

Radio- Electronics

**BUILD FOR LESS THAN \$10
DIGITAL LOGIC PROBE**

\$1.25 AUG. 1980

audio test accessories to build
uning in worldwide SW stations
tep-by-step TV IF alignment

The ultimate turntable pickup arm?
Inside a VHS videotape recorder
Build your own raceway videogame

**BUILD THIS
ROBOT FOR UNDER \$400**



BUILD

- 37 UNICORN-I ROBOT**
Part 1. Complete with manipulator arms and mobile base, you can build this robot for under \$400. Various levels of control and intelligence are described, including an on-board computer. **James A. Gupton, Jr.**
- 42 RACEWAY VIDEOGAME**
After you build this video game, you can pretend to be an Indy 500 race-car driver without ever leaving the comfort of your armchair. **L. Steven Cheairs**
- 46 6 AUDIO TEST ACCESSORIES**
Construction details for 6 easy-to-build accessories for the audio test bench. Useful for troubleshooting or checking the performance of your hi-fi system. **Gary Stock**
- 54 \$10 LOGIC PROBE**
A necessary instrument for troubleshooting digital circuitry. **Fred Blechman**

TECHNOLOGY

- 4 LOOKING AHEAD**
Tomorrow's news today. **David Lachenbruch**
- 16 SATELLITE TV NEWS**
The latest happenings in an exciting new industry. **Gary H. Arlen**
- 49 PICTORIAL GUIDE TO VHS THREADING**
A look at the threading mechanism inside the VHS videotape recorder. **Forest Belt**
- 66 HOBBY CORNER**
A quick and easy way to make one-of-a-kind printed circuit boards. **Earl "Doc" Savage, K4SDS**

VIDEO

- 62 STEP-BY-STEP TV IF ALIGNMENT**
How to align the video-IF stages of a TV receiver. **Jack Darr**
- 74 SERVICE CLINIC**
Hints for catching the touchy intermittent. **Jack Darr**
- 75 SERVICE QUESTIONS**
R-E's Service Editor solves technicians' problems.

AUDIO

- 56 SERVO-CONTROLLED PICK-UP ARM**
New JVC turntable includes a unique pick-up arm that electronically adjusts the damping characteristics to match virtually any cartridge. **Len Feldman**

RADIO

- 59 TUNING IN WORLDWIDE SW STATIONS**
The RF spectrum is chock full of interesting communications, including INTERPOL, the Strategic Air Command, NORAD, even spies. Here's a look at what's out there and how to tune them in. **Robert Grove**
- 70 COMMUNICATIONS CORNER**
A look at a remote-controlled coax switch for switching bands easily. **Herb Friedman**

EQUIPMENT REPORTS

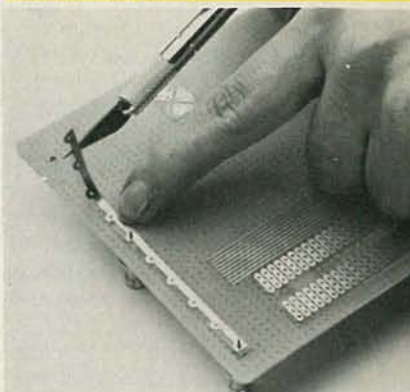
- 26 Leader LSG-16 RF Signal Generator**
- 32 MFJ Enterprises LSP-520BX Speech Processor**
- 34 Hickok 240 Video Pattern Generator**

DEPARTMENTS

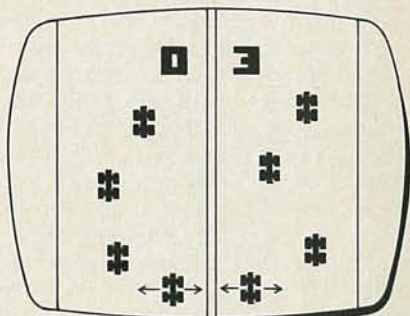
- | | |
|-------------------------------------|-------------------------|
| 94 Advertising Index | 22 Letters |
| 14 Advertising Sales Offices | 78 Market Center |
| 14 Editorial | 69 New Products |
| 95 Free Information Card | 6 What's News |

ON THE COVER

Finally, the construction article you've all been asking for: An 8-part series describing a full blown, fully mobile robot complete with manipulator arms. Options include remote control operation, operation via external computer via the remote-control link and an on-board computer. Suggestions are given for adding senses such as sight and feel. The basic robot, minus the options, can be built for under \$400. Get started building yours today. Complete details start on page 37.



A QUICK AND EASY way to make one-of-a-kind printed circuit boards. The details start on page 66.



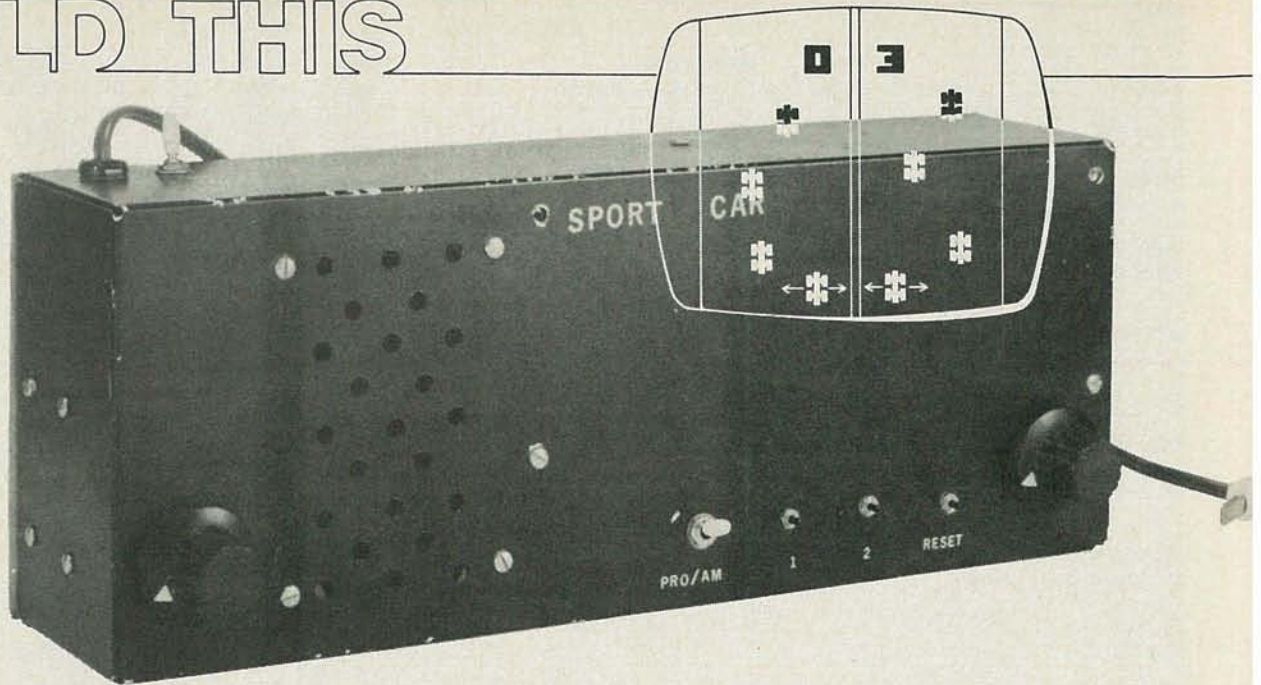
RACEWAY VIDEO GAME you can build lets you pretend to be a *Indy 500* race-car driver without ever leaving the comfort of your armchair. Construction details start on page 42.

Radio-Electronics, (ISSN 0033-7862) Published monthly by Gernsback Publications, Inc., 200 Park Avenue South, New York, NY 10003. Phone: 212-777-6400. Controlled Circulation Postage Paid at Concord, NH. One-year subscription rate: U.S.A. and U.S. possessions, \$13.00. Canada, \$16.00. Other countries, \$18.00. Single copies \$1.25. © 1980 by Gernsback Publications, Inc. All rights reserved. Printed in U.S.A.

Subscription Service: Mail all subscription orders, changes, correspondence and Postmaster Notices of undelivered copies (Form 3579) to Radio-Electronics Subscription Service, Box 2520, Boulder, CO 80322.

A stamped self-addressed envelope must accompany all submitted manuscripts and/or artwork or photographs if their return is desired should they be rejected. We disclaim any responsibility for the loss or damage of manuscripts and/or artwork or photographs while in our possession or otherwise.

BUILD THIS



RACEWAY VIDEOGAME

Build this road-race game and enjoy all the excitement of the arcade version on your own video screen. Gentlemen (and ladies) . . . Start your engines!

L. STEVEN CHEAIRS

AMONG THE POPULAR ARCADE GAMES, THE road-race type has always stood out. Many varieties of that game exist; they range from the animated types to the more recent video units, of the type we're about to describe. There is a major difference between the game described here and the average Arcade road-race—the average Arcade game's price tag is in the thousands of dollars; while this game will cost you less than a hundred dollars.

In the pages of **Radio-Electronics** magazine we have presented two other video-game kits: a tank and a motorcycle game. The tank game (Nov. 1978) required two players; while the motorcycle game (Jan. 1979) was only for a single player. The present game allows both single- and dual-player operation. Thus, if you find yourself alone, or where no one else seems to want to play the game when you do, you can use the single game mode. But, when two or more players are available. . . .

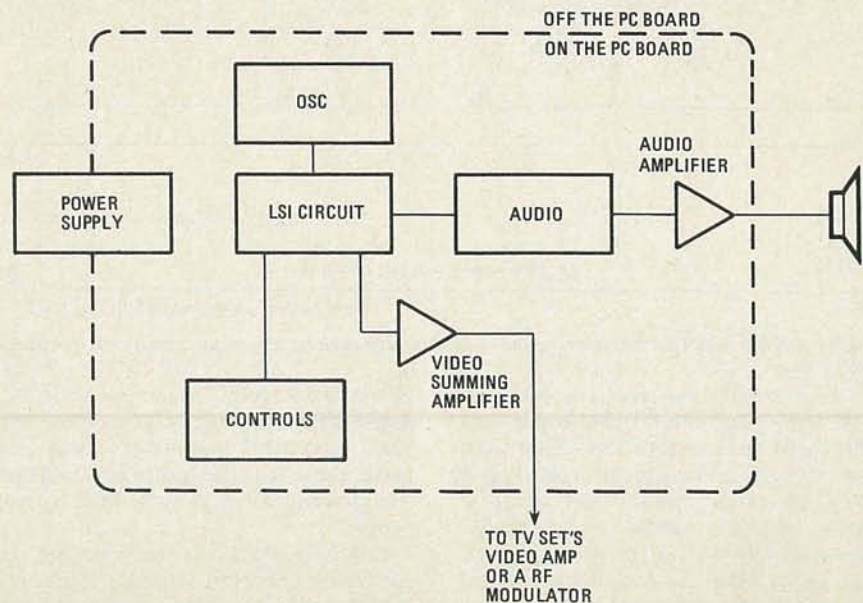


Fig. 1—BLOCK DIAGRAM of the Raceway videogame showing the major components of the system. Block labelled "Controls" is actually located off the board (controls are mounted on case).

NOTE: PINS 12, 15, 17, 26, 27, & 28 ON IC3 ARE NOT USED

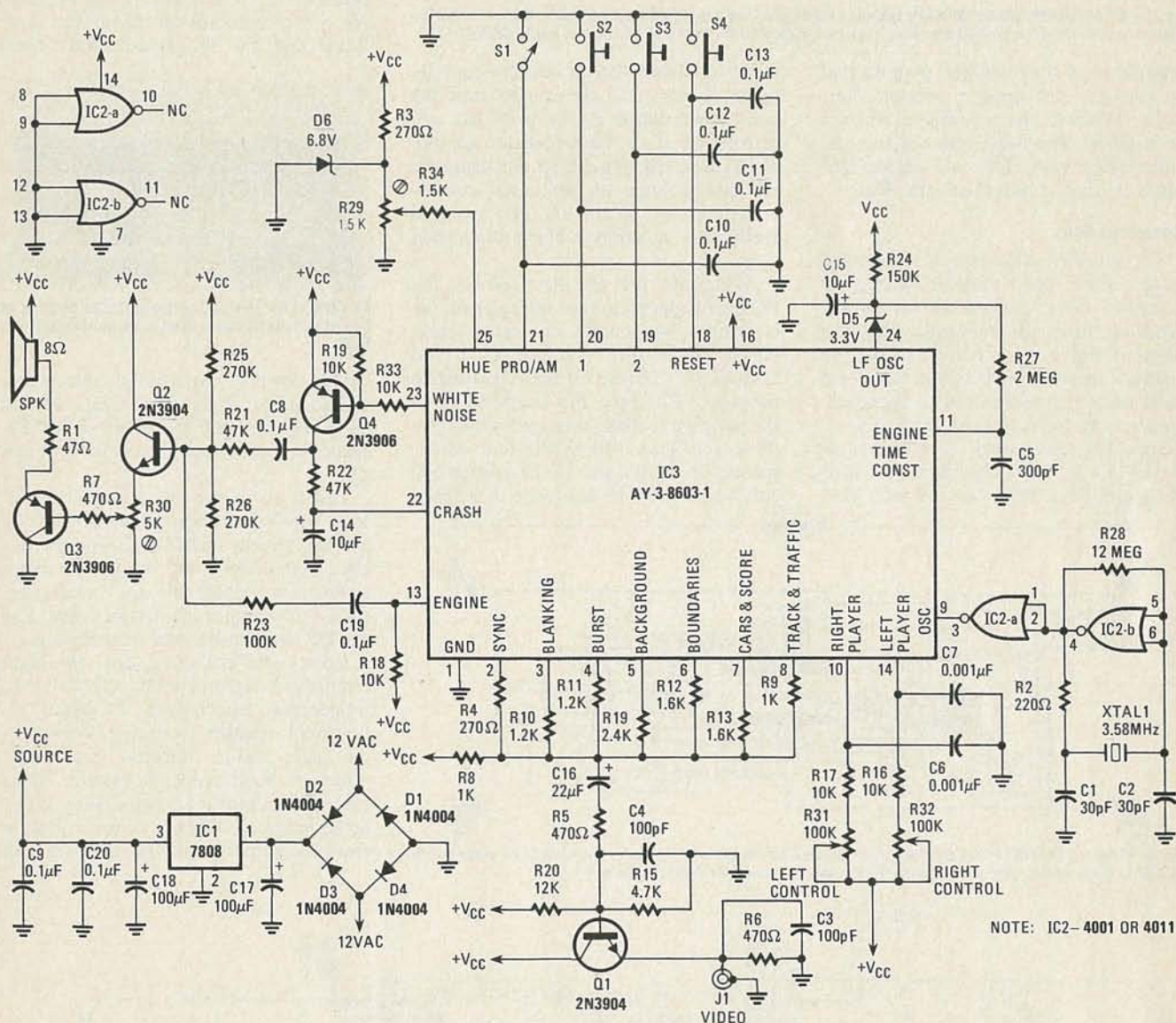


Fig. 2—COMPLETE SCHEMATIC of the Raceway game. The project may be built on a PC board using the foil pattern in Fig. 4 or wired point-to-point following this diagram.

System description.

The raceway game contains an assembled PC board and the switches, transformer, case and other hardware required for project assembly. Assuming that you wish to connect the system to a standard NTSC 525-line TV set, you will also need an RF modulator—many of which exist in the hobbyist's market.

The components contained on the printed-circuit board form seven distinct circuits. Two of those circuits contain components that are off the card; refer to the block diagram in Fig. 1 and the schematic in Fig. 2. The power supply provides 8 volts DC using a 12-volt AC, power source located off the board. The 12 volts AC is rectified by four silicon rectifiers and then filtered to reduce the 120-

Hz ripple that is created by the full-wave bridge. A three-terminal linear regulator develops the operating voltage—additional filtering is provided at the regulator's output.

The control section is composed of two potentiometers, four switches, two R-C timing networks, and four capacitors. The potentiometers are used to vary the R-C time constant; that time constant is proportional to the position of the user's race car image on the TV screen. One or two race cars can be steered using these controls. Switch S1, labelled PRO/AM, is used to select the level of difficulty. Two normally-open switches are used for selecting the number of players (S2, labelled 1, selects the 1 player option; S3, labelled 2, selects 2 players.) The third push-but-

ton normally-open switch S4 is provided to reset the game. A minor amount of debounce is provided by the capacitor across the switch contacts.

The 3.579-MHz crystal oscillator is formed using a CMOS gate, two resistors, two capacitors and a crystal. Another CMOS gate is used as a buffer between the oscillator and the LSI integrated game circuit. Next, the audio amplifier and filtering circuit is formed using three transistors and a few capacitors and resistors.

The video summing circuit is of the passive-resistive type. The resistors R4, R9-R14 are chosen such to give a video signal with an appearance similar to Fig. 3. The video signal out of the summing network is AC-coupled to the video amplifier Q1 which is wired as an emitter-follower. Note: if you use an RF modulator you may need to adjust the output



Fig. 3—COMPOSITE VIDEO SIGNAL typical of that produced by the summing network. It is a combination of raw video, sync and blanking signals generated by the IC. See text for explanation.

impedance of the amplifier. You do that by changing the emitter resistor. Normally, however, the adjustment will not be required. The final section is the LSI integrated circuit. That is a 28-pin DIP MOS IC that contains the game logic.

Construction

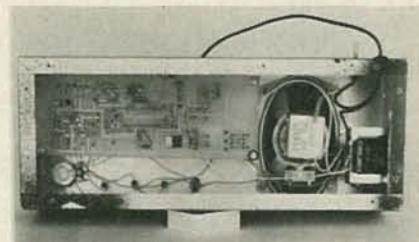
The raceway game may be assembled using either point-to-point wiring or wirewrap or a printed circuit board. Working from the schematic diagram shown in Fig. 2 any of those construction methods may be used. If you decide to build using the printed-circuit approach, then use the foil pattern shown in Fig. 4. Components are placed on the board as shown in Fig. 5. (An etched and drilled PC board is available—see the parts list.)

Also, for those who do not have an adequate source of all the components, the source mentioned in the parts list will provide all of the hard-to-locate components on an individual basis or a complete kit that includes all electronic components, the PC board and the required hardware—including a blank unpunched case.

Assuming that you have chosen the PC board approach, start by laying all the electronic components out on a workbench. Make sure that the MOS and CMOS IC's remain in their conductive packages. Compare the components to the parts list to make sure you have everything you need. Mount the four corner spacers on the foil side of the printed circuit board with the hardware mentioned

in the parts list; that way the spacers will act as table legs and raise the PC card off the work surface.

Install the two IC sockets in the proper location noting the proper orientation of pin 1 (see Fig. 5). Place a piece of cardboard on top of the sockets and by keeping a firm pressure on top of the cardboard and the PC board rotate them



COMPLETED UNIT. Components on bottom of board have been relocated in version described here.

upside-down so that the foil side is now up. Solder all of the pins using a 40-watt soldering iron with rosin-core solder. Replace the board with the component side up.

Install all of the resistors and capacitors. Verify their location and solder. Follow that step by installing the diodes, rectifiers, transistors, and voltage regulator; again, after placement and orientation, solder the components to the board. Lay the PC board aside until final assembly.

Locate the enclosure; drill the holes required for the potentiometers, switches, transformer attachment, PC-board attachment, speaker mounting, video output jack, and a line-cord strain-relief grommet. Next, paint the exterior of the case. After the paint is dry use dry-transfer lettering to label the controls. Follow that procedure by spraying the case with

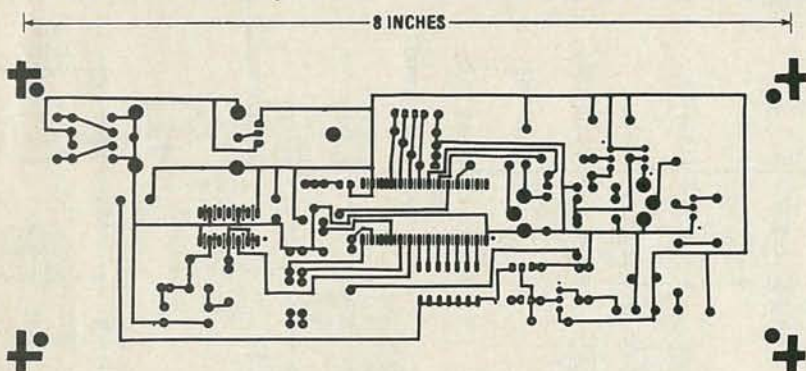


Fig. 4—FOIL PATTERN for the printed circuit board. For those who prefer not to etch their own, one is available from Quest-Star Electronics. See parts list for ordering information.

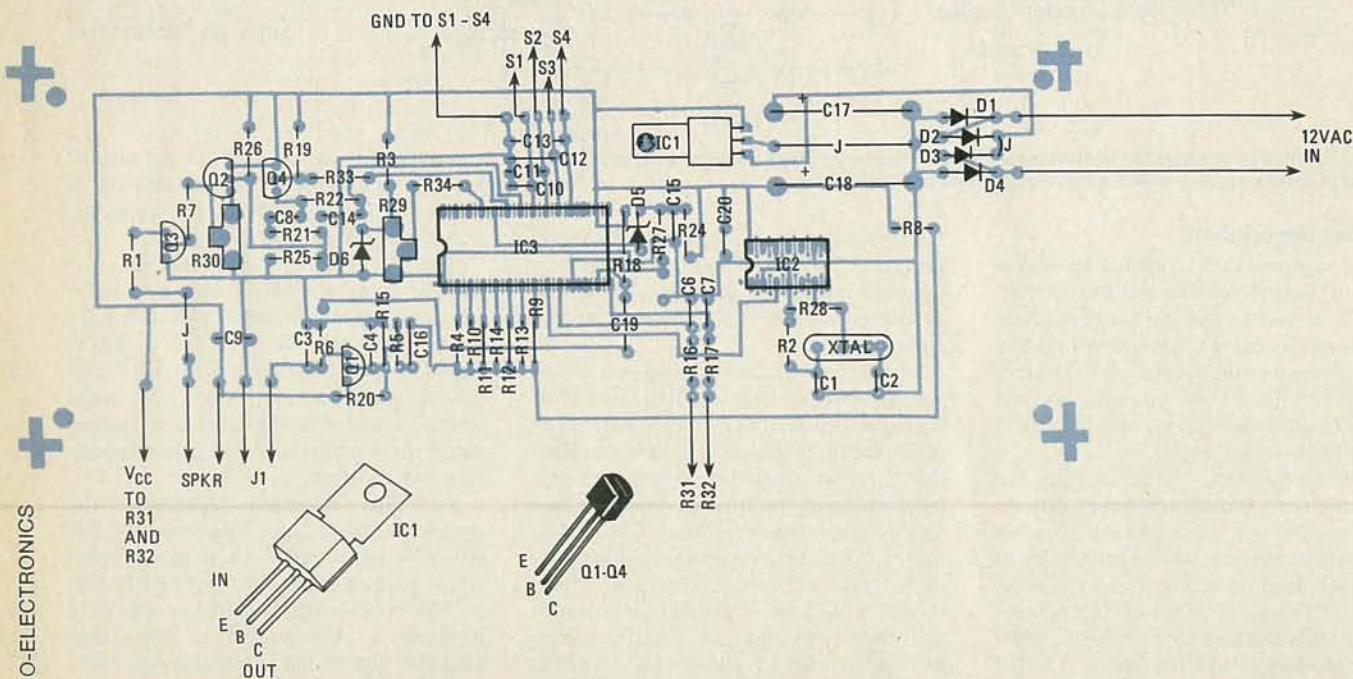
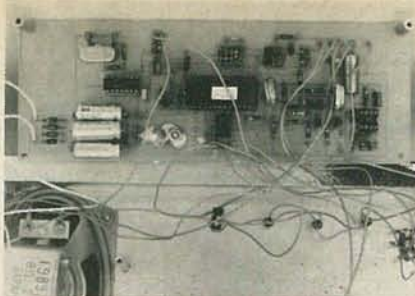


Fig. 5—PARTS PLACEMENT DIAGRAM. Power transformer, control potentiometers and switches, speaker and video jack are mounted off the board, on the case.



PC BOARD prototype.

PARTS LIST

Resistors 1/4 watt, 5% unless otherwise noted

R1—47 ohms
 R2—220 ohms
 R3, R4—270 ohms
 R5—R7—470 ohms
 R8, R9—1000 ohms
 R10, R11—1200 ohms
 R12, R13—1600 ohms
 R14—2400 ohms
 R15—4700 ohms
 R16—R19—10,000 ohms
 R20—12,000 ohms
 R21, R22—47,000 ohms
 R23—100,000 ohms
 R24—150,000 ohms
 R25, R26—270,000 ohms
 R27—2 megohms
 R28—12 megohms
 R29—1500 ohms, potentiometer, PC mount
 R30—5000 ohms, potentiometer, PC mount
 R31, R32—100,000 ohms, potentiometer
 R33—10,000 ohms
 R34—1500 ohms

Capacitors

C1, C2—30 pF
 C3, C4—100 pF
 C5—300 pF
 C6, C7—.001μF
 C8—C13—0.1 μF
 C14, C15—10 μF, 15 volts, tantalum
 C16—22 μF, 15 volts, tantalum
 C17, C18—100 μF, 15 volts, electrolytic
 C19, C20—0.1 μF

Semiconductors

D1—D4—1N4004
 D5—1N746A Zener diode, 3.3 volts, 5%, 400 mW
 D6—1N754A Zener diode, 6.8 volts, 5%, 400 mW
 Q1, Q2—2N3904
 Q3, Q4—2N3906
 IC1—7808 voltage regulator, 3 terminals, 8 volts
 IC2—4001 quad 2-input NOR gate or 4011 quad 2-input NAND gate
 IC3—AY-3-8603-1 raceway game IC
 S1—SPST miniature toggle switch
 S2—S4—SPST normally open miniature push-button switch
 SPKR1—small speaker, 8 ohms
 J1—miniature phone jack
 XTAL1—crystal, 3.58 MHz

Miscellaneous: knobs, line cord, 12-volt, 850 mA (or higher) transformer, case and hardware.

Note: The following may be ordered from Quest-Star Electronics, 5412 Burntwood Way, Las Vegas, NE 89108: Kit of all parts \$59.95, AY-3-8603-1 game IC \$27.00, PC board \$12.95. Add \$1.75 for shipping. Nevada residents add local taxes.

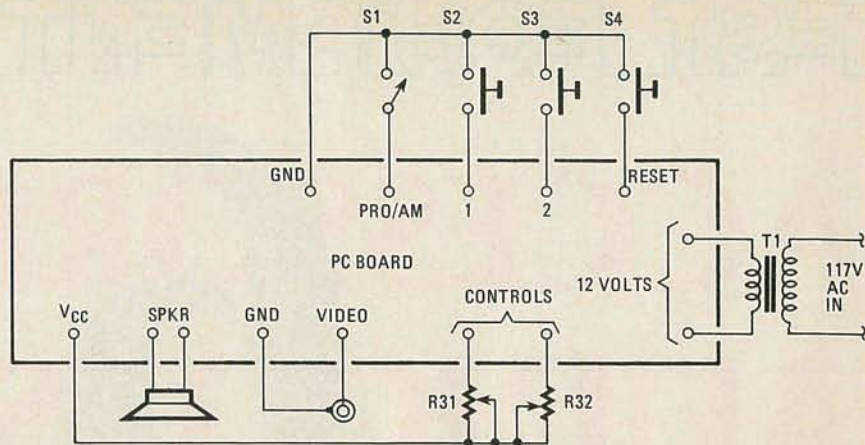


Fig. 6—DETAILS of off-the-board component connection. This should be used in conjunction with the parts placement diagram, Fig. 5. Also refer to photographs.

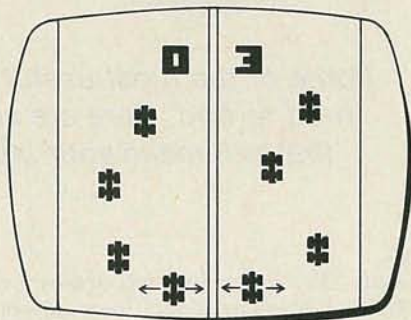


Fig. 7—RACEWAY VIDEOGAME display as it would appear on TV set or video monitor.

a clear lacquer paint to protect the finish—let the case dry for 12 to 24 hours.

Install the controls, transformer, linecord, output jack, and speaker. Wire those components as shown in Fig. 6. Recheck the wiring! Plug the line cord into a wall outlet and check to see if the proper DC voltage exists—around 8 volts. If so, discharge the filter capacitors and then install the IC's. Remove the spacers from the wiring side of the PC board and reinstall them on the component side of the board. Next, mount the PC board in the case. The assembly is now complete. Note: if an RF modulator is used it may be installed in the enclosure or inside of the TV cabinet. That is up to your discretion.

About the game

A typical game display consists of a two-lane highway with two player-controlled cars and randomly generated traffic. Each lane has a score at the top of the screen—see Fig. 7. The driver for each car is located at the bottom of each track. Adjust the TV contrast so the road is displayed as a white field; while the embankment, center line, player cars, and scores are gray. The traffic is displayed as black images. The car has horizontal motion only; that is a function of the potentiometer position. After the reset button is pressed the game starts. The TV screen shows the two tracks with the drivers' cars and the traffic. The scores are set to zero. Both tracks have the same set of random traffic. The traffic on the right is

24 horizontal scan lines ahead of the traffic on the left side of the screen. Thus, if the two-player game is selected, both players will encounter the same degree of difficulty.

The speed of the traffic in relation to the driver increases every two seconds, for up to a maximum of seven speeds, until one of the two players crashes his car into one of the obstacle cars. At that point all video motion stops and a crash sound is generated. The game again restarts in the slow motion and increases in speed every two seconds once more; during this time realistic engine sounds are simulated. The engine sound starts from a low and increases in pitch at four-second intervals during the periods when motion is observed on the screen. Every time a crash occurs, a point is scored for the opponent. The game ends when one of the players reaches 15 points.

The single-player game proceeds as outlined above, with the exception that only one of the player cars is present. The right car is removed—the left car is operable. After every eight cars that the driver passes he scores a point; those must be consecutive passes. The occurrence of a collision resets the pass counter—thus those cars passed between the last score and the crash will not be counted toward a new point. The score above the right track records the number of crashes. Thus the user is playing against the machine, since the first score to reach 15 points wins the game.

As can be seen, a realistic raceway game may be produced for use with a standard television receiver fed through a video modulator. (Several suitable video modulators are available on the market. You can get them through Radio-Electronics advertisers and computer stores. If you have an option, select one with a UHF output.) This game provides realistic motor and crash sounds. Also, skill selection is provided for easy or difficult driving conditions. Scoring is automatic and on-screen; it is color-keyed for each player. Both one- and two-game selections exist; all the timing signals for

continued on page 77

RACEWAY

continued from page 45

black-and-white are provided.

Adjustment and troubleshooting.

There are two PC board potentiometers that require adjustment; the audio level and hue. The hue control (R29) is adjusted for the best contrast. The audio output (R30) should be adjusted to provide the desired noise level.

If problems occur after assembly use the following check list:

1. Are all components in the proper location?
2. Is PC board wired correctly to the external components?
3. Is the power supply voltage correct?
4. Is a 3.58-MHz clock signal present at pin 9 of the AY-3-8603-1?
5. Is there audio output?
6. Is there a composite video signal? (See Fig. 3 for waveform.)

If a "no" answer is generated by any of those questions then repair that portion of the circuit. For example, if a normal image is displayed, but the players' cars are not present; then check pin 7 to see if a video signal is present. If it is not, then the IC is bad; if a signal is present check the summing resistors. **R-E**

9 reasons why the real pros prefer Endeco desoldering irons



1. Operates at 120v, 40w. Idles at 20w for longer tip life
2. Flexible, burn resistant Neoprene cord set
3. Cool, unbreakable polycarbonate handle
4. Exclusive bracket insures alignment, prevents damage
5. Safety light in handle tells when it's on
6. Stainless steel construction
7. Temperature control. Low, high or off.
8. Eight tip sizes. Comes with .063 I.D.
9. Converts to soldering iron with 1/4" shank type tip

See your distributor or write . . .

Enterprise Development Corp.

5127 E. 65th St. • Indianapolis IN 46220
PHONE (317) 251-1231

CIRCLE 49 ON FREE INFORMATION CARD

Attention
Atari Owners:

Now you can boost your 400 or 800 to 16K performance in just 16 minutes.

Mosaic Electronics has now developed a RAM expansion kit that can up-grade your Atari 400 or 800 to 16K performance. The modification takes just 16 minutes. RAM expansion kit meets or exceeds OEM timing specs, includes all needed hardware and comes complete with pictorially presented instructions.

only \$79

(we pay postage)

Kit also available for TRS-80.

just \$69

(we pay postage)

Order today and receive our FREE software catalog

MOSAIC

ELECTRONICS

P.O. Box 748 • Oregon City, OR 97045

Mosaic Electronics is in no way affiliated with either Atari or Radio Shack

CIRCLE 15 ON FREE INFORMATION CARD

NOW! For the first time . . . a clear, concise, understandable book on the Earth's most promising energy source.

Solar Electricity

Only \$6.95 Ppd.

140 EASY-TO-READ FACT FILLED PAGES

Loaded with charts, graphs, pictures of actual solar installations—by World's Foremost Authority SOLAREX

Most books and articles on Solar Energy are either jam packed with mind-boggling technical jargon, or they're so basic you can't find what you really want to know.

Here for the first time—is a definitive study of all the real (not blue sky) applications of solar, written by the world's leading experts . . . but written in everyday language so you can understand and put to work the real, significant benefits of Solar electricity in scores of practical ways, both large and small. Must reading for everyone from the casual enthusiast right up to the trained solar professional.

Nine Clear, Concise Chapters
Covers everything from a glossary of solar electric terms, how to use cells and practical solar electric generators, to the rapidly exploding variety of industrial,

educational, consumer, and military applications. It also includes solar electric projects, commercially available accessories the use of solar cells as light sensors rather than as power sources, and much, much more.

Don't take our word for it!

Take your time. In fact—take two full weeks. Order the book. Read it. See if you don't completely agree that this is the best Solar electric summary you've ever read. If not—simply return the book and we'll refund your money by return mail or credit your account. Use handy coupon below or phone 301-948-0202.

Dealers' inquiries invited.
STOCK NO. 37005DR... \$6.95 Ppd.



Only \$6.95 Ppd.

COMPLETE AND ORDER TODAY

SOLAREX CORP. CPD-Dept. 100DR 1335 Piccard Drive, Rockville, MD 20850

Please send me _____ copies of "Guide to Solar Electricity" @ \$6.95 each \$ _____

Shipping & Handling \$1.00
TOTAL _____

(Md. resident please add 5%)

Enclosed is _____ check, _____ M.O. in amount of \$ _____

Charge to my: * VISA MASTER CHARGE

Account No. (Interbank No.) _____

Signature: _____

Name _____

Address _____ PLEASE PRINT

City _____ State _____ Zip _____

SOLAREX Corporation CPD-Dept. 100DR 1335 Piccard Drive, Rockville, MD 20850

Visa/Master Charge credit cards accepted

301-948-0202

Minimum Order \$15 (Two or More Books)

IF YOU'RE AN ADVERTISER WHO NEEDS JUST A LITTLE SPACE LIKE THIS 1/6 PAGE, CALL YOUR NEAREST RADIO-ELECTRONICS SALES OFFICE RIGHT NOW. YOU'LL DISCOVER YOU DON'T HAVE TO SPEND A LOT OF \$\$\$ TO REACH THE PEOPLE WHO DO SPEND A LOT.

NEW YORK
Stan Levitan
212-777-6400

CHICAGO
Ralph Bergen
312-446-1444

LOS ANGELES
J.E. Publishing
213-659-3810

Radio-Electronics



AUGUST 1980