ELECTRONICS PROJECTS READY-REFERENCE

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Preface

Electronics Projects Ready-Reference is one of five books in the Ready-Reference series. These books are the product of cover-to-cover searching of back issues of U.S. and foreign electronics periodicals, the published literature of electronics manufacturers, and recent electronics books, together filling well over 100 feet of shelving. This same search would take weeks or even months at a large engineering library, plus the time required to write for manufacturer literature and locate elusive sources.

Each circuit has type numbers or values of all significant components, an identifying title, a concise description, performance data, and suggested applications. At the end of each description is a citation giving the title of the original article or book, its author, and the exact location of the circuit in the original source.

To find a desired circuit quickly, start with the alphabetically arranged table of contents at the front of the book. Note the chapters most likely to contain the desired type of circuit, and look in these first. If a quick scan does not locate the exact circuit desired, use the index at the back of the book. Here the circuits are indexed in depth under the different names by which they may be known. Cross-references in the index aid searching. The author index will often help find related circuits after one potentially useful circuit is found, because authors tend to specialize in certain circuits.

To the original publications cited and their engineering authors and editors should go major credit for making this book possible. The diagrams have been reproduced directly from the original source articles, by permission of the publisher in each case.

Abbreviations Used

A	ampere
AC	alternating current
AC/DC	AC or DC
A/D	analog-to-digital
ADC	analog-to-digital converter
A/D, D/A	analog-to-digital, or digital-to-analog
ADP	automatic data processing
AF	audio frequency
AFC	automatic frequency control
AFSK	audio frequency-shift keying
AFT	automatic fine tuning
AGC	automatic gain control
Ah	ampere-hour
ALU	arithmetic-logic unit
AM	amplitude modulation
AM/FM	AM or FM
AND	type of logic circuit
AVC	automatic volume control
b	bit
BCD	binary-coded decimal
BFO	beat-frequency oscillator
b/s	bit per second
C	capacitance; capacitor
°C	degree Celsius; degree Centigrade
CATV	cable television
CB	citizens band
CCD	charge-coupled device
CCTV	closed-circuit television
cm	centimeter
CML	current-mode logic
CMOS	complementary MOS
CMR	common-mode rejection
CMRR	common-mode rejection ratio
cm^2	square centimeter
coax	coaxial cable
COHO	coherent oscillator
COR	carrier-operated relay
COS/MOS	complementary-symmetry MOS (same as CMOS)
CPU	central processing unit
CR	cathode ray
CRO	cathode-ray oscilloscope
CROM	control and read-only memory
CRT	cathode-ray tube
CT	center tap
CW	continuous wave
D/A	digital-to-analog
DAC	digital-to-analog converter
dB	decibel
dBC	C-scale sound level in decibels
dBm	decibels above 1 mW
dBV	decibels above 1 V
DC	direct current
DC/DC	DC to DC
DCTL	direct-coupled transistor logic
diac	diode AC switch
DIP	dual in-line package
DMA	direct memory access
DMM	digital multimeter
DPDT	double-pole double-throw
DPM	digital panel meter
DPST	double-pole single-throw
DSB	double sideband
DTL	diode-transistor logic
DTL/TTL	DTL or TTL
DUT	device under test
DVM	digital voltmeter
DX	distance reception; distant
EAROM	electrically alterable ROM
EBCDIC	extended binary-coded decimal interchange code
ECG	electrocardiograph
ECL	emitter-coupled logic
EDP	electronic data processing
EKG	electrocardiograph
EMF	electromotive force
EMI	electromagnetic interference
EPROM	erasable PROM
ERP	effective radiated power
ETV	educational television
eV	electronvolt
EVR	electronic video recording
EXCLUSIVE-OR	type of logic circuit
EXCLUSIVE-NOR	type of logic circuit
F	farad
°F	degree Fahrenheit
FET	field-effect transistor
FIFO	first-in first-out
FM	frequency modulation
4PDT	four-pole double-throw
4PST	four-pole single-throw
FS	full scale
FSK	frequency-shift keying
ft	foot
ft/min	foot per minute
ft/s	foot per second
ft^2	square foot
F/V	frequency-to-voltage
F/V, V/F	frequency-to-voltage, or voltage-to-frequency
G	giga- (10^9)
GHz	gigahertz
G-M tube	Geiger-Mueller tube
h	hour
H	henry
HF	high frequency
HFO	high-frequency oscillator
hp	horsepower
Hz	hertz
IC	integrated circuit
IF	intermediate frequency
IGFET	insulated-gate FET
IMD	intermodulation distortion
IMPATT	impact avalanche transit time
in	inch
in/s	inch per second
in^2	square inch
I/O	input/output
IR	infrared
JFET	junction FET
k	kilo- (10^3)
K	kilohm (,000 ohms); kelvin
kA	kiloampere
kb	kilobit
keV	kiloelectronvolt
kH	kilohenry
kHz	kilohertz
km	kilometer
kV	kilovolt
kVA	kilovoltampere
kW	kilowatt
kWh	kilowatthour
L	inductance; inductor
LASCR	light-activated SCR

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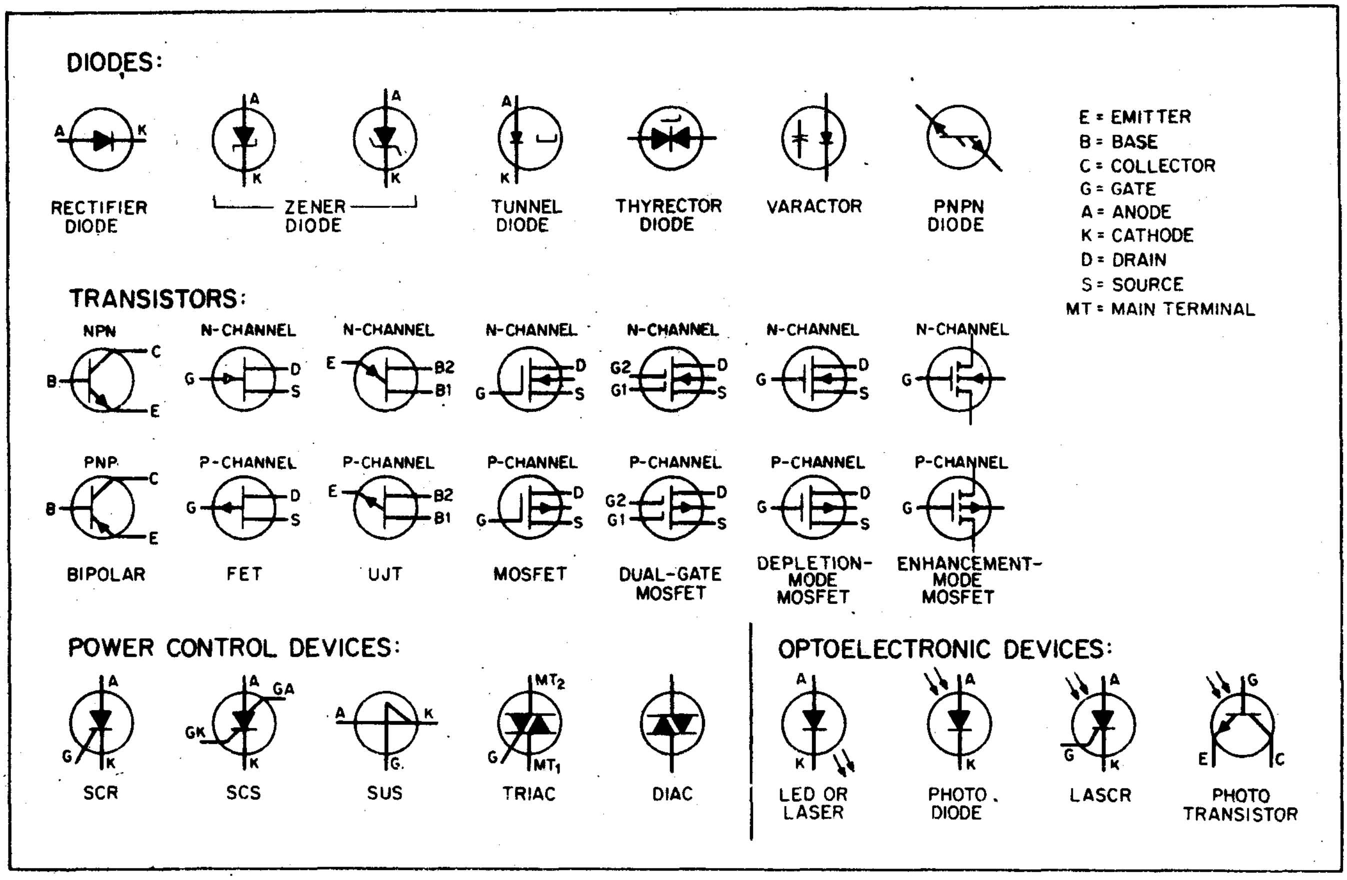
LASCS	light-activated SCS
LC	inductance-capacitance
LCD	liquid crystal display
LDR	light-dependent resistor
LED	light-emitting diode
LF	low frequency
LIFO	last-in first-out
lm	lumen
LO	local oscillator
logamp	logarithmic amplifier
LP	long play
LSB	least significant bit
LSI	large-scale integration
m	meter; milli- (10^{-3})
M	mega- (10^{6}); meter (instrument); motor
mA	milliampere
Mb	megabit
MF	medium frequency
mH	millihenry
MHD	magnetohydro-dynamics
MHz	megahertz
mi	mile
mike	microphone
min	minute
mm	millimeter
modem	modulator-demodulator
mono	monostable
MOS	metal-oxide semiconductor
MOSFET	metal-oxide semiconductor FET
MOST	metal-oxide semiconductor transistor
MPU	microprocessing unit
ms	millisecond
MSB	most significant bit
MSI	medium-scale integration
m^2	square meter
μ	micro- (10^{-6})
μA	microampere
μF	microfarad
μH	microhenry
μm	micrometer
μP	microprocessor
μs	microsecond
μV	microvolt
μW	microwatt
mV	millivolt
MVBR	multivibrator
mW	milliwatt
n	nano- (10^{-9})
N	negative
nA	nanoampere
NAB	National Association of Broadcasters
NAND	type of logic circuit
nF	nanofarad
nH	nanohenry
NMOS	N-channel MOS
NOR	type of logic circuit
NPN	negative-positive-negative
NPNP	negative-positive-negative-positive
NRZ	nonreturn-to-zero
NRZI	nonreturn-to-zero-inverted
ns	nanosecond
NTSC	National Television System Committee
nV	nanovolt
nW	nanowatt
OEM	original equipment manufacturer
opamp	operational amplifier
OR	type of logic circuit
p	pico- (10^{-12})
P	peak; positive
pA	picoampere
PA	public address
PAL	phase-alternation line
PAM	pulse-amplitude modulation
PC	printed circuit
PCM	pulse-code modulation
PDM	pulse-duration modulation
PEP	peak envelope power
pF	picofarad
PF	power factor
phono	phonograph
PIN	positive-intrinsic-negative
PIV	peak inverse voltage
PLL	phase-locked loop
PM	permanent magnet; phase modulation
PMOS	P-channel MOS
PN	positive-negative
PNP	positive-negative-positive
PNPN	positive-negative-positive-negative
pot	potentiometer
P-P	peak-to-peak
PPI	plan-position indicator
PPM	parts per million; pulse-position modulation
preamp	preamplifier
PRF	pulse repetition frequency
PROM	programmable ROM
PRR	pulse repetition rate
ps	picosecond
PSK	phase-shift keying
PTT	push to talk
PUT	programmable UJT
pW	picowatt
PWM	pulse-width modulation
Q	quality factor
QRP	low-power amateur radio
R	resistance; resistor
RAM	random-access memory
RC	resistance-capacitance
RF	radio frequency
RFI	radio-frequency interference
RGB	red/green/blue
RIAA	Recording Industry Association of America
RLC	resistance-inductance-capacitance
RMS	root-mean-square
ROM	read-only memory
rpm	revolution per minute
RTL	resistor-transistor logic
RTTY	radioteletype
RZ	return-to-zero
s	second
SAR	successive-approximation register
SAW	surface acoustic wave
SCA	Subsidiary Communications Authorization
scope	oscilloscope
SCR	silicon controlled rectifier
SCS	silicon controlled switch
S-meter	signal-strength meter
S/N	signal-to-noise
SNR	signal-to-noise ratio
SPDT	single-pole double-throw
SPST	single-pole single-throw
SSB	single sideband
SSI	small-scale integration
SSTV	slow-scan television
SW	shortwave
SWL	shortwave listener
SWR	standing-wave ratio
sync	synchronizing
T	tera- (10^{12})
TC	temperature coefficient
THD	total harmonic distortion
TR	transmit-receive
TRF	tuned radio frequency
triac	triode AC semiconductor switch
TTL	transistor-transistor logic

TTY	teletypewriter
TV	television
TVI	television interference
TVT	television typewriter
TWX	teletypewriter exchange service
UART	universal asynchronous receiver-transmitter
UHF	ultrahigh frequency
UJT	unijunction transistor
UPC	universal product code
UPS	uninterruptible power system
V	volt
VA	voltampere
VAC	volts AC
VCO	voltage-controlled oscillator
VDC	volts DC
V/F	voltage-to-frequency
VFO	variable-frequency oscillator
VHF	very high frequency
VLF	very low frequency
VMOS	vertical metal-oxide semiconductor
VOM	volt-ohm-milliammeter
VOX	voice-operated transmission
VRMS	volts RMS
VSWR	voltage standing-wave ratio
VTR	videotape recording
VTVM	vacuum-tube voltmeter
VU	volume unit
VVC	voltage-variable capacitor
VXO	variable-frequency crystal oscillator
W	watt
Wh	watthour
WPM	words per minute
WRMS	watts RMS
Ws	wattsecond
Z	impedance

Abbreviations on Diagrams. Some foreign publications, including *Wireless World,* shorten the abbreviations for units of measure on diagrams. Thus, μ after a capacitor value represents μF, n is nF, and p is pF. With resistor values, k is thousand ohms, M is megohms, and absence of a unit of measure is ohms. For a decimal value, the letter for the unit of measure is sometimes placed at the location of the decimal point. Thus, 3k3 is 3.3 kilohms or 3,300 ohms, 2M2 is 2.2 megohms, 4μ7 is 4.7 μF, 0μ1 is 0.1 μF, and 4n7 is 4.7 nF.

Semiconductor Symbols Used



The commonest forms of the basic semiconductor symbols are shown here. Leads are identified where appropriate, for convenient reference. Minor variations in symbols, particularly those from foreign sources, can be recognized by comparing with these symbols while noting positions and directions of solid arrows with respect to other symbol elements.

Omission of the circle around a symbol has no significance. Arrows are sometimes drawn open instead of solid. Thicker lines and open rectangles in some symbols on diagrams have no significance. Orientation of symbols is unimportant; artists choose the position that is most convenient for making connections to other parts of the circuit. Arrow lines outside optoelectronic symbols indicate the direction of light rays.

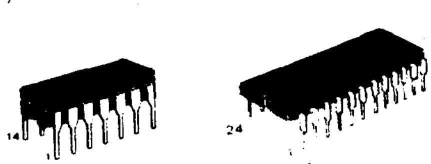
On some European diagrams, the position of the letter k gives the location of the decimal point for a resistor value in kilohms. Thus, 2k2 is 2.2K or 2,200 ohms. Similarly, a resistance of 1R5 is 1.5 ohms, 1M2 is 1.2 megohms, and 3n3 is 3.3 nanofarads.

Substitutions can often be made for semiconductor and IC types specified on diagrams. Newer components, not available when the original source article was published, may actually improve the performance of a particular circuit. Electrical characteristics, terminal connections, and such critical ratings as voltage, current, frequency, and duty cycle, must of course be taken into account if experimenting without referring to substitution guides.

Semiconductor, integrated-circuit, and tube substitution guides can usually be purchased at electronic parts supply stores.

Not all circuits give power connections and pin locations for ICs, but this information can be obtained from manufacturer data sheets. Alternatively, browsing through other circuits may turn up another circuit on which the desired connections are shown for the same IC.

When looking down at the top of an actual IC, numbering normally starts with 1 for the first pin *counterclockwise* from the notched or otherwise marked end and continues sequentially. The highest number is therefore next to the notch on the other side of the IC, as illustrated in the sketches below. (*Actual positions* of pins are rarely shown on schematic diagrams.)



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Unitrode Corp., 580 Pleasant St., Watertown, MA 02172
Wireless World, Dorset House, Stamford St., London SE1 9LU, England

About the Author

John Markus is a professional writer residing in Sunnyvale, California. He serves as a special consultant to the McGraw-Hill Book Company, an organization he was associated with for 27 years before he struck out on his own as a writer and consultant. During that time he held many positions, including that of feature editor on *Electronics* magazine.

In this capacity he was responsible for many state-of-the-art reports in the field of electronics. One of these reports earned him the Jesse H. Neal Editorial Award for outstanding journalism.

He later served as technical director on the Technical Research Staff of the McGraw-Hill Book Company, applying electronic techniques to the mechanization of information publishing systems. His last assignment was as manager of information research for McGraw-Hill divisions on nontraditional publishing and information retrieval.

Mr. Markus is a senior member of the Institute of Electrical and Electronics Engineers. He is the author, coauthor, and editor of numerous books for McGraw-Hill, including *Electronics Dictionary*, Fourth Edition; *Television and Radio Repairing*, Second Edition; *How to Make More Money in Your TV Servicing Business; Sourcebook of Electronic Circuits; Electronic Circuits Manual*; and *Guidebook of Electronic Circuits*. He also is consulting editor and contributing editor to the McGraw-Hill *Dictionary of Scientific and Technical Terms*, and has contributed over 30 articles to the 15-volume McGraw-Hill *Encyclopedia of Science and Technology*, Fourth Edition.

Contents

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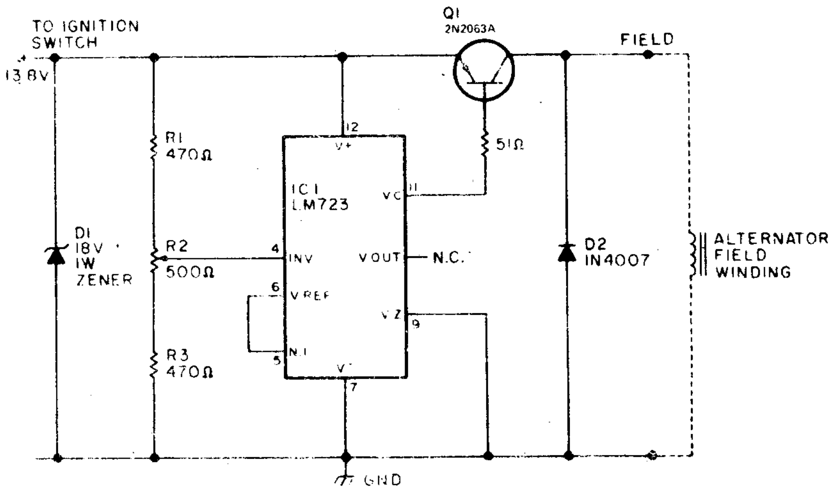
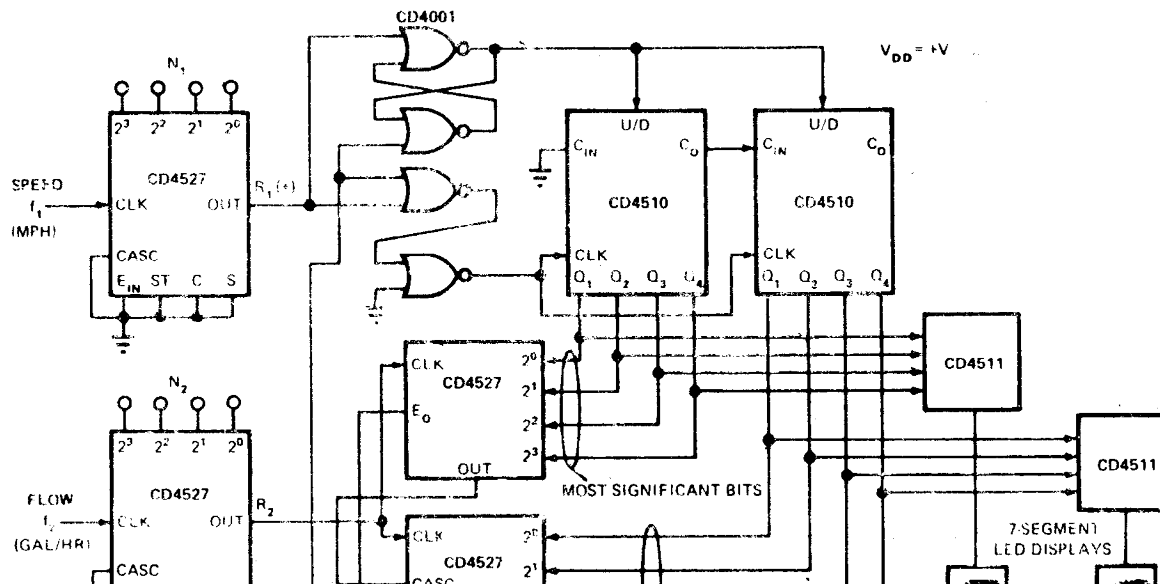
CHAPTER 1

Automotive Circuits

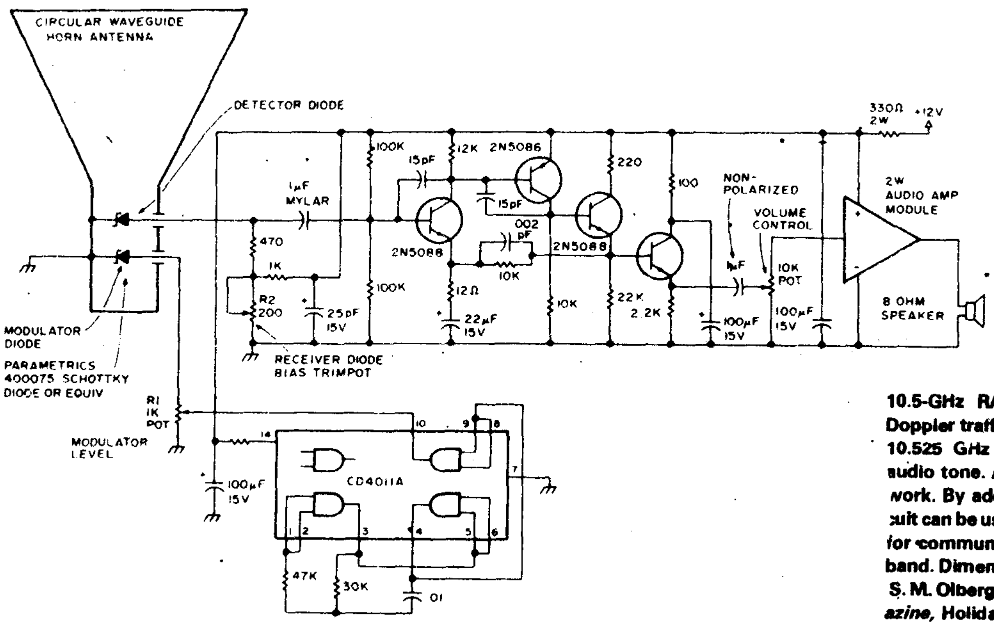
Includes capacitor-discharge, optoelectronic, and other types of electronic ignition, tachometers, dwell meters, idiot-light buzzer, audible turn signals, headlight reminders, mileage computer, cold-weather starting aids, wiper controls, oil-pressure and oil-level gages, solid-state regulators for alternators, overspeed warnings, battery-voltage monitor, and trailer-light interface. For auto theft devices, see Burglar Alarm chapter.

SOLID-STATE AUTO REGULATOR—Replaces and outperforms electromechanical charging-voltage regulator in autos using alternator systems. Prolongs battery life by preventing undercharging or overcharging of 12-V lead-acid battery. Uses LM723 connected as switching regulator for controlling alternator field current. R2 is adjusted to maintain 13.8-V fully charged voltage for standard auto battery. Article gives construction details and tells how to use external relay to maintain alternator charge-indicator function in cars having idiot light rather than charge-discharge ammeter. Q1 is 2N2063A (SK3009) 10-A PNP transistor.—W. J. Prudhomme, Build Your Own Car Regulator, *73 Magazine*, March 1977, p 160–162.



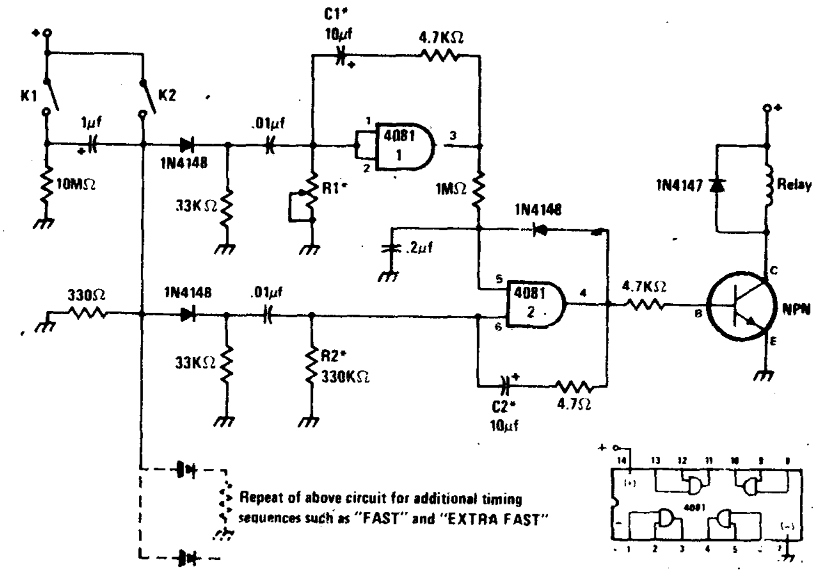


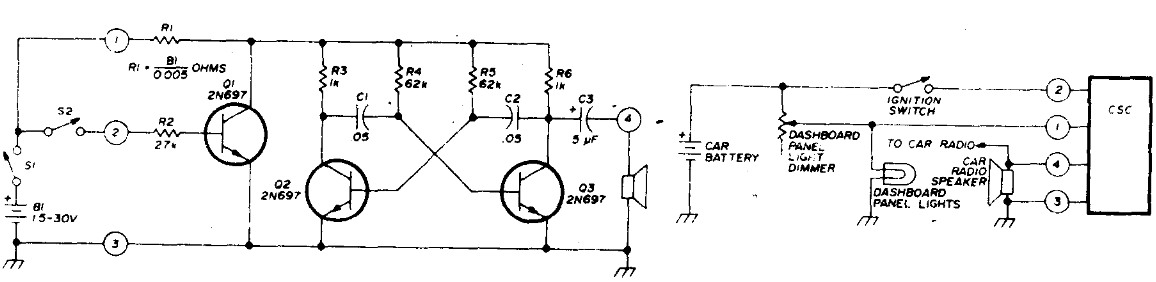
MILEAGE COMPUTER—Fuel consumption in miles per gallon is continuously updated on 2-digit LED display. Entire system using CMOS ICs can be built for less than $25 including gas-flow sensor and speed sensor, sources for which are given in article along with operational details. Circuit uses rate multiplier to produce output pulse train whose frequency is proportional to product of the two inputs. Output rate is time-averaged. Speed sensor, mounted in series with speedometer cable, feeds speed data to CD4527 rate multiplier as clock input. Gas-flow sensor, mounted in series with fuel line, feeds clock input of other rate multiplier.—G. J. Summers, Miles/Gallon Measurement Made Easy with CMOS Rate Multipliers, *EDN Magazine*, Jan. 20, 1976, p 61–63.



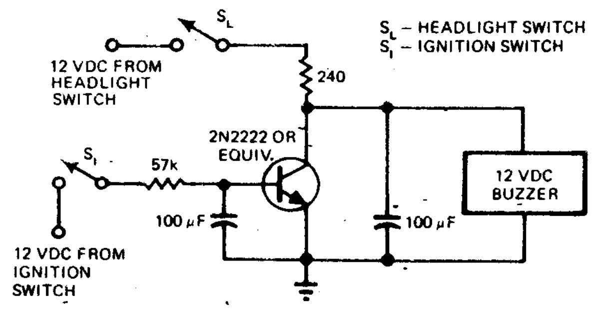
10.5-GHz RADAR DETECTOR—Picks up CW Doppler traffic radar signals in X-band region at 10.525 GHz and alerts speeding driver with audio tone. Article also tells how traffic radars work. By adding 10.5-GHz oscillator, same circuit can be used in 10.5-GHz amateur radio band for communicating with other cars using this band. Dimensioned diagram of horn is given.—S. M. Olberg, Mobile Smokey Detector, *73 Magazine*, Holiday issue 1976, p 32–35.

SPEED TRAP—Time required for auto to activate sensors placed measured distance apart on driveway or road is used to energize relay or alarm circuit when auto exceeds predetermined speed. If speed limit chosen is 15 mph, set detectors 22 feet apart for travel time of 1 s. Sensors can be photocells or air-actuated solenoids. For most applications, R1 can be 1-megohm pot. Transistor type is not critical. Values of R2 and C2 determine how long alarm sounds.—J. Sandler, 9 Projects under $9, *Modern Electronics*, Sept. 1978, p 35–39.

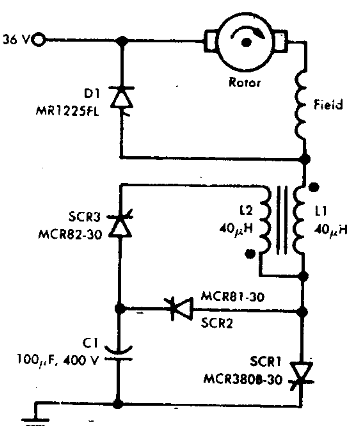




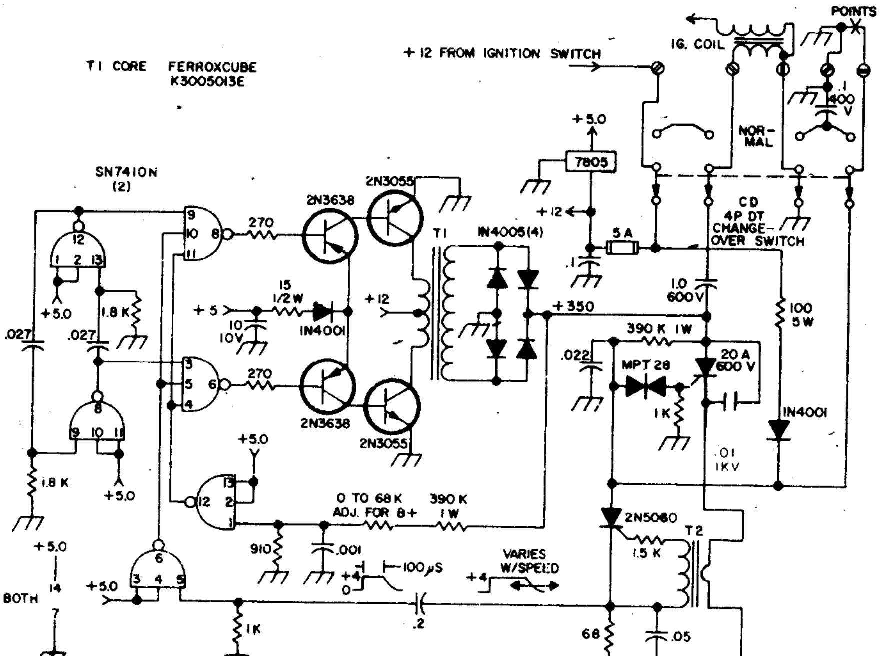
HEADLIGHT REMINDER—Uses basic oscillator consisting of Q2 and Q3 arranged as collector-coupled astable MVBR. Power is taken from collector of Q1 which acts as switch for Q2 and Q3. With S1 closed and S2 open, oscillator operates. Closing S2 saturates Q1 and stops oscillator. When used as headlight reminder for negative-ground car, B1 is omitted and power for oscillator is taken from dashboard panel lights since they come on simultaneously with either parking lights or headlights. If ignition key is turned on, Q1 saturates and disables Q2-Q3. With ignition off but lights on, Q1 is cut off and oscillator receives power. Audio output may be connected directly to high side of voice coil of car radio loudspeaker without affecting operation of radio. Almost any NPN transistors can be used. Changing values of R4 and R5 changes frequency of reminder tone.—H. F. Batie, Versatile Audio Oscillator, *Ham Radio*, Jan. 1976, p 72–74.



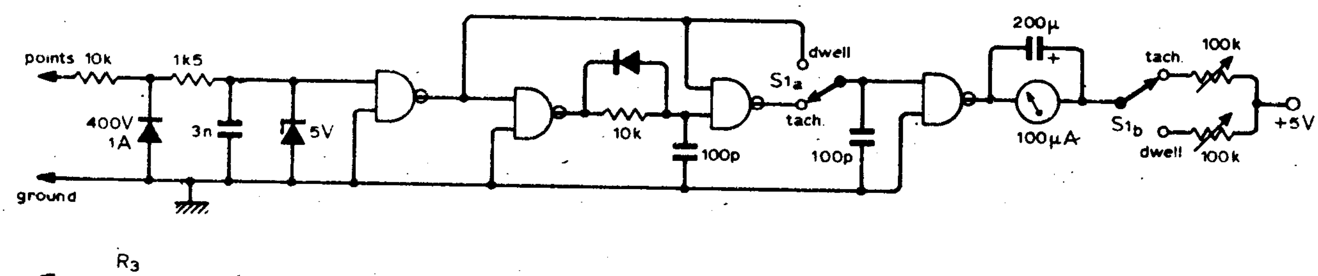
HEADLIGHTS-ON ALARM—Designed for cars in which headlight switch is nongrounding type, providing 12 V when closed. When both light and ignition switches are closed, transistor is saturated and there is no voltage drop across it to drive buzzer. If ignition switch is open while lights are on, transistor bias is removed so transistor is effectively open and full 12 V is applied to buzzer through 240-ohm resistor until lights are turned off.—R. E. Hartzell, Jr., Detector Warns You When Headlights Are Left On, *EDN Magazine*, Nov. 20, 1975, p 160.

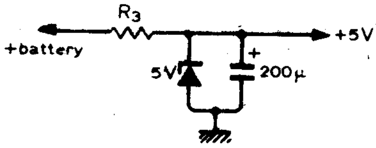


ELECTRIC-VEHICLE CONTROL—SCR1 is used in combination with Jones chopper to provide smooth acceleration of golf cart or other electric vehicle operating from 36-V on-board storage battery. Normal running current of 2-hp 36-V series-wound DC motor is 60 A, with up to 300 A required for starting vehicle up hill. Chopper and its control maintain high average motor current while limiting peak current by increasing chopping frequency from normal 125 Hz to as high as 500 Hz when high torque is required.—T. Malarkey, You Need Precision SCR Chopper Control, *New Motorola Semiconductors for Industry*, Motorola, Phoenix, AZ, Vol. 2, No. 1, 1975.

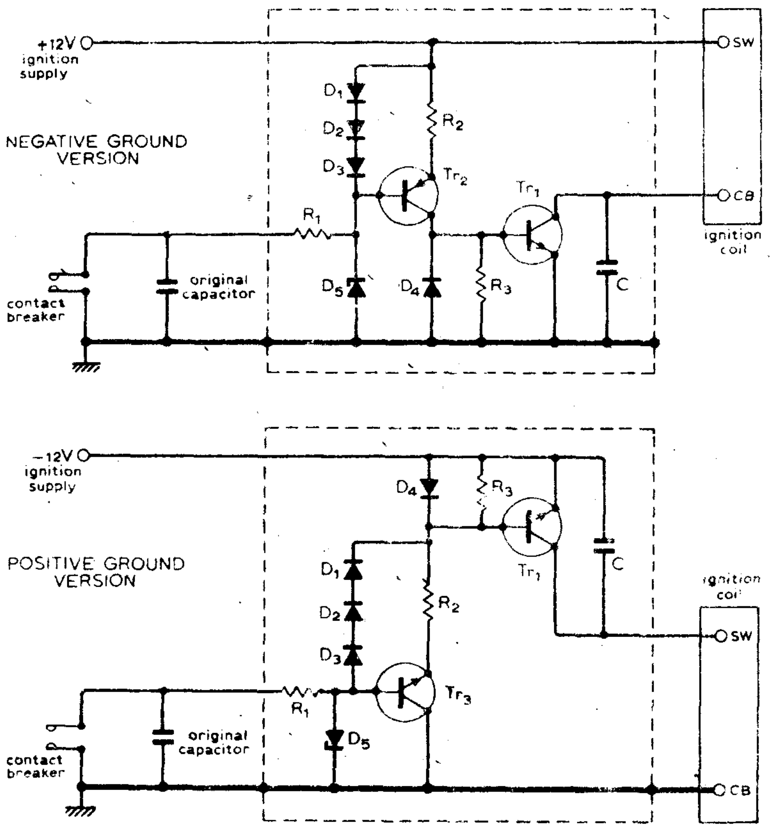


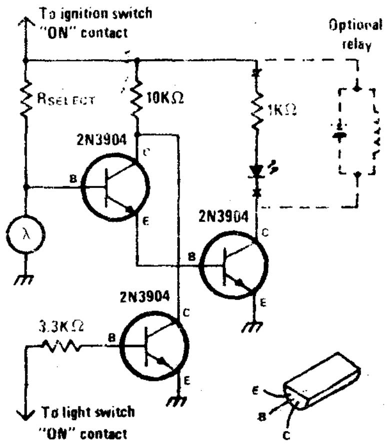
CD IGNITION—Uses master oscillator—power amplifier type of DC/DC converter in which two sections of triple 3-input NAND gate serve as 10-kHz square-wave MVBR feeding class B PNP/NPN power amplifier through two-gate driver. Remaining two gates are used as logic inverters. Secondary of T1 has 15.24 meters of No. 26 in six bank windings, with 20 turns No. 14 added and center-tapped for primary. T2 is unshielded iron-core RF choke, 30–100 μH, with several turns wound over it for secondary. When main 20-A SCR fires, T2 develops oscillation burst for firing sensitive gate-latching SCR. Storage capacitor energy is then dumped into ignition coil primary through power SCR.—K. W. Robbins, CD Ignition System. *73 Magazine*, May 1974, p 17 and 19.





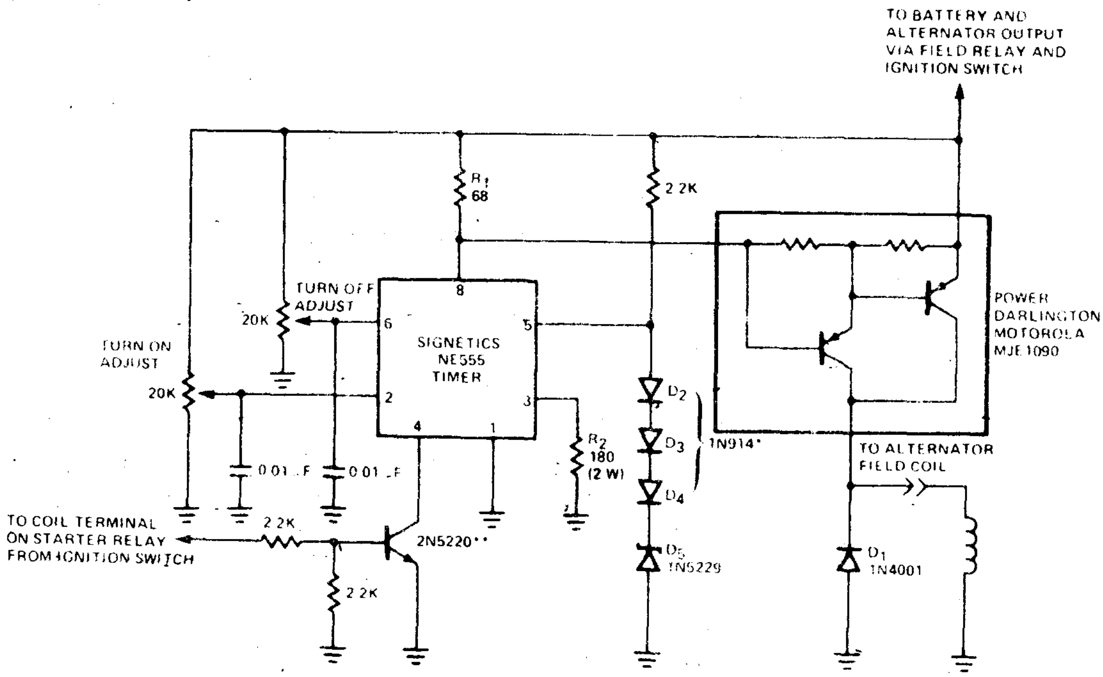
TACH/DWELL METER—Built around SN7402 NOR-gate IC. Requires no internal battery; required 5 V is obtained by using 50 ohms for R_3 in zener circuit shown if car battery is 6 V, and 300 ohms if 12 V. Article gives calibration procedure for engines having 4, 6, and 8 cylinders; select maximum rpm to be indicated, multiply by number of cylinders, then divide by 120 to get frequency in Hz.—N. Parron, Tach-Dwell Meter, *Wireless World*, Sept. 1975, p 413.



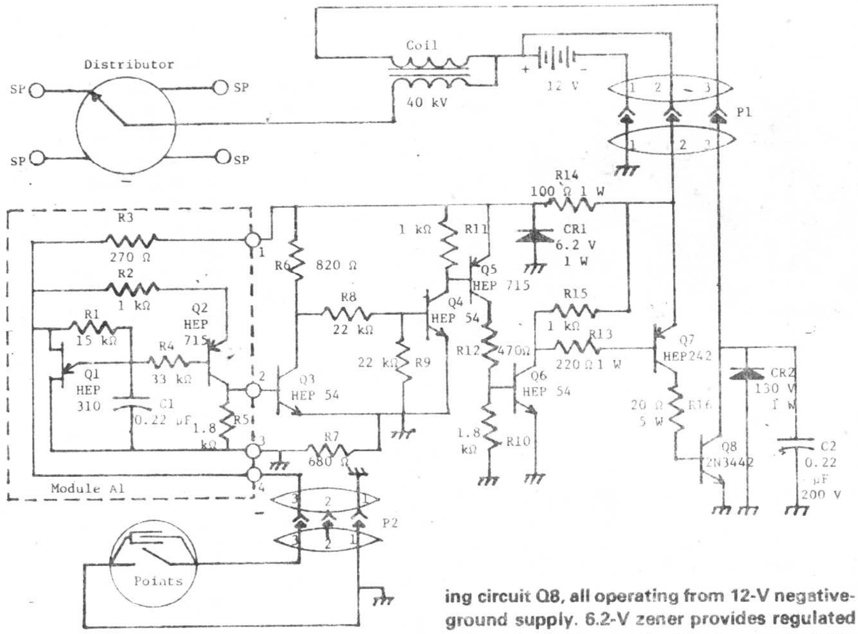


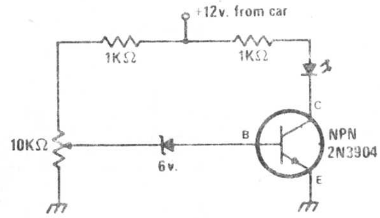
HEADLIGHT REMINDER—Photocell energizes circuit at twilight to remind motorist that lights should be turned on. Indicator can be LED connected as shown or relay turning on buzzer for more positive signal. Circuit can be made automatic by connecting relay contacts in parallel with light switch, provided delay circuit is added to prevent oncoming headlights from killing circuit. Mount photocell in location where it is unaffected by other lights inside or outside car.—J. Sandler, 9 Projects under $9, *Modern Electronics*, Sept. 1978, p 35–39.

TRANSISTORIZED BREAKER POINTS—Uses Texas Instruments BUY23/23A high-voltage transistors that can easily withstand voltages up to about 300 V existing across breaker points of distributor in modern car. Circuit serves as electronic switch that isolates points from heavy interrupt current and high-voltage backswing of ignition coil, thereby almost completely eliminating wear on points. Values are: Tr_2 2N3789; Tr_3 (for positive ground version) 2N3055; D_1-D_4 1N4001; D_5 18-V 400-mW zener; R_1 56 ohms; R_2 1.2 ohms; R_3 10 ohms; C 600 VDC same size as points capacitor. Article covers installation procedure.—G. F. Nudd, Transistor-Aided Ignition, *Wireless World*, April 1975, p 191.



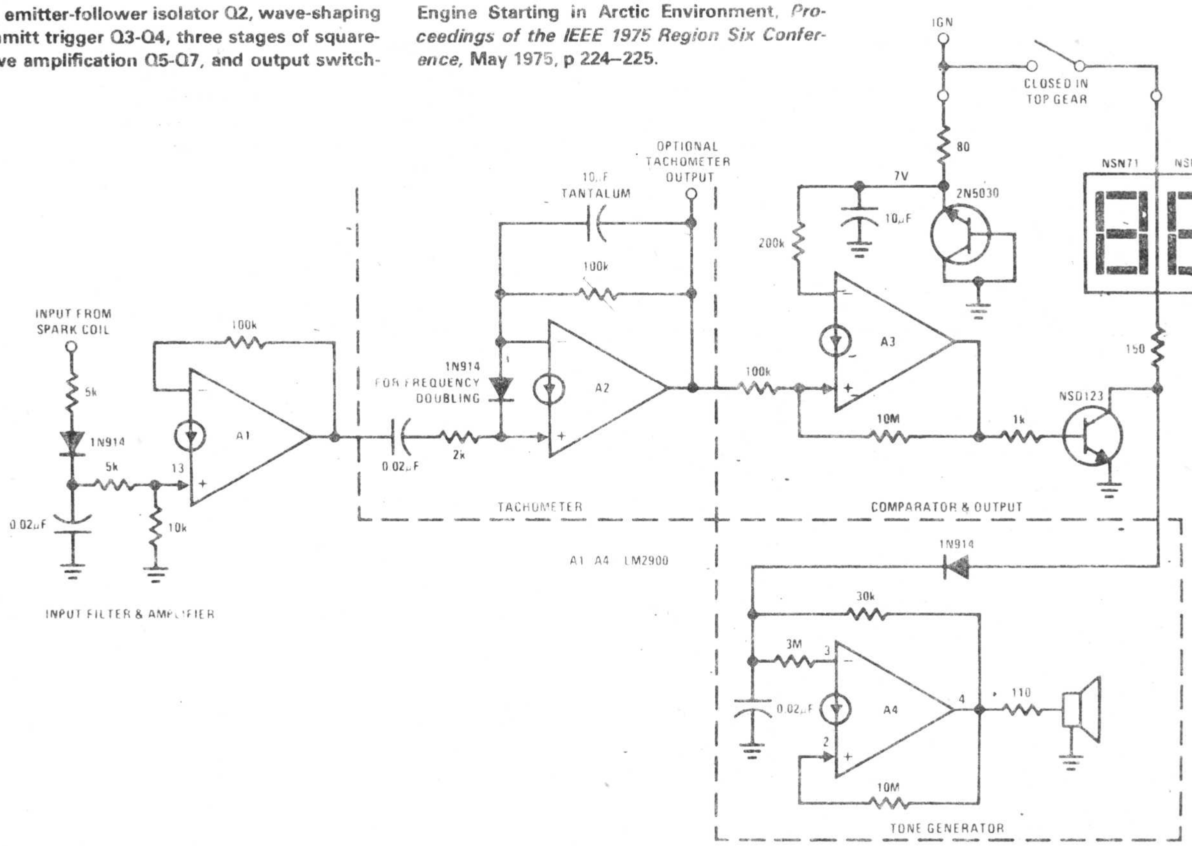
VOLTAGE REGULATOR—Timer and power Darlington form simple automobile voltage regulator. When battery voltage drops below 14.4 V, timer is turned on and Darlington pair conducts. Separate adjustments are provided for preset turn-on and turnoff voltages.—"Signetics Analog Data Manual," Signetics, Sunnyvale, CA, 1977, p 731.



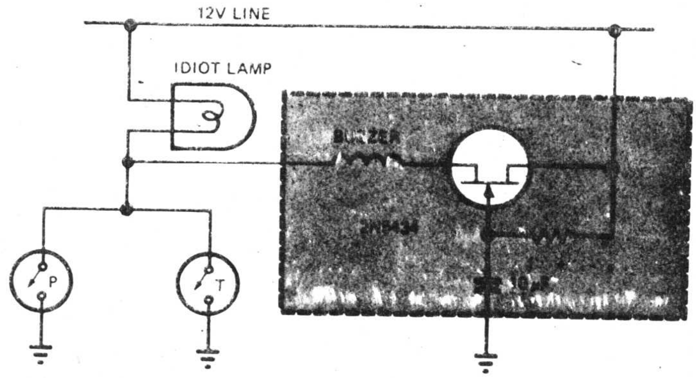


BATTERY MONITOR—Basic circuit energizes LED when battery voltage drops to level set by 10K pot. Any number of additional circuits can be added, for reading battery voltage in 1-V steps or even steps as small as 0.1 V. Circuit supplements idiot light that replaces ammeter in most modern cars. LED type is not critical.—J. Sandler, 9 Projects under $9, *Modern Electronics*, Sept. 1978, p 35–39.

COLD-WEATHER IGNITION—Multispark electronic ignition improves cold-weather starting ability of engines in arctic environment by providing more than one spark per combustion cycle. Circuit uses UJT triangle-wave generator Q1, emitter-follower isolator Q2, wave-shaping Schmitt trigger Q3-Q4, three stages of square-wave amplification Q5-Q7, and output switching circuit Q8, all operating from 12-V negative-ground supply. 6.2-V zener provides regulated voltage for UJT and Schmitt trigger. Initial 20,000- to 40,000-V ignition spark produced by opening of breaker points is followed by continuous series of sparks at rate of about 200 per second as long as points stay open.—D. E. Stinchcomb, Multi-Spark Electronic Ignition for Engine Starting in Arctic Environment, *Proceedings of the IEEE 1975 Region Six Conference*, May 1975, p 224–225.

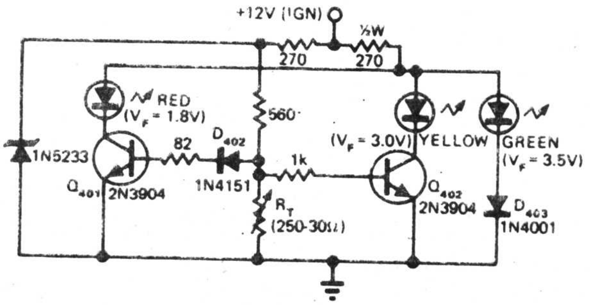


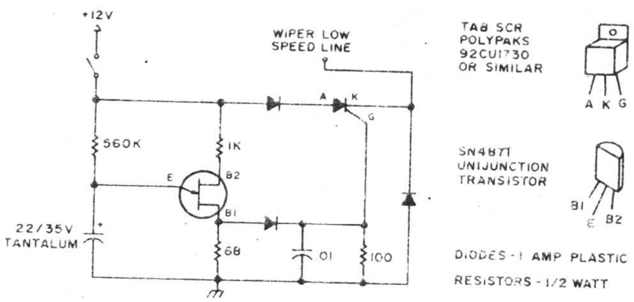
HIGH-SPEED WARNING—Audible alarm tone generator drives warning loudspeaker to supplement 2-digit speed display that can be set to trip when vehicle speed exceeds 55-mph legal limit. Engine speed signal is taken from primary of spark coil. Switch in transmission activates circuit only when car is in high gear. All functions are performed by sections of LM2900 quad Norton opamp. A1 amplifies and regulates spark-coil signal. A2 converts signal frequency to voltage proportional to engine speed. A3 compares speed voltage with reference voltage and turns on output transistor at set speed. A4 generates audible tone. Circuit components must be adjusted for number of cylinders, gear and axle ratios, tire size, etc. 10-μF capacitor connected to A3 can be increased to prevent triggering of alarm when increasing speed momentarily while passing another car.—"Linear Applications, Vol. 2," National Semiconductor, Santa Clara, CA, 1976, LB-33.



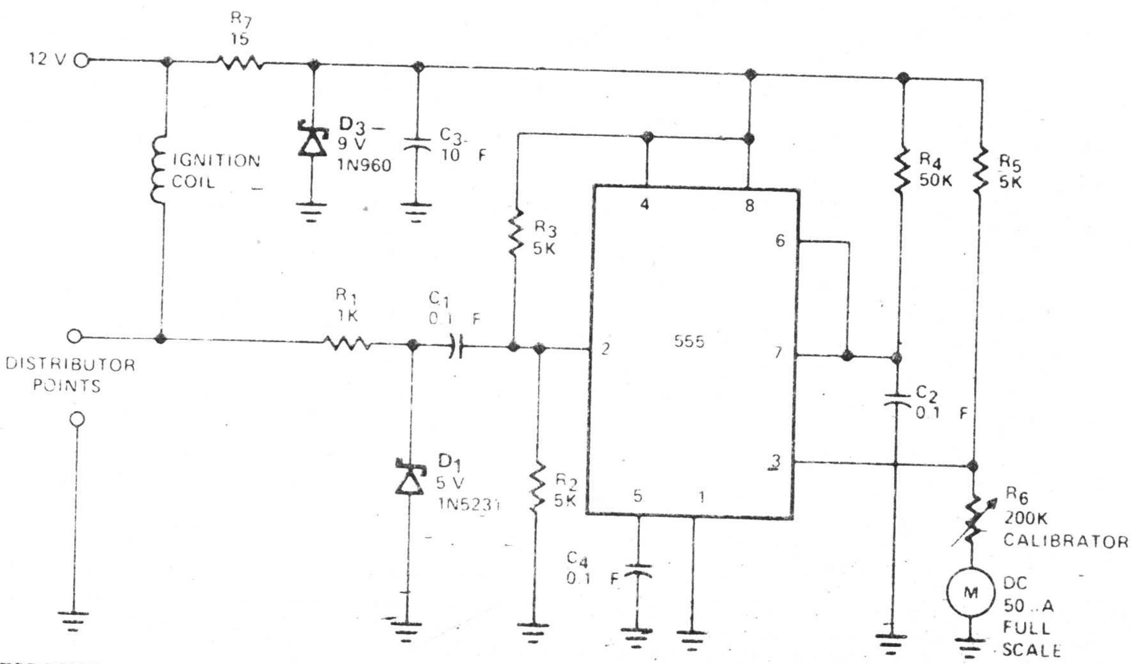
BUZZER FOR IDIOT LIGHT—Provides audible supplement to engine-monitoring indicator lamps that are often difficult to see in daylight. Uses 2N5434 JFET to provide delay of about 7 s each time ignition switch is turned on, to allow for peaceful starting of car and normal buildup of oil pressure when lamp is monitoring oil-pressure and engine-temperature sensors. Entire circuit can be mounted inside plastic housing of unused or disconnected dashboard warning buzzer in late-model car.—P. Clower, Audio Assist Gives "Idiot Lights" the "Buzz," *EDN Magazine*, June 20, 1976, p 126.

OIL-PRESSURE DISPLAY—Red, yellow, and green LEDs give positive indication of oil pressure level on electronic gage console developed for motorcycle. Transducer converts oil pressure to variable resistance R_T which in turn varies bias on transistors. LEDs have different forward voltages at which they light, so proper selection of bias resistors ensures that only one LED is on at a time to give desired indication of oil pressure.—J. D. Wiley, Instrument Console Features Digital Displays and Built-In Combo Lock, *EDN Magazine*, Aug 5, 1975, p 38–43.





WIPER CONTROL—Operates wipers automatically at intervals, as required for very light rain or mist. Changing 560K resistor to 500K pot in series with 100K fixed resistor gives variable control of interval.—Circuits, *73 Magazine*, July 1977, p 34.



DISTRIBUTOR-POINT TACHOMETER—555 timer receives its input pulses from distributor points of car. When timer output (pin 3) is high, meter receives calibrated current through R_6. When IC times out, meter current stops for remainder of duty cycle. Integration of variable duty cycle by meter movement serves to provide visible indication of engine speed.—"Signetics Analog Data Manual," Signetics, Sunnyvale, CA, 1977, p 724–725.

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