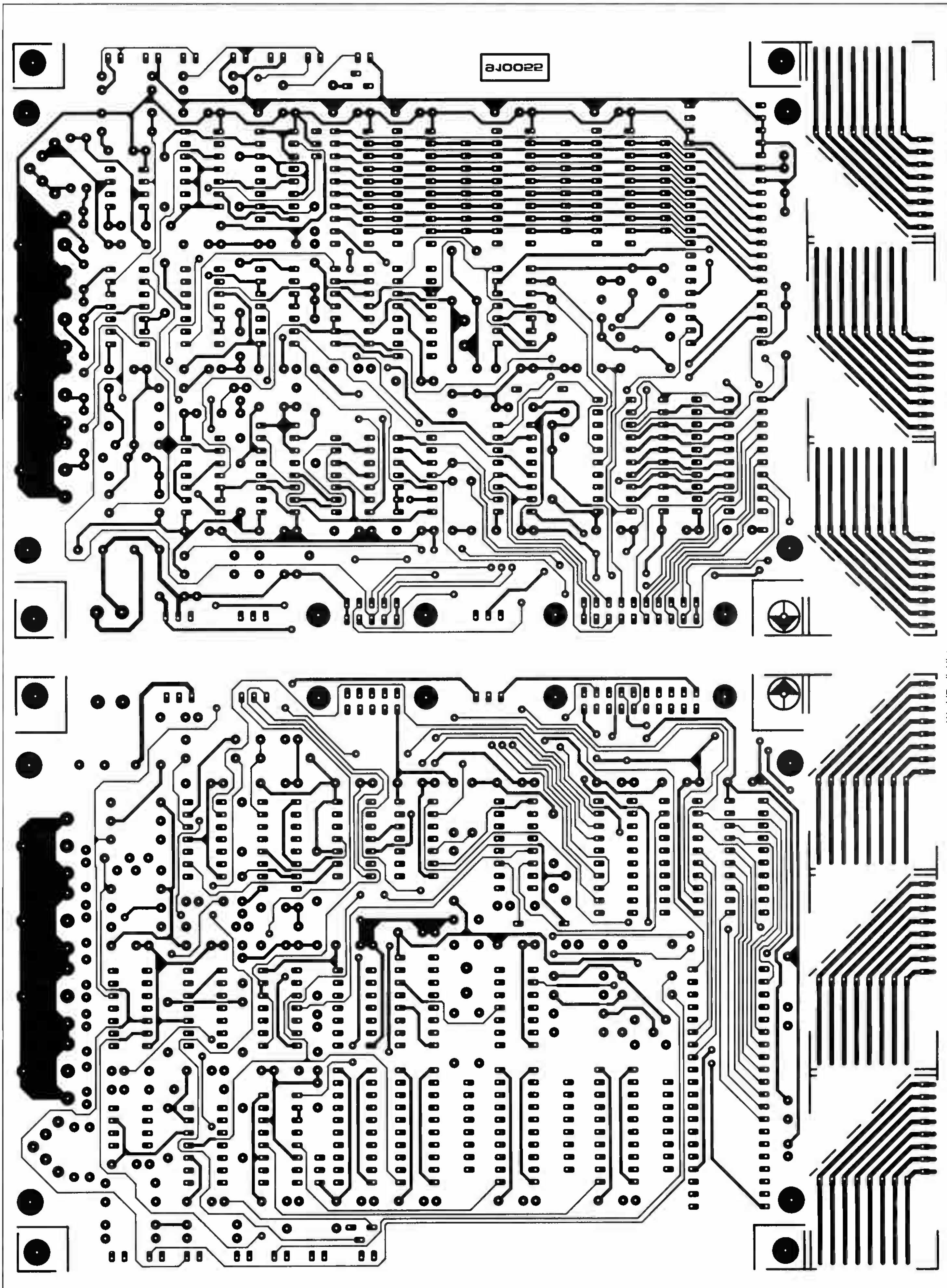
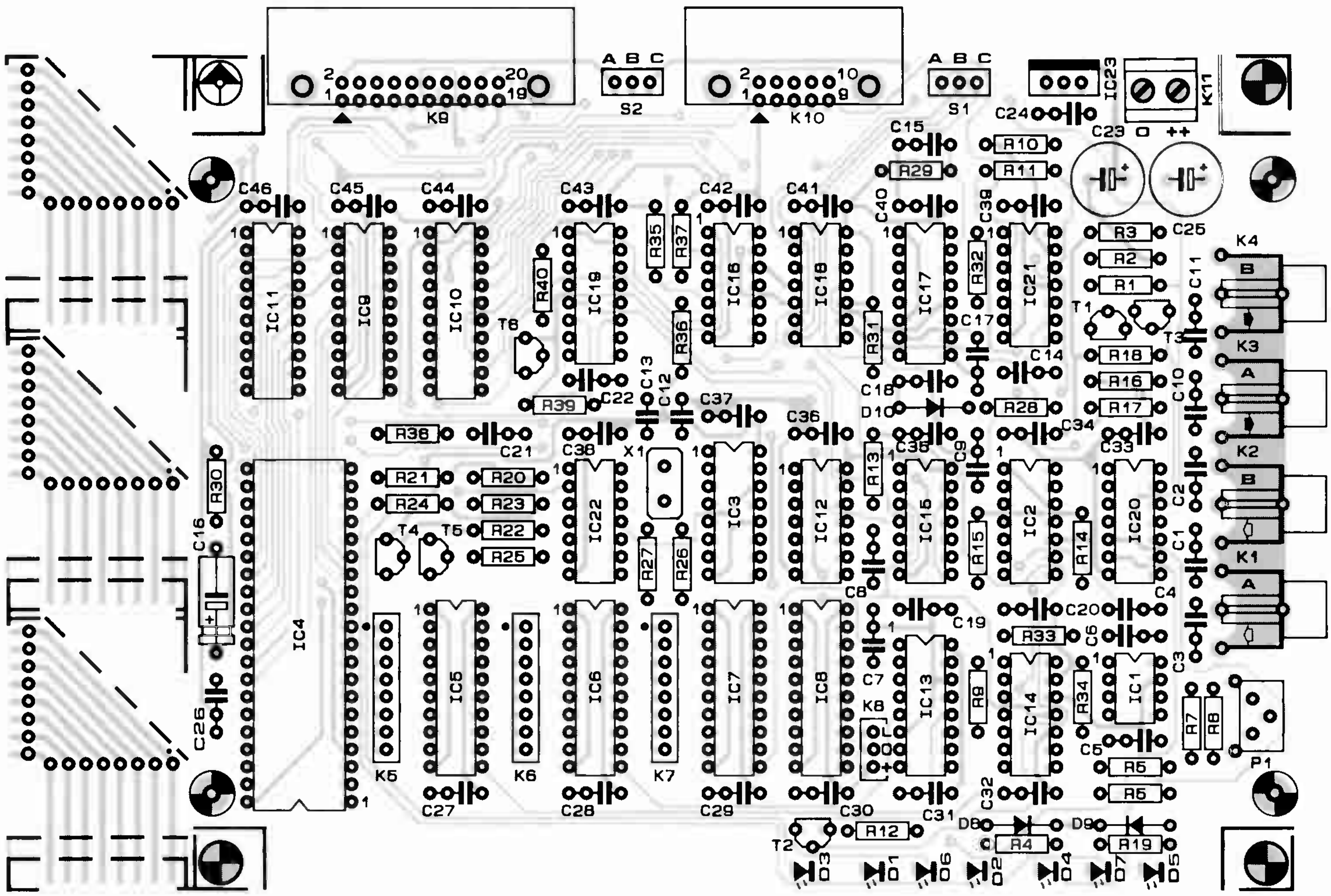


Fig. 8. Double-sided through-plated PCB for the timecode interface. The three corner pieces for the display unit are cut off from the main board.



COMPONENTS LIST

TIMECODE INTERFACE — MOTHER-BOARD

Resistors:

6	470Ω	R4;R12;R19;R21; R24;R30
8	1kΩ	R2;R13;R17;R27; R33;R34;R39
1	1kΩ2	R15
1	3kΩ9	R14
2	4kΩ7	R1;R16
15	10kΩ	R3;R7;R10;R11; R18;R20;R22; R23;R25;R28; R35-R38;R40
1	18kΩ	R9
1	22kΩ	R29
1	39kΩ	R8
4	100kΩ	R5;R6;R31;R32
1	1MΩ	R26
1	100kΩ preset V	P1

Capacitors:

2	27pF	C12;C13
1	100pF	C4
5	1nF	C6;C8;C14;C19; C20
1	10nF	C15
1	18nF	C7
1	33nF	C9
1	68nF	C17
2	22nF	C21;C22
28	100nF	C1;C2;C3;C5;C10; C11;C18;C24; C26-C46
1	100µF; 10V; axial	C16
1	100µF; 16V; radial	C25
1	100µF; 25V; radial	C23

Semiconductors:

7	LED 3 mm red	D1-D7
3	1N4148	D8;D9;D10
6	BC547B	T1-T6
1	AY-3-1015	IC4
1	3130	IC1
1	74HCT00	IC12
1	74HCT32	IC16
2	74HCT74	IC14;IC18
1	74HCT93	IC2
2	74HCT123	IC13;IC17
1	74HC132	IC15
1	74HCT139	IC19
1	74HCT245	IC11
2	74HCT541	IC8;IC9
4	74HCT574	IC5;IC6;IC7;IC10
1	74HCT4060	IC3
3	74HCT4066	IC20;IC21;IC22
1	7805	IC23

Miscellaneous:

4	PCB-mount line (RCA) socket	K1-K4
3	8-pin SIL pin header	K5;K6;K7
1	3-pin SIL pin header	K8
1	20-way PCB mount IDC connector with angled pins and side latches	K9
1	10-way PCB mount IDC connector with angled pins and side latches	K10
1	2-way PCB terminal block (5mm pitch)	K11
2	slide switch with changeover contact	S1;S2
1	5.2 MHz quartz crystal	X1
1	enclosure Retex * Re2 (145×171×56mm)	
1	printed circuit board	910055
1	front panel foil	910055-F
1	control software on disk	ESS 1611

* Imhof-Bedco Standard Products Ltd., Ashley Works, Ashley Road, Uxbridge, Middlesex UB8 2SQ.

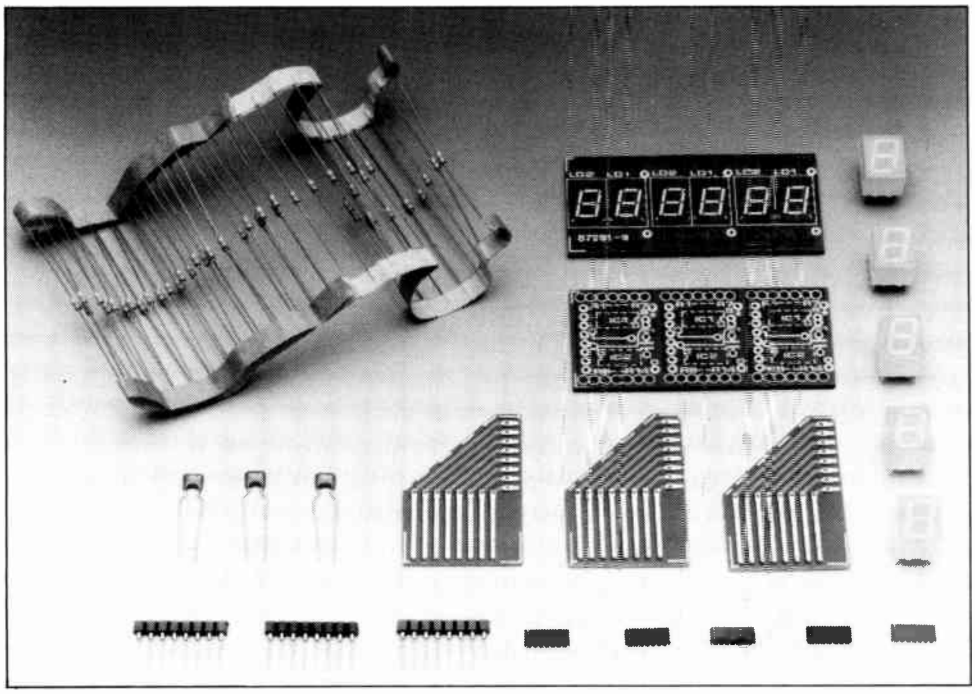


Fig. 9. All parts required to build the display. Note the IC pin strips with long pins.

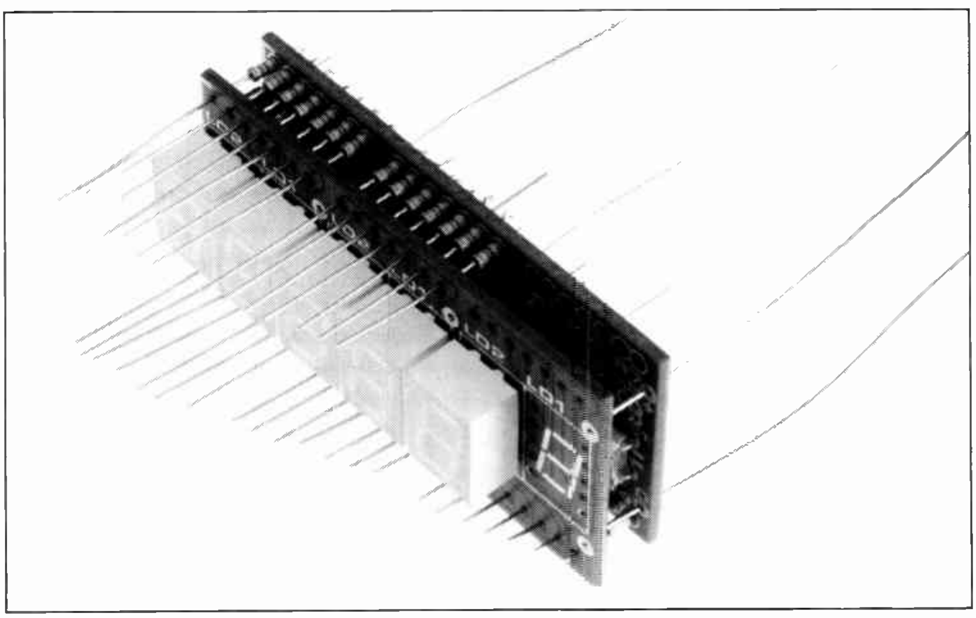


Fig. 10. In this way the display and the SMA boards can be joined easily.

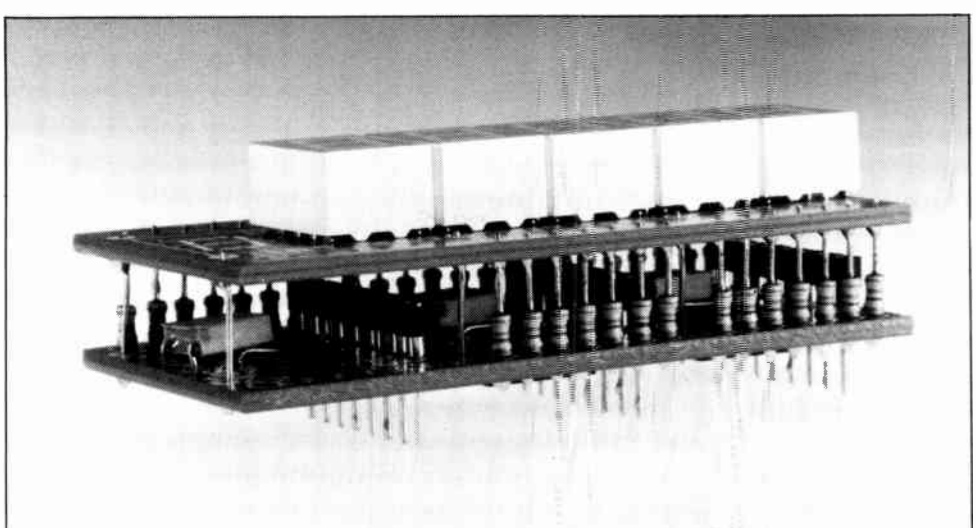


Fig. 11. The completed display. The IC pin strip is visible here.

Although fairly large and densely populated, the motherboard is easily built with the aid of the component overlay and the components list. The PCB accommodates all components, with the exception of switches S1 and S2. Its size is geared to the inside dimensions of the enclosure mentioned in the components list.

The construction of the display boards is a little more complicated than that of the motherboard, and discussed separately below. Note that the displays are optional — they are not strictly required when a computer is used to control the unit. They do, however, allow incorrect settings of, for instance, switch S1, the baudrate or preset P1, to be noticed immediately. The small PCB pieces you have already cut off allow the display module to be mounted to the motherboard in a simple and secure manner. The supply voltage and the LOAD signal are fed to the display via connector K8.

Display

As already noted, the read-out used is based on an earlier design developed for the Elektor Electronics Digital Train System (EEDTS). The construction of this display unit is discussed in Ref. 2 (see Part 1). There are, however, a number of points that deserve your attention.

1. The PCB used for the address display is the triple version, order code 87291-9a, which accommodates six displays. Here, we use only five displays, so that the display section at the extreme right — LD1, IC1 and R1-R7 of the associated SMA section — must not be fitted.

2. Before you start the construction of the display module, cut off the display section from the SMA section. Next, mount the wire links, capacitors, SMA ICs and the displays on the boards (note that the bevelled edge of the ICs marks the position of pin 1). The SMA parts are best soldered with thin solder wire of a diameter smaller than 1 mm. The SMA ICs are best fitted by first soldering two diagonal corner pins, and then aligning the other pins with the copper pads below before they are soldered. Those of you who want a clear separation between the minutes and the seconds indications may fit the two 680-Ω resistors between pins 6 of the two LD1 displays and ground (see Fig. 13).

3. To enable the display units to be connected to the corner pieces, use IC pin strips with long pins (1 cm; see Fig. 9). These pin strips must be fitted before the two PCBs are joined.

4. On the SMA PCB, all parts are fitted as closely together as possible. If you use the enclosure mentioned in the components list, you must use ultra-miniature resistors (max. length 5 mm). When the display board and the SMA board are joined, these resistors are inserted simultaneously. This is easiest done when the wire ends are cut such that they form an oblique line from one side of the board to the other (see Fig. 10).

5. The supply wires are soldered to the display board..

6. Check the complete construction before

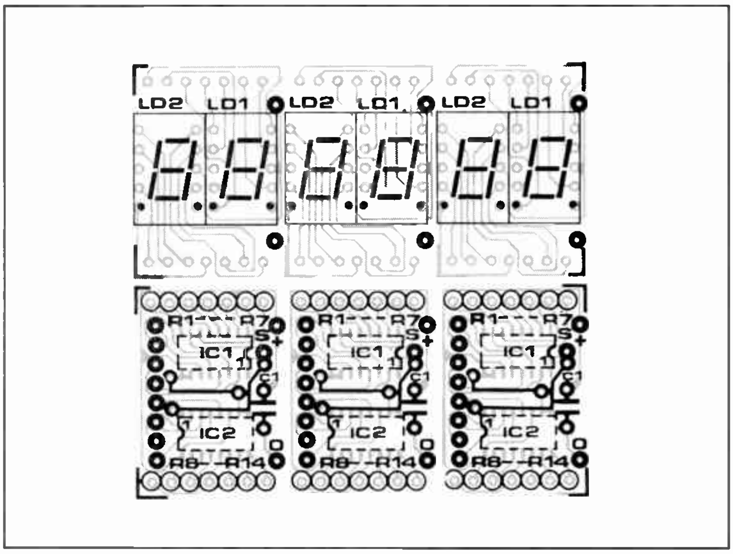


Fig. 12. Printed circuit board for the 5-digit address readout. The surface-mount assembly (SMA) ICs are fitted at the track side.

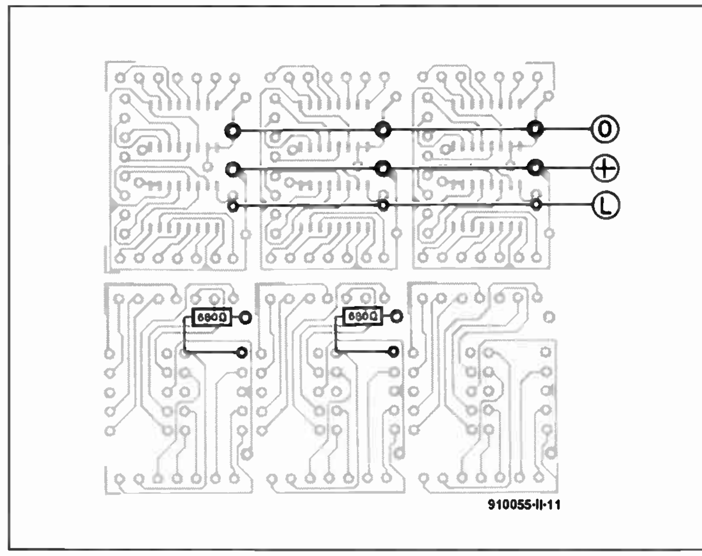


Fig. 13. These connection must be made at the rear of the SMA PCB, and wired to connector K8. Also shown here is how the two decimal points of two display can be joined.

COMPONENTS LIST

TIMECODE INTERFACE — DISPLAY BOARD

Parts list for 2½ display sections = 5 digits.

Resistors:		
35	680Ω miniature	R1-R14
Capacitors:		
3	47nF	C1
Semiconductors:		
5	4543 (SMA)	IC1;IC2
5	HD1105R	LD1;LD2
Miscellaneous:		
1	printed circuit board	87291-9a

you put the two PCBs together. First, solder the four resistors at the edges. Check that the PCBs align, and that there is sufficient room to solder the resistors properly. Also ensure that there remains sufficient space between the IC pin strip and the display PCB, so that short-circuits can not occur. When the Retex RE2 enclosure is used, the distance between the two PCBs is about 8 mm. Finally, solder the remaining resistors and the supply wires (see Fig. 11).

7. As shown in Fig. 14, the supply and the LOAD connections are interconnected between the PCB sections. They are connected to wires that allow the display to be driven from the main board via connector K8.

Putting it together

Cut the clearance in the front panel to size before you mount the completed display unit on to the motherboard. The clearance should be carefully cut (with a jig-saw) and widened (with a small file) so that the displays just about pass. The corner pieces are fitted on to the PCB with the aid of a straight header or short pieces of solid wire. The dashed lines on the corner pieces indicate the length to which they must be cut to obtain the correct height for the Retex enclosure. If you use a different enclosure, determine the required size of the corner pieces before cutting them.

Start the assembly by fitting the headers (or the wire pieces) on to the motherboard. Next, secure the motherboard in the enclosure. Insert the display into the clearance in the front panel. Solder each of the three corner pieces at one point, so that their tops are level with the pins of the display. Next, solder the display unit on to the four corner points, so that the front panel is positioned straight.

Before soldering the remaining points, run a thorough check on the assembly to make sure everything remains in place when the enclosure is closed.

Note that the front panel is designed such that the display unit is fitted as far as possible to the left. As shown in Fig. 14, each corner piece is at the left of the header, while the display section is fitted with its left side to the corner pieces.

The timecode interface is best powered by a mains adaptor with an output voltage of between 9 V and 12 V d.c. The current con-

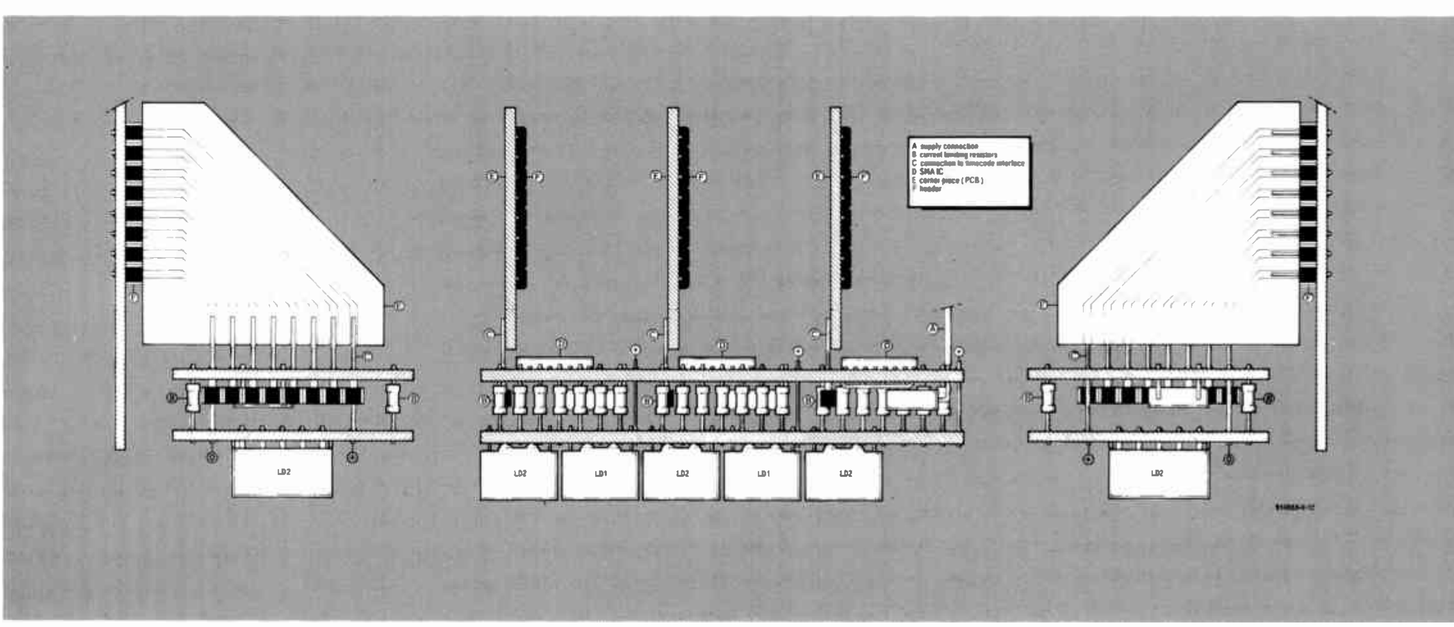
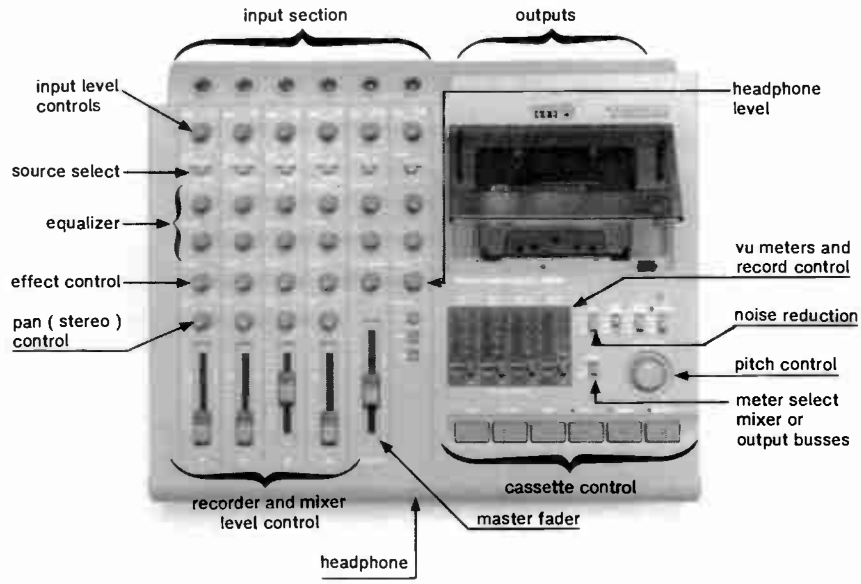


Fig. 14. Showing how the display and the corner pieces are mounted on to the main board.

THE MULTITRACK SYSTEM

Multitrack cassette recorders are popular with musicians, disk-jockeys and others who want to mix existing as well as original sound material on tape. It is well known that many pop bands and 'budding' artists use multitrack recorders for the production of demo tapes that are offered as promotion material to radio stations and record companies. In the hi-fi audio scene, the multitrack cassette deck is rarely used as its sound reproduction quality is, in principle, not better than that of a stereo cassette deck. Because of this, the multitrack recorder may be unfamiliar to many of you, whence the following basic description.

In its basic form, the multitrack recorder is a standard cassette recorder. It has all the familiar functions like recording, noise suppression and a tape transport mechanism. The first difference, however, is found when we look inside the cassette compartment. The recording/playback head is not a 2-track type, but a 4-track or even 6- or 8-track type. Looking at the tape erase function we find that there are a corresponding number of individual heads. The use of more than two record/playback and erase heads allows each track to be recorded and erased individually. This is arranged with the aid of a number of switches and input and output sockets that enable you to use any individual track for recording or playing back. Since the tracks are physically distributed over the full tape width, the cassette can be used in one direction only.



A multitrack recorder alone is not sufficient to produce, say, a demo tape for an artist — you will also need a mixing console to control the level of the individual sources (whether new or already recorded signals), and mix them down to a complete production ('post mixing', although this term is really used with 40+-channel mixing consoles only), or to another track. In the days when mixers and multitrack recorders were separate units, such a production job meant struggling with a lot of plugs and cables, with a great risk of errors occurring at all stages of the production line. The introduction of the so-called portastudio put an end to all this trouble by combining a simple mixing console and a multitrack cassette recorder in a single lightweight case. From then on, producing demo tapes with acceptable quality no longer required a sound engineer doing his bit with lots of wires and plugs — a great advantage for artists and pop bands, witness the start of the 'garage rock' period. From its introduction, the portastudio was a real success, combining ease of use with good sound quality and the freedom to record music, or mix it with existing sound material, almost anywhere, from the attic or basement to the garage or local music club. The term dubbing refers to using an existing recording to make a new one. By making clever use of a portastudio, up to 10 sources can be recorded while only one dub is required. This is accomplished by first recording three signals, either simultaneously or one after the other, on tracks 1-3. Next, these three signals are mixed with a fourth signal, and the result is recorded on track 4. This dubbing operation allows tracks 1-3 to be used again for new recordings. After repeating this operation three times, a total of 10 signals have been recorded. When it is time for the final mix, the panorama ('pan') control is used to give each track its place in the stereo image. The advantage of this way of working is that the previously recorded signal can be listened to while playing along and recording an additional signal (i.e., instrument or voice).

Besides level and pan controls, most portastudios have loop-through connections for effects equipment. A headphone output is standard, and inputs can be switched between line and microphone signals. A pitch control or tape speed switch is sometimes provided for the purpose of playing along at low speed. An increasing number of portastudios offer a tape speed of 9.5 cm/s, which provides significantly better reproduction quality.

The differences between portastudio units are mainly the number of inputs of the mixing console, the control system (mechanically or electronically), the noise suppression system (Dolby or DBX), and whether or not all tracks are accessible.

The timecode interface described in this article is preferably used with a 4-track recorder that has outputs for all four tracks (some multitrack recorders have only three outputs). In general, noise suppression should not be used because it may affect the frequencies of the control signals recorded on the tape. Problems are likely to occur at relatively high recording levels when the noise suppression is switched on. Simply try out the effect on your recorder — if problems occur, you will have to make do without the noise suppression. Unfortunately, this means that the music programme with your slide presentation has to be recorded without noise suppression.

Finally, use good quality cassette tapes, and have your recorder adjusted to these. The little extra money spent on a quality cassette is a good investment because it prevents many problems. ❑

sumption of the unit, including the display, is about 250 mA when it is not powered by another circuit or by a computer via connector K9.

The right track

You will need at least a stereo tape recorder to be able to use the timecode interface. The sound channel is then recorded in mono, while the other track is used for the timecode signal. The sound programme must be mixed prior to recording the timecode.

The timecode signal is recorded and played back via the normal cinch-, line- or DIN socket of one of the channels available on the recorder.

For more sophisticated work, use a multitrack tape recorder which enables you to record or play back four tracks either simultaneously or individually. This has the advantage of allowing the sound programme to be recorded and played back in stereo. The timecode is put on one of the remaining tracks, and this can be done independently of the sound programme. By the way, you can not use the (optional) special data format provided by the timecode interface unless you have a multitrack recorder.

Another advantage of a multitrack recorder is that it usually features a simple mixing console. After mixing and recording the sound programme for the slide series, the timecode signals are recorded on track 4. When this is done, you have an absolute time reference relative to the music. This time reference is independent of tape stretch and tracking. Track 3 then remains free to record a special data format.

Finally, a remark on the system timing: if you want to change the frequency of quartz crystal X1, remember that the time constant of R9-C7 must be changed accordingly. Capacitor C9 will need to be changed, too. Clock frequencies higher than 5.2 MHz are not recommended, however, since they increase the error rate. ■

FIBER OPTICS — Part 1

Fiber optics are the latest transmission media in communications and instrumentation technology. Fibers are showing up in telecommunications, in computer data communications, and all manner of scientific, engineering and medical instruments. Briefly stated, fiber optics is that technology in which light is passed through a plastic or glass fiber so that it can be directed to a specific destination. If the light is encoded (modulated) with an information signal, then that signal is transmitted over the fiber optical path.

Joseph J. Carr

THERE are many advantages to the fiber optical communications or data link, including:

- Very high bandwidth (accommodates video signals, many voice channels, or high data rates in computer communications).
- Very low weight and small size.
- Low loss compared with other media.
- Freedom from electromagnetic interference (EMI).
- High degree of electrical isolation.
- Explosion proof.
- Good data security
- Improved 'fail-safe' capability.

The utility of the high bandwidth capability of the fiber optical data link is that it can handle a tremendous amount of electronically transmitted information simultaneously. For example, it can handle more than one video signal (which typically requires 500 kHz to 10 MHz of bandwidth, depending on resolution). Alternatively, it can handle a tremendous number of voice communication telephony channels (which is why you see those advertisements on television). High speed computer data communications capability is also possible. Either a few channels can be operated at extremely high speeds, or a larger number of low-speed parallel data channels are available on the fiber. Fiber optics are so significant, that one can expect to see them proliferate in the communications industry for years to come. Indeed, some futurists are calling for an extensive nationwide fiber optic communications network for data communications that is the info-age equivalent of the interstate highway system.

The light weight and small size of fiber optics, coupled with relatively low loss, makes the fiber optic communications link a very good economic advantage when large numbers of channels are contemplated. To obtain the same number of channels using coaxial cables or 'paired wires' the system would require a considerably larger, bulkier and heavier, infrastructure.

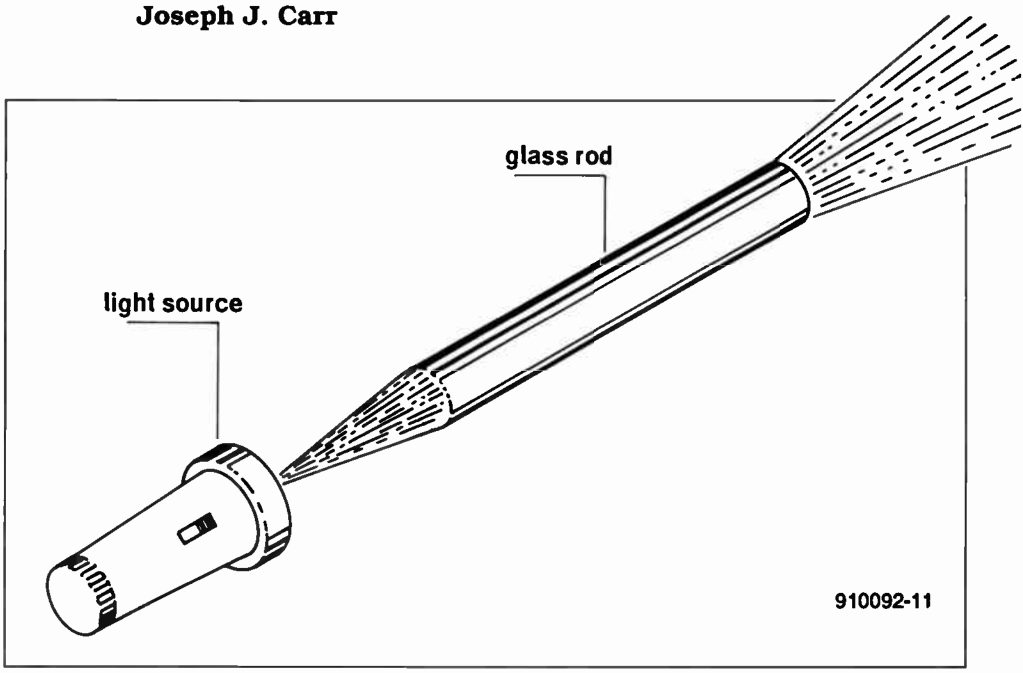


Fig. 1. Light travelling in glass rods was demonstrated more than one hundred years ago.

Electromagnetic interference (EMI) has been a destructive factor in electronics since Marconi and DeForest interfered with each other in radio trials for the Newport Yacht Races just prior to the turn of the 20th century. Today, EMI can be more than merely annoying, and can cause tragic accidents. For example, airliners are operated more and more from digital computers. Indeed, one airline co-pilot recently quipped (about modern aircraft) that one does not need to know how to fly anymore, but one does need to be able to type on a computer keyboard at 80 words per minute. While the pilot's comment was meant to be a joke, it points out just how dependent aircraft have become on modern digital computers and intercommunication between digital devices. If a radio transmitter, radar, or electrical motor is near one of the intercommunications lines, then it is possible to either introduce false data or corrupt existing data with potentially disastrous results. Because the EMI is caused by electrical or magnetic fields coupling between electrical cables, fiber optics (being free of such fields) produces dramatic freedom from EMI.

Electrical isolation is required in many instrumentation systems either for the safety of the user, or the health of the electronic circuits connected to the system. For example, in some industrial processes, high electrical voltages are used, but the electronic instruments used to monitor the process are both low-voltage and ground referenced. As a result, the high voltage can damage the instruments. In fiber optical systems, it is possible to use an electrically floating sensor, and then transmit the data over a fiber link to an electrically grounded, low-voltage computer, instrument or control system.

The fact that fiber optics uses light beams, and these are generated in non-contacting electronic circuits, make the fiber optic system ideal for use in switching and control systems around flammable gases or fumes. For example, in monitoring gasoline systems, or in cases where natural gas or medical anesthetic agents such as ether or cyclopropane[1] are used. Regular mechanical switches or relays arc either on contact, or when decontacting, and those sparks can create an explosion if flammable gases or fumes are present. A number of operating room explosions in hospitals occurred prior to about 1960, and some gasoline stations have exploded because of arcing in electrical switches.

System security is enhanced because fiber op-

[1] These agents are only rarely used today, being considered too dangerous since the late 1970s when non-flammable substitutes became widely used.

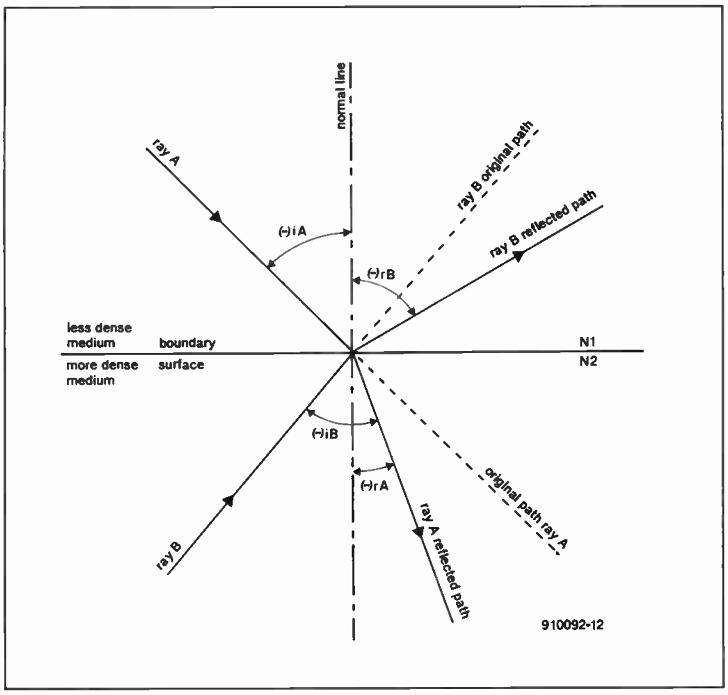


Fig. 2. **Basic refraction phenomenon.**

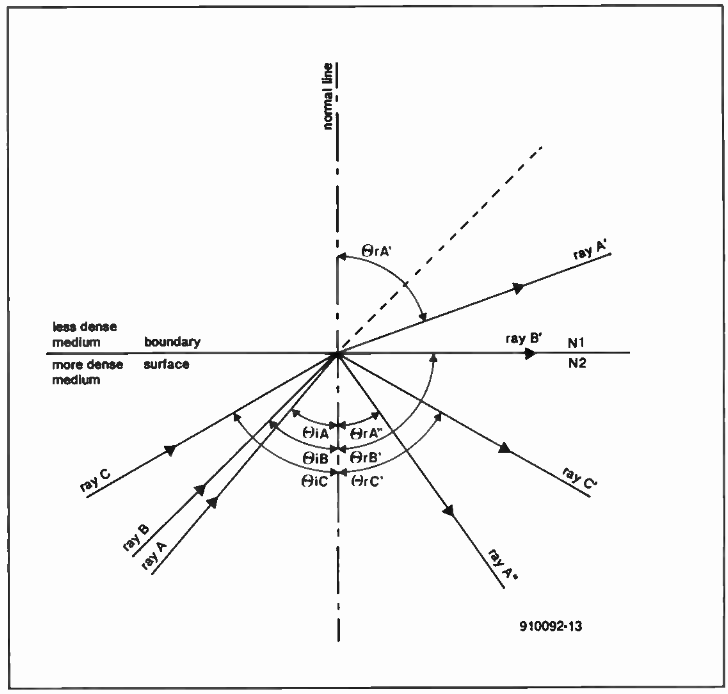


Fig. 3. **Refraction involved in 'total internal reflection'.**

tics is difficult to tap. An actual physical connection must be made to the system. In wire systems, capacitive or inductive pick-ups can acquire signals with less than total physical connection, i.e., no splice is needed. Similarly, a system is more secure in another sense of the word because the fiber optical transmitters and receivers can be designed to fail safe so that one fault does not take down the system. I recall a hospital coronary care unit data system that used parallel wire connections between the data output ports on bedside monitors and the central monitoring computer at the nurses station. A single short circuit in parallel data lines would reduce the system to chaos! That is less likely to happen in a fiber optical system.

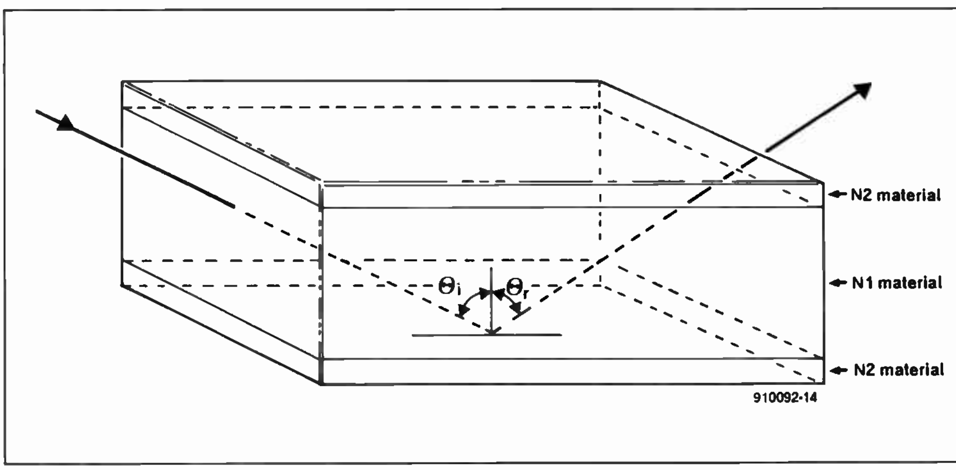


Fig. 4 **Waveguide analogy to fiber optics.**

Fiber optics: history and practical applications

The basic fact of fiber optics, i.e., the propagation of light beams in a transparent glass conductor (Fig. 1), was noted in the early 1870s when John Tyndall introduced members of The Royal Society to his experimental apparatus. An early, but not very practical, colour television system patented by J.L. Baird used glass rods to carry the colour information. By 1966, G. Hockham and C. Kao (Great Britain) demonstrated a system in which light beams carried data communications via glass fibers. The significant fact that made the Hockham/Kao system work was the reduction of loss in the glass dielectric material to a reasonable level. By 1970, practical fiber optic communications was possible.

Medicine has made use of fiber optics for more than two decades. Fiber optic endoscopes can be passed into various orifices of the body, either natural or surgically made, to inspect the interior of a patient's body. Typically there are two bundles, one for viewing and one for passing a light from a (misnamed) 'cold' light source into the body. For example, gynaecologists can inspect and operate on certain internal organs in females using a laprascope introduced through a 'band-aid' incision in the abdomen. Knee surgeons can use a fiber optic arthroscope to perform nearly miraculous operations on the human knee with far less trauma than previous procedures. Other physicians use fiber optic endoscopes to inspect the stomach and gastric track. A probe is passed through the mouth or nose, down the esophagus into the stomach so that tumors and ulcers can be inspected without resort to surgery. In more recent times, miniature TV cameras using CCD arrays have been made available, with the fiber optics carrying the light into the stomach.

Fiber optic inspection is used elsewhere than in medicine. For example, I recall an advertisement for a septic tank service company that used fiber optics and television to inspect the tank; similarly for plumbers. Other industrial and residential services also use fiber optics to inspect areas that are either inaccessible or too dangerous for direct viewing.

Before examining fiber optic technology, it is useful to discuss some of the basics of optical systems as applied to the fiber optic system.

Review of some basics

The index of refraction (n), or refractive index of a material, is the ratio of the speed of the light wave in a vacuum to the speed of the light wave in the material (e.g., glass, plastic, water). For practical purposes, the speed of light in air is close enough to the speed in a vacuum to be considered the same. Mathematically, the index of refraction, n, is:

$$n = \frac{c}{v_m} \qquad [1]$$

where
c is the speed of light in a vacuum (approx. 3×10^8 m/s);
v_m is the speed of light in the medium.

Refraction is the phenomenon in which a light ray changes direction as it passes across the boundary surface (or 'interface') between two mediums of differing indices of refraction ($n_1 \neq n_2$). Consider Fig. 2 in which two materials, with indices of refraction n_1 and n_2 respectively. Consider incident lightray A, approaching the interface from the less dense side ($n_1 \rightarrow n_2$). As it crosses the interface it changes direction towards a line normal (i.e., at right angles) to the surface. Conversely, lightray (B) approaches the interface from the more dense side ($n_2 \rightarrow n_1$). In this case, the lightray is similarly refracted from its original path, but the direction of refraction is away from the normal line.

In refractive systems the angle of refraction is a function of the ratio of the two indices of refraction, i.e., it obeys Snell's law:

$$n_1 \sin \Theta_{i\,a} = n_2 \sin \Theta_{r\,a} \quad [2]$$

or,

$$\frac{n_1}{n_2} = \frac{\sin \Theta_{r\,a}}{\sin \Theta_{i\,a}} \quad [3]$$

The particular case which concerns fiber optics is where the light ray passes from a more dense medium to a less dense medium. We can use either a water to air system, or a system in which two different glasses, with dissimilar indices of refraction, are interfaced. This type of system was addressed in Fig. 2 by ray B. Figure 3 shows a similar system with three different lightrays (ray A, ray B and ray C) approach the same point on the interface from three different angles (i_a, i_b and i_c, respectively). Ray A approaches at a subcritical angle, so it will split into two portions (A' and A"). The reflected portion (A") contains a relatively small amount of the original light energy, and may indeed be nearly indiscernible. The major portion of the light energy is transmitted across the boundary, and refracts at an angle r_a' in the usual manner.

Lightray B, on the other hand, approaches the interface at the critical angle, r_b', and is refracted along a line that is orthogonal to the normal line, i.e., it travels along the interface boundary surface. This angle is normally labelled *C* in optical textbooks.

Finally, ray C approaches the interface at an angle greater than the critical angle, i.e., a supercritical angle. None of this ray is transmitted across the boundary, but rather it is turned back into the original media; i.e., it is subject to total internal reflection (TIR). It is the phenomenon of total internal reflection that allows fiber optics to work.

Fiber optics

The fiber optic is somewhat similar to a microwave waveguide, and an understanding of waveguide action is useful in understanding fiber optics. A schematic model of a fiber optic is shown in Fig. 4. A slab of denser material (n_1) is sandwiched between two slabs of a less dense material (n_2). Lightrays that approach from a supercritical angle are totally internally reflected from the two interfaces ($n_2 \rightarrow n_1$ and $n_1 \rightarrow n_2$). Although only one 'bounce' is shown in our illustration, the ray will be subjected to successive TIR reflections as it propagates through the n_1 material. The amount of light energy that is reflected through the TIR mechanism is of the order of 99.9 per cent, which compares quite favourably with the 85-96 per cent typically found in planar mirrors.

Fiber optic lines are not rectangular, but rather are cylindrical, as shown in Fig. 5. These components are called clad fiber optics because the denser inner core is surrounded by a less dense layer called cladding. Shown in Fig. 5 are two rays, each of which is propagated into the system such that the critical angles are exceeded. These rays will propagate down the cylindrical optical fiber with very little loss of energy. There are actually two forms of propagation. The minority form (Fig. 6a), called meridional rays, are easier to understand and mathematically model in textbooks because all rays lie in a plane with the optical axis. The more numerous skew rays (Fig. 6b) follow a helical path, so are somewhat more difficult to discuss (Ref. 1).

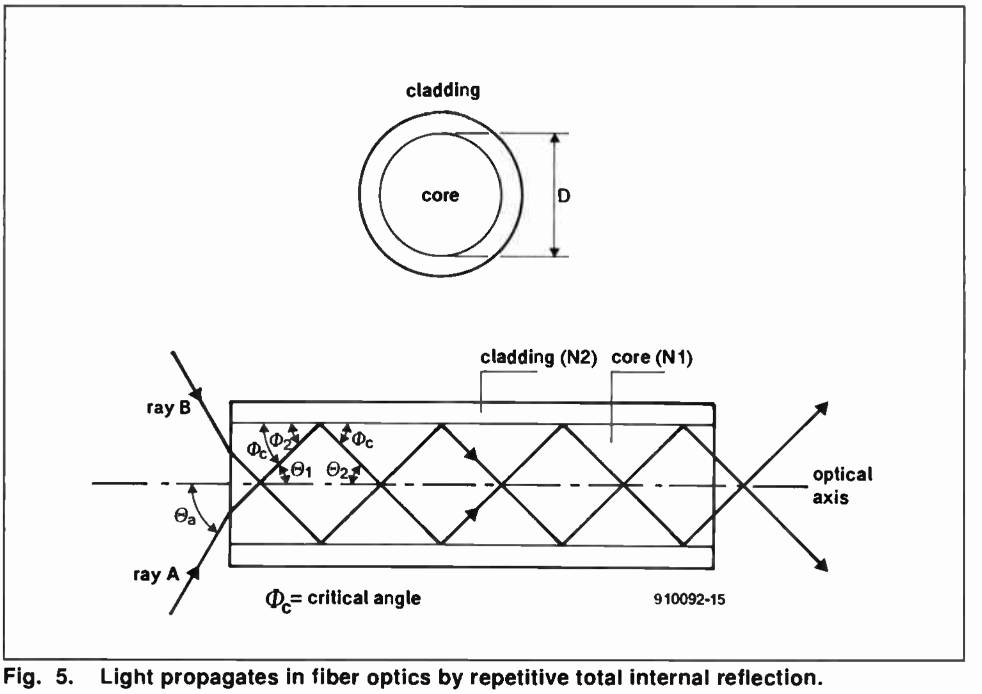


Fig. 5. Light propagates in fiber optics by repetitive total internal reflection.

The light acceptance of the fiber optic (Fig. 7) is a cone shaped region centred on the optical axis. The acceptance angle *a* is the critical angle for the transition from air ($n = n_a$) to the core material ($n = n_a$). The ability to collect light is directly related to the size of the acceptance cone, and is expressed in terms of the numerical aperture, NA, which is:

$$\mathrm{NA} = \sin \Theta_a \quad [4]$$

The refraction angle of the rays internally, across the air-n_1 interface, is given by Snell's law:

$$\Theta_{b\,1} = \arcsin \left(\frac{n_a \sin \Theta_a}{n_1} \right) \quad [5]$$

In terms of the relative indices of refraction between the ambient environment outside the fiber, the core of the fiber and the cladding material, the numerical aperture is given by:

$$\mathrm{NA} = \sin \Theta_a = \frac{1}{n_a} \sqrt{n_1^2 - n_2^2} \quad [6]$$

If the ambient material is air, then the numerical aperture equation reduces to:

$$\mathrm{NA} = \sqrt{n_1^2 - n_2^2} \quad [7]$$

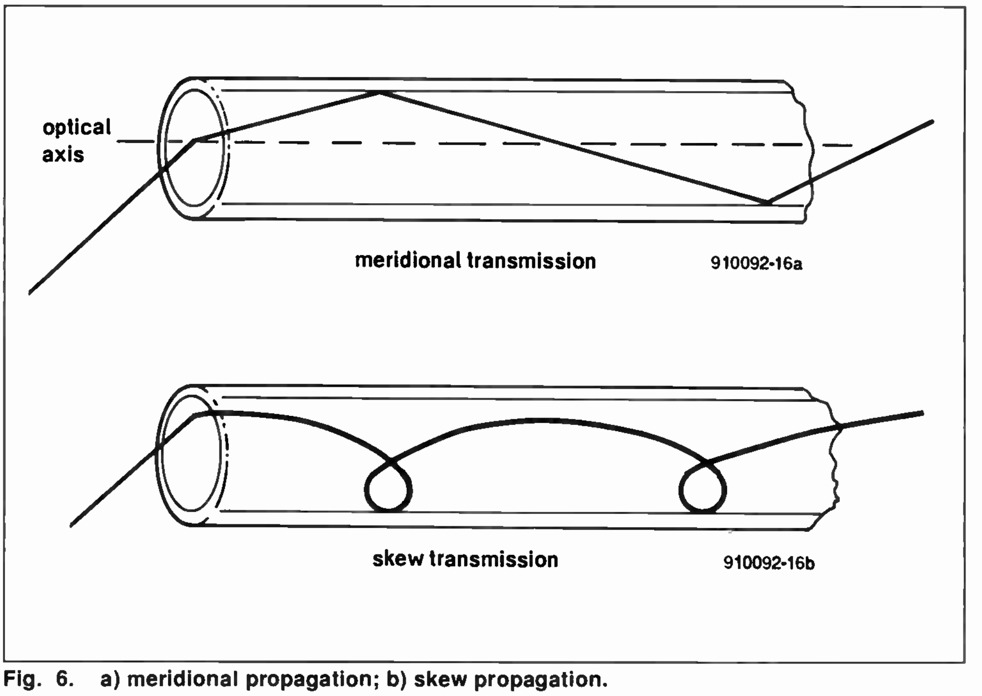


Fig. 6. a) meridional propagation; b) skew propagation.

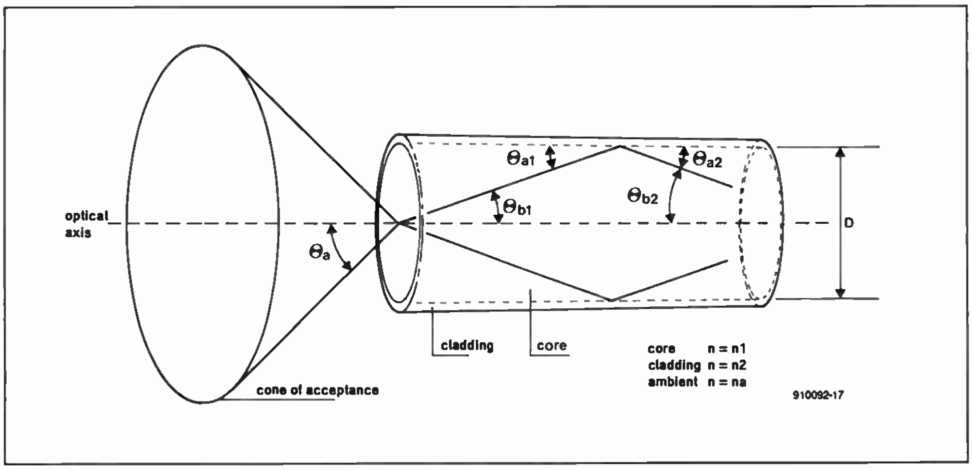


Fig. 7. Cone of acceptance of a fiber cable.

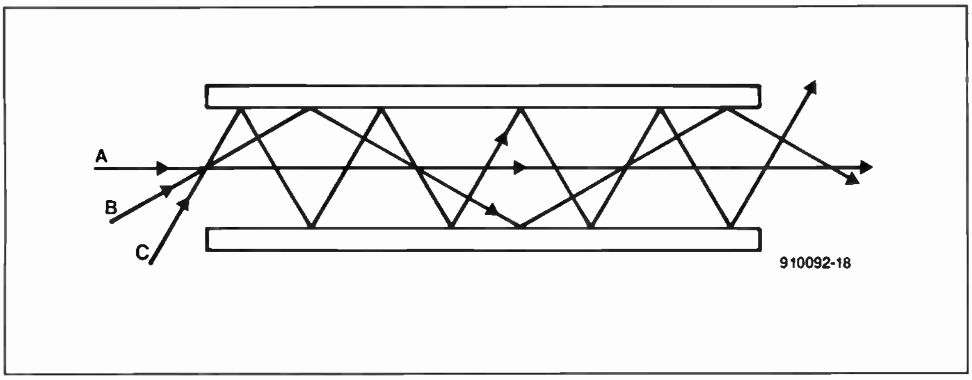


Fig. 8. Transmission modes in fiber optics.

Internally, the angles of reflection (a_1 and a_2), at the critical angle, are determined by the relationship between the indices of refraction of the two materials, n_1 and n_2:

$$\Theta_{a1} = \frac{\arcsin\sqrt{n_1^2 - n_2^2}}{n_1} \qquad [8]$$

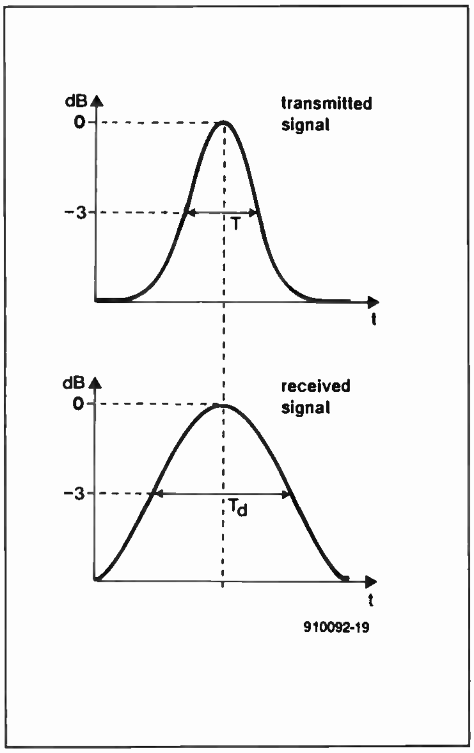


Fig. 9. a) input light pulse; b) output pulse is dispersed in time.

Typical fiber optic components have numerical apertures of 0.1 to 0.5; typical fibers have a diameter D of 25 μm to 650 μm. The ability of the device to collect light is proportional to the square of the numerical aperture:

$$\zeta \equiv (\mathrm{NA} \times D)^2 \qquad [9]$$

Intermodal dispersion

When a light ray is launched in a fiber optic it can take any of a number of different paths, depending in part on its angle of arrival (Fig. 8). These paths are known as transmission modes, and vary from very low order modes parallel to the optical axis of the fiber (ray A in Fig. 8), to the highest order mode close to the critical angle (ray C); in addition, there are a very large number of rays in between these two limits. An important feature of the different modes is that the respective path lengths vary tremendously, being shortest with the low order modes and longest with high order modes. If a fiber optic has only a single core and single layer of cladding, it is called a step index fiber because the index of refraction changes abruptly from the core to the cladding. The number of modes, N, that can be supported are given by:

$$N = \frac{(\pi D\,[\mathrm{NA}]/\lambda)^2}{2} \qquad [10]$$

Any fiber with a core diameter, D, greater than about ten wavelengths (10λ) will support a very large number of modes, so is typically called a multimode fiber. A typical light beam launched into such a step index fiber optic will simultaneously find a large number of modes available to it. This may or may not affect analogue signals, but has a deleterious effect on digital signals called intermodal dispersion.

Figure 9 illustrates the effect of intermodal dispersion on a digital signal. When a short duration light pulse (Fig. 9a) is applied to a fiber optic that exhibits a high degree of intermodal dispersion, the received signal (9b) is smeared, or 'dispersed', over a wider area. At slow data rates this effect may prove negligible because the dispersed signal can die out before the next pulse arrives. But at high speeds, the pulses may overrun each other (Fig. 10), producing an ambiguous situation that potentially exhibits a high data error rate.

Intermodal dispersion is usually measured relative to the widths of the pulses at the –3 dB (i.e., half-power) points. In Fig. 9, the –3-dB point on the incident pulse transmitted into the fiber optic is T, while in the received pulse the time between –3 dB points is T_d. The dispersion is expressed as the difference, or:

$$\text{Dispersion} = T - T_d \qquad [11]$$

A means for measuring the dispersion for any given fiber optic element is to measure the dispersion of a Gaussian (normal distribution) pulse at those –3-dB points. The cable is then rated in terms of nanoseconds dispersion per kilometre of fiber (ns/km).

The bandwidth of the fiber, in megahertz per kilometre (MHz/km), can be specified from knowledge of the dispersion, using the expression:

$$B\,(\mathrm{MHz/km}) = \frac{310}{\mathrm{Disp.(ns/km)}} \qquad [12]$$

Graded index fibers

A solution to the dispersion problem is to build a fiber optic with a continuously varying index of refraction such that n decreases at distances away from the optical axis. While such smoothly varying fibers are not easy to build, it is possible to produce a fiber optic with layers of differing index of refraction (Fig. 11). The relationship of the respective values of n for each layer are:

$$n_1 > n_2 > n_3 > n_4 > n_5 > \ldots\ n_i \qquad [13]$$

The overall index of refraction determines the numerical aperture, and is taken as an average of the different layers.

With graded fibers, the velocity of propagation of the light ray in the material is faster in the layers away from the optical axis than in the lower layers. As a result, a higher order mode wave will travel faster than a wave in a lower order.

The number of modes available to the graded index fiber are:

$$N = \frac{(\pi D\,[\mathrm{NA}]/\lambda)^2}{4} \qquad [14]$$

Some cables operate in a critical mode, designated HE_{11} (to borrow from microwave terminology) in which the cable is very thin compared with multimodal cables. As the diameter of the core decreases, so does the number of available

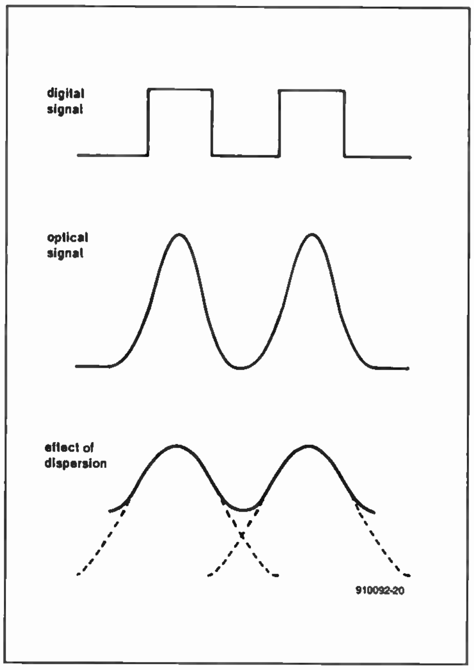


Fig. 10. Effects of dispersion on digital signal bandwidth: a) original data signal; b) light pulse inputto fiber system; c) dispersed light pulses overlapped.

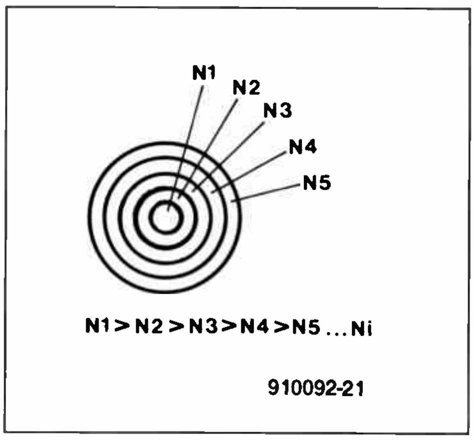


Fig. 11. Graded index fiber.

modes and eventually the cable becomes monomodal; If the core gets down to 3 to 5 microns, then only the HE_{11} mode becomes available. The critical diameter required for monomodal operation is:

$$D_{crit} = \frac{2.4\lambda}{\pi\,[NA]} \qquad [15]$$

Because the monomodal cable potentially reduces the number of available modes, it also reduces intermodal dispersion. Thus, the monomode fiber is capable of extremely high data rates or analogue bandwidths.

Next month...

In the second and final instalment of this article we will take a look at losses in fiber optic systems, fiber optic communications and some of the basic driver and receiver circuits needed to make fiber optics work. ❑

Reference:

1. "Optical-fibre communication" *Elektor Electronics* February 1991.

CORRECTIONS

Wattmeter

April 1991, p. 32-35

With reference the circuit diagram, Fig. 1, the right-hand terminal of the lower section of switch S2 should be connected to the circuit ground. This point is indicated by a dot.

In the adjustment procedure given on page 35, the references to presets P4 and P5 have been transposed. Contrary to what is stated, P4 sets the VY offset, and P5 the VX offset. The functions of the presets are shown correctly in the circuit diagram, Fig. 1.

To improve the accuracy of the instrument, connect R5 direct to the circuit ground instead of junction R6-R7. Finally, all circuit board tracks carrying mains current must be strengthened with 2.5-mm^2 cross-sectional area solid copper wire if currents higher than about 5 A are measured.

80C32/8052 Single-board computer

May 1991, p. 17-23

When a CPU type 8031 or 8052AH-BASIC is used, IC1, IC2, IC3, and IC8-IC12 must be 74HCT types. Jumper B is erroneously reffered to as Br2 in the text under "On-board EPROM programmer". Contrary to what is stated, this jumper must be fitted only when an EPROM is to be programmed — for all other use of the SBC, it must be removed. Also note that jumper B may only be fitted when the programming LED is out.

Sequential control

July/August 1991, p. 61

Motor M should be a d.c. type, not an a.c. type as shown in the circuit diagram.

Digital phase meter

June 1991, p. 32-39

In Fig. 5, the switch between input 'A' and IC1 should be identified 'S1', and that between input 'B' and IC2 'S2'. Switch S4 is an on/off type, not a push-button as shown in the diagram. Capacitors C3 and C6 are shown with the wrong polarity. The component overlay of the relevant printed-circuit board (Fig. 8) is all right.

Universal NiCd battery charger

June 1991, p. 14-19

The parts list on page 19 should be corrected to read

C7 = 2200µF 25V

When difficult to obtain, the BYW29/100 (D5) may be replaced by the BY229, which is rated at 6 A.

The text under the heading 'Calibration' should be replaced by:

4. Connect a multimeter between points G and H on the board, and adjust P4 until the measured voltage is 1 V lower than the voltage on the battery terminals.

MIDI program changer

April 1991, p. 14-17

The contents of the EPROM should be modified as follows:

address	data
OOBC	E5
00C7	80
00C8	CB
00C9	F5
00CA	7B
00CB	12
00CC	00
00CD	D2
00CE	C2
00CF	02
00D0	80
00D1	C2

Readers who have obtained the EPROM ready-programmed through the Readers Services may return it to obtain an update.

Electronic exposure timer

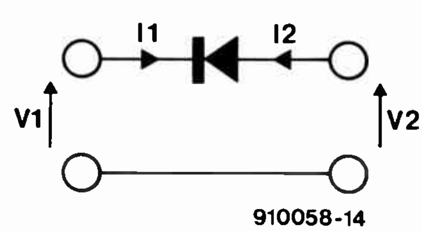
March 1991, p. 31-35

Please add to the parts list on page 32:
C16 = 33 pF

Augmented A-matrices

May 1991, p. 42-43

The drawing below was erroneously omitted in the left-hand bottom corner of page 43.



MEASUREMENT TECHNIQUES – PART 6

Faultfinding in analogue circuits

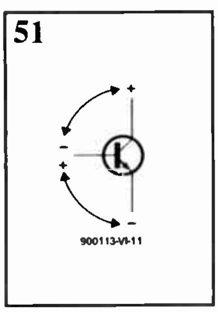
by F.P. Zantis

Voltage analysis

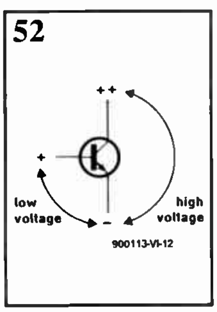
If a circuit ceases to function and it shows no visible damage, a voltage analysis should be the first step in locating the fault. Voltages can normally be measured without the need of breaking connections or the removal of components. The level and polarity of a voltage are two aspects that indicate the state of a component or circuit. Because of that, many circuit and wiring diagrams give the voltage level and polarity at important junctions. Such indications are a great help in faultfinding, but even without them, the voltage at many points in a circuit is known. For instance, the potential across a p-n junction of a diode or the base-emitter junction of a transistor should be 0.2–0.4 V (germanium) or 0.6–0.8 V (silicon).

Polarity, too, may be an indication whether a single semiconductor is defect or not. For example, in the case of an n-p-n transistor with correctly set operating point, the base is always positive with respect to the emitter and negative with respect to the collector—see Fig. 51. If the emitter voltage is taken as reference, the base potential should be +0.20.6 V, while the collector should have a much larger positive potential—see Fig. 52. These polarities are reversed in p-n-p transistors.

51



52

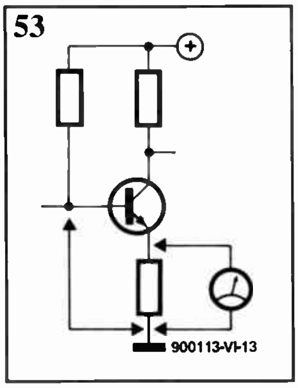


If the measurements do not accord with what has been said, either the transistor itself or a component determining its operating point may be defect. Note, however, that there are applications in which, for instance, the base of an n-p-n transistor is purposely negative with respect to the emitter.

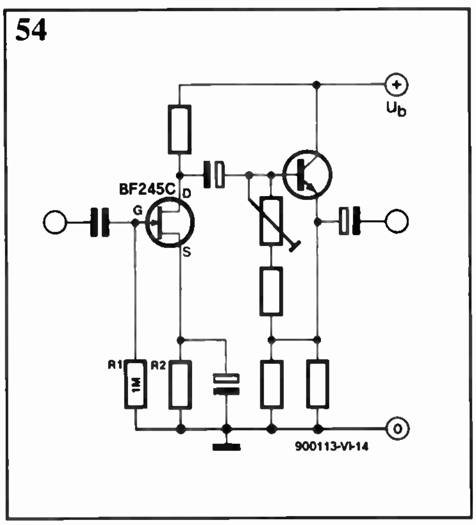
Usually, the collector current decreases when the base-emitter voltage is reduced, while the collector-emitter voltage rises. A simple test is, therefore, measuring the collecttor-emitter voltage and, while the equipment is on, short-circuiting the base-emitter junction.

If there is a resistor in the emitter circuit, the voltage across that may be measured—see Fig. 53—while the base is short-circuited to ground; the collector current will then drop to zero. Consequently, the voltmeter will show a large reduction in the potential drop across the emitter resistor.

53

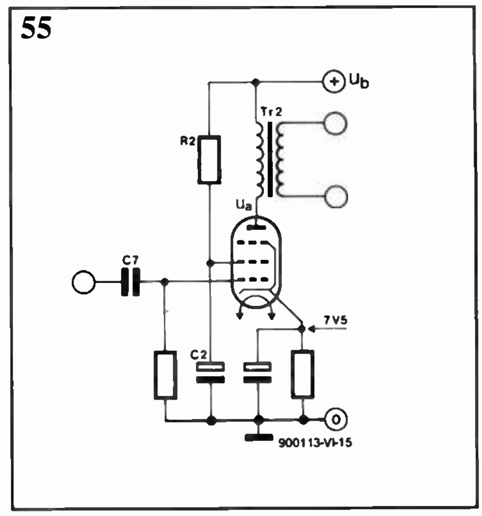


54

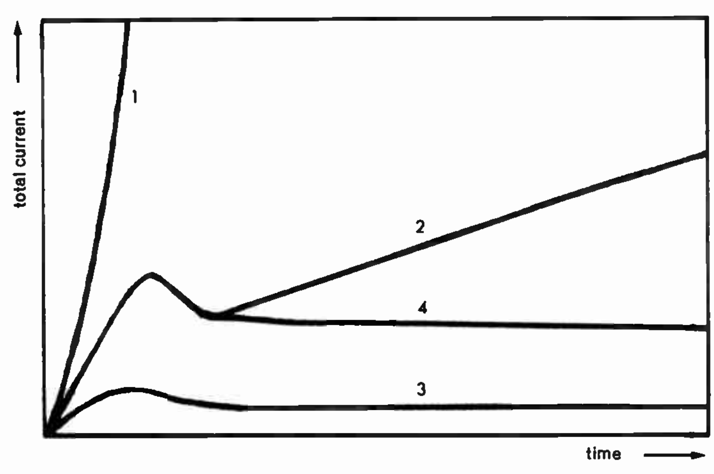


Similar measurements may also be carried out on field-effect transistors—FETs—but in these the correct interpretation of the various voltage ratios is rather more difficult owing to the large number of different types (although there are only six basic types). The most frequently encountered type is the n-channel, insulated-gate FET, shown in a typical circuit in Fig. 54. Taking the source (S) terminal as reference, there should be a small negative voltage at the gate (G) and a large positive voltage at the drain (D). If the circuit ground is taken as reference, there should be no voltage at the gate, since no current flows through gate resistor R_1. If the circuit of Fig. 54 is in actual operation, it should be borne in mind that the measurements

55



56



greatly reduce the input impedance of the circuit and thus affect the circuit.

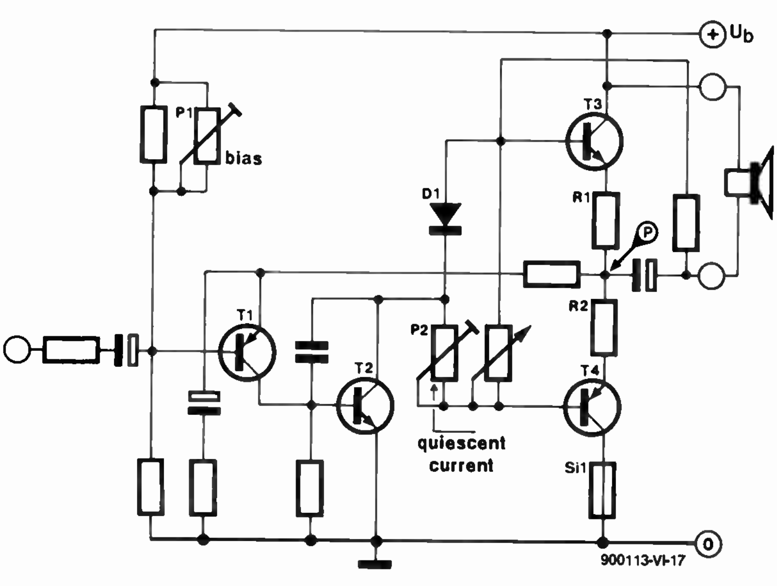
For voltage measurements in a valve circuit as shown in Fig. 55, ground is taken as the reference. The full supply voltage, decoupled by R_2 and C_2, should exist at the screen grid. Owing to the drop across the d.c. resistance of the output transformer, the voltage at the anode will be slightly smaller than that at the screen. The usual voltage at the cathode is 3–8 V. There should be no discernible voltage at the signal grid; if there, is, either the valve or capacitor C_7 is defect.

Current analysis

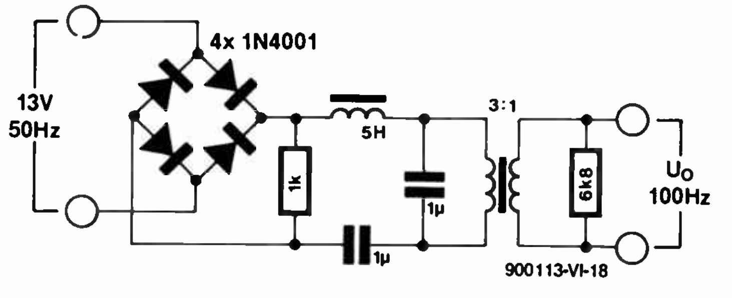
Current measurements normally mean breaking connections, involving time and effort, and are, therefore, normally only carried out when voltage analysis has failed to come up with an answer. There are, of course, circuits that facilitate current measurements by the incorporation of special wire bridges that are easily removed, or even of the plug-in type. Battery connections are often easily broken at the battery. Fuses also provide an easy means of measuring current.

Figure 56 shows the results of some current measurements in an audio amplifier. If the current rises sharply immediately the amplifier is switched on—curve 1—the cause is almost certainly a short-circuited output transistor. Curve 2 possibly indicates incorrect stabilization of the operating point or a defect regulator in the mains supply. If the current remains at a steady low level, the fault is normally an open connection (often in the output transistor circuit—curve 3. The correct current is indicated by curve 4: initially it rises sharply but soon tails off to its normal level.

57



58



Bias setting

Examples of both voltage and current analysis will be given on the basis of setting the bias voltage in an audio output stage with feedback—see Fig. 57. The potential at point P, with respect to earth, must be half the supply voltage, U_b, and this is set accurately with the aid of P_1. The quiescent direct current is set with P_2.

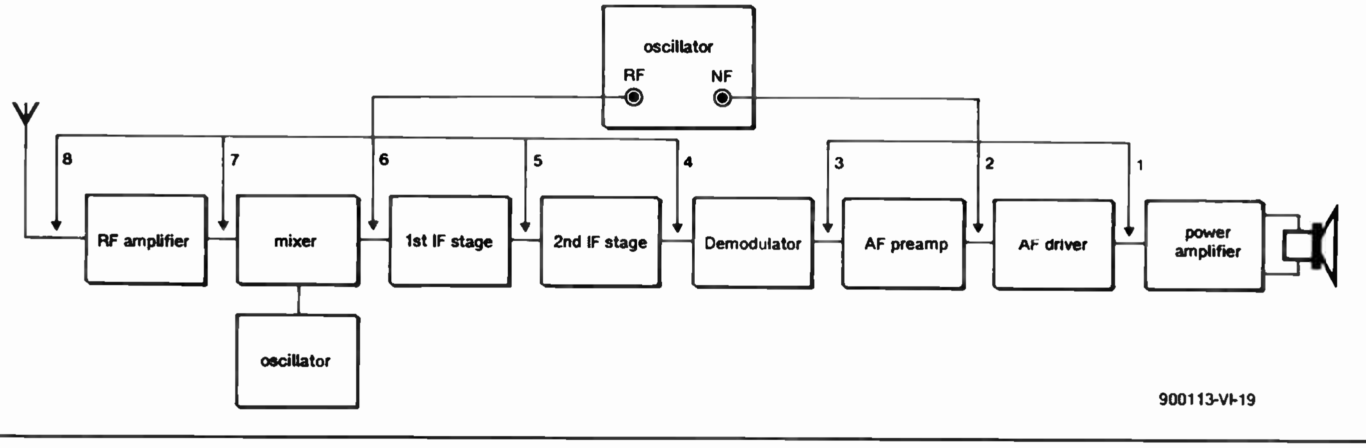
The quiescent current is measured by replacing fuse F by an ammeter or by measuring the voltage across R_1 or R_2. In the first case, the current may be read directly on the ammeter, while in the second case it is calculated according to Ohm's law. In direct current measurements, the internal resistance of the ammeter will affect the readingt. The meter resistance in voltage measurements may be ignored, since it is much smaller than the value of either R_1 or R_2. The voltage is fairly small: 100–300 mV. It is advisable, before starting the measurement, to calculate the approximate voltage level, then measure it on the correct meter range, and finally adjust the potentiometer. If, for instance, both R_1 and R_2 are 0.82 Ω, and the required quiescent current is 50 mA, the voltage across either resistor should be 41 mV. The voltmeter should thus be set to the 100 mV range.

Resistance analysis

Resistance analysis is used in faultfinding when the fault has already been isolated by voltage or current analysis. It is, of course, also useful if the equipment can not be switched on during faultfinding.

In valved equipment, whole sections may be examined for short circuits, open circuits or leakage. This is normally not possible in solid-state circuits, since the internal resistance of semiconductors is invariably low and, moreover, its value varies according to the polarity of the meter. Before the power to a section of a circuit is switched on, it is

59



strongly advisable to check with an ohmmeter that there are no short circuits in either the components or the connecting wires or tracks in case of a PCB.

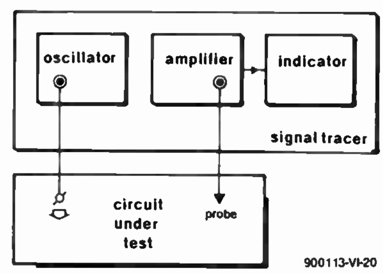
Signal tracing

A fault in a multi-stage audio amplifier is rapidly tracked to a particular stage with the aid of a signal applied to each stage individually or to the input and traced through the amplifier.

In the first case, a signal from an a.f. signal generator, or from a circuit as shown in Fig. 58, is applied first to the output stage and the output measured. If that is all right, the signal is applied to the driver stage(s) and the output checked. In this way, the signal is applied to the various stages backwards from the output, until the faulty stage is found.

The signal may also be applied to the input of the amplifier and then traced from

60



the input onwards to the output. That stage which does not process the signal correctly, or not at all, is the faulty one.

All further faultfinding can now be concentrated on the faulty stage.

These methods of faultfinding may also be used in r.f. and i.f. amplifiers, but an appropriate r.f. or i.f. signal generator must then, of course, be used for the stages preceding the audio section—see Fig. 59.

As before, signal tracing is carried out from the input onwards. The input may be the first stage of an a.f. amplifier or the antenna input of a radio or television receiver. The output of each successive stage must then be inspected; this may be done with the aid of headphones in an audio amplifier. A sudden disappearance, distortion or attenuation of the signal at the output stage will indicate a faulty stage. If faultfinding is carried out frequently, it is advisable to obtain a signal tracer, which replaces a fairly expensive a.f. or r.f. generator and millivoltmeter. The principle of such an instrument is shown in Fig. 60—see also Ref. 1. (900113-VI)

References

"LF/HF Signal Tracer", *Elektor Electronics*, December 1989, pp. 20–23.

ASYMMETRICAL-TO-SYMMETRICAL CONVERTER

by M. Eller

IT OFTEN happens in electrophonics (electronic music) that hum-and-noise loops occur when two or more different instruments are intercoupled as in Fig. 1a. Some musicians play with their lives by covering the earth pins with insulating tape to get rid of the hum. This is, of course, not only very stupid, but also highly dangerous.

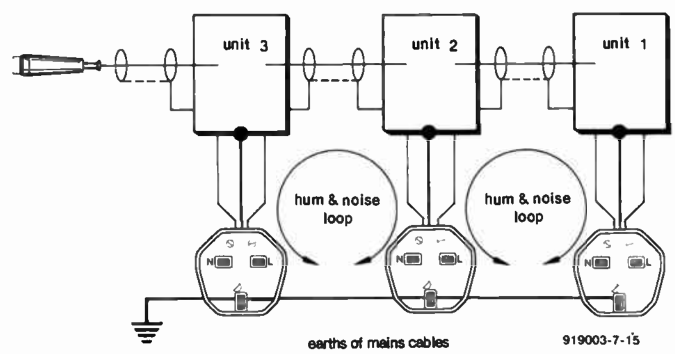
A safe and certain method of getting rid of these loops is offered by the converter whose circuit is shown in Fig. 2. The converter is connected between two instruments as shown in Fig. 1b to provide electrical separation of the instruments. Make sure that the 'isolated' instruments are not drawn into new hum-and-noise loops through a common enclosure: each and every instrument must be isolated from the enclosure.

The converter resolves another problem also. On cost grounds, many commercial instruments have only a relatively high impedance output. Even pick-ups often suffer from this. When long connecting leads are used, or the signal is divided, or a following instrument has a low impedance input, noise and hum are the result and the quality of the music suffers. The converter has a high impedance input, and two low impedance outputs (one not isolated).

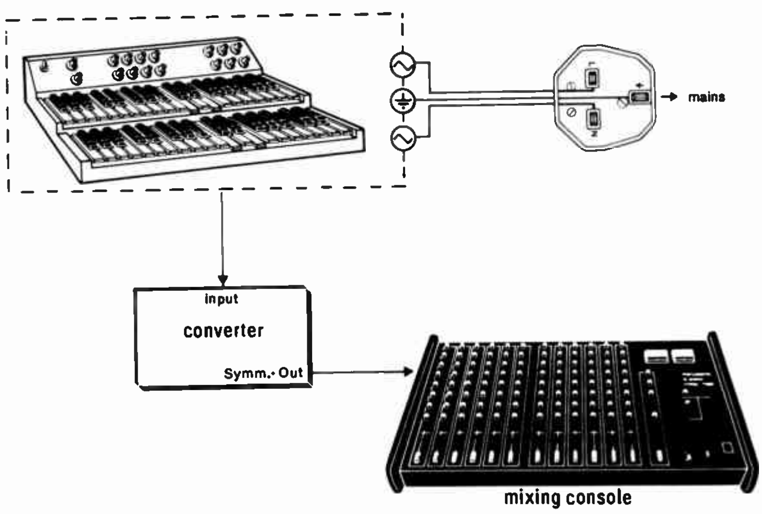
Circuit description

The input signal arrives at K_1 and from there it is applied via C_5 to IC_2, which is arranged

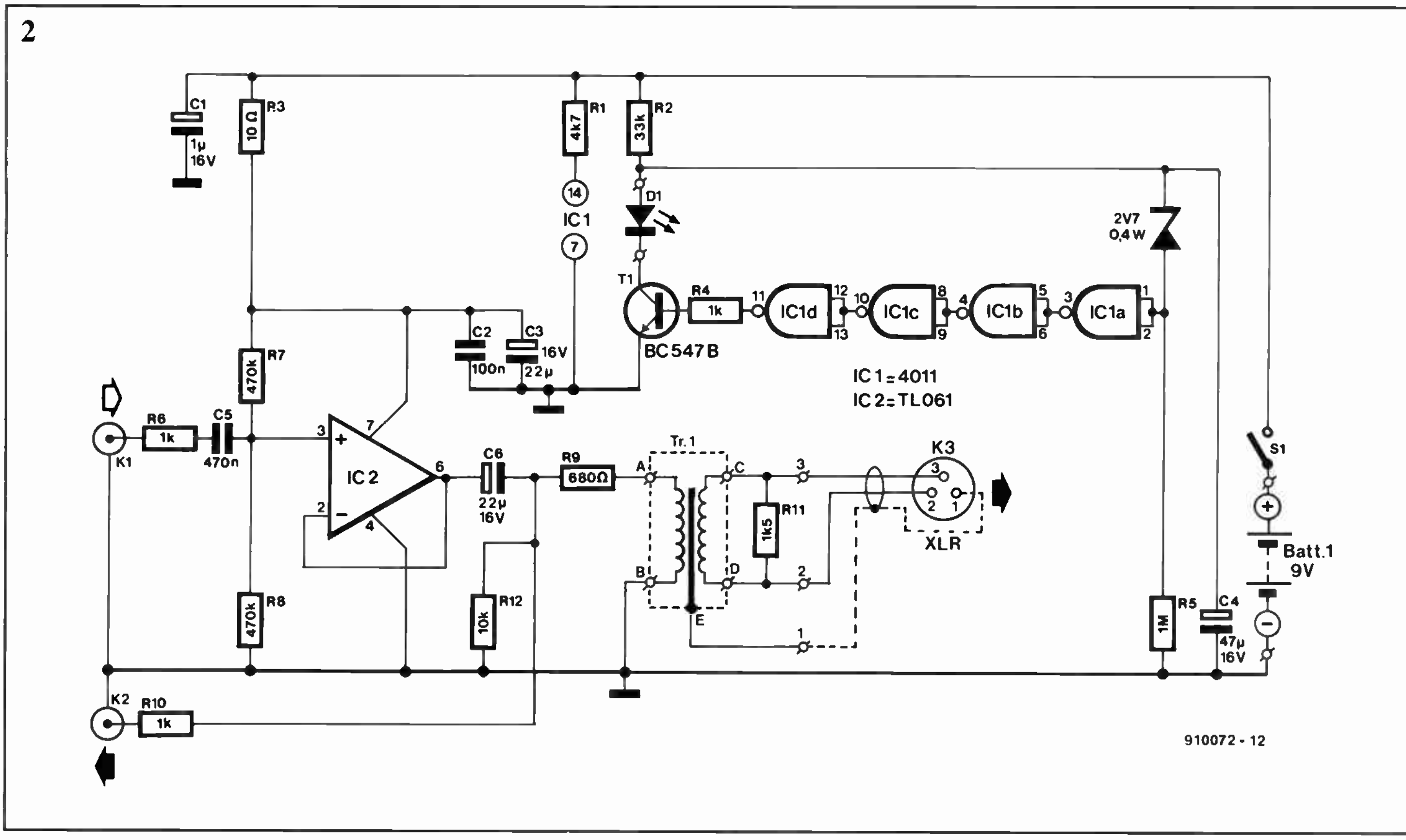
1a



1b



2



as an impedance converter. The TL 061 was designed specially for use in battery operated circuits. Its input impedance is determined by R_7 and R_8.

The output of IC_2 is taken via C6 to K2, which is the non-isolated output that may be used, as in Fig. 3, as the input to an amplifier.

The output of IC2 is also taken via R_9 to the heart of the converter: transformer Tr1, which must

- operate from a 600 Ω source;
- have a transformation ratio of 1:1;
- have a linear frequency response over the range 20 Hz to 20 kHz;
- be able to handle signal levels of 600 mV+.

These characteristics are met by a number of available commercial types; final choice depends on the operational requirements. The size of the transformer core determines the undistorted signal level at low frequencies: the larger the core, the better the performance, but, unfortunately, also the higher the price and the size of the converter.

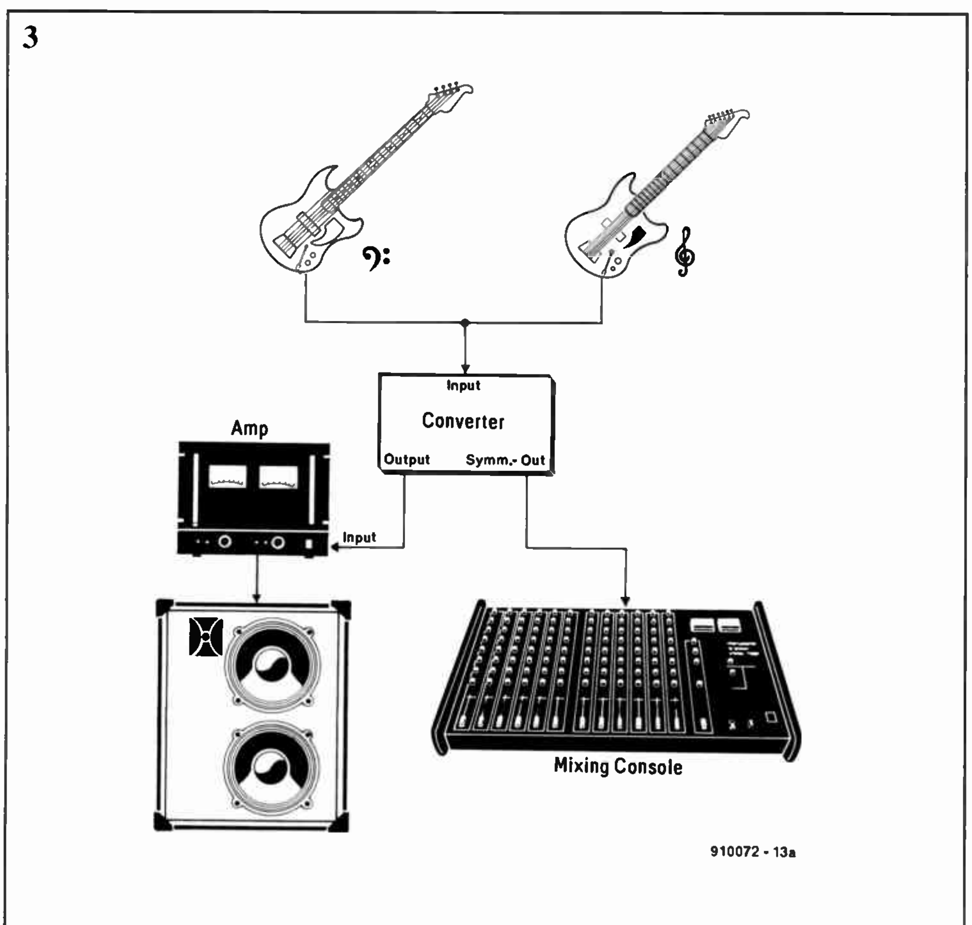
Low-frequency distortion may be reduced by increasing the value of R_9, but this will be to the detriment of the signal level.

Normally, the LED is connected to the supply line via a series resistor. It then draws a current of about 10–20 mA, which is too much for battery operation. The gate-chain, contained in IC_1, reduces this to about 1% of these values. When S_1 is closed, C_4 is charged slowly via R_2 until D_2 conducts. There is then a high at the input of the gate-chain, which is repeated through the four gates, whereupon it switches on transistor T1, resulting in the LED lighting. Since the value of R_2 is too high for the LED current, the diode draws its energy from C_4.

After a while, the voltage across C_4 becomes too low to energize the LED, whereupon zener diode D_2 switches off and the logic levels at the gates are reversed. The circuit is once again in the output state, until C4 has been charged anew. The LED will flash in a rhythm determined by time constant R_2-C_4.

Resistor R_1 also serves to conserve energy by reducing the current drawn by IC_1 and changing the switching threshold from low to high. These measures ensure that a 9 V battery(PP3) gives roughly 400 hours operation. The average current drain at full drive is about 1 mA. The battery should be replaced when its voltage under load drops

3



below 6 V.

Construction of the converter is straightforward if the printed-circuit board shown in Fig. 4 is used. As mentioned earlier, make sure that the converter is fully isolated when it is used in a common enclosure. ■

PARTS LIST

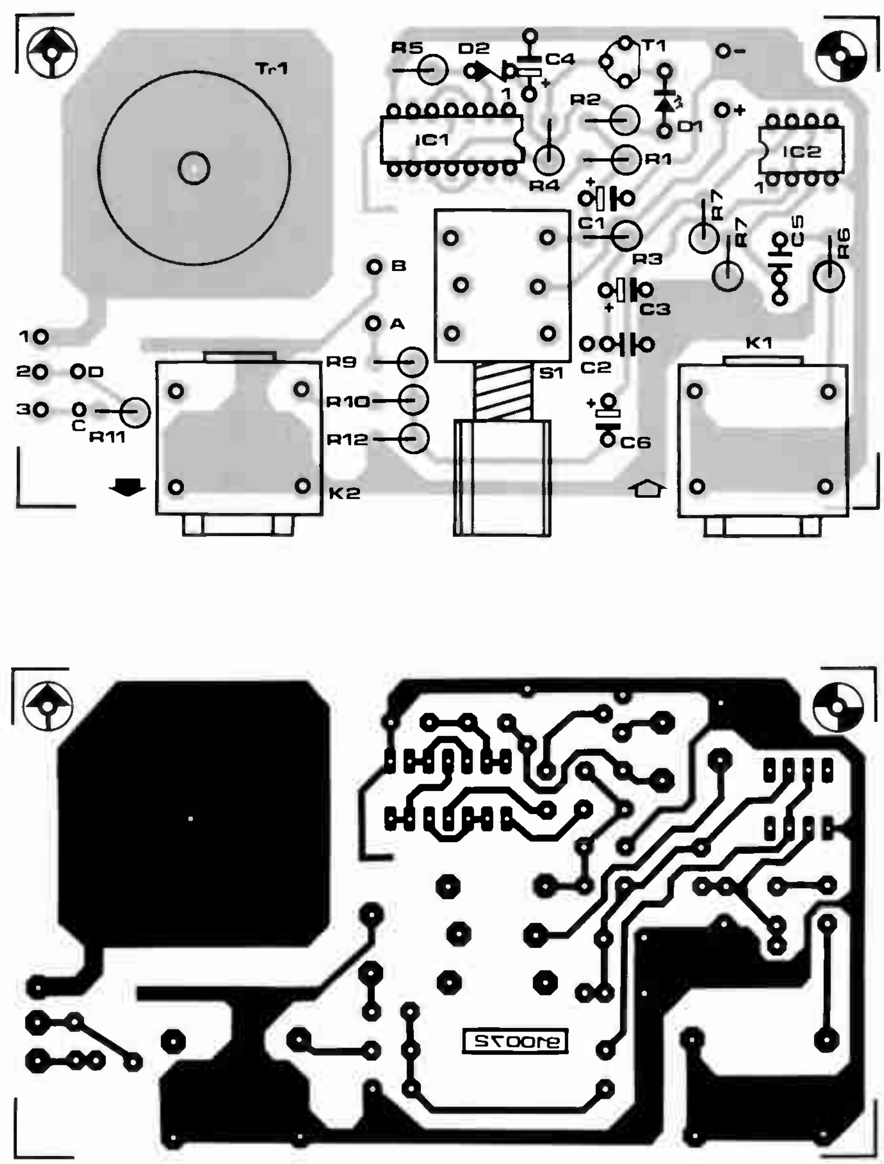
Resistors:
R1 = 47 kΩ
R2 = 33 kΩ
R3 = 10 Ω
R4, R6, R10 = 1 kΩ
R5 = 1 MΩ
R7, R8 = 470 kΩ
R9 = 680 Ω
R11 = 1.5 kΩ
R12 = 10 kΩ

Capacitors:
C1 = 1 µF, 16 V, radial
C2 = 100 nF
C3, C6 = 22 µF, 16 V, radial
C4 = 47 µF, 16 V, radial
C5 = 470 nF

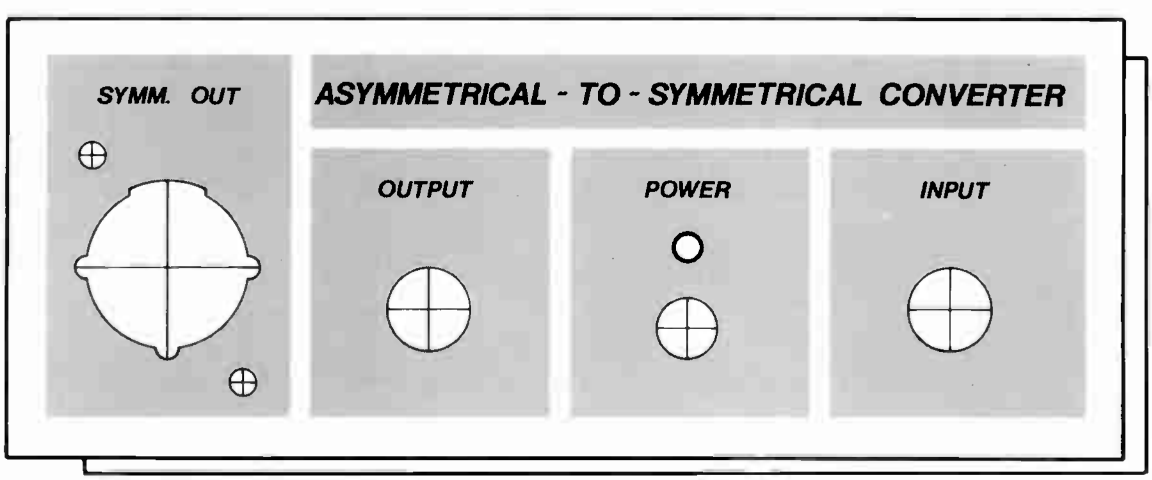
Semiconductors:
D1 = LED for chassis mounting
D2 = zener, 2.7 V, 400 mW
T1 = BC547B
IC1 = 4011
IC2 = TL061

Miscellaneous:
S1 = SPST switch
K1, K2 = 6.3 mm audio socket for panel mounting, mono, insulated
K3 = XLR socket for panel mounting
Batt.1 = 9-V battery (UK: PP3)
Tr1 = 600 Ω transformer – see text
Enclosure to personal requirements
PCB 910072
Front panel foil 910072-F

4



5



910072-F

APPLICATION NOTES

The contents of this article are based on information obtained from manufacturers in the electrical and electronics industry and do not imply practical experience by *Elektor Electronics* or its consultants.

REMOTE CONTROL ICs MV500 AND MV601 (Plessey Semiconductors)

TWO integrated circuits from Plessey, the MV500 transmitter and the MV601 receiver, allow remote control systems to be built from a minimum of components. The two ICs have been used already in a number of projects carried in this magazine (Refs. 1, 2). The infra-red remote controls described there are reliable, marked by low cost, a low component count, and the absence of quartz crystals and adjustable inductors. Note, however, that the MV601 receiver requires one IC, an SL486, to be added when used to build an infra-red remote control system.

Data coding and transmission

The inputs of the transmitter are supplied with the information to be conveyed to the receiver. This information is provided in parallel form by, for instance, a keyboard. As shown in Fig. 1, the parallel data is transmitted serially. The transmit operation is initiated by a start pulse with a synchronization pause, after the key debounce time, t_d. Then follow the five databits. The data packet is transmitted as long as the key is pressed. When the key is released, the data packet is always completed,

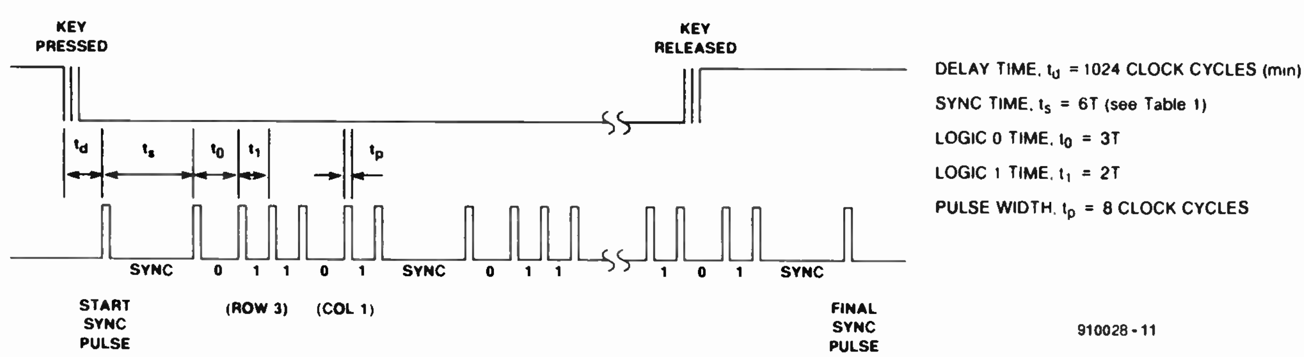
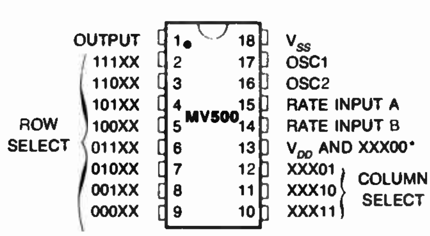


Fig. 1. Pulse/pause modulation applied in the MV500 transmitter.



*Via resistor

DP18, MP18

ABSOLUTE MAXIMUM RATINGS

Supply voltage	−0.5V to 11V
Input voltage (all pins)	−0.5V to VDD + 0.5V
Operating temperature range	0°C to +70°C
Storage temperature range	−55°C to +125°C

ELECTRICAL CHARACTERISTICS

Test conditions (unless otherwise stated)

T_{amb} = 0°C to 70°C, V_{DD} = +3V to +10.5V

Characteristic	Pin	Value Min	Value Typ	Value Max	Units	Conditions
Operating supply current	13		0.5	2	mA	Circuit fig 4
Standby supply current	13		0.3	2	µA	All inputs open circuit V_{DD} = 9V, T_{amb} = 25°C
Output source current	1	50	100	200	mA	V_{DD} = 6V, V_{OH} = 1V
		10	25	50	mA	V_{DD} = 3V, V_{OH} = 1V
Keyboard contact resistance	2-12					
Closed		0		20	kΩ	
Open		100		∞	kΩ	
Oscillator Frequency	16,17	400		1000	kHz	

910028 - 12

Fig. 2. Main data and pinning of the MV500 transmitter.

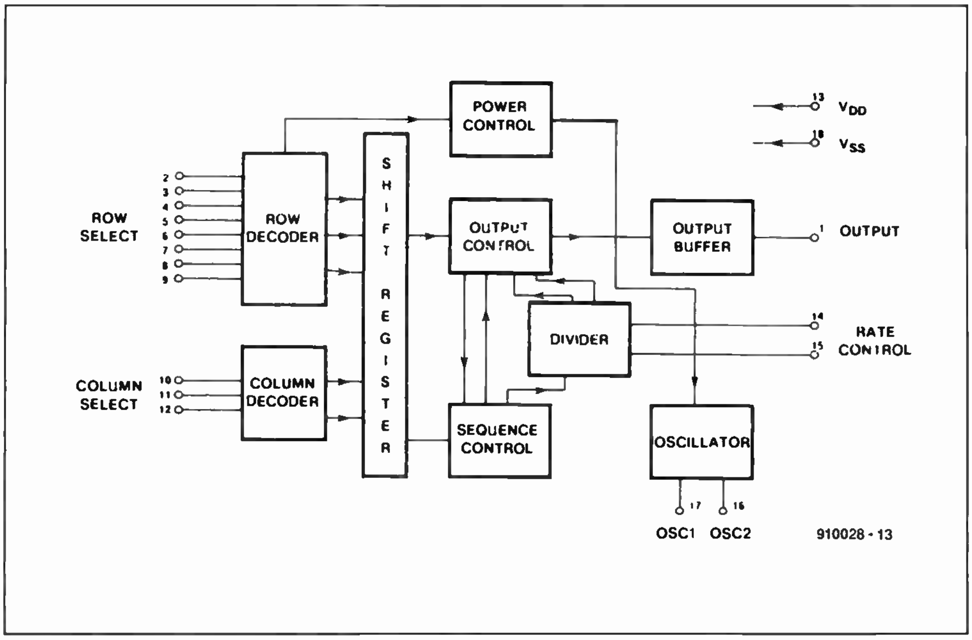


Fig. 3. Internal diagram of the MV500.

Table 1. Transmission rate settings

A	B	clocks	t_1	t_0	t_3
0	0	outputs disabled			
0	1	2048	4096	6144	12288
1	0	1024	2048	3072	6144
1	1	512	1024	1536	3072

and a stop pulse is affixed.

The modulation of the information carrier (i.e., infra-red light) is based on pulse/pause (mark/space) modulation. This means that the five databits and synchronization bits are encoded by means of their length ('mark') and the position of the pauses ('space'). A short pause of two times the bit transmission rate, T, indicates a logic 1; a slightly longer pause of $3T$ indicates a logic 0; and a pause of $6T$ indicates synchronization (see Fig. 1). In this system, the logic levels are thus determined by the length and the position of the pauses in the serial datastream. The pulses serve no other purpose than to set the pauses apart, and can, therefore, be relatively short (t_p=17 µs) and of a fixed length.

As compared with pulsewidth modulation, the pulse/pause encoding system is less susceptible to interference, and more efficient in regard of battery power—the average current drawn by the actuated transmitter is smaller than 10 mA.

The length of the pauses is not constant, not even when they have the same logic content. This is caused by the three transmission rates, A, B, or A+B, that can be set on the transmitter and the receiver. The use of different transmission rates on transmitter/receiver sets allows up to three remote control systems with 32 channels each to be used in one room. This gives a total of no fewer than 96 remotely controlled channels.

Transmitter MV500

The most essential information on the MV500 remote control transmitter is given in Figs. 2 and 3. IC pins 2 to 12 form the channel selection inputs, which allow up to 32 channels to be used with the aid of a (switch-) matrix of 8 rows and 3 columns. A shift register converts the parallel information into a serial datastream. A sequence control block in the MV500 operates together with the output control to ensure the correct pause position and timing. The required transmission rate is set at pins 14 and 15. When both inputs are made logic low, the IC is disabled. The clock frequency is furnished by a oscillator that operates with an external ceramic resonator (fundamental resonance frequency between 400 kHz and 1 MHz; max. tolerance 5%).

As shown in the diagrams, the power control block is connected to the row decoder. In quiescent mode, the associated inputs are held at ground potential. The oscillator is then disabled, and the IC is switched to its power-down state in which the current consumption is reduced to 2 µA or so. On detection of a high level at one of the column decoders, the power controller actuates the entire IC, and the transmitter starts to operate (provided, of course, one of

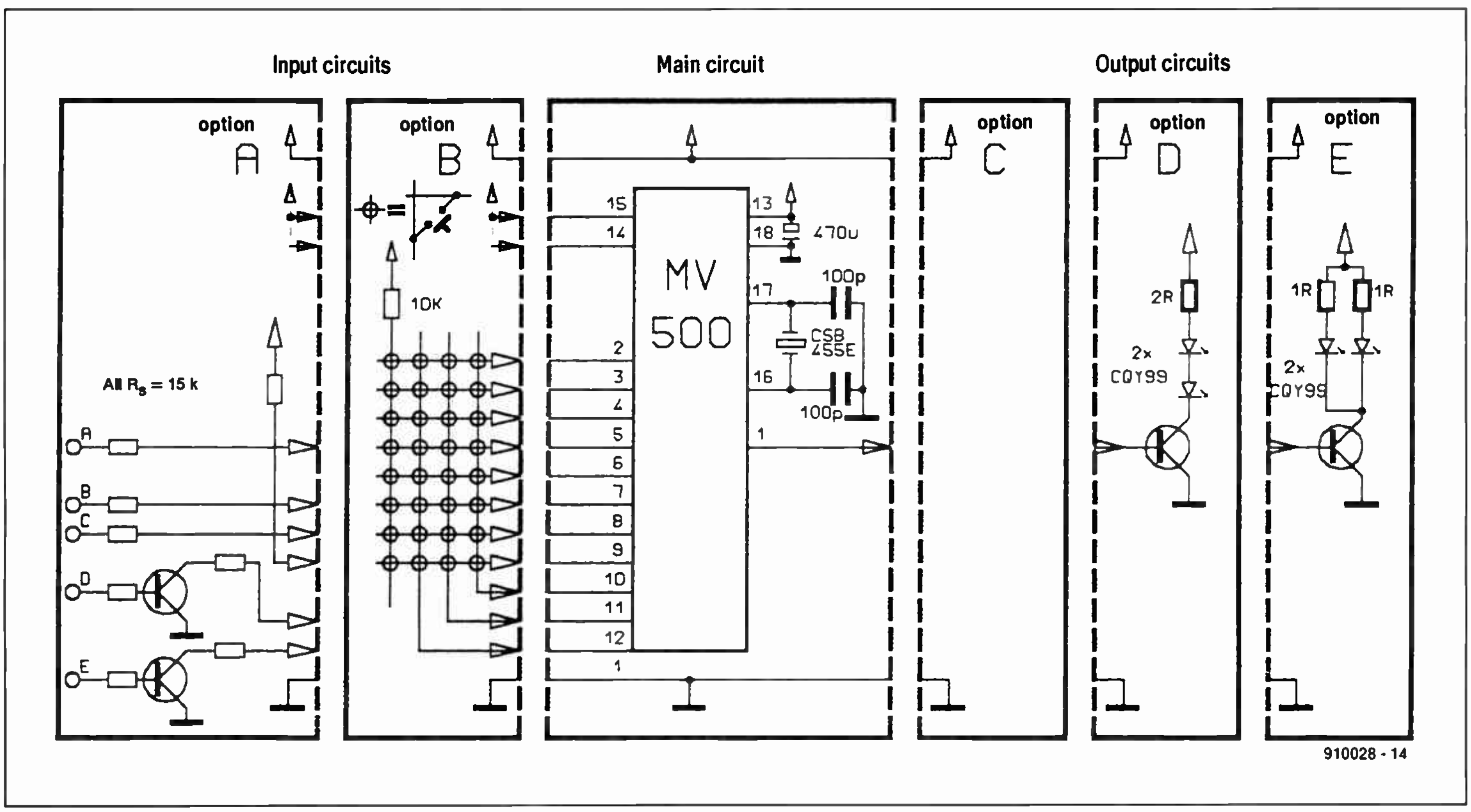
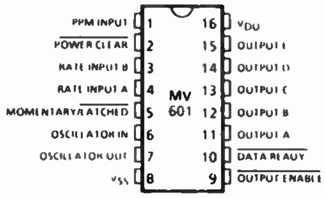


Fig. 4. Options for the input and output circuitry of the MV500.



DP16

ABSOLUTE MAXIMUM RATINGS

Supply Voltage V_{DD}	+7V
Input Voltage	V_{DD} + 0.3V to V_{SS}-0.3V
Operating Temperature	0°C to +70°C
Storage Temperature	-55°C to +125°C
Output Sink and Source Current	50mA
Humidity	85%

ELECTRICAL CHARACTERISTICS
Test conditions (unless otherwise stated)
T_{amb} = 0°C to 70°C, V_{DD} = +4.5V to +5.5V

Characteristic	Pin	Value			Units	Conditions
		Min	Typ	Max		
INPUTS						
OSCIN, RATE A, RATE B,	6, 4, 3,					
MOM / LAT, OEN	5, 9					
Input low voltage (V_{IL})				V_{DD} / 3		
Input high voltage (V_{IH})		VDD x 2/3				
PPM, CLEAR	1, 2					
Input low voltage (V_{IL})				1.0	V	VDD = 5.0V
Input high voltage (V_{IH})		2.0			V	
Threshold voltage rising			1.85		V	
Threshold voltage falling			1.05		V	
CLEAR, RATE A, RATE B	2, 4, 3					
Input low current			-33	-100	µA	Nom 150K pullup resistor
All other inputs except OSCIN Input current	1, 5, 9			±2.5	µA	V_{IN} = Vss -0.3V to V_{DD} +0.3V
OSCIN	6					
Input current				±10	µA	V_{IN} = Vss -0.3V to V_{DD} +0.3V
OUTPUTS						
A - E, DATA READY						
Output low current (sink)		13	26		mA	V_{OL} = 0.4V
Output high current (source)		-21	-45		mA	V_{OH} = 2.4V
Output leakage current (A-E)				±10	µA	VO V_{SS} -0.3 to V_{DD} + 0.3V pin 9 = V_{DD}
OSCOUT						
Output low voltage (sink)		1.0			mA	V_{IO} = 0.3V
Output high current (source)		-1.0			mA	V_{OH} = V_{DD} 0.3V

910028-15

Fig. 5. Main data and pinning of the MV601 receiver.

the transmission rate inputs is made logic high; otherwise, the IC remains off).

The main application circuits of the transmitter are given in Fig. 4. As already mentioned, very few external parts are required — the basic circuit works with an inexpensive ceramic resonator and two capacitors.

In principle, there is a choice between two types of input circuit. Of these, the most frequently applied is probably a keyboard matrix (option B). Alternatively, the code to be transmitted may be supplied by a computer or another digital circuit (option A).

When the inputs are connected to an 8×4 matrix (option B), the 5-bit parallel code is composed from bits A, B and C supplied by the row decoder, and bits D and E supplied by the column decoder. Note that bits D and E must be inverted because the relevant IC inputs, pins 11 and 12, are active low. The other data inputs, pins 2 to 9, are active high.

At the output of the MV500, the encoded serial data is modulated on to a carrier. In its simplest form, this carrier may be a direct voltage on a wire connected to pin 1. Add the ground wire to the receiver, and you have a simple 2-wire remote control system (option C). Note, however, that this arrangement requires the transmitter to operate at 5 V, i.e., at the same supply voltage as the receiver. For wireless control, the choice of infra-red light as the carrier is obvious. Since the output of the MV500 is not capable of driving an infra-red emitter diode direct, we need to insert a power driver. To increase the range of the transmitter, the IR beam emitted by the diode can be made narrower by fitting the device with a small reflector or, to achieve even greater directivity, a small lens. The current limiting resistor may be omitted when the full transmit power is called for. Note, however, that this increases the current drain, and shifts the operating point of the IR diode beyond that of maximum efficiency. Remember, the peak current through the IR diode can be as high as 2 A, although this current flows for a couple of microseconds only. The IR diode shown in the circuit diagram is a type with a peak pulse current of 2.5 A. Options D and E show suggested circuits for use with a 9-V battery block and a 5-V power supply respectively.

Receiver MV601

Figures 5 and 6 fill you in on the receiver IC, the MV601. The serial data applied to the input of the IC are converted into parallel to give an exact copy of the encoded data at the transmitter side. The block marked 'Noise

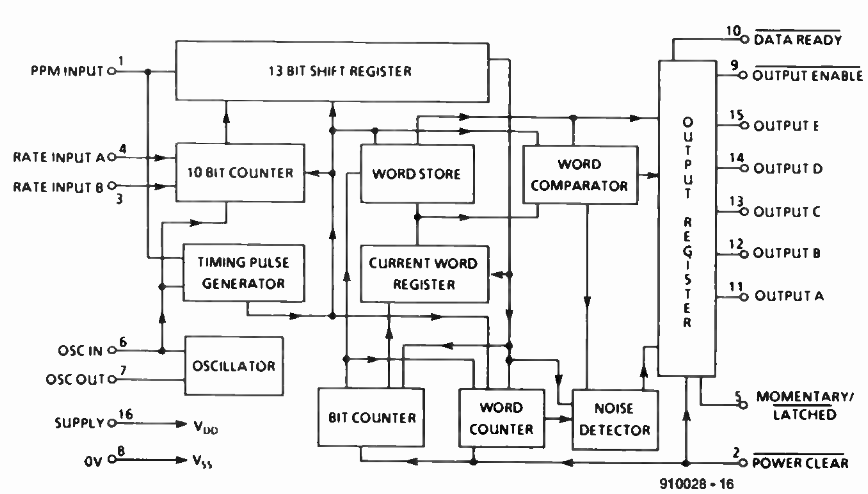


Fig. 6. Block diagram of the MV601.

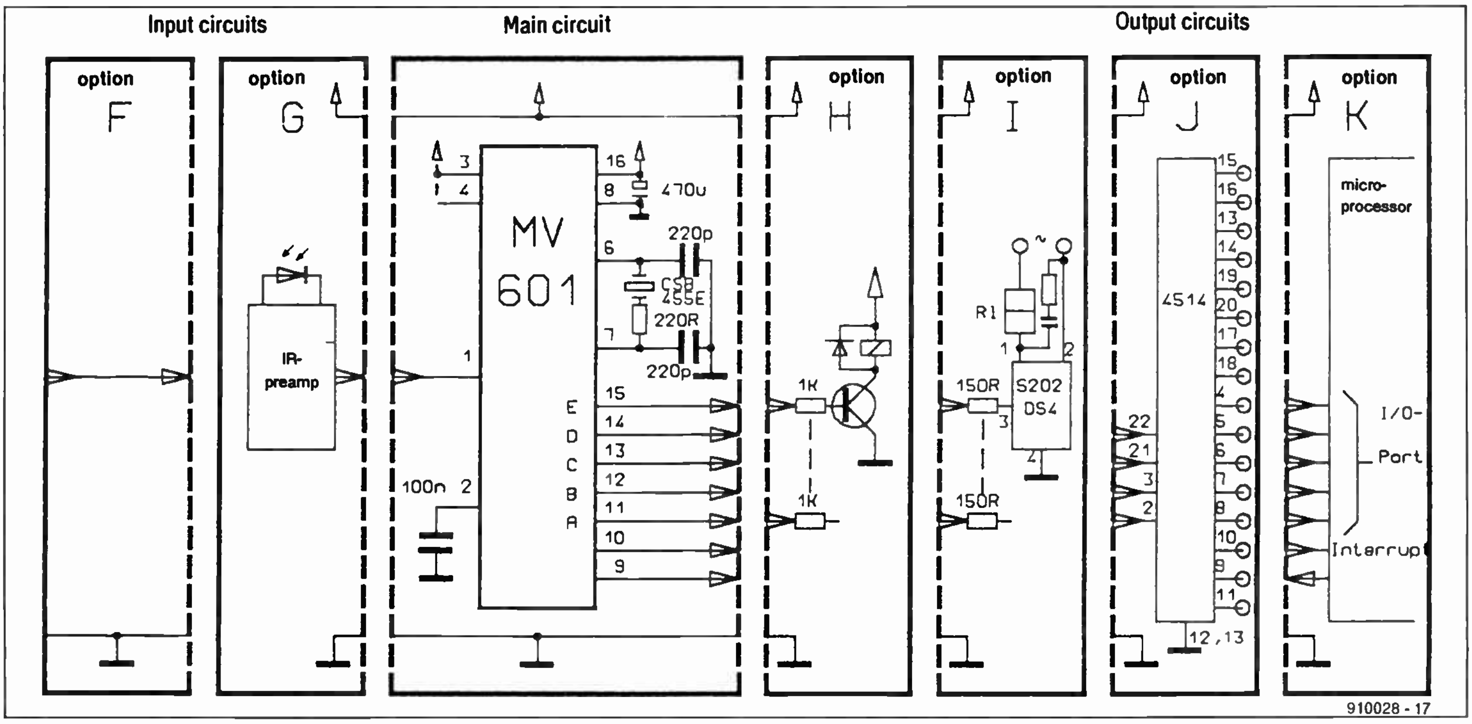


Fig. 7. Application options of the receiver.

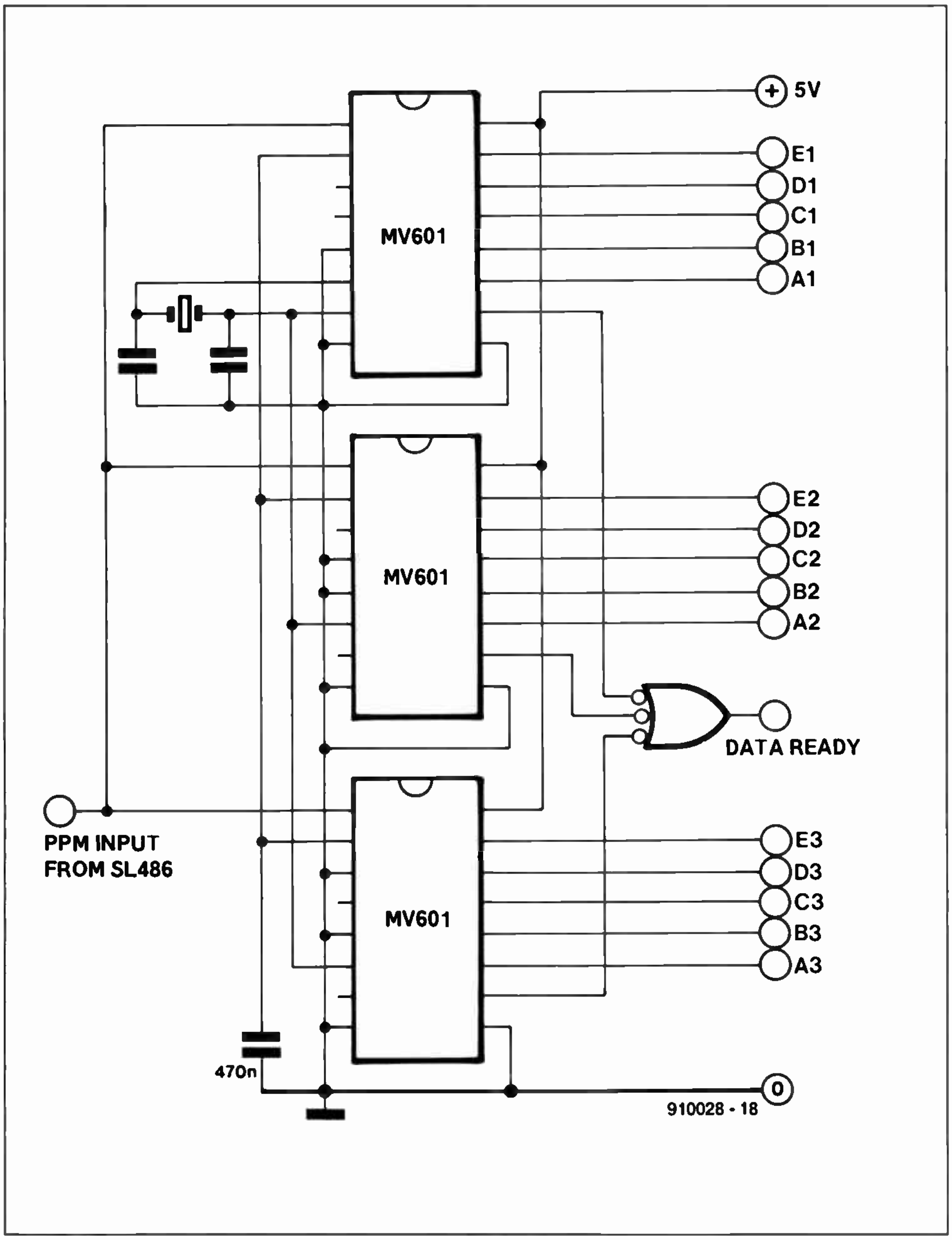


Fig. 8. 96-channel remote control extension.

Detector' is capable of recognizing and suppressing interference. Similar to that in the transmitter, the clock is provided by an oscillator. After being processed in a number of latches, counters and timers, the data are fed to the output latch, and from there to the IC output pins, A-D, pins 11-15. Each latch output can source 45 mA and sink 26 mA. The internal timers and the output latch may be reset with the aid of a low pulse at the POWER CLEAR input (pin 2). This input is connected to an on-chip 150-kΩ resistor, so that a single capacitor is sufficient to achieve automatic resetting of the IC on power-up.

The logic level applied to the MOMENTARY/LATCH input, pin 5, determines whether the data are kept in the latch (level = 0), or erased (level = 1) when there is no valid code at pin 1. When the OUTPUT ENABLE pin is made low, the dataword is fed to the IC outputs. A high level switches pins 11 to 15 to the high-impedance state. This allows the outputs of two or more MV601s to be connected to a databus. The DATA READY output goes low when a valid word is present.

The main application options of the MV601 are shown in Fig. 7. Like the transmitter, the receiver contains a small number of components only — the simplest application circuit works with a single ceramic resonator and two capacitors. A resistor may be connected in series with the resonator to ensure resonance at the fundamental frequency.

Depending on the transmitter configuration, there are several options for the receiver input circuit. No additional components are required for the two-wire remote control system, option F, where pin 1 of the receiver is simply connected to pin 1 of the transmitter. The wireless remote control, option G, is more complex because the MV601 requires an external infra-red preamplifier such as the SL486 (see Refs. 1 and 2).

The outputs of the MV601 may be con-

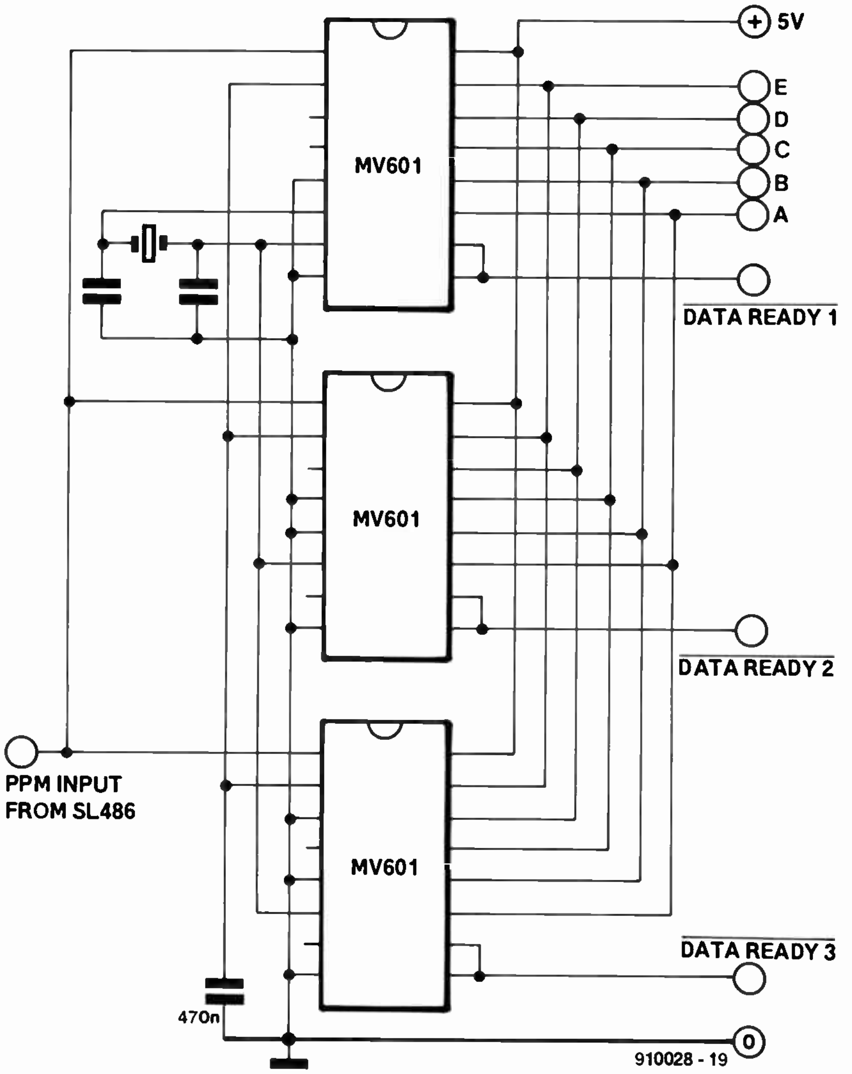


Fig. 9. 96-channel remote control receiver implemented on an 8-bit microprocessor bus.

nected to driver transistors (option H), or solid-state relays (option I). It should be noted, though, that these output configurations allow only 5 of the 32 possible channels to be switched, since decoding is not applied. When more than 5 channels are required, simply add one or two 1-of-16 decoders, e.g., the CD4514 (option J).

Receiver option K works with the previously mentioned computer-controlled version of the transmitter, option B. The output register is set to latching (pin 5 held logic low), and the outputs of the MV601 are connected direct to a microprocessor input port. A simple handshaking arrangement may be implemented between the IR receiver and the microprocessor with the aid of the DATA READY and the OUTPUT ENABLE lines.

A single receiver has a maximum decoding capacity of 32 channels. This figure can be trebled by using three sets of transmitter/receiver, each wired to operate at its own transmission rate. As shown in Fig. 8, the complexity of a 96-channel remote control system is still within reason, mainly because the clock for all three receivers is supplied by a single oscillator. Also, a single reset line is used for the complete receiver system.

Figure 9 shows how to implement a 96-channel receiver when an 8-bit microprocessor bus is available. Here, the DATA READY output is connected to the OUTPUT ENABLE input.

The receiver is not too complex either when it is extended. The two transmission rate inputs are held logic high with pull-up resistors. When a key is pressed, one of the inputs goes low, and a different MV601 is addressed. It is almost impossible to tamper with this system since the transmitter remains off when two keys are pressed simultaneously. Finally, the circuit in Fig. 10 shows an input configuration that allows you to switch between three keyboards. ■

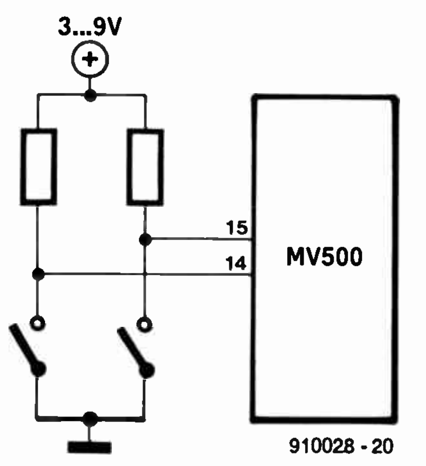


Fig. 10. Keyboard select extension for the transmitter.

References:

1. "Infra-red remote control", *Elektor Electronics* September 1990.
2. "Dimmer for halogen lights", *Elektor Electronics* April 1991.

Source:

Satellite & Cable TV IC Handbook, Publication P.S.2020, October 1988 (Plessey Semiconductors).

PLESSEY SEMICONDUCTORS

UK head office:
Plessey Semiconductors Ltd., Cheney Manor, Swindon, Wiltshire SN2 2QW, United Kingdom. Telephone: (0793) 36251, fax: (0793) 616763.

North American head office:
Plessey Semiconductors, Sequoia Research Park, 1500 Green Hills Road, Scotts Valley, California 95066, U.S.A. Telephone: (408) 438 2900, fax: (408) 438 6231.

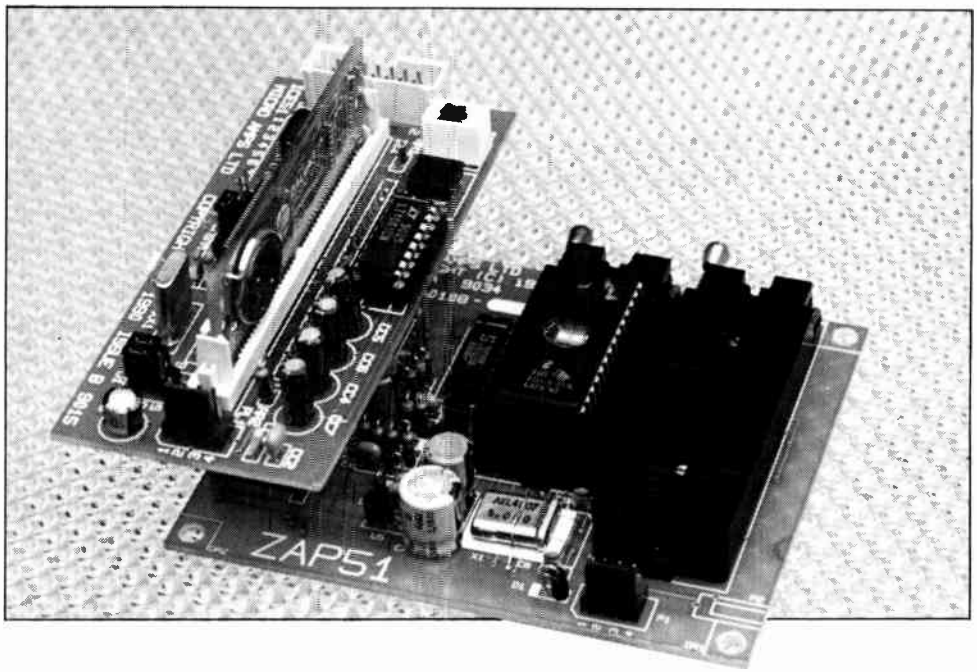
ZAP51: AN 87C51 PROGRAMMER

Dr. David Kyte (Micro Amps)

IN my first article (Ref. 1) I described the problems associated with developing 87C51 single-chip microcontroller applications, especially the software. In the second article (Ref. 2), I described a low-cost in-circuit emulator (ICE) that provides the hobbyist with a route into simulation — conventionally the province of corporate/professional developers only. One final problem remains for the hobbyist. Having developed the software in situ in the target environment, the single-chip microcontroller needs to be programmed. Most low-cost EPROM programmers have 28-pin sockets and can not, therefore, program the 40-pin 87C51.

The ZAP51 described here is a minimum cost programmer that uses the ICE51 hardware as the program controller. The diagram in Fig. 1 describes the hardware.

The ZAP51 consists of a socket, P3, to plug the ICE51 into; a voltage converter circuit to generate 12.5 V from the 15-V power supply; and two zero-insertion force (ZIF) sockets: one 28-pin type, U1, to program EPROM devices, and a 40-pin type, U6, to program the microcontrollers. The ZAP51 can program CMOS devices only: hence, it will program the 87C51, but not the NMOS part, the 8751. The 8751 requires a 21-V programming voltage that, on cost considerations, was rejected on the programmer.



Software

The software supplied with the ZAP51 is split into two parts. The first part executes on the PC; the second part runs on the ICE51. The ICE51 program extends the functionality of the standard ICE51 monitor program to include programming code. The PC software includes menu-driven code to control the ICE51. A brief description of the procedure to program a microcontroller is presented below. This is followed by a description of each menu option.

To program a device

1. The RAM on the ICE51 should be set high using the monitor. Move the cursor over the 'mon' option, then press return. Fill memory with $FF by typing

    x 1000-2000 ff

then exit back to the menu using

    q

2. The device type (microcontroller/EPROM) must be selected by positioning the cursor over the uC menu option, and then pressing return.

3. To load a file, select the 'mon' option, then enter the command line

    load [filename]

Enter 'q' to exit back to the menu.

4. The target address in the 87C51 must be set by defining the device offset address in hexadecimal.

    offset
    0

5. The number of bytes to program must be entered using the option

    #bytes
    0100

6. To program the device, select the 'program' option. The programmed data will be verified automatically after the programming function is complete.
7. Optionally, select the security lock, 1 and 2, or encryption functions during production device programming.
8. Repeat the entire procedure, or part of the procedure, on all devices, or exit the program to return to DOS.

Monitor

The software on the ZAP51 contains a superset of standard ICE51 commands. As such, the development facilities on the ICE51 exist and can be accessed by selecting the monitor option.

#Bytes

The #Bytes option enables the user to define the number of bytes to use in any operation. It affects the number of bytes that are programmed, read, verified and checksummed. The numeric value is entered in hexadecimal.

Offset

This option selects the address in the target device to start programming or reading the data from. The value is entered in hex. It can be used to move, copy or relocate data within a device. Under most conditions, this value will normally be set to 0.

Read

Data is read from the device into the ICE51 memory. It can be examined and modified using the monitor option. For example, to read $100 bytes from the start of an EPROM, enter

    offset 0
    #bytes 0100
    read

To modify the data, enter the monitor using the 'mon' option. Data is read into the ICE starting at address $1000. Hence, to dump the data, execute the monitor command

    x 1000 - 1010

To modify the code, enter

    x 1000 1,2,3,4 ...

To return to the menu, enter

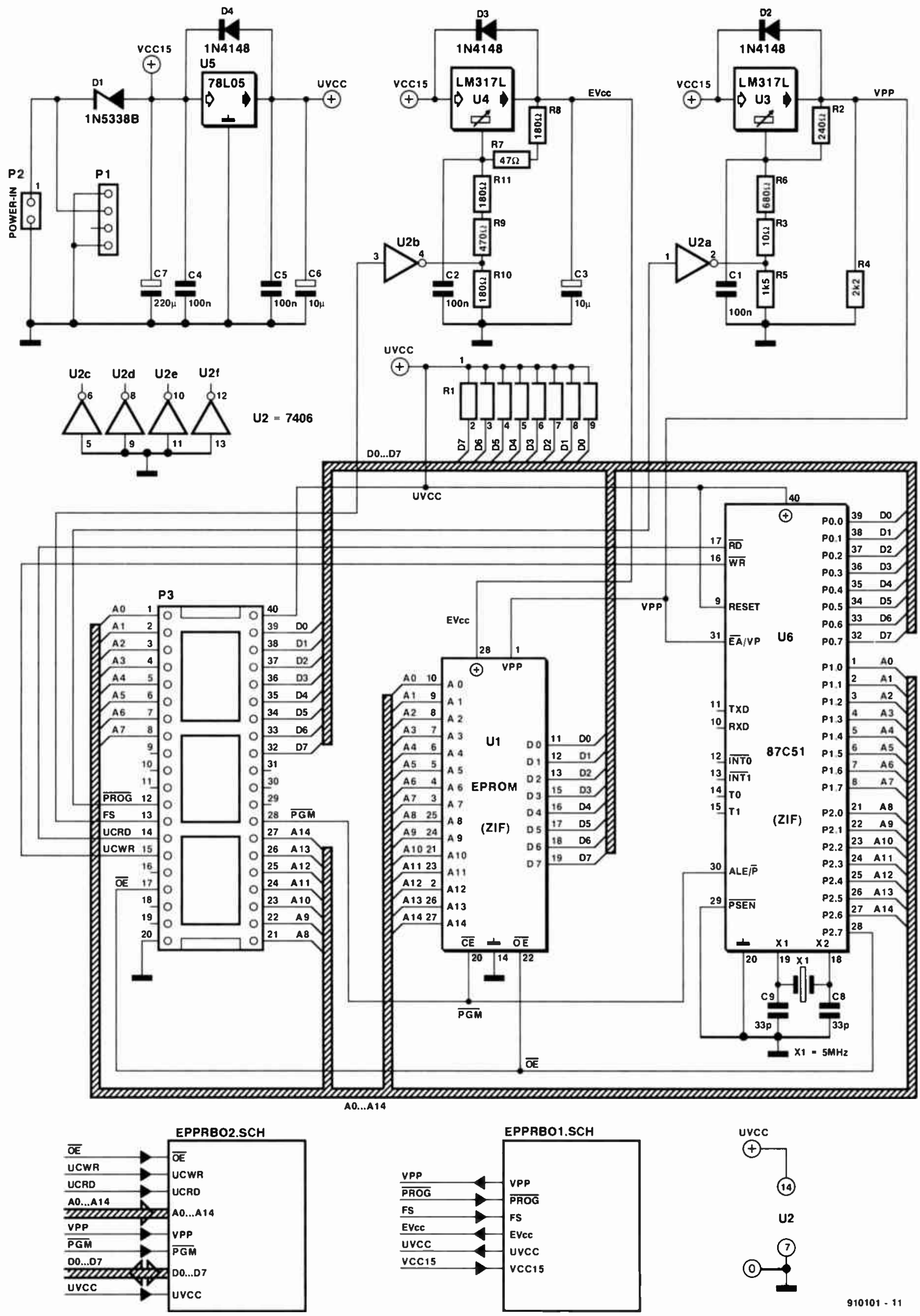
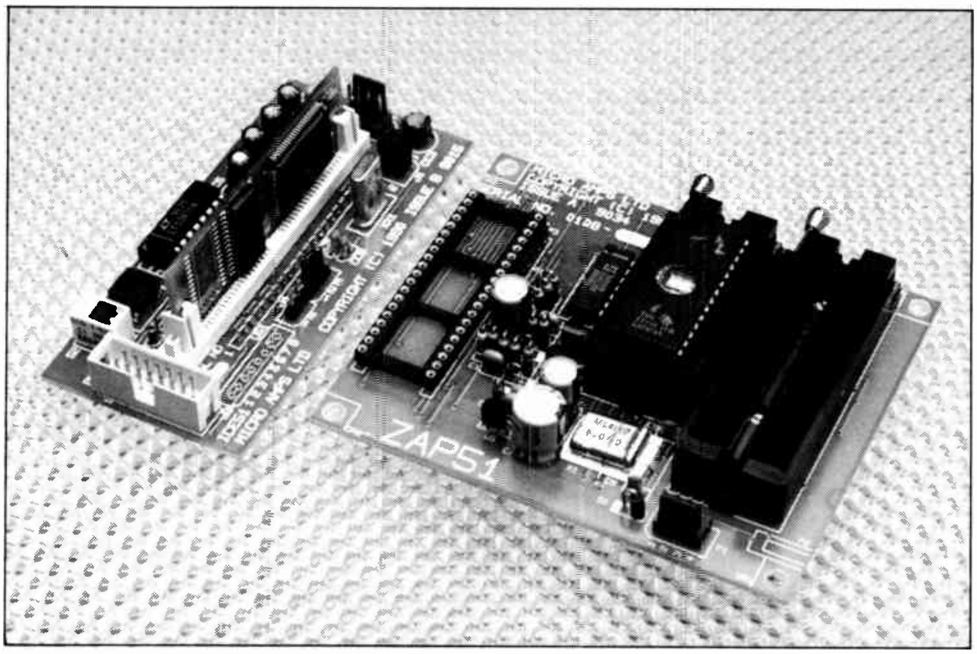


Fig. 1. Circuit diagram of the ZAP51.



q

The modified data can now be programmed into the new device. By default, when the ICE51 powers up, the ICE51 offset value is set to $1000 in the startup file. Consequently, data loaded from an Intel hex file is offset by $1000 bytes — the data byte for address 0 is loaded at address $1000, $1→$1001, etc.

To display the ICE51 offset value, enter

o

whilst in the monitor. The display should respond with the value of 1000. If any other value is displayed, set the offset back to 1000 by entering

o 1000

If code is read from an EPROM, it will be stored at address $1000 in the data memory. To disassemble that data, the data pointer in the ICE51 must be changed. The data pointer defines the boundary between data memory and code memory in the DS2250 device. Normally, the ICE51 code memory is set between addresses 0 and $0FFF when using the ZAP51. Data memory is then available above address $1000. The list command, 'l' is used to list disassembled code memory:

l 0-10

but it operates on code memory only. To disassemble the contents of data memory above $1000, the data memory must be temporarily changed to code memory. You can do this by entering

data 4000
l 1000-2000
data 1000

It is vital that the data pointer be returned to 1000 after executing this command sequence. Otherwise, incorrect data will be programmed or read from the device.

Program
#Bytes of data is programmed into the selected device starting at the target address of offset. 'Program' automatically calls 'verify' to check the result of the programming operation.

Verify
The contents of the device can be verified against the contents of either an Intel-hex file or another device. In the former case, data is read into RAM using the monitor to load the file as described above. Next, the file can be verified against the device in the socket. To compare two devices, read the first device, then verify its contents against that of the second device.

Checksum
This option enables the user to generate a checksum from the data in memory, which can be used to monitor the integrity whilst programming multiple devices. After each device is programmed, a checksum is generated reflecting the contents of memory used to program the device. The checksum provides a visual reassurance that consistent data is being used in successive devices.

27C128/27C256/87C51
These options select the type of device that is to be programmed. In the latter case, the 87C51 is programmed in the 40-pin ZIF socket, while with the former two devices the 28-pin socket is used.

BlankCheck
BlankCheck provides the user with the tools to check that a region of memory can be programmed, i.e., it is in an erased state.

Security locks
The 87C51 provides two security lock bits. The first, SL1, prevents further programming of the device — a useful feature if master devices are going to be generated. The second security bit, SL2, prevents the device from being read. This bit is programmed normally on production parts for commercial security reasons only. Both the lock bits are cleared when the device is erased using ultra violet light.

Encrypt
The 87C51 provides a facility to encrypt the data in the on-chip EPROM. A 32-byte encryption table is used to XNOR with the on-chip code. The encryption table provides a degree of security from unscrupulous software pirates.

Quit
This option takes the user back to the DOS command line interpreter.

Prospective

The 87C51 in its one-time programmable form costs about £18.00. Since it is often the only device required to implement many applications, custom designs are cheap to manufacture. An added advantage — if the designer creates a 'winning product' — is that the cost to manufacture in quantities by making a masked device tumbles to less than £2.00 per device. ■

References:
1. "The 8031/8751 Microcontroller", *Elektor Electronics* July 1990, p. 36.
2. "8031 In-circuit emulator", *Elektor Electronics* January 1991, p.50.

For further reading:
"Programmer for the 8751", *Elektor Electronics* November 1990.

For further information on the ICE51 and the ZAP51, contact the author at Micro Amps Ltd. • 66 Smithbrook Kilns • Cranleigh • Surrey GU6 8JJ • England. Telephone: (0483) 505395. Fax: (0483) 268397.

INTERMEDIATE PROJECT

A series of projects for the not-so-experienced constructor. Although each article will describe in detail the operation, use, construction and, where relevant, the underlying theory of the project, constructors will, none the less, require an elementary knowledge of electronic engineering. Each project in the series will be based on inexpensive and commonly available parts

BUILD THE OPTICALOCK – PART 1

by Michael Swartzendruber

Combination locks are useful because they can not be picked like a 'key' lock can. If a combination lock could sound an alarm before it was cracked', the odds of stumbling on the correct combination would be very slim. The trouble with combination locks is that they have preset/unchangeable combinations. Such combinations are a security risk, since the they may fall into the hands of the wrong people. So, how about creating a programmable combination lock system unlike any other in the world that is so innovative that practically nobody can crack the code?

THE lock system described in this article is well adapted for controlled entrances for the following reasons: 1) it will allow only three incorrect attempts at the correct combinations before it will trigger an alarm system; 2) the combination is programmable at any time – moreover, the process of re-programming is as easy as setting the frequency of a garage door opener; 3) the lock has 127 possible combinations – with only three entry attempts allowed, the risks of an unauthorized entry are very small; 4) because of its innovative nature, it is highly unlikely that any unauthorized person will possess a 'skeleton key'.

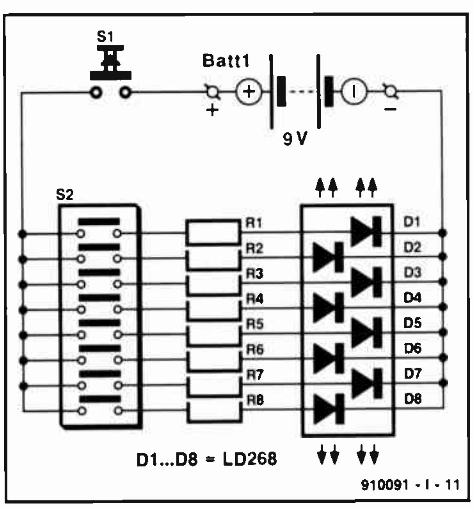


Fig. 1. Circuit diagram of the 'key' to the electronic combination lock.

The key

The design goal of the key to this system is convenience. It is reprogrammable at any time. And, since it is 'palm sized', it could be mounted into any small enclosure and could be added easily to a key ring.

The key's operation and construction are very basic. It may be easily assembled on the printed circuit board shown in Fig. 6.

The key operates as follows—see Fig. 1: all the enabled infra-red (IR) emitters are actuated by closing the normally open push-button switch. This connects battery power to the buses on the keyboard. Each of the IR emitters is wired in parallel across this power bus.

The only emitters that are enabled are those that have power passing through their branch; power is applied to the emitter by the DIP switch, S_2, in that branch. If the DIP switch in a branch is closed, current will flow through that branch and that emitter will be active. If the DIP switch in that channel is open, the emitter will have no current and will not be active. The resistors hold the current to a level that is safe for the reliable operation of the emitters.

The infra-red emitters correspond with detectors inside the lock unit. The lock will be programmed to expect certain IR emitters to be active by the setting of its corresponding DIP switch element. In this manner, any combination can be chosen or changed at will, but the lock will 'open' only if the combination in the lock and that in the key are exact matches.

The lock

The lock part of the combination system is divided into four distinct functional areas: the infra-red detector array and amplifier section; the combination programming section; the combination decoder logic array and lock driver; and the entry attempt counter and alarm trigger driver. Each of these sections will be described individually, after which the operation of the system should be easy to grasp.

Sensor/amplifier array (keyhole)

The infra-red detectors and detector amplifier array in Fig. 2 form the 'keyhole' of the system. The IR detector array, T_1–T_8, senses which of the emitters of the key are active. When the detectors are exposed to IR radiation, they begin to conduct. This raises the voltage at the base of the current amplifying transistor connected to the relevant detector. The transistor is then switched on and a logic high voltage becomes present at the emitter side of the biasing resistor. This voltage is used as the input to gates of logic sections. Amplifier channels that are not stimulated with IR energy stay clamped at a logic low level.

The combination decoder

The combination detector/lock driver section operates as follows—see Fig. 3. The eight output lines of the IR detector amplifier array, A–H, are applied in parallel to the eight Q inputs of magnitude comparator IC_3, and to the eight inputs of NOR gate IC_5. The eight P inputs of IC_3 are linked to DIP switch S_4 on which the unlock code is set. If the key described earlier is programmed with a specific emitter enabled, its relevant detector will clamp on and the amplifier circuit will apply a high-level signal to the P input and the input of IC_5 associated with that detector channel.

Provided the code set in the key matches that set in the receiver, that is, when the two DIP switches are set to the same bit combination, output P=Q (pin 19) of the comparator goes logic high when the push-button on the key is pressed. If the two bit combinations do not match, the P=Q output will remain logic low. When a match occurs, the high level at the P=Q output is applied to IC_8, a Type PWRDRV1 high-current drive IC. This driver actuates a solenoid locking mechanism or relay coil or any other electromechanical device you may wish to drive.

The 8-input NOR gate, IC_7, functions as a digital signal detector. Its output, pin 13, goes low whenever one or more inputs are taken logic high, that is, whenever the key is used to transmit a code, whether this is valid or not. This enables the NOR gate to clock the code entry counter, bistables (US: flip-flops) IC_{4a}–IC_{4b}, via the $\overline{CLK}$ input of IC_{4a}.

The lock mechanism may be overridden by switching the OUTPUT ENABLE pin of the 8-bit magnitude comparator to V_{cc}. This clamps the P=Q output low. Note also that an LED will light whenever the Power Driver is applying current to the load. This LED is used to indicate when the device is 'unlocked'.

The output signal of AND gate IC_{6b} is used to clear the counter in the unauthorized attempt detection block. The signal is applied to the $\overline{CLR}$ input of a pair of JK bistables (US: flip-flops), IC_{4a} and IC_{4b}.

The unauthorized-attempt counter and alarm driver

The unauthorized-attempt counter and alarm actuation block operates as follows. All the signals from the detector array are OR-ed together in IC_5. Whenever any of the sensors detects an IR signal, the output of IC_5 will pulse high while the excitation lasts and is used to clock a pair of JK bistables (US: flip-flops), IC_{4a} and IC_{4b}.

The bistables are hard-wired in toggle mode, that is, they will switch states with every clock input. The Q output of the first flip-flop is connected to the CLK input of the second bistable: this configuration forms a two-stage ripple counter. The Q outputs of both flip-flops are wired to an AND gate, IC_{6b}; when both are in a high state, representing binary 11 or decimal 3, the two inputs to the AND gate will be high. This enables the AND gate. Its output drives a Type PWRDRV1 chip that controls a relay.

The contacts of the relay can be wired easily as a normally open or normally closed switching detector in any existing alarm loop or they can enable an alarm.

The alarm may be disabled by closing the ALARM CLEAR switch, S_3. This action causes a pulse to be applied to the $\overline{CLR}$ lines of the bistables to disable the alarm relay.

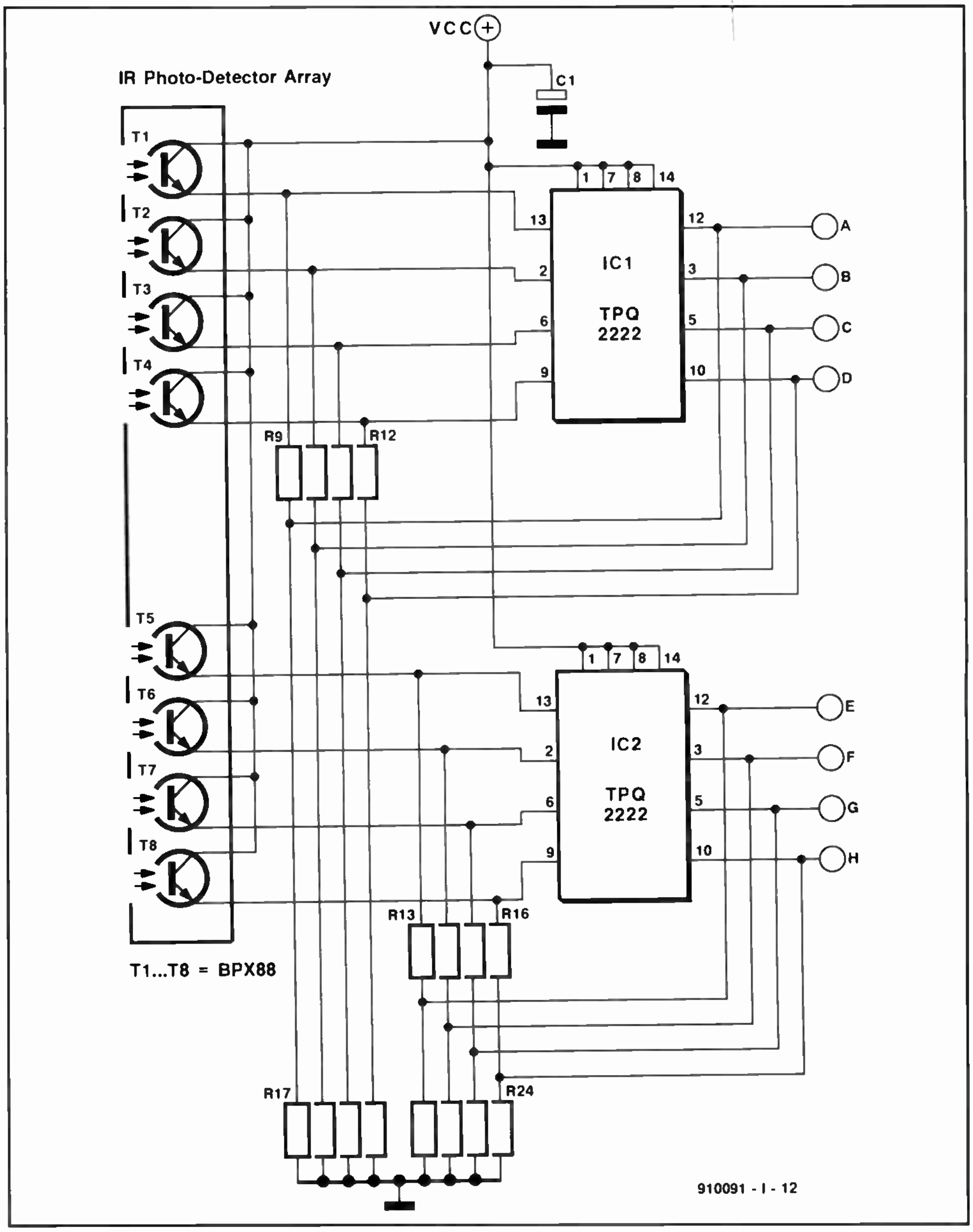


Fig. 2. Circuit diagram of the infra-red detector/amplifier array.

Constructing the lock

It is best to begin the project with constructing the key. Start by inserting a 16-pin DIP socket into the circuit board (marked S_1). Make sure that all the leads go cleanly through the board and that the socket is held firmly against the top side of the board. Solder all the leads of the socket to the board, taking care not to make any solder bridges between the closely spaced adjacent pads. Insert an 8-position single-pole, single-throw DIP switch into the socket.

Insert resistors R_1–R_8 into the appropriate positions on the board. Note that, in an effort to keep the board small, they should be placed at an angle: the part that is lifted off the board should point to the DIP switch socket.

Next, install the leads of a 9-V-battery clip in the holes marked + and –. Cut two 2-in. (5 cm) long pieces of solid hook-up wire and strip 1/8 in. (3 mm) of insulation from each end of the wires. Solder the two wire ends to the pads marked S1 on the board. Solder each of the free ends to one of the lugs of a normally-open momentary-contact pushbutton switch.

Finally, install the IR emitter array, D_1–D_8, according to the detail drawing. Note that this device is polarized, that is, it will work only if it is installed correctly. Once you are sure it is placed correctly, solder all terminals into place. Make all solder connections quickly or use a heatsink to avoid possible heat damage to the device.

When the board is completed, hook up

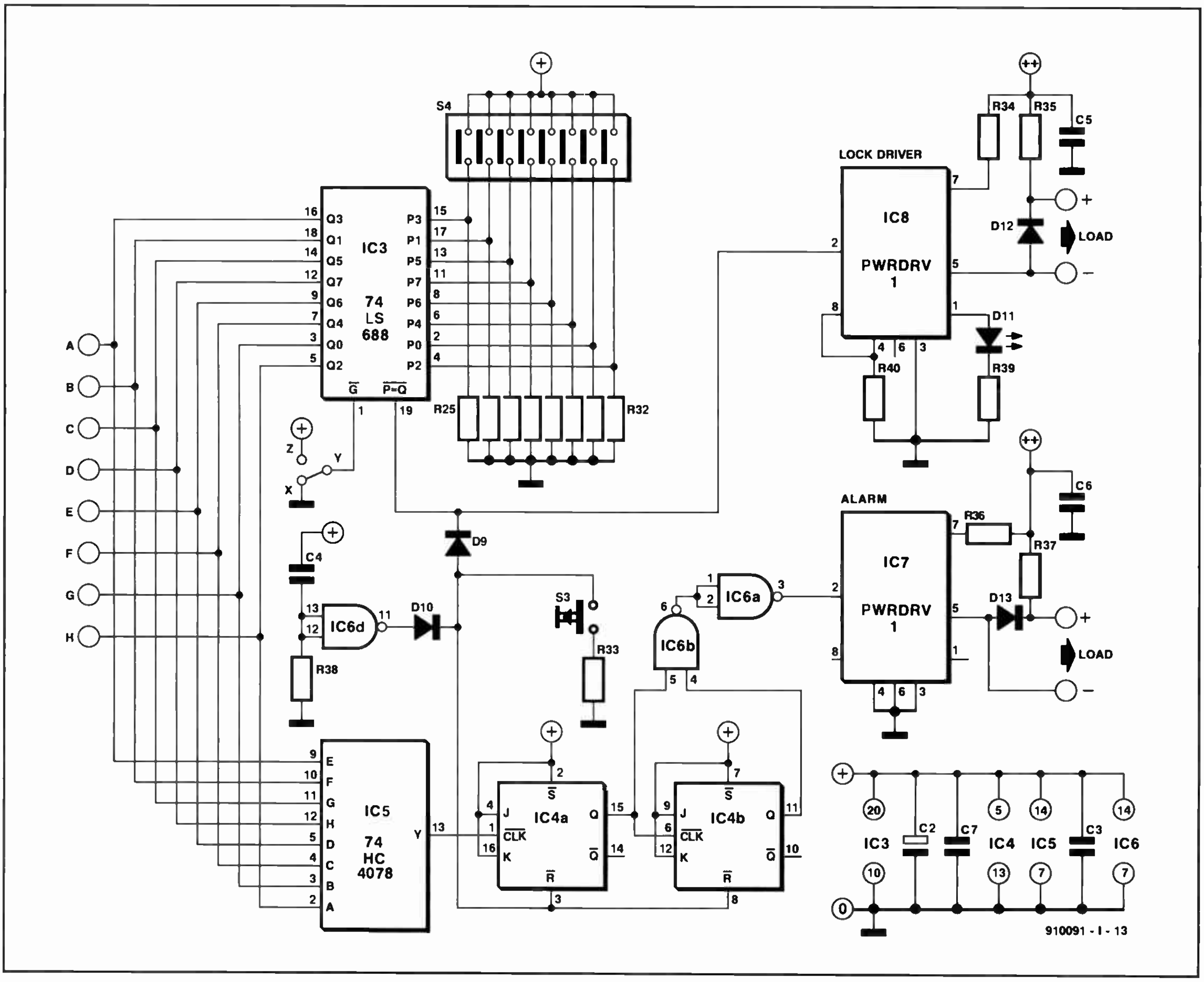


Fig. 3. Circuit diagram of the main logic board.

the simple test jig shown to test the operation. Open, or close, each of the DIP switches one at a time and aim that emitter at the test jig. The voltage level indicated by the meter should be about 5 V. If none of the emitters works, check the battery wiring, the polarity orientation of the array, and the wiring of the test jig. If one, or more but not all, of the emitters fails, replace the array.

Next, complete the sensor array and amplifier board. First, prepare the leads of the IR array, Q_1—Q_8, so that they will 'mate' with the corresponding emitters from the key according to the assembly detail drawing. Make sure that the polarized device is installed correctly or the entire assembly will not work properly. Solder the array into place; make all connections quickly or use a heat sink to avoid any possible damage to the devices contained in the array.

Next, install sockets for the current-amplifying circuits, IC_1 and IC_2. Seat them firmly against the board by bending out the corner leads at an angle of 60°. Solder the sockets to the board; be careful not to create solder bridges between any closely spaced pads.

Install base bias resistors R_9–R_{16} and emitter resistors R_{17}–R_{24} on to the board and bend their terminals to hold them in place. Then solder all terminals to the board and cut away all excess lead lengths.

Solder voltage stabilizing capacitor C_1 to the board. Observe correct polarity: improperly installed electrolytic capacitors can (and do) explode. When that happens, it is loud, messy and a little unnerving.

Prepare two pieces of 18 AWG (1 mm^2) wire by stripping $^1/_8$ in (3 mm) from one end of both pieces. Insert the bare ends into + and – respectively.

Test the board by applying 5 V d.c. (observe polarity) to the circuit. At each collector in the transistor sockets and on the detector array, 5 V should be measured. All other locations on the board should be 0 V. If the board passes this test, switch off the power and fit the transistor arrays.

The next test is to aim the emitter key at the array detectors and measure the voltages at the emitters of the amplifying transistors. They should be high if that emitter is enabled and low otherwise.

Remove the power from the assembly and attach an 8-conductor ribbon cable to the output port of the board. Carefully separate the wires from the ribbon over about 3–4 in. (7.5–10 cm). Carefully strip each of the conductors, twist the fine wires together and lightly tin the ends of each conductor. Insert one end of the ribbon cable into the output port of the sensor array board and put the assembly aside till the next board is completed.

Note: if the IR sensor array will be exposed to electric light, especially fluorescent light, in its normal application, RF bypass capacitors (0.001 µF polyester 'chicklet' types) should be soldered across the collector and emitter leads of each IR detector to prevent false amplifier circuit triggering from the electric light source. See the detail photograph that shows how this can be done.

The next module to be constructed is the main logic board. Start by fitting IC sockets for IC_3–IC_8. Make sure that the sockets are flush with the board before soldering them into place. Install a 16-pin DIP socket for S_4.

Prepare insulated jumper wires for each of the jumpers on the board by measuring the wire next to the jumper location and adding sufficient length to each end for PCB penetration and soldering. Carefully place the jumpers flat against the board and solder in place. Clip away all excess lead length. In some cases, the jumpers will lie very close to where other components or wire connections will be, so make sure to route them so that they

PARTS LIST

Resistors:
R1–R8 = 156 Ω*
R9–R16, R38 = 10 kΩ*
R17–R24 =220 Ω*
R25–R32 = 330 Ω*
R33 = 3.3 kΩ*
R34, R36 = 2.7 kΩ, 1/2 W, 5%
R35, R37 = 56 Ω, 1 W, 10%
R39 = 1 kΩ*
R40 = 470 Ω*
* = 1/4 W, 5%

Capacitors:
C1 = 100 µF, 16 V, electrolytic
C2 = 220 µF, 16 V, electrolytic
C3, C4, C7 = 1 µF**
C5, C6 = 10 µF**
** = ceramic or polyester

Semiconductors:
D1–D8 = 8-position IR emitter, Siemens Type LD268
D9, D10 = 1N914 or general purpose switching diode
D11 = LED, 3/4 Texas
D12, D13 = 1N4002
Q1–Q8 = 8-position IR phototransistor, Siemens Type BPX88
IC1, IC2 = transistor array, Sprague Type TPQ2222
IC3 = 8-bit magnitude comparator, Texas Type 74LS688
IC4 = dual JK flip-flop, Texas Type 74LS76
IC5 = 8-input OR gate, Texas Type 74HC4078
IC6 = quad AND gate, Texas Type 74LS00
IC7, IC8 = PWRDRV1 (Power Technologies)

Miscellaneous:
S1, S3 = normally open, momentary-contact switch
S2, S4 = 8-position SPST DIP switch
S5 = SPDT slide or toggle switch
circuit boards; solder; circuit (hook-up) wire; jumper wires; enclosures; mounting hardware; battery clip for 9 V battery; IC sockets; 0.1×0.1 in. right-angle circuit board headers; ribbon cable.

In the USA, the chip set may be obtained from Artronix, PO Box 221393, Sacramento, Ca. 95822, at a cost of $35.00 (excl. sales tax). Add $3.50 for postage and handling. Allow 4–6 weeks for delivery.

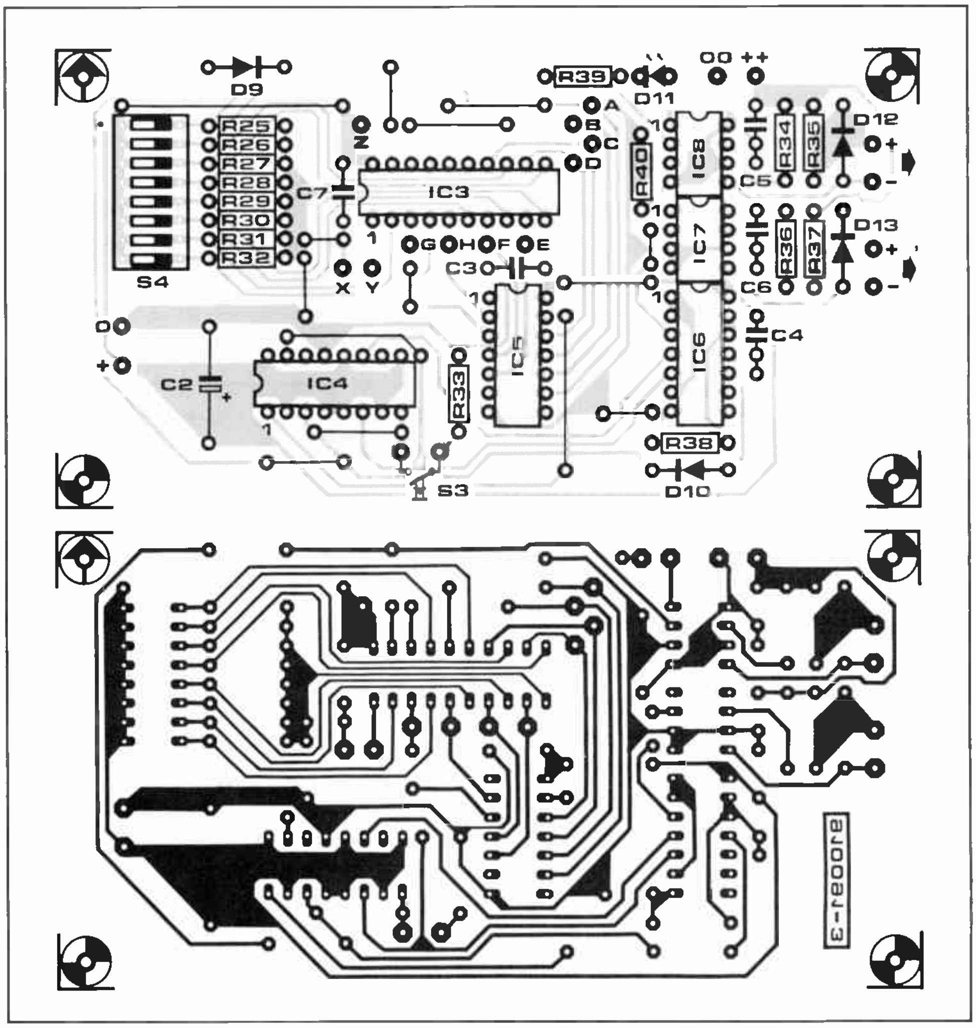


Fig. 4. Main logic board.

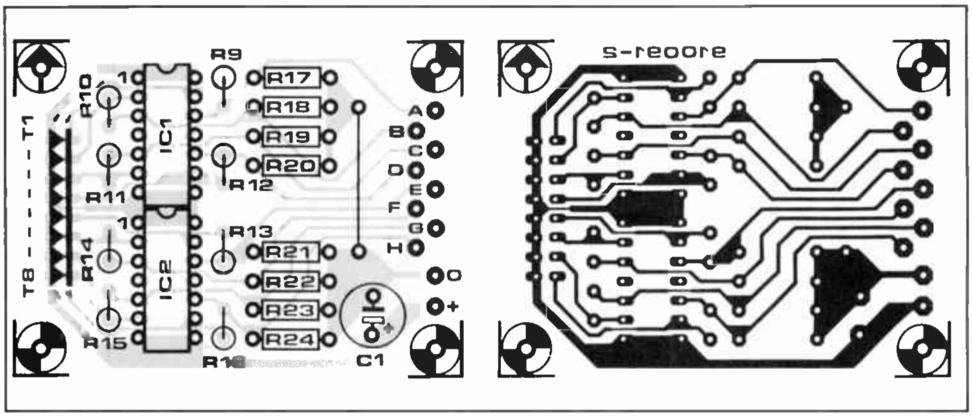


Fig. 5. PCB for the IR detector/amplifier array.

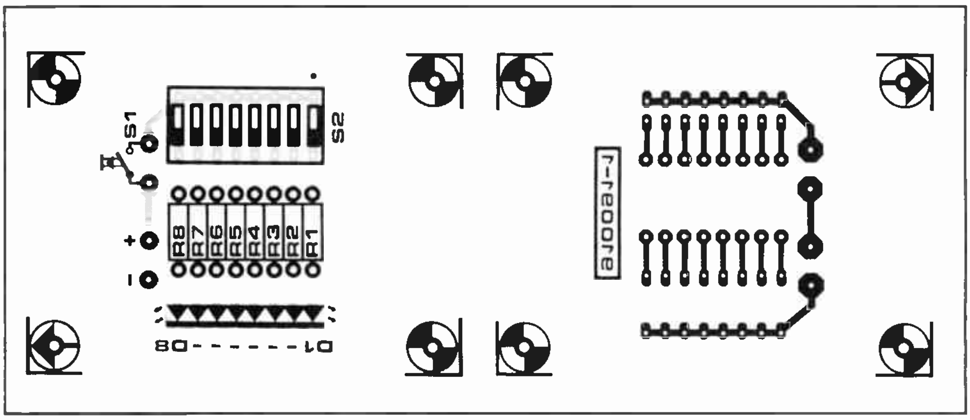


Fig. 6. Printed circuit board for the 'key'.

will not interfere with these components.

Next, fit resistors R_{25}–R_{40}. Clip away the excess lead length from these components after they are soldered in. Inspect your work as you progress, look for bad solder joints or solder bridges between any of the closely spaced pads or circuit tracks.

Install D_9–D_{13}. Use heat sparingly on these devices when soldering them to the board. Also, observe correct polarity. When you are certain that the devices are properly oriented, solder them to the board and clip away the excess lead lengths.

Fit capacitors C_2–C_7. Note that some of these components are polarized electrolytic types; make sure that correct polarity is observed. When the capacitors are fitted correctly on the board, solder them into place.

Prepare the following from solid 22 AWG (0.6 mm dia.) circuit wire: two 6-in. (15 cm) lengths, stripped 1/4 in. (6 mm) at each end for the alarm reset switch, S_3, and three 8-in. (20 cm) lengths for lock enable switch S_5. Solder these wires to the appropriate locations on the board and then attach them to the relevant lugs on the switches.

Test the board by applying 24 V d.c. and 5 V d.c. to the appropriate points on the board (observe polarity) and make the following measurements: pins 7 and 8 of IC_7 and IC_8 should be at 24 V d.c.; all others pins on the two sockets should be 0 V.

Insert S_4 into its socket with the ON side located towards R_{25}–R_{32}. Close all the switches, whereupon pins 2, 4, 6, 8, 11, 13, 15, and 17, of IC_3 should be at 5 V d.c. Open all the switches, whereupon these pins should be at 0 V. The level at pin 1 may be high or low, depending on the position of change-over switch S_5, connected to points X, Y and Z. Pin 20 should be at 5 V d.c. all the time. All other pins should be at 0 V all the time.

Pins 2, 4, 5, 7, 9, 12, and 16, of IC_4 should be at 5 V d.c. All other pins should be at 0 V all the time.

Pin 14 of IC_5 and IC_6 should be at 5 V d.c.; all other pins on these sockets should be at 0 V.

If you measure any levels other than the ones stated, stop and find the reason for the incorrect reading. Once this has been found, retest the board as outlined.

Next, remove the power from the circuit. Attach the ribbon cable between the sensor array board (completed earlier) and the main logic board. The letters on the main logic board correspond to the channel letter output of the sensor detector/amplifier array.

Prepare the cable for assembly by carefully stripping the insulation from the ends of the wires. Be careful not to nick the fine-strand conductors. Twist the conductors together and lightly tin the wires: take care not to damage the cable insulation with heat from the soldering iron. Separate the cable along the centre conductors in the cable to a length of 3 in. (7.5 cm) from the end. Next, separate each conductor in the ribbon over about 1 in. (2.5 cm) from the end. Insert the wires from each channel into the corresponding pad of the main logic board. Note that channels 7 and 8 are not in order and must be given a 'half twist'.

Attach a relay or solenoid coil, or any other suitable type of load, to the load points on the logic board. Mount the sensor detector/amplifier array, the main logic board and the output loads in an appropriate enclosure. Set switch S_5 so that pin 1 of IC_3 is low to enable the lock driver.

Install IC_3–IC_8 into their respective sockets: make sure that they are correctly oriented and that all pins insert correctly before pushing them home. Note that IC_3, IC_5, IC_7, and IC_8, are sensitive to electrostatic energy so take the appropriate precautions when handling these devices. ■

Next month's final part of this article will deal with programming and testing the opticalock.

DESIGN IDEAS

The contents of this column are based solely on information supplied by the author and do not imply practical experience by *Elektor Electronics*

Keyboard circuit

by D. Nelson

THERE are many chips on the market that may be used in a keyboard circuit, but many of these are fixed and do not provide all the keys required. For example, RCA's CDP 1871 is an excellent device, CMOS logic and low power requirement, but it does not provide for the backspace key to be coded as hex 08. Instead, it uses the delete key, coded as hex 7F. Although it is possible to change the software to recognize the different code, this is not always easy. The aim of the design offered here is a keyboard that can produce every code but is also able to be hooked up as a standard keyboard.

To provide a matrix that will encode the 128 combinations of the ASCII code, 16×8 lines are needed. If all 128 keys are to be used, a strobe output to signal that a key has been operated is also required.

In the diagram, IC_5, IC_6, and IC_8 are all CD4051 single 8-channel multiplexers. The strobe is generated by stopping the clock that drives seven-stage ripple counter IC_2 via an AND gate, because the battery on pin 9 is earthed via the matrix and two of the multiplexers.

The key code is contained in the output of the ripple counter and the strobe is provided by the Schmitt trigger NAND gate that will oscillate with an unequal mark-space ratio, since the diode used is a germanium type. A silicon diode would, of course, do as well, provided it is shunted by a high value resistor. The oscillation provides a repeat function of the key that is pressed. Since the strobe is in the wrong sense to that required by the following circuit, it is inverted by an additional transistor.

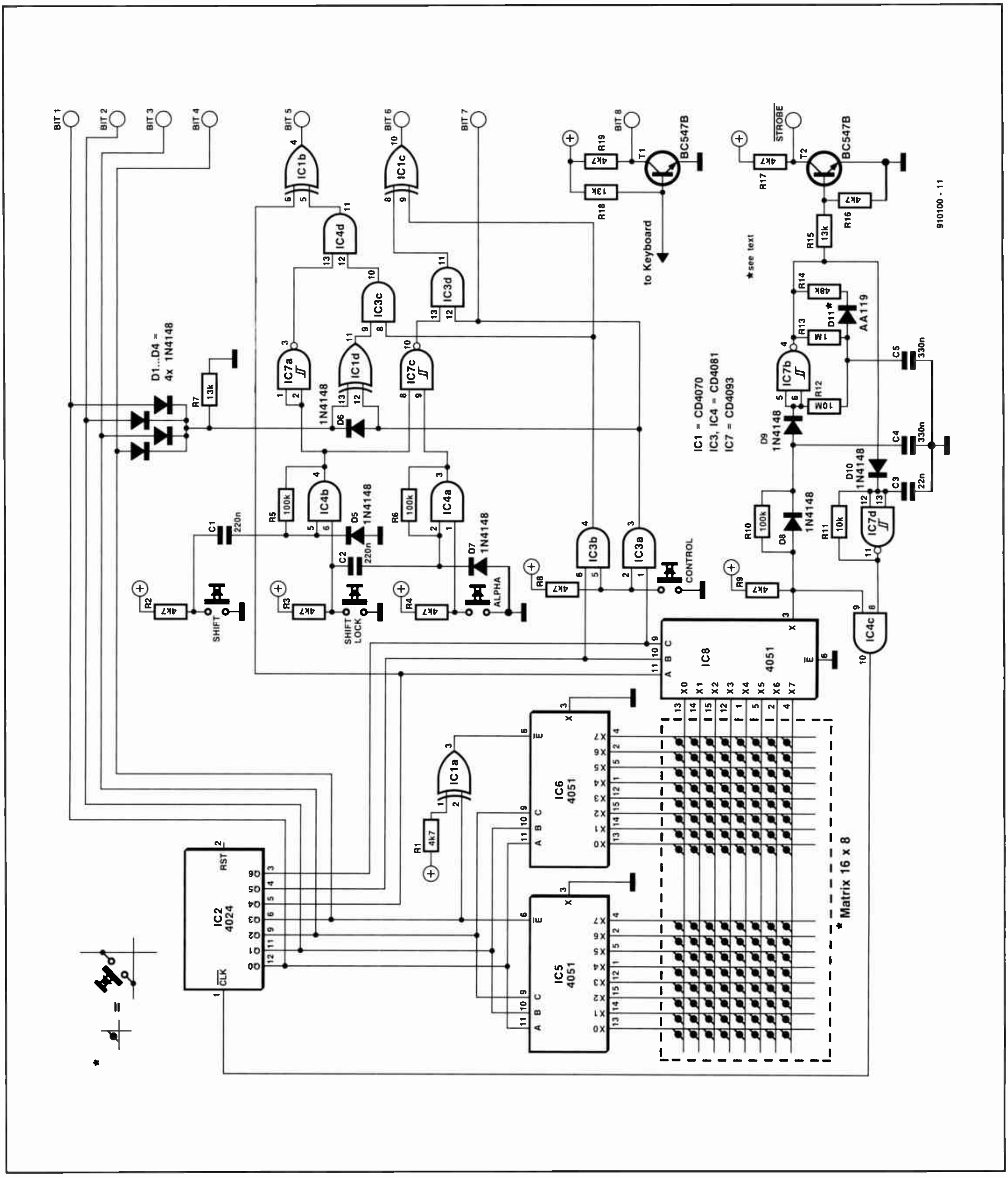
To give the conventional keyboard the functions of shift and control keys, extra gating is required, and that is the purpose of the rest of the circuit. Control has precedence and, by means of two AND gates, forces bits 6 and 7 low. The control key is non-locking.

The shift key is arranged to convert lower case letters to upper case so that it is necessary to wire the alpha keys in the lower case matrix positions. This key is conventional non-locking and inverts bits 6 and 5 of the output code. The shift-lock is coupled capacitively to the same AND gate as the shift key, so that the gate is toggled by the shift-lock key and will stay with the output low when the shift-lock is released. The shift-lock is released by pressing the shift key and releasing it again.

One other feature has been included to make the keyboard friendly to computers: the alpha key. This changes lower case to upper case without shifting the keys with an ASCII code between 20 and 3F hex, that is, the numbers row on a standard keyboard. This key is locking and implemented in the same way as the shift-lock key. The alpha key is released by operating the shift-lock.

Only one key now remains an enigma: the space bar. Without any extra gating, this gives a 0 if the shift or shift-lock is operated, and this is clearly not acceptable. To correct this, five diodes have been added, one each from the four least significant lines and one between the two inputs of the XOR gate in bit 5, so that a space remains a space, shifted or not.

Two further features of the circuit require a mention. One is the transistor feeding the most significant bit 8. If this is connected to its own key, it can be used in conjunction with other keys to give hex codes from 80 to FF. The other is tied up with the clock and strobe. A diode is fed back from the output of the repeat strobe oscillator to the main clock. This is necessary to prevent a false output if a second key is pressed before the first one is released. ■



A CHEAP, EFFICIENT, STRATEGIC FIRE ALARM

by C.C. Whitehead

A fire may be started by an unstubbed cigarette-end, a faulty electrical appliance carelessly left on, or lighted paper shoved through the letter-box by vandals. You may, like a great many people have furniture stuffed with deadly polyurethane foam, which catches alight easily, burns rapidly and produces vast quantities of dense and highly toxic smoke. In most cases, smoke is the killer. People asleep are poisoned and rendered helpless long before the heat gets to them to finish the job. And all this happens in a surprisingly short time: a few minutes at most.

A NEIGHBOUR of mine showed me the fire alarm she had had installed in her living room. It was not particularly cheap, but nevertheless reasonable in price. It was efficient, but certainly not strategic. In effect, it protected one room only, or at most one floor of a two-storey house if all doors on that floor were left open.

The experts—professional firemen—have shown us clearly how domestic fires nearly always start, what happens in the first few minutes from the start, and what the main danger to life is.

In all cases, *smoke* is the main hazard and that is why most fire alarms are smoke detectors. Fortunately, these can be made very efficient at little cost.

Once the fire has started, hot air carrying smoke quickly makes its way to the highest point it can reach in the building, forming a layer just below the ceiling, and then filling first the room or passage and subsequently the whole building from the ceiling downwards. That is why firemen, and those who are trying to escape from the fire, keep as low down near the floor as they can, even crawl if necessary. It is clear that a smoke detector should be installed on or near the ceiling, certainly high up in a room.

Fig. 1. Correct position of smoke detector.

A smoke detector/alarm can be installed in every room, but that is quite an expensive business. So is the installation of smoke detectors in every room connected to a central alarm, which involves wiring costs.

The cheapest method, without sacrificing too much in the way of efficiency is to install a single smoke detector/alarm at the most strategic point in the building. In a two-storey house that is at the top of the staircase leading to the second floor, close to or on the ceiling—see Fig. 1.

Dealers may, of course—and quite rightly—point out that this system loses a few seconds of time in indicating the start of the fire, and that, if the fire starts in a room of which the door is closed, considerable damage may occur before the alarm goes off. This is true, but the alarm still gives time to awaken sleeping people and allows them time to make their escape; in this respect it is as effective as any other system: it is all a matter of seconds after the start of a fire.

Circuit diagrams of a battery-operated version and of a mains-operated version of the unit are shown in Fig. 2 and Fig. 3 respectively. To avoid duplication of the description, the designation of the essential components is the same in the two diagrams.

The relay is a miniature type available from many suppliers; it has an operating 'on' voltage of 5–7 V at 10 mA. The coil resistance is 600 Ω. In a simplified version of the battery unit, Tandy Type 275-232 may be used: this has only one set of contacts. The

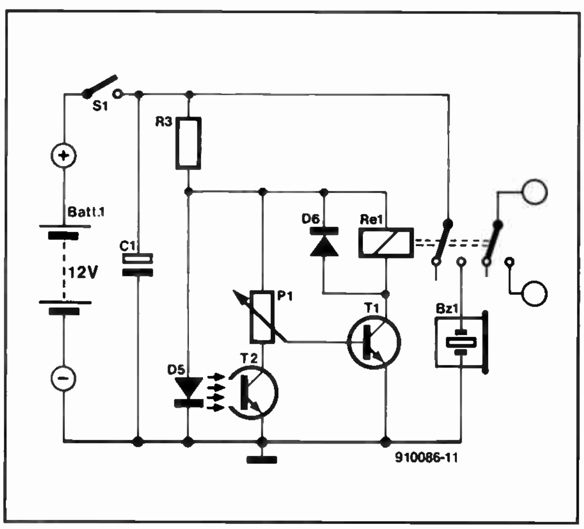


Fig. 2. Battery-operated version of smoke detector.

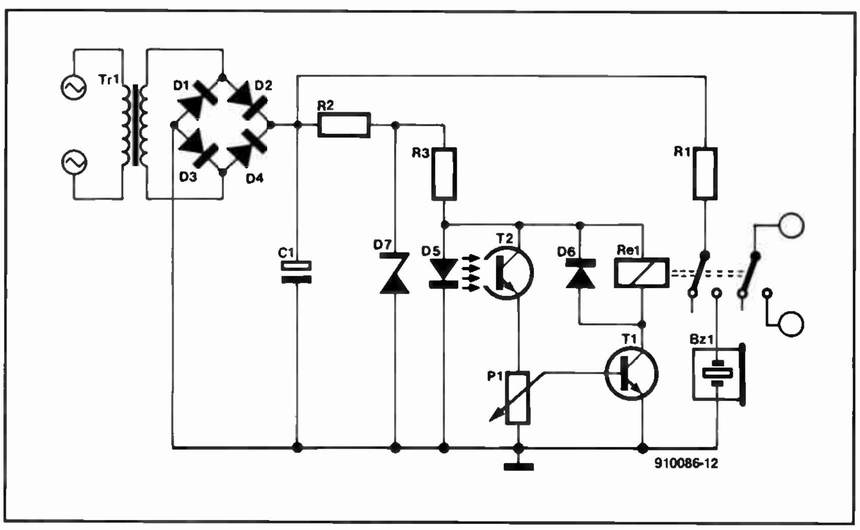


Fig. 3. Mains-operated version of smoke detector.

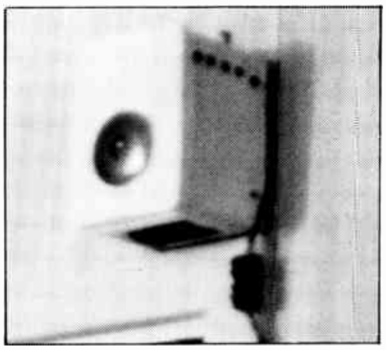


Fig. 4. Detail of mounting of unit (see Fig. 1).

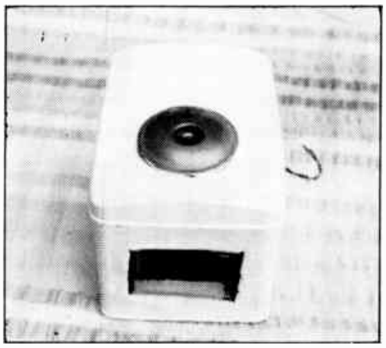


Fig. 5. Smoke hole at underside of unit.

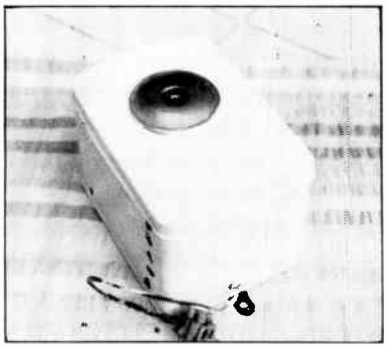


Fig. 6. General view of front of unit.

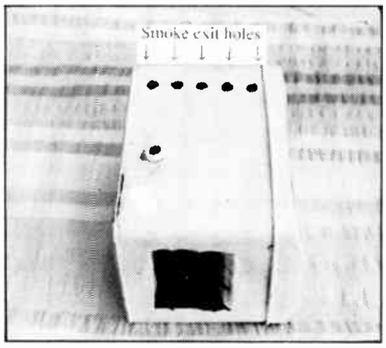


Fig. 7. General view of right-hand side of unit.

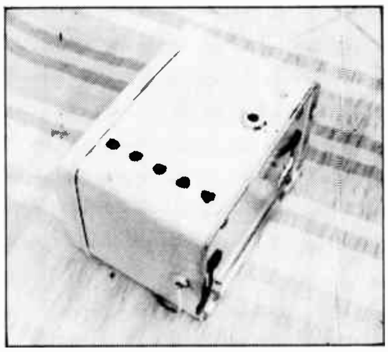


Fig. 8. Smoke escape holes and holes for connecting leads to mains, escape lamp and access to P_1.

objective is to keep the power consumption of the relay (in the non-alarm condition of the unit) as low as possible to extend the battery life.

There are two ways in which the unit can be made to function, depending on the position of infra-red (IR)emitting diode D_5 and IR photodetector T_2. As shown in the diagrams, when there is no interruption of the light path between D_5 and T_2, the relay is energized and the supply to the buzzer is held off. A slight obstruction of the light path causes the relay contacts to open, whereupon the buzzer (and the 'escape light', if fitted) is energized.

In the battery-operated version, the positions of D_5 and T_2 can be reversed and the connections of the relay contacts as shown to give a slightly reduced current drain on the battery. The circuit works well in either case.

Capacitor C_1 in the mains-operated version has two functions: the usual one of reservoir and that of holding a charge so that when the unit is disconnected or switched off, the buzzer gives a loud bleep. This shows that the unit is functioning correctly and is the reason that the capacitor is retained in the battery-operated version.

In the mains-operated version, the miniature transformer may have a secondary voltage of 12–20 V and be capable of providing a load current of 150–200 mA.

The value of R_2 is $15U_s$ where U_s is the secondary voltage of the transformer; its tolerance may be ±20%.

The unit may be constructed on a 10×7.5 cm (4×3 in.) piece of prototyping board (veroboard or perfboard). The location of the components, other than D_5, T_2, P_1 and the transformer, is not important. The positions of T_2 and D_5 are obvious and should be about 25 mm (1 in.) above the board.

The dimensions of the enclosure are 9×11.5×9 cm (3.5×4.5×3.5 in.) (L×W×D). The positions of the smoke holes and the hole for screwdriver access to adjust P_1 can be ascertained from the photographs.

It will be found that there are two points on P_1 at which the buzzer can be switched on and off: only one of these is correct. The adjustment may be made on a workbench, since T_2 is not sensitive to visible light. To find the correct adjustment point, waggle a matchstick between D_5 and T_2. Once this has been found, carefully adjust P_1 again until the buzzer just goes off. The buzzer should make a loud and unpleasant noise to make sure that it wakes healthy sleepers. ■

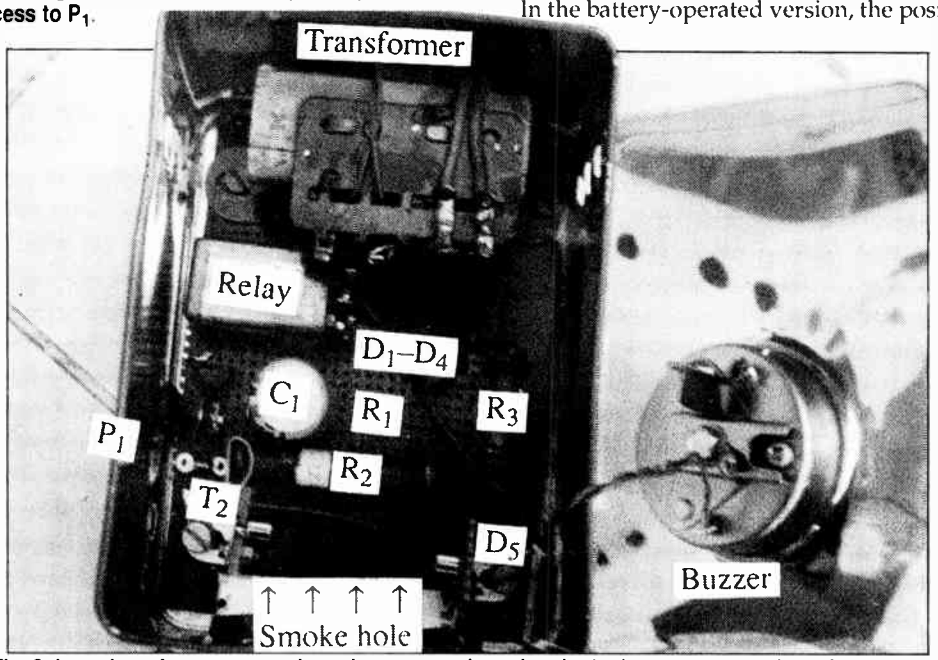


Fig. 9. Location of components in mains-operated version. In the battery-operated version, removal of the transformer, zener diode and R_2 makes space for the battery.

PARTS LIST

Resistors:
R1 = 50 Ω
R2 = see text
R3 = 300 Ω, 1 W
P1 = 22 kΩ preset

Capacitors:
C1 = 1000 µF, 35 V DC working

Semiconductors:
D1–D4 = 1N4001
D5 = infra-red emitting diode
D6 = 1N914
D7 = zener diode, 12 V, 1 W
T1 = BC149 or similar
T2 = infra-red photodetector

Miscellaneous:
S1 = SPST switch
Re1 = miniature relay, 5–7 V, 10 mA, coil resistance 600 Ω
Batt1 = 12 V battery
Tr1 = miniature mains transformer, secondary 12–20 V, 300mA
Bz1 = miniature buzzer, 12 V

Understanding the EDIF standard

by Tony K.P. Wong

EDIF is a standard data format for electronic design information transfer between CAD systems, and supports gate array and semicustom IC design. It plays an important role in the VLSI world. Some of the basic structure of the EDIF and an application of its netlist are presented in this article.

IT MAY be recognized that the VLSI integrated circuit design process relies heavily on communication between all parties involved in the design, manufacture and testing of VLSI products, that is, 'Joint Ventures' scheme. This has to be so irrespective of the different CAD systems that might be used at each end of the data exchange. However, problems arise since each CAD system employs its own system-specific data structure for storing product data. This data may not be transferred from one system to another or be read by other systems, as they have no common data structure. Hence, to obtain the maximum benefit from CAD systems, data exchange becomes essential to the manufacturers.

Many national and international organizations have developed a public domain standard for data transfer, which is called Electronic Design Interchange Format, or EDIF. This standard enables the designs of semicustom and custom ICs to be communicated unambiguously to device makers.

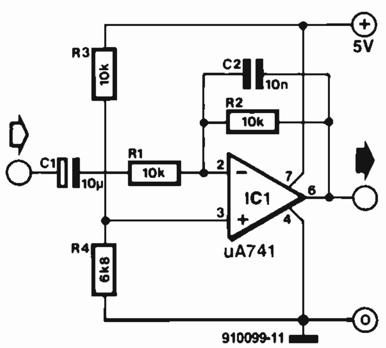
EDIF structure

EDIF is a neutral data format that may be used for transferring netlists, schematics, IC layouts and other electronic data between computer workstations. A translator program will be required to translate the information from the sender's data base and to create a sequential file in the format defined by the EDIF specification. Another translator program may be used to load the design information into the receiver's data base.

The basic format of the EDIF syntax is an ASCII file. An EDIF file consists of an hierarchical set of structures based on the LISP programming language. Each construct of the EDIF language is a parenthesized list of items of information. Each distinct EDIF construct is identified by a keyword. This syntax is very simple, easily parsed, and extensible, but its power for representing design information comes from its structure. The hierarchical structure of EDIF means that it is abstract at the highest levels and becomes progressively more detailed as one descends within the hierarchy. Figure 1 shows a portion of the EDIF structure model and the path of the netlist view is specified. Further details of the structure of EDIF may be obtained from Ref. 1.

In general, an EDIF file may contain one or more libraries of cell data. A library consists of cells grouped according to the common characteristics.

1



Cells in the library may contain instances of other cells from an external library. Each cell currently supports seven view types: behaviour; schematic; symbolic; netlist; mask layout; document; and stranger. Each view of the cell contains information particular to a specific use of the cell.

The 'library' and 'view' structures can make a possible change in the transfer of partial or incomplete design information, so that the data transfer time may be reduced.

View cells can be divided into two sections: the interface section defines the cell's communication with other cells, and the contents section defines the detailed implementation of the cell.

In the top level, the Design block contains the name of a design and provides a path for finding data. The Status block specifies the file information such as the program version, creation time, and so on. The User Data block contains the user specific data, for instance, local user extensions. All of the data describing a design is collected in the Library block. The Library may make reference to the External Library, that is, a library is known to the sender and receiver by name, but no details are transferred. Within the Technology construct, information of physical design rules, global constants, and so on, may be included.

For the View level, the Netlist view, the netlist description contains a list of cell instances and a collection of nets that specify signal connections among the ports on the instances and the external ports of the cell itself. It is possible to display the property name and its value in any context. Properties may include optional 'owner' and 'unit' values. For example,

```
(port AAA
   (property BBB (number (e X–Y))
      (unit CCC)
         (owner DDD)))
```

describes that the port named AAA of a cell has a property BBB (e.g., Cin). The value of the property is exp X $-Y$ (e.g., 1×10^{-12}) and it has the unit of CCC (e.g., capacitance). The owner of this property is DDD, which is user-defined to avoid the same name of properties from different data bases.

It should be noted that, when the file is translated into the receiver's data base, any scaling of values for the unit CCC, which is specified in the technology section of the EDIF library, would be applied to the property value.

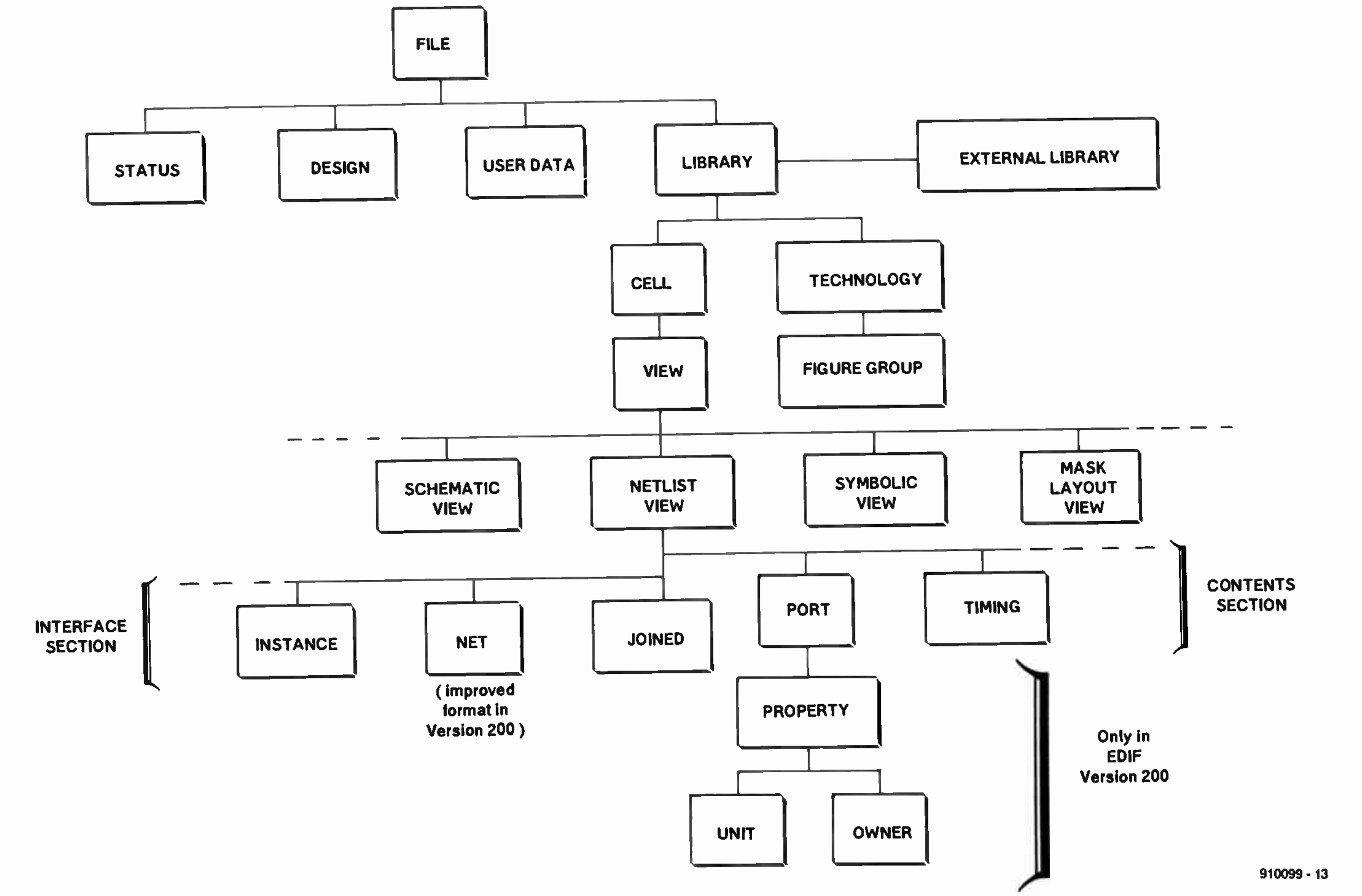
The Mask Layout view also contains an interface and a contents section. In the contents of the view there is a set of shapes on different mask layers, called figureGroups in EDIF, and an instance of another cell. The figureGroup will refer to a figure group defined in the technology library.

2

```
(EDIF OPAMP_SCH
 (status
  (EDIFVersion 1 1 0)
  (EDIFLevel 0)
  (Written
   (TimeStamp 1991  2  9 14  5 40)
   (comment "The ABOVE TimeStamp is local time")
   (accounting Program "NETLIST.EXE")
   (accounting ProgramVersion "    V3.20a  26-Jan-89")
   (comment "(C) Copyright 1985,1986,1987 OrCAD Systems.")
   )
  )
 (external ANALOG_LIB)
 (external ASSEMBLY_LIB)
 (external CMOS_LIB)
 (external DEVICE_LIB)
 (external INTEL_LIB)
 (external MOTO_LIB)
 (external PSPICE_LIB)
 (external SHAPES_LIB)
 (external SPICE_LIB)
 (external TTL_LIB)
 (external POWER_LIB)
 (design OPAMP_SCH (qualify lib root))
 (library lib
  (cell root
   (status
  (Written
   (TimeStamp 1991  2  9 14  4  4)
   (comment "The ABOVE TimeStamp is local time")
   (comment " February  9, 1991")
   )
  )
 (view NETLIST root_NET
  (interface
   (define input port VSS)
   (define input port IBARP
    (rename IBARP "I/P"))
   (define output port OBARP
    (rename OBARP "O/P"))
   (define input port X_PLUS5V
    (rename X_PLUS5V "+5V"))
   (define input port GND)
   )
  (contents
   (instance (qualify PSPICE_LIB X_10K) X_10K_NET R1)
   (instance (qualify PSPICE_LIB X_10K) X_10K_NET R2)
   (instance (qualify DEVICE_LIB X_0_01UF) X_0_01UF_NET C2)
   (instance (qualify PSPICE_LIB X_6_8K) X_6_8K_NET R4)
   (instance (qualify PSPICE_LIB X_10K) X_10K_NET R3)
   (instance (qualify ANALOG_LIB X_741) X_741_NET U1)
   (instance (qualify DEVICE_LIB X_10UF) X_10UF_NET C1)
           (joined
            (qualify C2 X_1)
            (qualify R2 X_1)
            (qualify R1 X_2)
            (qualify U1 MINUS_INPUT)
            )
           (joined
            (qualify C2 X_2)
            (qualify R2 X_2)
            (qualify U1 OUTPUT)
            OBARP
            )
           (joined
            IBARP
            (qualify C1 X_1)
            )
           (joined
            (qualify C1 X_2)
            (qualify R1 X_1)
            )
           (joined
            (qualify U1 PLUS_INPUT)
            (qualify R3 X_2)
            (qualify R4 X_1)
            )
           (joined
            (qualify U1 PLUS_V)
            X_PLUS5V
            (qualify R3 X_1)
            )
           (joined
            (qualify R4 X_2)
            GND
            VSS
            (qualify U1 MINUS_V)
            )
           )
          )
         )
        )
       )
```

910099-12

3



The Symbolic view contains the description on elements of connectivity and geometric layout. It can be used to describe placement and routeing problems, and to transmit symbolic layouts for technology re-mapping. Under the Symbolic view, the construct elements specified in the Interface and Contents sections may be implemented.

The Schematic view is used for the transmission of logic data and schematic diagram plus connectivity. The cells include logic elements and symbols.

An EDIF netlist application

Netlist is a list of components and connections that describes the connectivity of a circuit (Ref. 2). Figure 2 shows an EDIF file that describes the circuit of the band-pass network shown in Fig. 3. The schematic capture was produced by OrCAD/SDT III software. The EDIF netlist file is one of the formats that the software can support. The details of the file related to the circuit are described below.

OPAMP_SCH is the name of the file. Under the Status construct, the EDIF version and level are specified; the local time and the program (NETLIST.EXE) from which the EDIF file was generated are described in the Written block

Following these, the external library files are referred to; they are named with the extension, LIB, as shown and, in this case, they may be found in the library directory of Schematic capture software.

A root Cell must reside in the Design entity and be a cell in one of the libraries.

The Status block following the Cell root contains information about this particular cell. It then shows the Netlist view of the cell. At the beginning of the view, all input and output ports are defined under the Interface block.

The Rename construct shows the original port name. The designation of components and their electrical values are specified in the Instance construct. Each component value and its related library file are also mentioned with a Qualify construct. For instance, in this case, R_1 has a value of 10 kΩ and belongs to the external PSPICE library file.

Finally, the connectivity of the circuit is described in the Joined blocks. Each Joined block specifies the connections at one node of the circuit. In practice, a number is assigned to the terminals of each discrete component: the left-hand terminal is 1 and the right-hand one is 2. For instance, as shown in the first Joined block, terminal 1 of C_2 and R_2 is joined to terminal 2 of R_1 and the –ve input of U_2.

Conclusion

EDIF Version 1.00, published in 1985, has provided a solution to the data base compatibility problem in the gate array and semi-custom IC designs. Although it is not complete, users have processed a number of successful data base conversion programs. Many CAD software manufacturers have included the format in their products, for instance, OrCAD, HiWIRE, Schema III, and so on.

EDIF Version 2.00 has just been published. This can address many of the problems and difficulties of the earlier version, and meets the needs of real data transfer in the design and manufacture of printed circuit boards. Moreover, it contains provision for behavioural modelling and includes some new constructs, for instance, Net and Property. Unfortunately, even the latest version can not yet do everything: features that are still under development include:

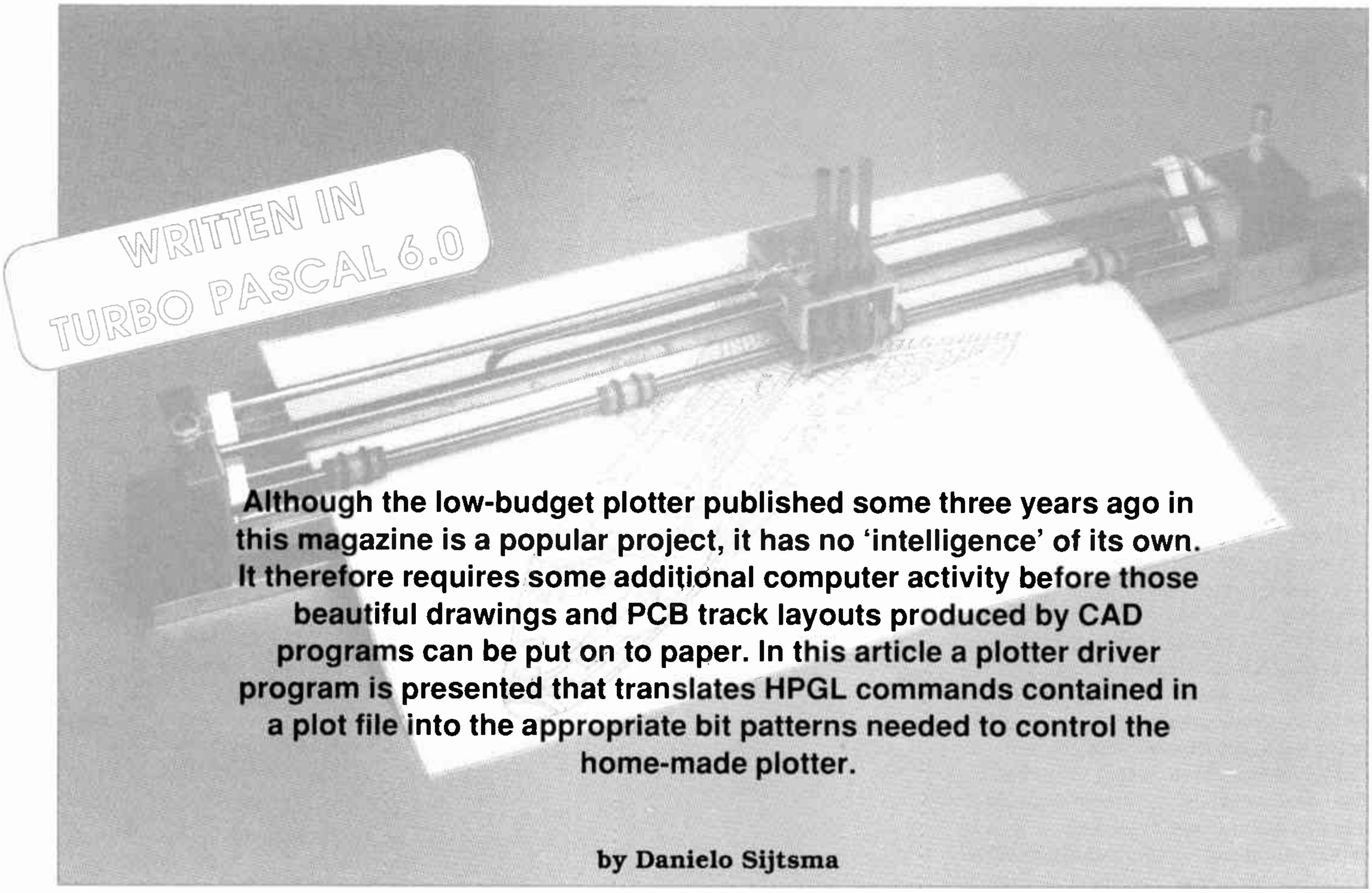
- transfer of design changes;
- PCB layout transfer between CAD systems;
- transfer of data for board testing;
- transfer of data from CAD systems to board manufacture;
- electrical design rules.

These features may form part of the next version. However, there will be a significant performance penalty to using EDIF for data exchange, because the format tends to require more storage space than the CAD data, and may slow down the data base conversions. Simplification and more advanced constructs may, therefore, be required. ■

***References*:**

1. *EDIF Specification*, Version 1.00, March 1985.
2. "Shaping up the Netlist", by Tony K.P. Wong, *Electronics World*, Vol. 96, No. 1656, Oct. 1990.
3. "Focus Report: Engineering Software", *IEEE Spectrum*, Vol. 27, No. 11, Nov. 1990, pp. 60–85.

PLOTTER DRIVER



Although the low-budget plotter published some three years ago in this magazine is a popular project, it has no 'intelligence' of its own. It therefore requires some additional computer activity before those beautiful drawings and PCB track layouts produced by CAD programs can be put on to paper. In this article a plotter driver program is presented that translates HPGL commands contained in a plot file into the appropriate bit patterns needed to control the home-made plotter.

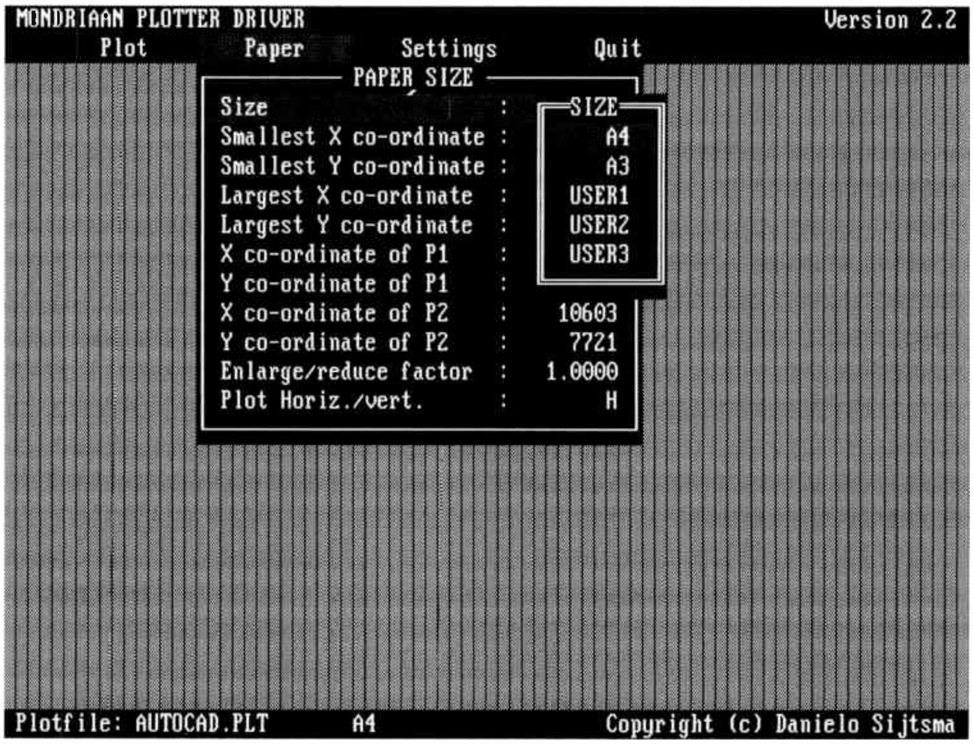
by Danielo Sijtsma

FOR those of you who have not followed the story so far: the plotter referred to above is a mechanical as well as electronic construction project described in Ref. 1, with some useful mechanical alterations brought together in a follow-up article, Ref. 2. The second article also describes a partly HPGL-compatible plotter driver, which is less sophisticated than the one discussed here. It may be useful to know that the modified version of the plotter is available as a kit from some regular advertisers in *Elektor Electronics*. It must be noted, though, that the contents of their kits may deviate from the modified mechanical parts list included in Ref. 2.

The driver program

CAD programs — or more generally, drawing programs — such as AutoCAD, OrCAD, DrawPerfect, Ultiboard and Smartwork, to mention but a few, provide drivers for plotters that work with a certain industry-standard 'language', for instance, HPGL (Hewlett Packard Graphics Language). Since the *Elektor Electronics* plotter is not compatible with any graphics language, it requires a conversion operation in which the commands contained in the computer output file are converted into appropriate bit combinations that can be applied to the interface board that belongs with the plotter. In practice, this conversion operation is carried out by the program described here. This program accepts HPGL input data, translates this into a series of plotter commands, and drives the plotter via the Centronics port on the PC and the interface board attached to the plotter.

The plotter driver program is written in Turbo Pascal 6.0, and comes on one 5¼-inch 360 KByte MS DOS formatted floppy disk. The program is suitable for MS-DOS computers only. It can be modified to drive plotters other than the *Elektor Electronics* one by adapting a number of procedures in one of the source files. Evidently, to be able to make such modifications you must be conversant



with the Turbo Pascal 6.0 compiler. The basic information on the modifications is contained in the source file itself.

The plotter driver program, PL.EXE, translates HPGL files into control commands for the *Elektor Electronics* plotter, and in addition allows a number of plotter-specific parameters to be defined.

Before the plotter driver can be used, the drawing made on the PC must be converted into an HPGL file. Most CAD programs can do this without problems when an HPGL-compatible plotter (e.g., the HP7475A) is selected in the output menu, and the plot file is printed to disk. When the HPGL file is available on the system, the plotter driver, PL.EXE, may be called up to complete the conversion into plotter commands. Completely menu-driven, the converter program is uncomplicated in practical use.

Hardware recap and tuning

The interface board with the *Elektor Electronics* plotter is connected to the Centronics port of the PC as shown in Fig. 1. Note that a number of pins on the Centronics connector are tied to +5 V to make them permanently logic high. The +5 V can be taken from the plotter interface via an unused wire in the cable to the Centronics port on the PC. For connector pin functions, look in the file PLPROC.PAS on the diskette.

Before you can start plotting a drawing, a number of parameters must be set. This is done in the 'settings' menu, and in particular, in the sub-menu 'mechanical characteristics'.

Wait time between steps

This parameter determines the plotting speed. The larger the wait time, the slower the plotting, but the more accurate the result. Since the wait time is set by means of a software counter, it may have to be adapted in accordance with the clock speed of the computer.

Half step

The half step parameter determines the final resolution of the plotter. When you switch the motors from half step mode to full step mode, the size of the plotted drawing will remain the same, i.e., the co-ordinates are rescaled internally.

Wait time between pen up/down

This is a constant that must be determined empirically for best results. It provides a certain delay before a pen is lifted or put down on the paper.

Y-compensation factor

This factor is a constant that allows differences in the resolution between the X and Y driving systems to be compensated. It is programmed by writing the following line of ASCII text, and sending it to the plotter:

```
PR1000,0; PR0,1000 ^Z
```

Make sure that the clipping area (see 'paper size') is not effective, and if necessary adapt the enlarge factor. The Y factor is obtained by dividing the distance travelled in the X direction by the distance travelled in the Y direc-

THE HPGL COMMAND SET — AN INTRODUCTION —

HPGL (Hewlett-Packard Graphics Language) commands are abbreviations of plotter control instructions. An HPGL file may be written with any ASCII-compatible word processor, and consists of HPGL commands and co-ordinates. The best known commands from the HPGL set are probably PA (plot absolute), SP (select pen), CI (circle) and LB (label).

The number of HPGL commands supported determines whether or not a certain plotter can be used with a drawing program. Most drawing programs use only a few of the 50 commands available in the HPGL. The well-known AutoCAD package is a good example, because it uses the HPGL basic commands only, such as PA (plot absolute) and SP (select pen). Texts generated with AutoCAD are plotted as series of PA commands rather than with the aid of the LB (label) command. The same goes for circles and arcs, which are also plotted with PA command strings. There are, however, other programs that use a much larger subset of HPGL commands. If you want to know if the *Elektor Electronics* plotter can be used with your drawing program, it is best to check the commands contained in a generated plot file against the commands supported by the driver program presented in this article.

Supported HPGL commands

The plotter driver program discussed here supports all the HPGL commands necessary to work with most commonly used drawing programs. In practice, the driver has been tested successfully in conjunction with AutoCAD, OrCAD, Ultiboard, Smartwork and DrawPerfect.

The HPGL commands supported by the author's Turbo Pascal 6.0 program are:

PU (X1,Y1)(,...):	Pen Up
PD (X1,Y1)(,...):	Pen Down
PA (X1,Y1)(,...):	Plot Absolute
PR (X1,Y1)(,...):	Plot Relative
CI radius(,chord angle):	CIrcle
AA X,Y,arc angle(,chord angle):	Arc Absolute
AR X,Y,arc angle(,chord angle):	Arc Relative
LB ASCII string (c):	LaBel ASCII string
DTc:	Define label Terminator (c)
SI width, height:	absolute character SIze
SR width, height:	Relative character Size
DI cos,sin:	absolute DIrection
SP n:	Select Pen
SC Xmin, Xmax, Ymin, Ymax	SCale into user units
IP P1x,P1y(,P2x,P2y):	InPut P1 (,P2)
IN:	INitialize
DF:	set DeFault values

Optional parameters in brackets (); parameters are delimited with a comma. HPGL commands in a plot file may be separated by a comma. The plot file may contain carriage returns (CRs) and line feeds (LFs) which are ignored by the driver. These control codes may however help to improve the readability of the plot file.

Co-ordinate system

A number of plotter commands are followed by co-ordinates, which can be absolute (i.e, with respect to the origin), or relative (i.e., with respect to the current pen position) depending on the preceding command.

The unit of distance used in the co-ordinate system is a plotter unit rather than a SI unit such as the millimetre. The values assigned to the co-ordinates depend more on the resolution used by the drawing program than on the size of the drawing. The plotter units used by the *Elektor Electronics* plotter are determined by the resolution of the stepper motors and the mechanical drive systems. In half-step mode, a resolution of about 0.1 mm is achieved.

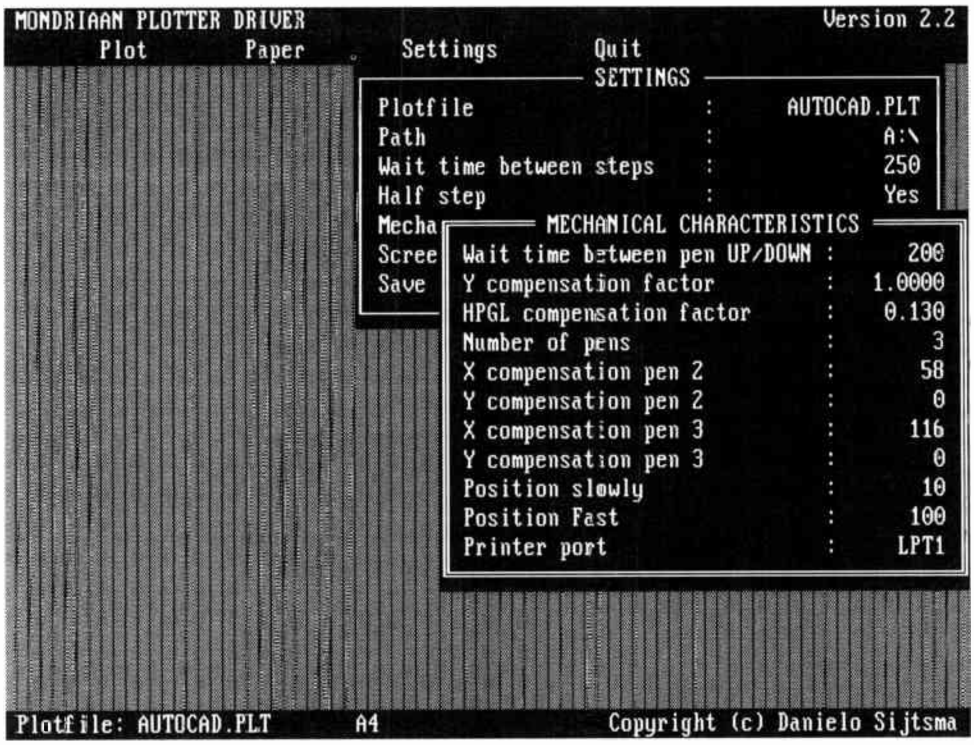
The HPGL provides the SC command for plotter-unit to user-unit conversion. The SC command also allows the origin to be moved, for instance, from the centre of the paper to the lower left-hand corner.

Another, related, scaling command, IP, enables two reference points to be defined, P1 and P2, which are also used during rescaling to user units. The SR command, which sets the relative character size, is also related to the reference points P1 and P2.

All the juggling with co-ordinates is of little interest to the user, who is only after the final size of the drawing. This size will depend on the drawing program used. A scaling manipulation feature must be built into the plotter driver or the drawing program to enable the output of different programs to be drawn on one (maximum) paper size.

In the drawing program, the scale is entered as a parameter together with the plot command, or as a global setting in the program itself. This allows the co-ordinates to be converted directly to the co-ordinates that belong with the new scale. Alternatively, the SC (scale into user units) command may be placed at the beginning of the plot file to enable the plotter driver to do the co-ordinate conversion itself.

When the driver is used to scale co-ordinates, this is best done with the aid of the reduce/enlarge option of which the parameters can be set via the 'paper' menu. ❑



tion: Y factor = dX/dY. The larger the distances travelled, the more accurate the Y factor.

X- and Y-compensation pen 1/2/3
These parameters serve to compensate the distance between the pens in the carriage. Enter the following text in an ASCII word processor, and send it to the plotter:

PU; SP1; PD; PU; SP2; PD; PU; SP3; PD; PU ^Z

This should produce a single spot on the paper without off-set between the individual dots made by the pens.

Number of pens
Optionally, you may work with fewer than three pens. The pen numbers in the SP commands are counted in a cyclic manner. When, for instance, the driver encounters the command 'SP3' (select pen 3), while the maximum number of pens is set to 2, pen 1 is selected.

Paper size
This parameter speaks for itself. The X and Y co-ordinates are not the HPGL co-ordinates in the plot file, but the maximum number of steps to be made by the stepper motors on the plotter. The limits that belong with a certain paper size setting can be calculated on the basis of the diameter of the platen and the string wheel for the carriage drive, and the number of steps per spindle revolution of the stepper motors used. Next, the enlarge/reduce factor is used to fit the drawing on the selected paper size. When the co-ordinates of the drawing fall outside these borders, the relevant part of the drawing is not plotted, and a warning is given when the plotting is finished.

Trouble shooting and user hints

It is very well possible that the first results obtained with the plotter and the driver program will look like drawing attempts of a two-year old. Any one with some experience in setting up electromechanical drawing equipment will confirm this without shame.

In the worst case, nothing is plotted. First, check whether manual pen positioning works (go to the sub-menu 'plotting'). If this works, you have probably loaded a non-HPGL compatible plot file (the name of the file processed is displayed in the lower left-hand corner of the screen).

A problem reported by many constructors of the *Elektor Electronics* plotter has to do with the lifting and lowering of the pens. First, check that the pens can move up and down without friction. Marker pens in particular are prone to remaining stuck. This happens because the lever that lifts the pen remains stuck to the core in the solenoid (lift magnet). The problem is simple to eliminate by sticking a small piece of self-adhesive tape between the core and the lever. This creates a small air gap between these two metal parts, and reduces the risk of sticking (caused by permanent magnetism) to a minimum.

'Real' plotter pens are much heavier than marker pens, and are much more likely to remain down on the paper because the solenoid in the carriage is incapable of lifting the weight. There are two possible solutions to this problem:

- reduce the tension of the solenoid springs, or remove them altogether;
- increase the value of capacitors C2, C3 and C4 on the interface board from 470 µF to 1,000 µF.

The distance between the lever and the pen is critical. When the lever is too close to the pen, it can not move freely. Conversely, when the distance is too great, the pen can bounce up when it is lifted. The critical distance can be 'tuned' by bending the 'rear leg' of the solenoid a little forward or to the rear.

If the plotted drawing is mirrored with respect to that produced with the CAD program, simply reverse the connections to one of the stator windings on one of the stepper motors.

Paper slip may be caused by insufficient pressure on the platen. The correct amount of pressure must be determined empirically by fitting springs with different tensions.

Another type of slip (in the X as well as in the Y direction) may occur when the platen or the string wheel for the carriage movement is not fitted securely on the spindle of the relevant stepper motor. ■

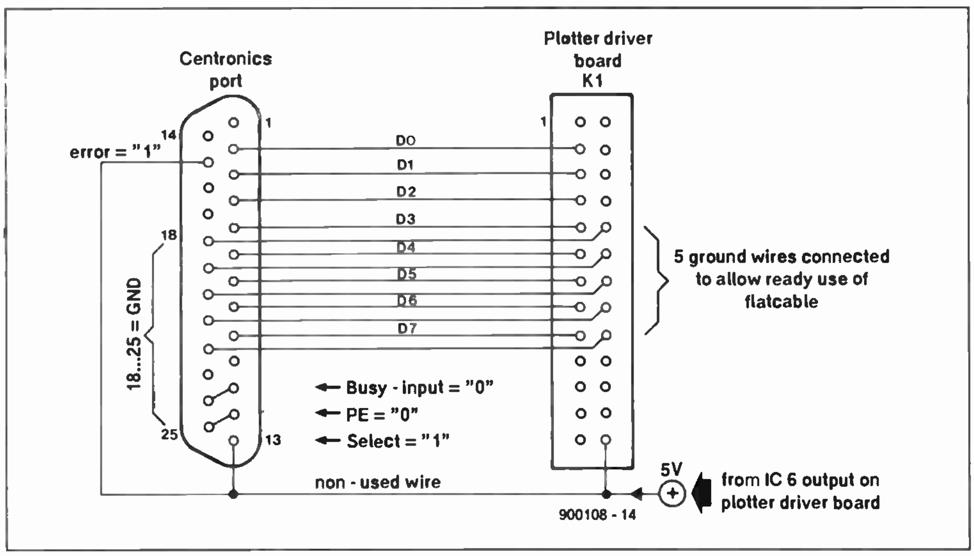


Fig. 1. Hardware recap: suggested connections between the PC Centronics port and the plotter driver board.

SOFTWARE ON DISKETTE

The plotter driver program and configuration utilities described in this article are available on a 5¼-inch 360 KByte MSDOS formatted floppy disk under order number ESS1541. Details on cost and ordering are given on the Readers Services page elsewhere in this issue.

References:

1. "Plotter," *EE*, May and June 1988.
2. "Plotter Mark II," *EE*, March 1990.

LETTERS

FORMULA ON TARGET

When I received the April issue of *Elektor Electronics USA*, I perused it cover to cover. I emphatically agree with Henry Armstrong (p. 66).

My interest lies in the area of power and its control and conversion. Will you have any circuits on DC to AC inverters; 100W, 200W, 400W, 1kW and 2kW, 5kW especially 60Hz sine wave and stable over some range; or alternative energy devices and controls like battery monitors and charge controllers? The whole world would do better if we had solid-state timers and controls for a lot of our appliances like the mechanical controls on present washers and dryers. Simple, dedicated task test instruments, and various weather monitoring and recording devices would also be welcome.

The magazine speaks British English very well. With a little filing and buffing, I believe it can get its US citizen papers and be a real winner.

Walter Jankowski
Golden, CO 80403-9054

A WELCOME RELIEF

I recently responded to your introduction of the periodical *Elektor Electronics USA*. I am familiar with this publication, having purchased occasional copies during travels to Europe during the 1970s, and have built a number of projects from its pages over the years.

As a charter subscriber to *Audio Amateur*, *Speaker Builder*, and *Computer Smyth* [*no longer published*], let me commend you for making high-quality audio and electronics construction (and tutorial) material available to the US audience. It is a welcome relief from the "batteryless code practice oscillator" and the "solar powered night light" construction articles of many of the popular electronics magazines. With the demise of Dynaco and Heath as sources of moderate quality (and cost) audio equipment, and the disappearance of serious construction articles from *Audio*, you remain as a continuing source of high-quality information and circuits for the dedicated audiophile.

In specific response to a remark made, I believe, in one of the consumer publications concerning your offering of *Elektor Electronics USA*, I have never had any problem with the 6k2 designations for the 6.2kΩ resistor, nor have I had any difficulty in figuring how large to make a 120mm × 200mm PC board. Please leave the articles in *Elektor* as they are and without the inevitable parenthetical conversions to US nomenclature or dimensions.

James D. Pryce
Dayton, OH 45424

RIDICULOUS FORMULA

I hope the reason you published the letter "Formula for Success" by Henry H. Armstrong (*EE* 4/91, p. 66) was in the spirit of an April the First type of issue. I suspect not, however, and so I must respond to it.

While he has some valid points regarding hard-to-find US parts, or the American equivalent of European parts, I believe much of his other criticism is unwarranted. For example, for him to say, "Make certain the schematics are complete and accurate. Also include full-sized printed circuit drawings where applicable *and see to it no ink runs between circuit lines*" (italics mine) is patently ridiculous. It shows a complete lack of understanding of how writing, editing, and composing articles is done, and also a lack of understanding of the publishing process in general.

In particular, it shows a complete lack of understanding of how *Elektor Electronics USA* is put together. Absolutely nothing is wrong with European symbols or schematics, or being able to buy ready-made PC boards for projects. In fact, the European style of schematic lends itself easily to PC board layout when compared to a typical US schematic. It is much easier to see where components might fit due to different sizes and connection (nodal) requirements. In the past, I have thought about writing an article on using "experimenter" boards for project building, and how the average "hardware hacker" can lay them out easily.

I had a book called *Introduction to Radio Wave Propagation* (BP293) published by Bernard Babani (publishing) Ltd., London, England. In writing it I used words like "aerial" instead of "antenna," "AC mains" instead of "AC power," "programmes" instead of "programs," "thousand-million" instead of "billion," and so on, and I had no trouble composing the text. (And I speak your basic Yankee English.)

I submit that with all his criticisms, Mr. Armstrong would be much happier publishing his own magazine. Yes, some things are wrong with American publications (I have voiced the same objections myself), but editorial style is not dictated solely by the readership. Nor should it be, particularly when more than one continent is involved.

My English publisher has excellent books for the "average electronics hobbyist," books that start at basic levels and continue into a broad area of electronic interests. He should get one of their catalogs—oops, catalogues—and go through it. They have a "book stockist" in New York in case he's interested.

Well, enough for now. Keep up the good work and keep the same format and projects coming. Nothing is wrong with having "audio" articles in the issues.

One final note: although most stocking distributors have a minimum charge for orders (they do have expenses, salaries, and overhead to pay), some do not if the order is prepaid. Two that come to mind are Circuit Specialists and DC Electronics in Scottsdale, AZ. Credit card orders are charged a $10 minimum at this time. And by the way, Jameco now has a $50 minimum on all orders.

I think the pot has been stirred sufficiently, so as my British friends say, "with kind wishes and best regards."

James G. Lee
San Jose, CA 95129

We Enjoy Hearing From You. *Elektor Electronics USA* is a place for readers to meet and discuss ideas, projects, and challenges. When you write, please include a self-addressed envelope with stamp attached with a clip if you expect a reply. If the author lives outside of the US, please include two International Postal Reply coupons (available at your post office) instead of stamps on your envelope. Because of space limitations, we do reserve the right to edit all letters. Although we read and note all letters, only those of general interest are selected for publication. When responding to an article, please cite the name of the magazine, article, letter, department, and the page number. Address all correspondence to the **Letters Department**, *Elektor Electronics*, Box 576, Peterborough, NH 03458.

READERS SERVICES

All orders, except for subscriptions, should be sent to Old Colony Sound Lab: by mail to PO Box 243, Peterborough NH 03458-0243; Visa/MasterCard charge orders by FAX to (603) 924-9467 (24 hours) or by voice 8–4 weekdays to (603) 924-6526 or 6371. Please use the form opposite for all orders. All prices are postpaid to customers in the fifty states except for books. **Please add $2.00 for the first book and 75¢ for each additional book ordered. Canadians, please add $4.50 US for the first book, and 75¢ for each additional one. Outside North America, please add 20%.** Canadians may expect Canadian duty charges on shipments of any items except books and subscriptions.

SUBSCRIPTIONS

Subscriptions can be provided anywhere in the United States and its territories as well as Canada by sending mail subscriptions to *Elektor Electronics USA*, PO Box 876, Peterborough NH 03458-0876. Visa/MasterCard orders may be telephoned directly to (603) 924-9464 between 8 and 4 on business days and to our machine recorders at other hours and on weekends. Orders may be FAXed at any time to (603) 924-9467. US subscription rates: $28 for one year (11 issues); $50 for 2 years. Canadian rate: $38.80 for one year. Student rate to full-time, registered students, $15 per year (photocopy of student ID required).

PAST ISSUES

Back issues of the British *Elektor* from July/August 1987 onward are available from Worldwide Subscription Service Ltd., Unit 4, Gibbs Reed Farm, Pashley Road, Ticehurst TN5 7HE, England, United Kingdom. Single copies are $4.50 surface mail, $7.50 airmail. Back issues of *Elektor Electronics USA* from October 1990 onward (except 2/91) are available from Old Colony for $4 postpaid, $6 for July/August or December double issues.

PAST ARTICLES

Photocopies of articles from the British *Elektor* from January 1979 onward are available from Old Colony Sound Lab for $5 each (multi-part articles: $5 per part); $6 in Canada. Indexes are available. Send a stamped (50¢), self-addressed business-size envelope to Old Colony, at the address above, for **EACH YEAR** desired. A complete set of indexes for 1979–90 is available for $7.50 postpaid. Also available postpaid:
Digital model train (13 parts)........$15.00

TECHNICAL QUERIES

Although we are always prepared to assist readers in solving difficulties they may experience with projects that have appeared in *Elektor Electronics USA*, we regret that these cannot, under any circumstances, be dealt with by telephone or FAX.

COMPONENTS

Components for projects appearing in *Elektor Electronics USA* are usually available from appropriate advertisers in this magazine. If you have difficulty finding parts, please send a self-addressed postcard listing the parts you desire and we will attempt to locate a source. If difficulties in the supply of components are envisaged, a source will normally be advised in the article.

BOOKS

The following *Elektor* books are currently available from Old Colony Sound:

301 Circuits	$12.50
302 Circuits	$12.50
303 Circuits	$15.95
Data Sheet Book 2	$16.50
Databook 3	$17.95
Databook 4	$17.95
Microprocessor Data Book	$17.90

SHELF BOXES

Blue heavy-duty *Elektor* vinyl shelf box (holds 6 issues)....................$6.00

OLD COLONY SOUND LAB — ORDER FORM

PO BOX 243
PETERBOROUGH, NH 03458

TELEPHONE CHARGE ORDERS
(603) 924-6371, 924-6526
Answering machine before 8 a.m.,
FAX: (603) 924-9467, 24 hours

CUSTOMER ADDRESS	SHIPPING ADDRESS IF DIFFERENT
NAME	NAME
STREET & NO.	COMPANY
CITY STATE ZIP	STREET & NO.
MAGIC NUMBER (FROM SUBSCRIPTION LABEL)	CITY STATE ZIP

PAYMENT METHOD FOR CHARGE CARD ORDERS UNDER $10, PLEASE ADD $2.

☐ CHECK ☐ MONEY ORDER ☐ MASTERCARD ☐ VISA

CARD NUMBER________ EXPIRES____/____

AUTHORIZED SIGNATURE________ DAYTIME PHONE________

Qty.	Part Number and Description	Price	Total
	CALL OR WRITE FOR YOUR FREE OLD COLONY CATALOG!		

Please supply the following: For PCBs, front panel foils, EPROMs, and cassettes, state the part number and description; for books, state the full title; for photocopies of articles, state full name of the article and month and year of publication. Please use block capitals.

SUBTOTAL
SHIPPING
TOTAL

FRONT PANEL FOILS

PROJECT	No.	Price $	Issue
Video mixer	87304-F	33.00	1-4/90
The complete preamplifier	890169-F	15.00	3/91
All solid-state preamplifier	890170-F1	33.50	12/89
	890170-F2	18.50	1/90
LF/HF signal tracer	890183-F	18.50	12/89
Q meter	900031-F	23.00	4/90
Budget sweep/ function generator	900040-F	20.00	5/90
High current h_{FE} tester	900078-F	28.00	2/91
400W lab power supply	900082-F	35.00	10-11/90
Variable AC PSU	900104-F	28.00	6/91
Universal battery charger	900134-F	11.00	6/91
Milliohmmeter	910004-F	28.00	12/90
Wattmeter	910011-F	16.50	4/91
Digital phase meter	910045-F	20.00	6/91
Timecode interface	910055-F	15.00	9/91

EPROMS/PALS/MICROCONTROLLERS

PROJECT	No.	Price $	Issue
Multifunction measurement card for PCs	561	17.50	2/91
MIDI control unit (1 x 27C64)	570	20.00	6-7/90
Digital model train (1 x 2764)	572	33.50	2-5,7/89–4/90
Darkroom clock (1 x 27128)	583	18.50	2/90
Slave indication unit for I.T.S. (1 x 8748H)	700	30.00	3/88
EPROM emulator (1 x 8748H)	701	30.00	12/89
Microcontroller-driven power supply (1 x 8751)	702	95.00	5,6,9/88
Autonomous I/O controller (1 x 8751)	704	95.00	12/88
Video mixer (1 x 2764)	5861	20.00	1-4/90
Four-sensor sunshine recorder (1 x 27128)	5921	20.00	6/90
μP-controlled telephone exchange (1 x 27128)	5941	26.00	10/90
MIDI program changer (1 x 2764)	5961	26.00	4/91
Logic analyzer (IBM interface) (1 x PAL 16L8)	5971	14.00	1-2,4/91
MIDI-to-CV interface	5981	26.00	2/91
Multifunction I/O for PCs (1 x PAL 16L8)	5991	14.00	7-8/91
Stepper motor board (1) (1 x 16L8)	6011	14.00	6/91
8751 programmer (1 x 8751)	7061	70.50	11/90

DISKETTES

PROJECT	No.	Price $	Issue
Digital model train	109	11.50	2-5,7/89–4/90
Logic analyzer for Atari ST (b/w only)	111	20.00	10/89
Computer-controlled Teletext decoder	113	20.00	10/89
Plotter driver (Lewetz)	117	11.50	5-6/88
FAX interface, IBM PCs	119	14.00	6/90
RAM extension for BBC-B	123	10.00	7/89
EPROM simulator	129	11.50	12/89
RS-232 splitter	1411	11.50	4/90
Centronics ADC/DAC	1421	11.50	5/90
Transistor characteristic plotting (Atari ST b/w)	1431	13.00	5/90
ROM-copy for BASIC	1441	13.00	9/90
Multifunction measurement card for PCs	1461	13.00	2/91
8751 programmer	1471	13.00	11/90
PT100 thermometer	1481	13.00	11/90
Logic analyzer software, incl. GAL			
IBM	1491	33.00	6/91
Atari	1501	33.00	6/91
Plotter driver (Sijtsma)	1541	19.00	9/91
PC-controlled weather station (1)	1551	13.00	3/91
I/O interface for Atari	1571	13.00	4/91
Tek/Intel file converter	1581	13.00	4/91
B/W video digitizer	1591	19.00	7-8/91
Timecode interface	1611	13.00	9/91
RTC for Atari ST	1621	13.00	6/91

PRINTED CIRCUIT BOARDS

PROJECT	No.	Price $
MARCH 1991		
The complete preamplifier		
input board	890169-1	44.40
main board	890169-2	67.00
Electronic exposure timer	900041	18.50
PC-controlled weather station (1)	900124-3	7.50
2m band converter	900006-1	8.50
APRIL 1991		
Logic analyser (3) control board	900094-5	31.50
MIDI program changer	900138	11.50
8-bit I/O for Atari	910005	21.00
6m band transverter	910010	19.50
Wattmeter		
meter board	910011-1	11.00
display board	910011-2	7.00
MC preamplifier	910016	18.00
Dimmer for halogen lights		
transmitter	910032-1	7.00
receiver	910032-2	7.50
MAY 1991		
8032/8052 computer	910042	20.50
Battery tester	906056	7.00
Moving-magnet (MM) preamplifier	900111	11.50
Universal I/O interface for IBM PCs	910046	18.50
JUNE 1991		
Universal battery charger	900134	16.00
Logic analyser (4)		
power supply board	900094-7	15.00
Atari interface	900094-6	21.50
IBM interface	900094-1	24.50
Digital phase meter (set of 3 PCBs)	910045-1/2/3	44.50
Light transceiver	UPBS-1	3.90
Variable AC PSU	900104	10.50
Light switch w/TV IR r/c	910048	9.50
RTC for Atari ST	910006	10.50
Stepper motor board (1) PC insertion card	910054	49.50
JULY/AUGUST 1991		
Multifunction I/O for PCs	910029	41.50
B/W video digitizer	910053	38.50
Stepper motor board (2) power driver board	910054-2	48.50
LED voltmeter	914005	9.50
Wien bridge	914007	7.00
Angled bus extension card for PCs	914030	20.50
Sync separator	914077	7.50
SEPTEMBER 1991		
Timecode interface for slide control		
main board	910055	41.50
display board	87291-9A	7.00
Asymm-symm converter	910072	9.50

TERMS OF BUSINESS

PRICING
Prices, except as noted, include shipping in the continental USA. The minimum order is $10. A $2 service charge will be added to orders of less than $10. Prices are subject to change as our costs change. WE RESERVE THE RIGHT TO MAKE PRICE CHANGES WITHOUT NOTICE.

TELEPHONE ORDERS
Telephone orders are welcome between the hours of 9:00 a.m. and 4:00 p.m. EDT, Monday-Friday. Orders for parts are to be made on the ORDER FORM provided. Payment for telephone orders is by MC/VISA only. Our TELEPHONE ORDER NUMBER IS (603) 924-6371 or 924-6526. Our answering machine for MC/VISA orders during non-business hours is (603) 924-6371. FAX: (603) 924-9467 (24 hours).

PAYMENT
All remittances **MUST BE IN US FUNDS DRAWN ON A US BANK.** Payment for telephone orders must be made by MasterCard or VISA. Mail order payment may be made by MC/VISA, money order, cashier's check or personal check. If payment is made by personal check, allow up to 2 weeks for clearance before order is shipped. Should check be returned for any reason, there will be a $10 charge.

SHIPPING
Unless noted, freight is prepaid by Old Colony. All orders shipped USPS first class mail or by UPS. Allow two to three weeks for delivery. Please inquire about appropriate funds for special handling (UPS next day or second day). UPS requires a street address. If you cannot receive UPS delivery, please include an extra $2 for insured service via Parcel Post. We cannot accept responsibility for safety or delivery of uninsured Parcel Post shipments. **Absolutely no COD shipments.**

BOOKS, RECORDINGS, CDs, and SOFTWARE
The shipping/handling charge for the US is $2.00, plus 75¢ each additional item. In Canada, please add $4.50 for the first item, 75¢ each additional. **No returns.** According to the Connecticut Dept. of Revenue Services, Regulation #27, Section 12-426-27, in order to sell software to residents of Connecticut, we must register with the department as well as collect taxes for the state from the purchaser. We regret to inform our customers that we will not sell software to anyone from Connecticut, as it will prove to be too costly and burdensome.

OVERSEAS ORDERS
For orders to be shipped outside North America, add 20% to the total order to cover shipping.

RETURNS
If you wish to return all or part of an order for any reason, please call or write first. If we are in error, correction will be made promptly, without charge.

WARRANTY
We warrant that all items sold conform to the quality and specifications set forth. We make no representations. We accept no responsibility whatever for further use by the customer. We accept no monetary liability in excess of the original cost or replacement of the material if originally defective or damaged in transit.

COPYRIGHT

LIMITATION OF LIABILITY
Elektor Electronics USA shall not be liable in contract, tort, or otherwise, for any loss or damage suffered by the purchaser whatsoever or howsoever arising out of, or in connection with, the supply of goods or services by *Elektor Electronics USA* other than to supply goods as described, or at the option of *Elektor Electronics USA*, to refund the purchaser any money paid in respect of the goods. ■

NOW THAT YOU'VE SEEN OUR NEWEST TREASURE . . .

WHY NOT HAVE A LOOK AT THE REST?

GLASS AUDIO

The newest publication from the folks who bring you *Audio Amateur* and *Speaker Builder*

Glass Audio features the best vacuum tube designs for audio reproduction—past and contemporary. The new designs take advantage of improved components and control techniques that make the end results far superior to anything possible during the early days of audio's rebirth after World War II.

That's why tubes are having such a renaissance of interest as a perfectionist approach to good sound. And that's why tubes are reappearing in original equipment, in high end consumer and professional audio systems.

Published twice a year in June and December, *Glass Audio* will inform you about new innovations in the field and about parts sources. We'll also include modification projects, reviews of technical basics and regular columns such as Tube Troubles, Tube Tips and much more.

Subscribe today!

AudioAmateur
THE JOURNAL FOR AUDIOPHILE CRAFTS

The innovative, independent audiophile journal for the thoughtful and capable music lover

Audio Amateur's articles deal with how audio equipment works, as well as how to build or modify it. Construction and modification articles are plentiful, supplying all needed parts, performance and assembly details. Exceptionally high quality designs.

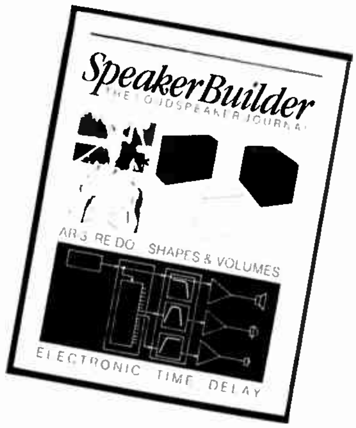
Audio Amateur offers a number of features in each issue that abound with useful ideas. The *Letters* column is an open forum for problem solving and information interchange; *Classic Circuitry* reprints schematics of state-of-the-art gear—old and new; *Audio Aids* relates readers' experience with simple modifications to equipment and construction techniques. We also feature many useful and practical hi-fi accessories you can build to further your audio enjoyment.

For a small investment you can make your music system sound better—very probably a lot better.

SpeakerBuilder
THE LOUDSPEAKER JOURNAL

The magazine that finally deals seriously with the art and craft of speaker building

The *Art* of building a speaker is to optimize that mixture of design and engineering to balance all the parameters for the most beautiful sound possible. The *Craft* is knowing how and why. ***Speaker Builder*** gives you knowledge—from driver parameters and crossovers to woodworking—to develop and refine your techniques, and to get the most out of your system.



Speaker Builder helps you explore new designs with how-to construction articles, and can show you how to modify your old speakers and make them sound better than ever. Learn from our writers who turn abstract theory into practical approaches, and from the experience of other readers who have been down the road before you. ***Speaker Builder*** is the best investment you can make in your system—six issues per year filled with stimulating and exciting ideas.

GLASS AUDIO
- ☐ **Two years,** (4 issues) **$18**
- ☐ **One year,** (2 issues) **$10**

Canada add $2 per year postage

AUDIO AMATEUR
- ☐ **Two years,** (8 issues) **$35**
- ☐ **One year,** (4 issues) **$20**

Canada add $4 per year postage

SPEAKER BUILDER
- ☐ **Two years,** (12 issues) **$45**
- ☐ **One year,** (6 issues) **$25**

Canada add $4 per year postage

NAME

STREET & NO.

CITY STATE ZIP

MC OR VISA NUMBER EXPIRE

AUDIO AMATEUR PUBLICATIONS

PO Box 576, Dept. E91, Peterborough, NH 03458-0576 • (603) 924-9464 • FAX: (603) 924-9467

Answering machine for credit card orders only: before 9:00 a.m., after 4:00 p.m. and weekends. Have all information plus MC/VISA available.

FOR SALE

Nakamichi 350 cassette recorder w/automobile power cord, like new cond., $180; Hitachi UKC600 color video camera w/zoom, $85; D. Neely, 40 Maple Ave., Hampstead, NH 03841, (603) 329-7109.

TRADE

GET YOUR "FCC COMMERCIAL GENERAL RADIO-TELEPHONE LICENSE." Electronics home study. Fast, inexpensive! Free Details! ***COMMAND PRODUCTIONS***, D-266, Box 2824, San Francisco, CA 94126-2824.T1/92

WANTED

FM SCA unit with data, (need to modify), solid state. D. Neely, 40 Maple Ave., Hampstead, NH 03841.

CLASSIFIEDS

Boot disk for Amoro CPM/MPM for IBC Middi Cadet computer; CPM for TRS-80 model 4 and 4p; Osborne executive boot disk; early model Morrow Micro Decision boot disk; SCSI to MFM (ST-506) controller/adapter. 830 Briarwood, Nampa, ID 83651 (208) 466-1931.

DMX 512 Protocol schematic needed also a schematic to drive a series of Addressable stepper motors with light dimmer, will pay. Jack Hill, 13040 Tom White Way #C, Norwalk, CA 90650, (213) 404-0543.

Schematic for Korling radio Model 1007W. Leo Smith, PO Box 945, Yountville, CA 94599.

Apple][+ computers, peripherals, and technical documentation. Especially wanted is an M&R Enterprises 80-column card, or any information leading thereto. Phill Peterson, 15 N. Lincoln St., Redlands, CA 92374-4146, (714) 335-5996 PDT.

CLUBS

CONNECTICUT AUDIO SOCIETY is an active and growing club with activities covering many facets of audio — including construction, subjective testing, and tours of local manufacturers. New members are always welcome. For a copy of our current newsletter and an invitation to our next meeting, write to: Richard Thompson, 129 Newgate Rd., E. Granby, CT 06026, (203) 653-7873.

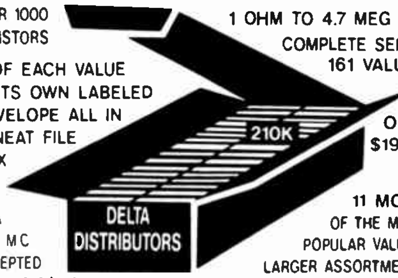
RESISTORS 5% 1/4 WATT

OVER 1000 RESISTORS

1 OHM TO 4.7 MEG THE COMPLETE SERIES 161 VALUES

5 OF EACH VALUE IN ITS OWN LABELED ENVELOPE ALL IN A NEAT FILE BOX

ONLY $19.95



VISA AND M C ACCEPTED

11 MORE OF THE MORE POPULAR VALUES. LARGER ASSORTMENTS AVAILABLE

1 (800) 234-4196

DELTA DISTRIBUTORS - BOX 87R EAST DERRY, N.H. 03041

INDEX OF ADVERTISERS

RECOMMENDED SOURCES FOR ELEKTOR ELECTRONICS USA EUROPEAN PARTS

Borbely Audio
Erno Borbely
Melchior Fanger Strasse 34A
8031 Neu-Gilching
Germany
Tel 49-8105-5291
Fax 49-8105-24605 (24H)

Meek It Electronics
Rob Planken
Paveljoensgracht 35A
2515 BL Den Haag
The Netherlands
Tel 31-70-609554
Fax 31-70-397-9707

C-I Electronics
PO Box 22089
6360 AB Nuth
The Netherlands
Fax 31-45-241877

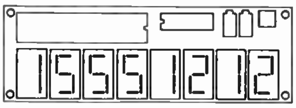
ELV France
BP 40
F-57480 Sierck-les-Bains
France
Tel 33-82-83-72-13
Fax 33-82-83-81-80

Technomatic
Technohouse
486 Church Lane
London NW9 8UF
United Kingdom
Tel 44-081-205-9558
Fax 44-081-205-0190

Bull Electrical
250 Portland Road
Hove
Sussex BN3 5QT
United Kingdom
Tel 44-0273-203500
Fax 44-0273-23077

Note: Although some numbers above may seem to be too long/short, they are correct as shown. USA residents need to preface calls with "011".

HEAR THE TONES...SEE THE NUMBERS!
TOUCH-TONE DECODER/DISPLAY AND ASCII CONVERSION BOARD



***EIGHT DIGIT DISPLAY**
***32 CHARACTER BUFFER**
***ASCII SERIAL OUTPUT**

Model **TDD-8** decodes and displays all 16 DTMF digits and provides an ASCII serial output. Digits are displayed on eight LED's. 32 character memory can be scrolled. It will accept almost any audio source such as a tape recorder, telephone answering machine, scanner, etc. Perfect for remote computer data entry using a telephone keypad. Serial output can be connected to your computer. IBM compatible software included for displaying, storing/printing time, date and number for automatic logging. **Ideal for automatically logging your auto-patch traffic!**

TDD-8 DTMF DECODER/DISPLAY/ASCII	**$99.00**	**MoTron Electronics**
CAB-1 AUDIO & COMPUTER CABLES	**$20.00**	**310 Garfield St., #4**
PS-12 110VAC TO 12VDC POWER PACK	**$10.00**	**Eugene, OR 97402**

add $5 S/H - VISA/MC ACCEPTED

TEL: 800-338-9058 503-687-2118 FAX: 503-687-2492

(Touch-Tone is a trademark of AT&T)

BATTERIES

BATTERIES FOR ALL YOUR POWER REQUIREMENTS

NICKEL CADMIUM
SEALED LEAD ACID
GEL CELLS
MERCURY
ALKALINE
LITHIUM

E.H. YOST & COMPANY
7344 TETIVA ROAD
SAUK CITY, WISCONSIN 53583
TELEPHONE (608) 643-3194
FAX # (608) 643-4439

WorldRadioHistory

RADIO SHACK

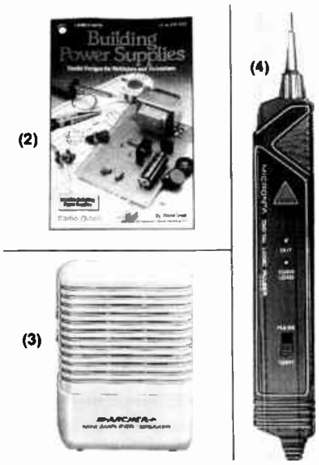
PARTS PLACE℠

(1) **NEW! "Shirt Pocket" Multimeter.** Take it along! Features LCD display, autoranging with manual override, continuity sounder. Measures to 400 volts AC/DC and resistance. With fold-up vinyl case, manual and replaceable batteries. #22-169 .... **27.95**

(2) **NEW! Building Power Supplies.** Easy-to-understand, 96-page book explains linear and switching supplies. Includes complete plans for building five useful supplies with Radio Shack parts. #276-5025 .... **4.95**

(3) **Mini Audio Amplifier.** Great for computer voice/music synthesis, signal tracing and more. Has a built-in speaker, 1/8" headphone jack, 1/8" input jack and volume control. Put one on your bench today! #277-1008 .... **11.95**

(4) **Digital Logic Probe.** LEDs and tone outputs reveal logic states instantly. It's the fast way to check operation and pinpoint problems in all types of digital circuits. #22-303 .... **16.95**



Parts Special-Order Hotline. Your local Radio Shack store stocks over 1000 popular electronic components. Plus, we can special-order over 10,000 items from our warehouse—linear and digital ICs, transistors and diodes, vacuum tubes, crystals, phono cartridges and styli, even SAMS® service manuals. Your order is sent directly to your Radio Shack store and we notify you when it arrives. Delivery time for most items is one week and there are no postage charges or minimum order requirements.

(1) **Shielded RS-232 Jumper Box.** Top-quality inline D-sub 25 adapter. Wire the included jumper wires and board to suit your need. #276-1403 .... **9.95**

(2) **Computer RS-232 Tester.** Dual-color LEDs monitor seven data/control lines to help you spot problems quickly. D-sub 25. Connects inline. #276-1401 .... **14.95**

(3) **Grounded-Tip Soldering Iron.** 15W. #64-2051 .... **7.49**

(4) **Vacuum-Type Desoldering Tool.** #64-2120 .... **6.95**

(5) **Locking Forceps.** 6" long. Stainless. #64-1866 .... **4.95**

(6) **Rosin Soldering Paste Flux.** 1 oz. #64-021 .... **1.79**

(7) **Lead-Free Solder.** 96% tin, 4% silver. 0.25 oz. #64-025 .... **1.99**

(8) **10-Amp Microwave Oven Fuses.** #270-1256 .... **Pkg. of 2/1.29**

(9) **2-Amp Fast-Acting Fuses.** #270-1275 .... **Pkg. of 3/79¢**

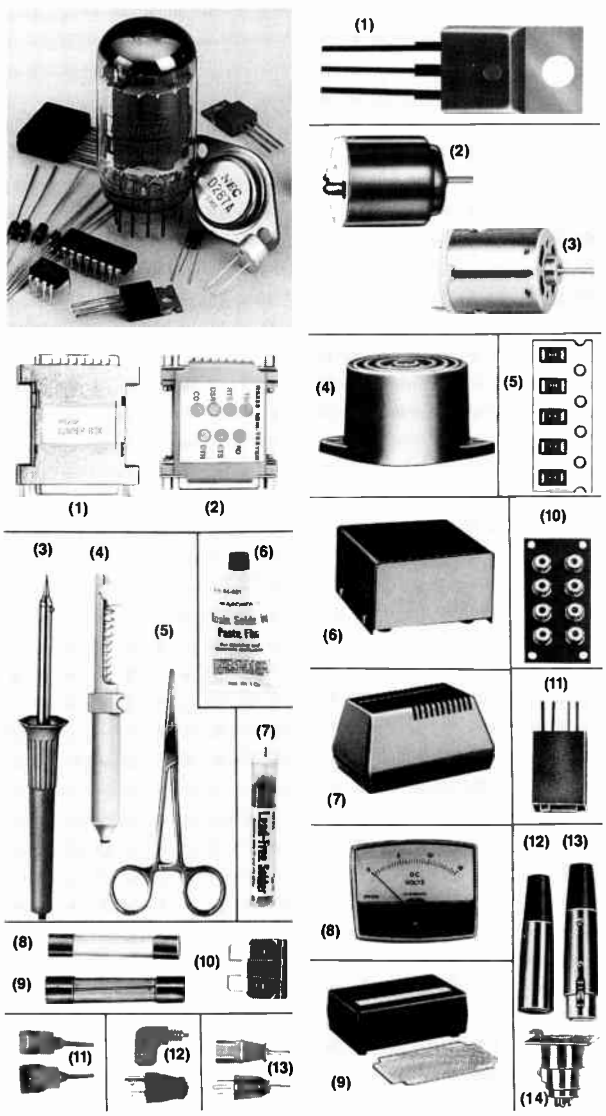
(10) **5-Amp "Blade" Vehicle Fuses.** #270-1205 .... **Pkg. of 2/89¢**

Computer/Printer/Business Machine AC Power Cords. 6 feet long.

(11) **Extension.** Just plug in to lengthen existing cord. #278-1259 .... **4.99**

(12) **With Space-Saving 90° CEE Connector.** #278-1260 .... **5.99**

(13) **With Straight CEE Connector.** #278-1257 .... **3.99**



(1) **Voltage Regulator ICs.** Feature built-in overload protection and thermal shutdown. Great for custom projects. Maximum input: 35VDC.
7805. 5V. #276-1770 .... **1.19**
7812. 12V. #276-1771 .... **1.19**

(2) **Low-Voltage Motor.** Just the thing for science projects, robotics and solar power demos. Operates from 1 1/2 to 3VDC. About 1 1/2" long. #273-223 .... **99¢**

(3) **High-Speed 12VDC Motor.** Up to 15,200 RPM, no load. About 2" long. #273-255 .... **2.99**

(4) **"Ding-Dong" Chime.** This IC and mini-speaker combo is ideal for a customer-entry alert or doorbell. Produces 80 dB sound pressure at 12VDC. Operates from 6 to 18VDC. #273-071 .... **8.99**

(5) **Surface-Mount Resistors.** 200-piece assortment of 15 popular values. Rated 1/8 watt, 5%. #271-313 .... **Set 4.99**

(6) **Metal Project Cabinet.** An attractive, easy-to-drill housing at a low price. 3 x 5 1/4 x 5 7/8". #270-253 .... **6.79**

(7) **Power Supply Project Case.** Vented 2 1/2 x 4 5/8 x 3 1/4" molded case. #270-287 .... **3.99**

(8) **0 to 15 DC Voltmeter.** Quality jeweled movement. #270-1754 .... **7.95**

(9) **Box/Board Combo.** Molded enclosure plus predrilled 2 x 3 1/8" board, labels and more. #270-291 .... **4.99**

(10) **Eight-Position Audio Phono Jack Board.** #274-370 .... **1.69**

(11) **1:1 Audio Transformer.** Z: 600-900Ω. #273-1374 .... **3.59**

(12) **Three-Pin XLR Mike Plug.** Metal body. #274-010 .... **2.99**

(13) **Three-Pin XLR Inline Socket.** #274-011 .... **2.99**

(14) **Three-Pin XLR Panel Socket.** #274-013 .... **3.69**

Since 1921 Radio Shack has been the place to obtain up-to-date electronic parts as well as quality tools, test equipment and accessories at low prices. Our 7000 locations are ready to serve you—NOBODY COMPARES

Prices apply at participating Radio Shack stores and dealers. Radio Shack is a division of Tandy Corporation

Radio Shack®
AMERICA'S TECHNOLOGY STORE